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[54] **METHOD OF ROTATABLY RELEASING A
 TUBULAR RUNNING STRING FROM A FLOATING
 DRILLING VESSEL**
16 Claims, 5 Drawing Figs.

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166/301
 [51] Int. Cl. **E21b 43/01**
 [50] Field of Search **166/.5, .6,**
77.5, 315, 87, 301, 117.5; 285/114, 18; 175/7

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ABSTRACT: Casing is run in a well underlying the ocean from a floating vessel by a tubular running string attached to a casing hanger by left-hand threads. The casing hanger is landed in a hanger body fixed to the ocean floor and locked in place. The casing is then cemented in place, whereupon the running string is rotated while applying fluid pressure to its interior, which exerts a lifting force at the top of the running string and supports a major portion of its weight, thereby relieving the threads of such weight and of the accompanying friction. This facilitates complete unthreading of the running string from the casing hanger.

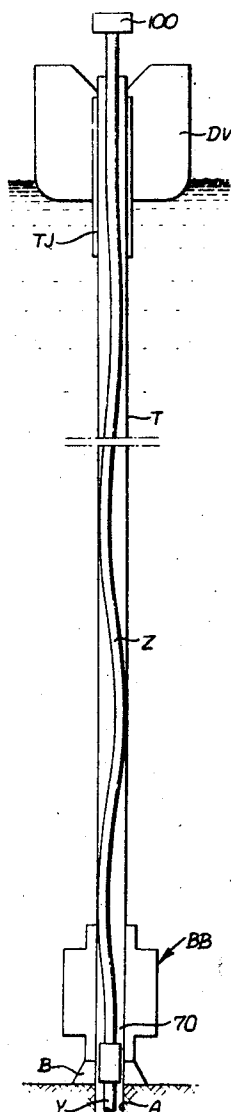


FIG. 1.

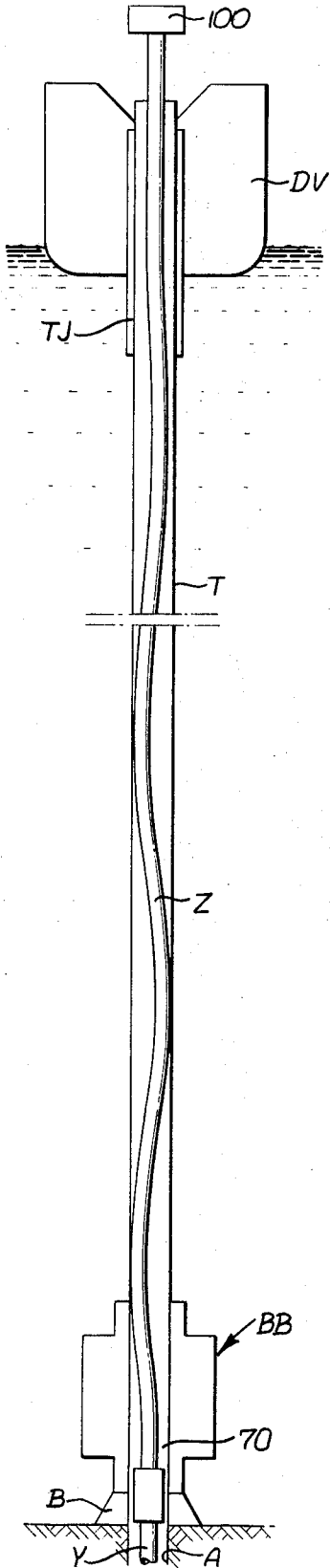


FIG. 2.

