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ROTARY DRILLING HEAD

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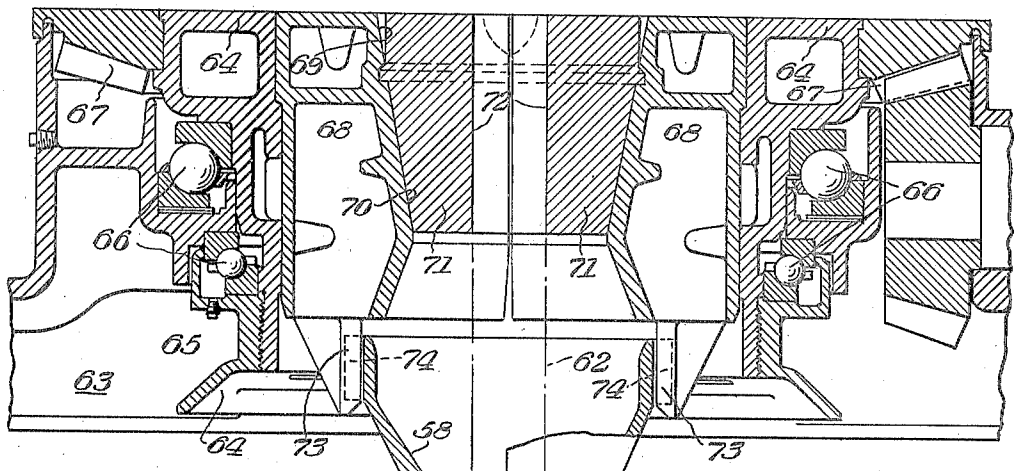


Fig. 1.

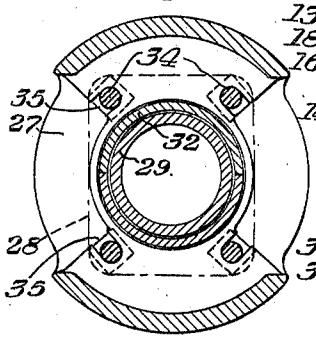


Fig. 2.

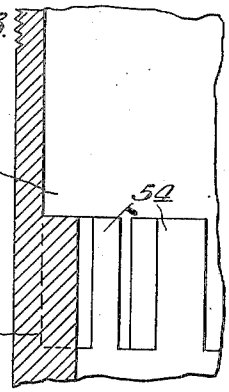


Fig. 3.

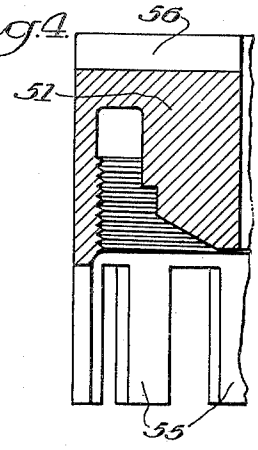


Fig. 4.

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ROTARY DRILLING HEAD

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4 Claims. (Cl. 255—1)

This invention relates generally to rotary well drilling apparatus and more particularly to a combined rotary drilling machine and rotary casing head for driving and sealing a drill string during drilling operations.

The present rotary drilling equipment is mounted on the derrick floor with the rotary table opening directly above the well hole. The rotating casing head is secured to the casing head structure mounted on the well casing in a cellar below the derrick floor. The casing head structure may comprise a subhead having vents with controlled lead-offs for conveying mud laden water or slush carrying the drillings from the well casing. These lines may be used for controlling fluid under pressure liberated from a pressure strata pierced by the drill. Valve heads may also be included in the casing head structure above and below the vented subhead for closing the well when the drill string is withdrawn. The drill string comprises a series of pipe sections having a drill bit secured to the lower end and generally a flat sided kelly at the upper end arranged to engage a mating split drill stem bushing in the rotary table for driving the same.

