

Aug. 5, 1958

E. W. DAVIS
DRILLING HEAD

2,846,247

Filed Nov. 23, 1953

3 Sheets-Sheet 1

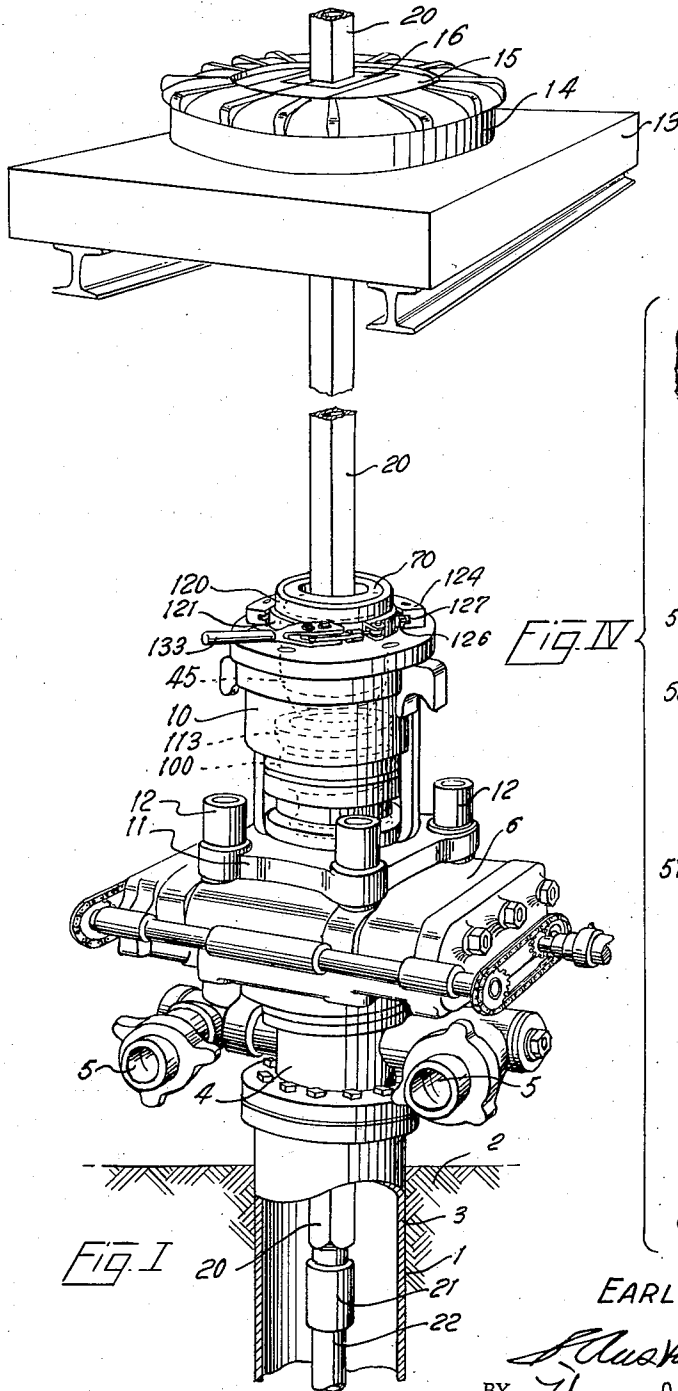
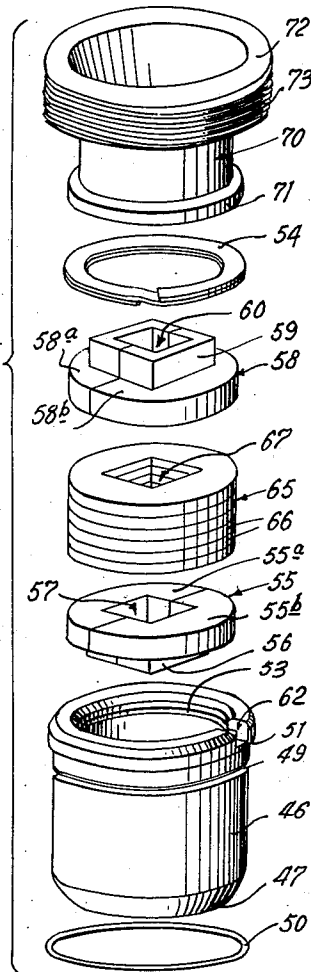


Fig. IV



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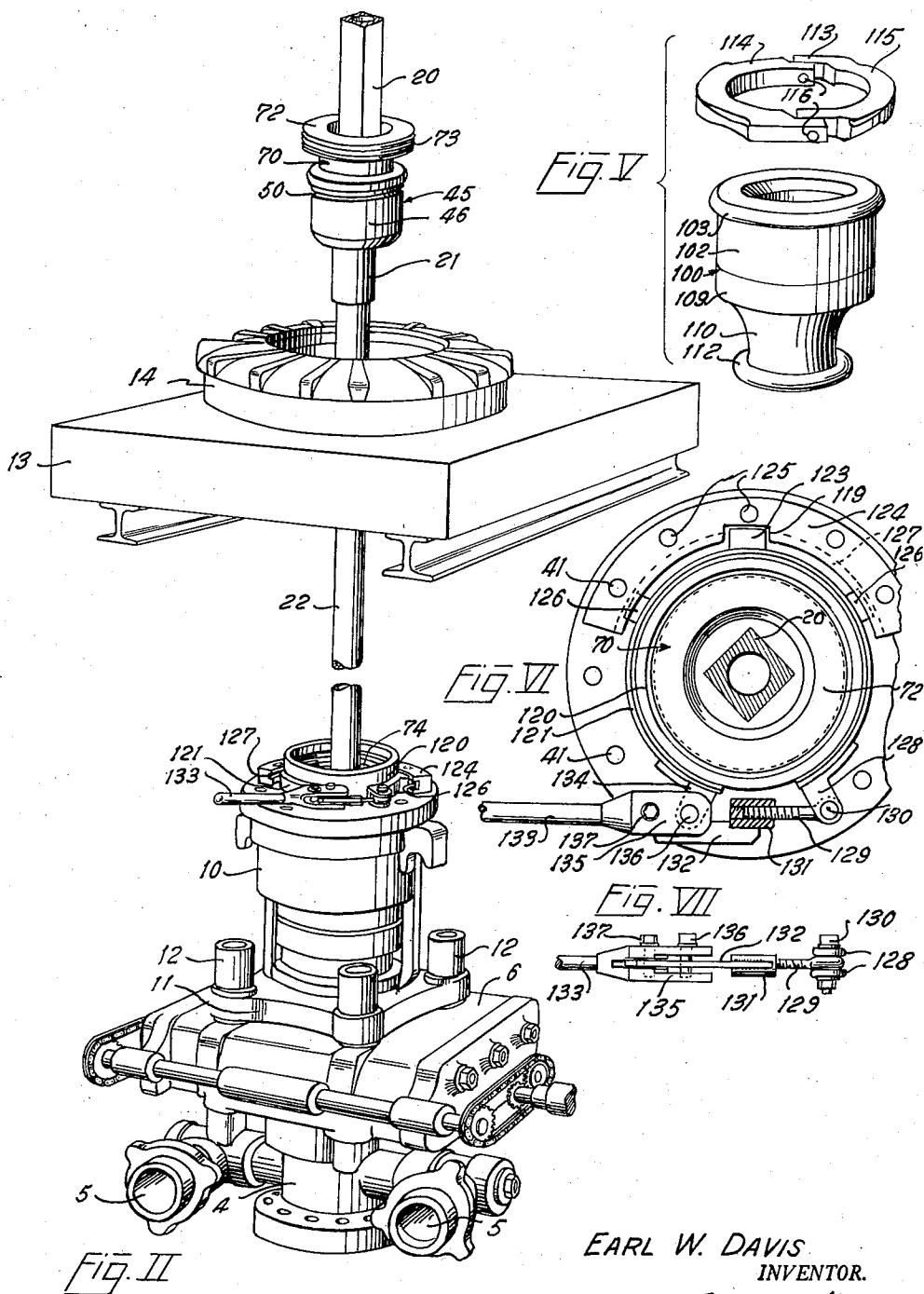
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3 Sheets-Sheet 2



