Jan. 17, 1956 G. S. KNOX 2,731,281

KELLY PACKER AND BLOWOUT PREVENTER

Filed Aug. 19, 1950 3 Sheets-Sheet 1

Fig. 1.

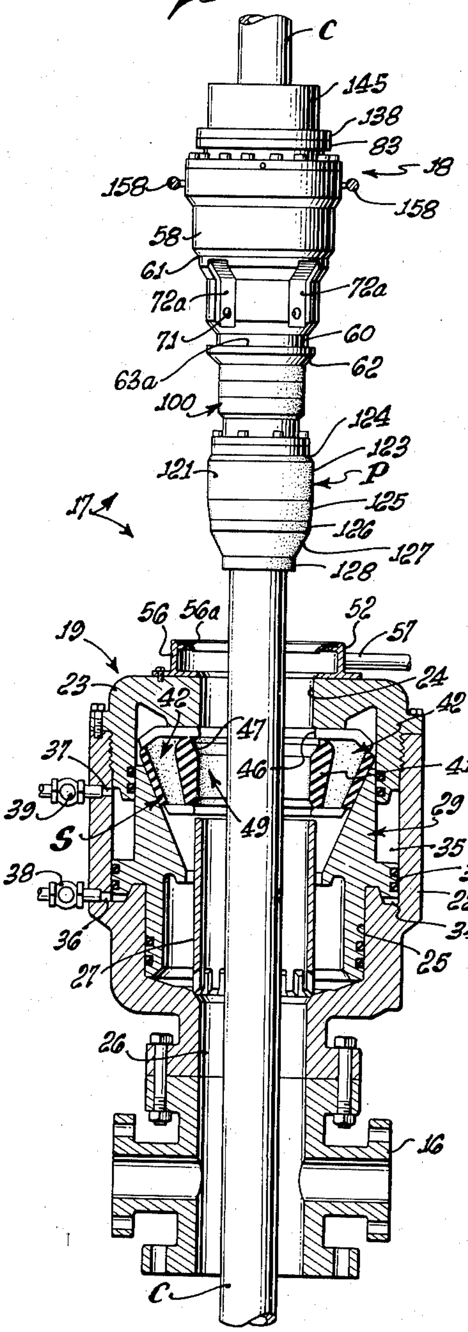
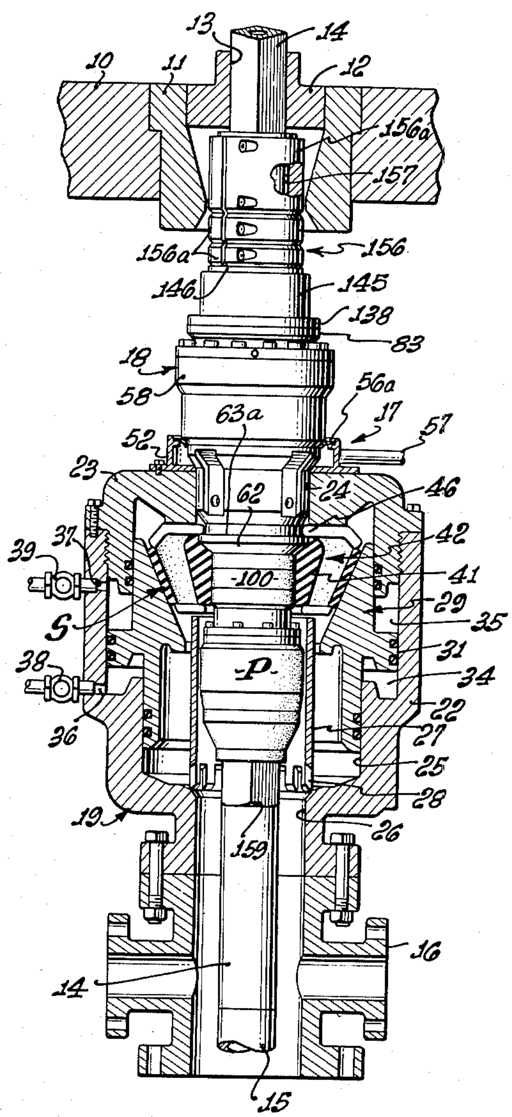


Fig. 2.



GRANVILLE S. KNOX, INVENTOR.

BY

Barkelew & Scantlebury

ATTORNEYS.

