

June 15, 1954

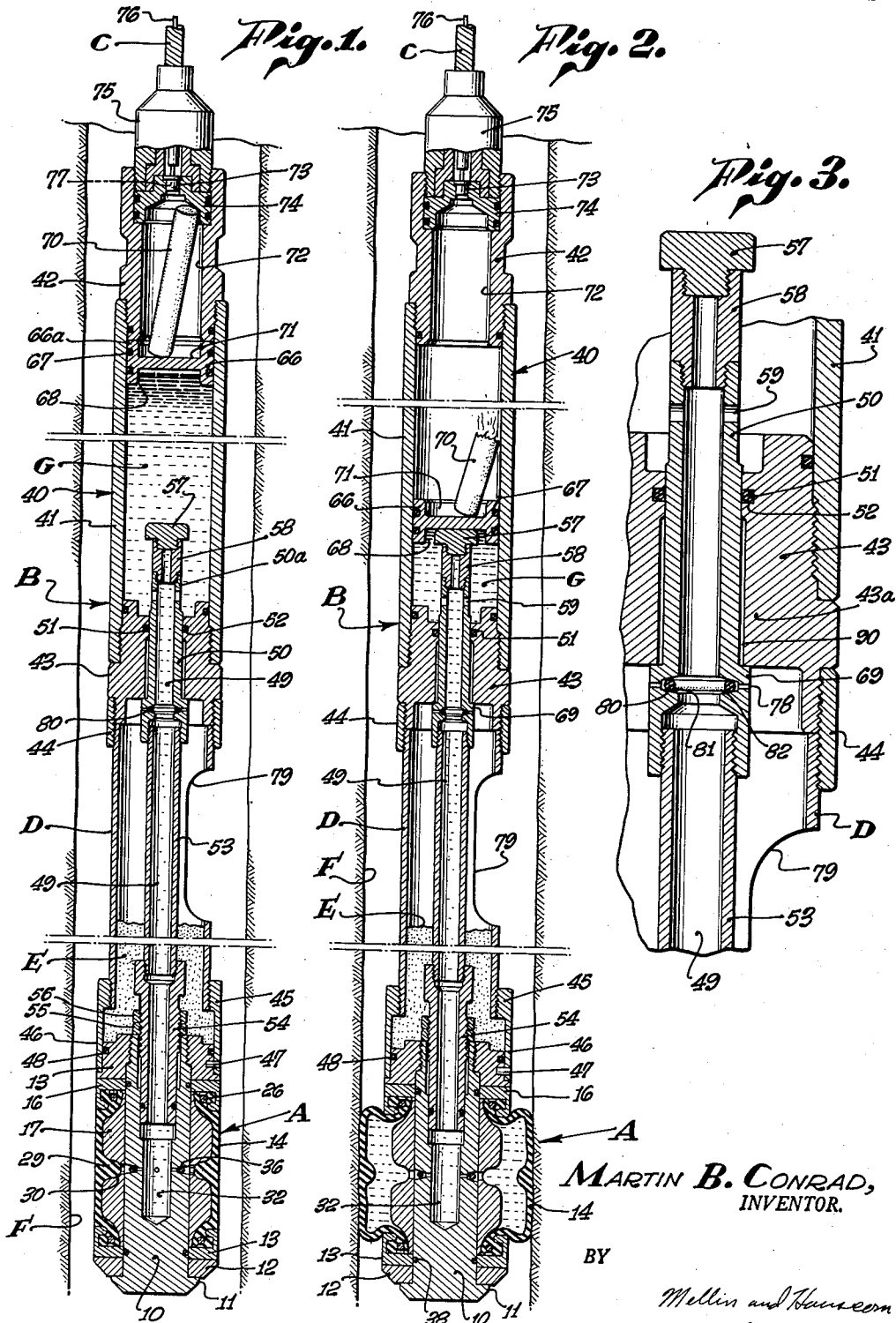
M. B. CONRAD

2,681,114

WELL PACKER AND SETTING APPARATUS

Filed Nov. 25, 1950

3 Sheets-Sheet 1



June 15, 1954

M. B. CONRAD

2,681,114

WELL PACKER AND SETTING APPARATUS

Filed Nov. 25, 1950

3 Sheets-Sheet 2

Fig. 4.