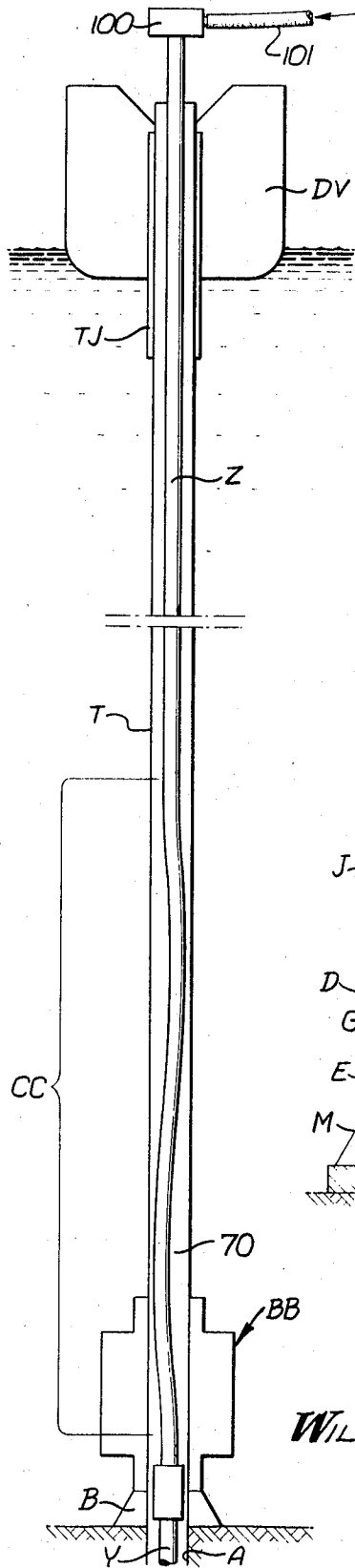
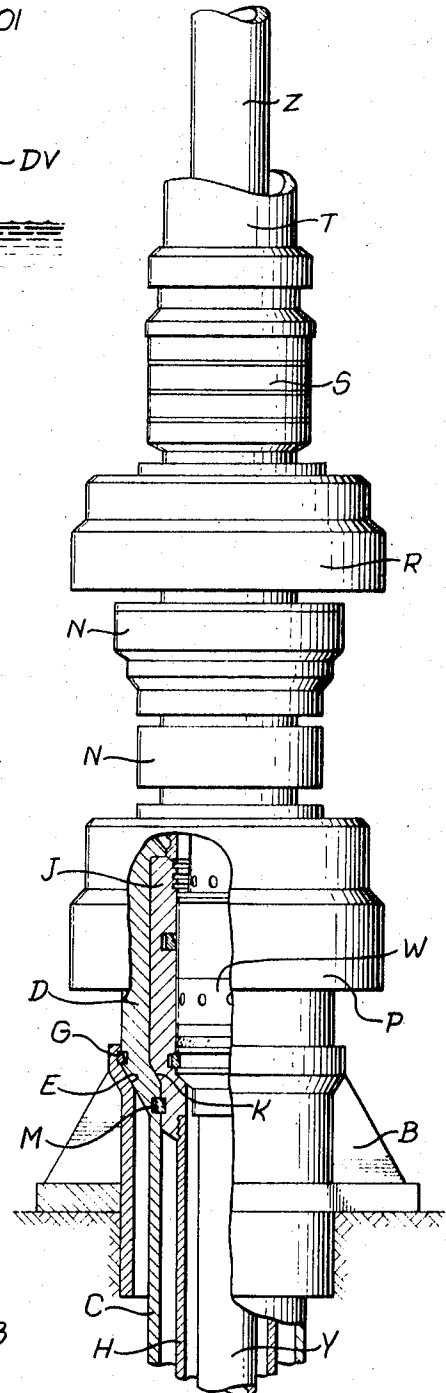


FIG. 3.



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FIG. 4a.

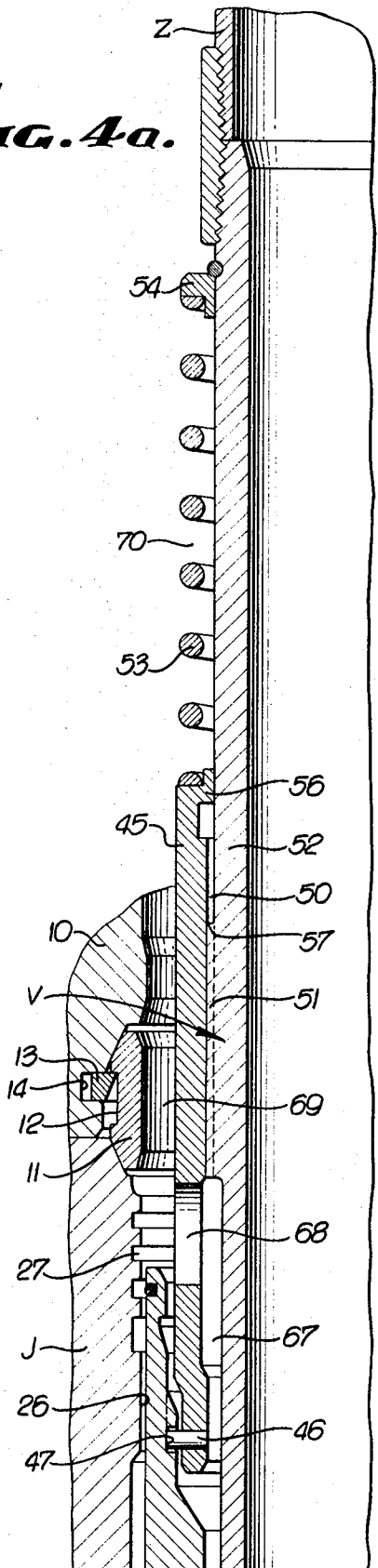
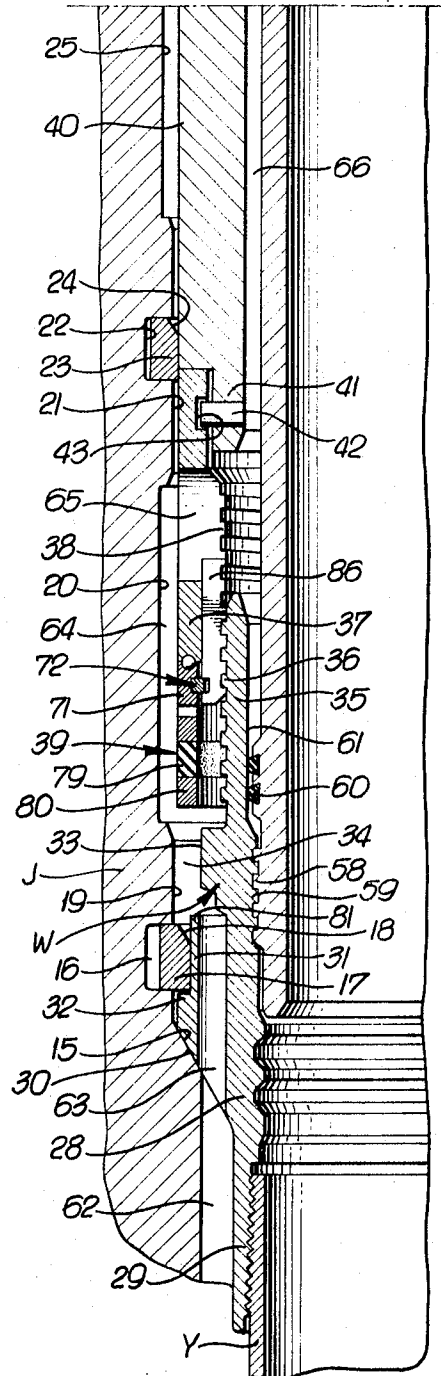