During operation the bit of the drill bores into the earth. The drill stem or kelly and the drill pipe move down into the well as the bit bores into the earth. If the bit becomes jammed or wedged it is necessary to lift it free and again lower it while rotating to continue the drilling operation. When the top of the stem of the drill string approaches the table of the rotary drilling apparatus it is necessary to draw the string out of the well sufficiently to clear the joint between the stem and the first section of drill pipe. This joint is broken and a new section of pipe is inserted therein. The string is again lowered in the well and boring is continued until it is necessary to add another section of pipe to the string. Again it is sometimes necessary to sharpen or replace the drilling bits. This necessitates withdrawing the whole drill string from the well.

In performing these rotary drilling operations with the present equipment it is usually necessary to have a man in the cellar under the derrick floor for manipulating valves and split oil savers on the casing head structure and for removing and inserting packing in the rotating casing heads to withdraw and insert the square stem therein and to permit the couplings, which are usually larger in diameter than the pipe, to pass therethrough.

The present rotating casing heads are provided with a split collar having a square hole arranged to receive the drill stem for driving the rotary sleeve in the head. This collar may or may not be a portion of the packing unit. However the packing must always be removed when the stem is withdrawn, which in many instances represents the time that it is most needed.

The principal object of this invention is the provision of a new and improved rotating casing head arranged to seal any portion of the drill string during all drilling operations.

Another object is the provision of a rotating casing head arranged to be directly driven by the rotary table drilling apparatus.

Another object is the provision of an improved rotating casing head for sealing a drill pipe and stem as it is being raised and lowered under well pressure.

Another object is the provision of a rotating casing head having a packing for sealing a drill string against the escape of well pressure and which need not be attended as the string is passed vertically therethrough.

Another object is the provision of an improved rotating casing head having a plurality of means for sealing a drill string when subjected to different well pressures.

Another object is the provision of a unitary drill string sealing element.

Other objects and advantages of this invention appear in the following description and claims.

In the accompanying drawing a practical embodiment illustrating the principles of this invention are shown wherein:

Fig. 1 is a side elevation partly in section illustrating the improved rotary drilling apparatus comprising this invention.

Fig. 2 is a sectional view taken on the lines 2—2 of Fig. 1.

Figs. 3 and 4 are fragmentary views of the splined connection between the rotating sleeve and the packing cartridge respectively.

The rotating casing head 10 is made up of an outer tubular shell 11 threadably connected to the adaptor ring 12 which in turn is arranged to be secured to the upper end of the casing head structure of a well in a cellar below the derrick floor. The shell is provided with an enlarged upper bore 13 having spaced annular bearing seats 14 and 15 for receiving the stationary races of the lower and upper anti-friction bearings 16 and 17 respectively. The movable or inner races of the lower and upper bearings are arranged to fit on the spaced annular bearing

seats 18 and 19 formed in the perimetral surface of the rotary sleeve 20 for rotatably supporting the latter. An annular collar 21 bolted to the upper end of the shell 11 is provided with a depending annular flange 22 which engages the outer race of the upper bearing and retains the sleeve and the bearing assembly against longitudinal movement in the shell. The collar 21 is also provided with an upwardly extending flange 23 arranged to receive the lubricant seal 24 mounted in the cap ring 25 removably secured to the upper end of the sleeve 20. A second lubricant seal 26 is provided between the shell 11 and the sleeve 20 below the lower bearing 16. Thus the two seals retain lubricant in the bearing chamber between the shell and the sleeve.

Below the bore 13 the wall of the shell 11 is provided with oppositely disposed openings or windows 27 for receiving the rectangularly shaped packing ring 28 shown in dotted lines in Fig. 2. This ring is provided with a circular bore for receiving the lower end 29 of the sleeve 20. Below the openings 27 the bore of the shell 11 is provided with an annular shoulder 30 which forms a chamber with the depending sleeve portion 29 for receiving the packing 31. 32 represents a split gland ring arranged to fit around the depending sleeve portion 29 and having a shoulder on the upper edge thereof for receiving the packing ring as indicated at 33. The square corners of the ring 28 are provided with vertically disposed holes for receiving the bolts 34, the heads of which fit into sockets 35 formed in the lower part of the openings 27 of the shell.

