Oct. 12, 1965 W. D. MYERS ETAL 3,211,226

RETRIEVABLE HYDROSTATICALLY SET SUBSURFACE WELL TOOLS

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FIG. 1.

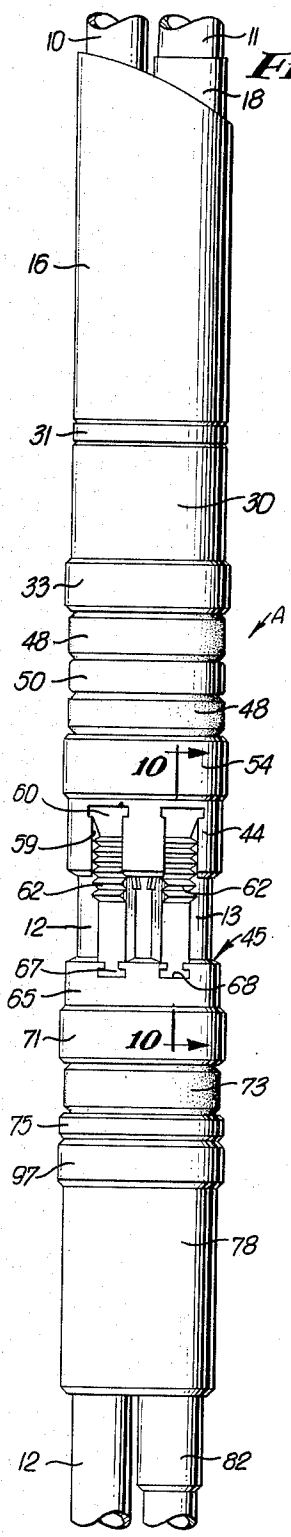
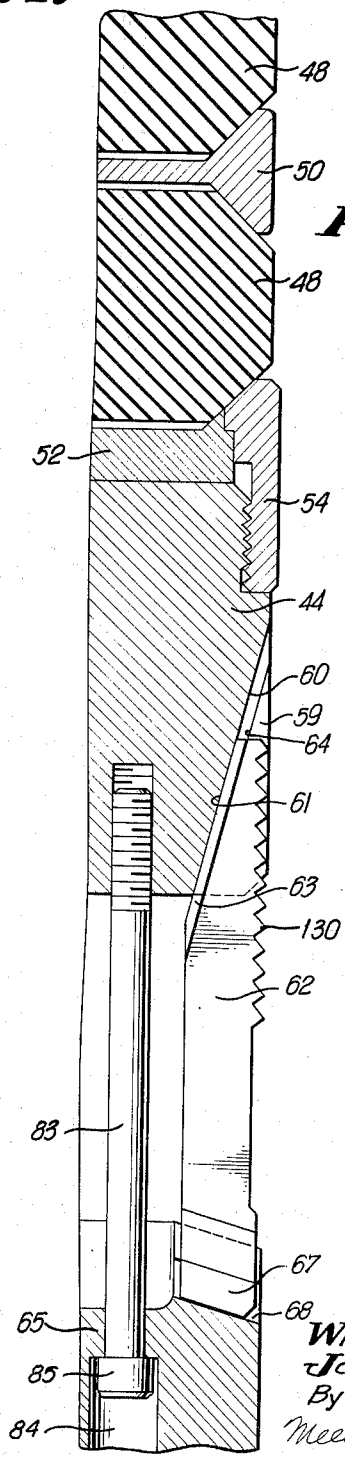


FIG. 1a.



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FIG. 2.

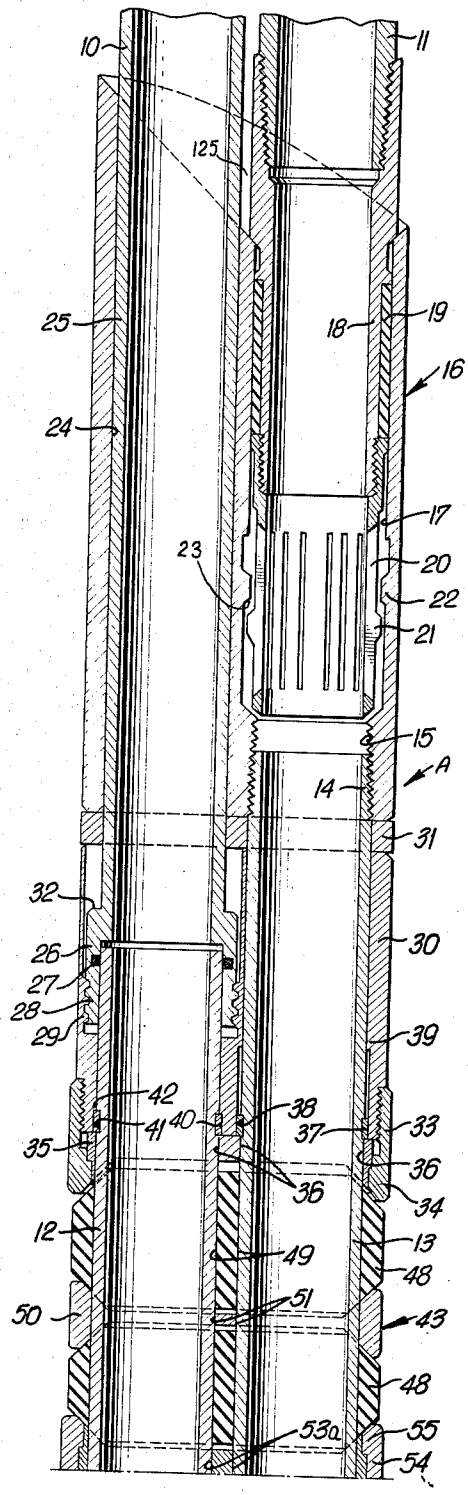
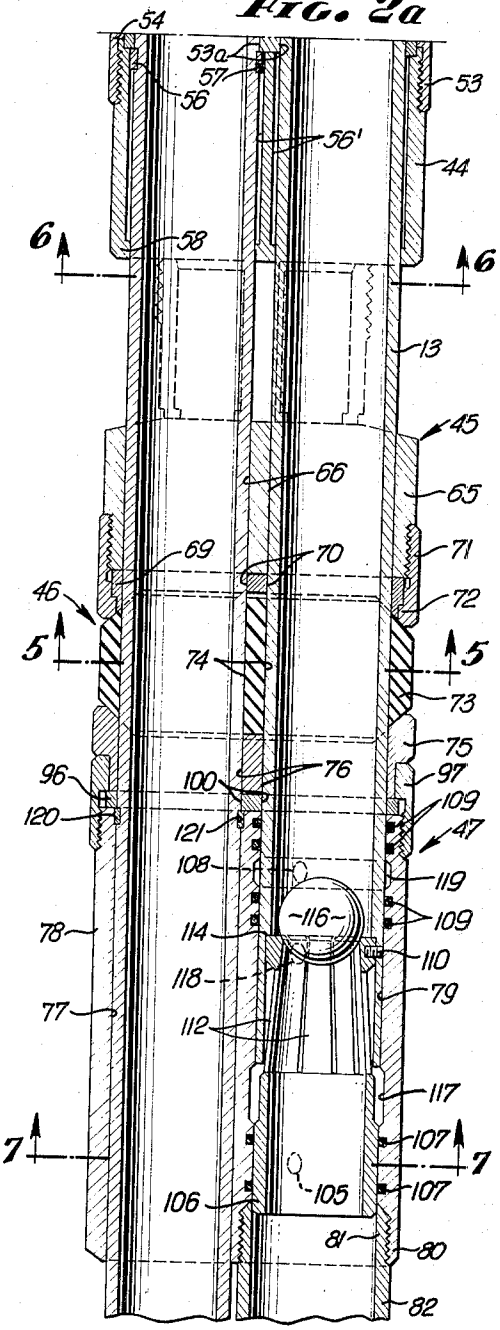


FIG. 2a



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FIG. 3.

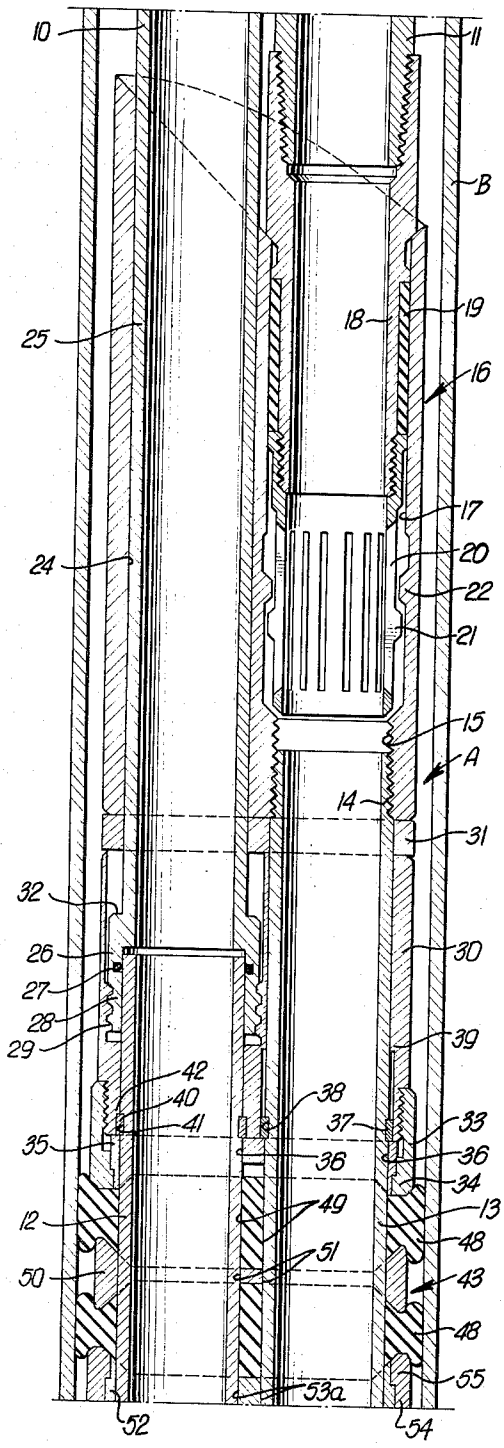
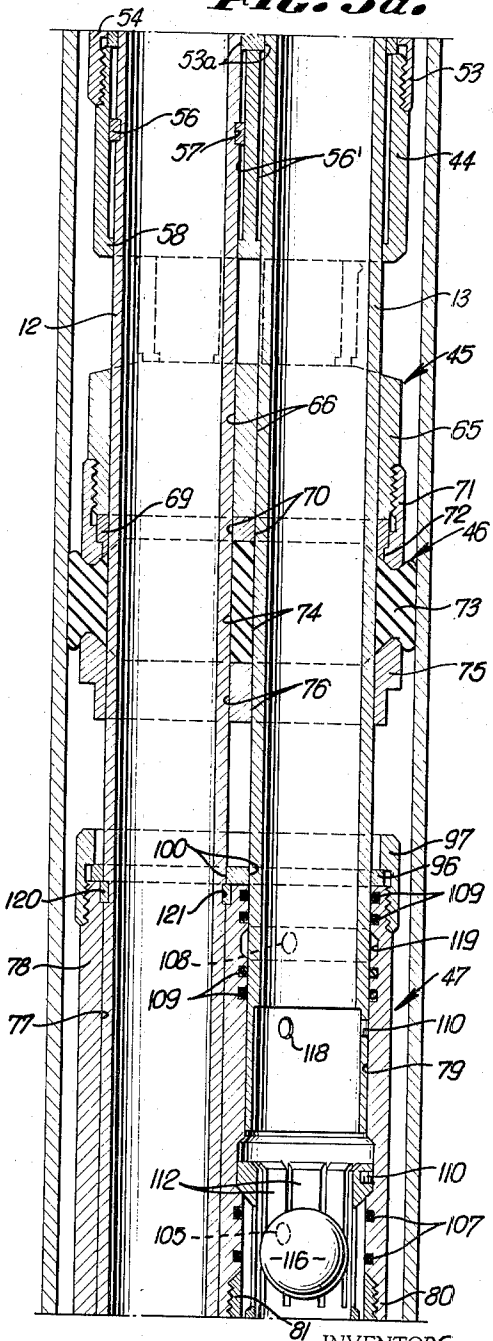