FIG. 4b.



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METHOD OF ROTATABLY RELEASING A TUBULAR RUNNING STRING FROM A FLOATING DRILLING VESSEL

The present invention pertains to a method of releasing a tubular running string from apparatus connected thereto, and more particularly to a method of releasing running strings from a casing hanger in which rotation of the running string is required to effect its release.

In the drilling of oil and gas wells at an underwater site, casing strings are hung at the ocean floor. These casing strings are run-in in the well bore through use of a tubular running string, such as a string of casing, from a floating vessel. After the casing has been properly hung and cemented in place, the running string is disengaged. Where a left-hand threaded connection is used between the running string and the hanger, disengagement occurs as a result of rotating the running string.

Upon landing and locking the casing hanger in position, the running string becomes firmly attached to the wellhead. As a result, relative motion occurs between the drilling vessel and the running-in string because of the action of waves and wind on the vessel. As a result of the heaving or other motion of the drilling vessel, the running-in string, which is fixed at its lower end to the hanger, is allowed to stand in compression, since no adequate means has been developed heretofore to support the weight of the string under these conditions. Wave compensation devices have been proposed for the purpose of overcoming this problem, but they are cumbersome and time consuming in placing them in position for use.

Because of the running string standing in compression, its unthreading from the casing hanger at its left-hand threaded connection therewith becomes difficult, since the weight of the running string itself results in excessive friction in the left-hand thread. Since the drilling vessel is moving up and down while the running string is rotated for the purpose of effecting its unthreading from the casing hanger, there is no effective way for lifting the running string weight off the left-hand thread. In addition, the running string will tend to lie against the inside wall of the drilling riser or conduit through which the casing, casing hanger, and casing hanger running string are guided into position, which causes a lateral force against the exterior wall of the running string that adds to the frictional resistance which must be overcome for the purpose of unthreading the left-hand thread running tool at the lower end of the running string from the left-hand thread inside the casing hanger body itself.

By virtue of the present invention, the standing of the tubular running string in compression and the friction which is associated therewith are overcome, which facilitates unthreading of the running tool, secured to the lower end of the running string, from the casing hanger body. Such unthreading action usually occurs after the casing string has been cemented in place. The usual practice is to have a top cementing plug at the charge of cement slurry pumped down through the running-in string and through the suspended casing, this top cementing plug coming to rest against a shoe or collar at the lower end of the casing string, which prevents any further downward passage of drilling mud or other fluid within the casing string. The top of the running string is closed, as by attaching a cementing head thereto, and a fluid under pressure pumped into the running-in string at its upper end, as at its cementing head, of a desired value, this fluid pressure acting upwardly on the cementing head and overcoming or supporting a portion of the weight of the running string extending upwardly from its point of left-hand threaded connection with the casing hanger body. While this pressure is being exerted, the running string is rotated to the right to unscrew the left-hand male thread of the running tool from the casing hanger body itself, the running tool being maintained in appropriate sealed relation with the hanger body until after it has been completely unscrewed therefrom, so as to avoid loss of the fluid pressure imposed in the tubular running string itself.

If desired, the full weight of the running string can be overcome simply by applying the appropriate unit pressure to the fluid therein acting over the effective area of the running

string itself. However, it may be desirable to allow a small portion of the weight of the running string to remain on the left-hand threaded connection, such small portion being insufficient to result in any substantial friction in the left-hand threaded connection. This may result in the lower portion of the tubular running string standing in compression, but a large length of the running-in string is lifted by the hydraulic pressure and will be held in tension, thereby avoiding any significant leaning of the running string against the side of the marine conductor or other drilling riser through which the running string extends between the drilling vessel and the location immediately above the casing hanger at the floor of the ocean.

By use of the proposed method of applying internal pressure to the running string, excessive rotational friction caused by the weight of the running string is avoided, which reduces the possibility that excessive torques are required in disengaging the left-hand thread running tool from its companion thread in the casing hanger body, which might cause damage to the running string joints (used to make up the pipe sections) to the point where these joints or couplings could fail during rotation.

