May 5, 1964 J. F. MUSE ETAL 3,131,764

HIGH TEMPERATURE PACKER FOR WELL BORES

Filed Dec. 11, 1961 4 Sheets-Sheet 1

FIG. 1.

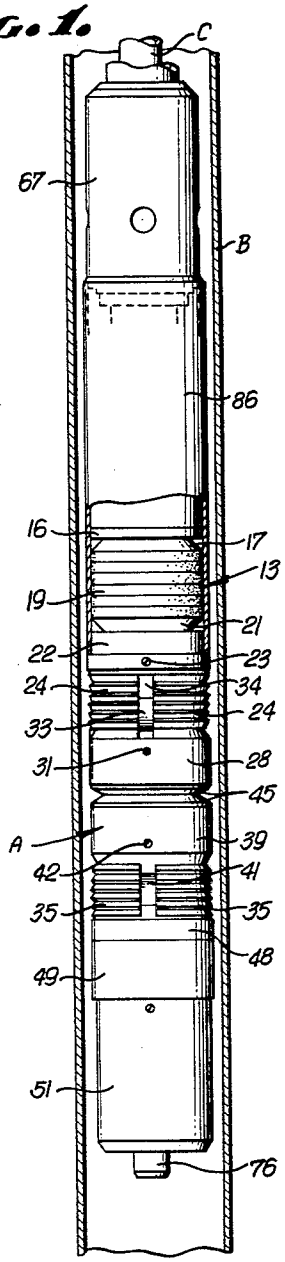

FIG. 3.

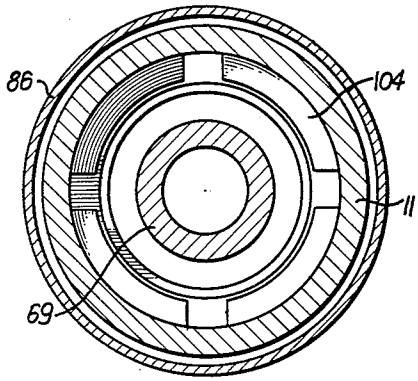

FIG. 4.

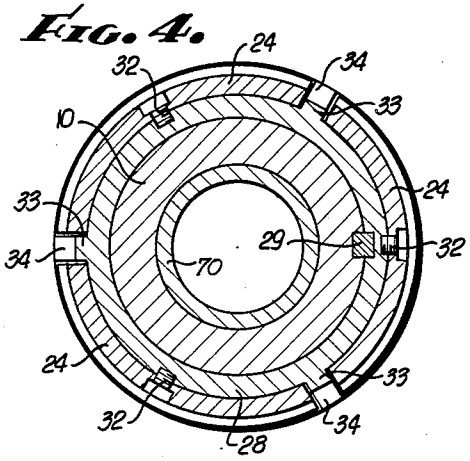

FIG. 5.

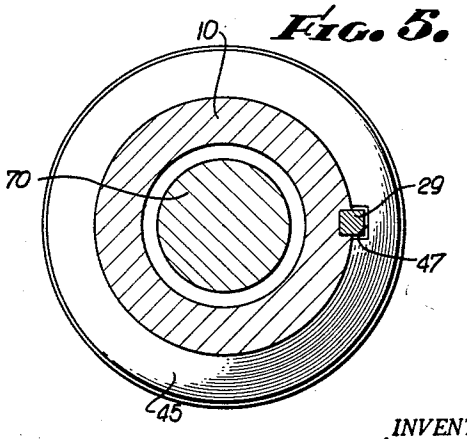

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FIG. 2.

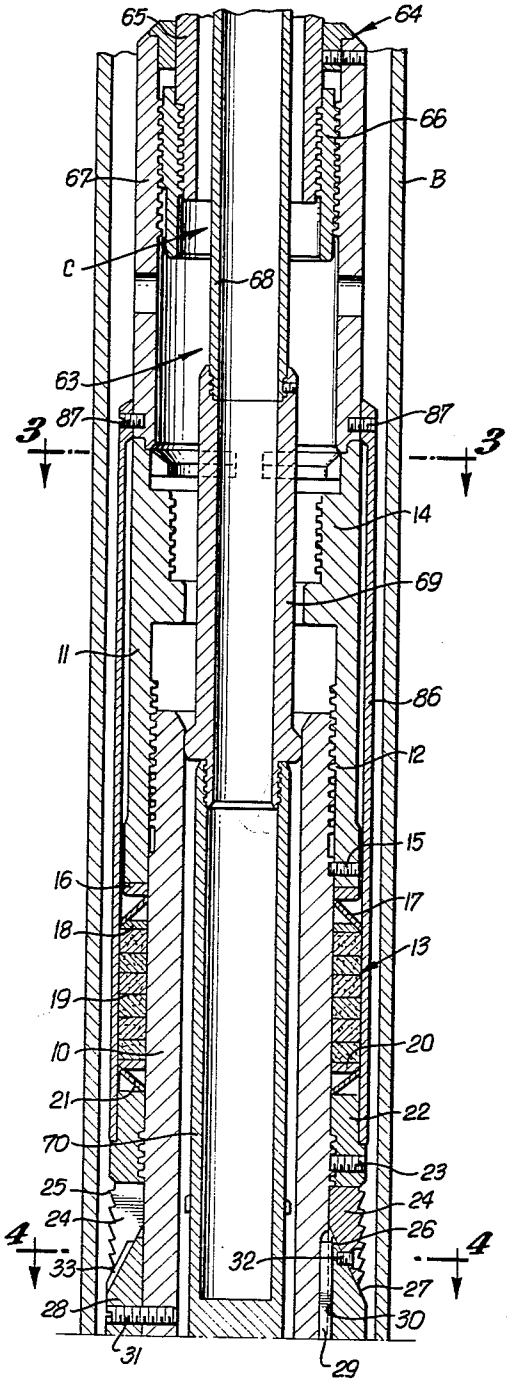

FIG. 2a.