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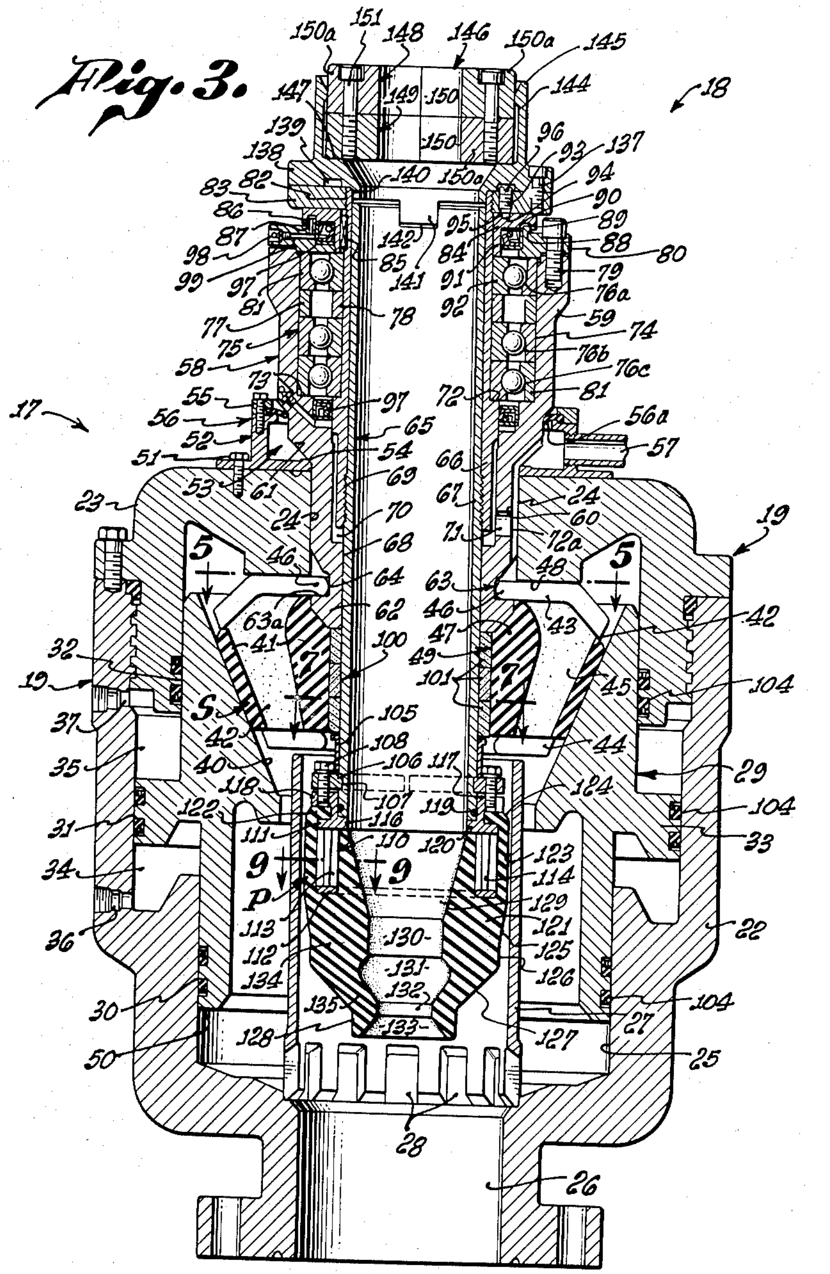
Fig. 3.



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3 Sheets-Sheet 3

Fig. 4.

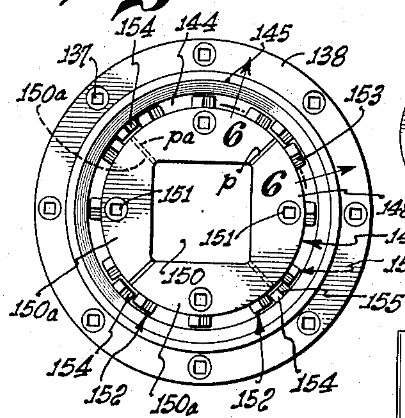


Fig. 14.

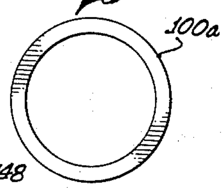


Fig. 10.

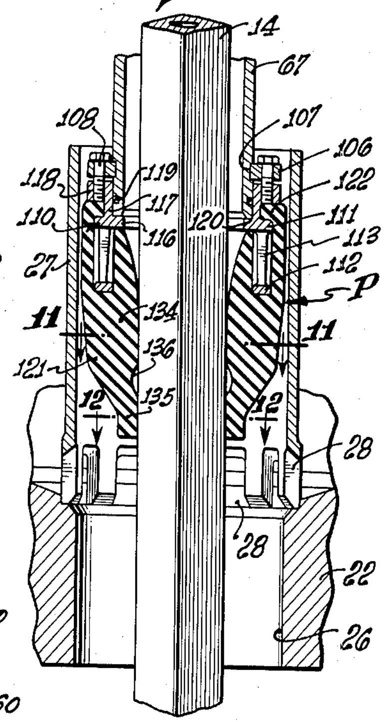


Fig. 13.

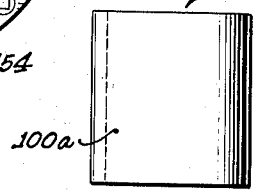


Fig. 6.

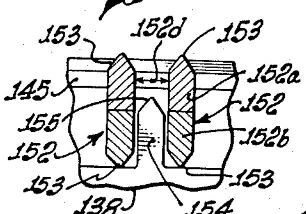


Fig. 5.

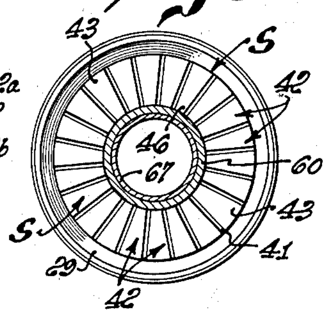


Fig. 9.

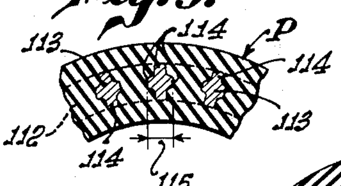


Fig. 7.

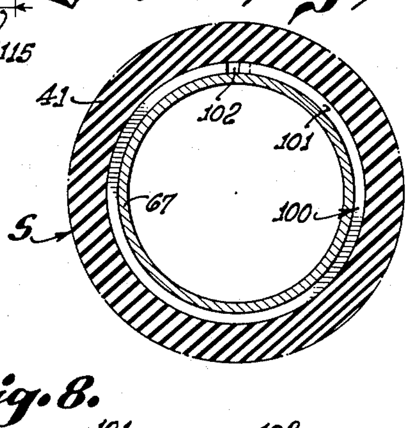


Fig. 11.