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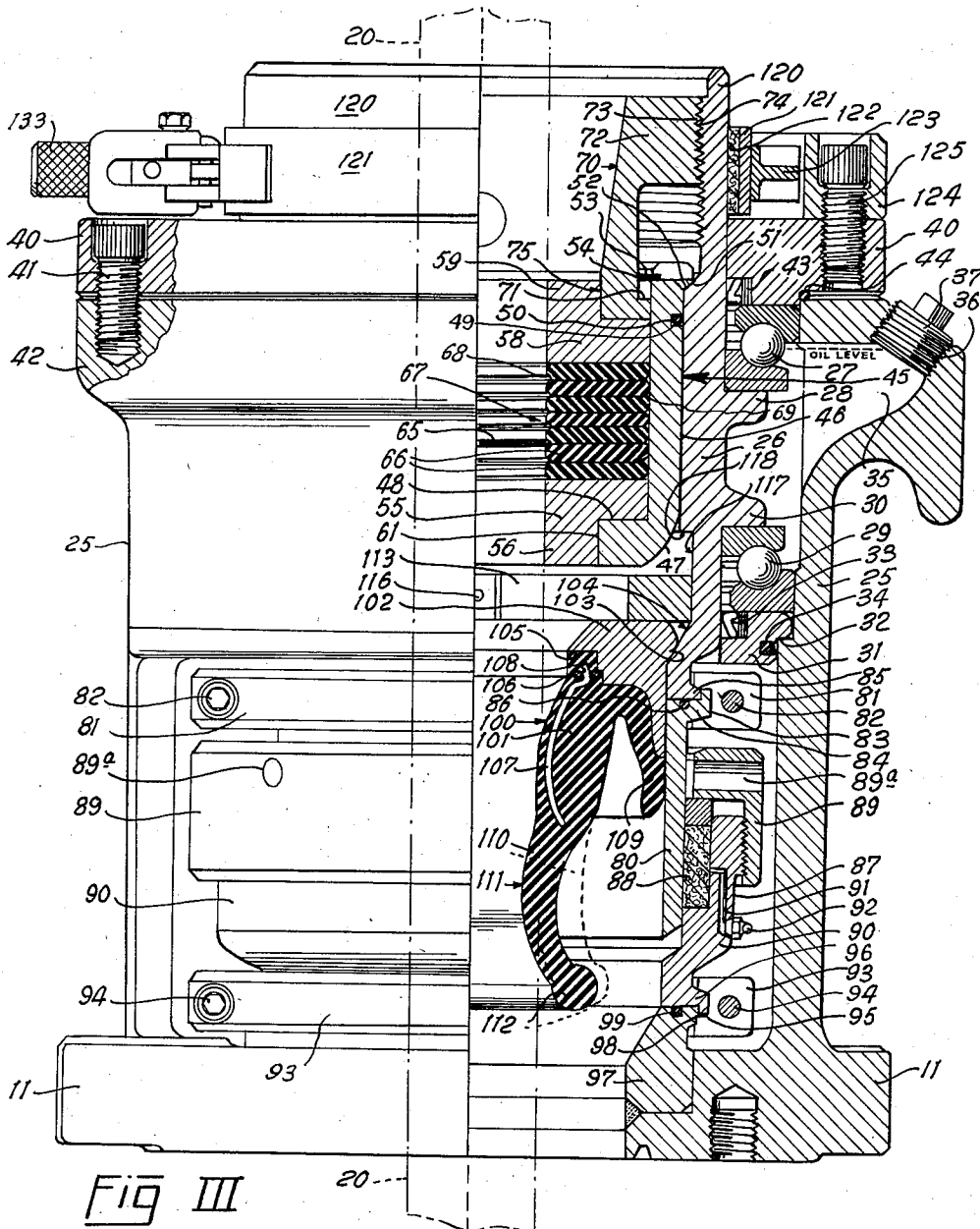
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DRILLING HEAD

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Application November 23, 1953, Serial No. 393,789

10 Claims. (Cl. 286—16.1)

This invention is concerned with a rotary drilling head used in drilling wells and is particularly concerned with sealing means for preventing the flow of fluids about conduits slidably extending through a rotary drilling head.

The rotary drilling head is customarily attached to the top of the well casing and arranged below the derrick floor.

The more essential parts of a rotary drilling head usually include an outer casing and a rotatable spindle carried therein. A square or hexagonal shaped hollow conduit, known as a kelly, slidably extends through the rotary table, which is carried on the derrick floor. The kelly also slidably extends through the spindle, which is carried in the drilling head. The kelly is keyed to the spindle so as to rotate the same within the drilling head casing.

The cylindrical conduit called a drill stem, extending into the well, is attached to the lower end of the kelly, and it is rotated by the kelly. Both are part of the drilling string.