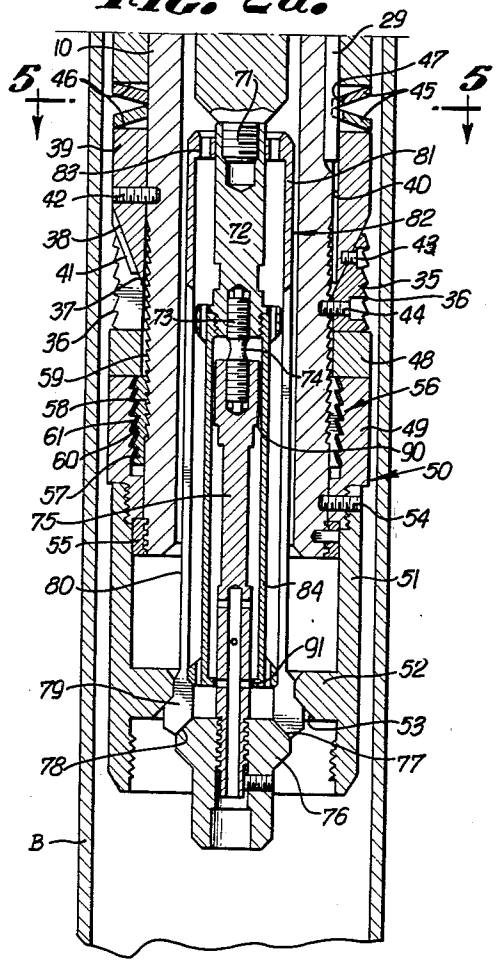

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FIG. 6.

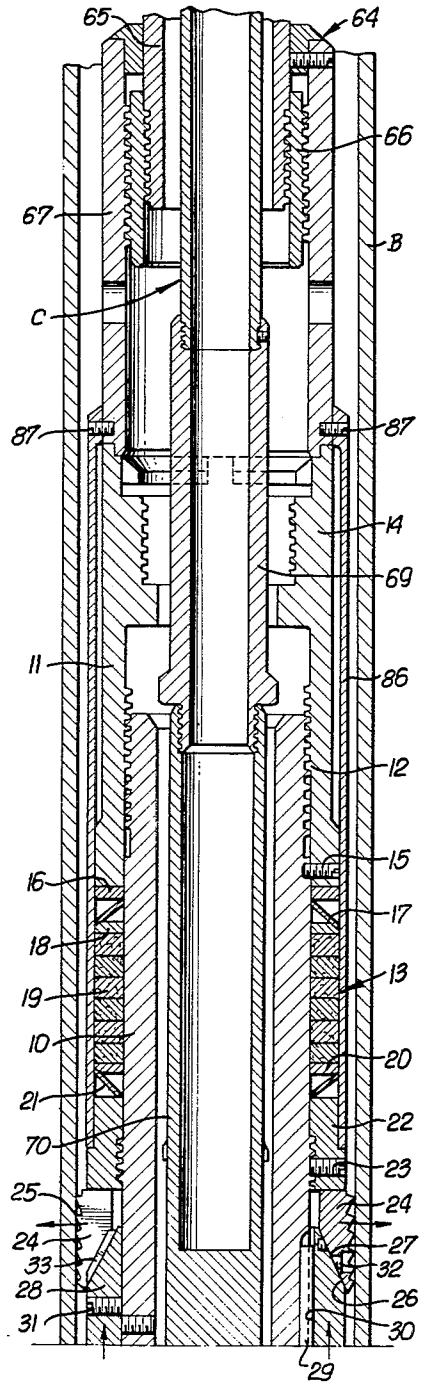
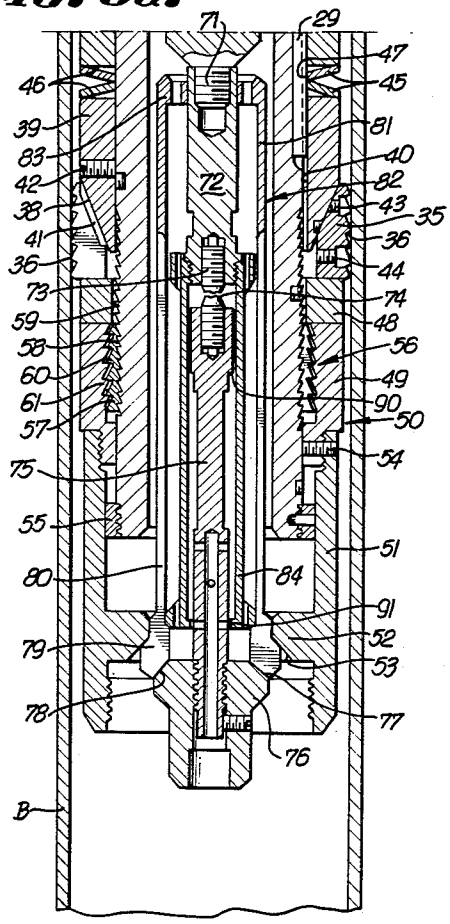


FIG. 6a.



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HIGH TEMPERATURE PACKER FOR WELL BORES

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FIG. 1.

