Feb. 16, 1965 M. W. HAINES 3,169,579

AXIALLY SPACED WELL PACKERS

Original Filed Nov. 30, 1953 2 Sheets-Sheet 1

Fig. 1.

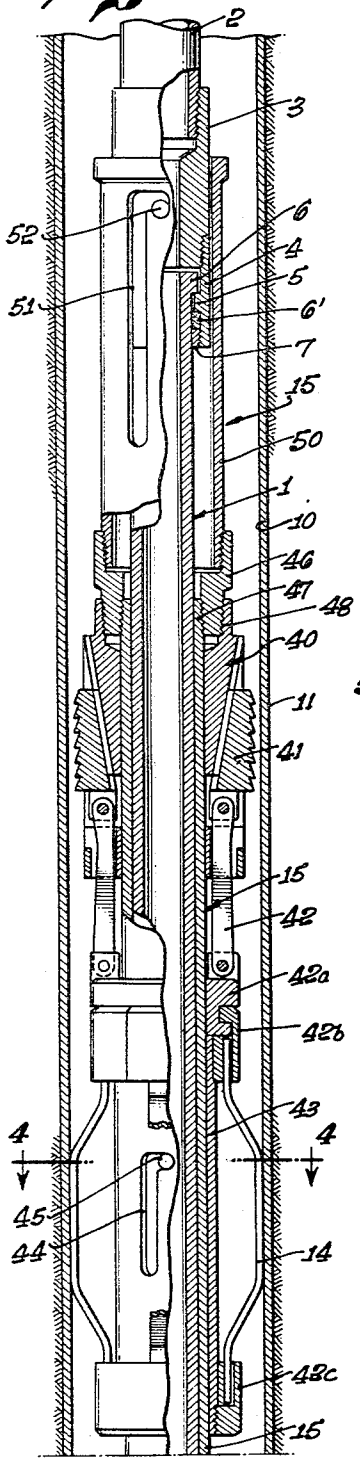


Fig. 1a.

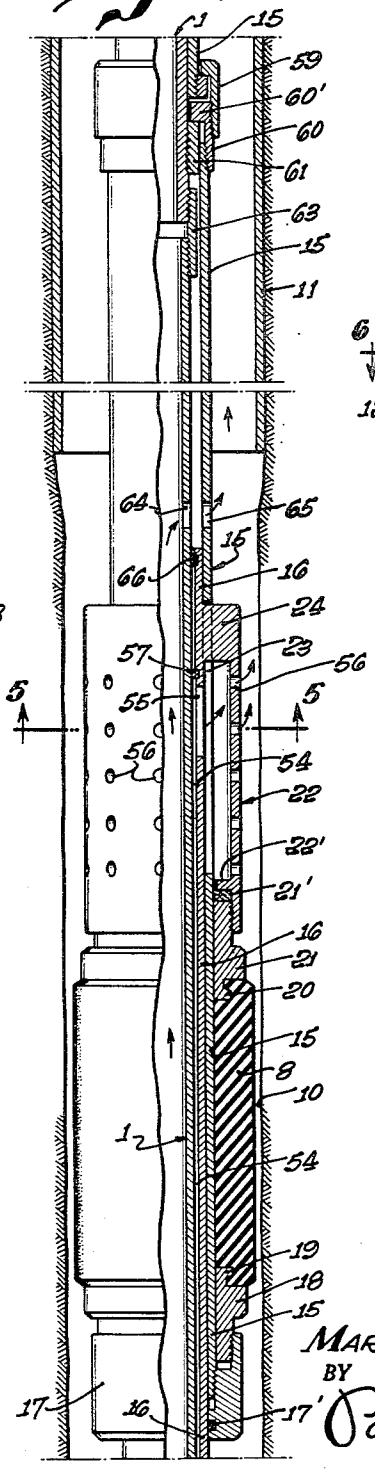
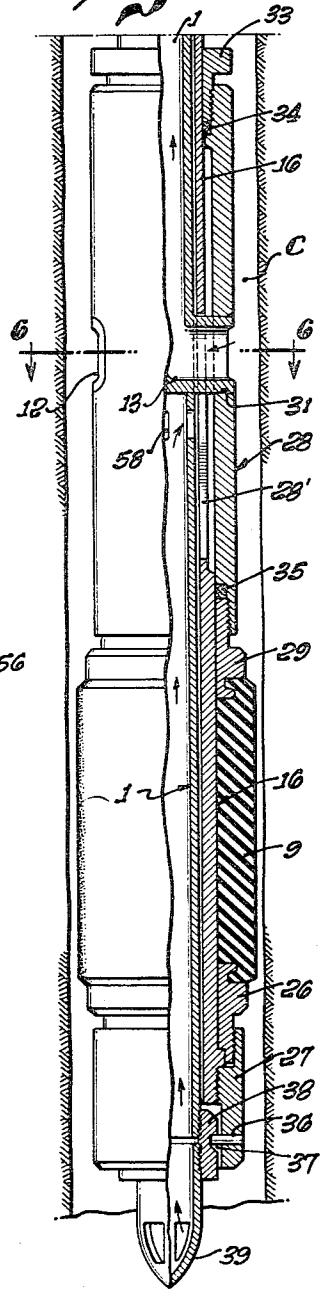