This invention possesses many other advantages and has other purposes which may be made more clearly apparent from a consideration of a method embodying the invention. This method is shown and described in the present specification in connection with the drawings accompanying and constituting a part thereof. Such drawings and method 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:

FIG. 1 is a diagrammatic view of a running string in association with a drilling vessel and a casing hanger, illustrative of prior methods of disconnecting a tubular running string from a casing hanger;

FIG. 2 is a view similar to FIG. 1, illustrative of a method of effecting disconnection between the running string and the casing hanger in accordance with the present invention;

FIG. 3 is a somewhat diagrammatic general view of a blowout preventer stack, casing hangers and concentric casings located in a well bore at the floor of the ocean; and

FIGS. 4a and 4b together constitute a quarter longitudinal sectional view of a typical running string and casing hanger apparatus employed in connection with the running and cementing of casing in a well bore underlying a body of water, in which the running tool has a left-hand threaded connection with a casing hanger body, FIG. 4b being a lower continuation of FIG. 4a.

As illustrated diagrammatically in FIGS. 1 and 2, a well bore A underlies an ocean or other body of water and extends downwardly from the ocean floor F. A suitable base structure B is mounted on the ocean floor and supports casing hangers, blowout preventers, and the like, BB, which are secured to the lower end of a marine conductor pipe T extending upwardly to a drilling vessel DV floating at the surface of the body of water. The marine conductor pipe usually extends through a telescopic joint TJ in the drilling vessel, which carries a drilling rig (not shown) for drilling the well and for running and cementing casing in the well bore.

A typical installation of apparatus at the ocean floor is illustrated somewhat diagrammatically in FIG. 3. The base structure B, supported on the ocean floor, carries an outer casing C of relatively large diameter suspended from a casing hanger body D resting upon an outer seat E on the base and locked thereto by a suitable lock ring G. Disposed within the outer casing is an intermediate string of casing H extending down into the well bore and suspended from a suitable casing hanger body J resting upon a companion tapered seat K in the outer body and suitably locked thereto by a locking ring M. One or a stack of blowout preventers N are connected by means of a

suitable connector P, such as a hydraulic connector illustrated in U.S. Pat. No. 3,321,217, to the head D, the blowout preventer, in turn, being connected by a suitable hydraulic or other connector R to a flexible joint S, made of sections, secured to the marine conductor pipe T extending to the drilling rig located on the floating vessel DV. An inner string of casing Y is disclosed in FIG. 3 as having been locked in packed-off condition in the intermediate hanger body J, the casing hanger apparatus for this inner casing being disclosed in FIGS. 4a and 4b. This hanger apparatus and running tool V are disclosed and claimed in the application of Arthur G. Ahlstone, Ser. No. 503,561, filed Oct. 23, 1965, for "Well Bore Casing Hanger Apparatus," and is presented herein in some detail as an aid in explaining the present invention.

As shown in FIGS. 4a and 4b, the casing hanger assembly W is connected to a running tool V, the upper end of which is connected to a suitable tubular running string Z, such as casing or drill pipe, extending through the blowout preventers, connectors, flexible joint and marine conductor pipe to the drilling vessel DV. The hydraulic connector P, which is actually secured to the outer casing hanger body D in the manner illustrated in the above-identified U.S. Pat. No. 3,321,217, includes an adapter 10 above the hanger bodies, the inner end of the adapter clamping a suitable seal ring 11 between it and the upper end of the intermediate hanger body J, this seal ring having a groove 12 receiving a seal ring retainer 13 mounted in an internal circumferential groove 14 in the coupling adapter. The intermediate hanger body J has a lower downwardly tapering seat or shoulder 15 above which is located an internal circumferential ring groove 16 containing a split inherently contractable lockring 17 having an upper inner beveled surface 18. Above the lockring groove is an internal seal surface 19 of cylindrical form, and above this seal surface is an enlarged internal bore 20 which terminates at another internal cylindrical surface 21, which may be of the same diameter as the seal surface. Another internal circumferential groove 22 opens through this last-mentioned cylindrical surface and contains a split inherently contractable lockring 23 having an upper inner beveled surface 24. Above the cylindrical surface 21, the outer hanger body has another enlarged bore 25, and above this enlarged bore, the body J has another internal cylindrical surface 26 above which is provided a suitable internal thread 27 in the hanger body.

The casing hanger apparatus includes a body 28 having a lower hanger thread 29 connected to the casing Y suspended therebelow. This body has a downwardly facing tapered seat 30 adapted to engage the upwardly facing seat 15 in the surrounding hanger body J. Above this seat is a reduced external diameter portion 31 providing an upwardly facing shoulder 32 engageable with the lower end of the lockring 17 when the hanger body is moved past the lockring, during which time the latter is expanded outwardly within its internal groove 16, then contracting partially inwardly and across the shoulder 32 so as to lock the hanger body 28 in place by preventing its upward movement.

