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LOAD BALANCING FULL OPENING AND ROTATING BLOWOUT PREVENTER APPARATUS

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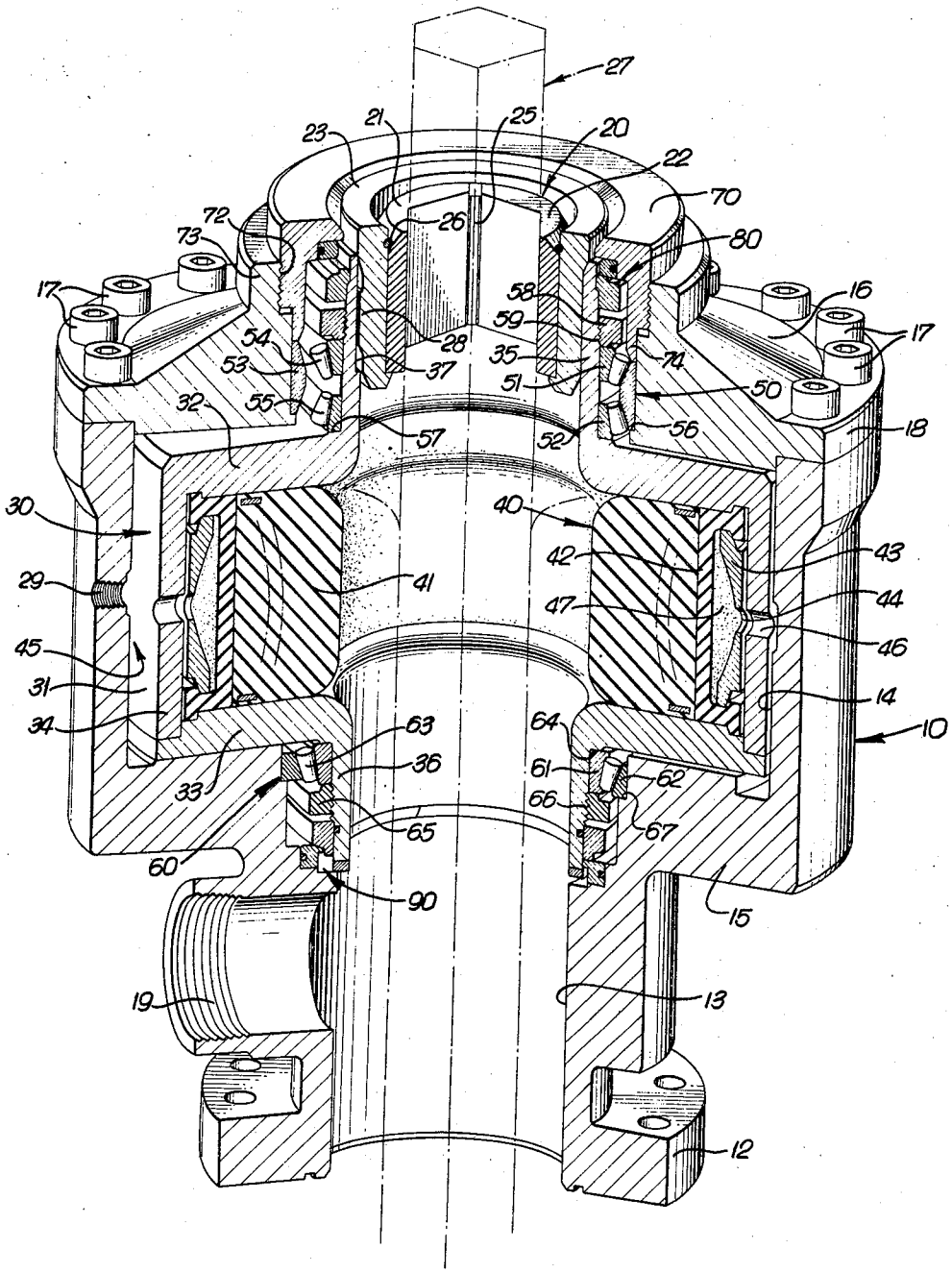