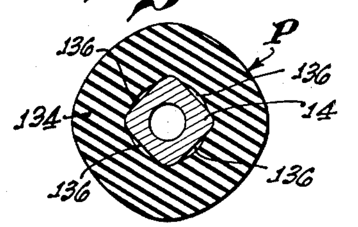


Fig. 12.

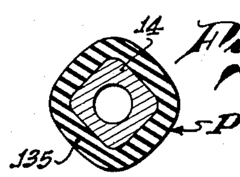
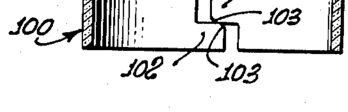


Fig. 8.



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BY
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ATTORNEYS

United States Patent Office

2,731,281

Patented Jan. 17, 1956

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2,731,281

KELLY PACKER AND BLOWOUT PREVENTER

Granville S. Knox, Los Angeles, Calif., assignor to Hydril Corporation, Los Angeles, Calif., a corporation of California

Application August 19, 1950, Serial No. 180,480

10 Claims. (Cl. 286—16.1)

This invention relates generally to oil well drilling and control equipment and is more particularly concerned with improvements in kelly packers and blowout preventers.

As is well known, the drive from a rotary table to a drill stem is imparted through a grief pipe of non-circular cross section and commonly called a "kelly." The cross section of the kelly is usually square or hexagonal but it may be of any non-circular shape which will give it proper drive characteristics.

Because of its non-circular cross section, it is not an easy matter to pack it off effectively during stripping operations—that is, when the drill stem with its enlarged collars are being moved longitudinally through the well casing. It is therefore an object of the invention to provide particularly effective means for packing off the kelly during stripping operations and certain of my claims are drawn to that feature regardless of whether or not the kelly is rotating during the pack-off period, and therefore the fact that the description will be mainly directed to a packer which is effective during rotation of the kelly, is not to be construed as indicating that the invention, considered in its broader aspects, is limited to the rotatable packer mounting which I will describe. In other words, the stripping packer is here shown as being rotatable with respect to the main housing of the device, but this rotatable feature may be dispensed with if stripping, alone, is to be accomplished. And, as a matter of fact, the novel stripping packer, per se, has very considerable advantage in connection with packing off work in environments other than as here disclosed.

Of course, when the kelly, of polygonal cross-section, is rotating, the difficulty of packing it off is increased markedly, and another object of my invention is to provide means whereby that difficulty is completely overcome. Generally, this is accomplished by rotating the stripping packer with the kelly, rather than rotating them relatively, and then sealing off the member, of circular cross-section, which support and rotates the packer.

The device is especially adapted for use in controlled pressure drilling and reverse circulation drilling, and has performed effectively with well pressures as high as 2000 pounds per square inch while rotating up to 150 R. P. M. It is capable of being quickly put into operative condition when occasion for its use arises and is swift and sure of operation.

It is also an object of the invention to provide a strong, sturdy device which is exceedingly compact and, when installed, occupies but relatively little space. Further, I have provided novel, quick-acting, and sure means for detachably locking certain of the units together.

During pressure drilling operations, lengths of pipe can be added to or removed from the drill string without loss of time and without inconvenience. The stripper portion of the assembly need be removed from the rest of the assembly only when passing the drill bit.

Another important object and feature of the device is the means whereby the tightness of the seal around the

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rotating stripper-carrying member may be accurately controlled. It can be controlled with such delicacy that just sufficient leakage of well fluid is permitted to properly lubricate and cool the relatively rotating sealing surfaces.

Many other objects and features of the invention will be apparent from the following detailed description, reference being made to the accompanying drawings, in which:

Fig. 1 is a view, partly in section and partly in elevation, showing my device during the stage of assembling or disassembling the units thereof;

Fig. 2 is a view similar to Fig. 1, but showing the units in assembled condition;

Fig. 3 is an enlarged, medial section of the device in a condition similar to that of Fig. 2, but omitting the kelly and the representations of the rotary table equipment and of the fitting below the preventer;

Fig. 4 is a top, plan view of Fig. 3;

Fig. 5 is a section on line 5—5 of Fig. 3;

Fig. 6 is a fragmentary section on line 6—6 of Fig. 4;

Fig. 7 is a fragmentary section on line 7—7 of Fig. 3;

Fig. 8 is a medial cross section through the packing ring shown in Fig. 7;

Fig. 9 is an enlarged fragmentary section on line 9—9 of Fig. 3;

Fig. 10 is a fragmentary section illustrating approximately the deformation of the stripper packer when it is engaged by the kelly;

Fig. 11 is a section on line 11—11 of Fig. 10;

Fig. 12 is a section on line 12—12 of Fig. 10;

Fig. 13 is an elevation of a modified form of packer sleeve; and

Fig. 14 is a top plan view of Fig. 13.

In Fig. 2 there is illustrated a conventional rotary table **10** adapted to drivingly receive a central, non-circular, and split master or table bushing **11** which, in turn, drivingly accommodates a usual, non-circular kelly drive bushing **12**. The kelly bushing has a non-circular, axial opening **13** to take the non-circular kelly **14** which is coupled to drill string **15** in the usual manner. The kelly and kelly bushing are relatively axially slidable, and rotative drive from the table to the kelly is imparted through the interfitting master and table bushings. I have here illustrated the kelly and the mating opening of the kelly bushing as being of square cross section, but it is obvious that they may have other polygonal shapes.