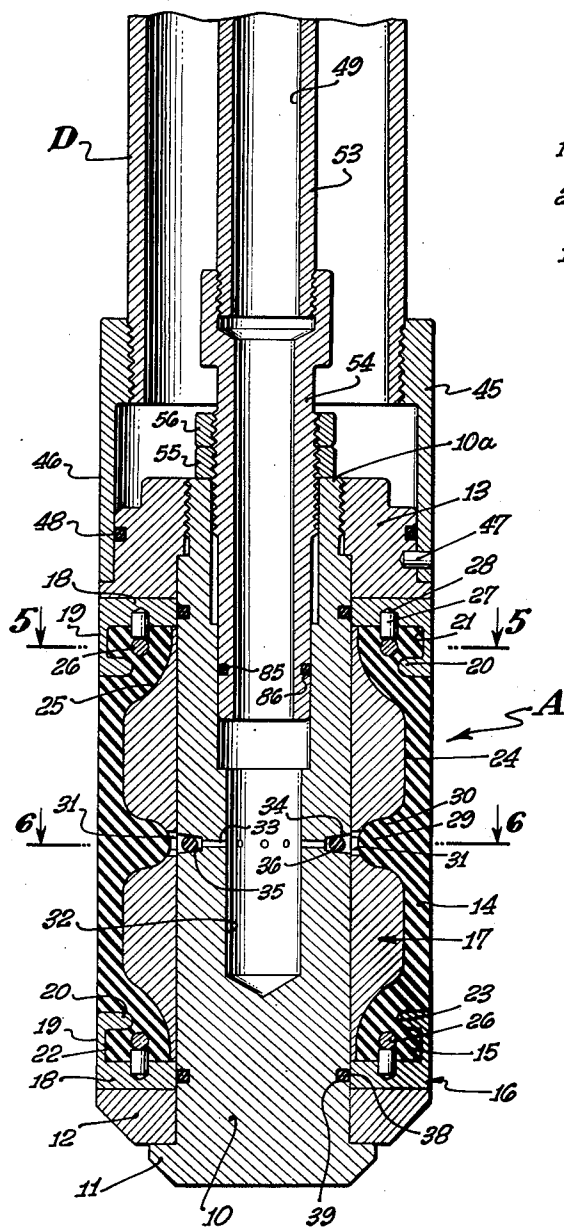


Fig. 5.

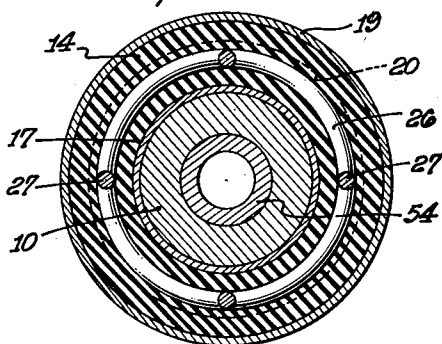


Fig. 6.

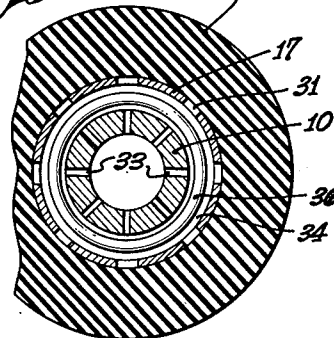
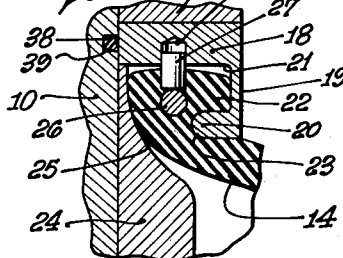


Fig. 7.



MARTIN B. CONRAD,
INVENTOR.

BY

Mellier and Humeon
ATTORNEYS

June 15, 1954

M. B. CONRAD

2,681,114

WELL PACKER AND SETTING APPARATUS

Filed Nov. 25, 1950

3 Sheets-Sheet 3

Fig. 8.

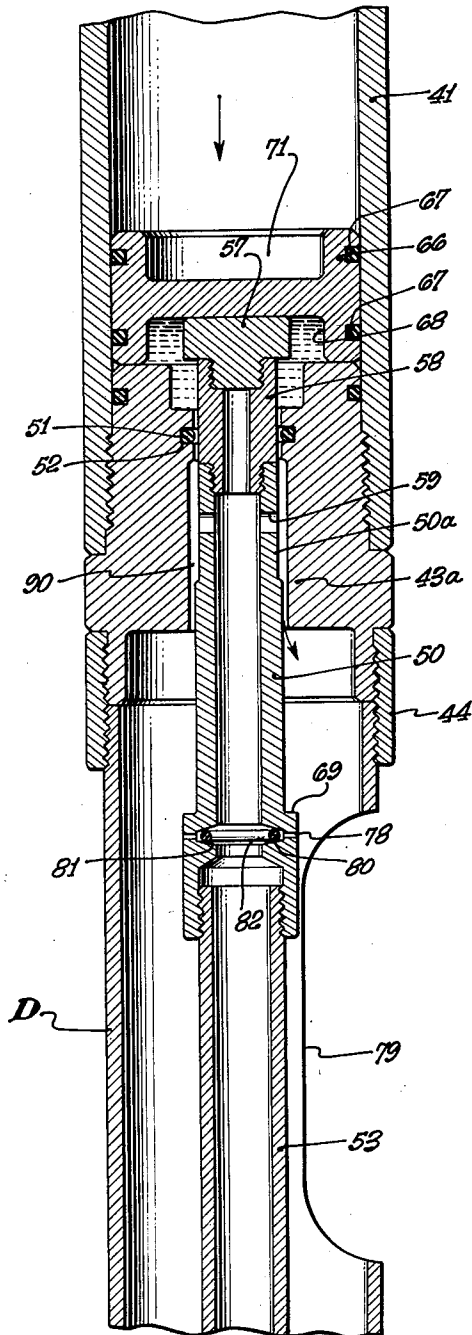
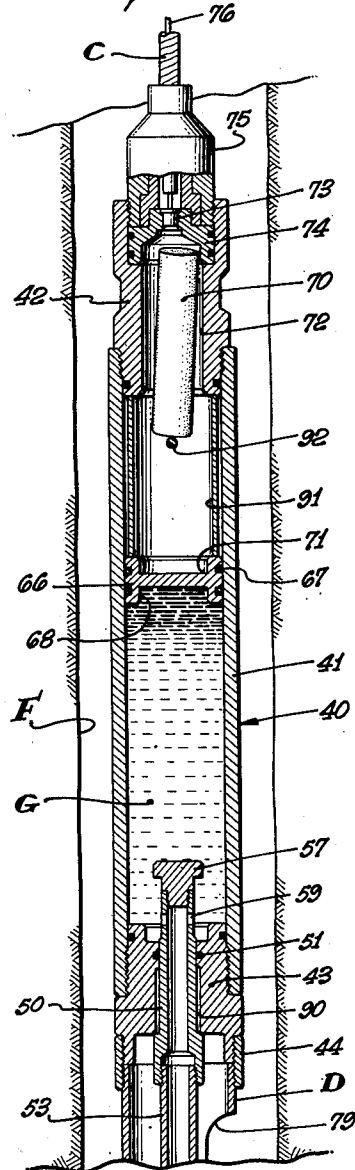


Fig. 9.