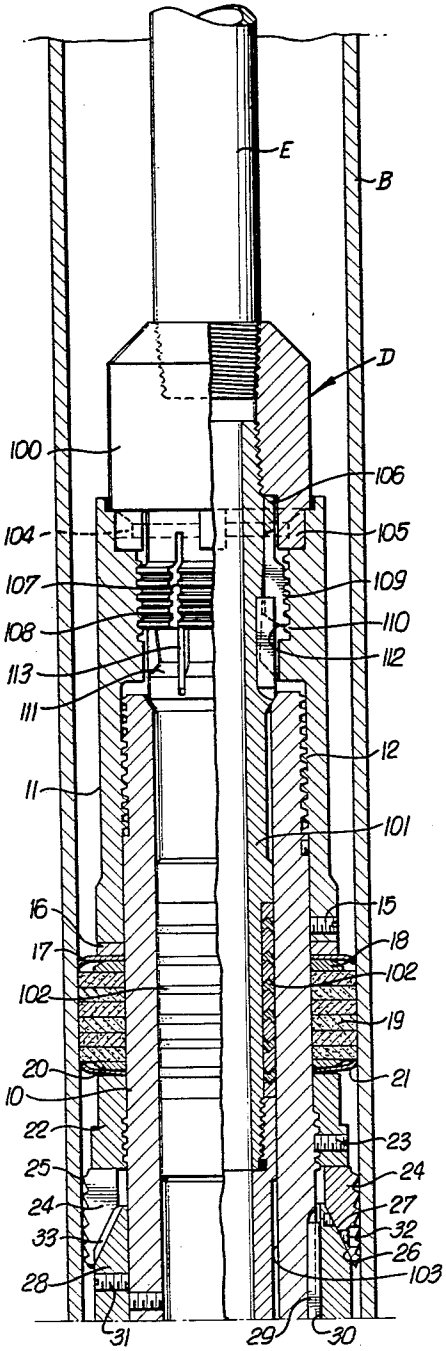
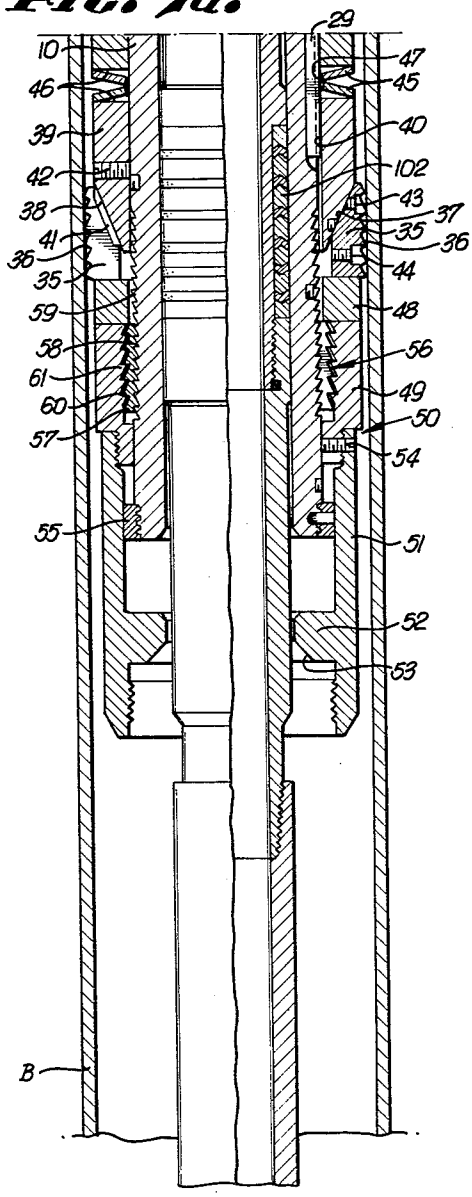


FIG. 1a.



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3,131,764

HIGH TEMPERATURE PACKER FOR WELL BORES

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Filed Dec. 11, 1961, Ser. No. 158,399
17 Claims. (Cl. 166—123)

The present invention relates to subsurface bore hole apparatus, and more particularly to well packers adapted to be set in packed-off condition in well casings, and similar conduit strings, disposed in well bores.

Well packers set in well bores subjected to high temperatures or high pressures, or both, tend to loosen and leak for several reasons. These include the extrusion of the packing material through clearing spaces in the packer and between the packer and the surrounding well conduit, and expansion and contraction of the packer parts due to temperature changes. Variations in temperature can be quite extensive. For example, in secondary or tertiary recovery of production from well bores, a well packer may be used in connection with the injection of high temperature steam into the surrounding formation. Temperature changes occur as the result of varied rate at which the steam is injected through the packer into the surround well bore.

It is an object of the present invention to provide an improved well packer capable of being set and remaining anchored in packed-off condition in a well conduit, despite its being subjected to high temperature and high pressure operating conditions.

Another object of the invention is to provide a well tool capable of being set and remaining anchored in a well conduit, despite being subjected to wide variations in temperature.

A further object of the invention is to provide a well packer capable of being set and remaining anchored in packed-off condition in a well conduit against movement in both longitudinal directions, despite being subjected to high temperatures and high pressures imposed both from below and above the packer.

An additional object of the invention is to provide a well packer having an initially retracted packing structure, which is protected against inadvertent expansion and from engagement with the wall of the well casing during lowering of the packer in the well casing to its setting depth.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It 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 an apparatus being lowered through a well casing, through use of a setting tool for partially setting the well packer in the well casing;

FIGS. 2 and 2*a* together constitute a longitudinal section through the apparatus disclosed in FIG. 1 within the well casing, the packer parts being in their initial retracted positions, FIG. 2*a* constituting a lower continuation of FIG. 2;

FIG. 3 is a cross-section taken along the line 3—3 on FIG. 2;

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

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

FIGS. 6 and 6*a* are views corresponding to FIGS. 2 and 2*a*, with the packer anchored in the casing against longitudinal movement in both directions, FIG. 6*a* constituting a lower continuation of FIG. 6;

FIGS. 7 and 7*a* are views corresponding to FIGS. 2 and 2*a*, illustrating the well packer both anchored in the well casing against movement in both longitudinal directions, and also packed-off against the well casing, in combination with other apparatus, FIG. 7*a* constituting a lower continuation of FIG. 7.

As disclosed in the drawings, a well packer A is provided which is adapted to be anchored in packed-off condition in a well casing B against movement in both longitudinal directions. As shown in FIGS. 1 to 6*a*, inclusive, the well packer may be lowered in the well casing on a suitable running-in string (not shown), such as a wire line, connected to a setting mechanism C releasably secured to the well packer, so that the setting mechanism can be removed from association with the well packer after the latter has been partially set in the well casing. Such setting mechanism is then removed from the well casing and another setting or operating device D (FIGS. 7, 7*a*) is lowered on a tubular string, such as a string of drill pipe E, to the well packer and is placed in association therewith to effect a pack-off of the well packer against the wall of the surrounding well casing.

As shown in the drawings, the well packer A includes a tubular body 10, the upper end of which is threadedly connected to a rotatable sleeve 11 extending upwardly from the upper end of the body, the threaded connection 12 being right hand so that right hand turning of the rotatable sleeve 11 feeds it downwardly along the body for the purpose of shortening a packing structure 13 surrounding the body and expanding it outwardly into sealing engagement with the wall of the well casing B, as well as in firm sealing engagement with the periphery of the body 10. The upper portion of the rotatable sleeve 11 has a threaded box 14 therein, preferably of left hand, for cooperation with the mechanism D for rotating the sleeve, as hereinafter described.

