

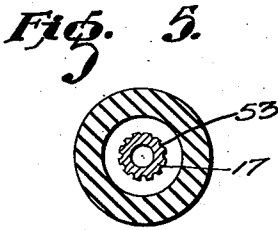
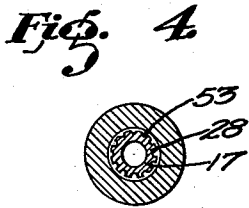
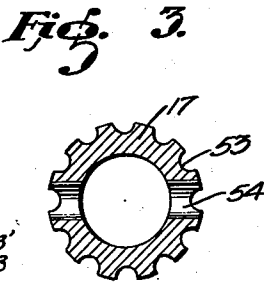
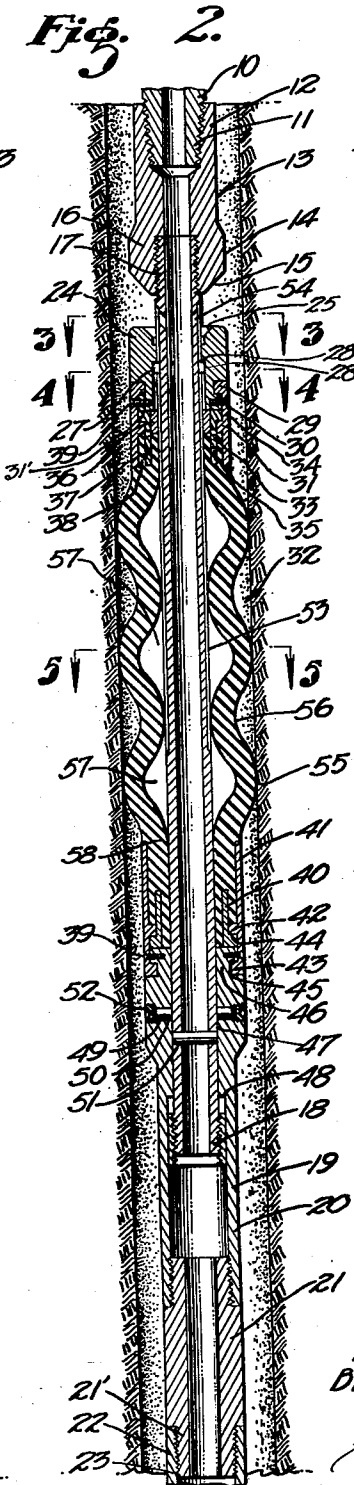
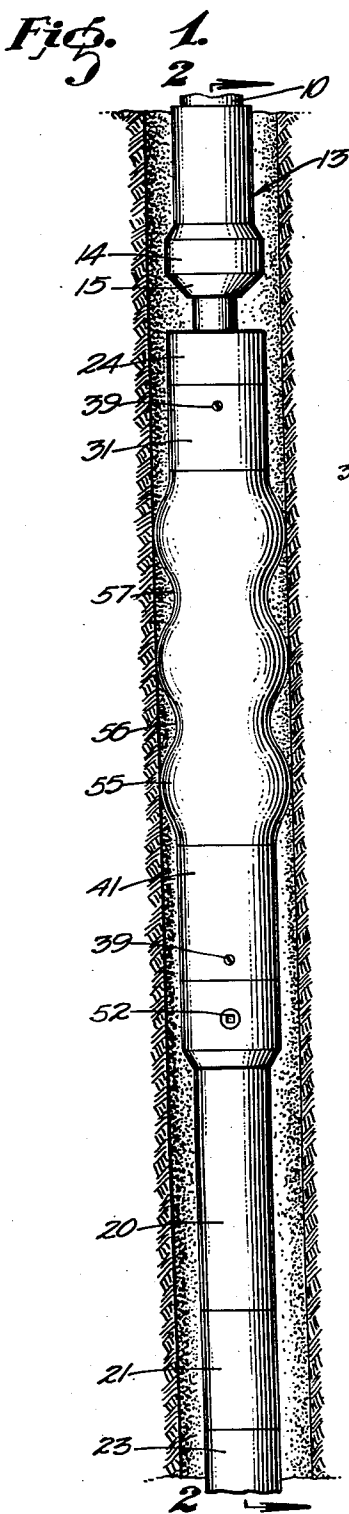
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WELL PACKER

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WELL PACKER

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3 Claims. (Cl. 166—10)

This invention relates to oil well equipment and particularly pertains to a well packer.

