United States Patent

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[54] ADAPTER FOR CONVERTING A STATIONARY BLOWOUT PREVENTER TO A ROTARY BLOWOUT PREVENTER

12 Claims, 4 Drawing Figs.

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[51] Int. Cl. E21b 33/00, F21b 7/12
[50] Field of Search ..... 166/.5, .6; 175/7; 285/276; 277/31

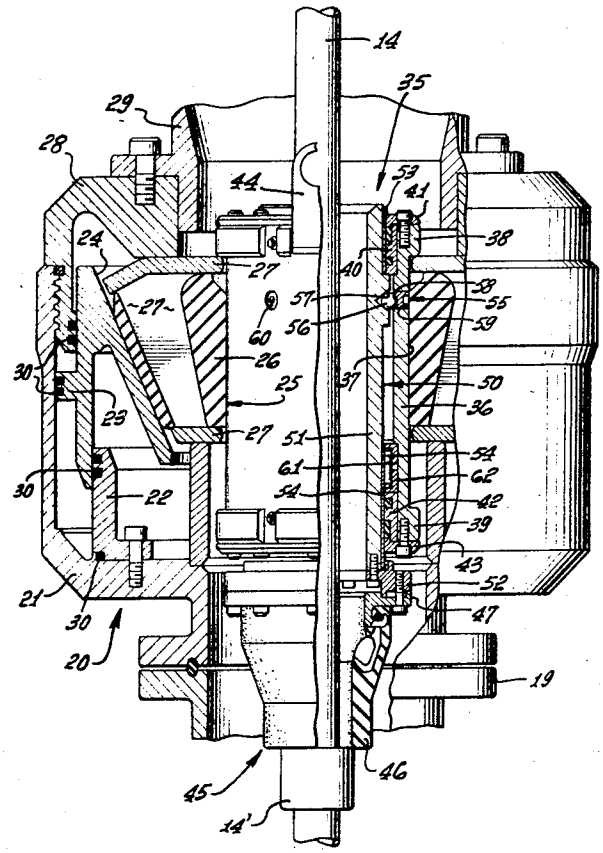
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ABSTRACT: An adapter for converting a stationary blowout preventer to a rotary blowout preventer includes a housing with a cylindrical outer surface for being sealingly engaged by the blowout preventer rubber seal, a radially outwardly extending flange on either axial end thereof for engagement with the metal reinforcing of the rubber seal upon relative axial displacement therebetween to halt the displacement, and a tubular inner member rotatably mounted within the housing and itself mounting a seal for sealingly engaging a rotating pipe tool extending through the adapter.



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SHEET 1 OF 2

FIG. 1.