Inadvertent turning of the rotatable sleeve 11 on the body 10 is prevented by one or more shear screws 15 securing the sleeve to the body. The lower end of the sleeve 11 bears against an upper thrust ring 16, which, in turn, bears against an upper back-up or extrusion preventing ring 17, which is circumferentially continuous and of frusto-conical shape, with the smaller end of the ring engaging the thrust ring 16 and its larger end engaging a solid upper ring 18 bearing against the upper end of a packing gland 19 surrounding the body 10 and which is capable of withstanding comparatively high temperatures, such as of the order of 750° F. This packing gland 19 may be made of a material used for preventing leaks in high pressure steam lines, such as impregnated woven asbestos, in which the threads are reinforced with fine Monel wires. The lower end of the packing gland or sleeve 19, which is initially in the retracted position disclosed in FIG. 2, engages a solid ring 20, which, in turn, engages a lower back-up or extrusion preventing ring or disc 21 of frusto-conical shape, the larger end of the lower ring engaging the lower metal ring 20, and its smaller end bearing against the periphery of the body 10 of the tool and engaging an abutment ring 22 threadedly secured to the body and forming a part thereof. This abutment ring 22 is prevented from becoming loose on the body by a suitable set screw 23. The upper and lower back-up rings or frusto-conical discs 17, 21 are made of a malleable metal, such as steel, capable of being expanded outwardly when the packing gland 19 is expanded

outwardly, and are brought into intimate metal contact with the wall of the well casing B, as well as with the periphery of the body 10, leaving no gaps through which the packing gland material can be extruded, or otherwise passed.

For the purpose of anchoring the packer A in the well casing against upward movement, an upper set of segmental slips 24 is provided, which have wickers or teeth 25 facing in an upward direction and which bear against the lower end of the abutment ring 22. These slips have inner tapered surfaces 26 inclined in an upward and inward direction, engaging a companion external tapered surface 27 on an upper expander 28 slidably keyed to the body, as by suitably fixing a longitudinal key 29 to the body which is received within a longitudinal groove 30 in the upper expander. The upper expander 28 is held in an initial position on the body by means of one or more shear screws 31; whereas, the slips 24 are held initially in a retracted position with respect to the expander 28 by shear screws 32 securing them to the latter. The upper expander 28 can slide longitudinally relative to the body 10, but is prevented from turning with respect thereto by means of the key and keyway interconnection 29, 30. Relative rotation between the upper expander 28 and the slips 24 is also prevented by providing radial ribs or keys 33 integral with the expander 28 and extending radially outwardly into the gaps or spaces 34 between adjacent slip segments 24 (FIG. 4).

Downward movement of the well packer in the well casing is prevented by a set of lower segmental slips 35 having downwardly facing wickers or teeth 36 adapted to be embedded in the wall of the well casing B. These lower slips have inner expander surfaces 37 inclined in a downward and inward direction and engaging a companion surface 38 on a lower expander 39 slidably keyed to the body 10, as by having the longitudinal body key 29 movable relatively within a longitudinal keyway 40 in the lower expander. The lower expander also has inclined radial ribs or keys 41 extending between adjacent lower slip segments 35 to prevent relative rotation between the lower expander and lower slips. The lower expander 39 is held in an initial position on the body by one or more shear screws 42; whereas, the lower slips 35 are held in retracted position on the expander 39 and the body 10 of the tool by shear screws 43 attaching them to the lower expander and other shear screws 44 attaching them to the body of the tool.

Disposed between the upper and lower expanders 28, 39 and capable of exerting a continuing and substantial longitudinal force thereon after the slips 24, 35 have been anchored against the well casing B is a very strong spring device, which may consist of a plurality of conical spring-like washers 45, such as Belleville washers, which are oppositely arranged in engagement with one another, as by having their small ends abut one another and their large ends abutting the confronting end faces 46 of the upper and lower expanders. These frusto-conical washers 45 are also prevented from turning with respect to the body 10, and also with respect to the upper and lower expanders, by reason of the key 29 extending through keyways 47 in the washers, as shown most clearly in FIG. 5.

The lower slips 35 engage a lower ring 48 surrounding the body, which, in turn, rests upon an upper section 49 of a setting sleeve structure 50, the lower end of which is threadedly secured to the lower section 51 of the setting sleeve structure, having an inwardly directed flange 52 providing a downwardly facing shoulder 53 tapering in an upward and inward direction. The setting sleeve structure 50 is initially secured to the lower portion of the packer body 10 by one or more shear screws 54, and occupies an initial lower position, resting upon a stop ring 55 threadedly secured to the lower end of the body.

Relative upward movement of the setting sleeve structure 50 along the body 10 is permitted, but its relative downward movement is prevented by a one-way lock device 56, which can assume any suitable form. As disclosed, a split ratchet ring or sleeve 57 surrounds the body 10 and has downwardly facing internal ratchet teeth 58 adapted to engage companion upwardly facing ratchet teeth 59 on the periphery of the body. The exterior of the ring 57 has tapered cam teeth 60 adapted to engage companion internal cam teeth 61 in the upper setting sleeve member 49, there being sufficient clearance or play between the external and internal cam teeth 60, 61 as to permit the ratchet ring 57 to expand outwardly when it is moved upwardly over the body ratchet teeth 59. However, any tendency for the setting sleeve structure 50 to move downwardly will cause the cam members 60, 61 to force the ring 57 inwardly and maintain the internal and external ratchet teeth 58, 59 fully meshed with one another, thereby preventing downward movement of the setting sleeve structure 50 relative to the body 10. Any suitable one-way lock arrangement 56 may be used.

The upper and lower slips 24, 35 are released and expanded into firm anchoring engagement with the wall of the well casing by moving the body 10 downwardly and the setting sleeve structure 50 upwardly with respect to one another. Such action can occur by means of wire line setting equipment C, such as the setting equipment illustrated in United States Patent No. 2,640,546. As set forth in such patent, a pressure setting assembly (not shown) is employed in which a gas pressure is developed which will exert an upward force and movement on a tension mandrel or tube 63 and a downward force and movement on a sleeve structure 64, including an inner sleeve 65 and adjusting nut 66 threadedly mounted thereon, and an outer adapter sleeve 67 threaded on the exterior of the nut. The lower end of the outer adapter sleeve 67 bears against the upper end of the rotatable sleeve 11, so that any downward force and movement imposed on the adapter sleeve 67 is transmitted through the rotatable sleeve 11 to the body 10 of the well packer, in view of their threaded interconnection 12.