Above the lock shoulder 32 is a reduced diameter, external, cylindrical seal surface 33 which will be disposed opposite the internal seal surface 19 of the surrounding hanger body J and in spaced relation therewith, when the hanger body comes to rest upon its companion seat, to provide an annular passage 34. Above this seal surface 33, the hanger body has a reduced external diameter portion 35 provided with a right-hand thread 36 to which is adjustably and threadedly secured a packer actuating sleeve 37 having an internal thread 38 meshing with the right-hand thread 36. This packer actuator sleeve supports and will also exert an axial force against a pack-off assembly 39 so as to shorten the latter and compress it between the opposed sealing surfaces 19, 33, as described hereinbelow.

The actuator sleeve 37 is connected to a seat protector 40 thereabove, which has a reduced diameter portion 41 piloted within the sleeve. The seat protector has a plurality of circumferentially spaced radial torque pins 42 extending into in-

verted T-shaped slots 43 in the sleeve 37. The seat protector is connected to a torque tube or sleeve 45 forming part of the running and actuating roll V by means of a plurality of circumferentially spaced coupling pins 46 on the lower portion of the tube disposed within companion J-slots 47 in the seat protector 40. The torque tube or sleeve 45 has internal splines 50 adapted to mesh with external splines 51 on the running tool mandrel 52, the upper end of which is threadedly secured to the tubular running string Z, such as casing or drill pipe, extending to the drilling vessel DV. A helical compression spring 53 surrounds the mandrel 52, its upper end bearing against a spring seat 54 suitably secured to the mandrel, and its lower end bearing against the upper end of the torque tube 45 and tending to urge the latter in a downward direction along the mandrel, limited by engagement of an upper flange 56 of the torque tube with an upwardly facing shoulder 57 on the mandrel. The lower portion of the mandrel has an external left-hand thread 58 meshing with a companion internal left-hand thread 59 in the hanger body 28, and above its threads, the mandrel carries one or a plurality of seal rings 60 adapted to seal against an extended cylindrical inner wall 61 of the body 28 above its threaded portion 59.

When the hanger apparatus W and the casing Y suspended therefrom is connected to the running tool V and lowered through the marine conductor pipe T and the equipment connected thereto therebelow by means of the casing string Z to the position illustrated in FIGS. 4a and 4b, in which the hanger body 28 rests upon its seat 15 and the lock ring 17 has contracted over the upwardly facing shoulder 32, a bypass circulating passage exists between the hanger apparatus W and the surrounding hanger body J. As shown, this bypass communicates with the annulus 62 in the well bore surrounding the suspended casing Y and includes a plurality of circumferentially spaced longitudinal fluid passages 63 extending through the hanger body to the annular passage 34 between the opposed seal surfaces 19, 33. Fluid can then pass upwardly through the annular space 64 between the pack-off assembly and the enlarged bore 20 of the external casing hanger, and thence inwardly through a plurality of fluid bypass holes 65 formed through the upper portion of the actuator sleeve 37 to the interior of the latter, then passing upwardly through an annular passage 66 between the seat protector 40 and the mandrel 52, the bypass path then continuing through an annular passage 67 between the lower portion of the torque tube 45 and the mandrel 52 which communicates through a plurality of side ports or holes 68 in the torque tube with the annulus 69 around the latter, the fluid flow then being capable of continuing upwardly through the annular passage 70 between the mandrel 52 and the tubular running string Z thereabove and the surrounding apparatus to the drilling rig.

The packer assembly 39 includes an upper abutment ring 71 secured to the lower portion of the threaded packing actuator sleeve 37 by means of a suitable swivel 72. The lower end of the upper abutment ring 71 engages an initially retracted packing ring 79 made of an elastomer material, such as rubber or a rubberlike material, the lower end of this packing ring being engaged by a lower abutment 80 which is adapted to engage an upwardly facing shoulder 81 on the hanger body 28 below its external seal surface 33.

Prior to lowering the casing hanger apparatus and the casing suspended therefrom into the well bore, the casing hanger apparatus has its parts in their relative positions illustrated in FIGS. 4a and 4b in which the packing element or ring 79 is retracted and with the actuator sleeve 37 occupying its upper threaded position on the hanger body 28, the actuator sleeve being connected to the seat protector 40 by means of the pin and T-slot connection 42, 43 and the seat protector 40 being connected to the torque tube 45 through the pin and J-slot connection 46, 47. The lower portion of the mandrel 52 is secured to the hanger body 28 by means of the left-hand thread connection 58, 59.