Fig. 1b.



INVENTOR.
MARCUS W. HAINES,
BY
Paul A. Weilein
ATTORNEY.

Feb. 16, 1965 M. W. HAINES 3,169,579

AXIALLY SPACED WELL PACKERS

Original Filed Nov. 30, 1953 2 Sheets-Sheet 2

Fig. 2.

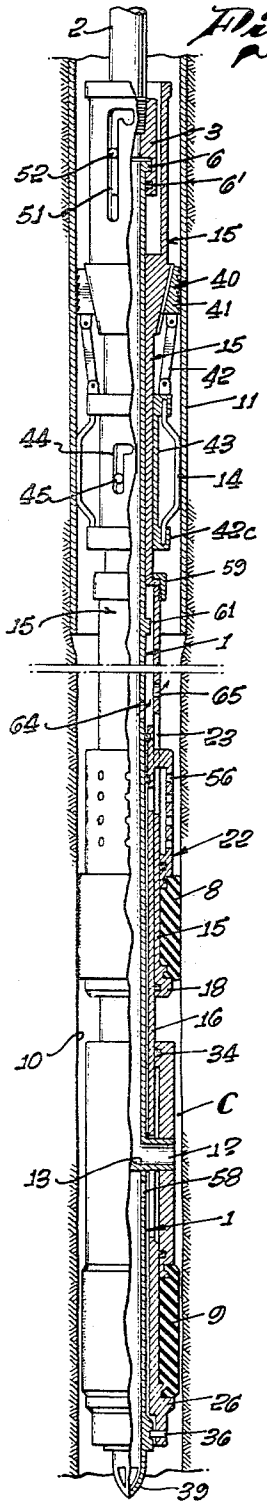


Fig. 3.

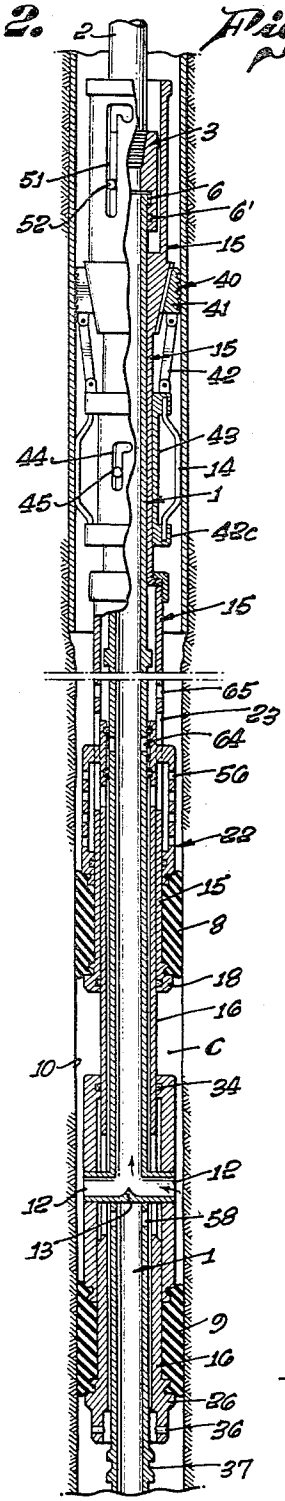


Fig. 4.