The tension mandrel or tube 63 is made in a plurality of sections, including an upper section 68 threadedly attached to an intermediate section 69, which is, in turn, threadedly attached to a lower section 70 extending downwardly into the body 10 of the tool. This lower section 70 is a lower threaded pin 71 threadedly attached to the upper end of an upper release head 72, which is threadedly secured to a release stud 73 having an intermediate section 74 of reduced diameter at which the stud will pull apart when subjected to sufficient tension exceeding its ultimate strength. The lower end of the release stud 73 is threadedly secured to a lower release head 75 that has a retainer member 76 threadedly attached thereto. With the adapter sleeve 67 bearing against the upper end of the rotatable sleeve 11, the upwardly tapering exterior 77 of the retainer 76 engages companion internal surfaces 78 in a plurality of latch fingers 79, which engage the tapered shoulder 53 on the lower setting sleeve member 51. The latch fingers or feet 79 constitute the lower terminals of a plurality of spring-like latch legs 80 integral with an upper circumferential continuous portion 81 of a latch sleeve 82 and having inwardly directed upper shoulder 83. Threadedly mounted on the upper release head 72 is a retrieving sleeve 84 adapted to move upwardly and engage the upper flange 83 on the latch sleeve 82 after the release stud 73 has been disrupted, in the manner described hereinbelow.

Initially, the well packer parts occupy the relative positions illustrated in FIGS. 2 and 2*a*. The lower portion of the wire line operated setting mechanism C is connected to the well packer with the retainer 76 disposed behind the latch fingers 79 to hold them under the setting sleeve shoulder 53, and with the lower end of the adapter sleeve 67 engaging the upper end of the rotatable pack-off sleeve 11. All of the shear screws are intact at this time. The packing structure 13 is covered completely by a protector sleeve 86, which is secured to the lower portion of the

adapter sleeve 67 by screws 87, or the like, and which extends downwardly along the rotatable sleeve 11 and the entire packing structure 13, coming to rest upon an external shoulder 88 formed in the abutment ring 22 below the packing structure 13.

The assembly of apparatus is lowered in the well casing on a wire line (not shown) to the desired setting point. Pressure is then developed in the pressure setting assembly (as described in the above-mentioned United States Patent No. 2,640,546), which will cause an upward pull to be exerted on the tension tube 63 and a downward force exerted on the adapter sleeve 67. The upward force is transmitted through the retainer 76 and latch fingers 79 to the lower setting sleeve structure 50, the downward force being transmitted through the rotatable sleeve 11 to the body 10. When such force exceeds the shear value of the screws 54 holding the setting sleeve structure 50 to the body 10, the screws are disrupted and the setting sleeve structure commences upward movement relative to the body, forcing the lower ring 48 against the lower slips 35, the upper ring 22 bearing against the upper slips 24. As the setting force increases, the shear values of the screws 43, 44, 32 holding the lower slips 35 to the lower expander 39 and body 10 and the upper slips 24 to the upper expander 28 are exceeded, the upper and lower slips then being shifted along the upper and lower expanders, respectively, and radially outwardly into engagement with the wall of the well casing. Upon engaging the wall of the well casing, the force exerted on the upper and lower slips 24, 35 will be transmitted to the upper and lower expanders 28, 39, respectively, and when such force exceeds the shear strength of the upper and lower expander screws 31, 42, the latter are disrupted and the upper and lower expanders are forced toward one another, partially flattening the Belleville washers 45 therebetween, which then exert a substantial and comparatively large spring force resisting movement of the expanders toward one another, and tending to maintain these expanders wedged behind the upper and lower slips.

As the pressure in the pressure setting assembly increases, the body 10 of the packer is urged downwardly and the setting sleeve structure 50 upwardly with increasing force, to more firmly anchor the slips 24, 35 in the wall of the well casing, the spring force exerted by the Belleville washers 45 being still further increased to urge the upper expander 28 and lower expander 39 behind the slips with increasing force. During the upward movement of the setting sleeve structure 50 along the body 10, the ratchet ring 57 will ratchet upwardly freely. However, the ratchet ring will prevent downward movement of the setting sleeve structure 50 relative to the body 10.

The upward force is imposed on the setting sleeve structure 50 through the tension tubing 63, upper head 72, release stud 73, lower head 75, retainer 76, and latch sleeve device 82. When such upward force exceeds the strength of the central weakened section 74 of the release stud 73, the latter is disrupted, which allows the lower head 75 and the retainer 76 attached thereto to drop downwardly, removing the retainer from its relation behind the latch fingers 79. The lower head 75 drops downwardly until an upper external flange 90 thereon comes to rest upon an internal shoulder 91 in the retrieving sleeve 84. Upward movement of the setting mechanism C and its tension tube 63 will bring the upper end of the retrieving sleeve 84 against the upper flange 83 of the latch sleeve 82, the latch sleeve then being moved upwardly, with the latch fingers 79 sliding along the shoulder 53 in an inward direction or to a released position. The entire setting mechanism C can then be removed from within the well packer A, with the adapter sleeve 67 being moved upwardly away from the rotatable sleeve 11 and the protector sleeve 86 being slipped upwardly off the packing assembly 13 and the rotatable sleeve 11. The entire setting mechansm C can then be removed from the well casing B by elevating the wire line (not shown).

The well packer A then occupies the position illustrated in FIGS. 6 and 6*a*, with the slip setting mechanism C removed. The packing assembly 13 is still in a retracted position. It is expanded outwardly against the wall of the well casing B by rotating the sleeve 11 on the body 10, which will feed the sleeve 11 downwardly to shift the lower end of the sleeve toward the abutment ring 22, shortening the distance between these two members and correspondingly shortening the packing gland 19 of impregnated asbestos, or the like, causing the latter to be expanded outwardly against the wall of the well casing. The rotatable sleeve 11 is turned until the upper and lower backup rings 17, 21 are also deformed outwardly into metal-to-metal contact with the wall of the well casing B, as well as against the periphery of the packer body 10, leaving no gaps between the rotatable sleeve and the well casing, and between the abutment ring 22 and the well casing through which the packing material 19 can be extruded. The packing material will remain in the expanded condition, such as disclosed in FIG. 7.