The casing Y is lowered from the drilling rig through the equipment disposed above the ocean floor and into the well

bore A, the uppermost portion of the casing string being secured to the hanger apparatus W, which has its parts in the relative relationship illustrated in FIGS. 4a and 4b, and which is secured to the casing string Z. The tapered shoulder 30 of the hanger body 28 will move past the upper locking 23 and shift it outwardly out of its way and will then move downwardly into engagement with the lower locking 17, expanding it into its groove 16 out of its way until the hanger body engages its companion seat 15 in the surrounding hanger body J, whereupon the locking 17 will contract across the body shoulder 32 and lock the hanger body 28 and the casing Y suspended therebelow in place. At this time, the seat protector 40 or actuator sleeve 37 is disposed across the upper locking 23 and the seal ring 44 on the seat protector is out of sealing relation to its companion seal surface 26 at the upper portion of the outer hanger body. An upward pull can now be taken on the running string Z to insure that the hanger body 28 is locked in place. Circulating fluid can now be pumped down through the tubular running string Z and through the apparatus, continuing on down through the casing Y and then passing around its lower end or through suitable casing ports into the annulus 62 between the suspended casing string and the well bore A, and also between the casing string and whatever casing string H is surrounding it. The circulating fluid flows upwardly through the body passages 63 and through the annular passage 34 between the internal and external seal surfaces 19, 33, flowing upwardly around the packing assembly 39 and also upwardly between the packing assembly and the threaded portion 35 of the hanger body, continuing upwardly through internal grooves 86 in the actuator sleeve 37 to a position above the hanger body 28. Fluid will also pass from the annular space 64 externally of the packing assembly through the bypass holes 65 in the sleeve 37, then combining with the fluid passing upwardly through the internal grooves 86 for upward movement through the annular passage 66, 67 between the seat protector and mandrel 52, as well as between the torque tube 45 and mandrel, discharging through the torque tube holes 68 into the annulus around the torque tube, continuing upwardly through the annulus 70 around the mandrel 52 and the running string Z to the drilling rig.

The circulating fluid can be followed by the pumping of a suitable charge of cement slurry down through the running string Z, the apparatus V and the suspended casing string Y. This charge of cement has an upper cementing plug (not shown) at its upper end, which will slidably seal along the tubular casing string Z and then pass downwardly through the mandrel 52 and the casing string Y until the plug engages the casing shoe (not shown) at the lower end of the casing string, the cement moving upwardly through the annulus 62 around the casing string to the desired height, in a known manner, the fluid in advance of the charge of cement slurry passing upwardly through the bypass path through and around the casing hanger apparatus W.

After the cement has been displaced around the casing Y, the running string Z and the mandrel 52 are rotated, the rotation of the mandrel being transferred through the torque sleeve 45 to the seat protector 40 and from the seat protector to the packer actuator sleeve 37 to thread the latter in a downward direction along the casing hanger body 28, and thereby move the packer assembly 39 downwardly along the body 28 and the surrounding hanger body J. At the same time, rotation of the mandrel 52 is effecting its unthreading from the hanger body 28, because of the left-hand thread interconnection 58, 59 therebetween. Before the lower abutment 80 of the packing assembly 39 reaches the body shoulder 81, the mandrel 52 will have been unscrewed completely from the hanger body 28, whereupon rotation of the casing string Z and the mandrel 52 can continue to continue the downward threading of the actuator sleeve 37 along the mandrel body and the shifting of the packing assembly 39 downwardly until the lower abutment 80 engages the body shoulder 81, at which time the retracted packing sleeve 79 is disposed between the internal and external seal surfaces 19, 33. A continuation of the rota-

tion of the running string Z and mandrel 52 will effect a continued downward shifting of the actuator sleeve 37 along the body 28, moving the upper abutment 71 toward the lower abutment 80 and shortening the packing sleeve or ring 79 and expanding it outwardly and inwardly into firm sealing engagement with the internal and external sealing surfaces 19, 33 on the outer and inner hanger bodies J, 28. A sufficient torque is imposed on the apparatus to insure the firm sealing of the packing sleeve 79 against its companion surfaces.

It is to be noted that following the complete unthreading of the mandrel 52 from the packer body 28, its seal ring or rings 60 still maintain a sealed relationship with the internal body surface 61. Accordingly, the effectiveness of the packed-off seal 39 can now be tested with all of the apparatus remaining in place. A suitable pressure is imposed on the fluid in the annulus 70 surrounding the tubular running string Z, as, for example, by closing a blowout preventer N thereagainst and then subjecting the fluid in the annulus below the blowout preventer to adequate pressure. If no pressure loss occurs, assurance is had that the seal is effective. The fact that the mandrel is still sealed against the anchor body 28 will prevent fluid from passing between the mandrel and the hanger body. If a leak is detected, which is determined to be due to the packing 79, an additional compression of the packing sleeve 79 can be undertaken by turning the running string Z and the mandrel 52, which will effect an additional downward threading of the actuator sleeve 37 along the anchor body 28.

Assuming the seal does not leak, the running tool V can now be disconnected from the seat protector 40 merely by partially turning the running string Z to the right to be assured that the torque tube pins 46 are disposed against the ends of the J-slots 47 and in alignment with their vertical legs, whereupon the tubular running string Z is moved upwardly to move the pins 46 out of the J-slots, which permits the running tool V to be removed from the casing hanger apparatus W and elevated through the equipment thereabove to the drilling vessel.