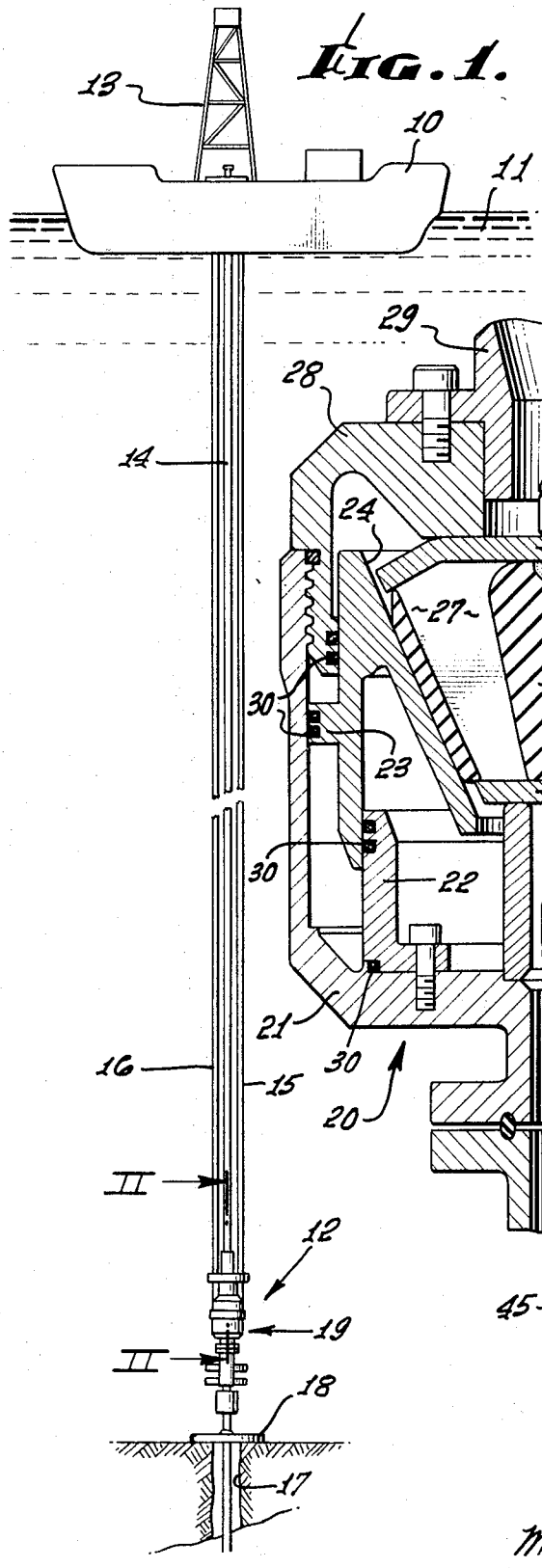
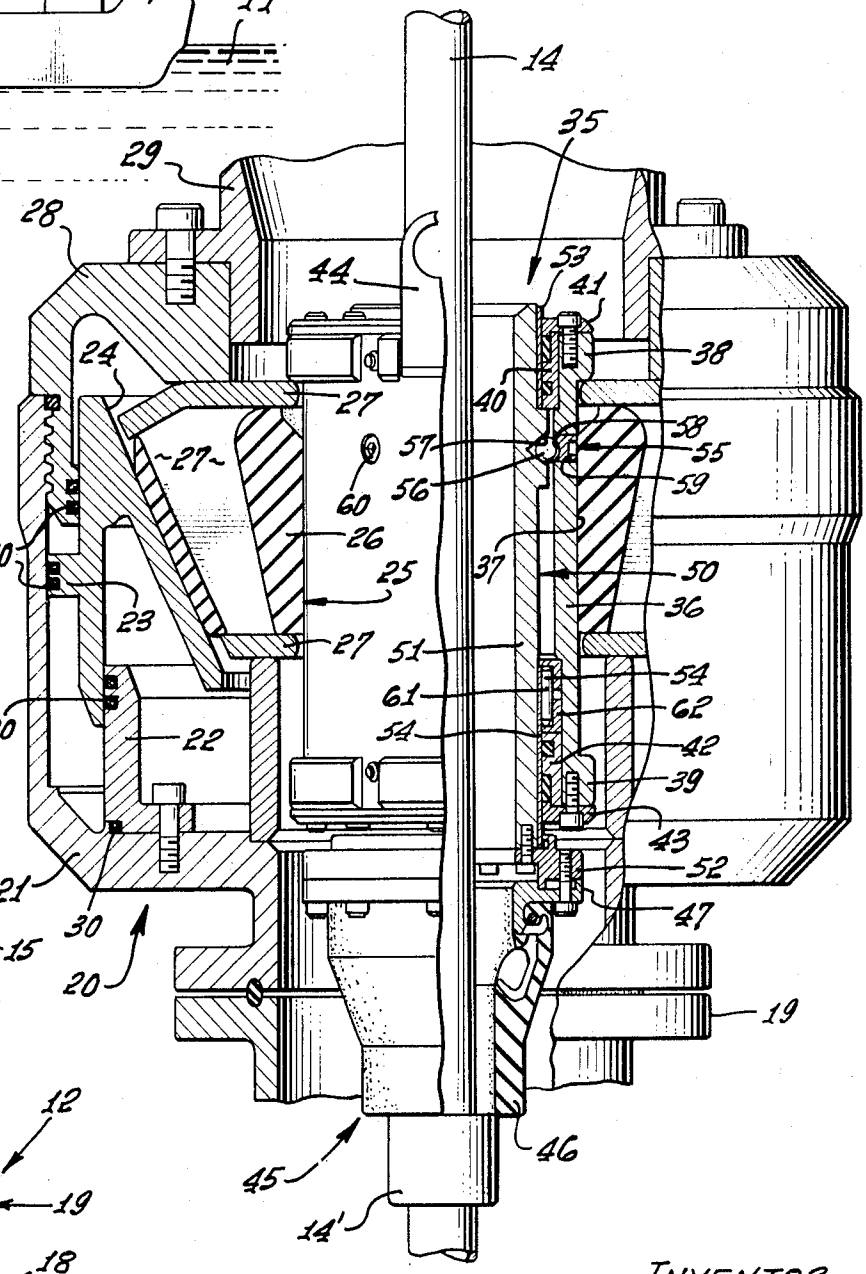


FIG. 2.



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FIG. 3.