MARTIN B. CONRAD,
INVENTOR.

BY

Mellin and Houseman
ATTORNEYS

UNITED STATES PATENT OFFICE

2,681,114

WELL PACKER AND SETTING APPARATUS

Martin B. Conrad, Downey, Calif., assignor to
Baker Oil Tools, Inc., Vernon, Calif., a corpora-
tion of California

Application November 25, 1950, Serial No. 197,541

15 Claims. (Cl. 166—63)

1

The present invention relates to subsurface well apparatus, and more particularly to well packers and apparatus for setting such packers in bore holes.

In my prior application filed July 10, 1950, jointly with Reuben C. Baker, Serial No. 172,927, for "Well Packer, Setting Apparatus and Dump Bailers," a setting tool is employed capable of pumping a predetermined volume of fluid or fluent material into the packing element of a well packer, for the purpose of inflating or expanding the element considerably into sealing engagement with the wall of a confining well bore. The specific embodiments illustrated in the above application are effective in accomplishing the desired objectives and results. However, there are additional desirable features that are absent from such embodiments and which are included in the present invention.

Accordingly, an object of the present invention is generally to improve inflatable types of well packers and apparatus for setting them in bore holes.

Another object of the invention is to inflate and expand the packing element of a well packer by pumping a predetermined volume of fluid into the packing element, in which the quantity of such fluid pumped into the element can be adjusted or varied by the operator for the purpose of altering the extent to which the element can be inflated.

A further object of the invention is to inflate the packing element of the well packer by pumping a predetermined volume of fluid into the element, any excess fluid above that required being automatically by-passed and prevented from entering the packing element.

Yet another object of the invention is to provide improved and simplified apparatus for inflating a well packer in a well bore and for releasing a setting tool from the packer after a predetermined volume of inflating fluid has been pumped into the packer.

Still a further object of the invention is to provide a setting tool that inflates the packing element of the well packer in a well bore by pumping a fluid into it, the setting tool being automatically released from the well packer, in which the hydrostatic head of fluid in the well bore cannot tend to release the setting tool from the packer.

Another object of the invention is to provide a setting tool for inflating the packing element of a well packer by pumping a fluid into it, after which the setting tool becomes automatically re-

2

leased from the well packer, in which recoil effects in the setting tool, as a result of its release from the packer, are largely minimized.

A further object of the invention is to provide a piston arrangement in a setting tool for subsurface well apparatus, which makes it immaterial to the operation of the setting apparatus whether or not the piston is assembled reversely in the tool.

Another object of the invention is to provide a well packer embodying an inflatable packing element, in which the ends of the element are firmly secured to preclude their pulling out of their mounting or retaining members when subjected to comparatively high inflation pressures.

Yet another object of the invention is to provide a well packer embodying an inflatable packing element, in which the end portions of the element are pressed more firmly against the parts to which they are secured as the inflation pressure increases, in order to prevent leakage from the interior of the packing element.

Still a further object of the invention is to cause the end portions of the inflatable packing element of a well packer to become more firmly secured to the parts to which they are anchored as the inflating pressure increases, thereby precluding the end portions from pulling out of such parts.

Another object of the invention is to provide an inflatable packing element in a well packer which expands against the wall of the well bore with a greater longitudinal surface in contact with the well bore wall, thereby increasing the sealing effectiveness of the packing element against the wall.

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, 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 longitudinal section through an apparatus disposed in the well bore prior to setting of the packer portion;

Fig. 2 is a view similar to Fig. 1, disclosing the packer expanded against the well bore;

Fig. 3 is an enlarged longitudinal fragmentary

3

section of a portion of the apparatus disclosed in Fig. 1;

Fig. 4 is an enlarged longitudinal section through the packer portion of the apparatus, with its parts in retracted position;

Fig. 5 is a cross-section taken along the line 5—5 on Fig. 4;

Fig. 6 is a cross-section taken along the line 6—6 on Fig. 4;

Fig. 7 is a fragmentary longitudinal section disclosing the manner in which an end of the packing element of the packer is anchored;

Fig. 8 is a view corresponding to Fig. 3, illustrating the bleeding of excess packing inflating fluid from the apparatus;

Fig. 9 is a longitudinal section through a modified form of packer setting apparatus.

As described in the drawings, a well packer A is provided which is releasably secured to a setting tool B that is, in turn, attached to a lower end of a running-in string C, such as a wire line. The lower portion of the setting tool may be constituted as a bailer or container D capable of retaining cementitious material E for deposit upon the packer, after the latter has been set in the well bore F.

The combination of apparatus disclosed is so devised that the setting tool B will expand and set the packer A in the well bore, becoming released when it pumps a predetermined volume of a fluid G into the packer. Upon such release, the contents E of the bailer D are deposited upon the set packer.