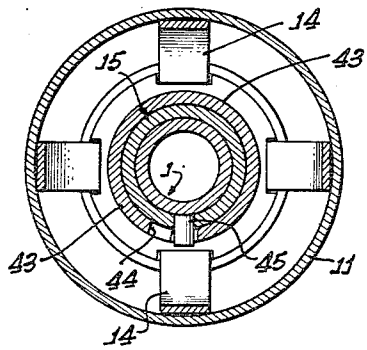


Fig. 5.

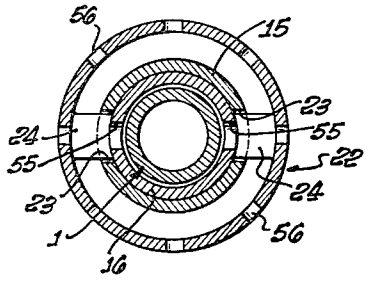
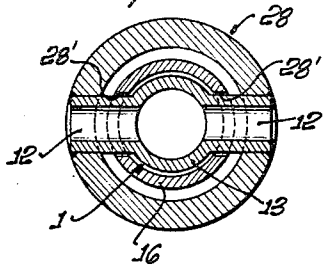


Fig. 6.



INVENTOR.
MARCUS W. HAINES,
BY
Paul A. Weilein
ATTORNEY.

United States Patent Office 3,169,579 Patented Feb. 16, 1965

3,169,579

AXIALLY SPACED WELL PACKERS

Marcus W. Haines, Long Beach, Calif., assignor to McGaffey-Taylor Corporation, Long Beach, Calif., a corporation of California

Original application Nov. 30, 1953, Ser. No. 394,928. Divided and this application Feb. 14, 1961, Ser. No. 102,330

5 Claims. (Cl. 166—119)

This application is a division of my co-pending application, Serial No. 394,928, filed November 30, 1953, (now Patent No. 3,012,611 granted December 12, 1961).

This invention has for an object thereof the provision of a well tool which is adapted to be anchored to the casing of a well and operated in a highly efficient manner to perform useful work in the open formation below the casing.

Accordingly, a well tool embodying this invention includes one or more packers that may be set and released in the open formation responsive to relative movement between the tool members.

An object of this invention is the provision of tools such as described wherein no bodily movement of packers forming parts of the tools is required while the packers are expanded into contact with the wall of the well bore, thereby preventing impairment of the packers.

Further, it is an object of this invention to provide a tool such as described whereby advantages herein noted are achieved by having portions of the tool engage the ends of the sleeve packers and causing these portions to be relatively moved for placing the packers under compression or tension according to the manipulation of the run-in string.

This invention possesses many other advantages and has other objects which may be made more easily apparent from a consideration of the embodiment shown in the drawings accompanying and forming part of the present specification. This embodiment will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this 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 fragmentary vertical sectional view partly in elevation of the upper portion of a well tool embodying the present invention, showing the parts of this portion as they would appear while positioning the tool in or removing it from the well.

FIG. 1*a* is a fragmentary vertical half sectional view of the middle portion of the tool of this invention;

FIG. 1*b* is a fragmentary vertical half sectional view of the lowermost portion of the tool;

FIG. 2 is a vertical half sectional and partly schematic view of the complete tool shown in FIGS. 1, 1*a* and 1*b*, as when anchored to the well casing with one of the sleeve packers expanded into sealing position while the other packer is in inoperative position;

FIG. 3 is a fragmentary vertical sectional and partly schematic view partly in elevation of the tool shown in FIG. 2 with both packers expanded to seal against the well wall;

FIG. 4 is a cross sectional view taken on the line 4—4 of FIG. 1, on an enlarged scale;

FIG. 5 is a cross sectional view taken on the line 5—5 of FIG 1*a*; and

FIG. 6 is a cross sectional view taken on the line 6—6 of FIG. 1*b*.

The well tool embodying the present invention, as shown in FIGS. 1–6, includes a tubular body 1 adapted

to be connected to a tubular run-in string 2 for positioning a well. A coupling member 3 for connecting the body 1 with the tubing string is threadedly coupled to a collar 4 rotatably mounted on the upper end of the body 1. This collar is provided with an internal annular flange 5 which is rotatably confined between an external flange 6 on the body 1 and a sealing ring 6′ held in the collar by an annular nut 7 threaded into the inner end of the collar. This arrangement provides for rotation of the collar 4 relative to the body 1 responsive to rotation of the tubing string 2, for the purpose to be hereinafter described.