The drill stem is entered in a usual well casing (not shown) to the upper end of which is coupled any suitable flow-fitting **16**.

The assembly **17** comprising my improved kelly packer and blowout preventer, is made up, in the main, of two cooperating units **18** and **19**, unit **18** including a kelly stripper packing P, and unit **19** including sealing means S for sealing off unit **18** from an outer housing or body member **22** coupled to fitting **16** or to any other suitable fitting which may comprise the upper terminal of the well casing.

Unit **19** may, in itself, comprise a blowout preventer effective normally to function as such on drill pipe or in open hole when unit **18** is not being used, though this is not at all limitative on the broader aspects of my invention. For illustrative purposes I have shown, as a blowout preventer particularly well adapted to the present purpose, the device fully described and claimed in my copending application entitled Control Head and Blowout Preventer, Serial No. 691,110, filed August 16, 1946, now Patent No. 2,609,836 issued September 9, 1952, but this showing is not to be considered as limitative on my broader claims.

Cap member **23** of housing or body member **22**, has a central bore **24** which opens to cylinder bore **25**, the lower end of the bore opening to flow passage **26**. A standpipe **27** is welded at its lower end to the housing and extends upwardly in bore **25**. The lower end of pipe **27** has flow-passage notches **28**. Annularly spaced from pipe **27** is a packer actuator **29** having piston fit at **30**, **31** and **32** (Fig. 3) with the opposing defining walls of bore **25**. The piston head **33** divides a portion of bore **25** into chambers **34** and **35**, said chambers being provided with flow passages **36** and **37**, respectively, controlled by valves **38** and **39**, respectively, whereby fluid under pressure may be selectively admitted to or exhausted from said chambers to cause controlled reciprocation of member **29** or to hold that member in adjusted position.

Actuator **29** has a downwardly converging, conical bore **40** within which is positioned the complementary, conical sealing member generally indicated at S. This member comprises a massive annulus **41** of natural or synthetic rubber or some other suitable resilient plastic. Neoprene having a durometer hardness of 65 to 70, has been found to be a suitable substance. Molded within the annulus are circumferentially spaced, metal inserts **42** which comprise upper and lower plates or flanges **43** and **44**, respectively, connected by vertical webs **45**. It will be noted that the inner ends **46** of top plates or flanges **43** project radially inward beyond the immediately underlying portion **47** of annulus **41**. The member S is held against vertical displacement by the engagement of insert flanges **43** and **44** with the underside **48** of cap **23** and the upper end of standpipe **27**, respectively.

When actuator **29** is down in the position of Fig. 1, the annulus **41** is inherently radially expanded to an extent which opens the major bore **49** of the annulus and the bore defined by flange ends **46** to extents approximately equal to the diameter of cap-bore **24**. It will be seen that by admitting fluid under pressure to chamber **34** and relieving the pressure in chamber **35**, actuator **29** is forced upwardly from the position of Fig. 1 and will radially constrict member S and thus reduce the diameter of its effective bore. The inserts **42**, with their webs **45** and flanges **43**, **44**, control the flow of the plastic **41** and prevent harmful axial extrusion thereof, all as explained in detail in said copending application. As soon as the annulus closes about work of any nature, well pressure below member **29** is effective against piston area **50** to aid in further radially constricting the plastic annulus.

On the other hand, when fluid pressure is relieved from chamber **34** and applied in chamber **35** (assuming the actuator **29** is up in the position of Fig. 3) the piston is forced downwardly, and the resiliency of the annulus **41** restores said annulus to the radially expanded condition of Fig. 1.

Bolted at **51** to the upper face of housing cap **24**, is an annular drain tray **52** whose bore **53** registers with cap-bore **24**, and which tray has a conical positioning shoulder **54**, whose purpose will presently be described. An annular cover ring **55** is bolted to the upper edge of the tray-flange **56** and clamped therebetween is a flexible wiper seal **56a** made, for instance of molded "Hycar." The drain tray has a drainage outlet pipe **57**.

Unit **18** is actually assembled about kelly **14** (or some other element of the drill string) and then lowered into unit **19**, but it will be more easily described by first assuming it is in the position of Fig. 3, in which figure the kelly is omitted in order to expose the full structure of the unit. Actually, the kelly occupies the bore of unit **18** when that unit is in the position of Fig. 3, and the packing member P will be deformed by the kelly to take approximately the shape shown in Fig. 10.

The housing **58** of stripper unit **18** includes a tubular body portion **59** and a relatively reduced, elongated and tubular neck-portion **60**, the junction between the two portions being formed as a conical portion **61** which is adapted to seat on the conical positioning shoulder **54** when the unit **18** is lowered to the position of Fig. 3. When in this position, wiper seal **56a**, engages the outer surface of housing **58**. The neck portion **60** fits the cap-bore **24** with working clearance and its lower end **62** extends below cap **23** and, in this extended end, there is provided an annular groove **63** which, when positioning shoulders **54** and **61** are in engagement, lines up horizontally with insert-ends **46**. The unit **18** is lowered into unit **19** when the latter is in the condition of Fig. 1, neck **60** thus being passable, with annular clearance, through the bore of the ring formed by insert flanges **43**. Then, when member S is radially constricted by raising actuator **29**, as has been described, flange ends **46** enter groove **63** so as to overlie the square-cut, upwardly facing shoulder **63a** defining the lower side of the groove and to pressurally engage the groove-bottom **64**, thus releasably holding unit **18** against upward dislodgement from and rotation with relation to the unit **19**. Continued elevation of actuator **29** causes the plastic material of annulus **41** to flow around the now-stationary inserts **42** and to sealingly engage another element of unit **18**, as will be described later. Thus, flange ends **46**, or more broadly, member S, form a releasable latch for holding units **18** and **19** in assembly, the "latch," thus formed, being controllable by actuation of member **29**. Ends **46** may be considered as latching fingers.