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LOAD BALANCING FULL OPENING AND ROTATING BLOWOUT PREVENTER APPARATUS

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ABSTRACT OF THE DISCLOSURE

A blowout preventer apparatus for sealing off well pressure about a rotating kelly or other rotating well drilling or production tool run therethrough where a full opening packer element is rotatably mounted by a load balancing mounting frame journaled on bearing means equally spaced outboard of the packer element. A rotating packer mounting frame with a configuration developed by rotating a vertically disposed inwardly opening hat section about a central axis receives and mounts an annular resilient packer element recessed within the central segment of the frame, the packer element having a non-deformed inner diameter generally as large as the diameter of the preventer apparatus through bore through which the kelly or other tools are run, with circular bearing means recessed within the apparatus bore and outboard of the packer element in association with tubular vertical extensions of the frame above and below the frame central segment, and packer pressurizing means for compressing the packer element from a recessed full opened position into the apparatus bore, inwardly of the apparatus, to seal about the kelly or other well tool therein while rotating therewith.

BACKGROUND OF THE INVENTION

This invention relates in general to rotating blowout preventers used for sealing off well pressures about rotating well drilling or production tools. More particularly, this invention relates to an improved full opening and load balanced blowout preventer adapted to seal about irregularly configurated well tools, as the kelly employed in well drilling operations, while rotating therewith, which need not be removed from the well apparatus to allow the running of tools into and out of the well and which balances the loading transmitted from the packer element through the rotating packer mounting frame into the surrounding blowout preventer housing.

In conventional well drilling operations, it is common to drill the well by rotating a drilling bit on the lower end of drill pipe run down into the well by means of a kelly operated at the upper end of the drill pipe at the drilling rig. The kelly normally has a hexagonal or other non-round or irregular cross-sectional shape to facilitate its rotation by conventional driving apparatus at the drilling rig. In order to control the flow of drilling fluids normally employed in conventional drilling operations, as well as to contain well pressures therein, it is necessary to effect a tight fluid seal about the rotating kelly by means of a rotating blowout preventer apparatus during the drilling operations. The kelly and the associated drill pipe are also periodically raised upwardly through the blowout preventer to facilitate the insertion of additional drill pipe in order to continue further drilling operations. The blowout preventer sealing element is therefore subjected to radially directed loading due to the rotation of the kelly about which it is compressed as well as lateral movement of the kelly during the drilling operations plus vertical or thrust loading due to the internal well pressures

as well as the vertical movement of the kelly against which the sealing element is tightly compressed.

In prior blowout preventer devices devised to seal about irregularly configured well tools such as the kelly employed in drilling operations under the conditions above described, the sealing or packer elements and the associated mounting means for rotatably mounting the sealing or packer elements have not allowed the full opening of the preventer apparatus bore to allow the running therethrough of other well tools having a diameter larger than that of the kelly or drill string. It has therefore been necessary to remove the blowout preventer sealing element and its mounting frame whenever such larger diameter running tools are to be run into the well. Also, such prior art blowout preventers, in attempting to obtain a tight seal about a rotating irregularly configured drilling or production tool run therethrough have failed to provide mounting means for the packer element which will balance or equally distribute loading from the packer element into the surrounding housing. Such unbalanced loading by the packer element upon its rotating mounting means causes accelerated wearing of the associated bearing or journal means shortening the working life of the blowout preventer apparatus and perhaps even producing failures during critical and very expensive well drilling or producing operations.

It is therefore the primary object of the present invention to disclose and provide a rotating blowout preventer apparatus which includes a full opening load balanced packer element and associated mounting means wherein the packer element when not under pressure opens to the full diameter of the apparatus through bore, approximately equal to the casing bore upon which the apparatus is mounted, and which can be easily compressed about a tool run therethrough and in a rotating sealing engagement with such tool balance and equally distribute loading on the packer from the associated tool into the surrounding apparatus housing.