FIG. 3a.



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FIG. 4.

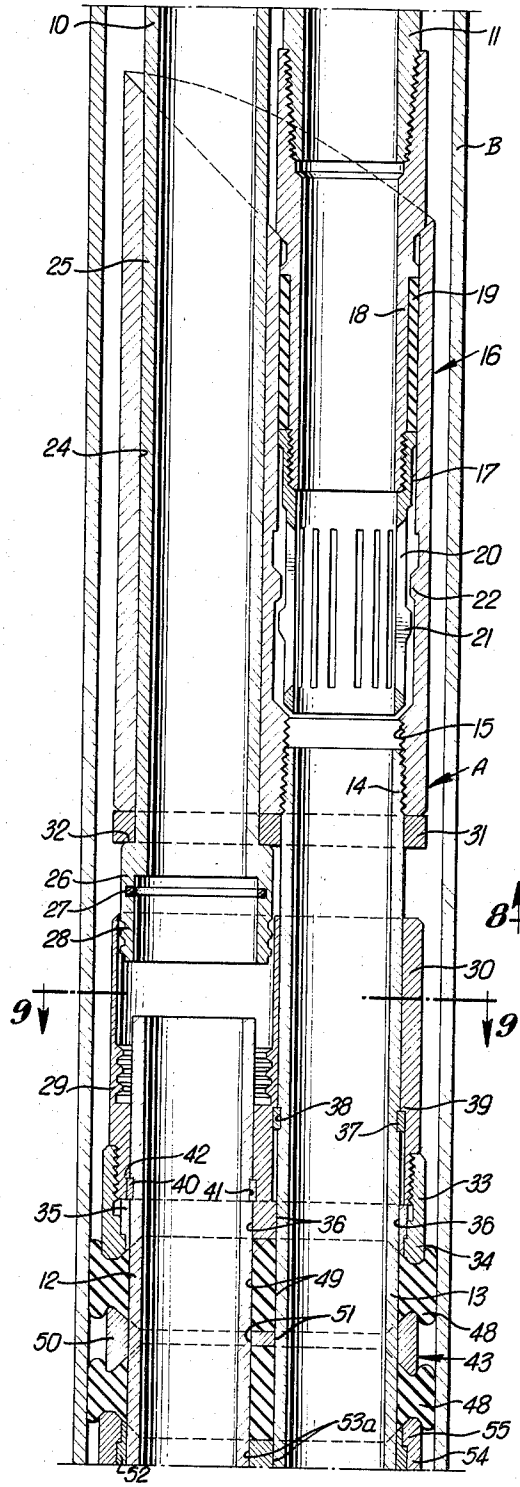
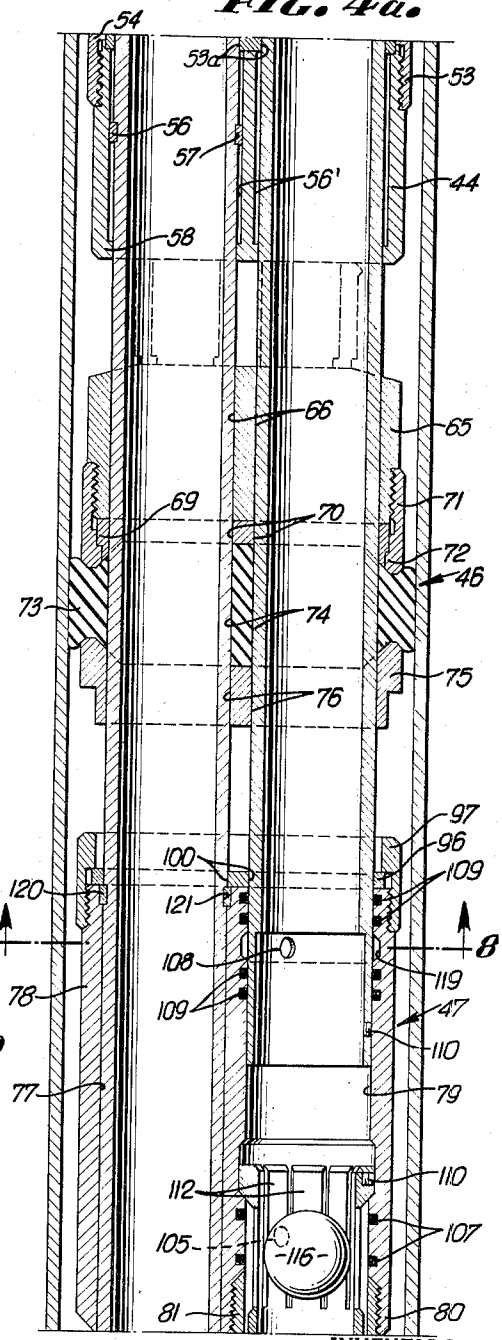


FIG. 4a.



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FIG. 5.

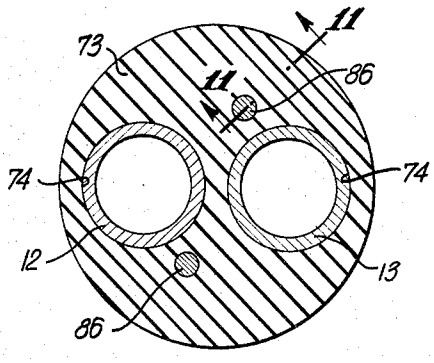


FIG. 6.

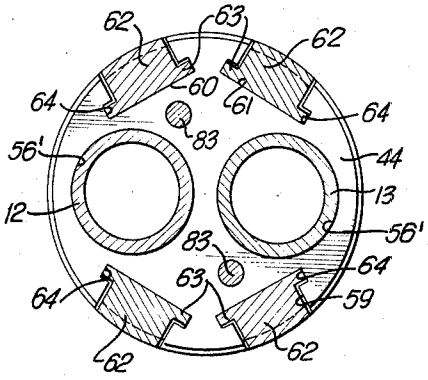


FIG. 7.

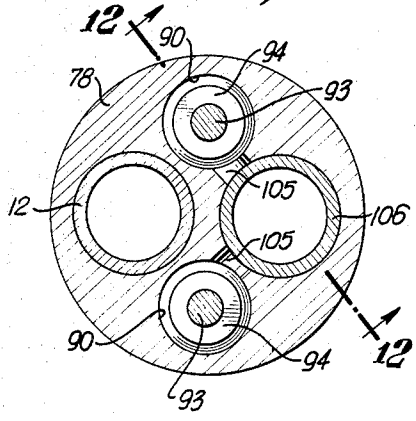


FIG. 8.

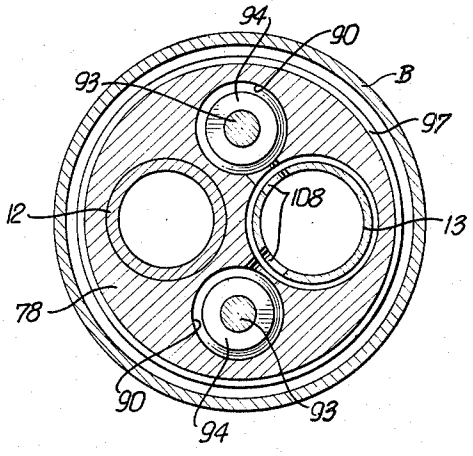
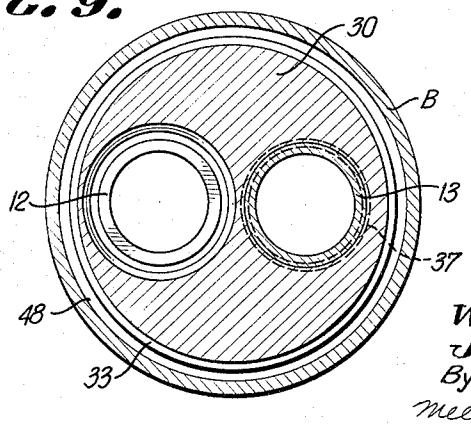


FIG. 9.



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FIG. 11.