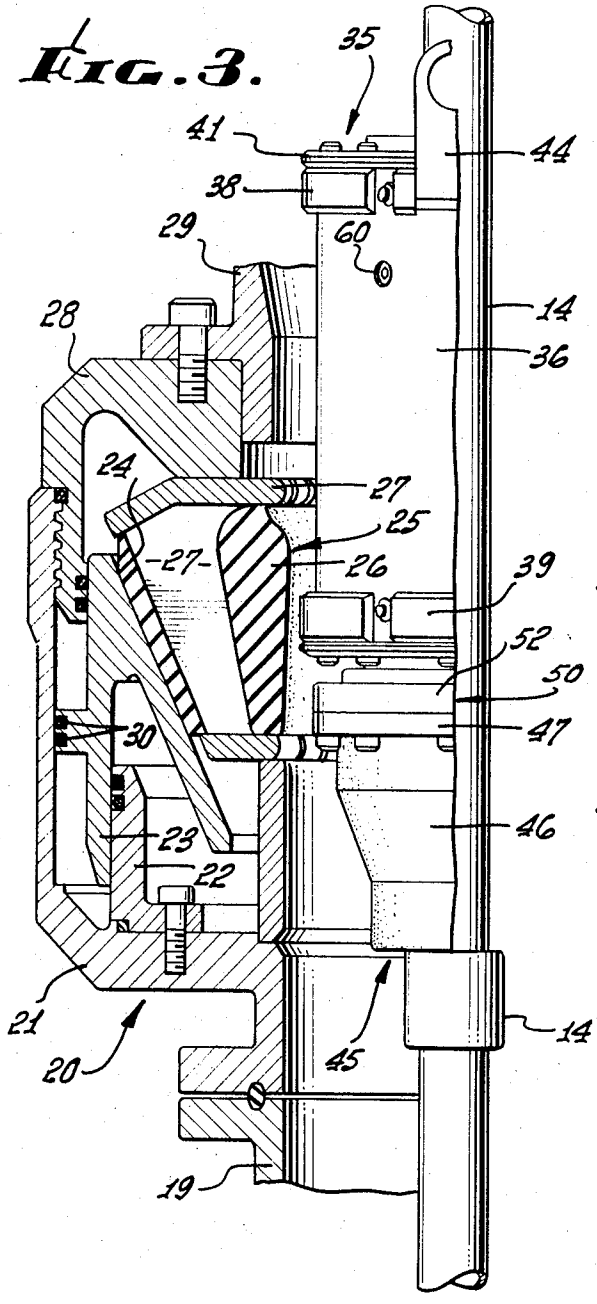
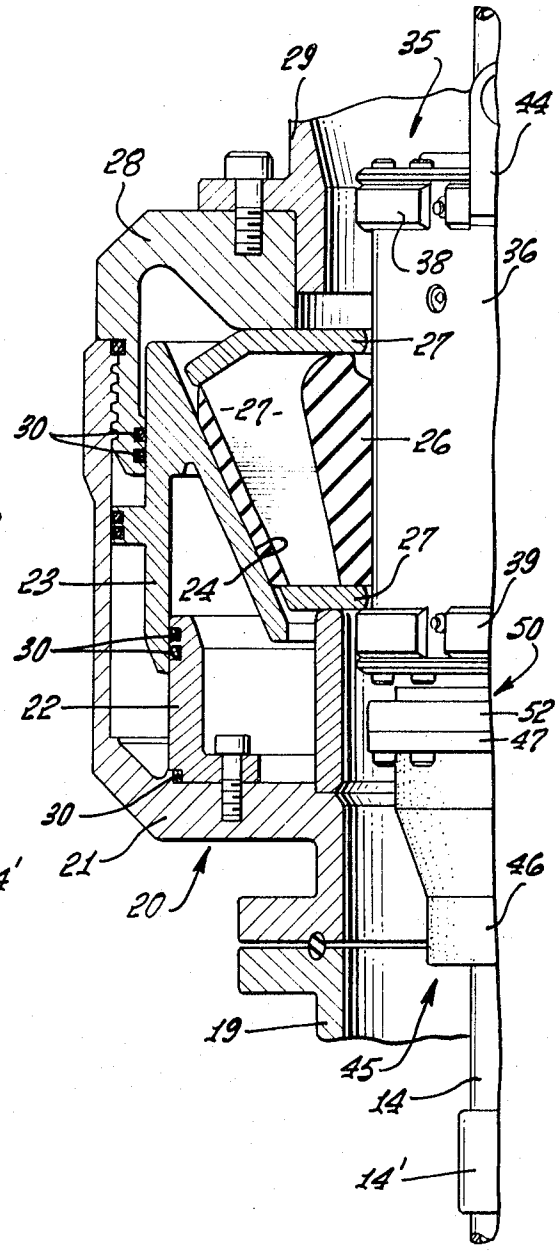


FIG. 4.