A composite tube **65** is rotatably supported within and by body member **59**, this tube being made up of a bearing sleeve **66** and a stripper sleeve **67**, the two sleeves being telescoped throughout the extent of sleeve **66**, while the lower end of sleeve **67** projects downwardly below sleeve **66**, and extends, with running fit, through the bore **68** of neck **60**. The two sleeves are threadably connected at **69**. The lower end of bearing sleeve **66** extends, with annular clearance, into the counterbore **70** of neck **60**, said counterbore communicating through ports **71** with drainage channels **72a** sunk in the external face of neck **60** and opening at their upper ends to drainage tray **52**.

Bearing sleeve **66** has an upwardly facing, annular shoulder **72** which is flush with the bottom wall **73** of housing-counterbore **74**. Within this counterbore and bottomed on shoulder **72** and wall **73**, is a stack **75** of "radio-thrust bearings" preferably, though not necessarily, three in number, and individually designated at **76a**, **76b** and **76c**. This type of bearing not only serves well as a rotational bearing but also has exceptionally high rating as an end thrust bearing. The bearings **76a** and **76b** are axially separated from one another by outer and inner spacer rings **77** and **78**, respectively. Bolted at **79** to the upper end of housing **18** is a bearing ring-cap **80** which engages the outer race **81** of bearing **76a**, there being vertical clearance **82** between the cap and housing, so by tightening bolts **79**, the outer races of all the bearings are rigidly clamped between the cap and housing shoulder **73**.

Screwed at **82** on the upper end of sleeve **67** is a drive ring **83**, and between this ring and bearing **76a** is a bearing-adjusting collar **84**. This collar is keyed at **85** to bearing sleeve **66** and has an annular groove **86** to take upstanding flange **87** on ring cap **80**. The flange and groove have running fit at **88**, but vertical and annular clearances **89** and **90**, respectively, are provided so ring **80** and collar **84** may be capable of relative vertical movement during the adjustment of the bearing **75**, as will be described.

Adjusting collar **84** has a depending annular flange **91** engaging the inner race **92** of bearing **76a**, and threaded through drive ring **83** are adjustment bolts **93** whose lower, unthreaded ends **94** are entered in sockets **95** provided in adjusting collar **84**. By threading the bolts downwardly, adjusting collar **84** is depressed in a manner to clamp the assembly of ring **78** and the inner races of bearings **76a**, **76b** and **76c** in longitudinal compression. When the clamping compression is of the proper degree, a wire **96** is run through the heads of bolts **93** to releasably lock them, and therefore collar **84** and the bearing elements in adjusted positions.

Preferably a grease seal-off ring-assembly **97** is provided between the relatively rotatable adjusting collar **84** and ring **80**.

It will be seen that due to the described connection of parts, drive ring **83** acts as a head for composite tube **65**, and that this head, in effect, suspends said tube and all parts carried thereby from the bearing stack **75**, thus efficiently mounting the tube for rotation with respect to housing **58**. Bearings **76***a*, **76***b* and **76***c* are matched, precision, radio-thrust ball bearings, and the two lower bearings **76***b* and **76***c* are mounted in tandem so they equally share the load imposed by the upward thrust of well pressure against rotating tube **65**. Upper bearing **76***a* resists the comparatively small downward load imposed in passing tool joints down through packer P. The bearings are preferably pre-packed with grease. Grease-gun fittings **98** which are in communication with passageways **99** provide means for introducing sealing-grease to the ends of the bearing assembly.

It will be seen that drive ring **83**, adjusting collar **84**, bearing sleeve **66**, and stripper sleeve **67** are adapted to rotate as one when rotative force is applied to drive ring **83**.

Mounted on the extended end of stripper sleeve **67** at a point just below neck **60**, is a deformable packer sleeve generally indicated at **100**. This sleeve is made of any suitable material and may be of various formations. For instance, in Figs. 13 and 14, is a one-piece, cylindrical, tubular packer sleeve **100***a* which may be made, for instance, of "Hycar" which is a synthetic rubber plastic having a durometer hardness of from **85** to **90**. On the other hand, I may use the three piece sleeve **100** shown in Fig. 3, each piece being made up of a ring **101** (see Figs. 7 and 8) of "Micarta" which is a synthetic which is "dead hard" and resilient. These rings are split at one side and have circumferentially overlapping portions **102**, much in the manner of a piston ring. Corners **103** are preferably chamfered, as shown.

When sealing member S is constricted in the manner previously described, it sealingly engages the annulus **41** with bearing sleeve **100**, and radially deforms said sleeve, whether it be of the type shown in Fig. 3 or in Fig. 13, in a manner to sealingly engage it with stripper sleeve **67**. Thus, since the annulus is also sealed against actuator **29** and the actuator is sealed at **104** against housing **22** there will be, in effect, a horizontal sealing barrier extending from housing wall **22** to sleeve **67**, and fluid under pressure with flow passage **26** will be unable, if the seal is sufficiently tight, to pass upwardly through housing **22** around the outside of sleeve **67**. However, the radial constriction of packer sleeve **100** will not prevent rotation between sleeve **67** and the packing elements when sufficient torque is applied to sleeve **67**.