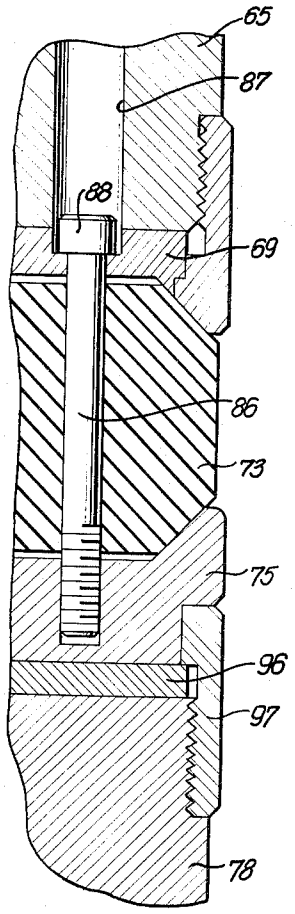
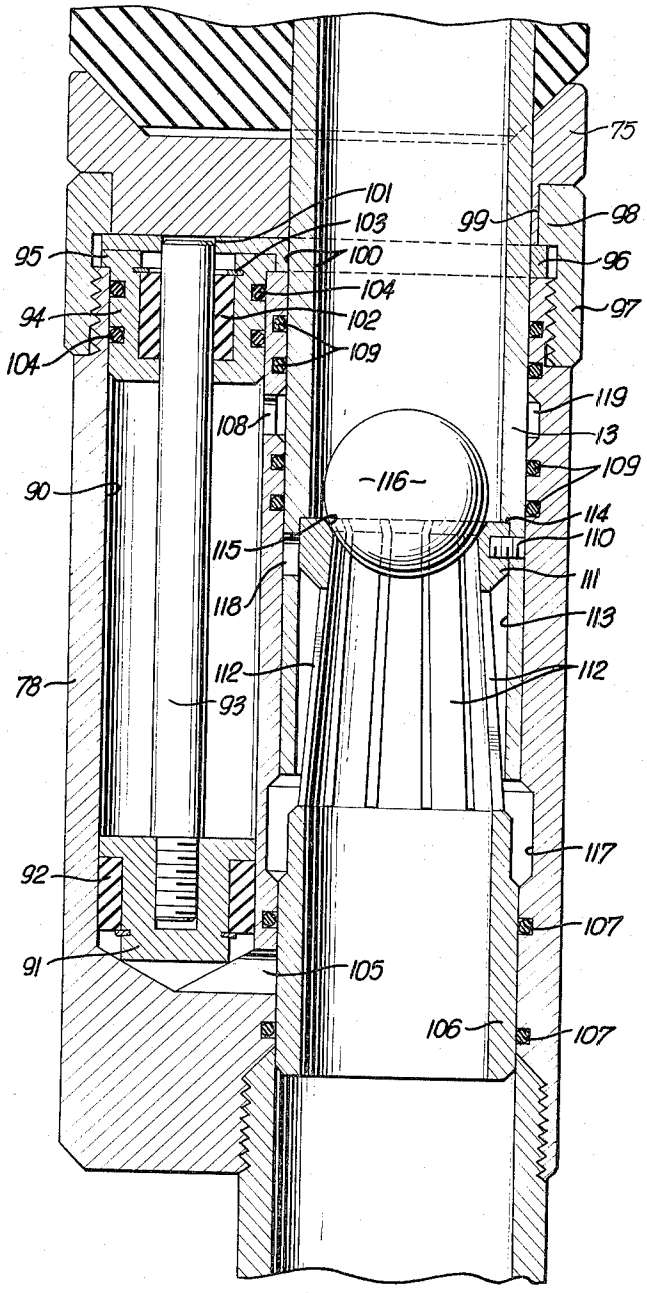


FIG. 12.



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FIG. 13.

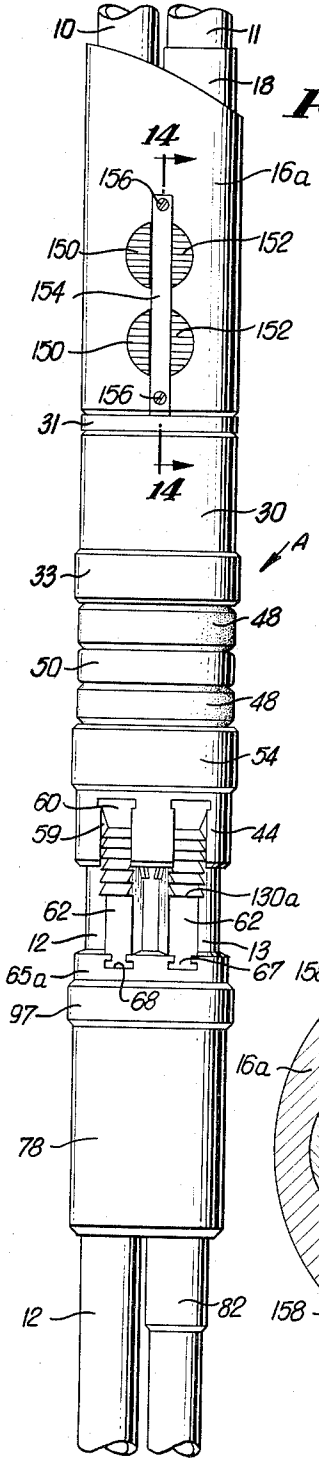


FIG. 14.

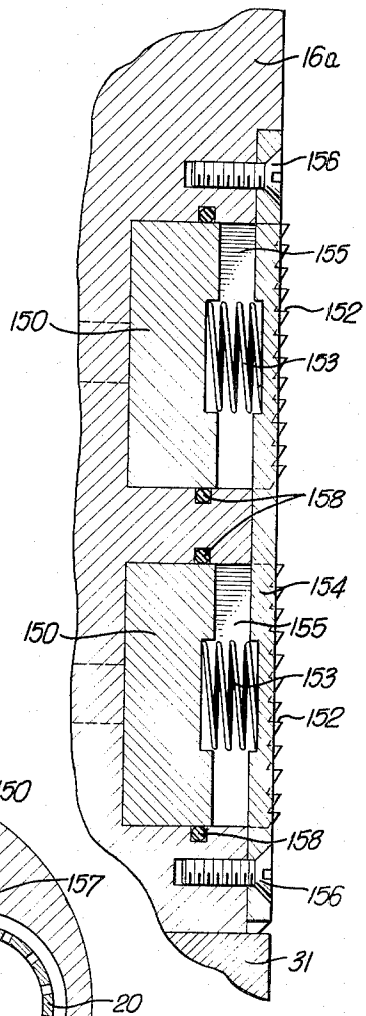
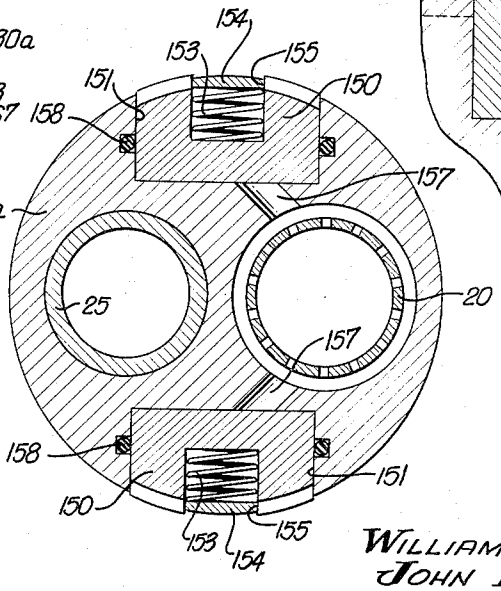


FIG. 16.



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FIG. 15.

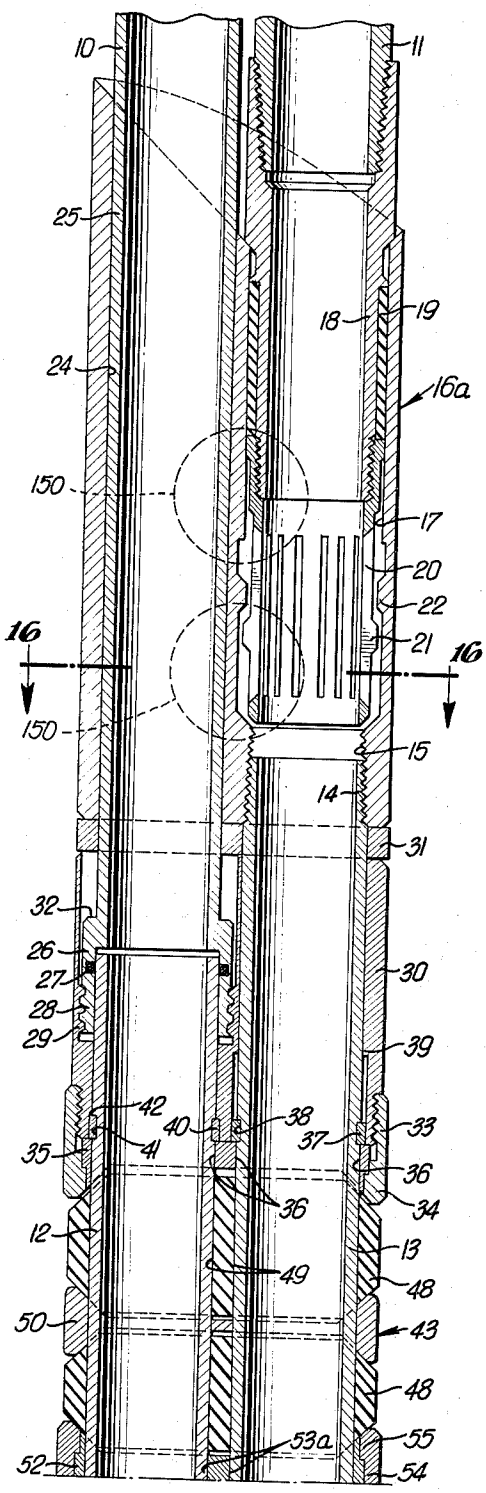
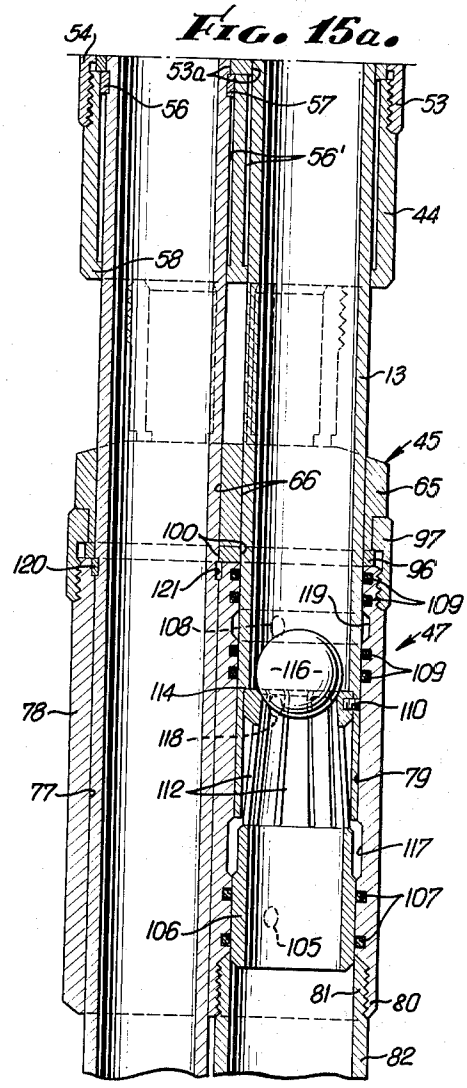


FIG. 15a.