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ADAPTER FOR CONVERTING A STATIONARY BLOWOUT PREVENTER TO A ROTARY BLOWOUT PREVENTER

BACKGROUND OF THE INVENTION

This invention relates to rotary blowout preventers, and more particularly to an adapter for converting a conventional stationary blowout preventer to a rotary blowout preventer.

The oil well industry uses both stationary and rotary blowout preventers to prevent internal well pressures from opening the well about pipe run therein and the consequent loss of drilling mud or well fluids therefrom. A stationary blowout preventer is normally mounted in the wellhead apparatus and hydraulically presses a nonrotatable rubber seal against an oil well tool, such as a production pipe run through said apparatus, to seal the well about the stationary tool. A rotary blowout preventer performs the same sealing function, but additionally allows the tool to rotate relative the wellhead to rotate with rotating pipe run therethrough, such as in drilling operations.

Stationary blowout preventers tend to be somewhat more simple in construction, and therefore less expensive, than rotary blowout preventers. However, if a stationary blowout preventer is used to seal about a rotating tool, the rotation of the tool wears the rubber seal quickly causing failure of the seal and the necessity of replacing it. Rotary blowout preventers are more of a specialty type of oil well tool required only during drilling operations or other rotating operations and are not necessarily required for production operations once the drilling has been completed, although they are frequently left in the well after drilling operations are completed because of the difficulty in retrieving them.

Therefore, it would be desirable to provide an adapter which would convert a conventional stationary blowout preventer normally installed in a wellhead apparatus to a rotary blowout preventer for the drilling operation. Such an adapter could be inserted in any stationary blowout preventer when more than one is provided in the wellhead so that the remaining stationary blowout preventers could perform their sealing function at times when the drilling is shut down. Also, such adapter could be removed after the drilling operation is completed to be used in other drilling operations at other wells while the original stationary blowout preventer could also be reinserted into the stationary blowout preventer if any further rotating tool work over or reentry operations were required.

Therefore, it is a primary object of this invention to provide an adapter for converting a stationary blowout preventer to a rotary blowout preventer.

It is another object of this invention to provide such an adapter which is insertable into an open stationary blowout preventer and sealingly engaged thereby in the closed position.

It is another object of this invention to provide such an adapter having a housing for being inserted into and sealingly engaged by the packing of the stationary blowout preventer and having a seal rotatably mounted to the housing for sealingly engaging a rotating pipe therethrough.

It is yet a further object of this invention to provide such a housing having flanges which halt axial displacement of the housing relative the blowout preventer by engaging the metal reinforcing of the rubber packing thereof.

It is another object of this invention to provide such an adapter which may be removed permitting its use elsewhere, the stationary blowout preventer to function as a stationary blowout preventer.

It is a further object of this invention to provide a method of converting a stationary blowout preventer to a rotary blowout preventer by providing a housing for sealing engagement with the stationary blowout preventer packing, providing a mount for a seal which is rotatably mounted within the housing, opening the packing of the stationary blowout preventer and inserting the housing therein, closing the packing of the stationary blowout preventer to sealingly engage the outer surface of the housing whereby the seal rotates with a pipe tool run therethrough while the housing remains stationary with the stationary blowout preventer.

It is a further object of this invention to provide such a method for use in an undersea wellhead mounted stationary blowout preventer.

SUMMARY OF THE INVENTION

Generally stated, the adapter of this invention for converting a stationary blowout preventer to a rotary blowout preventer includes a housing inserted within the annular packing of the stationary blowout preventer and sealingly engaged thereby, annular seal means for sealingly engaging a pipe run therethrough, and means rotatably mounting the seal means to the housing for relative rotation therebetween while preventing relative axial movement therebetween, whereby the seal means rotates with the pipe while the housing is held stationary in the packing of the stationary blowout preventer. In a preferred embodiment, the housing has a radially outwardly extending flange at either end for engaging the metal reinforcing of the annular packing when axially displaced to halt such axial displacement and the means for rotatably mounting the seal includes a tubular inner member mounting at the lower end of a stripper seal and being rotatably mounted within the housing by bearings therebetween.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a schematic representation, in elevation, of a floating vessel positioned above a subsea wellhead mounted stationary blowout preventer apparatus utilizing a preferred exemplary embodiment of adapter device according to the present invention to convert a stationary blowout preventer to a rotary blowout preventer;

FIG. 2 is an enlarged elevational view, partially in section, of the subsea blowout preventer apparatus and exemplary adapter of FIG. 1 taken therein along the plane II–II;

FIG. 3 is a cross-sectional view of the preventer apparatus of FIG. 2 showing the exemplary adapter being inserted into the stationary blowout preventer;