A packing is customarily provided about the kelly and drill stem and arranged between these conduits and the rotating spindle. Such conventional packing is provided in an attempt to confine pressures in the well and to prevent the drilling fluid from escaping between the spindle and these slidable members of the drilling string.

In past practice, a single packing seal member of conventional character has usually been employed in an attempt to seal about the square or hexagonal shaped kelly and about the round drill stem. Such attempts to employ a single packing to seal about these two different geometrical shapes has been largely unsuccessful. Such practice is also dangerous.

The kelly must be progressively lowered vertically through the packing in the drilling head spindle while drilling is in progress. Also the kelly and drill stem must be periodically moved upward vertically, through the packing in the drilling head spindle, to the upper side of the derrick floor. This is necessary in order to detach the kelly from the drill stem so that an additional section of drill stem may be incorporated in the drilling string.

The single conventional sealing member heretofore employed has failed to effectively seal against the escape of fluid during this transition from a conduit of one geometrical shape and size to a conduit of another geometrical shape and size. Both the square (or hexagonally) shaped kelly and the round drill pipe have heretofore been raised and lowered through such conventional sealing member, with attendant damage to such member and danger to other equipment and to the workmen.

Furthermore, in past practice, it has not proved practical or safe to relax the Kelly seal, prior to withdrawing the kelly and drill stem therethrough, in order to prevent the sealing material from being torn up by friction and by abrasive engagement with the enlarged couplings on the drill stem.

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Reverse circulation, in which the drilling fluids are pumped down the annulus between the well casing and drill stem, through the drill bit and upward through the drill stem, has become widely accepted in the well drilling industry. Reverse circulation is advantageous because the higher velocity of fluid movement upward through the smaller drill stem more quickly carries away the cuttings of the bit.

However, this most effective type of circulation by reverse flow has been restricted and hindered in the past because of the absence of any satisfactory or safe means for sealing around the kelly and the drill stem, within the drilling head spindle.

Recently, gas drilling has become widely employed. In such operation compressed gas is injected through the drill stem and drill bit and forced upward through the annulus (between drill stem and well casing), in lieu of liquids, as a medium for removing the bit cuttings from the well and also to provide a cooling medium for the frictionally heated drill bit. The use of compressed gas as the circulating fluid creates a serious fire and explosion hazard, and it further emphasizes the desirability and necessity of providing a truly effective and dependable seal about the conduits of varied sizes and shapes which are required to be passed into and out of the well through the drilling head.

Heretofore, drilling head packings have customarily been placed in the head and then compressed to sealing condition about the kelly by forcing a compression gland against the packing. Such gland has usually been held in place by means of a flange, with studs or bolts passing therethrough. This procedure required several men who had to manually perform the required operation within the cramped space under the derrick floor.

This cumbersome manual operation is time consuming, expensive, and dangerous. Such procedure must be repeated frequently during drilling operations in order to adjust the packing to compensate for wear, and to adjust it to changing magnitudes in the varying pressures encountered while drilling. Whenever such adjustment was being made, the drilling operation was interrupted. Costly equipment was thus made idle, while an unprofitable and expensive operation by hand labor was performed.

My invention is intended to overcome the above recited problems and shortcomings of prior practices and of the old apparatus employed therein.

A primary object of my invention is to provide apparatus in a drilling head to safely and effectively make and maintain a seal between the differently shaped conduits (which become parts of a drilling string) and the rotating spindle in the drilling head, when the drilling string is moved upwardly and/or downwardly through the spindle.

Another important object of my invention is to provide co-acting sealing members, carried within the spindle in a drilling head, one of which seals about the square kelly while the drilling is progressing and the other operates to seal about the round drill stem, and the couplings thereon, after the Kelly seal is disengaged, subsequent to raising the drill stem within the drill stem seal.

A further important object of my invention is to provide a Kelly sealing assembly for a drilling head in which the sealing material may be set, compressed, sealed and adjusted about the kelly by the rotation of the kelly itself.

A still further object of my invention is to provide a Kelly sealing assembly for a drilling head which may be disengaged and removed from the drilling head by reverse rotation of the kelly.

Another object of my invention is to provide a self-

contained Kelly seal assembly for a drilling head which may be detachably set in the rotating spindle, and which is arranged to slide upon the kelly when released from the spindle.

An additional object of my invention is to provide a Kelly seal assembly for a drilling head which may be quickly positioned in, and also easily removed from, the rotating spindle in the drilling head by the application of a brake to the rotating spindle.

Another object of my invention is to provide a drill stem sealing element in a drilling head which safely and effectively seals about the round drill stem upon disengagement and removal of the Kelly packing, and withdrawal of the kelly from the drilling head, for the purpose of incorporating an additional section of drill stem in the drilling string.

A further object of my invention is to provide a Kelly seal in a drilling head which may be adjusted in its compression without interrupting the drilling operation.

A further object is to provide a Kelly seal assembly in which the sealing material is automatically adjusted in compression in response to variations in pressure exerted against the lower end thereof.

Another object of my invention is to provide a drill stem seal in a drilling head which effectively adjusts itself to seal about the drill stem and also about the enlarged couplings on the drill stem, as the drill stem is passed vertically through the seal, and without damage to sealing material or other equipment.

Other and further objects of my invention will become apparent upon reading the detailed specification hereto attached and by referring to the drawings forming a part hereof.

In the drawings suitable apparatus is shown for carrying out my invention, wherein:

Fig. I is a fragmentary, partially sectionalized perspective view showing my drilling head assembled in relation to a casing, a well head, a blowout preventer, a derrick floor and the drilling string, as it would be disposed while drilling is in progress.

Fig. II is a view similar to Fig. I showing the Kelly packing assembly removed from the drilling head spindle and supported above the derrick floor by the Kelly sub.

Fig. III is a partially sectionalized elevational view of a drilling head incorporating my invention.

Fig. IV is a perspective exploded view of the Kelly packing assembly.

Fig. V is a perspective view of the drill stem sealing cup, and the latching ring for limiting the upward movement of the cup in the spindle.

Fig. VI is a top plan view of the drilling head showing the spindle brake mechanism.

Fig. VII is a side elevational view of the brake actuating mechanism.

Numeral references are employed to designate the various parts shown in the drawings, and like numerals designate like parts throughout the various figures of the drawings.

Referring first to Fig I, the numeral 1 indicates a well bore extending vertically into the earth's strata 2. A well casing 3 is disposed in the bore 1. A well head 4 is attached to the upper end of the casing 3 by means of suitable flange and bolt connections, and fluid communication connections 5 are provided on the well head through which drilling fluid may flow through the well head into or from the annulus between the casing and the drill stem.