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United States Patent Office 3,211,226 Patented Oct. 12, 1965

3,211,226

RETRIEVABLE HYDROSTATICALLY SET SUBSURFACE WELL TOOLS

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Filed Apr. 3, 1961, Ser. No. 100,329
22 Claims. (Cl. 166—120)

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

An object of the invention is to provide a well packer adapted to be set hydraulically in a well bore, and in which the hydraulic setting force remains constant throughout the life of the packer, despite some extrusion or other loss, of packing material that might tend to lessen the hydraulic setting force.

Another object of the invention is to provide a well packer adapted to be set in a well bore by the hydrostatic head of fluid therewithin, and maintained in set condition by such hydrostatic head of fluid.

A further object of the invention is to provide a well tool, such as a well packer, adapted to be set hydrostatically in a well bore which can be readily released and retrieved from the well bore.

An additional object of the invention is to provide a well tool, such as a well packer, adapted to be hydrostatically set in a well bore against movement in both longitudinal directions, and which is readily releasable and retrievable from the well bore.

Yet another object of the invention is to provide a well packer for multiple zone production having a plurality of distinct parallel passages for association with parallel tubular strings, and through which production from the zones can be separately conducted, the packer being set hydraulically in the well bore without moving any tubular string, thereby enabling all surface connections to be made at the well head to control the well pressures during the removal of the drilling mud, or other weighting material, from the well bore, and before the packer is set, subsequent setting of the packer and completion of the well occurring without disturbing the surface connections.

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 it 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:

FIGURE 1 is a side elevational view of a well packer embodying the invention;

FIGS. 2 and 2*a* together comprise a longitudinal section, on an enlarged scale, through the well packer illustrated in FIG. 1, prior to setting of the well packer, FIG. 2*a* constituting a lower continuation of FIG. 2;

FIGS. 3 and 3*a* together constitute a longitudinal section similar to FIGS. 2 and 2*a*, respectively, illustrating the well packer anchored in packed-off condition in a well casing, FIG. 3*a* constituting a lower continuation of FIG. 3;

FIGS. 4 and 4*a* together constitute a longitudinal section corresponding to FIGS. 3 and 3*a*, with the well packer conditioned for release from the well casing, FIG. 4*a* constituting a lower continuation of FIG. 4;

FIG. 5 is a cross-section taken along the line **5—5** on FIG. 2*a*;

FIG. 6 is a cross-section taken along the line **6—6** on FIG. 2*a*;

FIG. 7 is a cross-section taken along the line **7—7** on FIG. 2*a*;

FIG. 8 is a cross-section taken along the line **8—8** on FIG. 4*a*;

FIG. 9 is a cross-section taken along the line **9—9** on FIG. 4;

FIG. 10 is a fragmentary longitudinal section, on an enlarged scale, taken along the line **10—10** on FIG. 1;

FIG. 11 is a fragmentary enlarged longitudinal section taken along the line **11—11** on FIG. 5;

FIG. 12 is an enlarged longitudinal section taken along the line **12—12** on FIG. 7;

FIG. 13 is a side elevational view of another embodiment of well packer, with its parts in retracted position;

FIG. 14 is an enlarged fragmentary longitudinal section taken along the line **14—14** on FIG. 13;

FIGS. 15 and 15*a* together constitute a longitudinal section, on an enlarged scale, of the well packer illustrated in FIG. 13, FIG. 15*a* constituting a lower continuation of FIG. 15;

FIG. 16 is an enlarged cross-section taken along the line **16—16** on FIG. 15.

The well packers illustrated in the drawings are particularly provided for use in conducting well production from a plurality of separate zones in a well bore through separate paths and tubular strings **10**, **11** to the top of the well bore. In its broader aspect, however, it is to be understood that the invention is applicable to a well packer having a single passage and adapted to conduct production through a single tubular string associated therewith to the top of the well bore. Certain aspects of the invention are also applicable to subsurface well tools generally, and are not confined to well packers.

In the form of invention illustrated in FIGS. 1 to 12, inclusive, a well packer A is provided of the retrievable type, which is adapted to be anchored in packed-off condition in a well casing B against movement in both longitudinal directions. The well packer includes first and second parallel tubular body members **12**, **13**, the second tubular body **13** having an upper threaded pin **14** threaded in a lower bore **15** in a receptacle or parallel string head **16**. The passage through the second tubular string **11** communicates with a second passage **17** extending upwardly through the parallel string head **16**. The second tubular string **11** is adapted to be lowered from the top of the well bore into the casing B for reception within the second passage **17**. As illustrated, the lower portion of the second tubular string includes a sub **18** having a suitable side seal **19** mounted thereon for sealing against the wall of the second passage **17**. Depending from the sub is a latch device including a plurality of spring-like arms **20** having central cam projections or fingers **21** adapted to be received under a flange or shoulder **22** in the parallel string head below the sealing region of the second passage. These fingers **21** are engageable with the head shoulder **22** when the second tubular string **11** is being inserted in the passage **17**, such engagement springing the fingers **21** and arms **20** inwardly sufficiently so that the fingers ride past the shoulder to a position therebelow, to retain the second tubular string **11** releasably latched in the second passage **17** with its seal **19** engaging the wall of the second passage. The exertion of a sufficient upward pull on the second tubular string **11** will cause the fingers **21** to engage the lower tapered surface **23** of the head shoulder, which will cam or force the fingers **21** and the latch arms **20** inwardly until the fingers ride past the flange **22**, whereupon the

second tubular string 11 can be withdrawn completely from the second passage 17.

The parallel string head also has a first longitudinal passage 24 extending therethrough from its upper end. Slidably mounted in the first passage is the lower portion or mandrel 25 of the first tubular string 10 extending to the top of the well bore. This first tubular string has a lower threaded head 26 piloted over the upper end of the first tubular body 12, leakage between these parts being prevented by a suitable seal ring 27 mounted in the head and engaging the periphery of the body 12. The head 26 has an external left-hand thread 28 threaded into a companion left-hand thread 29 in an upper connector and abutment member 30 into which both the first and second tubular bodies 12, 13 extend. The upper end of this abutment member engages a spacer member 31 through which both the second tubular body 13 and the mandrel portion or upper extension 25 of the first tubular body project. Prior to release of the tool, after it has been set in the well casing, an upwardly facing shoulder 32 on the threaded head 26 is spaced a substantial distance below the spacer member 31 to allow left-hand rotation of the first tubular string 10, as described hereinbelow, to effect an unthreading of the head 26 from the upper connector member 30 and elevation of the threaded head into engagement with the spacer member 31.

Threaded on to the lower end of the connector 30 is an upper gauge ring 33 having an inwardly directed flange 34 that clamps an upper insert 35 against the lower end of the upper connector 30, this insert having two holes 36 therethrough for reception of the first and second tubular bodies 12, 13. The second tubular body member 13 has a split ring 37 mounted in its peripheral groove 38, the lower end of this ring bearing against the insert 35, and the upper end of the ring being spaced from a downwardly facing shoulder 39 on the upper connector 30, to permit upward movement of the second tubular body 13 relative to the connector, as described hereinbelow. The first tubular body 12 also has a split ring 40 mounted in its peripheral groove 41 and engaging the insert 35, the upper end of the ring engaging a shoulder 42 in the connector, so that the first tubular body member 12 and the connector 30 are secured together, relative movement therebetween being prevented.

The first and second tubular body members 12, 13 extend downwardly through an initially and normally retracted packing structure 43, an expander 44, a slip structure 45 for anchoring the well packer A against longitudinal movement in the well casing B, an elastic holding structure 46 for preventing upward movement of the packer in the well casing, and a hydraulic actuating mechanism 47. The packing structure 43 specifically illustrated includes a plurality of pliant, elastic packing elements 48 made of rubber, or rubber-like material, having a pair of bores 49 therethrough to accommodate the first and second body members 12, 13, and also an intervening spacer 50 having a pair of bores 51 through which the body members 12, 13 extend. The upper packing element 48 is engageable by the upper gauge ring 33 and insert 35, its lower end engaging the spacer 50 which, in turn, engages the lower pliant, elastic packing element 48, which contacts a lower insert 52 having bores 53*a* receiving the body members 12, 13. It also contacts a lower gauge ring 54 threaded on a lower connector and expander 44, the lower gauge ring having an inwardly directed flange 55 clamping the insert 52 against the expander. The expander 44 is also provided with a pair of bores or passages 56′ through which the the first and second members 12, 13 extend. The expander 44, lower insert 52, and lower gauge ring 53 are movable as a unit relatively to the first and second tubular body members 12, 13. Downward movement of these parts relative to the first tubular body member 12 is prevented by a split stop ring 56 mounted in a groove 57 in the first body member 12 and engaging the lower end of the lower insert 52. The bore 56′ through the expander, however, is of an enlarged diameter along an extended length so as to permit relative upward movement of the expander 44 along the body members 12, 13 to the extent limited by engagement of the lower flange 58 on the expander with the stop ring 56.

The lower expander 44 has a plurality of spaced slots 59 in which are located expander surfaces 60 tapering in a downward and inward direction (see particularly FIGS. 1, 6 and 10) adapted to coact with companion tapered surfaces 61 on the inner portions of slips 62 which are movable longitudinally relative to the expander 44 and laterally outwardly and inwardly into and from engagement with the wall of the well casing B. Each slip 62 has opposed side tongues 63 slidable in companion grooves 64 in the expander so that the slips are moved positively from an expanded to a retracted position upon relative longitudinal separation between the expander 44 and slips 62. The lower ends of the slips are connected to a slip ring 65 having a pair of bores 66 through which the body members 12, 13 extend, there being a slidable connection between T-shaped heads 67 of the slips and companion T-shaped grooves 68 formed in the slip ring 65, so that the slips 62 are moved jointly longitudinally with the slip ring 65, the slips being permitted to move radially of the slip ring toward the well casing B and from the well casing. To facilitate such radial movement, the T-shaped heads 67 and the companion grooves 68 in the slip ring are inclined to a small extent in an outward and downward direction, as disclosed most clearly in FIG. 10.

A lower thrust plate or insert 69 having a pair of bores 70 through which the body members 12, 13 extend is clamped against the lower end of the slip ring 65 by a clamp ring 71 having an inwardly directed flange 72 engaging the plate. A pliant, elastic member 73, such as a rubber or rubber-like packing, that is initially and normally retracted, has parallel passages 74 through which the body members extend, this packing member engaging the thrust plate 69 and the upper clamp or abutment 71, its lower end engaging a lower abutment 75 having passages 76 through which the body members 12, 13 extend in slidable relation.