As illustrated, the well packer A includes a central main body portion 10 having an annular flange or shoulder 11 upon which a lower body abutment 12 rests. An upper body abutment 13 is threadedly, or otherwise, attached to the upper end of the central body portion 10 in longitudinal spaced relation to the lower body abutment 12, providing a space around the central body for the accommodation of an inflatable packing element 14, of rubber, or rubber-like, material. The ends 15 of the packing element are secured to upper and lower retainers 16 engaging the upper and lower abutments 13, 12, respectively. The element is also disposed around a retainer and spacer sleeve 17 engaging the upper and lower retainers and holding them in spaced relation.

The upper and lower packing element retainers 16 and the end portions 15 of the spacer sleeve are alike, although oppositely arranged. Each retainer 16 has a disc-like base portion 18 engaging the body abutment 12 or 13, and is also provided with a longitudinally extending skirt portion 19 merging into an intumed flange 20, forming a space 21 with the base portion 18 into which an external flange 22 on the packing element extends. The intumed flange 20 fits into a circumferential space or groove 23 in the rubber packing element, the two flanges 20, 22, in effect, forming interlocking circumferential hooks anchoring the packing sleeve to the retainer.

The retainer and spacer sleeve 17 is mounted upon the central body portion 10, and may have a generally cylindrical external portion 24. Each end 25 of the sleeve is concave, tapering inwardly toward the retainer 16 and forming a space with the retainer flange 20 that decreases in the direction of divergence of the tapered surface 25.

Also disposed in each end portion 15 of the packing element 14 is a gripper ring 25, which is spaced longitudinally from the retainer base 18, and which initially occupies a position slightly longitudinally outward of the intumed flange 20.

4

The outside diameter of this ring 26 is substantially equal to, but slightly less, than the inside diameter of the intumed flange 20, to function in the manner described below. The ring itself may initially be held coaxially with the well packer by a plurality of centering pins 27 welded to the ring and slidably received in companion sockets 28 in the base 18 of the retainer 16.

As disclosed in the drawings, the packing element 14 is also provided with a central circumferential rib or flange 29 received within a companion external groove 30 in the spacer sleeve 17. This rib or flange has the purpose of causing the packing to be expanded or inflated flatwise against the wall of the well bore F, rather than only a narrow longitudinal extent of contact being obtained.

The entire packing structure may be made by mounting the upper and lower retainers 16 with the retainer sleeve grip rings 26 and centering pins 27 in a suitable mold (not shown), and with the packing structure parts occupying the relative positions described in Fig. 4. The packing element 14 may then be molded around the spacer sleeve 17 and in the spaces between the sleeve 17 and the upper and lower retainers 16, the grip rings 26 being completely embedded in the rubber or rubber-like material. Of course the periphery of the rubber sleeve 14 may be molded to the desired form, such as the cylindrical surface disclosed in the drawings, substantially coinciding with the cylindrical surfaces of the retainers 16. Some of the rubber material may also extend into radial ports 31 disposed centrally in the spacer sleeve 17.

The packing element 14 is designed for outward expansion under the influence of fluid under pressure pumped or forced into its interior, such fluid under pressure passes into a central passage 32 in the body, and through radial body ports 33 and the spacer sleeve ports 31 to the interior of the packing. The subjecting of the fluid to high pressure will stretch and inflate the packing element 14 in a lateral direction toward sealing engagement with the wall of the confining enclosure F, such as the wall of an uncased well bore. However, when such inflation takes place, the inflating fluid, or fluent materials, must be prevented from flowing back out of the inflated sleeve 14. This action is forestalled by providing a check valve across the body ports.

As illustrated, the body ports 33 open into a peripheral or circumferential body groove 34 having tapered side walls 35 converging inwardly toward each other. The back pressure valve 36, in the form of a round rubber seal ring, or O ring, is disposed in the groove 34 and tends inherently to contract into snug sealing engagement with the tapered walls 35 of the groove. Such engagement occurs with the O ring 36 disposed somewhat outwardly of the outer ends of the body ports 33.

When fluid under pressure is forced through the body passage 32 and ports 33, it will enter the inner portion of the peripheral groove 34. This pressure will then stretch the back pressure valve ring 36 outwardly, to allow the fluid to pass around the ring and into the outer large portion of the tapered groove 34, from where it can flow through the spacer ports 31 to the interior of the packing sleeve 14. When the internal pressure is released, the valve member 36 contracts into snug engagement with the tapered walls 35 of the groove, and prevents the fluid from flowing in a reverse direction through the body ports 33.

The fluid is also prevented from escaping along

5

the spacer sleeve 17 and body 10 to the exterior of the packer, by providing seal rings 38 in grooves 39 in the central body portion engaging the upper and lower retainers 16.

As fluid is pumped into the packing sleeve 14, it is inflated and stretched outwardly into engagement with the wall of the well bore F. The central circumferential rib or flange 29 prevents the central portion of the packing element from first engaging the well bore wall along a comparatively narrow wall length, such as tends to occur in the absence of the rib. The much thicker section of the packing element presented by the central rib 29 resists concentration of the expansible force at that particular portion of the packing sleeve, and causes expansion of the sleeve 14 to take place along an extended portion of its length in cylindrical fashion into sealing engagement with the wall of the well bore. As a result, a much greater area of sealing contact is obtainable between the exterior of the packing element 14 and the wall of the well bore F, even under a comparatively low pressure and inflating condition, such as occurs when the packing element is expanded outwardly to a comparatively large diameter, which, for example, may be two to three times its initial retracted diameter.