With the type of apparatus described above for the purpose of explaining the present invention, the casing hanger body 28 is locked to the surrounding body J. Because of the left-hand threaded connection 58, 59 of the mandrel to the body 28, the lower end of the tubular running-in string of casing or the like is anchored in place against longitudinal movement. Due to heaving of the drilling vessel, it is necessary to allow the running string Z to stand in compression, and where such running string is of an extended length, for example, 250 feet or more, its weight results in excessive friction at the left-hand threaded connection 58, 59, the running string itself lying at several points along its length against the inside wall of the marine conductor pipe T through which the tubular string Z extends. Such condition of the running string is illustrated diagrammatically in FIG. 1. As a result of the friction at the left-hand threads 58, 59, and of the portions of the running string bearing against the interior wall of the marine conductor pipe T, excessive torque has heretofore been required in rotating the running string and in effecting disconnection of the mandrel threads 58 from the companion threads 59 in the casing hanger body 28.

By virtue of the present invention, the weight-friction problem is overcome. During the pumping of the cement down through the running string Z and the casing Y, a cementing head 100 of any known and suitable type is connected to the upper end of the running string Z, cement being pumped through this head and down through the pipe Z, Y for discharge from the casing and upward movement through the annulus 62 surrounding the casing Y. As noted above, a top cementing plug (not shown) is placed at the upper end of the charge of cement slurry, and this plug bumps against the usual casing shoe (not shown), or the like, in sealed relation therewith to prevent any further discharge of fluid from the casing string. In effect, the top cementing plug acts as a complete barrier or plug sealed against the inner wall of the casing shoe or casing section immediately thereabove. Thus, fluid cannot move downwardly in the running string Z and cas-

ing Y, and it is prevented from leaking through the left-hand threaded connection 58, 59 by the seal rings 60 bearing against the inner cylindrical wall 61 of the hanger body 28.

A hose 101 is connected to the cementing head 100 at the drilling vessel, and fluid pressure applied through the hose and cementing head to the fluid in the interior of the running string Z and the casing Y. This fluid under pressure exerts an upward force on the top of the running string, which can be sufficient in amount to overcome a desired portion of the total weight of the running string Z, which thereby places at least a portion of the running string Z in tension and removes a large part of the weight from the left-hand threaded connection 58, 59. Thus, the friction forces in the threaded connections are reduced considerably, as well as the extent of bearing of the running string Z against the inner wall of the riser T. In fact, there may be virtually no frictional engagement of the running string Z against the inner wall of the marine conductor pipe T. With a large portion of weight of the running string Z removed from the threaded connection 58, 59, the running string Z can be rotated to the right in effecting disconnection of the mandrel threads 58 from the hanger body threads 59. During the time that rotation proceeds, the pressure is maintained on the fluid inside the conductor pipe Z, the seal 60 remaining in sealed engagement with the extended cylindrical sealing surface 61 of the casing hanger body. The reduction in the friction force makes it comparatively easy for a full threaded disconnection to take place, and such full threaded disconnection will take place before the seal rings 60 come out of sealing engagement with the internal cylindrical surface 61.

A typical example of the effectiveness of the method of supporting the running string Z, at least partially, by applying fluid pressure to its interior can be given. Let it be assumed that a casing running string Z, of 9 $\frac{1}{2}$ inches, 47 lb./ft. casing, 400 ft. long, is run and landed in a 13 $\frac{1}{2}$ inch wellhead, the mud weight in the marine conductor pipe P and in the well casing Y being 95 lbs. per cubic foot. This 400 ft. length of casing will weigh 18,800 lbs. in air, but due to the buoyant affect of the mud, its weight is reduced to 15,150 lbs. If this weight is unsupported, considerable torque would be required to rotate the running-in string, because of the friction of the threads 58, 59 and the contact of the running string with the wall of the marine riser T (FIG. 1). To minimize such friction forces, an internal pressure of 170 p.s.i. can be placed through the hose 101 and cementing head 100 to the interior of the running string Z, which will provide a lift of 12,600 lbs. on the running string Z, leaving about 2,550 lbs. of weight remaining on the left-hand threaded connection 58, 59. It is preferred not to provide sufficient internal pressure in the running string Z to exactly balance its weight, as a safety factor in the operation of the apparatus. The lifting force will hold almost the entire 400 ft. length of the casing running string in tension, and only its lower portion will purposely be allowed to stand in compression, as exemplified by the bracket CC in FIG. 2. The weight remaining on the left-hand threads 58, 59 results in relatively low friction at the threaded connection and allows the running string Z to be rotated for the purpose of disconnecting the threads 58 from the threads 59 at a relatively low torque.

No special connections are required at the cementing head for applying the fluid pressure internally of the running string Z, since the flexible hose 101 will merely coil around the cementing head 100 or around the running string Z during rotation of the latter by the number of turns required to produce complete unthreading of the connections 58, 59. If desired, the hose 101 can be coiled partially in a left-hand direction around the cementing head or running string Z before rotation of the running string Z to the right commences, so that such rotation is accompanied by uncoiling of the hose, followed, if desired, by a coiling of the hose on the cementing head or running string in the opposite direction by a few turns.