FIG. 4 is a cross-sectional view of the preventer apparatus of FIGS. 1 through 3 showing the exemplary adapter displaced upwardly from the position shown in FIG. 2 relative to the stationary blowout preventer.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred exemplary embodiment of the method and apparatus for converting a stationary blowout preventer to a rotary blowout preventer according to the present invention will now be described in detail with reference to the aforedescribed FIGS. Referring to FIG. 1 initially, a floating vessel or barge **10** is shown positioned by suitable anchor means (not shown) in a body of water or sea **11** over a subsea wellhead **12**. A conventional drilling rig, indicated at **13**, may be provided on the barge or vessel **10** for running a conventional drill string **14** down to the subsea head indicated generally at **12**, at the well site. The drilling rig **13** has one or more fluid supply lines **15** and one or more well fluid or drilling mud return lines **16** which are connected between the vessel **10** and the subsea wellhead indicated at **12**.

The subsea head **12** is of conventional design mounted above well **17** by template **18** with a series of stationary blowout preventers, indicated generally at **19**, and operably connected to the fluid supply or pressure line **15**. As seen in FIG. **2**, one of the stationary blowout preventers, preventer **20**, is shown with an adapter device indicated generally at **35**, according to this invention, for converting the stationary blowout preventer to a rotary blowout preventer for use with rotating drill pipe **14**.

The stationary blowout preventer **20** in the exemplary embodiment is of conventional design and includes a preventer body **21** having an open top, a bowl-shaped body and a flanged lower end for sealingly mounting to the flanged upper

end of another blowout preventer 19. The preventer body 21 contains an internal body sleeve 22 mounted therein and secured thereto by conventional capscrews. A contractor piston 23 is inserted between the outer surface of the body sleeve 22 and the inner surface of the preventer body 21, which moves vertically in response to a differential fluid pressure applied through line 15. The contractor piston 23 has a cylindrical outer surface, a V-shaped cross section, and an inverted frustoconical center surface 24 which translates the vertical motion of the contractor piston into radial motion against packing unit 25 relative the axis of the preventer body 21.

A packing unit 25 of essentially annular shape, with a frustoconical outer surface and a cylindrical inner surface, is located within the central opening of the contractor piston 23. The packing unit 25 includes a rubber seal 26 and metal reinforcing members 27 integral with the rubber seal 26. The packing unit 25 is movable between an open position, as seen in FIG. 3, wherein there is a center opening in the unit and a closed position, as in FIGS. 2 and 4, wherein the opening in the center is reduced in size to the point of closing completely if need be.

The preventer body 21 has a preventer head 28 screwed to the upper end thereof to close the upper end of the preventer body 21. Preventer head 28 maintains the packing unit 25 within the stationary blowout preventer 20 in the axial direction while permitting radial movement thereof. A protector head 29, with a funnel-shaped interior opening, may be provided on body head 28 for guiding tools into the central opening of the stationary blowout preventer 20.

The stationary blowout preventer 20 is provided with several sets of U-ring seals 30 to seal the opposing surfaces of the preventer parts.

The stationary blowout preventer 20 operates conventionally in response to differential fluid pressure from the fluid supply lines 15. The differential fluid pressure raises the contractor piston 23 with the center surface thereof 24 pressing the packing unit axially inwardly from the open position of FIG. 3 to the closed position of FIGS. 2 and 4, to close the central opening of the blowout preventer 20. In response to opposite differential fluid pressure, the contractor piston 23 lowers, allowing the packing unit 25 to expand from the closed position of FIGS. 2 and 4 to the opened position of FIG. 3, opening the central opening of the blowout preventer 20.

The preferred exemplary adapter, according to this invention, for converting a stationary blowout preventer to a rotary blowout preventer is shown in FIGS. 2, 3 and 4 inserted into the aforedescribed stationary blowout preventer 20. The adapter, indicated generally at 35, includes a generally hollow, cylindrical housing 36. Housing 36 has a central cylindrical outer surface 37 adapted for being sealingly engaged by the rubber seal 26 of the packing unit 25. The cylindrical outer surface 37 is bounded at the upper axial end by an upper radially outwardly extending flange 38, and at the lower axial end by a lower radially outwardly extending flange 39. As best seen in FIG. 3, the lower radial flange 39 has a diameter which is less than the diameter of the opening in the rubber seal 26 when the seal is in the opened position. As seen in FIGS. 2 and 4, both the upper and lower radial flanges 38 and 39 have a diameter which is greater than the internal diameter of the metal reinforcing 27 when the rubber seal 26 sealingly engages the cylindrical outer surface 37 of the housing 36.