The first body member 12 extends downwardly through one passage 77 in a hydraulic housing 78, whereas the other body member 13 extends into another passage 79 in the hydraulic housing. This latter passage has a lower threaded bore 80 adapted to receive the upper pin end 81 of tubing 82 depending therebelow. Such tubing may receive production from an upper zone in a well bore, to conduct it through the second body member 13 and the second tubular string 11 to the top of the hole. The first tubular body member 12 projects below the hydraulic housing 78 and may have tubing (not shown) suitably connected thereto for leak-proof association with a lower packer (not shown), which is set above a lower producing zone, for the purpose of conducting the fluid from the lower zone through the first body member 12 and the first tubular string 10 to the top of the well bore.

In setting the well packer A in the well casing B, or similar conduit string disposed in the well bore, the expander 44 and slip ring 65 are moved toward each other. Movement of the expander and slip ring away from each other is limited by a plurality of longitudinally extended limit or connector screws or pins 83 (FIG. 10) threadedly secured to the expander 44 and extending into bores 84 in the slip ring 65. The extent of movement of the expander and slip away from one another is limited by engagement of the slip ring 65 with the heads 85 at the lower ends of the screws 83. In a similar fashion, the pliant, elastic packing member 73, that tends to hold the slips 62 outwardly against the well casing B, is expanded outwardly by relative movement of the slip ring 65 and upper abutment 69 toward the lower abutment 75. Movement of

these members away from each other is limited by a plurality of connecting or limit screws or pins **86** (FIG. 11), the lower ends of which are threaded into the lower abutment **75**, the screws extending through the elastic element **73** and the thrust plate **69**, being slidable in an upward direction through the latter and within bores **87** in the slip ring **65**. Movement of the lower abutment **75**, on the one hand, and the slip ring **65** and thrust plate **69**, on the other hand, in directions away from each other is limited by engagement of upper heads **88** on the screws with the thrust plate **69**.

Relative longitudinal movement between the several parts for the purpose of effecting their expansion into engagement with the wall of the well casing is obtained hydraulically, and more particularly by the hydrostatic head of fluid in the well bore. The hydraulic force is transmitted in a downward direction to the upper connector **30** above the packing structure **43**, and in an upward direction onto the lower abutment **75**. As disclosed, the hydraulic housing **78** has a plurality of longitudinally extending cylinders **90** therein (FIGS. 7, 8, 12), each cylinder containing a piston **91** having a suitable packing or seal ring **92** thereon slidably sealing against the wall of the cylinder. Secured to each piston is a piston rod **93** extending upwardly therefrom and through an upper cylinder head **94**, which has an external flange **95** held against the upper end of the housing **78** by a retainer plate **96** secured against the housing and the upper ends of the cylinder heads **94** by a clamp ring **97** threaded on the upper end of the housing, and having an inwardly directed flange **98** encompassing the lower portion **99** of the lower abutment **75** and bearing against the retainer plate **96**. This plate has a plurality of bores **100** through which the first and second tubular members **12, 13** extend, and also a plurality of openings **101** through which the piston rods **93** are slidable, the upper ends of the piston rods being engageable with the lower surface of the lower abutment **75**. To prevent leakage of fluid between each piston rod **93** and cylinder head **94**, a suitable rod packing **102** is held in the cylinder head by a split snap ring **103**, this seal slidably and sealingly engaging the periphery of the piston rod. The cylinder head **94** is sealed against the wall of the cylinder **90** by one or a plurality of seal rings **104** in the head engaging the wall.

A lower inlet port **105** is provided from the housing passage **79** into the lower end of each cylinder **90** below the piston **91** contained therein, which is normally closed by a sleeve valve **106** disposed in the passage **79** thereacross to prevent fluid entry into each cylinder. Leakage of fluid between the sleeve valve **106** and the housing **78** is prevented by seal rings **107** in the housing disposed on opposite sides of the ports **105** and sealingly engaging the periphery of the sleeve **106**, so that fluid pressure in the second tubular body member **13**, or from any other source, is initially prevented from passing into the inlet ports **105** and the cylinders **90**. Similarly, upper inlet ports **108** are provided in the housing **78** from the passage **79**, a port opening into each cylinder **90** on the low pressure side of the piston **91** and immediately below its cylinder head **94**. These ports are also communicable with the second tubular body member **13**, but are initially closed by such body member extending across them, leakage of fluid being prevented by one or more side seal rings **109** on opposite sides of the ports **108** and mounted in the housing, which sealingly engage against the periphery of the second tubular body member **13**. Initially, each cylinder **90** on the low pressure side or above the piston **91** merely contains air at atmospheric pressure, and fluid is prevented from entering such cylinder space by disposition of the second tubular body member **13** across the upper inlet port **108**.

The sleeve valve **106** is also initially disposed across the lower inlet ports **105**, the sleeve being held in such port closing position by a releasable device in the form of a shear screw **110** threadedly secured to the second tubular body member **13** and engaging an upper finger **111** of a latch portion of the sleeve valve. Such latch portion includes upwardly extending, spring-like latch arms **112** integral with the lower portion of the sleeve valve **106** and with the fingers **111**, which are slidably disposed in a counterbore **113** in the lower portion of the second tubular body member **13**, initially engaging a shoulder **114** at the upper end of the counterbore. The latch arms **112** and fingers **111** inherently tend to spring outwardly, but are confined in an inward position, to project within the passage through the second tubular body member **13**, by the wall of the counterbore **113**. When projecting inwardly, the inner upper corners of the fingers collectively provide a valve seat **115** adapted to be engaged by a suitable tripping or valve element **116**, such as a ball member, adapted to be dropped down the second tubular string **11** from the top of the hole. When the ball valve member engages its companion seat **115**, sufficient pressure can be applied to the fluid in the second tubular body member **13** for downward action upon the ball **116** and the sleeve valve **106** to shear the screw **110** and shift the sleeve valve to a lower position, in which its imperforate portion is disposed below the seal rings **107**, as determined by the outward springing of the fingers **111** into a recess **117** in the housing **78** below the lower end of the second tubular body member **13**, in which position the lower inlet ports **105** leading to the lower ends of the cylinders **90** are open. The outward springing of the fingers **111** increases the minimum diameter through the latch portion of the sleeve valve **106** to an extent at which the ball **116** drops completely through the sleeve valve **106** and from the packer apparatus.

Fluid pressure can now act upwardly on the pistons **91** to effect a setting of the apparatus in the manner described hereinbelow. At this time, it is to be noted that the upper inlet ports **108** are still closed by the second tubular body member **13**, which has a port **118** extending through its wall below the seal rings **109**. When such port **118** is brought into substantial alignment with a recess **119** in the housing communicating with the upper inlet ports **108**, the fluid pressure can also enter the low pressure side of each cylinder **90** above the piston **91**, as described hereinbelow.

The first tubular body member **12** is secured to the hydraulic housing **78** by a split ring **120** in a peripheral groove **121** in the member **12** clamped by the retainer plate **96** against the housing **78**.

Initially, the well packer apparatus has its parts in the relative position shown in FIGS. 1, 2, 2*a*, 10 and 11, in which the slips **62** are retracted, as well as the upper packing structure **43** and the lower elastic packing element **73**. The second tubular string **11** is not disposed in the parallel string head or receptacle **16**, but the first tubular string **10** is disposed therethrough and is threadedly connected, by means of its threaded head **26**, to the upper connector and abutment member **30**. The well packer A is lowered in the well casing B on the first tubular string **10** until a tubular extension (not shown) of the first tubular string body **12** appropriately seats within a lower packer (not shown) disposed between lower and upper producing zones. The length of the tubular extension is such that the packer A illustrated in the drawings will then be located in the well casing B at a desired point above the upper producing zone. When the setting location is reached, the second tubular string **11** is then run in the well casing along side of the first tubular string **10**, its lower end engaging an upper tapered guide surface **125** on the parallel string head **16** which will guide it into the second passage **17**, its latch fingers **21** snapping past the shoulder **22** to releasably retain the second tubular string attached to the head, and with its seal **19** sealingly engaging the wall of the second passage **17** in the head.

The surface connections (not shown) are then made at the top of the well bore and appropriately secured to the first and second tubular strings **10, 11**, which need not thereafter be moved. Drilling mud, or other weighting

fluid, in the well casing can now be displaced, as by pumping an appropriate circulating fluid down the second tubular string **11**, through the second tubular body **13** and through the sleeve valve **106** for discharge from the lower tubing **82** depending from the hydraulic housing **78** into the well casing B, the fluid then flowing upwardly through the casing B around the well packer A and the first and second tubular strings **10**, **11** to the top of the well bore, the circulating fluid carrying the weighting material ahead of it out of the well casing.

After the drilling mud or other weighting material has been removed from the well casing, the packer A is set hydraulically. The trip or valve ball **116** is dropped into the second tubular string **11** and will gravitate therethrough until it comes in contact with its seat **115** at the top of the latch portion of the sleeve valve **106**. Pressure of the proper amount is then imposed on the fluid in the second tubular string **11** (for example, of the order of 500 to 1,000 p.s.i.) which will act downwardly on the ball **116** and the sleeve valve **106** sufficient to shear the screw **110** securing the sleeve valve **106** to the second tubular body **13**, moving the sleeve valve downwardly to a position opening the lower inlet ports **105**, the fingers **111** of the sleeve valve snapping into the recess **117** and then permitting the valve ball **116** to pass downwardly through the sleeve valve to a position below the apparatus, where it merely drops into the casing and will not interfere with the flow of fluid into the casing and through the apparatus.

With the lower ports **105** open (FIGS. 3 and 3*a*), the hydrostatic head of fluid in the second tubular string **11** and in the well casing B can then pass through the inlet ports **105** and force the pistons **91** and piston rods **93** upwardly in the cylinders **90** and the hydraulic housing **78**, since the cylinder spaces above the pistons **91** merely contain air at atmospheric pressure. At the same time, the hydrostatic head of fluid is acting downwardly on the lower portions or heads of the cylinders **90**, urging the housing **78** in a downward direction, this downward force being transferred from the retainer plate **96**, which is clamped to the housing, to the split stop ring **120** secured to the first body member **12**. The piston rods **93** move upwardly, sliding through the retainer plate **96**, and engaging the lower abutment or thrust member **75**, urging the latter upwardly from the clamp ring **97** and against the lower elastic member **73**, forcing this lower elastic member, as well as the slip **65**, upwardly along the first and second tubular body members **12**, **13**. The slips **62** slide upwardly along the expander **44** and outwardly into engagement with the wall of the well casing. They may continue to slide along the casing B, carrying the expander **44** upwardly with it, to move the expander, the lower insert **52** and the lower gauge ring **53** toward the upper gauge ring **33**, insert **35** and upper connector **30**, which is prevented from moving upwardly by being attached to the first body member **12** through the agency of the split snap ring **40**.