The application of the internal pressure to the running string Z supports a large portion of its weight, and thereby reduces considerably the rotational friction at the threads, vir-

tually eliminating the rotational friction between the running string Z and the marine riser T, since the major length of string Z hangs in tension, enabling the threaded disconnection to take place through the application of low torques to the running string Z. Without the application of the internal pressure, the excessive torque required in disengaging the left-hand thread running tool 58, 59 from the hanger body 28 might cause damage to the joints of the casing string Z used in connecting the casing sections to one another. The couplings at the casing joints might fail upon the imposition on them of excessive torques.

I claim:

1. A method of facilitating rotation of a tubular string extending downwardly from a drilling rig and having a connection with apparatus at a well bore, comprising closing the upper portion of the tubular string, closing the apparatus below the connection against downward passage of fluid, and applying fluid pressure internally of the tubular string while rotating the tubular string in the desired direction, whereby the fluid under pressure within the tubular string supports a substantial portion of the weight of the tubular string above the connection.

2. A method as defined in claim 1; wherein said connection comprises members threadedly engaged with one another, the fluid pressure being applied internally of the tubular string and the tubular string rotated until one of the members has been threaded along the other of said members to a desired condition.

3. A method as defined in claim 1; wherein said connection requires rotation to effect its disconnection, the fluid pressure being applied internally of the tubular string and the tubular string rotated until the connection is conditioned for disconnection.

4. A method as defined in claim 1; wherein said connection comprises a threaded member threaded into another threaded member, the fluid pressure being applied internally of the tubular string and the tubular string rotated until the members are threadedly disconnected from one another.

5. A method of facilitating rotation of a tubular string extending downwardly from a vessel floating in a body of water and having a connection with the apparatus at a well bore underlying the vessel and body of water, comprising closing the tubular string at the floating vessel, closing the apparatus below the connection against downward passage of fluid, and applying fluid pressure internally of the tubular string while rotating the tubular string in the desired direction, whereby the fluid under pressure within the tubular string supports a substantial portion of the weight of the tubular string above the connection and extending downwardly from the floating vessel.

6. A method as defined in claim 5; wherein said connection comprises members threadedly engaged with one another, the fluid pressure being applied internally of the tubular string and the tubular string rotated until one of the members has been threaded along the other of said members to a desired condition.

7. A method as defined in claim 5; wherein said connector comprises a threaded member threaded into another threaded member, the fluid pressure being applied internally of the tubular string and the tubular string rotated until the members are threadedly disconnected from one another.

8. A method of facilitating rotation of the tubular string extending downwardly from a vessel floating in a body of water above a well bore underlying the vessel and body of water, the tubular string having a releasable connection with a wellhead fixed at the floor of the body of water, comprising closing the tubular string at the floating vessel, closing the well bore below the connection against downward passage of fluid, and applying fluid pressure internally of the tubular string while rotating the tubular string to effect release of the connection and disconnection of the tubular string from the wellhead.

9. A method as defined in claim 8; wherein said connection comprises a threaded member secured to said tubular string

and threadedly connected to a threaded member secured to said wellhead, the fluid pressure being applied internally of the tubular string and the tubular string rotated until the members are threadedly disconnected from each other.

10. A method comprising providing a releasable connection between a casing string and a tubular string and lowering said casing string in a well bore on said tubular string, pumping cementitious material through the tubular string and casing string for discharge from the casing string and upward passage in the well bore around the casing string, closing the casing string below the releasable connection against downward passage of fluid, closing the upper portion of the tubular string above the releasable connection, and applying fluid pressure internally of the tubular string while rotating the tubular string to effect release of the connection and disconnection of the tubular string from the casing string.

11. A method as defined in claim 10; wherein the casing string is closed by pumping a cementing plug downwardly therein at the upper end of the cementitious material.

12. A method as defined in claim 10; wherein said connection comprises a threaded member secured to said tubular string and threadedly connected to a threaded member secured to said casing string.

13. A method comprising connecting a casing string to a hanger body, securing said body to a tubular string having a releasable connection with said body, lowering said tubular string, hanger body and casing string from a vessel floating in a body of water to lower said casing string in a well bore underlying the vessel and body of water until said hanger body is

supported by a wellhead fixed at the floor of the body of water, pumping cementitious material through the tubular string and casing string for discharge from the casing string and upward passage in the well bore around the casing string, closing the casing string below the releasable connection against downward passage of fluid, closing the upper portion of the tubular string at the vessel, and applying fluid pressure internally of the tubular string while rotating the tubular string to effect release of the connection and disconnection of the tubular string from the hanger body.

14. A method as defined in claim 13; wherein the casing string is closed by pumping a cementing plug downwardly therein at the upper end of the cementitious material.

15. A method as defined in claim 13; wherein said connection comprises a threaded member secured to said tubular string and threadedly connected to said hanger body, the fluid pressure being applied internally of the tubular string and the tubular string being rotated until the threaded member is threadedly disconnected from said hanger body.

16. A method as defined in claim 13; wherein said connection comprises a threaded member secured to said tubular string and threadedly connected to said hanger body, the fluid pressure being applied internally of the tubular string and the tubular string being rotated until the threaded member is threadedly disconnected from said hanger body; the casing string being closed by pumping a cementing plug downwardly therein at the upper end of the cementitious material.

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