As a matter of fact, it is a feature of my invention to provide means whereby the radial constriction of the sealing elements is so nicely controllable that just sufficient leakage of well fluid between sleeves **67** and **100** is permitted to properly lubricate and cool the relatively rotating elements. That is, after a full seal is effected by forcing actuator **29** upwardly a sufficient distance, the actuator is controllably depressed to precisely an extent as will relieve the radial pressure between sleeves **67** and **100** sufficiently to permit the described slight leakage of well fluid. This is accomplishable regardless of the value of the well pressure encountered.

Ring **100** is held against downward vertical displacement along sleeve **67**, by the spacing ring **105**, which, in turn, is held up by the two-part or diametrically split mounting ring **106**. The two halves of ring **106** are entered in the annular groove **107** provided near the end of sleeve **67**, after the removable stripping packer P is mounted on the sleeve. The ring halves are then bolted at **108** to the packer, said assembly thereafter holding the ring halves against separation and the ring, in turn, suspending the packer from sleeve **67**.

Packer P includes a rigid metal armature generally indicated at **110** which is made up of rings **111** and **112** held in vertically spaced relation by integral bars **113**. These bars are circumferentially spaced apart (Fig. 9) and may be considered, together, as making up an open-work cage. Each bar preferably has four vertically extending and equi-angularly spaced ribs **114**. The angular spacing between the bars is preferably, though not necessarily approximately equal to the lengths of their minor axes **115**. Preferably, also, the bars have slight inward and downward taper.

Upper ring **111** has an internal horizontal flange-portion **116**, a vertical flange portion **117**, and, at the top of vertical flange **117**, an external horizontal flange **118**. Flange **117** fits nicely around sleeve **67**, and, preferably, there is an O ring seal **119** between the opposed peripheral faces of the flange and sleeve.

Flange **118** takes bolts **108**, and, when these bolts are tightened up, flange **116** is brought into tight contact with the lower end face **120** of sleeve **67**.

Armature **110** is preferably molded into the packer-proper **121**, this packer being in the form of a sleeve of resilient plastic material such as natural or synthetic rubber and preferably has a durometer hardness of from 65 to 70. The upper end **122** of sleeve **121** is molded over the top of armature flange **111**. Externally, the sleeve **121** has a cylindrical portion **123**, a short, upwardly and inwardly tapered portion **124** above the cylindrical portion, a downwardly and inwardly tapering portion **125** just below the cylindrical portion, a cylindrical portion **126**, a more sharply tapered portion **127**, and a terminal cylindrical portion **128**.

Internally, sleeve **121** has a downwardly converging, tapered bore **129** leading to a cylindric bore **130** which is vertically spaced by the concavity **131** from the smaller-diameter and shorter cylindrical bore **132**. An outwardly flaring bore **133** opens to the lower, free end of the packer sleeve.

The sleeve **121** thus has relatively thick walls **134** at its central portion, and a tapered lip formation **135** near its lower end which has a tendency to flex bodily outwardly about concavity **131** when a kelly is inserted therethrough.

The described formation of the armature **110** serves to anchor the material of the upper end of packer **121** so external well pressure will not objectionably radially collapse the upper end of the packer nor cause objectionable axial flow of the packer material.

However, the circumferential spacing of bars **113**, permits the limited radial "breathing" of the packer necessary to the passage of drill string enlargements through its bore.

As an example of relative sizes, I have found the following to give very satisfactory results. With a square kelly which is 3½" across the flats, the diameter of bore **130** may be 3¼", the major diameter of cavity **131** may be 4" and the diameter of bore **132** may be 2¼". When a kelly of such dimension is thrust through a packer having the given dimensions, the packer is deformed to take, approximately, the shape shown in Figs. 10, 11 and 12. The thick-walled central portion of the packer effectively grips the kelly but will not ordinarily engage the full faces thereof, and thus small voids, such as at **136**, will be left (Fig. 11). The sealing lip **135** will, however, tightly engage the kelly throughout its perimeter. Then, when the well pressure is applied to the outer face of the packer, the voids **136** disappear, and the central portion **134** of the packer, as well as lip portion **135**, sealingly engage the kelly and resist the efforts of even extremely high well pressure to cause leakage between the kelly and the packer.

In this condition, provided the seals from sleeve **67** to housing **22** are in operative condition, the kelly is fully packed off with relation to the housing, except for the slight lubricating leakage previously mentioned. When the kelly is rotated, the packer P rotates with it and therefor the non-circular cross-section characteristics of the kelly do not interfere in any way with the rotative movement. On the other hand the seals between such parts as do relatively rotate are on cylindrical surfaces, and therefore can be relatively easily accomplished. By reason of the described arrangement, the severe wearing and tearing effects which result from relatively rotating two sealingly engaged parts of which one, at least, is non-circular, are entirely eliminated.

I will now describe the means whereby the rotative drive of kelly **14** is imparted to tube **65** and hence to packer P, so said kelly and packer rotate as one. Bolted at **137** to drive ring **83** is a driving head or ring **138** which has an annular groove **139** to take, with clearance, the heads of adjustment bolts **93**. The head **138** has an internal flange **140** which fits the bore of sleeve **66**, the flange being vertically extended to form lugs **141** which project into notches **142** provided in the upper end of sleeve **67**. The notched-and-lug engagement helps in transmitting rotary drive from head **138** to sleeve **67** and also prevents the accidental unscrewing of sleeve **67** from sleeve **66**. When it is desired or necessary to replace sleeve **67**, it is merely necessary to detach head **138** from ring **83**, and unscrew sleeve **67** from sleeve **66**, it being noted that this replacement operation does not involve any manipulation or unlocking of the bearing adjustment bolts **93**. Sleeve **67** is preferably made of steel which has been flame-hardened and thus has long service life, but when occasion finally arises for its replacement, the replacing operation is very simple and quickly accomplished.