The movement of the expander **44** towards the upper connector **30** shortens the packing elements **48** and expands them outwardly into sealing engagement with the wall of the well casing B. After the packing elements have expanded against the wall of the well casing and the slips **62** are engaging the well casing, the slips and the slip ring **65** cannot move upwardly to any additional significant extent, whereupon the lower abutment **75** will move toward the slip ring **65** to shorten the lower packing element **73** and expand it outwardly against the wall of the well casing. As pointed out above, the hydrostatic head of fluid is also acting downwardly on the cylinders **90** and the hydraulic housing **78**, urging the housing in a downward direction, such downward movement being transmitted through the first tubular body member **12** to the upper connector **30**, so that, in effect, the lower abutment **75** is urged upwardly and the upper connector **30** is moved downwardly to further shorten the upper packing structure **43**, as well as the lower packing structure **73**, and to urge the expander **44** more firmly down within the slips **62** to embed the wickers **130** on the latter in the wall of the well casing. Such wickers **130** are shaped to hold the well packer A against longitudinal movement in the well casing in both upward and downward directions, and are maintained and constantly urged upwardly of the expander **44**, to be further wedged out against the well casing, by the tendency of the lower packing element **73** to expand, which will exert a constant upward force on the slips. Any tendency for the well packer apparatus to move downwardly is prevented by the downward wedging of the expander **44** within the slips **62**, whereas any tendency for the apparatus to be released and moved upwardly in the well casing, as by fluid pressure in the well casing below the packer apparatus, is prevented by the fact that such pressure acts on the lower packing **73**, which is constantly tending to elongate or expand and urge the slips upwardly of the expander.

The packer A is thus set in packed-off condition against movement in the well casing in both longitudinal directions and will remain in such set condition until purposely released. The hydrostatic head of fluid in the second tubing string **11** is constantly acting on the pistons **91**, urging them in an upward direction and the cylinders **90** and housing **78** in a downward direction, to maintain the setting force on the packing elements **48**, **73**, expander **44** and slips **62**. The setting force is not diminished and will be maintained despite the fact that there might be some elastic material extruding around the several abutments and gauge rings and between such parts and the wall of the well casing, such as illustrated in FIGS. 3 and 3*a*. The extrusion causes the pistons **91** and rods **93** to move upwardly in the cylinders **90** to an additional extent. However, the hydrostatic head of fluid is still present to continue to exert substantially the same force on the parts, to hold them anchored in packed-off condition against the wall of the well casing.

Fluid from the lower zone will then pass upwardly through the lower packer (not shown) and through the tubular extension attached to the first tubular body **12**, through the latter and into the first tubing string **10**, flowing to the top of the well bore. Fluid from the upper producing zone will then pass into the casing B and upwardly through the lower tubing **82** and sleeve valve **106** into the second tubular body **13**, flowing therefrom into the second passage **17** in the head **16**, and then through the second tubular string **11** to the top of the well bore. In this manner, production through separate parallel paths is maintained at all times from the different producing zones in the well bore.

In the event the well packer A is to be released, the hydrostatic head of fluid acting upwardly on the pistons **91** is also permitted to act downwardly on the pistons, by passing through the upper ports **108** and into the cylinders **90** above the pistons. To secure such equalizing in pressure, the second tubular string **11** is removed from the receptacle **16** by taking an upward pull thereon sufficient to cam the fingers **21** inwardly and allow the latch elements to move past the parallel string head shoulder **22**, the second tubular string **11** being elevated in the well casing B and withdrawn completely therefrom. The first tubular string **10** is then rotated to the right, its head **26** threading upwardly in the upper connector **30** until it is completely unthreaded therefrom, whereupon the first tubular string **10** is moved upwardly until the upper shoulder **32** on the head **26** engages the spacer member **31**, which, in turn, is contacting the lower end of the parallel string head **16**. An upward pull is now taken on the first tubular string **10**, which is transmitted through its head **26** and spacer member **31** to the parallel string head **16**, this head **16** moving upwardly to carry the second body member **13** upwardly with it and within and relative to the upper connector member **30**, to the extent determined by engagement of the stop ring **37** secured

to the second tubular member with the lower shoulder **39** of the upper connector (FIGS. 4 and 4*a*). At this time, the second tubular body **13** has been pulled upwardly within the packing structure **43**, expander **44**, slip sleeve **65**, lower packing **73**, and hydraulic housing **78** to a position at which the release port **118** in the lower portion of the second tubular body member **13** is aligned with the circumferential recess **119** in the housing **78**, into which the upper inlet ports **108** open. When in this position, the hydrostatic head of fluid can then flow through the upper ports **108** into the cylinders **90** above the pistons **91**, to equalize the pressure thereon and thereby removing the hydrostatic setting force from the apparatus.

Continued upward movement of the first tubular string **10** then moves the receptacle **16** and second tubular body **13** upwardly with it, the split ring **37** on this latter member carrying the upper connector and abutment **30** upwardly to raise the upper gauge ring **33** with respect to the lower gauge ring **53**, removing the compressive force on the packing structure **43** and allowing the packing elements **48** to inherently retract to the position illustrated in FIG. 2. Such upward movement of the upper connector **30** also carries the first body member **12** upwardly with it, which also slides upwardly within the packing structure **43** and the expander **44**, until the split stop ring **56** on the tubular member **12** engages the lower insert **52**, which is secured, through the lower gauge ring **53**, to the expander **44**. Accordingly, the first tubular string **10** is moved upwardly to a further extent, and the expander **44** is pulled upwardly relative to the slips **62**, the tongue and groove inclined connection **63**, **64** between the expander and slips causing the slips **62** to be shifted positively laterally inwardly to a retracted position.

Further upward movement of the parts will cause the heads **85** on the longitudinal screws **83** to engage the slip ring **65** and shift it upwardly, to carry the lower thrust plate **69** away from the lower abutment **75**, allowing the lower packing member **73** to retract inherently to its initial position. As the slip ring **65** moves upwardly, the thrust plate **69** clamped thereagainst engages the heads **88** of the longitudinal screws **86** secured to the lower abutment **75**, carrying the latter upwardly with it. In addition, it is to be noted that upward movement of the first tubular body member **12** carries the hydraulic housing **78** upwardly with it, because of the interconnection of the parts with one another through the agency of the split ring **120**, the hydraulic piston retainer plate **96**, and the clamp ring **97**. Thus, all of the parts are carried upwardly in the well casing B, with the slips **62** and the packing structures **43**, **73** in retracted position. If desired, the tubular string **10** can be removed completely from the well casing, in order to remove the packer A from the well casing B, as well as any tubing extension, or the like, that might be secured to the lower end of the packer.

In the form of invention shown in FIGS. 1 to 12, inclusive, the slip wickers **130** are designed to hold against the casing to prevent longitudinal movement in both directions, downward movement of the packer in the casing being prevented by the downward wedging of the expander **44** in the slips **62**, and upward movement being prevented by the continued longitudinal force imposed by the lower elastic member **73** on the slips **62**, to hold them wedged upon the expander **44** and against the well casing B. In the form of invention illustrated in FIGS. 13 to 16, inclusive, the lower elastic member **73** is eliminated and the well packer apparatus anchored against upward movement in the well casing by hydraulically actuated gripper members **150** mounted in the upper receptacle **16***a*. As shown in the drawings, the apparatus illustrated in FIGS. 13 to 16, inclusive, is essentially the same as that disclosed in FIGS. 1 to 12, inclusive, except that the slip ring **65***a* is movable upwardly out of the clamp ring **97** that secures the piston retainer plate **96** and the first body member **12** to the hydraulic housing **78**.

The upper receptacle **16***a* has a plurality of radial cylinders or bores **151** therein, each of which contains a radially movable gripping member **150**, in the form of a piston having external wickers or teeth **152** facing in an upward direction and adapted to grip or embed in the wall of the well casing. The gripping members are urged in an inward or retracted direction by springs **153** bearing against a retainer and spring seat **154** extending across vertical slots **155** in the gripping members and secured to the receptacle or head in any suitable manner, as by means of screws **156**. The retainer **154** fits within each gripper member external slot **155** to prevent their turning in the cylinder **151**, and to insure the maintenance of the wickers **152** in a properly oriented direction.

The pistons **150** are urged in an outward direction against the force of the springs **153** in response to fluid pressure in the second passage **17** in the parallel string head **16***a*, which can pass through ports **157** leading from such passage to the gripper member cylinders **151**. Leakage of fluid between the pistons **150** and the cylinder walls is prevented by side seal rings **158** in the cylinders slidably and sealingly engaging the peripheries of the pistons.

The apparatus illustrated in FIGS. 13 to 16, inclusive, is run in the well bore on the first tubular string **10** in the same manner as in the other form of invention, and the second tubular string **11** then lowered into place and positioned in the second passage **17** in the receptacle **16***a*. The ball **116** is dropped into the second tubular string **11**, to engage the seat **115** in the sleeve **106**, and pressure applied in the same manner as in the other form of the invention, to shear the screw **110** and shift the sleeve **106** downwardly to a position opening the lower ports **105**, allowing the hydrostatic head of fluid to enter the lower portion of the cylinders **90** and effect an expansion of the packing structure **43** and of the slips **62** against the wall of the well casing. If there is any pressure present in the well casing below the well packer tending to shift the well packer upwardly in the casing, such pressure will pass through the second tubular body **13** into the second passage **17**, and through the ports **157** in the receptacle **16***a* (which are disposed below the seal **119** of the second tubular string **11**) into the cylinders **151**, the pressure urging the gripping members **150** outwardly to embed their wickers **152** in the wall of the well casing. Thus, the gripper members **150** will prevent upward movement of the well packer in the well casing; whereas the lower slips **62**, which preferably have their wickers **130***a* oriented in a downward direction, will prevent downward movement of the well packer in the well casing.