It is another object of the present invention to disclose and provide a full opening rotating blowout preventer apparatus for use in well drilling and producing operations wherein a housing having a vertical bore therethrough is provided with an enlarged internal bore segment, an annular resilient packer element is provided with a non-deformed inner diameter generally as large as the smallest housing vertical bore, packer mounting frame means are provided for mounting the packer element within the housing enlarged bore segment recessed relative to the housing vertical bore and pressurizing means are provided for compressing the packer element from its non-deformed full bore open position within the housing enlarged bore segment toward a full closed position about a well tool or tubing run through the housing vertical bore.

It is a further object of the present invention to disclose and provide a blowout preventer apparatus as in the foregoing object wherein the packer mounting frame means is journaled upon vertically spaced circular race bearings provided within the housing at two load bearing areas generally equally spaced above and below the packer element, i.e. outboard of the packer element, to balance and equally distribute loading from the packer element via its frame mounting means into the surrounding apparatus housing.

It is a still further object of the present invention to disclose and provide a rotating blowout preventer apparatus for use in well drilling and producing operations characterized by its load balancing outboard bearing means wherein a housing having a generally vertical bore therethrough to receive well drilling or production tools is provided with a resilient packer element and frame means for mounting the packer within the housing and particularly wherein at least two circular bearing means

are mounted within the housing for rotatably mounting the frame and associated packer element within the housing, such bearing means being generally equally spaced above and below the packer element and in generally vertical alignment with each other to engage vertical extensions of the frame means above and below the packer means generally outboard of the packer element in order to balance loading from the packer element through the frame means and bearing means into the surrounding apparatus housing.

SUMMARY OF THE INVENTION

Generally stated, the present invention attains the foregoing objects through the provision of a housing including a body portion having a vertical bore therethrough with an enlarged central bore segment and a head portion to removably receive kelly and drive bushings associated with the kelly run down through the housing. An annular resilient packer element having a non-deformed inner diameter generally as large as the diameter of the body bore is provided so that large diameter tools capable of being run through the body bore also can be run through the full open packer element without need for removing the packer element and its associated mounting means. The packer mounting frame means provided rotatably mount the packer element within the body enlarged central bore segment in a recessed relation to the body bore when in full open non-deformed state. Pressurizing means are associated with the housing and are operable through the rotating mounting frame in order to cause compression of the rotatable packer element about the kelly or other tool run therethrough. In order to balance the loading generated between the rotating kelly and packer element tightly compressed thereabout, the packer mounting frame is mounted by circular race bearing means in two load bearing areas spaced above and below the centrally mounted packer element, the bearing means being termed generally herein as outboard bearing means. Preferably, such outboard bearing means are equally spaced above and below the packer element in association with vertical extensions of the frame means in order to balance the loading transmitted from the packer element into the housing means. Also, such outboard bearing means are preferably disposed in recessed portion of the housing through bore at locations in as close proximity to the housing bore as is possible while still allowing for a full opened passage through the associated frame means with an internal diameter thereof approximating that of the body bore therebelow.

The rotating blowout preventer, according to the present invention, therefore has the advantages of being full opening to allow the running of large diameter tools therethrough without the need for removing the packer element and its associated rotating frame mounting means. The frame mounting means and the associated outboard bearing means balance and distribute loading from the packer element evenly into the housing above and below the packer element during the adverse loading conditions normally encountered during the complex rotational, vertical and lateral movement of the kelly during drilling operations with the packer element tightly compressed thereabout. These, as well as various additional advantages and objects of the present invention, will become apparent to those skilled in the art from a consideration of the following detailed explanation of an exemplary embodiment of a load balanced full opening and rotating blowout preventer apparatus according to the present invention. Reference will be made to the appended sheet of drawings in which:

There is shown a vertically sectioned perspective view of an exemplary embodiment of the load balanced full opening and rotating blowout preventer apparatus according to the present invention with an exemplary well drilling tool shown therein in phantom line.

Referring to the drawing, the rotating blowout preventer apparatus of the preferred exemplary embodiment includes generally a housing, indicated generally at **10**, within which an annular resilient packer element, indicated generally at **40**, is rotatably mounted by packer mounting frame means, indicated generally at **30**, with associated outboard bearing means indicated generally at **50** and **60**, respectively.