The device for rotating the sleeve on the body in order to expand the packing structure 13 into engagement with the wall of the well casing B may form part of a tubular mechanism D for injecting fluid into the well bore through the packer A, or for receiving production from the well formation for conveyance to the top of the well bore. As disclosed, the lower end of a tubular string of drill pipe E, or the like, is threadedly secured to a collar or head 100, which is, in turn, threadedly secured to the upper end of a tubular extension 101, which may be made of several sections threaded together. This tubular extension carries suitable side seals 102 thereon for sealing against the inner wall 103 of the packer body 10 to prevent leakage therebetween. The head 100 is provided with a coupling mechanism for securing it to the upper end of the rotatable sleeve 11. As disclosed in the drawings, the rotatable sleeve is provided with a plurality of circumferentially spaced clutch teeth 104. Depending from the head 100 are companion clutch teeth 105 that can fit between the spaces of the sleeve teeth 104 and come into engagement therewith, thereby coupling the head 100 to the sleeve 11. When such coupling action occurs, the tubular string E is rotated to the right, the motion being transmitted through the head 100 and the coengaging clutch teeth 104, 105 to the rotatable sleeve 11, rotating the latter on the body 10 of the tool. The body of the tool cannot rotate, since the slips 24, 35 are firmly anchored against the wall of the well casing B, and such slips are keyed to the expanders 28, 39 through the expander ribs or keys 33, 41, the expanders, as well as the retaining washers 45 therebetween, being keyed to the body 10 of the tool through the agency of the key 29. Thus, turning of the body 10 of the tool is positively prevented, so that a large torque can be imposed on the rotatable sleeve 11 when the clutch teeth 104, 105 are coengaged. The initial turning effort disrupts the shear screw 15 securing the sleeve to the packer body 10; whereupon the rotatable sleeve 11 feeds downwardly along the body 10 as the result of the threading action of the sleeve on the body to shorten the packing structure 13 and expand it outwardly into firm sealing engagement with the wall of the well casing B.

The apparatus for rotating the sleeve 11 on the body and for securing the packed-off condition of the well packer against the well casing can be releasably latched to the well packer, so that the tubular string E can be maintained in tension, if desired. As shown, a latch sleeve 106 surrounds the tubular extension or mandrel 101, the upper portion of the latch sleeve being circumferentially continuous, and its lower portion having a plurality of longitudinal slots 107 opening through its lower end providing latch dogs 108 having external left-hand

threads 109 adapted to mesh with a companion left-hand thread 110 in the rotatable sleeve box 14. The co-engaging faces of the teeth 109, 110 are preferably tapered so that the dogs 108 will retract inwardly and slide or ratchet past the box thread 110 when the collar 100 engages the upper end of the latch sleeve 106 to force it into the threaded box 14. The tubular mandrel 101 behind the latch dogs 108 may be relieved to permit such inward retracting action to occur. However, the dogs can inherently expand outwardly into engagement with the box thread 110, and they are held in such expanded position as a result of slightly elevating the tubular string E and the mandrel 101 to bring a tapered retainer portion 111 on the mandrel behind a companion lower tapered portion 112 on the threaded dogs 108, which holds them outwardly in mesh with the box thread 110. When the retainer 111 engages the lower portion 112 of the threaded dogs 108, the clutch teeth 105 on the head 100 are above and disengaged from the companion clutch teeth 104 on the rotatable sleeve 11, so that the tubular string E, head 100 and the tubular mandrel 101 can be rotated. Such rotation occurs when it is desired to unthread or disconnect the latch dogs 108 from the well packer A. As shown, the mandrel 101 has longitudinal keys 113 secured thereto, fitting into the spaces 107 between the latch dogs. Elevation of the tubular string E and the head 100, to disconnect the clutch 104, 105 will enable the tubular string E, collar or head 100, and tubular mandrel 101 to be rotated. Right-hand rotation of these parts will also rotate the threaded latch dogs 108 within the sleeve 11, and in view of their left-hand threaded interconnection 109, 110, the latch dogs 108 will thread upwardly completely out of the threaded box 14, disconnecting the latch device from the well packer A and allowing the tubular string E and the tubing extension or mandrel 101 to be removed from the well packer.

With the well packer A in use and anchored in packed-off condition in the well casing B, high pressure and high temperature steam may be injected through the tubular string E and through the tubing extension 101 for discharge into the well bore therebelow for action on the formation. The high temperature steam elevates the temperature of all of the well packer parts to a substantial degree. As an example, the temperature may be raised to about 700° F. Despite such increase in temperature, the slips 24, 35 and the packing structure 13 remain firmly against the wall of the well casing B. Even though the parts tend to expand or elongate as the result of the increasing temperature, there is a substantial force being exerted by the Belleville washers 45, which tend to hold the expanders 28, 39 wedged firmly behind the upper and lower slips 24, 35, the Belleville washers automatically compensating for the elongation or contraction of the parts. The packing material 19 is capable of withstanding high temperatures, and even if the high temperatures and pressures imposed thereon from either above or below the well packer may tend to force the packing material from its sealing region against the well casing, such action cannot occur since the packing is backed up both above and below its point of sealing engagement with the well casing by the circumferentially continuous steel, or other metallic, extrusion preventing discs 17, 21, which form solid bridges between the packer body 10 and the wall of the well casing B. The packing 13 prevents leakage of fluid in both upward and downward direction thereby under both high temperature and high pressure conditions. The upper and lower slips anchor the well packer against movement in both upward and downward directions, the intervening Belleville washers assuring against loosening of the slips as the result of imposition of pressure or other forces on the well packer, or due to the effect of thermal expansion and contraction resulting from temperature changes in the region surrounding the well packer.