The well packer illustrated in FIGS. 13 to 16, inclusive, is released in the same manner as in the other form of invention by unscrewing the lower head **26** on the first tubular body or mandrel member **25** from the abutment member **30** and elevating the latter, preceded preferably by removal of the second tubular string **11** from the well bore. Upward movement of the first tubular string **10** will then effect elevation of the second body member **13** within the hydraulic housing **78** to a position in which the bleeder port **118** is placed in communication with the upper inlet ports **108** of the cylinders, equalizing the hydrostatic pressure in the apparatus and allowing all of the parts to be shifted or to inherently shift to their initial retracted position. The release of the packing **43** from the well casing will equalize the pressures internally and externally of the cylinders **151** in which the gripper members **150** are disposed, allowing the springs **153** to shift them inwardly to their retracted position. The apparatus can now be withdrawn completely from the well bore by elevating the first tubular string **10**, in the same manner as the other form of the invention.

The inventors claim:

1. In apparatus adapted to be set in a well bore: body

means; normally retracted means on said body means adapted to be expanded outwardly into engagement with the wall of the well bore; hydraulically operable means for expanding said normally retracted means outwardly and having a high pressure side and a low pressure side; means for preventing the hydrostatic head of fluid in the well bore internally and externally of said body means from acting on said high pressure and low pressure sides; means for shifting a portion of said preventing means to a position permitting action of said hydrostatic head of fluid on said high pressure side, but not on said low pressure side, to cause said hydraulically operable means to expand said normally retracted means; and means for shifting a portion of said preventing means to a position permitting action of said hydrostatic head of fluid on said low pressure side to substantially equalize the hydrostatic head acting on said high and low pressure sides and enable said normally retracted means to be retracted from its outwardly expanded position.

2. In apparatus adapted to be set in a well bore: body means; normally retracted means on said body means adapted to be expanded outwardly into engagement with the wall of the well bore; cylinder and piston means on said body means operatively connected to said normally retracted means to expand said normally retracted means outwardly; said cylinder and piston means having a high pressure side and a low pressure side in which a gaseous medium is confined initially; first passage means for conducting the hydrostatic head of fluid in the well bore to said high pressure side of said cylinder and piston means to expand said normally retracted means outwardly; second passage means for conducting the hydrostatic head of fluid in the well bore to the low pressure side of said cylinder and piston means to enable said normally retracted means to retract from its outwardly expanded position; first means initially closing said first passage means; second means initially closing said second passage means to confine the gaseous medium in said low pressure side and prevent entry through said second passage means of the hydrostatic head of fluid in the well bore into said low pressure side; means for shifting said first closing means to open position; and means for shifting said second closing means to open position.

3. In apparatus adapted to be set in a well bore: body means; normally retracted means on said body means adapted to be expanded outwardly into engagement with the wall of the well bore; hydraulically operable means having a high pressure side responsive to the hydrostatic head of fluid in the well bore for expanding said normally retracted means outwardly, said hydraulically operable means having a low pressure side and a confined gaseous medium on said low pressure side; means for preventing the hydrostatic head of fluid from acting on said high and low pressure sides of said hydraulically operable means; means responsive to fluid pressure in said body means for shifting a portion of said preventing means to a position permitting action of the hydrostatic head of fluid on the high pressure side of said hydraulically operable means, but not on said low pressure side to retain said gaseous medium confined; and means for substantially equalizing the hydrostatic head of fluid acting on said high and low pressure sides of said hydraulically operable means to enable said normally retracted means to be retracted from its outwardly expanded position.

4. In apparatus adapted to be set in a well bore: body means; normally retracted means on said body means adapted to be expanded outwardly into engagement with the wall of the well bore; hydraulically operable means having a high pressure side responsive to the hydrostatic head of fluid in the well bore for expanding said normally retracted means outwardly, said hydraulically operable means having a low pressure side and a confined gaseous medium on said low pressure side; means for preventing the hydrostatic head of fluid from acting on said high and low pressure sides of said hydraulically operable means; means for shifting a portion of said preventing means to a position permitting action of the hydrostatic head of fluid on the high pressure side of said hydraulically operable means but not on said low pressure side to retain said gaseous medium confined; and means movable by manipulation of said body means for substantially equalizing the hydrostatic head of fluid acting on said high and low pressure sides of said hydraulically operable means to enable said normally retracted means to be retracted from its outwardly expanded position.

5. In apparatus adapted to be set in a well bore: body means; normally retracted means on said body means adapted to be expanded outwardly into engagement with the wall of the well bore; hydraulically operable means having a high pressure side responsive to the hydrostatic head of fluid in the well bore for expanding said normally retracted means outwardly, said hydraulically operable means having a low pressure side and a confined gaseous medium on said low pressure side; means for preventing the hydrostatic head of fluid from acting on said high and low pressure sides of said hydraulically operable means; means responsive to fluid pressure in said body means for shifting a portion of said preventing means to a position permitting the hydrostatic head of fluid to act on said high pressure side of said hydraulically operable means, but not on said low pressure side to retain said gaseous medium confined; and means movable by manipulation of said body means for substantially equalizing the hydrostatic head of fluid acting on said high and low pressure sides of said hydraulically operable means to enable said normally retracted means to be retracted from its outwardly expanded position.

6. In apparatus adapted to be set in a well bore: body means; normally retracted means on said body means adapted to be expanded outwardly into engagement with the wall of the well bore; hydraulically operable means for expanding said normally retracted means outwardly and having a high pressure side and a low pressure side, said hydraulically operable means including a confined gaseous medium on said low pressure side; sleeve valve means for preventing the hydrostatic head of fluid from acting on said high pressure side; manipulative means movable by said body means for preventing the hydrostatic head of fluid from acting on said low pressure side and said gaseous medium; means for shifting said sleeve valve means to a position permitting action of said hydrostatic head of fluid on said high pressure side, but not on said low pressure side; said manipulative means being movable by said body means to a position permitting action of said hydrostatic head of fluid on said low pressure side and the gaseous medium to enable said normally retracted means to be retracted from its outwardly expanded position.

7. In apparatus adapted to be set in a well bore: body means; normally retracted means on said body means adapted to be expanded outwardly into engagement with the wall of the well bore; cylinder and piston means on said body means operatively connected to said normally retracted means to expand said normally retracted means outwardly; said cylinder and piston means having a high pressure side and a low pressure side in which a gaseous medium is confined initially; first pasage means for conducting the hydrostatic head of fluid in the well bore to said high pressure side of said cylinder and piston means to expand said normally retracted means outwardly; second passage means for conducting the hydrostatic head of fluid in the well bore to the low pressure side of said cylinder and piston means to enable said normally retracted means to retract from its outwardly expanded position; a sleeve initially closing said first passage means; manipulative means movable by said body means initially closing said second passage means to confine the gaseous medium in said low pressure side and prevent entry through said second passage means of the hydrostatic head of fluid in the well bore into said low pressure side; means

for shifting said sleeve to a position opening said first passage means; said manipulative means being movable by said body means to a position opening said second passage means.

8. In apparatus adapted to be set in a well bore: body means; normally retracted means on said body means adapted to be expanded outwardly into engagement with the wall of the well bore; hydraulically operable means for expanding said normally retracted means outwardly and having a high pressure side and a low pressure side; first means for preventing fluid pressure from acting on said high pressure side; second means for preventing fluid pressure from acting on said low pressure side and confining a gaseous medium on said low pressure side; means for shifting said first preventing means to a position permitting fluid pressure to act on said high pressure side to cause said hydraulically operable means to expand said normally retracted means; and means for shifting said second preventing means to a position permitting fluid pressure to act on said low pressure side and said gaseous medium to enable retraction of said normally retracted means from its outwardly expanded position.

9. In apparatus adapted to be set in a well bore: tubular body means; normally retracted means on said body means adapted to be expanded outwardly into engagement with the wall of the well bore; cylinder means on said body means; piston means slidable relatively in said cylinder means; said piston means and cylinder means being operatively connected to said normally retracted means to expand the same outwardly upon relative movement of said piston means in said cylinder means; first passage means for conducting fluid under pressure to said cylinder means on one side of said piston means to expand said normally retracted means; second passage means for conducting fluid under pressure to said cylinder means on the other side of said piston means to enable said normally retracted means to retract; first means initially closing said first passage means; second means initially closing said second passage means and confining a gaseous medium in said cylinder means on said other side of said piston means; means for shifting said first closing means to open position; and means for shifting said second closing means to open position.

10. In apparatus adapted to be set in a well bore: body means adapted to be connected to a tubular string extending to the top of the well bore; a normally retracted packing on said body means; abutment means on said body means engageable with said packing at one end thereof; expander means on said body means engageable with said packing at the other end thereof; normally retracted slip means engaging said expander means and expandible outwardly thereby; cylinder and piston means on said body means for shifting said slip means and abutment means relatively toward each other to expand said packing and slip means laterally outwardly; first passage means for conducting the hydrostatic head of fluid in the well bore to one side of said cylinder and piston means to expand said packing and slip means outwardly; second passage means for conducting the hydrostatic head of fluid in the well bore to the other side of said cylinder and piston means to enable said packing and slip means to retract from their outwardly expanded positions; first means initially closing said first passage means; second means initially closing said second passage means and confining a gaseous medium on said other side of said cylinder and piston means; means for shifting said first closing means to open position; and means for shifting said second closing means to open position.

11. In apparatus adapted to be set in a well bore: body means adapted to be connected to a tubular string extending to the top of the well bore; a normally retracted packing on said body means; abutment means on said body means engageable with said packing at one end thereof; expander means on said body means engageable with said packing at the other end thereof; normally retracted slip means engaging said expander means and expandible outwardly thereby; cylinder and piston means on said body means for shifting said slip means and abutment means relatively toward each other to expand said packing and slip means laterally outwardly; first passage means for conducting the hydrostatic head of fluid in the well bore to one side of said cylinder and piston means to expand said packing and slip means outwardly; second passage means for conducting the hydrostatic head of fluid in the well bore to the other side of said cylinder and piston means to enable said packing and slip means to retract from their outwardly expanded position; a sleeve initially closing said first passage means; manipulative means movable by said body means initially closing said second passage means and confining a gaseous medium on said other side of said cylinder and piston means; means for shifting said sleeve to a position opening said first passage means; said manipulative means being movable by said body means to a position opening said second passage means.

12. In apparatus adapted to be set in a well bore: body means adapted to be connected to a tubular string extending to the top of the well bore; a first normally retracted packing on said body means; abutment means on said body means engageable with said packing at one end thereof; expander means on said body means engageable with said packing at the other end thereof; normally retracted slip means engaging said expander means and expandible outwardly thereby; a second normally retracted packing on said body means engaging said slip means; cylinder and piston means on said body means and engaging said second normally retracted packing for shifting said abutment means and second packing relatively toward each other to expand said first packing, second packing, and slip means laterally outwardly; first passage means for conducting the hydrostatic head of fluid in the well bore to one side of said cylinder and piston means to expand said first and second packings and said slip means outwardly; second passage means for conducting the hydrostatic head of fluid in the well bore to the other side of said cylinder and piston means to enable said first and second packings and said slip means to retract from their outwardly expanded position; first means initially closing said first passage means; second means initially closing said second passage means and confining a gaseous medium on said other side of said cylinder and piston means; means for shifting said first closing means to open position; and means for shifting said second closing means to open position.