In the preferred exemplary embodiment, the blowout preventer housing, indicated generally at **10**, includes a body portion **11** having a lower body flange **12** for mounting the housing on appropriate associated well drilling and/or producing equipment. Housing body **11** has a vertical through bore **13** extending upwardly from bottom flange **12**. The body bore is enlarged at the upper portion of body **11**, centrally of the housing to provide a central bore segment **14**. In the preferred exemplary embodiment, the enlarged central bore segment **14**, formed by the surrounding body side wall and the body web **15**, provides an upwardly opening cavity to receive the annular resilient full opening packer means, indicated generally at **40**, and its associated rotating mounting frame, indicated generally at **30**.

A head or cap flange **16** is provided to enclose the central bore segment or cavity **14** after the assembly of the resilient packer means and its associated rotating mounting frame. Head **16** may be removably assembled to the body **11** by means of conventional bolts **17** securing the outer flange portion **18** to the body side wall as seen in FIG. 1. Head **16** also has a vertical bore therethrough to receive kelly and drive bushings as hereinafter explained, the head or cap flange and body **11** thereby forming, in the preferred exemplary embodiment, a drum-like housing having a vertical through bore and a recess or enlarged central bore segment.

During expected drilling or production operations with the preferred exemplary embodiment of blowout preventer, it is expected that fluids such as drilling mud will be flowing through the housing bore **13** via side port **19**. In drilling operations, a kelly and associated tubing are run down through the housing bore with the drilling fluids passing thereabout through bore **13** and side port **19**. It is the function of the blowout preventer to close off the vertical bore through the housing above side port **19** by means of a resilient packer means, as the packer indicated generally at **40** in FIG. 1. In order to reduce the wear on the resilient packing means, the packing means is adapted to rotate with the tubing or irregularly shaped kelly as hereinafter explained.

As seen in the upper portions of FIG. 1, a split kelly bushing **20** is provided including a left bushing half **21** and a right bushing half **22** fitted within a drive bushing **23** and seated therein on the drive bushing ledge **24**. A pair of splines, as spline **25**, are provided in the drive bushing to transmit torque to the split kelly bushing halves therein. A conventional snap ring retainer **26** is also provided. The kelly **27** is shown in phantom line run down through the split kelly bushing **20** and passing through the vertical bore down through the blowout preventer housing, indicated generally at **10**. As hereinafter explained, rotation of the irregularly shaped kelly **27** is transmitted through the kelly bushing **20** and drive bushing **23** to a a rotating frame means mounting the resilient packer means, according to the present invention, within the blowout preventer housing.

Rotating packer mounting frame means are provided, according to the present invention, to mount a full opening rotating packer means, indicated generally at **40**, within the housing in a load balancing relationship with the housing. In the preferred exemplary embodiment, such rotating packer mounting frame means includes a frame means, indicated generally at **30**, which has a configuration which is developed by rotating a vertically disposed inwardly opening hat section about the axis of the housing bore. Such configuration includes a central drum-like body portion **31** having upper and lower spaced, parallel

walls 32 and 33 interconnected by the circular vertical outer wall or web 34. Vertical and oppositely extending tubular extensions or flanges 35 and 36 extend vertically upwardly and vertically downwardly of the ported frame walls 32 and 33, respectively. The central drum-like body portion 31 is adapted to fit within the central enlarged bore segment 14 of the housing, with sufficient clearance between the associated walls to allow rotation therebetween as well as the passage of hydraulic fluid therebetween, as explained subsequently. The frame means, indicated generally at 30, is adapted to be rotated by drive bushing 23 through the interaction of the splined engagement between drive bushing 23 and the frame means upper tubular extension 35, as by tongue or key portion 28 on drive bushing 23 received in the spline or keyway 37 in tubular extension 35.