In the use of various types of oil well equipment it is desirable to place a packer in a well to seal off a particular area of the well and to produce a barrier around a member lowered into the well and within the space between said member and the wall of the well bore, whether this be an open hole or a cased well. In most instances the packer is expanded to its sealing position by anchoring the lower end of the packer structure against longitudinal movement within the well bore and thereafter imposing a weight upon the packer to deform it and to expand it in a manner to create a shut-off between the length of well bore above the packer and that occurring therebeneath. Due to the irregularity of the contour of the surface of the well bore against which the packer is often seated, it will be evident that in order to produce a satisfactory sealing action a considerable expanding or wedging force must be exerted to seat the packer against the wall, and since it is common practice to construct the packer of yieldable material, such as rubber or rubber and fabric, it is evident that the packer may become lodged in the well and that if it is successfully removed the packer may be mutilated and in some instances may be thereafter useless. It is desirable, therefore, to provide a packer which may have a normally small diameter so that it may be easily introduced into the well bore and which may be thereafter readily expanded to be properly seated and sealed, after which it may be contracted so that its outer surface will be drawn away from the seat and it can be readily removed from the well bore without detrimental mutilation.

The present invention contemplates the provision of a packer of tubular construction mounted upon a suspending member, the wall of the packer being relatively thin and forming a plurality of transverse longitudinally arranged corrugations which make it possible for the wall to be distended while making a firm seal against the seat in the well bore and to be subsequently contracted to facilitate in the removal of the packer from the well bore, the invention further contemplating that the pressure of the hydrostatic head of fluid within the well and within which the packer is submerged will cooperate to expand the packer when it reaches its set position, and will act further to transmit force exerted by the suspending member in an act to expand the packer further as desired.

The invention is illustrated by way of example in the accompanying drawing, in which: Figure 1 is a view in side elevation showing the application of a packer to a structure known as a packer of the "sleeve" type.

Fig. 2 is a view in longitudinal section through the packer structure as seen on the line 2—2 of Fig. 1.

Fig. 3 is a view in transverse section through the packer as seen on the line 3—3 of Fig. 2.

Fig. 4 is a view in transverse section through the packer as seen on the line 4—4 of Fig. 2.

Fig. 5 is a view in transverse section through the packer as seen on the line 5—5 of Fig. 2.

Referring more particularly to the drawing, 10 indicates a string of tubing or a drill-string provided with a pin 11. The pin 11 is threaded into the box 12 of a packer head 13. The packer head is formed with a lower enlarged valve element 14, the lower end face of which is downwardly and inwardly tapered, as indicated at 15. The valve element 14 is internally threaded at 16 to receive the upper end of a tubular mandrel 17. The tubular mandrel 17 extends downwardly and is fitted at its lower end with an enlarged head 18 which reciprocates within a bore 19 of a lower sleeve 20. The lower sleeve 20 is fitted with a sub 21 including a sleeve 21', and is here shown as threaded into the box 22 of an anchor pipe 23.

It is to be understood that while this invention is disclosed as being embodied in a packer of the sleeve type, which utilizes an anchor pipe in connection with the setting of the packer, that the packer can be readily used with the structure of a hook-wall type without departing from the spirit of the invention, and that furthermore, if desired, it may be adapted for use as a rat-hole packer in which the general contour of the outer surface of the packing element would be conical rather than cylindrical, as here shown.

The upper end of the mandrel 17 extends through a valve head 24, which valve head is formed with a conical valve seat 25. The conical face 15 of the valve element 14 will seat against the valve seat 25 under certain conditions to be hereinafter described. The bore 26 of the valve head 24 and through which the mandrel 17 reciprocates is formed with a plurality of longitudinally extending keyways 27, which receive keys 28 formed upon the mandrel 17 and which keys may reciprocate within the keyways 27 while preventing relative rotational movement between the valve head 24 and the mandrel.