13. In apparatus adapted to be set in a well bore: body means adapted to be connected to a tubular string extending to the top of the well bore; a normally retracted packing on said body means; abutment means on said body means engageable with said packing at one end thereof; expander means on said body means engageable with said packing at the other end thereof; normally retracted slip means engaging said expander means and expandible outwardly thereby; cylinder means on said body means; piston means slidable relatively in said cylinder means; said piston means and cylinder means being operatively connected to said abutment means and slip means to expand the same outwardly upon relative movement of said piston means in said cylinder means; first passage means for conducting fluid under pressure to said cylinder means on one side of said piston means to expand said packing and slip means; second passage means for conducting fluid under pressure to said cylinder means on the other side of said piston means to enable said packing and slip means to retract; first means initially closing said first passage means; second means initially closing said second passage means and confining a gaseous medium in said cylinder means on said other side of said piston means; means for shifting said first closing means to open position; and means for shifting said second closing means to open position.

14. In apparatus adapted to be set in a well bore: body means adapted to be connected to a tubular string extending to the top of the well bore; a first normally retracted packing on said body means; abutment means on said body means engageable with said packing at one end thereof; expander means on said body means engageable with said packing at the other end thereof; normally retracted slip means engaging said expander means and expandible outwardly thereby; a second normally retracted packing on said body means engaging said slip means; cylinder means on said body means; piston means slidable relatively in said cylinder means; said piston means and cylinder means being operatively connected to said second normally retracted packing and said abutment means to expand said first and second packings and said slip means outwardly upon relative movement of said piston means in said cylinder means; first passage means for conducting fluid under pressure to said cylinder means on one side of said piston means to expand said first and second packings and said slip means; second passage means for conducting fluid under pressure to said cylinder means on the other side of said piston means to enable said first and second packings and said slip means to retract; first means initially closing said first passage means; second means initially closing said second passage means and confining a gaseous medium in said cylinder means on said other side of said piston means; means for shifting said first closing means to open position; and means for shifting said second closing means to open position.

15. In apparatus adapted to be set in a well bore: body means adapted to be connected to a tubular string extending to the top of the well bore; abutment means on said body means; a normally retracted packing on said body means having its upper portion engageable with said abutment means; expander means on said body means below and engageable with said packing; normally retracted slip means below and engaging said expander means and expandible outwardly thereby; cylinder and piston means on said body means below said slip means for shifting said slip means and abutment means relatively toward each other to expand said packing and slip means laterally outwardly; first passage means for conducting the hydrostatic head of fluid in the well bore to said cylinder below said piston means to expand said packing and slip means outwardly; second passage means for conducting the hydrostatic head of fluid in the well bore to said cylinder above said piston means to enable said packing and slip means to retract from their outwardly expanded positions; first means initially closing said first passage means; second means initially closing said second passage means and confining a gaseous medium in said cylinder above said piston means; means for shifting said first closing means to open position; and means for shifting said second closing means to open position.

16. In apparatus adapted to be set in a well bore: body means adapted to be connected to a tubular string extending to the top of the well bore; abutment means on said body means; a first normally retracted packing on said body means having its upper portion engageable with said abutment means; expander means on said body means below and engageable with said packing; normally retracted slip means below and engaging said expander means and expandible outwardly thereby; a second normally retracted packing on said body means below and engaging said slip means; cylinder and piston means on said body means below said second packing and engaging said second packing for shifting said abutment means and second packing relatively toward each other to expand said first packing, second packing, and slip means laterally outwardly; first passage means for conducting the hydrostatic head of fluid in the well bore to said cylinder below said piston means to expand said first and second packings and said slip means outwardly; second passage means for conducting the hydrostatic head of fluid in the well bore to said cylinder above said piston means to enable said first and second packings and said slip means to retract from their outwardly expanded positions; first means initially closing said first passage means; second means initially closing said second passage means and confining a gaseous medium in said cylinder above said piston means; means for shifting said first closing means to open position; and means for shifting said second closing means to open position.

17. In apparatus adapted to be set in a well bore: body means adapted to be connected to a tubular string extending to the top of the well bore; abutment means on said body means; a normally retracted packing on said body means having its upper portion engageable with said abutment means; expander means on said body means below and engageable with said packing; normally retracted slip means below and engaging said expander means and expandible outwardly thereby; cylinder and piston means on said body means below said slip means for shifting said slip means and abutment means relatively toward each other to expand said packing and slip means laterally outwardly; first passage means for conducting the hydrostatic head of fluid in the well bore to said cylinder below said piston means to expand said packing and slip means outwardly; second passage means for conducting the hydrostatic head of fluid in the well bore to said cylinder above said piston means to enable said packing and slip means to retract from their outwardly expanded positions; a sleeve initially closing said first passage means; manipulative means movable by said body means initially closing said second passage means and confining a gaseous medium in said cylinder above said piston means; means for shifting said sleeve to a position opening said first passage means; said manipulative means being movable by said body means to a position opening said second passage means.

18. In apparatus adapted to be set in a well bore: body means comprising first and second tubular body members in side-by-side relation; normally retracted packing means on said body members and having an end portion engaging said body means; expander means on said body members engaging the opposite end portion of said packing means; slip means engaging said expander means to be expanded outwardly thereby; a housing secured to said first body member and having a passage receiving said second body member; said housing having a cylinder therein; piston means in said cylinder engageable with said slip means; first passage means for conducting the hydrostatic head of fluid in the well bore to said cylinder on one side of said piston means to expand said packing means and slip means outwardly; second passage means for conducting the hydrostatic head of fluid in the well bore to said cylinder on the other side of said piston means to enable said packing means and slip means to retract from their outwardly expanded positions; first means initially closing said first passage means; second means initially closing said second passage means; means for shifting said first closing means to open position; and means for shifting said second closing means to open position.

19. In apparatus adapted to be set in a well bore: body means comprising first and second tubular body members in side-by-side relation; normally retracted packing means on said body members and having an end portion engaging said body means; expander means on said body members engaging the opposite end portion of said packing means; slip means engaging said expander means to be expanded outwardly thereby; a housing secured to said first body member and having a passage receiving said second body member; said housing having a cylinder therein; piston means in said cylinder engageable with said slip means; first passage means for conducting the hydrostatic head of fluid in the well bore to said cylinder on one side of said piston means to expand said packing

means and slip means outwardly; second passage means for conducting the hydrostatic head of fluid in the well bore to said cylinder on the other side of said piston means to enable said packing means and slip means to retract from their outwardly expanded positions; a sleeve initially closing said first passage means; manipulative means movable by said second body member initially closing said second passage means; means for shifting said sleeve to a position opening said first passage means; said manipulative means being movable by said second body member to a position opening said second passage means.

20. In apparatus adapted to be set in a well bore: body means comprising first and second tubular body members in side-by-side relation; normally retracted packing means on said body members and having an upper end portion engaging said body means; expander means on said body members below and engaging the lower end portion of said packing means; slip means below and engaging said expander means to be expanded outwardly thereby; a housing below said slip means secured to said first body member and having a passage receiving said second body member; said housing having a cylinder therein; piston means in said cylinder engageable with said slip means; first passage means for conducting pressure fluid from said passage to said cylinder below said piston means to expand said packing means and slip means; second passage means for conducting pressure fluid from said passage to said cylinder above said piston means to enable said packing means and slip means to retract; first means initially closing said first passage means; second means initially closing said second passage means; means for shifting said first closing means to open position; and means for shifting said second closing means to open position.

21. In apparatus adapted to be set in a well bore: body means comprising first and second tubular body members in side-by-side relation; normally retracted packing means on said body members and having an upper end portion engaging said body means; expander means on said body members below and engaging the lower end portion of said packing means; slip means below and engaging said expander means to be expanded outwardly thereby; a housing below said slip means secured to said first body member and having a passage receiving said second body member; said housing having a cylinder therein; piston means in said cylinder engageable with said slip means; first passage means for conducting pressure fluid from said passage to said cylinder below said piston means to expand said packing means and slip means; second passage means for conducting pressure fluid from said passage to said cylinder above said piston means to enable said packing means and slip means to retract; a sleeve initially closing said first passage means; manipulative means movable by said second body member initially closing said second passage means; means for shifting said sleeve to a position opening said first passage means; said manipulative means being movable by said second body member to a position opening said second passage means.

22. In apparatus adapted to be set in a well bore: a receptacle having a passage therein for receiving a tubular string extending to the top of the well bore; an upper abutment below said receptacle; first and second tubular body members in side-by-side relation in said upper abutment, said second body member being secured to said receptacle in communication with the passage in said receptacle; a tubular mandrel extending along said receptacle and detachably secured to said abutment in sealing relation to said first body member; normally retracted packing means on said body members and having an upper end portion engaging said upper abutment; expander means on said body members engaging the lower end portion of said packing means; slip means below and engaging said expander means to be expanded outwardly thereby; a housing secured to said first body member below said slip means and having a passage receiving said second body member; said housing having a cylinder therein; piston means in said cylinder engageable with said slip means; first passage means for conducting pressure fluid from said housing passage to said cylinder below said piston means to expand said packing means and slip means; second passage means for conducting pressure fluid from said housing passage to said cylinder above said piston means to enable said packing means and slip means to retract; a sleeve valve in said housing passage initially closing said first passage means; said second body member extending initially across said second passage means to close the same; means for shifting said sleeve valve to a position opening said first passage means; said tubular mandrel being released from said upper abutment to shift said receptacle upwardly and said second body member upwardly of said housing to open said second passage means.

References Cited by the Examiner

UNITED STATES PATENTS

2,060,352	11/36	Stokes	175—268
2,279,676	4/42	Hart	166—63
2,328,840	9/43	O'Leary	166—194 X
2,595,014	4/52	Smith et al.	166—98
2,734,581	2/56	Bonner	166—98
2,841,224	7/58	Baker et al.	166—134
2,903,066	9/59	Brown	166—120 X
2,991,833	7/61	Brown et al.	166—122
3,002,564	10/61	Baker	166—120 X
3,011,558	12/61	Conrad	166—212
3,020,961	2/62	Orr	166—179

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