During the inflation of the packing element 14 there may be a tendency for its ends 15 to pull out of the retainers 16. As inflation occurs, the flange portions 22 of the packing element at each end move toward each other, shifting the grip rings 26 toward the inturned flanges 20 of the retainers 16. Each grip ring 26 has a diameter that is only slightly less than the internal diameter of its associated flange 20. The movement of the grip ring 26 toward the flange 20 causes it to grip or pinch intervening rubber packing material between it and the inturned flange (see Fig. 7). In addition, as the grip ring 26 is moved longitudinally, it comes closer to the tapered portion 25 of the retainer and spacer sleeve 17, also pinching and clamping the rubber material between it and the spacer sleeve. Thus, it is apparent that the grip rings 26 are effective in more securely anchoring the ends 15 of the packing sleeve to their companion elements 16, 17, precluding pulling out of such ends under the normal pressures employed in fully expanding the packing 14 into sealing engagement with the wall of the well bore, F.

The flanged ends 22 of the packing sleeve 14 form a seal with the retainer flanges 20, to prevent leakage of fluid from the interior of the packing sleeve around its ends to the exterior of the packing sleeve. As expansion of the sleeve 14 takes place, the force of engagement between each inturned flange 20 and the packing sleeve increases, which increases the sealing effectiveness between these parts. Such sealing effectiveness is further enhanced by the clamping of the grip ring 26 upon the packing sleeve, forcing the latter more firmly against the inturned flange 20.

Inflation of the packer A is accomplished through use of the setting tool B lowered with the packer into the well bore F. This setting tool includes a cylinder 40, consisting of a cylinder sleeve 41 threaded onto an upper head 42 and also onto a lower head 43. The lower head is threaded into a coupling 44 threadedly receiving a lower setting sleeve D, or bailer or container, having a sleeve 45 threaded on its lower end and encompassing a cylindrical portion 46 of the upper body abutment 13. This sleeve 45 is initially secured to the body abutment 13 by one or more shear

6

screws 47. Leakage between such sleeve and the body abutment is prevented by a suitable seal ring 48, such as an O ring, mounted in the abutment 13 and engaging the inner wall of the sleeve 45.

The cylinder 40 contains the fluent material G, such as a liquid, which also fills the passage 49 through a compression tube 50 extending centrally through the lower head 43. Leakage between the lower head and compression tube is prevented by use of a suitable seal 51 mounted in a groove 52 in the head 43 and slidably engaging the exterior of the compression tube 50. The compression tube is threaded onto the upper end of a tubular extension 53, which is, in turn, threaded into a thrust tube or nipple 54 extending into the upper end of the packer body 10. The nipple has a stop nut 55 threaded upon it engaging the upper end 10a of the body 10, the stop and thrust nut being locked in position on the nipple by a suitable lock nut 56.

The upper end of the compression tube 50 may have a cap 57 threaded directly into it; or a spacer member 58 may be threaded into the compression tube 50 and the cap 57 secured to the spacer member.

As stated above, the liquid G fills the cylinder 41, being capable of passing through parts 59 in the compression tube above the lower cylinder head 43 into the central passage 49 through the compression tube 50, tubular extension 53, nipple 54 and body passage 32, as well as the ports 33 in the latter, the tapered groove 34 and the sleeve port 31. A floating or pumping piston 66 rests upon the upper end of the liquid G in the cylinder 40, suitable piston rings 67 being provided on the piston for sliding engagement with the cylinder sleeve 41. The piston 66 is H-shaped in cross-section, providing a lower chamber 68 into which some air may be compressed upon filling the cylinder 40 with the liquid G; so as to allow increases in temperature of the liquid to increase the volume of the liquid without subjecting the packing sleeve 14 to any material pressure. It is apparent that as the floating piston 66 is forced downwardly in the cylinder sleeve 41, the liquid G is forced out of the cylinder and through the tubular members 50, 53, 54 into the packer body 10, passing into the interior of the packing sleeve 14, inflating the latter to a desired extent.

The parts are originally held in place as illustrated in Fig. 1, with the screws 47 intact, the appropriate location of the parts being insured by engagement of a shoulder 69 on the compression tube 50 with the underside of the lower cylinder head 43. Downward movement of the floating piston 66, for the purpose of forcing the liquid G downwardly and inflating the packing element 14, is provided as a result of the combustion of a power charge 70 containing its own source of oxygen. This power charge rests upon the floating piston 66 within an upper recess 71 of the latter, and is initially disposed within a compression chamber 72 in the upper cylinder head 42. The upper end of the power charge is ignited by firing a cartridge 73 disposed within a gun barrel 74 clamped between the cylinder head 42 and a cable head 75 threaded into the latter. The wire line cable C is attached to the cable head 75, in a known manner, and has an electrically conductive wire or core 76 connected to a heating filament 77 in the cartridge.

During lowering of the apparatus through the fluid in the well bore, the hydrostatic head acting on the exterior of the packing element 14 in-

creases. It is desired to neutralize the hydrostatic head, and for this reason the well fluid is allowed to enter the tubular members 50, 53, 54 through ports 78 that may be provided in the compression tube 50 below the lower cylinder head 43. Thus, the well fluid can pass through a window or opening 79 in the dump bailer container D and thence through the ports 78, this pressure being exerted upon the liquid G in the tubular members 50, 53, 54, as well as within the packing 14 itself. However, when pressure is being applied by the floating piston 66 to the liquid G in the apparatus, the ports 78 are to be closed, to prevent escape of fluid G from the apparatus. For this reason, the ports are controlled by a one-way check or back pressure valve 80, which may be similar to the check valve 36 located in the packer A, although acting in a reverse direction.