The lower end of the head 24 is formed with an

annular lock groove 29 adjacent which is a lock shoulder 30. The lock shoulder 30 is of a smaller diameter than the diameter of the main body of the valve head 24 and accommodates anchor segments 31 by which the upper end of the sleeve packer 32 is anchored to the valve head. The anchor segments 31 are formed at their upper ends with inturned shoulders 31' which fit into grooves 29 while the body of the segments fit over and around the circumference of the shoulder 30. The segments 31 are also formed with annular inturned shoulders 33. These shoulders fit beneath a shoulder 34 formed upon an anchor thimble 35. This thimble is cylindrical and is formed with openings 36 throughout its length so that rubber of the extension ends 37 of the packing sleeve 32 may flow through the openings and thus form a homogeneous mass while holding the anchor thimbles therein. This particular structure is shown in Patent No. 2,125,665 issued to Wilbur F. Bettis August 2, 1938. Within the thimble a tubular portion 38 of the sleeve extension 35 is formed which conforms to the circumference of the mandrel 17. The segments 31 are held in position by screws 39 which are threaded into the shoulder portions 30 of the head 24, thus the upper end of the packing sleeve 32 is rigidly secured in position. The lower end of the packing sleeve is similarly constructed and includes an anchor thimble 40 which is circumscribed and engaged by segments 41. These segments are formed with shoulders 42 and 43 which interlock with the shoulder 44 on the thimble and shoulder 45 on a bottom collar 46. The bottom collar 46 is formed with a cylindrical bore 47 through which the lower end of the mandrel 17 reciprocates and with which it has a sliding fit.

The lower end of the mandrel 17, as previously described, is fitted with a bottom nut 18 which is threaded onto it and which nut reciprocates within the central bore 19 of the member 20. This nut limits upward movement of the mandrel 17 with relation to the member 20 by engagement with the lower face 48 of the bottom collar 46, and limits downward movement by abutting against the upper face of the bottom sub 21, previously described.

When the member 18 is in its upper abutting position against the shoulder 48 and prior to the entry of the packer into the well a shear pin 49 holds the mandrel and the outer packer structure against relative longitudinal movement. This shear pin extends through a transverse bore 50 of the member 46 and also openings 51 through the wall of the mandrel. Spanner wrench screws 52 are threaded into the opposite ends of the bore 50 and hold the shear pin in position.

Formed longitudinally of the outer cylindrical surface of the mandrel is a plurality of grooves 53 which extend from a point adjacent to the valve member 14 to a point within the packing sleeve 32. These grooves thus form a fluid course along which fluid may pass to the interior of the packer until the face 15 of the valve member 14 rests upon the face 25 of the valve head 24. Equalizing valve ports 54 are formed through the wall of the mandrel 17 and are open when the mandrel is in its uppermost position but are closed when the mandrel is closed when the valve faces 15 and 25 seal against each other.

The packing sleeve 32 is of prime importance in the present invention since it is of novel design and provides functions which are not present in the usual form of sleeve packer. The portion of the sleeve intermediate the opposite end

thimbles, previously described, is tubular and circumscribes the mandrel 17. This sleeve is preferably formed of fabric and rubber so that it can contract, expand and be distended. The sleeve, when considered throughout its length, has a plurality of convexed outer faces 55 which represent the outer deflecting portions of circumferentially extending corrugations, a plurality of which are formed at intervals throughout the length of the sleeve. Intermediate these convex portions 55 are concave portions 56 which may be distended by hydraulic pressure, as will be hereinafter described. The walls of the convex portions substantially contact on their inner faces with the outer surface of the mandrel 17. Attention is directed to the fact that the wall of the sleeve 32 is not of uniform thickness, but that the portions of the wall defining the concavities 56 are thicker than the portions of the wall defining the convexities 55. Attention is also directed to the fact that due to this arrangement a substantially equal cubical volume of rubber will occur within the convexed portions 55 and within the concaved portions 56. This makes it possible for the convexed portions to be deformed and to be drawn inwardly and into alignment with the concaved portions 56. It will be evident, therefore, that since the diameter of the convexed portions is materially greater than the outer diameter of the concaved portions, it will be possible for the packing sleeve 32 to distend and assume a substantially cylindrical shape without having an excessive bulk of rubber in the convexed portions which could not be accommodated between the concaved portions, and which would tend to prevent the packer from contracting. Intermediate these points of contact annular cavities 57 occur within the sleeve and around the mandrel. Fluid from the well communicates with these cavities through the longitudinal courses 53 which are formed on the outer circumference of the mandrel. Thus, when the mandrel is in its uppermost position fluid from the well within which the packer is lowered is free to flow through the water courses 53 and into the spaces 57 within the sleeve. When, however, the valve members 14 and 24 are moved to their closed positions with relation to each other and their faces 15 and 25 are in contact the flow of fluid through the courses 53 and into the sleeve is interrupted, and since there is a tight fit between the lower extension 58 of the packer sleeve and the mandrel any fluid which has passed into the sleeve will be entrapped for a purpose to be hereinafter described.