In connection with replacement due to wear, consideration must be given to the fact that bearing sleeve **100** is exposed to severe wear effects. If replacement becomes necessary, it is an easy matter to dismount packer P, strip spacer **105** and sleeve **100** from sleeve **67**, put on the new bearing sleeve, and remount the spacer and packer. However, it will be noted that the sleeve **100** may wear almost completely away before it needs replacement, for sealing member S is self-adjusting to the sleeve regardless of its diminished diameter. In fact, if sleeve **100** wears away completely, the sealing member S will adjust itself to and seal off directly against sleeve **67**. While direct contact between sealing member S and sleeve **67** is not ordinarily to be desired because of the relatively rapid wear on annulus **41**, it is not at all fatal if it occurs, and my invention broadly contemplates inclusion of a device in which such direct contact exists.

Driving head **138** has an enlarged counterbore **144**, defined by vertical flange **145**, adapted to receive the drive bushing **146** which, during certain stages of operation, bottoms on the upwardly facing shoulder **147**. Bushing **146** may be of any suitable form which will transmit rotary drive from kelly **14** to head **138**, but I have illustrated a preferred form which is particularly easily engageable with the kelly and with the head. The bushing is made up of upper and lower rings **148** and **149**, respectively, each of which is diametrically divided so the rings may be readily assembled about the kelly. Thus each ring is made up of two half-sections **150***a*. The rings, which have square openings **150** to take the kelly **14** with working clearance, are arranged so the parting line *p* between the sections of one ring is normal to the parting line *pa* between the sections of the other ring (Fig. 4). It follows that when the rings are connected by bolts, the entire assembly of sections is held intact. It thus becomes possible to have vertically extending connecting bolts instead of radially or tangentially extending fastening means, thus leaving the entire outer periphery of the bushing available for driving lugs or the like.

Bushing **146** has a series of twelve circumferentially spaced, vertically extending driving lugs **152**, though this number is not at all limitative. Each full lug is made up of a half-lug **152***a* on ring **148** which matches a half-lug **152***b* on ring **149**, as shown in Fig. 6. The full lugs are pointed at both ends, as at **153**, so the bushing may be reversed top for bottom if occasion arises.

Flange **145** is provided with four, equi-angularly spaced, vertical driving lugs **154** which are of a width to be taken between any two bushing lugs **152**, and their upper ends are pointed as at **155**. When bushing **146** is lowered into head **138** during a stage of the operation to be described later, lugs **154** enter between pairs of lugs **152**, the pointed ends **153** and **155** acting as cams to rotate bushing **146** with relation to head **138** sufficiently to register the lugs and the between-lug spaces **152***d* if they are originally out of line. The lugs are of such arrangement and number that no matter where the head and bushing first engage, it will require only slight relative rotation to bring about full registration of lugs and between-lug spaces.

Preferably, split spacing collars **156**, having square holes to take kelly **14**, are arranged on the kelly between driving bushing **146** and the underside of kelly bushing **12**. The sections **156***a* of each spacing collar are bolted together at **158** to hold them in assembly about the kelly. The collars **156** are supplied in a variety of thicknesses, so a selected number may be combined to make up an overall spacing element which will reach from bushing **146** to bushing **12** in any given installation. The combined spacers act to add the weight of kelly bushing **12**, as well as their own weight, to the weight of bushing **146**, to insure sufficient force to cam-rotate bushing **146** to bring lugs **152** into registry with the spaces between lugs **154** if they are out of line when the bushing **146** first engages head **138**. Spacers **156** also act to transmit upward force from bushing **146** to bushing **12** when the kelly is lifted sufficiently to unseat bushing **146** from head **138**, as will be described, thus causing coincident elevation of kelly bushing **12** and freeing it from master bushing **11**.

To describe the assembly and operation of the device, it will first be assumed that we are about to apply and use the device in connection with pressure drilling. However, the following discussion of step-by-step procedure is not to be considered as implying in any way that this is the only procedure or the only order of steps that are feasible in the use of my device. Nor is it to be considered that the operations I will describe are the only ones that can be performed with the device.

We will assume that rising pressure in the well has warned the operator that he must prepare for pressure drilling and he has accordingly lifted the entire string from the well and has closed off the master valve (not shown) provided in the casing below fitting **16**. The sealing member S of preventer unit **19** will be in the wide open condition of Fig. 1. The bit (not shown) is detached from the drill collar C (since the bit is the only normal drill-string element which cannot be stripped through packer P). Drain tray **52** is bolted to preventer cap **23**, and unit **18** is lowered into the bore of unit **19**, but is not, at this time, locked in by latch fingers **46**. Detachable hoisting eyes **158** on body **59** provide convenient means for applying a hoisting or cat-line to unit **18** for controllably lowering it to place. The drill collar is now dropped down through tube **65** and its lower end is forced through packer P, a tapered applying mandrel (not shown) being attached, if desired, to the lower end of the drill collar to aid in opening the packer to receive the body of the drill collar. The packer P now tightly and sealingly engages the drill collar.