We claim:

1. In a well tool adapted to be set in a well conduit disposed in a bore hole:
   - a body;
   - normally retracted upper slip means and normally retracted lower slip means on said body;
   - upper expander means and lower expander means on said body between and engaging said upper slip means and lower slip means, respectively, to expand said upper slip means and lower slip means outwardly into engagement with the well conduit;
   - means for moving said upper and lower slip means relative to said upper and lower expander means, respectively, to expand both of said slip means against the well conduit;
   - and spring means between and engaging said upper expander means and lower expander means to urge them away from each other to hold said upper and lower slip means engaged with the well conduit.

2. In a well tool adapted to be set in a well conduit disposed in a bore hole:
   - a body;
   - normally retracted upper slip means and normally retracted lower slip means on said body;
   - upper expander means and lower expander means on said body between and engaging said upper slip means and lower slip means, respectively, to expand said upper slip means and lower slip means outwardly into engagement with the well conduit;
   - means for moving said upper and lower slip means relative to said upper and lower expander means, respectively, to expand both of said slip means against the well conduit;
   - and one or more frusto-conical spring washers between and engaging said upper expander means and lower expander means to urge them away from each other to hold said upper and lower slip means engaged with the well conduit.

3. In a well tool adapted to be set in a well conduit disposed in a bore hole:
   - a body;
   - normally retracted upper slip means and normally retracted lower slip means on said body;
   - upper expander means and lower expander means slidable on said body between and engaging said upper slip means and lower slip means, respectively, to expand said upper slip means and lower slip means outwardly into engagement with the well conduit;
   - means for shifting said upper and lower slip means relatively toward each other and along said upper and lower expander means to expand both of said slip means against the well conduit;
   - and spring means between and engaging said upper expander means and lower expander means to urge them away from each other to hold said upper and lower slip means engaged with the well conduit.

4. In a well tool adapted to be set in a well conduit disposed in a bore hole:
   - a body;
   - normally retracted upper slip means and normally retracted lower slip means on said body;
   - upper expander means and lower expander means slidable on said body between and engaging said upper slip means and lower slip means, respectively, to expand said upper slip means and lower slip means outwardly into engagement with the well conduit;
   - means for shifting said upper and lower slip means relatively toward each other and along said upper and lower expander means to expand both of said slip means against the well conduit;
   - and one or more frusto-conical spring washers between and engaging said upper expander means and lower expander means to urge them away from each other to hold said upper and lower slip means engaged with the well conduit.

5. In a well tool adapted to be set in a well conduit disposed in a bore hole:
a body;
normally retracted upper slip means and normally retracted lower slip means on said body;
upper expander means and lower expander means slidably splined on said body between and engaging said upper slip means and lower slip means, respectively, to expand said upper slip means and lower slip means outwardly into engagement with the well conduit;
means preventing relative turning between said upper slip means and upper expander means and between said lower slip means and lower expander means;
means for shifting said upper and lower slip means relatively toward each other and along said upper and lower expander means to expand both of said slip means against the well conduit;
and spring means between and engaging said upper expander means and lower expander means to urge them away from each other to hold said upper and lower slip means engaged with the well conduit.

6. In a well tool adapted to be set in a well conduit disposed in a bore hole:
a body;
normally retracted upper slip means and normally retracted lower slip means on said body;
upper expander means and lower expander means slidably splined on said body between and engaging said upper slip means and lower slip means, respectively, to expand said upper slip means and lower slip means outwardly into engagement with the well conduit;
means preventing relative turning between said upper slip means and upper expander means and between said lower slip means and lower expander means;
means for shifting said upper and lower slip means relatively toward each other and along said upper and lower expander means to expand both of said slip means against the well conduit;
and one or more frusto-conical washers between and engaging said upper expander means and lower expander means to urge them away from each other to hold said upper and lower slip means engaged with the well conduit.

7. In a well tool adapted to be set in a well conduit disposed in a bore hole:
a body;
normally retracted upper slip means and normally retracted lower slip means on said body;
upper expander means and lower expander means slidable on said body between and engaging said upper slip means and lower slip means, respectively, to expand said upper slip means and lower slip means outwardly into engagement with the well conduit;
means secured to said body and engaging one of said slip means to prevent its movement along said body in a direction away from said other slip means;
means engaging said other of said slip means and shiftable along said body to move said other slip means toward said one of said slip means to move both of said slip means along their respective expander means and outwardly against the well conduit;
and spring means between and engaging said upper expander means and lower expander means to urge them away from each other to hold said upper and lower slip means engaged with the well conduit.

8. In a well tool adapted to be set in a well conduit disposed in a bore hole:
a body;
normally retracted upper slip means and normally retracted lower slip means on said body;
upper expander means and lower expander means slidably splined to said body between and engaging said upper slip means and lower slip means, respectively, to expand said upper slip means and lower slip means outwardly into engagement with the well conduit;

means preventing relative turning between said upper slip means and upper expander means and between said lower slip means and lower expander means;
means secured to said body and engaging one of said slip means to prevent its movement along said body in a direction away from said other slip means;
means engaging said other of said slip means and shiftable along said body to move said other slip means toward said one of said slip means to move both of said slip means along their respective expander means and outwardly against the well conduit;
and spring means between and engaging said upper expander means and lower expander means to urge them away from each other to hold said upper and lower slip means engaged with the well conduit.

9. In a well tool adapted to be set in a well conduit disposed in a bore hole:
a body;
normally retracted upper slip means and normally retracted lower slip means on said body;
upper expander means and lower expander means slidable on said body between and engaging said upper slip means and lower slip means, respectively, to expand said upper slip means and lower slip means outwardly into engagement with the well conduit;
an abutment secured to said body and engaging said upper slip means;
a setting sleeve slidable on said body and engaging said low slip means;
means for moving said body downwardly and said setting sleeve upwardly with respect to each other to shift said upper slip means and lower slip means along said upper expander means and lower expander means, respectively, and outwardly against the well conduit;
and spring means between and engaging said upper expander means and lower expander means to urge them away from each other to hold said upper and lower slip means engaged with the well conduit.