The drilling fluid may be either circulated down the annulus and upwardly through the drill stem, or it may be circulated downwardly through the drill stem and upwardly through the annulus. The purpose of the circulation of fluid through the well flow circuit, as described above, is to take away the cuttings of the drill bit, and

to provide a cooling medium for the drill bit while drilling is in progress.

A blowout preventer 6 is customarily attached to the upper side of the well head. The blowout preventer is, in effect, a large gate valve having opposed slidable rams therein, which rams carry sealing material on the opposed ends thereof. The rams may be moved inwardly to engage and seal about the drill stem and thereby confine and control any unusual pressures encountered while drilling. The blowout preventer rams may be operated either manually or by power means. The one shown in the drawing is arranged for power operation.

The blowout preventer 6 does not form any part of the present invention, and it is not considered necessary to illustrate or describe the details thereof.

A drilling head, indicated generally as at 10, which incorporates a suitable form of my invention, is attached to the upper side of the blowout preventer by means of stud bolts 12 passing through the attachment flange 11 on the drilling head and through the body of the blowout preventer.

A section of a derrick floor is indicated as at 13. Disposed on the upper side of the derrick floor is a rotary table 14, of conventional construction. The rotary table 14 has a master bushing 15 therein and a Kelly bushing 16 inside the master bushing. The bushings 15 and 16 are customarily placed in and/or attached to the rotary table in such a manner that they may be easily removed. These bushings are usually made of two or more complementary parts.

A square-shaped hollow kelly 20 extends through the Kelly bushing 16, drilling head 10, blowout preventer 6, and well head 4, said kelly being free to slide vertically through these members, and into and out of the well, as desired by the driller.

The opening in the Kelly bushing 16, through which the square kelly slidably extends, is square in shape, whereby the kelly is keyed to the rotary table and is rotated with the rotary table.

The rotary table is arranged to be rotated by means of suitable power and power-transmitting mechanism (not shown), whereby the drilling string, consisting of the kelly and the dependingly connected drill stem, may be rotated.

An interiorly threaded sub 21 may be attached to the lower end of the kelly 20, and the hollow cylindrically shaped drill stem 22 may be threadedly attached to the sub. The drill stem is made up of a plurality of elongated sections joined together by cylindrical couplings, and a drill bit (not shown) is carried at the lower end of the drill stem. Drilling fluid is circulated through the kelly and drill stem during the drilling operation.

The construction of the drilling head 10, in assembled condition, incorporating my invention, is shown in detail in Fig. III.

Drilling head 10 has a generally cylindrical housing 25, in which a rotating spindle 26 is journaled on suitable bearings.

An upper ball bearing assembly 27 (including ball-race) is mounted between the housing 25 and the rotating spindle 26, such bearing being supported and held in place between the retainer shoulder 28, on the outer side of the spindle 26, and the cover plate 40, on the drilling head.

A lower ball bearing assembly 29 (including ball-race) is disposed between the housing 25 and the spindle 26, said bearing being supported and held in place between the lower bearing retainer shoulder 30, arranged on the outer side of the spindle 26, and the lower bearing support plate 31.

The lower bearing support plate 31 is engaged with the shoulder 32, arranged on the inner side of the housing 25, and is supported thereby.

A packing ring 33 is disposed between the inner side

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of the support plate 31 and the outer side of the spindle 26, and a packing member, shown as O ring 34, is arranged between the outer side of the support plate 31 and the inner side of the housing 25. The packing members 33 and 34 prevent the lubricant in the oil reservoir 35 from escaping.

A threaded opening 36 may be provided in the upper side of the housing 25, through which the oil reservoir 35 may be filled, and such opening 36 may be closed by a threaded plug 37.

The oil reservoir is filled with suitable lubricating oil, in order to provide proper lubrication for the bearings 27 and 29.

The spindle 26 is threadedly engaged with the compression gland 70, which in turn is keyed to the kelly 20, so that the spindle 26 rotates on the bearings 27 and 29, relative to the stationary housing 25, upon rotation of the kelly, except when the brake is applied to the spindle 26, for the purpose of setting or removing the Kelly packing assembly, as will be hereinafter described.

A cover plate 40 may be secured to the upper side 42 of the housing 25 by means of cap screws 41, extending through the cover plate 40 and into the upper side 42 of the housing.

A packing seal 43 is provided between the inner side of the cover plate 40 and the outer side of the spindle 26; and ring packing seal 44 is provided between the lower side of the cover plate 40 and the upper side 42 of the housing 25. Such seals are provided for the purpose of preventing the escape of lubricant from the oil reservoir 35.

The rotatable spindle 26 extends through the cover plate 40, such spindle having an upward extension above the cover plate, indicated as at 120. The extension 120 provides an engaging surface for the brake, hereinafter described.

A Kelly packing assembly, indicated generally as at 45 in Fig. II, and shown in an exploded view in Fig. IV, is arranged to be threadedly engaged within the spindle 26.

The hollow Kelly packing housing 46 is substantially cylindrical in shape and has an annular bevel 47 on the lower end thereof, such beveled surface 47 being provided for the purpose of guiding the Kelly packing assembly into the spindle 26 when lowered therein.

An internally extending, annular flange 48 is provided in the lower end of the housing 46, such flange being arranged to receive and support the lower Kelly drive plate 55.

An annular packing ring groove 49 is provided on the outer side of the housing 46; and packing ring 50 is disposed in such groove for the purpose of sealing between the outer surface of the housing 46 and the inner surface of the spindle 26.

A beveled outer annular lip 51 is provided at the upper end of the housing 46, such lip being engageable with the companion internal shoulder 52 in the spindle 26, whereby the housing 46 is held and supported against further downward movement in the spindle 26, after lip 51 and shoulder 52 have become engaged.

An annular internal channel 53 is provided at the upper end of the housing 46, such channel being arranged to receive a spiral retainer ring 54. The spiral ring 54 is made of flexible spring-like material and may be inserted in the channel 53 by engaging a free end of the ring 54 with the upper inner side of the channel and rotating the ring until it is guided into the channel.

A slot 62 (Fig. IV) may be cut in the top of the housing 46, extending into the channel 53, so that a free end of the ring 54 may be extended through such slot and engaged with the inner side of the channel 53.

The inner edge of the ring 54, when disposed in the channel 53, extends inwardly of the inner side of the housing 46, so that it is engageable with the shoulder

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71 on the lower end of the compression gland 70. The ring 54 hangs and suspends the housing 46 to the compression gland 70 when the Kelly packing assembly 45 is in relaxed condition. It so appears in Fig. II.