The operator then lifts unit **18** out of unit **19** by hoisting the drill collar C, for the friction grip had by the packer P on that collar is sufficient to hold the unit from dropping off the collar-end. The device is now in the condition of Fig. 1. The bit is screwed back onto the lower, exposed end of the drill collar C and unit **18** is again lowered into unit **19** by lowering away on the drill collar. The drill collar, by the way, will be provided with a usual back pressure valve (not shown) to prevent well fluid under pressure from subsequently passing upwardly through the drill string bore.

Sealing member S is now closed about tube **65** in the manner previously described, flanges **46** entering groove **63** in neck **60** to releasably lock units **18** and **19** together, and annulus **41** packing off the tube **67** at packer sleeve **100**, as previously described. Since there is now a seal completely about the kelly and the tube **65**, the master valve is reopened and the drill collar is forced downwardly through packer P, which now is located within standpipe **27**. The drill string is now made up stand-by-stand and gradually passed downwardly through packer P, said packer radially yielding sufficiently to allow tool joints (not shown) and other enlargements on the drill string to strip therethrough, but maintaining a seal on the drill pipe irrespective of its changing outside diameter.

When the string has been extended and lowered to about drilling depth, kelly **14** is applied to the uppermost stand. To this kelly there will have been applied the drive bushing **146**, spacing collars **156** and kelly bushing **12**, the assembly of bushings and collars being kept from dropping off the end of the kelly by virtue of the shoulder **159** formed at the junction of the round and square portions of the kelly. The string is now further lowered by the kelly until lugs **152** on drive bushing **146** operatively engage lugs **154** on driving head **138**, at which time the apparatus will be in the condition of Fig. 3, except that kelly **14** will occupy the bores of tube **65** and packer P, and the packer will have been deformed as in Fig. 10.

The kelly is now lowered to bottom the bit, and usual drilling operations are carried on by simultaneously rotating and lowering the kelly; tube **65** and packer P rotating as one with the kelly due to the connections described above. The kelly continues to be packed off throughout the operation.

In coming out of the hole the operations are performed in reverse order, the tool joints being stripped through packer P but the seal being maintained constantly regardless of the changing effective diameter of the drill string.

While I have shown and described a preferred embodiment of my invention, it will be understood various changes in design, structure and arrangement may be made without departing from the spirit and scope of the appended claims.

I claim:

1. In a device of the character described, a housing having a vertically arranged, axial bore, a radially constrictable annular packing member in the housing and coaxial with the housing bore, means for controllably constricting said packer member and allowing it to expand; circumferentially arranged, rigid inserts carried by said packing member and individually movable radially inward and outward when the packing member is constricting and expanding, respectively, a second housing removably entered in the housing bore above the packing member, there being an external annular groove in said second housing exposed within the bore of the first housing and in the horizontal plane of said inserts, said inserts entering said groove when the packing member is radially constricted and thereby holding the two housings against vertical separative movement, a sleeve rotatably mounted in said second housing and held against axial movement with respect thereto, said sleeve extending through and below said packing member, the packing member being operatively constrictable about the sleeve, and a second packing annulus of resilient, plastic material attached to the extended end of said sleeve and radially constrictable to close upon work extending axially through the sleeve bore.

2. In a device of the character described, a first housing having a vertically arranged, axial bore, a radially constrictable annular packing member in the housing and coaxial with the housing bore, means for controllably constricting said packing member and allowing it to expand, a second housing removably entered in said housing bore above the packing member, an upwardly facing shoulder on the second housing, a latch member supported within the first housing and movable to and from a position overlying said shoulder, said latching member, when in said position, positively holding the second housing against upward vertical movement with respect to the first housing, a sleeve rotatably mounted in the second housing and held against axial movement with respect thereto, said sleeve passing through said packing member, said packing member being operatively constrictable with respect to the sleeve, and a second packing annulus of resilient, plastic material on the sleeve and radially constrictable to close upon work extending axially through the sleeve bore.

3. A device as in claim 2; wherein said sleeve has an axial extension beyond said packing member, and said second packing annulus is mounted on said extension.

4. A device as in claim 2, in which said latch member is carried by the first mentioned packing member.

5. A device as in claim 2, in which said latch member is carried by the first mentioned packing member and is actuatable by constrictive and expansive movement of said first mentioned packing member.

6. A device as in claim 2, in which said second packing member comprises an armature connected at one end to said sleeve, the armature comprising a rigid ring secured to the sleeve, a plurality of circumferentially spaced, rigid bars connected to the ring and extending substantially parallel to the ring axis, and an annulus of resilient plastic material embedding said bars and having a portion extending axially beyond the free end of the armature, the plastic material which extends circumferentially from bar to bar also extending continuously, in a radial direction, from the inside to the outside peripheral faces of the annulus.

7. A device as in claim 6, in which said armature further comprises a second rigid ring embedded in said annulus and connecting the bars at their ends which are remote from the first mentioned ring.

8. A device as in claim 2; including also a bearing annulus mounted on said sleeve and held in the effective horizontal plane of and engageable by said first packing member upon constriction thereof, said bearing annulus being radially contractible about said sleeve and into sealing engagement therewith, and being so contracted by forcible radial constriction of the first packing member thereabout.

9. A device as in claim 2, including also a bearing annulus mounted on said sleeve and held in the effective horizontal plane of and engageable by said first packing member upon constriction thereof, said bearing annulus comprising a plurality of split rings adapted sealingly to engage said sleeve when the first packing member is radially constricted thereabout.

10. A device as in claim 2, in which said second packing member comprises an armature connected at one end to said sleeve, the armature comprising an annular rigid, open-work cage, and an annulus of resilient plastic material embedding said armature, the annulus having portions extending radially through and beyond the cage and extending continuously from the inner to the outer peripheral faces of the annulus.

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