The compression tube 50 may be provided with an inner circumferential groove 81 communicating with the radial ports 78. This groove has tapered side walls 82 converging in an outward direction toward each other. The O ring check valve member 80 is disposed within this groove 81 and tends to expand outwardly into engagement with the tapered side walls 82. Pressure exerted within the compression tube 50 in excess of the hydrostatic head externally thereof forces the O ring against the tapered side walls 82 and prevents the fluid from flowing outwardly through the ports 78, but when the hydrostatic head or fluid in the well bore overbalances the fluid pressure within the tubular members 50, 53, 54, the O ring 80 is urged inwardly out of sealing engagement with the tapered side walls 82, and allows the hydrostatic pressure to be exerted upon the liquid G in the apparatus.

The apparatus is assembled with the parts occupying the relative position illustrated in Fig. 1. Prior to attachment of the setting tool B to the well packer A, the liquid G is placed in the setting tool, with the floating piston 66 adjacent the upper cylinder head 42. Since the upper and lower portions of the piston are symmetrical, it is immaterial which end of the piston is first placed in the cylinder 40. The end 66a of the piston will engage the upper cylinder head 42, with the power charge 70 resting within the upper cup portion 71 of the piston. The lower cup portion 68 of the piston will provide the desired air chamber that will allow expansion of the fluid G upon increase in its temperature.

The setting tool B is then assembled appropriately on the packer A, the nipple 54 being piloted in the central body bore 32 until the stop nut 55 engages the upper end 10a of the body. A seal ring 85 is disposed in a nipple groove 86 and engages the wall of the body bore, to prevent leakage of fluid in an upward direction around the nipple. The screws 47 are then threaded into the setting sleeve 45 and upper abutment 13. The apparatus is then lowered into the well bore F. In the event that the bore hole contains fluid, the hydrostatic head is equalized by the fluid pressure being imposed upon the liquid G, through the expedient of passing through the ports 78 and unseating the upper check valve 80. As a result, the pressure both internally and externally of the packer portion A of the apparatus, as well as the setting tool portion B, is equalized until the well packer is being set.

When the setting location in the well bore F is reached, the electrical circuit through the fil-

ament 77 is completed, firing the cartridge 73 and causing the flame issuing from it to ignite the upper end of the power charge 70. This latter combustible fuel commences burning and generates a gas at a gradually increasing pressure. This gas under pressure acts downwardly on the floating piston 66, which begins to move downwardly in the cylinder sleeve 41, forcing the liquid G ahead of it. The liquid in the tool is subjected to pressure, as a result of the movement of the floating piston 66, greater than the hydrostatic head of fluid in the well bore F. This pressure holds the upper check valve ring 80 in closed position against the tapered walls 82 of the circumferential groove 81 and effectively closes the upper ports 78. The pressure also acts in an outward direction upon the lower check valve O ring member 36, urging the valve 36 out of engagement with the tapered seats 35, and allowing the fluid to flow around the valve 36, through the spacer sleeve ports 31 into the interior of the packing element 14. As the pressure increases, the fluid G pumps or inflates the packing element 14 in an outward direction, until it contacts the wall of the well bore F along an extended longitudinal length, whereupon the packing element may elongate along the well bore wall in up and down directions.

As the floating piston 66 moves downwardly, because of the continued burning of the power charge 70, it forces the liquid G ahead of it, and approaches the stop cap 57 at the upper portion of the compression tube 50 or spacer member 52. When the floating piston 66 engages the cap 57, a predetermined volume of fluid G has been pumped into the packing element 14. As the power charge 70 continues to burn, it builds up an increasing pressure in the cylinder 40 above the piston 66. This pressure is now exerted directly upon the cap 57, spacer member 58 (if one is used), compression tube 50, tubular extension 53, nipple 54 and stop nut 55 directly upon the packer body 10. When the gaseous pressure force exceeds the shear strength of the screws 47, it disrupts them, thereby releasing the setting tool B from the well packer A. After the shear screws 47 have been disrupted, the setting tool B may be elevated to the top of the hole and used again with another packer in another well bore. If the setting tool B includes the bailer portion D containing cementitious material E, the elevation of the setting tool B, following shearing of the screws 47, will allow the cementitious material E to be dumped from the bailer upon the set packer A.

It is to be noted that a certain quantity of liquid G remains below the floating piston 66 upon its contact with the compression tube cap 57, and that the piston and compression tube move downwardly after the shear screws 47 have been disrupted, until the piston 66 engages the lower cylinder head 43. Inasmuch as it is desired to inflate the packing element 14 to a predetermined extent, by pumping only a fixed volume of fluid G into it, substantially all of the fluid G below the piston, following its engagement with the cap 57, is bled to the exterior of the apparatus. As a result, the volume of fluid G pumped into the packing 14 is the volume of liquid displaced by the piston 66 in moving from its uppermost position to a position in engagement with the cap 57. By varying the length of the spacer member 58 secured to and between the compression tube 50 and cap 57, the displace-

ment volume of the piston 66 can be varied, which correspondingly alter the volume of fluid G pumped into the packing element 14. Of course, the spacer member 53 may be eliminated and the cap 57 screwed directly into the compression tube 50, under which condition the floating piston 66 will pump a maximum quantity of fluid G into the packing 14.