Surrounding the body 1 are resilient axially spaced sleeve packers 8 and 9 adapted to be mechanically moved into and from sealing contact with the wall 10 of the well bore. When expanded as shown in FIG. 3 to seal against the well wall, these packers will form therebetween a pressure chamber C into which fluid under pressure may be introduced through ports 12 in the body 1 for the desired treatment of the formation, such fluid being pumped down the tubing string 2. The ports 12 are provided by a tubular member 13 extending transversely of the bore of the body 1 so as to close this bore below the ports whereby the working fluid is prevented from flowing through the lower open end of the body 1.

Means are provided for mounting the sleeve packers 8 and 9 on the body 1 in a manner making it possible to mechanically compress and expand them into sealing contact with the well wall responsive to downward movement of the tubing string 2 and the body 1 relative to such mounting means. This means is also operable to retract the packers under tension responsive to lifting of the tubing string and body 1 relative to the mounting means. Consequently, the mounting means and body 1 are telescopically connected in a manner permitting relative axial movement and rotative movement thereof.

As the tool is subject to operation at any depth in the well, it is necessary to releasably hold the mounting means against movement whereby the packers thereon may be mechanically actuated responsive to axial movement of the body 1 relative to the mounting means. Accordingly, anchoring means is operatively connected with the mounting means for engaging the casing 11 to anchor the mounting means thereto.

The packer mounting means and the body 1 are also operatively connected with locking means for releasably holding the anchoring means and the packers in inoperative position on the body 1 whereby the tool may be freely moved in the well. This locking means releases the body 1 for axial movement relative to the mounting means responsive to rotative movement of the tubing string 2 and the body 1 relative to the mounting means. Accordingly, conventional drag springs 14 are associated with the anchoring means to frictionally contact the casing 11 and restrain movement of the mounting means in a manner permitting movement of the tubing string 2 and body 1 to release the locking means, setting the anchoring means and mechanically expanding the packers.

As the downward movement of the body 1 causes the anchoring means to operate before the packers are expanded, it is apparent that on the upward movement of the body member 1, the packers will be retracted before the anchoring means is released. Thus, at no time in the use of the tool is it necessary to move the packers bodily in the well while they are expanded, thereby preventing damage of the packers as would be caused if so moved while in contact with the well wall.

The mounting means for the packers 8 and 9, as shown in FIGS. 1–6, is constructed and arranged so that these packers are sequentially expanded and retracted. As here provided the upper packer 8 will expand first, after which the lower packer 9 will expand. Although the

lower packer 9 is moved bodily axially of the well while expanding and retracting the upper packer 8, it is not expanded during such movement and consequently is not damaged by contact with the wall of the well. In retracting the packer the reverse of the expanding operation takes place as the lower packer is retracted before the upper packer.

To provide for these operations the packer mounting means is constructed of two tubular main sections 15 and 16 which telescope the body 1 and in turn are telecopically connected for relative axial movement. The section 15 is uppermost and section 16 lowermost on the tool body.

The upper sleeve packer 8 surrounds the lower portion of the upper section 15 so that the lower end of this packer is fixed to a thimble 17 threadedly connected to the lower end of the section 15. A sealing ring 17' is carried by the thimble 17 to form a seal between the thimble and the section 16. A retainer ring 18 is vulcanized and interlocked as at 19 with the lower end of the packer 8 and threadedly connected with the thimble to fix the packer to the thimble.

The upper end of the upper sleeve packer 8 is bonded to and interlocked as at 20 with a ring 21 corersponding to the ring 18 and threadedly connected with the lower end of a cylindrical cage member 22 fixedly connected with the upper end of the lower tubular section 16 of the packer mounting means. A sealing ring 21' is confined between the ring 21 and an internal flange 22' on the cage 22 to form a seal between the ring, cage and section 15. The upper end of the lower section 16 telescopes the body 1 and extends within the upper section 15 to a point above the packer 8. Opposed longitudinal slot 23 (see FIGS. 1*a* and 5) are formed in the upper section 15 to slidably accommodate webs 24 which join the lower section 16 with the cage 22. Thus, the cage 22 telescopes the slotted portion of the upper section 15 of the packer mounting means and is movable axially relative thereto. As the ends of the upper packer are fixed to the cage 22 and lower end of the upper tubular section 15 respectively, it will be apparent that this packer will be expanded and retracted on appropriate relative movement between the cage 22 and the upper section 15 of the packer mounting means, it being noted that this cage, in effect, is a part of the lower section 16 of the packer mounting means.