The ring 54 also limits the outward movement of the compression gland 70, relative to the housing 46, by engagement with the shoulder 71, thereby retaining the internal portions of the Kelly packing assembly within the housing 46.

The lower Kelly drive plate 55 is preferably made of separable halves 55a and 55b (Fig. IV) so as to permit it to be more easily inserted, and assembled with the housing 46. The Kelly drive plate 55 has a square-shaped extension 56 thereon which mates with a square passage 61 in the lower end of the housing 46, whereby the drive plate 55 is keyed to the housing 46. The drive plate 55 also has a square passage 57 therethrough, through which the square kelly 20 slidably passes so that the kelly is keyed for rotation with the plate 55.

The upper Kelly drive plate 58 is shown to be the same in construction as the lower Kelly drive plate 55, being made in separable halves 58a and 58b and having a squared extension 59 thereon. Such extension 59 is disposed upwardly and mates with a square opening 75 in the lower end of the compression gland 70, whereby the Kelly drive plate 58 is keyed for rotation with the compression gland 70. The kelly 20 extends through the square passage 60 in the plate 58, so that the kelly is keyed for rotation with the plate 58.

The packing material 65 is disposed about the kelly between the drive plates 55 and 58. The Kelly packing material 65 is preferably made up of a plurality of separate layers or wafers 66 of rubber, neoprene or other suitable resilient packing material, but the packing material could be a solid body, if desired. The layers 66 are preferably provided on their inner edges with chamfers, indicated at 68, and on their outer edges with chamfers, indicated at 69.

The packing material 65 has a square passage 67 there-through, through which the square kelly 20 extends, such packing material being arranged to seal about the kelly when compressed thereagainst, in the manner which will be hereinafter described.

The compression gland 70 is provided with an external annular shoulder 71 at the lower end thereof and an enlarged upper end 72, having a plurality of annular threads on the outer periphery thereof. The threads 73 are arranged to co-act with the internal threads 74 on the inner side of the upper end 120 of the rotating spindle 26, so that the Kelly packing assembly 45 may be removably and adjustably positioned in the spindle.

A rotatable sleeve 80 is secured to the lower end of the spindle 26 by means of the split clamp 81, such split clamp being secured together by means of bolts 82. When so secured together, the split clamp 81 is provided with an annular internal recess 83, in which recess is engaged the interfitting annular extensions 84 and 85 on the sleeve 80 and on the spindle 26, respectively.

An O ring seal 86 is provided between the upper side of the sleeve 80 and the lower side of the spindle 26.

A packing gland 87 is positioned about the sleeve 80, such packing gland having resilient packing material 88 engaged with the outer wall of the sleeve 80. The internally threaded compression ring 89 is arranged to be threaded upon the externally threaded stuffing box 90 for the purpose of compressing and sealing the packing 88 against the sleeve 80.

Wrench sockets 89a may be provided about the compression ring 89 in order that a wrench may be inserted and the compression gland may be rotated and threaded upon the stuffing box, for adjustment of the packing material 88. A channel 91 may be provided through the stuffing box 90 for the purpose of supplying grease to the packing therein, such channel being closed by plug 92.

A split clamp 93 may be provided for securing the

stuffing box 90 to the drilling head housing 25. The split clamp 93 is usually secured together by means of bolts 94. When the clamp is secured, an annular recess 95 is shown to be provided on the inner side of split clamp 93. Recess 95 receives and holds together the interfitting extensions 96 and 98, on the lower end of the stuffing box 90 and the upper side of the insert 97, respectively.

The insert 97 may be welded in place on the inner side of the lower end of the drilling head housing 25 in order to provide a connection for the stuffing box 90. An O ring packing seal 99 is provided between the lower end of the upper stuffing box 90 and the upper face of the insert 97.

A drill stem sealing cup 100 is positioned in the sleeve 80 and so arranged and equipped as to provide a packing to close and seal the space between the round drill stem, and enlarged couplings thereon, and the sleeve 80 when the drill stem is raised upwardly through the cup 100 for the purposes and in the manner which will be described hereinafter. The cup 100 is preferably provided with a round central bore therethrough to coincide in shape to the round drill stem.

The sealing cup 100 has a body portion 101 made of rubber, neoprene or other flexible and resilient material. The body portion 101 should be molded to the supporting metallic bushing 102. Bushing 102 has an outer annular beveled shoulder 103 thereon, which shoulder is arranged to rest upon a companion shoulder 104 on the inner side of the spindle 26.

A recess 105 is provided on the inner side of the bushing 102, in which recess a reinforcing wire retainer ring 106, carrying the reinforcing wires 107, is inserted at the time of molding the cup. A plurality of reinforcing wires 107 are spaced about the body 101 and are imbedded and molded therein. Said reinforcing wires 107 have hooks 108 on the upper ends thereof. The retainer ring 106 has holes spaced thereabout through which holes the hooks 108 are inserted.

The ring 106 and the wires 107 are assembled, with the hooks extending through the holes in the wires, before the body 101 is molded to the bushing 102. The ring, with the reinforcing wires assembled therewith, is inserted in the groove 105 and the body is molded to the bushing, thereby embedding the ring and reinforcing wires in the body of resilient material.

The reinforcing wires 107 constitute spring-like members which reinforce the resilient material of the body and support it in pre-determined position while relaxed.

An outer lip 109 is provided on the body 101 of the cup 100, such outer lip being engageable with the inner surface of the sleeve 80 so as to seal thereagainst.

A downwardly extending inner skirt 110 is provided on the body 101, such skirt 110 being curved inwardly as indicated at 111. The portion 111 is engageable with, the seals against, the round drill stem 22, and the round couplings thereon, when these members are extended through the cup.

The lower, outer edge of the skirt 110 is curved outwardly and is terminated with an enlarged rounded, annular bead 112. Such rounded bead 112 strengthens and reinforces the outer edge of the skirt 110 and prevents it from splitting when the skirt is stretched and expanded by the passage through the cup of an enlarged member, such as the couplings on the drill stem. The bead 112 constitutes a friction-minimizing guide and barrier, preventing the tearing of the skirt 110 at its outer edge.

The rounded bead 112 guides the enlarged couplings on the drill pipe through the cup, thus preventing the lower end of the skirt from hanging up with the couplings and being torn thereby.