The excess fluid G below the piston 66, upon its engaging the cap 57, is bled to the exterior of the apparatus after shearing of the screws 47, which allows the compression tube 50 to move downwardly in the lower cylinder head 43. During the downward movement of the piston 66 in the cylinder 40 to inflate the packing element 14, the seal ring 51 prevents leakage of the fluid downwardly around the exterior of the compression tube 50. However, the upper portion 50a of the compression tube has a reduced diameter and the lower cylinder head portion 43a below the seal ring has a larger diameter; so that the downward movement of the compression tube 50 will bring its smaller diameter portion 50a adjacent the seal ring 51, which cannot engage it, and which will, therefore, allow the excess fluid G to flow between such portion of the seal ring and then downwardly through the annular space 90 between the cylinder head 43a and the compression tube 50 into the bailer portion D of the apparatus. The longer the spacer member 52 the greater will be the quantity of fluid that must be bled out between the compression tube 50 and the lower cylinder head 43. When the cap 57 is threaded directly into the compression tube 50, in order to obtain maximum expansion of the packing element 14, there is very little fluid G remaining below the piston 66, following its engagement with the cap 57, and the bleeder or by-pass feature may be omitted, if desired.

In place of varying the volume of fluid G pumped into the packing element 14 by using spacer member 53 of different lengths, the volume may be varied by providing a sleeve 91 between the floating piston 66 and the upper cylinder head 42, such as disclosed in Fig. 9. A pin 92 may extend across the sleeve 91, to support the power charge 70 in the combustion chamber 72. The sleeve selected is of such length as to determine the volume of fluid in the cylinder 40 below the piston 66, and the amount displaced by the piston as it moves into engagement with the compression tube cap 57, which is threaded directly into tube 50. As the power charge 70 burns, the piston 66 is forced downwardly in the cylinder, forcing the liquid G ahead of it, causing it to flow through the compression tube ports 59 and tubular passages 49, and through the side ports 33, 31 into the packing sleeve 14, to inflate the latter. When the piston 66 engages the cap 57, an increase in the pressure within the cylinder 40, as a result of the combustion of the power charge 70, will shear the screws 47 and force the tube 50 downwardly, until the piston 66 and cap 57 engage the lower cylinder head 43, as disclosed in Fig. 8.

When the piston 66 engages the cap 57 there is very little distance remaining for such piston to travel, following shearing of the screws 47, before the piston 66 contacts the lower cylinder head 43. As a result, the sudden release of the force on the piston 66, because of shearing of the screws 47, will not result in a substantial impact blow by the piston 66 against the lower cylinder head 43, since it has a short distance to travel and cannot acquire sufficient momen-

tum. Accordingly, such impact on the setting mechanism is minimized, following the disruption of the shear screws 47 and release of the setting tool B from the well packer A.

In the form of invention disclosed in Fig. 9, it is only necessary to alter the length of the spacer sleeve 91 to predetermine the volume of fluid G pumped into the packing sleeve 14, and govern positively the extent of its inflation.

The well packer A is both described and claimed in my divisional application for "Well Packer," Serial No. 368,769, filed July 17, 1953.

The inventor claims:

1. In a tool for setting a well packer in a well bore: a cylinder for containing a fluent material; a piston in said cylinder to force the fluent material out of said cylinder; means for conducting the fluent material from said cylinder; means engageable and movable by said piston to arrest movement of said piston in said cylinder in a direction forcing the material from said cylinder; said last mentioned means providing a by-pass shifted to open position by said piston upon engagement of said last mentioned means by said piston, to enable escape of the fluent material from said cylinder.

2. In a tool for setting a well packer in a well bore: a cylinder for containing a fluent material and having a lower cylinder head; said cylinder having an upper head; means on said upper head attachable to a running-in string for lowering the tool in the well bore; means on the lower head for connecting said lower head to the well packer; a tubular member slidable through said lower cylinder head for conducting the material from said cylinder; a piston movable in said cylinder to force the fluent material out of said cylinder and into said tubular member; and means providing a seal between said tubular member and lower head.

3. In a tool for setting a well packer in a well bore: a cylinder for containing a fluent material and having a lower cylinder head; said cylinder having an upper head; means on said upper head attachable to a running-in string for lowering the tool in the well bore; a tubular member slidable through said lower cylinder head for conducting the material from said cylinder; a piston movable in said cylinder to force the fluent material out of said cylinder and into said tubular member; said tubular member and lower cylinder head cooperatively providing a by-pass operable for the passage of fluent material upon engagement and shifting of said member by said piston relative to said lower cylinder head.

4. In a tool for setting a well packer in a well bore: a cylinder for containing a fluent material and having a lower cylinder head; said cylinder having an upper head; means on said upper head attachable to a running-in string for lowering the tool in the well bore; means on the lower head for connecting said lower head to the well packer; a tubular member slidable through said lower cylinder head for conducting the material from the cylinder; a piston movable in said cylinder to force the fluent material out of the said cylinder and into said tubular member; and means engageable with said piston for positively determining the length of travel of said piston into engagement with said tubular member.

5. In a tool for setting a well packer in a well bore: a cylinder for containing a fluent material and having a lower cylinder head; said cylinder having an upper head; means on said upper head attachable to a running-in string for lowering

11

the tool in the well bore; means on the lower head for connecting said lower head to the well packer; a tubular member slidable through said lower cylinder head for conducting the material from said cylinder; a piston movable in said cylinder to force the fluent material out of said cylinder and into said tubular member; and means connected to said tubular member for determining the amount that said tubular member extends into said cylinder.

6. In a tool for setting a well packer in a well bore: a cylinder for containing a fluent material and having a lower cylinder head; said cylinder having an upper head; means on said upper head attachable to a running-in string for lowering the tool in the well bore; means on the lower head for connecting said lower head to the well packer; a tubular member slidable through said lower cylinder head for conducting the material from the cylinder; a piston movable in said cylinder to force the fluent material out of said cylinder and into said tubular member; and means in said cylinder engageable with said piston to determine the initial position of said piston in said cylinder.