The lower packer 9 surrounds the lower portion of the section 16. The lower end of this lower packer is vulcanized to and interlocked with a ring 26 (see FIG. 1*b*) threadedly connected to a thimble 27 in turn threadedly connected with the lower end of the lower tubular section 16. The upper end of this lower packer is fixed to the body 1 through the medium of a cylindrical cage member 28 fixed to the body 1 and telescoping the lower section 16. A ring 29 is vulcanized and interlocked with the upper end of the lower packer 9 (see FIG. 1*b*) and threadedly connected with the lower end of the cage 28. This cage is fixed to the body 1 by means of the tubular member 13 which forms the ports 12. The member 13 is welded to the body 1 so that it extends laterally from opposite sides of the body and into openings 31 in the cage 28. These ends of the member 13 are welded to the cage and thereby fix the cage to the body 1. Slots 28' in the section 16 slidably accommodate the member 13 whereby the cage 28 while fixed to the body 1 is slidable on the exterior of the section 16. An annular nut 33 is screwed into the upper end of the cage and holds a sealing ring 34 in place between the lower tubular section 16 and the cage. A similar sealing ring 35 is held in place by the ring 29 between the lower end of the cage and the lower section 16. These sealing rings prevent fluid from entering between cage 28 and the lower section 16.

As the ends of the lower packer 9 are fixed to the cage 28 which is a part of the body 1, and to the lower end

of the lower section 16 respectively, it is apparent that this packer will be expanded and retracted responsive to appropriate relative movement between the body 1 and the lower section 16.

In order that the upper packer 8 will be expanded before the lower packer 9, the lower section 16 of the packer mounting means must be moved downwardly while the upper section 15 is anchored to the casing. Such downward movement of the lower section 16 is effected by lowering the tubing string 2 and body 1. Thus, the lower section 16 must be connected to the body 1 in order to be lowered to expand the upper packer as well as raised to retract this packer. This connection of the body 1 and section 16 must be releasable after expansion of the upper packer, as it is then necessary to move the body 1 downwardly relative to the section 16 to expand the lower packer. Accordingly, detent means which releases under a given force is employed to releasably connect the body 1 with the tubular section 16. As here shown this detent means comprises a shear pin 36 fixed to the thimble 27 and engaged in a notch 37 formed in a collar 38 at the lower open end of the body 1. The collar 38 mounts a perforated sub 39 on the lower end of the body 1. The pin 36 will shear when the body 1 and the lower section 16 as a unit are moved downwardly relative to the upper section 15 sufficiently to expand the upper packer 8 into sealing engagement with the bore wall. Although the packer 9 is moved bodily downwardly with the aforesaid joint movement of the body 1 and the lower section 16, it is not expanded at this time and therefore not damaged.

Downward movement of the body 1 relative to the lower section 16 as affected when the pin 37 shears off, causes the packer 9 to be expanded into sealing engagement with the bore wall, thereby forming with the expanded packer 8 the pressure chamber C into which fluid under pressure may be introduced through the ports 12 to treat the formation as in acidizing or fracturing the formation or otherwise subjecting it to fluid under pressure for such treatment as may be desired.

The anchoring means for anchoring the packer mounting means to the casing 11 includes a down-drive type spear or expander 40 carried by the upper section 15 of the mounting means for moving slips 41 into and out of anchoring engagement with the casing. The slips 41 are slidably dovetailed on the expander and connected by means of links 42 with a collar 42*a* rotatably connected with a locking sleeve 43 surrounding the upper section 15. The collar 42*a* is rotatably interlocked with an annular member 42*b* welded to the upper end of the sleeve 42 for holding the upper ends of the drag springs 14 in place on the sleeve 43. A similar member 42*c* on the lower end of the sleeve 43 retains the lower ends of the drag springs. The locking sleeve 43 is provided with a J-slot 44, which with a pin 45 on the upper section 15 forms a conventional J-lock for releasably holding the slips 41 against axial movement relative to the expander.

The spear or expander 40 surrounds the upper section 15 and is fixed thereto by a collar 46 threadedly connected as at 47 with the upper section 15 and as at 48 with the upper end of the expander.