The latching ring 113 (Fig. V) is made in two corresponding halves 114 and 115, which are joined together by the diametrically spaced pivot pins 116, so that the

sections 114 and 115 may be pivoted about the pivot pins and folded together. The latching ring 113 may be folded for the purpose of inserting it through the internal bore of the spindle 26, and it may be unfolded into the enlarged bore 117 in the spindle 26.

The latching ring 113 normally rests upon the upper side of the bushing 102 of the cup 100. Latch 113 is free to move upwardly in bore 117 until it engages with the lower end of the housing 46. The latching ring 113 limits the upward movement of the cup 100.

When the Kelly rubber packing assembly is removed from the spindle, the cup 100 may move upwardly in response to pressure from below the cup until the latch 113 engages with the shoulder 118 at the upper end of the enlarged bore 117, thereby limiting the upward movement of the sealing cup 100 and retaining it within the spindle.

The upward movement of the sealing cup 100 should be so limited that, at the maximum extent of such movement, the lip 109 will still be in engagement with the inner bore of the sleeve 80 to form a seal therewith.

The cup 100 is so constructed that the greater the pressure from below, the tighter the skirt 110 and the lip 109 seal against the drill stem 22 and sleeve 80, respectively.

The flexible skirt 110 is conformable to different diameters of pipe extended therethrough, thus effectively sealing about the drill stem and enlarged couplings thereon.

The spindle 26 has a portion 120, extending above the cover plate 40. A brake mechanism is arranged to engage with extension 120 in order to prevent rotation of the spindle by the kelly when desired. This arrangement is made for the purpose of screwing the Kelly packing assembly in and out of the spindle by the rotation of the kelly itself.

The brake band 121 extends about the upward extension 120, said brake band being lined on the inner side with a suitable brake lining 122, which lining is engageable with the outer side of extension 120.

A lug 123 (see Fig. VI) is secured exteriorly of the brake band 121. This lug may be made to extend into the slot 119 in the inner side of the brake mounting block 124. The brake mounting block 124 is secured to the cover 40 of the drilling head housing 25 by means of suitable cap screws 125. Lug 123 engages with slot 119 and prevents the rotation of the brake band 121, relative to extension 120, when the brake is applied.

A pair of dogs 126 are secured on the outer side of brake band 121, such dogs being slidably engaged in channel 127 on the inner side of the mounting block 124. The dogs 126 position the brake band 121 vertically with relation to the extension 120 and secure the brake band against upward movement on the extension 120. However, the dogs 126 may slide circumferentially in the channel 127, permitting the brake band to be tightened about the extension 120 on the spindle.

An outwardly extending ear 128 should be provided on one end of brake band 121, and a threaded link 129 may be hingedly secured to ear 128 by means of pivot bolt 130. The outer end of the link 129 therefore, may be adjustably threaded to the internally threaded coupling 131. Through the use of this threaded connection the brake band may be adjusted in tension.

A thrust bar 132 is rigidly secured to the coupling 131, as by welding. The brake operating handle 133 has a bifurcated end 135 thereon. An outwardly extending boss 134 is secured to the other end of the brake band. The boss 134 is pivotally attached to the inner end of the bifurcated end 135 of the brake handle by means of a suitable pivot bolt 136, and the thrust bar 132 is pivotally attached to the outer end of the bifurcated end 135 of the operating handle by means of a suitable pivot bolt 137.

In order to tighten the brake band 121 about the upper

extension 120 of the spindle to prevent rotation of the spindle 26, the operating handle 133 may be pulled inwardly toward the drilling head, thereby drawing the ends of the brake band toward each other and tightening the band about the extension 120.

The operation, function and advantages of my invention will be more readily understood by reading a description thereof which follows:

The drilling head 10, as shown in Fig. I, is assembled in operative relationship with the well casing, well head and blowout preventer. The placing of the blowout preventer between the well head and the drilling head is customary, but is not essential to the operation of the drilling head.

As shown in Fig. I, the kelly 20 extends through the rotary table, the drilling head, the blowout preventer and the well head and into the well casing. The kelly is keyed to the removable bushings in the rotary table, and it is also keyed to the rotatable spindle 26 in the drilling head, so that by rotation of the rotary table, through suitable power connections, the drilling string is rotated, on the bearings 27 and 29, supporting the rotating spindle 26.

The Kelly packing assembly 45 is threadedly engaged in the rotating spindle 26, as a unit; and the said packing unit is arranged to slide vertically on the kelly, when detached from the spindle.

During drilling operations, it is necessary to periodically withdraw the kelly and the drill stem upwardly, through the drilling head and through the rotary table, to a position where the Kelly sub 21 is accessible from the upper side of the derrick floor, so that the drill stem may be detached from the Kelly sub for the purpose of incorporating in the drilling string an additional section of drill stem.

The bushings 15 and 16, in the rotary table, may be removed and the kelly 20 is drawn upwardly until the Kelly sub 21 engages the lower side of the lower Kelly drive plate 55. The Kelly sub is larger in diameter than the opening through the lower end of the lower Kelly drive plate 55 so that the Kelly sub will not pass there-through. The Kelly sub 21 and other enlarged pipe couplings will cause the flexible skirt 110 of the sealing cup 100 to flex, thereby allowing the Kelly sub and other enlarged pipe couplings to pass through the sealing cup 100.

The brake on the upper side of the drilling head is then applied so that it engages the extension 120 and holds the spindle 26 against rotation. The kelly is then rotated in a counter-clockwise direction, thus rotating the Kelly packing assembly 45 within the spindle 26, until the threads 73 are disengaged from the threads 74, and the Kelly packing assembly is disengaged from the spindle.

The kelly and drill stem may then be drawn upwardly through the opening left in the rotary table by removal of the bushings therefrom, carrying with them the Kelly packing assembly, which rests on the Kelly sub 21. The kelly and the Kelly packing assembly 45 are shown above the derrick floor 13 in Fig. II, of the drawings, after the Kelly packing assembly has been so removed from the head and the kelly has been drawn upwardly above the derrick floor, as described above.

The drill stem 22 may then be disconnected from the sub 21, and the kelly may be set aside in the conventional "rat hole," while an additional section of drill stem is joined to the drill stem string. As the kelly is run into the "rat hole," the Kelly packing assembly 45 may engage the upper edge of the "rat hole" and slide up the kelly. When the kelly is withdrawn from the rat hole, the Kelly packing assembly will again slide downwardly to a position of rest on the sub 21.