An annular resilient packer element, indicated generally at 40 in the preferred exemplary embodiment, is provided within the improved blowout preventer according to the present invention with a non-deformed inner diameter generally as large as the diameter of the housing vertical bore to allow full opening of the packer element when not under closing pressures to facilitate the running of large diameter drilling or production tools through the blowout preventer packer means without the need for its removal from the well apparatus. In the exemplary embodiment, the full opening packer means includes an inner resilient packer element 41 having an inner non-deformed diameter generally as large as the body bore 13, as seen in FIG. 1. Inner packer element 41 is completely received into the drum or recessed area of the rotating packer mounting frame means, indicated generally at 30, to be rotatably mounted and recessed within the central bore segment 11 of the housing, indicated generally at 10. In the preferred exemplary embodiment, an outer packer element or hydraulic fluid accumulator 42 is shown. Hydraulic fluid accumulator or retainer 42 is provided to prevent the loss of hydraulic pressuring fluid for pressuring the inner packer element 41. Outer packer element 42 is shown retained within the rotating frame means by means of a retainer 43 holding leg portions of the retainer in tight sealing engagement with upper and lower recesses formed in the rotating frame means. A port 44 is provided in the retainer to allow introduction of hydraulic pressuring fluid into the accummulator or bag 42 to force the associated inner packer element 41 inwardly of the housing against the kelly or other tool rotating therein as shown in phantom lines in FIG. 1.

Packer pressurizing means for compressing the packer element 41 inwardly of the frame means against an oil well tool or tubing run through the housing vertical bore includes the housing inlet 29 to be connected to a source of hydraulic fluid under pressure, a main hydraulic pressure chamber, indicated generally at 45, formed between the rotating frame means 30 and the surrounding housing bore 14 and the hydraulic fluid inlets, as inlet 46, in the packer mounting frame means. From the foregoing, it can be seen that hydraulic fluid under pressures exceeding the well pressure in body bore 13 may be introduced into the housing from a source of such pressure fluid through port 29 into the main pressure chamber formed between the rotating frame means and the surrounding housing. Hydraulic fluid may then be directed from the main pressure chamber, as chamber 45 within the central bore segment of the housing, to the packer pressurizing chamber 47 formed within the packer frame means by the outer packer element or hydraulic fluid accumulator 42, to the associated outboard bearing means, indicated generally at 50 and 60, for lubrication purposes and, also, outwardly thereof to the spaced mechanical seal means indicated generally at 80 and 90, respectively.

Bearing means are provided within the housing for rotatably mounting the packer mounting frame indicated generally at 30. As particularly contemplated within the present invention, the full opening packer element 41 and its associated rotating mounting frame are rotatably mounted by vertically spaced bearing means which are outboard of the packer element, i.e. the bearing means are vertically outwardly of the packer element 41 within the blowout preventer housing, indicated generally at 10. In the preferred exemplary embodiment, such outboard bearing means include the circular bearing means indicated generally at 50 and 60 in FIG. 1. While tapered roller bearings are employed in the preferred exemplary embodiment, other forms of circular bearings, including roller bearings and thrust bearings, may be employed.

Upper circular bearing means, indicated generally at 50, of the outboard bearing means employed in the preferred exemplary embodiment, include an upper inner fixed race 51 and a lower inner fixed race 52 mounted to the vertically upwardly extending tubular flange or extension 35 of the packer mounting frame means, indicated generally at 30. Fixed inner races 51 and 52 provide inwardly inclined or convergent bearing surfaces opposing a pair of bearing race surfaces provided upon the outer stationary race 53 with a plurality of tapered roller bearings 54 and 55 therebetween. Outer stationary race 53 is seated within the housing head or cap 16 upon a ledge 56 provided within the inner bore of head or cap 16. The lower inner rotating race 52 fitted about tubular extension 35 is seated upon a ledge 57 formed in the rotating frame at the juncture between extension 35 and frame web 32. A retainer ring 58 is mounted by threads 59 to the frame tubular extension 35 to retain the rotating inner upper race 51 in assembled relation.

As seen in the upper portion of FIG. 1, a collar 70 may be adjustably screwed into a threaded recess 72 provided in the boss 73 formed integrally with head or cap 16. A depending annular flange 74 on collar 70 may be employed to retain the upper bearing means outer race 53 in assembled relation with an upper recessed flange area of the collar retaining the upper seal means, indicated generally at 80, in assembled relation as hereinafter explained.