The ring 28, with the bolts held thereto by partially threading the nuts thereon, is inserted through one of the openings 27 of the shell and the sleeve 20 with the bearing assembly is mounted in the shell, with the depending portion 29 of the sleeve passing down through the bore of the ring 28. The packing 31 is then placed on the shoulder 30 and the split gland ring is placed around the sleeve and dropped into the packing chamber onto the packing 31. The upper end of the split gland ring is fitted into the bore of the ring 28 and the heads of the bolts are placed in their respective sockets 35. Thus by tightening each of the four nuts the packing is compressed, forming a seal between the sleeve and the rotary shell. This novel packing arrangement is easily accessible at any time for tightening or replacement without disturbing the rest of the rotating head and any leak that may happen to occur is discharged to the atmosphere without injury to or interference with the bearings supporting the sleeve. This is an important advantage of this invention.

The depending portion 29 of the sleeve 20 is smaller in diameter than the rest of the sleeve and is closer to the drill pipe. However it is protected by the inwardly extending abutment 36 adjacent the lower end of the shell 11. If the drill string slaps back and forth in the head it strikes the abutment 36 which prevents it from hitting the sleeve.

The bore of the sleeve 20 is cylindrical to a point near the lower bearing 16 where it is provided with a downwardly and inwardly tapered sealing surface 37 arranged to receive the complementary surface 38 on the lower end of the drill string packing cartridge 40. Two annular packing elements 41 are placed in the mating conical surface 38 of the cartridge to insure against leakage between these mating conical surfaces.

The cartridge snugly fits the bore of the sleeve 20 and it may be dropped in place from the derrick floor. The bore of the cartridge is also cylindrical and the lower end thereof is provided with a shoulder having an upwardly extending flange forming an annular groove 42 for receiving a depending flange on the head of the packing 43. This packing is held in place by the abutment ring 44 which fits the bore of the cartridge and has a shoulder 45 adjacent its lower perimetral surface for receiving the upwardly extending flange on the head of the packing 43. The lower end of ring 44 projects inwardly and downwardly over the full head of the packing 43 as indicated at 46 for backing up the same against pressure of the fluid in the well which would otherwise tend to tear the packing head from its seat.

The upper edge of the ring 44 is provided with a shoulder and an upstanding flange forming the annular groove 47 similar to that of the groove 42 for receiving the packing 48. The packing 48 is held in place by the abutment ring 49 which in turn supports the third packing 50 in the same manner as that just described. A cap abutment ring 51, which is preferably threadedly engaged to the upper perimetral surface of the cartridge 40, is shaped similarly to the other rings for holding the packing 50 in place.

Each of the packing elements 43, 48 and 50 may be assembled in the cartridge before dropping it into position in the bore of the sleeve 20. This novel improvement has many advantages in the casing head art and forms an important object of this invention.

The packing elements 43, 48 and 50 are preferably made of resilient material, such as rubber, and are of the flexible skirt type which, per se, form the subject matter of another invention. The packing elements 43 and 48 are the same but differ from the packing element 50 in that the latter is lighter and has an inwardly projecting sealing portion 52 for engaging the drill string to prevent the escape of fluid under low pressure from the well. The packings 43 and 48 being heavier are particularly designed for preventing the escape of fluid under high pressure from the well. The annular throats of these skirt packings are capable of passing and sealing any portion of the drill string, such as the square sided drill stem, the drill pipe or couplings which are usually larger in diameter than the drill pipe and thus provide a low and high pressure seal therewith.

The upper bore of the sleeve 20 is enlarged as indicated at 53 for receiving the perimetral portion of the ring 51. This bore is provided with a plurality of spline projections 54 for receiving therebetween the complementary spline projections 55 formed on the lower perimeter of the abutment ring 51, thus interlocking the sleeve 20 and the cartridge 40.

The upper surface of the ring 51 is provided with a pair of oppositely disposed upwardly open slots or pockets 56 arranged to receive the depending lugs 57 on the bottom of the bell-shaped driving connection 58. The driving connection is provided with a horizontally disposed annular flange 59 on the outer surface thereof which has a plurality of holes arranged to receive the upstanding studs 60 secured in the cap ring 25. When the nuts 61 are screwed on the studs 60 the driving connection secures the packing cartridge in the sleeve 20 and the rotating head is completely assembled and arranged to receive

the drill string which is indicated by the dotted lines 62.