7. In a tool for setting a well packer in a well bore: a cylinder for containing a fluent material and having a lower cylinder head; said cylinder having an upper head; means on said upper head attachable to a running-in string for lowering the tool in the well bore; means on the lower head for connecting said lower head to the well packer; a tubular member slidable through said lower cylinder head for conducting the material from said cylinder; a piston movable downwardly in said cylinder to force the fluent material out of said cylinder and into the tubular member; and spacer means above and engageable with said piston to determine the initial position of said piston in said cylinder.

8. In a tool for setting a well packer in a well bore: a cylinder for containing a fluent material and having a lower cylinder head; said cylinder having an upper head; means on said upper head attachable to a running-in string for lowering the tool in the well bore; a tubular member slidable through said lower cylinder head for conducting the material from said cylinder; a piston movable downwardly in said cylinder to force the fluent material out of said cylinder and into the tubular member; spacer means above and engageable with said piston to determine the initial position of said piston in said cylinder; and means in said cylinder above said piston providing a gaseous force for urging said piston downwardly in said cylinder.

9. In a tool for setting a well packer in a well bore: a cylinder for containing a fluent material and having a lower cylinder head; said cylinder having an upper head; means on said upper head attachable to a running-in string for lowering the tool in the well bore; a tubular member slidable through said lower cylinder head for conducting the material from said cylinder, said member having a side inlet port above said lower cylinder head for the entry of said fluent material; and a piston movable downwardly in said cylinder to force the fluent material out of said cylinder and through said port into said tubular member, said piston engaging said member to slide said member downwardly in said lower cylinder head.

10. In a tool for setting well apparatus in a well bore: a cylinder for containing a fluent material; a piston slidable in said cylinder; said piston

12

being H-shaped in cross-section and having a central cup-shaped upper portion and a central cup-shaped lower portion engageable with the upper end of the fluent material; and a source of gaseous pressure in said cylinder above said piston.

11. In a tool for setting well apparatus in a well bore: a cylinder for containing a fluent material; a piston slidable in said cylinder; said piston being H-shaped in cross-section and having a central cup-shaped upper portion and a central cup-shaped lower portion engageable with the upper end of the fluent material; and a combustible material in stick form resting in the cup-shaped upper portion of said piston.

12. In apparatus of the character described: a well device embodying hydraulically operable means movable by fluid under pressure; a tool connected with said well device and including a cylinder for containing a fluent material and in fluid communication with said hydraulically operable means, a piston in said cylinder to force the fluent material out of said cylinder and into said hydraulically operable means to shift said hydraulically operable means, means engageable by said piston to arrest movement of said piston in said cylinder in a direction forcing the material from said cylinder, said arresting means providing a by-pass shifted to open position by said piston upon engagement of said arresting means by said piston, to enable escape of the fluent material from said cylinder.

13. In apparatus of the character described: a well device embodying hydraulically operable means movable by fluid under pressure; a tool connected with said well device and including a cylinder for containing a fluent material and in fluid communication with said hydraulically operable means, said cylinder having a cylinder head, a tubular member slidable through said cylinder head for conducting the material from said cylinder to said well device and its hydraulically operable means, a piston movable in said cylinder to force the fluent material out of said cylinder and into said tubular member and hydraulically operable means to shift said hydraulically operable means, said tubular member and head cooperatively providing a by-pass for the fluent material upon engagement and shifting of said member by said piston.

14. In a tool for setting a well packer in a well bore: a cylinder for containing a fluent material and having a lower cylinder head; said cylinder having an upper head; means on said upper head attachable to a running-in string for lowering the tool in the well bore; means on the lower head for connecting said lower head to the well packer; a tubular member slidable through said lower cylinder head for conducting the material from said cylinder; a piston movable in said cylinder to force the fluent material out of said cylinder and into said tubular member; means providing a slidable seal between said tubular member and head; said tubular member being engaged and shifted by said piston to a position disrupting said seal to allow the fluent material to pass out of said cylinder between said tubular member and head.

15. In a tool for setting a well packer in a well bore: a cylinder for containing a fluent material and having a cylinder head; a tubular member slidable through said cylinder head for conducting the material from said cylinder; a piston movable in said cylinder to force the fluent material out of said cylinder and into said tubular mem-

13

ber; means providing a slidable seal between said tubular member and head; said tubular member having a reduced diameter portion; said tubular member being engaged and shifted by said piston to a position disrupting said seal and placing said reduced diameter portion opposite said head to allow the fluent material to pass out of said cylinder between said reduced diameter portion and head.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,523,286	Railsback	Jan. 13, 1925

15

Number
1,994,072
2,058,069
2,098,484
2,099,048
2,179,017
2,189,445
2,196,656
2,279,676
2,373,006
2,377,249
2,409,811
2,482,913
2,618,344

14

Name	Date
Hardcastle	Mar. 12, 1935
Dyer	Oct. 20, 1936
Brundred et al.	Nov. 9, 1937
Burns et al.	Nov. 16, 1937
Pieper	Nov. 7, 1939
Dale	Feb. 6, 1940
Burt	Apr. 9, 1940
Hart	Apr. 14, 1942
Baker	Apr. 3, 1945
Lawrence	May 29, 1945
Taylor et al.	Oct. 22, 1946
Jobe	Sept. 27, 1949
Turechek et al.	Nov. 18, 1952