When the kelly is pulled upwardly to a position where the Kelly sub 21 engages the lower end of the Kelly packing assembly, preparatory to disengaging the Kelly packing assembly from the drilling head, the round sub

21 and drill stem 22 are drawn into the internal bore of the cup 100, and the sealing surface 111 of the skirt 110 of the cup seals against the round drill stem and confines the pressure below the cup and prevents the leakage of fluid upwardly about the drill stem.

The Kelly packing assembly may be engaged within the spindle 26, and the sealing material 65 therein may be compressed into sealing engagement, by rotating the kelly in the manner described below.

The Kelly packing assembly 45 is slideably positioned on the kelly on the upper side of the derrick floor and is allowed to slide to a position of rest on the Kelly sub 21. The Kelly sub is joined with the drill stem 22, and the drill stem, the kelly and the Kelly packing assembly are lowered through the opening in the rotary table left by the removal of bushings 15 and 16.

When the drill stem and the kelly are lowered to a point where threads 73 on the outer side of the compression gland 70 come into contact with the threads 74 on the inner side of the spindle 26, the brake is applied to the upward extension 120 of the spindle 26, and the kelly 20 is rotated in a clockwise direction.

The kelly is keyed to the compression gland 70 and the spindle 26 is held against rotation, so that threads 73 and 74 are caused to interact, and the compression gland is threaded into the spindle until the shoulder 52 on the upper end of the housing 46 comes into engagement with the shoulder 51 on the inner side of the spindle 26.

When the shoulders 51 and 52 are so engaged, further threading of the compression gland into the spindle will cause compression gland 70 and housing 46 to telescope, thus compressing the packing material 65 between the plates 55 and 58 and sealing the packing material against the kelly.

After the compression gland has thus been moved downwardly to sufficient extent to seal the sealing material about the kelly, the brake is released and the kelly will then rotate the spindle 26 on the bearings 27 and 29, in normal drilling operations.

Should it become necessary while drilling is in progress to further compress the sealing material 65 in the Kelly packing assembly, in order to compensate for increased pressures encountered, or in order to adjust the seal to compensate for wear, such may be done by merely applying the brake to the rotating spindle and causing the kelly to further rotate and thread the compression gland 70 into the spindle, thereby further compressing the packing material.

Prior to withdrawal of the kelly upwardly, through the Kelly packing assembly, the brake should be applied, and the kelly should be rotated in reverse direction, for the purpose of unscrewing the compression gland 70 sufficiently to relax the sealing material 65, so that the sealing material will not be unduly abraded and damaged by friction as the kelly is drawn therethrough.

It will be noted that upon the removal of the Kelly packing assembly 45 from the spindle 26, the drill stem sealing cup 100 operates to seal about the drill stem and the couplings thereon against usual pressure conditions. Ordinarily, the Kelly packing material 65 confines the pressure when it is in sealing engagement with the kelly, while drilling is in progress, and the drill stem packing cup does not seal about the square kelly while extending therearound.

The two mutually related packings, to wit: the Kelly packing and the drill stem packing cup, co-act and relatedly react, to the extent that the Kelly packing will seal while the kelly and drill stem are in drilling position, and the drill stem packing cup will seal about the drill stem upon the removal of the Kelly packing assembly and the withdrawal of the round drill stem into the drill stem packing cup.

The Kelly packing material 65 is self-adjusting in compression in response to variations in pressure exerted from below the Kelly packing assembly. Upon increase

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in pressure from below, the increased pressure will act against the lower end of the Kelly packing assembly and will cause the Kelly rubber housing 46 to telescope upwardly with relation to the compression gland 70, thereby further compressing the sealing material 65 into tighter sealing engagement with the kelly. Upon the decrease of such pressure, the sealing material will be allowed to relax until it is in its preset compressive state.

Should sudden or abnormal pressures be encountered while drilling is in progress (as is often the case), the brake can be quickly applied to the spindle and the Kelly packing material can be quickly compressed into tighter sealing engagement with the kelly to thus safely and temporarily confine the abnormal pressures until the kelly can be withdrawn to a point where the rams of the blowout preventer can be closed about the drill stem and confine the abnormal pressure within the well.

In the operation of my continuous sealing device, the escape of fluid pressure about a slidable well drilling conduit made up of sections of different contours and sizes is prevented.

The sealing element carried within the upper part of the spindle effects a seal about a conduit of rectilinear contour. The sealing element carried within the lower part of the spindle (in spaced relation to the upper sealing element) effects a seal about a conduit of circular contour. The upper sealing element is keyed to the section of conduit of rectilinear contour, and may be rotated thereby. Upon reverse rotation of such section, the upper sealing element may be automatically released from engagement with such section.

Periodically, the entire drilling string is lifted up a short distance, the two different sections thereof are uncoupled, an additional section is incorporated, and the thus lengthened string is lowered again. It is during this lengthening operation that the greatest danger from blowouts, fire and explosion is experienced. A continuous seal is, therefore, of great advantage.

When the upper sealing element is temporarily released, then the lower sealing element is immediately and automatically expanded by the fluid pressure seeking escape about the conduit, with the result that the lower sealing element will thereupon retain the fluid pressure seeking escape. The design, construction, and operation of the lower sealing element is such that the seal made thereby is increased in effectiveness in response to the increased fluid pressure restrained by this element.

Nevertheless, this lower sealing element, even while maintaining a complete seal against great pressure, will allow the vertical sliding movement through the element of the drilling conduit, including the couplings thereon, which couplings are of greater diameter than the sections of conduit held together thereby.

These large couplings are guided into the lower part of the lower sealing element by the outward flare of the skirt thereof. The strengthening and restraining bead arranged around the end of this skirt prevents undue lateral extension of the skirt itself, while at the same time allowing such lateral movement of the main part of the skirt as is necessary to accommodate the body and skirt of the sealing element to the various diameters of the differing parts of the conduit encountered during the vertical sliding movement of the conduit.

Complete and continuous seal about the various shapes and sizes of the differing parts of the conduit is established and maintained by the cooperation of the two sealing elements which are carried within the rotatable spindle, until all of the fluid pressure seeking escape is restrained by the increasingly pressured lower seal upon the temporary release and/or removal of the upper seal while a new section of drilling conduit is being put into the drilling string as a requisite for drilling farther into the earth.

Resumption of the normal direction of rotation of the drilling string will cause the upper sealing element to

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re-engage the drive conduit of rectilinear contour and permit the resumption of normal drilling operations; and a continuous safe and effective seal against the escape of fluid pressure from within the well will have been maintained at all times.

This invention is, therefore, a safety device. The use of its mechanism results in the confining of pressures, excessive and/or ordinary, within a well being drilled.