The interior surface of the housing is generally cylindrical with several steps therein. Inserted within the housing 36 adjacent the upper axial end thereof is an upper seal ring 40 containing conventional U-ring seals. The upper seal ring 40 is maintained within the housing 36 by a ring cap 41 conventionally bolted to the upper axial end thereof. Likewise, a similar lower seal ring is inserted into the housing 36 adjacent the lower axial end thereof and maintained therein by a lower ring cap 43 conventionally bolted to the lower axial end of the housing 36.

The adapter 35 also contains annular seal means 45 for engaging the rotating drill pipe 14 to provide a sealing connection therebetween which is increased with pressure on the seal. The annular seal means 45 includes a stripper seal 46 mounted to a conventional strip or seal mount 47.

The housing 36 also contains apertured ears 44 extending upwardly from the upper end thereof, for attachment to a wire line tool which may be used for raising or lowering the adapter into the otherwise conventional stationary blowout preventer apparatus. In the exemplary embodiment, the adapter, indicated generally at 35, is shown being run into the preventer apparatus in FIG. 2 on a joint 14' of the drill string 14. Adapter 35 may be placed about the drill pipe with the seal 46, explained hereinafter, on a joint 14' and run with the pipe to the wellhead and into alignment with the preventer apparatus seal 26. Pipe string 14 may be guided to the wellhead by known methods, as by guide lines between vessel 10 and the wellhead, or the like.

The annular seal means 45 is rotatably mounted to the housing 36 for relative rotation therebetween by a mounting means 50. The mounting means 50 is a tubular inner member within the housing 36. The tubular inner member has a lower flange 52 on which the stripper seal mount 47 is conventionally bolted to secure the stripper seal 46 to the tubular inner member 51.

The tubular inner member 51 is generally cylindrical in shape and is provided with an upper hardened insert sleeve 53 adjacent the upper end thereof and a lower hardened insert sleeve 54 adjacent the lower end thereof which is sealingly engaged by the seals of upper and lower seal rings 40 and 42 so that any wear that occurs to the tubular member 51 because of the engagement will not occur on the tubular inner member 51 itself, but rather will occur on the replaceable sleeves 53 and 54.

Mounting means, indicated generally at 55, are provided for rotatably mounting the inner member 51 to the housing 36 for rotation therebetween. The rotatable mounting or bearing means 55 in the exemplary embodiment includes a set of ball bearings adjacent the upper ends of the tubular inner member 51 and the housing 36. The ball bearings 56 run in a circumferential outwardly opening V-groove 57 in the tubular inner member and in an aligned inwardly opening groove 58 in the housing 36. The housing 36 is provided with an access hole 59 from the outer surface 37 therethrough to the groove 58 through which the ball bearings 56 are inserted or replaced. The access hole 59 is plugged by a plug 60 conventionally maintained in the housing 36 to secure the ball bearings 56 in their proper location.

The exemplary mounting means 55 also includes roller bearings 61 mounted in a conventional bearing housing 62 and inserted through the lower end of the housing 36. The roller bearings 61 run on the upper half of the lower insert sleeve 54 around the tubular inner member 51. The bearing housing 62 is positioned above the lower seal ring 42 and maintained in position by the lower ring cap 43 as has been previously described.

The ball bearings 56 and the roller bearings 61 together rotatably mount the inner member 51 to the housing 36 with both sets of bearings 56 and 61 absorbing the radial load of rotation therebetween. The ball bearings 56 absorb the axial load therebetween and prevent any axial displacement of the inner tubular member 51 relative the housing 36.

To convert the stationary blowout preventer from a stationary blowout preventer to a rotary blowout preventer according to the method of the present invention, the blowout preventer 20 is opened by differential fluid pressure from the fluid supply lines 15 which causes a lowering of the contractor piston 23 which in turn allows the packing unit 25 to expand radially outwardly to the open position, opening the central opening of the rubber seal 26.

After the stationary blowout preventer 20 is open, the adapter 35 is mounted on the drill string joint 14' at the drilling rig 13 and is lowered into the stationary blowout

preventer 20 along with the drill pipe. As best seen in FIG. 3, the adapter 35 slides downwardly through the open stationary blowout preventer 20 with the lower radial flange 29 passing through the center opening of the rubber seal 26 in the open position. The adapter 35 is lowered until the position shown in FIG. 2 is reached, whereupon differential fluid pressure applied through the fluid supply lines 15 raises the contractor piston 23 and moves the packing unit 25 from the open position shown in FIG. 3 to the closed position shown in FIGS. 2 and 4, with the rubber seal 26 sealingly engaging the cylindrical outer surface 37 of the housing 36. As the rubber seal 26 is moved radially inwardly into the closed position, the metal reinforcing members 27 also move radially inwardly therewith from the open position shown in FIG. 3 to the closed position shown in FIGS. 2 and 4 wherein the metal reinforcing members 27 are positioned closely adjacent the cylindrical outer surface 37. The conversion of the stationary blowout preventer 20 to a rotary blowout preventer has been completed, and the thus adapted apparatus is ready to seal about the rotating drill pipe 14 during drilling operations.