The rotary drilling mechanism 63 is provided with the rotary table 64 supported on the base 65 by means of the anti-frictional bearings 66. A ring gear 67 is secured to the table 64 and is arranged to be connected to a source of rotary power. The table 64 is provided with a non-circular opening arranged to receive the table bushing 68. This bushing is provided with a throat, the upper portion of which is substantially square and the lower portion is tapered, forming an inverted conical surface as indicated at 69 and 70 respectively for receiving the split drill stem driving bushing 71 or slips. The split driving bushing has a flat sided hole 72 in the center thereof corresponding in shape to that of the sides of the drill stem to be used and is arranged to snugly fit the same when assembled in the table bushing. When the drill string is raised through the head it may be held by engaging the drill pipe with slips seated on the inverted conical surface 70 in the table bushing.

The lower end of the table bushing 68 is provided with a pair of downwardly projecting lugs 73 which extend between the spaced ears 74 on the outer perimetral surface of the bell of the driving connection 58. Thus rotation of the table 64 and table bushing 68 carried thereby is transmitted through the driving connection 58 directly to the rotary sleeve 20, as the pockets 56 may be extended into the sleeve 20 with the lugs 57 bridging both members, and the split bushing 71 within the table bushing fits the drill stem and drives the drill string independently.

It should be particularly noted that there is no metal connection or tight compressible packing between the drill string and the rotating casing head but merely a plurality of flexible skirt packing elements which absorb the shock and vibration of the drill string and prevent it from being transmitted to the casing head. This feature provides another important object of this invention.

The bell shaped driving connection 50 guides the drill string into the casing head and the skirt packings or strippers maintain a seal thereon regardless which part of the drill string is in or moving through the head. Again it is not necessary to have a workman in the cellar below the derrick floor to guide the drill string or to remove and replace the packing in the head and manipulate the split valves when a coupling of enlarged diameter is passed therethrough. The elimination of these difficulties which are attendant to the present rotating casing head structure provides a substantial advantage in the rotary drilling art.

We claim:

1. In a casing head structure for rotary drilling apparatus, the combination of a tubular shell arranged to be mounted on the well casing, a sleeve mounted within the shell and arranged to receive the drill string, antifriction bearings rotatably supporting the sleeve in the shell, the shell and the sleeve being extended below said bearings, a packing interposed between the lower portion of the shell and sleeve, a gland for compressing said packing, and means defining an opening in the wall of the shell adjacent the gland to provide access thereto to adjust the packing while the sleeve is mounted in the shell.

2. In a rotating casing head structure for receiving a rotary drill string the combination of a tubular shell member arranged to be secured to a well casing, a sleeve rotatably supported in said shell member, a packing between the shell member and the sleeve, a unitary packing structure removably mounted within the sleeve for sealing the drill string and comprising a plurality of packing elements arranged in tandem spaced relation, and means for retaining the unitary packing structure within the sleeve.

3. In a rotating casing head structure for receiving a rotary drill string the combination with a rotary driving mechanism, of a tubular shell member arranged to be secured to a well casing, a sleeve rotatably supported in said shell member, a packing between the shell member and the sleeve, a unitary packing structure adapted to be removably mounted in the bore of said sleeve and having interlocking engagement therewith, said packing structure having a plurality of packing elements mounted in spaced relation for sealing the drill string during drilling operations, a direct driving connection between the driving mechanism and the drill string, and a direct driving connection between the driving mechanism and said packing structure.

4. In a rotary well drilling apparatus, the combination of a casing head arranged to be secured to a well casing, a sleeve rotatably supported in said casing head, a rotary driving mechanism mounted above said casing head, a tubular member having upwardly diverging walls interposed between said driving mechanism and said sleeve and operatively connecting the same for rotation together, a rotary drill string extending into the well through said sleeve, a direct driving connection between the drill string and said driving mechanism, and a packing in said sleeve for sealing the drill string.

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