This invention provides mechanism and means whereby the several members of a drilling string, which are of different external diameters and of different cross-sectional patterns and contours, may be safely sealed about to prevent the passage of fluids (under pressure) therearound, under both normal and abnormal drilling conditions.

Having described my invention, I claim:

1. In a drilling head having a rotatable spindle journaled in a housing, said spindle being rotatable by a kelly slidably extending therethrough, the improvement which consists of a Kelly sealing assembly slidably disposed on the kelly and keyed thereto and arranged for threaded engagement with the spindle; and brake means attached to the housing and engageable with the spindle, whereby the spindle may be held against rotation so that the rotation of the kelly may thread and unthread the Kelly sealing assembly in the spindle.

2. In a drilling head having a rotatable spindle journaled in a housing, said spindle being rotatable by a kelly slidably extending therethrough, the improvement which consists of a kelly packing assembly comprised of telescoping members with resilient packing material positioned and held therebetween, the assembly being slidably carried on the kelly and keyed to the kelly; one of such telescoping members being threadedly attached to the spindle; support means in the spindle for the outer telescoping member; and brake means carried by the housing and engageable with the spindle to prevent rotation of the spindle, whereby the kelly may rotate the threadably attached telescoping member and thread and unthread it in the spindle.

3. In a drilling head, a housing; a spindle journaled in the housing; a packing assembly arranged to be threadedly engaged in the spindle, said packing assembly being arranged to be slidably disposed on a kelly and to be keyed thereto when the kelly is extended therethrough; and brake means carried by the housing and arranged to engage with the spindle to prevent rotation of the spindle relative to the housing, whereby the packing assembly may be rotated by the kelly relative to the spindle to thread the packing assembly in and out of the spindle.

4. In a drilling head, a casing; a spindle journaled in the casing; a Kelly packing housing suspended in said spindle; resilient packing material slidably supported in the housing; a compression gland having a portion telescopically extending into the housing, and an external portion of the gland threadedly engageable with the spindle; means engageable with the housing and the compression gland to limit the outward movement of the gland with respect to the housing; said packing material having a central passage therethrough arranged to conform to the surface contour of a kelly; means adapted for keying the compression gland and the housing to a kelly extendable therethrough; and brake means carried by the casing engageable with the spindle to prevent rotation of the spindle, whereby the compression gland may be rotated by the kelly with respect to the spindle.

5. In a drilling head, a housing; a spindle journaled in said housing; a Kelly packing assembly threadedly engaged in the spindle; said packing assembly being adapted to be slidably disposed on a kelly and to be keyed thereto for rotation therewith; a drill stem packing cup slidably suspended in said spindle below the packing assembly; a ring slidably disposed in the housing, and normally resting on the upper side of the cup; an overhanging shoulder in the spindle; said ring being engageable with the pack-

ing assembly to limit upward movement of the cup in the spindle when the packing assembly is in place in the spindle, and being engageable with the shoulder to limit upward movement of the cup in the spindle when the packing assembly is removed from the spindle.

6. A Kelly packing assembly arranged to be slidably carried on a kelly and to be keyed thereto so as to rotate therewith comprising: a housing; an internal annular flange at the lower end of the housing; a compression gland having a portion telescopically slidably extending into the housing; an external shoulder on the inner end of the gland; means extending inwardly of the upper end of the housing and engageable with the gland shoulder to limit the slidable outward movement of the gland with respect to the housing; and resilient sealing material slidably supported in the housing between the compression gland and the flange, whereby the resilient material may be compressed by telescoping movement between the compression gland and the housing.

7. A Kelly packing assembly having a central passage therethrough conformed to the shape of a kelly and adapted for slidable arrangement on a kelly, comprising: a housing; an internal annular flange at the lower end of the housing; a compression gland having a portion telescopically slidably extending into the housing; external threads on the outer end of the compression gland; an external shoulder on the inner end of the gland; means extending inwardly of the upper end of the housing and engageable with the gland shoulder to limit the slidable outward movement of the gland with respect to the housing; and resilient sealing material slidably supported in the housing between the compression gland and the flange, whereby the resilient material may be compressed by telescopic movement between the compression gland and the housing.

8. A Kelly packing assembly having a central passage therethrough conformed to the shape of a kelly so as to be slidable on a kelly and be rotatable therewith, comprising: a housing; an annular flange arranged internally of the housing; a compression gland having a portion telescopically slidably extending into the housing; external threads arranged on the outer end of the gland arranged for engagement with companion threads in a drilling head spindle; an external shoulder on the inner end of the gland; means extending inwardly of the upper end of the housing and engageable with the gland shoulder to limit the slidable outward movement of the gland with respect to the housing; resilient sealing material slidably supported in the housing between the compression gland and the flange, whereby the resilient material may be compressed by telescopic movement between the compression gland and the housing; and a shoulder on the outer side of the housing adapted for engagement with a complementary internal shoulder of a drilling head spindle so as to limit the downward movement of the housing with respect to the spindle.

9. A Kelly packing assembly having a central passage therethrough conformed to the shape of a kelly so as to be slidable on the kelly and roatable therewith, comprising: a housing; an annular flange extending internally of the housing; a compression gland having a portion telescopically arranged within the housing; an external shoulder on the inner end of the gland; external threads on the outer end of the gland engageable with companion threads in a drilling head spindle; an annular internal groove in the upper end of the housing; a ring carried in said groove engageable with the external shoulder on the gland to limit the outward movement of the gland with respect to the housing; and resilient sealing material slidably supported in the housing between the flange and the compression gland, whereby the resilient sealing material may be compressed by telescopic movement between the compression gland and the housing.

10. Sealing means for preventing the escape of fluid pressure about a slidable well drilling conduit made up of sections of different contours and sizes, comprising: a rotatable spindle adapted for the slidable movement therethrough of such a conduit, a sealing element carried within the spindle and adapted to seal about a conduit of rectilinear contour, a sealing element carried within the spindle in spaced relation to the first named element and adapted to seal about a conduit of circular contour, the first named seal being threadedly attached to the spindle, and the second named seal having an inner skirt slidably engageable with the conduit and an outer skirt slidably engageable with the spindle, said skirts being adapted to expand into sealing engagement with the conduit and the spindle respectively in response to fluid pressure seeking escape from the conduit, the last named seal being vertically movable in the spindle in response to fluid pressure of said seal in the spindle said means including an upwardly facing shoulder and a downwardly facing shoulder in the spindle engageable with the last named seal, said shoulders being spaced apart sufficiently to permit vertical slidable movement of the seal between the shoulders.

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