The drill pipe 14 is rotated by the drilling rig 13 to perform conventional drilling operations, and as it is rotated, the tubular inner member 54 rotates with the pipe 18 on the ball bearings 56 and the roller bearings 61 to rotate relative the housing 36 secured to the blowout preventer 20. The tubular inner member is prevented from moving axially relative the housing 36 by the ball bearings 56 in the aligned grooves 57 and 58.

If during the drilling operation a downward axial load is placed on the adapter 35, such as the weight of the drill pipe 18, the whole adapter 35 will slide axially relative the stationary blowout preventer 20 with the rubber seal 26 sliding on the cylindrical outer surface of the housing 36, until the upper radial flange 38 engages the metal reinforcing 27 of the packing unit 25 to halt the relative axial movements therebetween. The engagement between the upper radial flange 38 and the metal reinforcing 27 prevents the adapter 35 from being pushed downwardly out of the stationary blowout preventer 20.

If the internal pressure from the well hole is great, it will exert an upward force on the adapter 35 tending to push the adapter 35 upwardly out of the blowout preventer 20. The adapter 35 will move axially upwardly relative the blowout preventer 20, as seen in FIG. 4, until the lower radial flange 39 of the housing 36 engages the metal reinforcing 27 again to halt relative axial movement between the adapter 35 and the blowout preventer 20.

Removal of the adapter 35 is accomplished by reversing the insertion steps, i.e. the adapter is engaged by the drill pipe joint 14', the packing unit 25 is released to move to the open position of FIG. 3, and the adapter 35 is raised up out of the wellhead apparatus along with the drill string.

Thus, the adapter according to this invention can convert a stationary blowout preventer of a wellhead to a rotary blowout preventer whenever the same is desired and can be retrieved from the well when no longer needed. The adapter of the present invention therefore allows the ready conversion of a conventional stationary blowout preventer, normally placed at a wellhead to a rotary blowout preventer, even when at a subsea well remote from a floating vessel, whenever the same is desired and without the added cost and expense of placing a permanent rotating blowout preventer in the wellhead apparatus. Having thus described the adapter of the present invention, what I claim as my invention is set forth in the following claims.

I claim:

1. An adapter for converting a stationary blowout preventer normally provided in a wellhead apparatus to a rotary blowout preventer, said stationary blowout preventer having a radially yieldable annular packing with metal reinforcing, and means for compressing the packing radially inwardly from an open position to a closed position wherein the packing sealingly engages the surface of the member inserted therethrough, the adapter comprising:

a housing insertable entirely within said stationary blowout preventer and having an overall outside diameter smaller than the inside diameter of said annular packing in its open position, said housing having an outer surface configured to be sealingly engaged and thereby mounted by the annular packing when the housing is located in the packing and the parking is compressed to the closed position, and an inner bore through which a pipe may be run to said well;

annular seal means for sealingly engaging about a pipe run therethrough; and

means for rotatably mounting said seal means to said housing for relative rotation therebetween while preventing relative axial movement therebetween whereby said seal means may rotate with said pipe while said housing is held stationary and within the stationary blowout preventer by the packing thereof.

2. The adapter as recited in claim 1 wherein the metal reinforcing of the packing is radially slidable as the packing is compressed but is held against axial movement relative the stationary blowout preventer, and wherein:

each axial end of the housing is provided with a radial flange extending outwardly of said outer surface for engagement with at least a portion of said metal reinforcing when said packing is in the closed position, and said adapter is urged in an axial direction relative to the stationary blowout preventer, at least one of said radial flanges having an external diameter which is less than the internal diameter of the packing in the open position permitting the flange to pass through the packing in the open position, the engagement of either radial flange with the metal reinforcing in the closed position halting relative axial displacement therebetween.

3. A method of providing a rotating seal about a pipe tool to be run through an undersea wellhead mounted stationary blowout preventer comprising:

providing an outer housing member for insertion entirely into the stationary blowout preventer and having an outer surface for being sealingly engaged by an annular packing within said preventer and a pair of spaced radial flanges extending outwardly from said surface, an inner member mounted within the outer housing member for relative rotation but not axial displacement therebetween and mounting a seal means for sealingly engaging a pipe run therethrough to said inner member;

opening the packing of the stationary blowout preventer;

inserting the outer housing member and the inner member within the preventer with one of said pair of radial flanges on either side of said packing thereof;

closing the packing in the stationary blowout preventer upon the outer surface of the outer member between said flanges to sealingly engage and hold said housing within said preventer by the compression of said packing about said surface within the axial movement limits of the spacing of said flanges; and

running a rotating pipe through the inner member and through the seal thereon into the well associated with said wellhead.