Threadedly connected with the upper end of the collar 46 is a locking sleeve 50 which surrounds the upper end of the body 1 and telescopes the coupling member 3. The sleeve 50 is provided with a J-slot 51 which with a pin 52 on the coupling member 3 forms a conventional J-lock for releasably holding the body 1 and the sleeve 50 against relative axial movement. This lock cooperates as will be hereinafter described, with the J-lock on the sleeve 43 to releasably hold the slips and the expander against movement out of inoperative position with the slips retracted as shown in FIG. 1.

A constantly open by-pass passage 54 is provided as shown in FIGS. 1*a* and 1*b*, by the annular space between the body 1 and the lower tubular section 16. This by-pass passage extends from the lower end of the tool to

ports 55 formed adjacent the upper end of the lower section 16. The ports 55 open into the cage 22 whereby through openings 56 in the cylindrical wall of the cage, well fluid may flow into the by-pass 54 from the casing annulus or vice versa when positioning, repositioning or removing the tool. The by-pass passage 54 is closed above the ports 55 by means of a sealing ring 57 sealing between the upper end of the section 16 and the body 1, as shown in FIG. 1*a*. Fluid entering the portion of the bore of the body 1 below the tubular member 13 which closes the bore will pass through a port 58 in the body 1 into the by-pass passage 54 as indicated by the arrows in FIG. 1*b*. Should the lower packer fail, the pressure fluid in the chamber C will be released through the by-pass passage 54 thereby preventing this pressure from raising the tool and damaging the tubing string.

As shown in FIG. 1*a* the upper tubular section 15 is made in two parts connected by means of the coupling members 59 and 60. The coupling member 60 provides a shoulder 60′ opposed to a stop ring 61 threadedly mounted on the body 1. The stop ring 61 supports the weight of the two sections 15 and 16 and parts connected therewith, when the tool is locked for positioning in the well as shown collectively in FIGS. 1, 1*a* and 1*b*. The body 1 may also be made of two parts which as shown in FIG. 1*a* joined by a coupling member 63.

With reference to FIG. 1*a* it will be seen that opposed ports 64 and 65 are provided in the body 1 and upper tubular section 15 respectively, above the cage 22. Port 65 in the section 15 is open at all times. Port 64 however, is closed as shown in FIG. 3, by being straddled by the sealing ring 57 and a similar sealing ring 66 on the lower tubular section 16. This action takes place when the body 1 is lowered to dispose the port between the rings 57 and 66. The port 64 when open provides for scavenging the well fluid from the tubing string and tool into the casing to prepare the tool for operation as will be hereinafter described.

Operation

When the tool with the parts thereof locked against relative axial movement as shown in FIGS. 1, 1*a* and 1*b*, has been positioned on the tubing string 2 at the selected zone of the well to be treated, the tubing string is lifted slightly and turned in a clockwise direction. This causes the coupling member 3 which is rotatively coupled to the body 1 to be correspondingly turned relative to the body 1 whereby the pin 52 on the member 3 is moved to the limit of its horizontal movement in the J-slot 51 in the locking sleeve 50. Continued clockwise turning of the string 2 and coupling member 3 causes the pin 52 to drive the locking sleeve 50 so as to turn in a clockwise direction. As the sleeve 50 is a continuation of the upper tubular section 15 of the sectional mounting means for the packers, the slip expander 40, slips 41, links 42 and rotative collar 42*a* also turn in a clockwise direction with the section 15. At this time the drag springs 14, by frictional contact with the casing 11 will restrain rotative movement of the sleeve 43 so that as the section 15 continues to turn in a clockwise direction, the locking pin 45 on the section 15 will be positioned in the J-slot 44 in the sleeve 43 for axial movement in such slot.

When the parts of the tool are unlocked as above described, the tubing string is lowered, thereby allowing the sectional mounting means (tubular sections 15 and 16) for the packers 8 and 9 to lower by the weight thereof, whereby the slip expander 40 carried by the upper section 15 will be lowered relative to the slips 41. As the slips are held against axial movement by the drag spring 14, it is apparent that the lowering of the expander 40 will cause the slips to be moved into anchoring engagement with the casing 11 to anchor the upper section 15 thereto. During this slip setting operation the packers 8 and 9 move axially in the well but are not expanded and thus are moved freely.