Lower circular bearing means, indicated generally at 60, include an inner rotating race 61, a stationary outer circular race 62 and a plurality of tapered roller bearings 63 therebetween. Inner race 61 is fixed upon the frame lower tubular extension 36, seating upon ledge 64 formed in the frame at the juncture of extension 36 with frame web 33. A retainer ring 65 adjustably mounted to the tubular extension 36 by threads 66 is provided for retaining the rotating inner race assembled to the packer mounting frame, indicated generally at 30. Outer stationary race 62 is seated on a ledge 67 provided by an enlarged or recessed portion of bore 13. Roller spacer means 68 are provided for spacing of the plurality of tapered roller bearings 63, the lower leg of spacer 68 being seated upon the retainer ring 65.

The bore of head or cap 16 is enlarged sufficiently to allow positioning of the bearing means 50 in alignment with the bearing means, indicated generally at 60, recessed relative to the housing body bore 13. The vertically spaced, outboard bearing means, indicated generally at 50 and 60, are thus adapted to mount the rotating frame means within the housing recessed relative to the vertical housing bore so that the rotating frame and its associated packer means will not interfere with piping or other large diameter tooling run through the blowout preventer vertical bore. A particular advantage of the outboard positioning of the bearing means, indicated generally at 50 and 60, in the preferred exemplary embodiment is that the loading upon the frame means exerted by the packer element 41, about the kelly 27 or other tool run through the housing bore, is evenly distributed by the frame means to the spaced outboard bearing means at two load bearing areas which are generally equally spaced above and below the packer element. The use of tapered roller bearings as herein described allows for the balancing of

thrust loading axially of the frame as well as balancing of the radially directed loading.

In the preferred exemplary embodiment, the hydraulic pressure fluid within pressure chamber **45** employed for pressurizing the packer element **41** is also employed for lubricating the circular bearing means indicated generally at **50** and **60**. Sufficient clearance is provided between the rotating frame means and the surrounding housing portions including bore **14**, housing web **15** and removable head or cap **16** so that the hydraulic fluid within chamber **45** may travel around the rotating frame to the circular bearing means **50** and **60**. In order to prevent loss of such lubricating fluid for the bearing means, seal means are provided vertically outwardly of the bearings in association with the frame extensions **35** and **36** and the adjacent portions of the blowout preventer housing, indicated generally at **10**. In the preferred exemplary embodiment, such seal means, indicated generally at **80** and **90**, include mechanical seal means which comprise a stationary metal ring mounted to the housing and a rotating metal sealing ring mounted to the rotating frame means to bear in sealing engagement with the stationary ring.

For purposes of the present invention, any suitable seal means may be employed for the sealing means indicated generally at **80** and **90** respectively. The particular mechanical seal means herein disclosed have the advantage of a long wearing life and form a part of the invention and are more fully described in my co-pending application Ser. No. 644,197 entitled "Pressure Fluid System With Mechanical Seals for A Rotating Blowout Preventer Apparatus" filed concurrently with this application, and now abandoned.

From the foregoing detailed description of an exemplary embodiment of the load balanced full opening and rotating blowout preventer, according to the present invention, it can be seen that the rotating packer element, being full opening, need not be removed from the preventer apparatus and associated well apparatus in order to pass large diameter well tools through the preventer housing, the housing body bore **13** being approximately the same diameter as the casing bore upon which it is mounted. The packer, through full opening into a recessed position relative to the housing through bore, can be selectively pressurized within its mounting frame to be compressed about and rotate with a kelly or other tool run therethrough. Importantly, the loading on the packer mounting frame arising because of the forces between the vertically and laterally moving, as well as rotating, kelly and the packer, the fluid pressures between the packer and its frame mounting means and internal well pressures are distributed in a balanced manner by the frame means through its associated outboard thrust and radially loadable tapered, circular race, roller bearing means.

While a single preferred exemplary embodiment of the load balanced full opening and rotating blowout preventer apparatus according to the present invention has been described herein in detail, it is to be understood that this disclosure is intended to be exemplary only and is not intended to limit the scope of the invention which may include other embodiments, adaptations and modifications thereof made within the present invention as defined and limited only by the following claims.