In operation of the present invention the packer is assembled as shown in Fig. 1 of the drawing and preparatory to being lowered into a well is placed with its mandrel 17 drawn outwardly from the packing sleeve 32 until the opening 51 of the mandrel registers with the opening 50 in the member 46. A shear pin 49 is then placed within the member 46 and is held in position by the screws 52. It will be seen that under such conditions the packing sleeve 32 has been drawn to its elongated position but that in such position the corrugations in the packing sleeve still occur.

After the structure has been assembled with a suitable anchor pipe 23 and the drill string 10 it is lowered into the well and submerged within the fluid of the well. This will permit the spaces 57 within the packing sleeve 32 to fill with fluid from the well since this fluid flows downwardly along the grooves 53 formed in the sides of the mandrel. When the anchor pipe 23 reaches an

abutting position against the lower end of the well bore the weight of the drill string 10 will be imposed upon the pin 49 and when sufficient weight is imposed the pin 49 will be completely severed. This will permit the mandrel 17 to move downwardly within the sleeve 32 and will cause the ports 54 through the mandrel wall and the longitudinal grooves 53 in the outer surface of the mandrel to move downwardly into the valve head 24. When the mandrel has moved to the downward limit of its travel the valve faces 15 and 25 will abut against each other and will form a seal which will prevent any further entry of fluid through the valve ports 54 to the interior of the mandrel, and will at the same time prevent exit of fluid from around the mandrel and within the valve sleeve 32 and along the grooves 53. This will result in entrapping fluid within the packing element 32 so that further downward movement of the drill string 10 will have two actions. One will be to longitudinally compress the packing sleeve 32 so that its corrugations will tend to fold together. The other action is to compress the fluid which has been entrapped within the packing sleeve 32 so that the packing sleeve will tend to distend as longitudinally compressed. It will be evident that since the fluid normally within a well is an incompressible fluid, such as drilling mud or oil, the fluid in the packer will be substantially a non-yielding mass when affected by exterior force, but when force is exerted interiorly thereof will tend to expand in direct reference to the contour of the surface against which the packer is being forced so that a proper fluid seal will be created between the circumscribing wall and the packer sleeve. It will also be seen that due to the corrugated formation of the sleeve the intermediate concaved surface portions of the packing sleeve will be forced outwardly so that from the upper convex portion 55 to the lower convex portion 55 of the packing sleeve there will be continuity of contact between the outer surface of the sleeve and the circumscribing surface of the well bore. This insures a maximum sealing action as performed by the packing sleeve 32.

When it is desired to withdraw the packer from the well the drill string 10 and the mandrel 17 are lifted. This automatically raises the valve face 15 from the valve face 25 and uncovers the upper ends of the longitudinal grooves 53 and the ports 54. Fluid pressure through the packer will then be equalized so that the pressure in the section of the well bore beneath the packing sleeve 32 will be substantially the same as that occurring above the packer. This will eliminate difficulty in breaking the seal which the packer has created and will facilitate in withdrawing the packing sleeve 32 from its seat. It will also be noted that the shoulders of the keys 28 will move to an abutting position against the shoulders 28' within the valve head 24 so that the upper end of the valve sleeve 32 may be pulled upon. This will tend to contract the packer circumferentially and exhaust the fluid from within the packing sleeve, and since communication has been established between the spaces 57 within the packing sleeve 32 and the well the pressure will be equalized on both sides of the wall of the packing sleeve 32. The result will be that the inherent tendency of the preformed wall to assume its corrugated configuration will cause the concaved portions 56 to move inwardly against the mandrel and thereby reduce the amount of surface friction between the outer face of the packing sleeve 32 and the wall of

the well bore with which the sleeve had been in engagement.