After the upper section 15 is thus held against axial movement, the body 1 is lowered relative thereto and through the shear pin 36 causes the lower section 16 to be lowered correspondingly. As the cage 22 is fixed to the upper end of the lower section 16, movement thereof relative to the upper section 15 as permitted by the slots 23 in the latter, will cause the upper packer to be compressed between the cage 22 and the thimble 17 on the lower end of the then stationary upper section 15, thereby expanding this packer into sealing contact with the wall 10 of the well.

During this downward movement of the lower section 16 to expand the upper packer 8, the lower packer 9 is moved bodily downwardly in the well but is not expanded at this time. However, when the force developed by this downward movement of the body 1 and section 16 in compressing and expanding the upper packer 8, exceeds the holding force of the shear pin 36, this pin will break off and permit the body 1 to be moved downwardly relative to the lower section 16. On this relative downward movement of the body 1, the lower packer 9 confined between the cage 28 and the thimble 27 on the lower end of the lower section 16 will be compressed and expanded into sealing contact with the wall of the well. This will form the pressure chamber C between the packers 8 and 9 in the annular space between the tool and the wall of the well.

After the slips 41 are set and the upper packer 8 has been expanded to seal against the well wall, but before the lower packer 9 has been expanded, the body 1 will not have been lowered sufficiently to close the by-pass port 64. Thus, the port 64 is open as shown in FIG. 2 and the tool may be prepared for operation by pumping fluid down the tubing string to scavenge the well fluid through the ports 64 and 65 into the casing. When it is determined by the usual method that this pressure fluid reaches the tool, the tubing string and body 1 are lowered in the manner hereinbefore noted to expand the lower packer 9.

When the lower packer 9 is expanded to seal against the well wall, the by-pass port 64 is disposed between the sealing rings 57 and 66 and thereby closed. The pressure fluid forced from the top of the well through the tubing string 2 will now pass through the port 12 into the pressure chamber C for such treatment of the formation as may be desired according to the nature of the fluid directed into the chamber C.

It should be noted that the constantly open by-pass 54 in the tool makes it possible to move the tool freely through fluid in the well during positioning, repositioning and removing the tool.

Fluid under extremely high pressure may be employed in the operation of this tool as the weight of the tubing string is not relied upon to counteract hydraulic up-thrust forces of the pressure fluid.

The weight of the tubing string is directly applied to the upper end of the lower packer 9 only, and any tendency of axial movement of lower packer 9 under the working pressure can be compensated by lowering the tubing string.

To release the tool for removal from the well or to reset it in a zone above or below the zone previously worked, the tubing string 2 and the body 1 as a unit are lifted. Upon this lifting of the body 1 the packers are sequentially retracted, in the reverse order to the setting thereof.

On the initial upward movement of the body 1 from the position shown in FIG. 3, the weight of the tubing string 2 is relieved from the top of the lower packer 9 and as the lift of the body continues this packer is fully retracted by being placed under tension while the upper packer remains compressed and tightly sealed against the well wall. The upper packer 8 remains compressed and sealed against the well wall due to the fact that the body 1 and cage 28 carried thereby are movable upwardly relative to the lower section 16 by reason of the tubular member 13 on

the cage being free to move upwardly in the slots 28' in the lower section 16. When the tubular member 13 reaches the tops of the slots 28', the lower packer 9 is fully retracted. Continued upward movement of the body 1 at this time causes the lower section 16 to be lifted for retracting the upper packer. As the cage 22 carried on the upper end of the lower section 16 is fixed to the upper end of the upper packer 8 while the lower end of the packer is fixed to the lower end of the then anchored upper section 15, it is apparent that the aforementioned continued upward movement of the body 1 and consequent upward movement of the lower section 16 will place the upper packer under tension and fully retract it.

During the retraction of the upper packer 8 the cage 22 on the lower section 16 moves freely upwardly in the slots 23 in the anchored upper section 15, without causing any movement of this upper section, thereby assuring that the slips 41 will remain in anchoring contact with the casing during the retraction of the upper packer.

When the top of the cage 22 reaches the top of the slot 23 in the upper section 15, this upper section will be raised as the lifting of the body 1 continues, whereby the expander 40 will be lifted relative to the slips 41 to thereby release the slips. When the slips have been released the pins 45 and 52 will be disposed at the tops of the J-slots 44 and 51 whereby counter clockwise turning of the body 1 as effected through the tubing string 2 will cause the pin 52 to move horizontally into locking position in the locking sleeve 50 so as to turn this sleeve and the upper section 15 correspondingly. As the upper section 15 carries the pin 45 it will be moved horizontally to locking position in the J-slot 44 in the sleeve 43, which latter is held against turning by the drag springs 14. With the tool locked in this manner it may be positioned at any desired point in the well for further operation or removed from the well.