I claim:

1. An improved rotating blowout preventer apparatus for use in well drilling and producing operations characterized by its load balancing, full opening rotating packer means, said preventer apparatus comprising:

a housing including a body portion and an overlying head portion, each said portion having a generally vertical bore therethrough, said body portion including an enlarged central bore segment providing an upwardly opening cavity in said body portion partially enclosed by said overlying head portion;

circular bearing means recessed within the bore of each of said body and head portions, each of said bearing means including a stationary outer race mounted to the associated housing portion, an inner rotating race, and movable bearing elements between said races;

an annular resilient packer element having a nondeformed inner diameter generally as large as the diameter of said vertical bore through said body portion;

packer mounting frame means for rotatably mounting said packer element between said bearing means within said housing, said frame means including a central vertically apertured drum portion in which said packer element is received and thereby mounted within said enlarged central bore segment and a pair of oppositely extending tubular extensions of smaller outer diameter than said drum portion, each of said extensions extending outwardly of said drum segment and packer element into engagement with said bearing means outboard of said packer element and frame drum portion to rotatably mount said packer element and drum portion recessed in said housing relative to said housing bore, said frame means having an inner through bore through said extensions and drum portion having a diameter generally as large as the diameter of said housing body portion vertical bore; and

packer pressurizing means for compressing said packer element inwardly of said frame means against an oil well tool or tubing run through said housing vertical bore.

2. In a full opening rotating blowout preventer apparatus for use in well drilling and producing operations having

a housing having a generally vertical bore therethrough with an inner enlarged bore segment;

an annular resilient packer element having a nondeformed inner diameter generally as large as the diameter of said housing vertical bore and pressurizing means for compressing said packer from a nondeformed full bore open position within said housing toward a full closed bore position about a well tool or tubing run through said housing bore, the improvement comprising the provision of:

packer mounting frame means including an enlarged central drum portion for receiving and mounting said packer element within said housing enlarged bore segment and a pair of oppositely directed frame extensions having smaller outer diameters than that of said drum portion, said extensions lying generally in said housing bore with said drum portion being recessed relative thereto into said housing enlarged bore segment; and

bearing means provided within said housing bore adjacent said enlarged bore segment for mounting said frame means by said tubular extensions for rotation within said housing with said drum portion and packer element disposed between and recessed relative to said bearing means in said housing.

3. A rotating blowout preventer apparatus for use in well drilling and producing operations characterized by its load balancing outboard bearing means, said apparatus comprising:

a housing including a generally vertical bore therethrough to receive well drilling or producing tools;

a resilient packer element and frame means for mounting said packer within said housing to be compressed about a tool run therethrough, said frame means including vertically spaced and oppositely directed extensions; and

at least two circular bearing means mounted within said housing for mounting said frame means, said bearing means being generally equally spaced above and below the packer element received in said frame means and in generally vertical alignment, each said

bearing means receiving and rotatably mounting said frame means by engagement with a frame means extension outboard of the packer element retained in the frame means.

4. A full opening rotating blowout preventer apparatus for use on a well casing in well drilling and producing operations which allows for the running of large diameter tools through said casing without removal of said apparatus, said blowout preventer apparatus comprising:

a housing including a vertical through bore having a diameter generally equal to that of a well casing on which said housing is mounted and an enlarged central bore segment;

an annular resilient packer element having a non-deformed inner diameter generally as large as the diameter of said housing vertical bore;

packer mounting frame means having a through bore generally equal to that of said housing and an enlarged central drum portion in which said packer is mounted, said frame means including opposed tubular flange extensions extending axially outward of said drum section and packer within said housing bore;

bearing means provided in said housing bore adjacent said enlarged central bore segment for mounting said frame means by said tubular flange extensions

being engaged in said bearing means with said frame means drum portion recessed relative to said housing bore in said housing enlarged central bore segment to allow running of well tools having an outer diameter approaching that of said casing through said housing bore without removal of said packer element therefrom; and

pressurizing means for compressing said packer from a non-deformed full bore open position within said frame means toward a full closed bore position about a well tool or tubing run through said housing bore.

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