It will thus be seen that the well packer here disclosed while simple in construction provides an equalizing valve acting automatically as the packer is set and released, and that, furthermore, insures a minimum frictional contact between the surface of the packing sleeve and the well bore as the sleeve is being moved toward and away from its seated position, and a maximum packing action when the packer is seated. It will also be evident that this packer may be so constructed as to operate as a sleeve packer of the anchor type, the hook-wall type or that it may be readily constructed to be of the rat hole type.

While I have shown the preferred form of my invention as now known to me, it will be understood that various changes may be made in combination, construction and arrangement of parts by those skilled in the art, without departing from the spirit of my invention as claimed.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A packer structure including a tubular deformable packing sleeve, means for connecting a section of pipe to the lower end thereof, a tubular mandrel extending longitudinally through said sleeve and having limited longitudinal movement with relation thereto, means for connecting a string of pipe to the upper end of said mandrel, valve means above the packing sleeve for controlling the flow of the fluid within which the structure is submerged into the tubular packing and whereby when the mandrel is in collapsed position with relation to the packing sleeve the fluid within the packing sleeve will be entrapped and pressure may be imposed thereupon to distend the packing sleeve against the well bore within which the packer is positioned, said valve means also controlling the flow of fluid from the space surrounding the packer into and through the mandrel whereby said flow will be interrupted when the valve is closed and the packer is seated whereby the flow will be re-established as an initial movement to the unsetting of the packer.
2. A well packer comprising a tubular deformable packing sleeve having a wall of substantially uniform thickness and constructed to insure that the wall will normally assume a position in which annularly extending alternately arranged convex and concave surfaces will occur thereon, rigid fitting means at the opposite ends of said packing sleeve, a valve head secured to the upper rigid fitting means, a body member secured to the lower fitting means, a pipe section adapted to be fastened to said lower fitting means, a tubular mandrel extending longitudinally through the fitting means and the intermediate packing sleeve and forming a fluid-tight seal therewith, a valve element carried at the upper end of the mandrel and means for attaching a string of pipe thereto and by which the packing is suspended and manipulated, and fluid passageways formed along the outer wall of the mandrel and extending through the valve head, said passageways being adapted to be closed to the space around the structure when the valve element of the mandrel rests against the seat on the valve head, whereby force exerted downwardly will tend to compress and distend the packing sleeve and will act upon the fluid entrapped within the packing sleeve to force the wall thereof outwardly into sealing contact with the well bore within which the structure is positioned.
3. A well packer comprising a tubular de-

formable packing sleeve having a wall of substantially uniform thickness and constructed to insure that the wall will normally assume a position in which annularly extending alternately arranged convex and concave surfaces will occur thereon, rigid fitting means at the opposite ends of said packing sleeve, a valve head secured to the upper rigid fitting means, a body member secured to the lower fitting means, a pipe section adapted to be fastened to said lower fitting means, a tubular mandrel extending longitudinally through the fitting means and the intermediate packing sleeve and forming a fluid-tight seal therewith, a valve element carried at the upper end of the mandrel and means for attaching a string of pipe thereto and by which the packing is suspended and manipulated, fluid pas-

sageways formed along the outer wall of the mandrel and extending through the valve head, said passageways being adapted to be closed to the space around the structure when the valve element of the mandrel rests against the seat on the valve head, whereby force exerted downwardly will tend to compress and distend the packing sleeve and will act upon the fluid entrapped within the packing sleeve to force the wall thereof outwardly into sealing contact with the well bore within which the structure is positioned, and equalizer valve ports formed through the wall of the mandrel and communicating with the central passageway thereof whereby when the valve structure is open the fluid pressure above and below the packer will be equalized.

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