4. A method of converting a subsea wellhead mounted stationary blowout preventer into a rotary blowout preventer from a remote floating vessel which is positioned over said wellhead, comprising the steps of:

providing a housing for insertion entirely into said stationary blowout preventer with an outer surface configured to be sealingly engaged by an annular packing and an associated rotatably mounted annular seal means for sealing about and rotating with a drill string pipe run through a bore of said housing;

opening a packing provided in said subsea positioned stationary blowout preventer;

positioning said housing about a drill string pipe and seating it on a drill string joint;

running sad housing from said vessel on said drill string entirely into said preventer and into alignment with said preventer packing; and

closing said packing about said housing outer surface to sealingly hold said housing in said preventer.

5. An adapter for converting a stationary blowout preventer to a rotary blowout preventer, said stationary blowout preventer having a radially yieldable annular rubber packing with metal reinforcing and means for compressing the rubber packing radially inwardly from an open position to a closed position wherein the rubber packing sealingly engages a cylindrical member inserted therethrough, said metal reinforcing being radially slidable as the rubber packing is compressed but being held against axial movement to prevent axial movement of the rubber packing, the adapter comprising:

a tubular outer housing for insertion entirely into the stationary blowout preventer and within the annular rubber packing when the latter is in open position and having an outer surface configured to be sealingly engaged by the packing when said packing is compressed into said closed position about said outer surface;

a tubular inner member positioned within said tubular outer housing and mounting seal means at the lower end thereof for sealingly engaging about a pipe run therethrough; and

means mounting the inner member to the outer housing for relative rotation therebetween while preventing relative axial movement therebetween whereby the inner member may rotate with said pipe while the outer housing is held in said stationary blowout preventer packing.

6. An adapter as recited in claim 5 wherein said tubular outer housing is provided with at least one radial flange extending outwardly of said outer surface for engagement with at least a portion of said metal reinforcing when said packing is in said closed position and said adapter is urged in an axial direction away from the flange relative the stationary blowout preventer, said engagement halting such axial displacement therebetween.

7. The adapter as recited in claim 5 wherein the tubular outer housing includes a radial flange adjacent each end, at least one of said flanges being insertable through the annular packing in the open position and each flange being engageable with the metal reinforcing in the closed position of the packing after insertion of the housing therein upon axial displacement of the housing relative to the stationary blowout preventer, said engagement halting further axial displacement in either direction.

8. The adapter as recited in claim 5 wherein the mounting means includes a set of roller bearings and a set of ball bearings with both sets of bearings absorbing radial load and the ball bearings also absorbing axial load.

9. The adapter as recited in claim 8 wherein a hardened tubular insert is inserted around the inner tubular member between the two members and engaged by the roller bearings thereby preventing wear on the inner member.

10. The adapter as recited in claim 8 wherein the ball bearings run in aligned grooves in the inner and outer members, an access hole is provided through the outer member to the grooves for insertion or removal of the individual ball bearings, and a plug is located within the access hole to maintain the individual ball bearings within the grooves except when being inserted and removed, and means releasably securing the plug to the outer member.

11. An adapter for converting a stationary blowout preventer normally provided in a wellhead apparatus to a rotary blowout preventer, said stationary blowout preventer having a radially yieldable annular packing with metal reinforcing, and means for compressing the packing radially inwardly from an open position to a closed position wherein the packing sealingly engages the surface of the member inserted therethrough, the adapter comprising:

a housing insertable entirely within said stationary blowout preventer and having a smooth outer surface having an outside diameter smaller than the inside diameter of said annular packing when the latter is in an open position to fit therein and be sealingly held within said preventer by compression of said packing about said surface, said housing rotatably mounting an inner annular seal means for sealingly engaging about a pipe run therethrough; and

a pair of radially outwardly extending flanges on said housing spaced thereon a distance greater than the axial height of said packing to limit vertical axial movement of said housing relative to said packing through abutment of said respective flanges with outer ends of said packing.

12. A method of converting a stationary blowout preventer to a rotary blowout preventer comprising:

providing a housing with outside dimensions to be insertable entirely within a blowout preventer with an outer surface of said housing positioned within an annular packing provided in said blowout preventer, said housing also being provided with an inner rotatable seal means for sealingly engaging and rotating with a pipe run through said housing and seal means;

opening the blowout preventer annular packing of a stationary blowout preventer and inserting said housing entirely within said blowout preventer with said outer surface within said packing; and

closing said packing about said housing to sealingly engage said housing surface and to thereby hold said housing within said stationary blowout preventer while running and rotating the pipe therethrough.