10. In a well tool adapted to be set in a well conduit disposed in a bore hole:
a body;
normally retracted upper slip means and normally retracted lower slip means on said body;
upper expander means and lower expander means on said body between and engaging said upper slip means and lower slip means, respectively, to expand said upper slip means and lower slip means outwardly into engagement with the well conduit;
means for moving said upper and lower slip means relative to said upper and lower expander means, respectively, to expand both of said slip means against the well conduit;
spring means between and engaging said upper expander means and lower expander means to urge them away from each other to hold said upper and lower slip means engaged with the well conduit;
normally retracted packing means on said body above said upper slip means;
and means movable along said body and against said packing means to expand said packing means against the well conduit.

11. In a well tool adapted to be set in a well conduit disposed in a bore hole:
a body;
normally retracted upper slip means and normally retracted lower slip means on said body;
upper expander means and lower expander means on said body between and engaging said upper slip means and lower slip means, respectively, to expand said upper slip means and lower slip means outwardly into engagement with the well conduit;
means for moving said upper and lower slip means relative to said upper and lower expander means, respectively, to expand both of said slip means against the well conduit;

spring means between and engaging said upper expander means and lower expander means to urge them away from each other to hold said upper and lower slip means engaged with the well conduit;
normally retracted packing means on said body above said upper slip means;
and means threaded on said body and engaging said packing means and rotatable on said body to expand said packing means against the well conduit.

12. In a well tool adapted to be set in a well conduit disposed in a bore hole:
a body;
normally retracted upper slip means and normally retracted lower slip means on said body;
upper expander means and lower expander means slidable on said body between and engaging said upper slip means and lower slip means, respectively, to expand said upper slip means and lower slip means outwardly into engagement with the well conduit;
an abutment secured to said body and engaging said upper slip means;
means engaging said lower slip means and shiftable along said body to move said lower slip means toward said upper slip means to move both of said slip means along their respective expander means and outwardly against the well conduit;
spring means between and engaging said upper expander means and lower expander means to urge them away from each other to hold said upper and lower slip means engaged with the well conduit;
normally retracted packing means on said body above and engaging said abutment;
and means movable downwardly along said body and against said packing means to expand said packing means against the well conduit.

13. In a well tool adapted to be set in a well conduit disposed in a bore hole:
a body;
normally retracted slip means on said body;
expander means on said body engaging said slip means to expand said slip means outwardly against the well conduit;
means for relatively moving said slip means and expander means to expand said slip means against the well conduit;
normally retracted packing means on said body;
an abutment secured to said body and engaging one end portion of said normally retracted packing means;
and means threaded on said body and engaging the other end portion of said normally retracted packing means to expand said normally retracted packing means into engagement with the well conduit.

14. In a well tool adapted to be set in a well conduit disposed in a bore hole:
a body;
normally retracted slip means on said body;
expander means engaging said slip means to expand said slip means outwardly against the well conduit;
an abutment structure on said body engaging one of said means;
a setting sleeve slidable on said body and engaging the other of said means;
means for relatively moving said body and setting sleeve to shift said setting sleeve toward said abutment structure and expand said slip means against the well casing;
normally retracted packing means on said body above said abutment structure;
means threaded on said body and engaging said packing means and rotatable on said body to expand said packing means against the well conduit;
and protective means secured to said moving means and disposed entirely around said normally retracted packing means to protect the same, said moving means being removable from the well tool and carrying the protective means therewith from the normally retracted packing means.

15. In a well tool adapted to be set in a well conduit disposed in a bore hole:
a body;
normally retracted upper slip means and normally retracted lower slip means on said body;
upper expander means and lower expander means slidable on said body between and engaging said upper slip means and lower slip means, respectively, to expand said upper slip means and lower slip means outwardly into engagement with the well conduit;
an abutment secured to said body and engaging said upper slip means;
a setting sleeve slidable on said body and engaging said lower slip means;
normally retracted packing means on said body above and engaging said abutment;
means threaded on said body and engaging said packing means and rotatable on said body to expand said packing means against the well conduit;
means engaging said means threaded on said body and said setting sleeve for moving said body downwardly and said setting sleeve upwardly to shift said slip means along said expanders and outwardly against the well conduit;
and spring means between and engaging said upper expander means and lower expander means to urge them away from each other to hold said upper and lower slip means engaged with the well conduit.

16. In a well tool adapted to be set in a well conduit disposed in a bore hole:
a body;
normally retracted upper slip means and normally retracted lower slip means on said body;
upper expander means and lower expander means slidable on said body between and engaging said upper slip means and lower slip means, respectively, to expand said upper slip means and lower slip means outwardly into engagement with the well conduit;
an abutment secured to said body and engaging said upper slip means;
a setting sleeve slidable on said body and engaging said lower slip means;
normally retracted packing means on said body above and engaging said abutment;
means threaded on said body and engaging said packing means and rotatable on said body to expand said packing means against the well conduit;
means engaging said means threaded on said body and said setting sleeve for moving said body downwardly and said setting sleeve upwardly to shift said slip means along said expanders and outwardly against the well conduit;
and one or more frusto-conical spring washers between and engaging said upper expander means and lower expander means to urge them away from each other to hold said upper and lower slip means engaged with the well conduit.

17. In a well tool adapted to be set in a well conduit disposed in a bore hole:
a body;
normally retracted upper slip means and normally retracted lower slip means on said body;
upper expander means and lower expander means slidable on said body between and engaging said upper slip means and lower slip means, respectively, to expand said upper slip means and lower slip means outwardly into engagement with the well conduit;
an abutment secured to said body and engaging said upper slip means;
a setting sleeve slidable on said body and engaging said lower slip means;
normally retracted packing means on said body above and engaging said abutment;

means threaded on said body and engaging said packing means and rotatable on said body to expand said packing means against the well conduit;

means engaging said means threaded on said body and said setting sleeve for moving said body downwardly and said setting sleeve upwardly to shift said slip means along said expanders and outwardly against the well conduit;

one or more frusto-conical spring washers between and engaging said upper expander means and lower expander means to urge them away from each other to hold said upper and lower slip means engaged with the well conduit;

and a protective sleeve secured to said moving means and disposed entirely around said normally retracted packing means to protect the same, said moving means being removable from the well tool and carrying the protective means therewith from the normally retracted packing means.

References Cited in the file of this patent

UNITED STATES PATENTS

1,436,274	Mack	Nov. 21, 1922
2,765,852	Brown	Oct. 9, 1956
2,851,108	Reed	Sept. 9, 1958