I claim:

1. A well tool including: a tubular body and tubular means connected for relative axial movement; resilient sleeve packers axially spaced on said tubular means; said body having a port therein opening outside said tubular means between said packers; said tubular means including a pair of members connected for relative axial movement; means connecting the lower ends of said packers with said members; means for anchoring one of the members in the well; means releasably connecting the other of said members and said body for joint axial movement relative to said one member; means on said other member engaged with the upper end of the uppermost packer for compressing and expanding said packer responsive to said joint axial movement of said other member and body relative to said one member; said releasable means releasing said body for axial movement relative to said other member and being responsive to a predetermined load imposed on said releasable means by the axial movement of said body during said compression of said uppermost packer; and means on said body engaged with the upper end of the lowermost packer operable to compress and expand the lowermost packer responsive to said axial movement of said body relative to said pair of members.

2. A well tool as defined in claim 1, wherein said releasable means comprises frangible means coengaged with said body and said other of said members.

3. A well tool including: a tubular body and mounting means connected for relative axial movement; resilient sleeve packers axially spaced on said mounting means; said body having a port therein opening outside said mounting means between said packers; said mounting means including an outer tubular member and an inner tubular member telescopically connected for relative axial movement; means fixing the lower end of the upper packer to said outer tubular member; means fixing the lower end of the lower packer to said inner tubular member; means for anchoring said outer tubular member against axial movement in the well; means releasably connecting said inner tubular member and said body for limited joint axial movement relative to said outer tubular member; means on said inner tubular member for engaging the upper end of the upper packer to expand it into sealing contact with the wall of the well; said outer tubular member having longitudinal slots therein through which said last named means is extended for engaging said upper packer and in which said last named means is slidable; said last named means operating to expand said upper packer responsive to said joint axial movement of said inner tubular member and said body; said releasable means releasing said inner tubular member and said body for relative axial movement responsive to a predetermined load imposed on said releasing means during said expansion of said upper packer; said inner tubular member having longitudinal slots therein; and means on said body extended through said last named slots and engaged with the upper end of the lower packer for expanding the lower packer into sealing engagement with said wall, responsive to axial movement of said body relative to said tubular members.

4. A well tool as defined in claim 3, wherein said releasable means comprises frangible means coengaged with said body and said other of said members.

5. A well tool including: a tubular body and tubular means connected for relative axial movement; resilient sleeve packers axially spaced on said tubular means; said body having a port therein opening outside said tubular means between said packers; said tubular means including a pair of members connected for relative axial movement; means connecting the lower ends of said packers with said members; means for anchoring one of the members in the well; means releasably connecting the other of said members and said body for joint axial movement relative to said one member; means on said other member interlockingly coengaged with the upper end of the uppermost packer for compressing and expanding said packer and for retracting said packer responsive to said joint axial movement of said other member and body relative to said one member in opposite directions; said releasable means releasing said body for axial movement relative to said other member and being responsive to a predetermined load imposed on said releasable means by the axial movement of said body during said compression of said uppermost packer; and means on said body interlockingly coengaged with the upper end of the lowermost packer operable to compress and expand the lowermost packer and to retract said packer responsive to said axial movement of said body relative to said pair of members in opposite directions.

References Cited by the Examiner

UNITED STATES PATENTS

886,114	4/08	Collingwood	166—201 X
2,107,655	2/38	Vogt et al.	166—127
2,156,939	5/39	Fulkerson	166—140 X
2,190,442	2/40	Costello	166—119 X
2,223,099	11/40	Fisher	166—140
2,290,141	7/42	Burt	166—201 X
2,341,832	2/44	Verheul et al.	166—146
2,565,130	8/51	Humason	166—147
2,568,087	9/51	Page	166—129 X
2,618,340	11/52	Lynd	166—4
2,675,876	4/54	Conrad et al.	166—140
2,703,662	3/55	Austin	166—140 X

BENJAMIN HERSH, *Primary Examiner.*

BENJAMIN BENDETT, CHARLES E. O'CONNELL, *Examiners.*