Aug. 8, 1961 W. C. GIBSON ET AL 2,995,196

DRILLING HEAD

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Fig. 1.

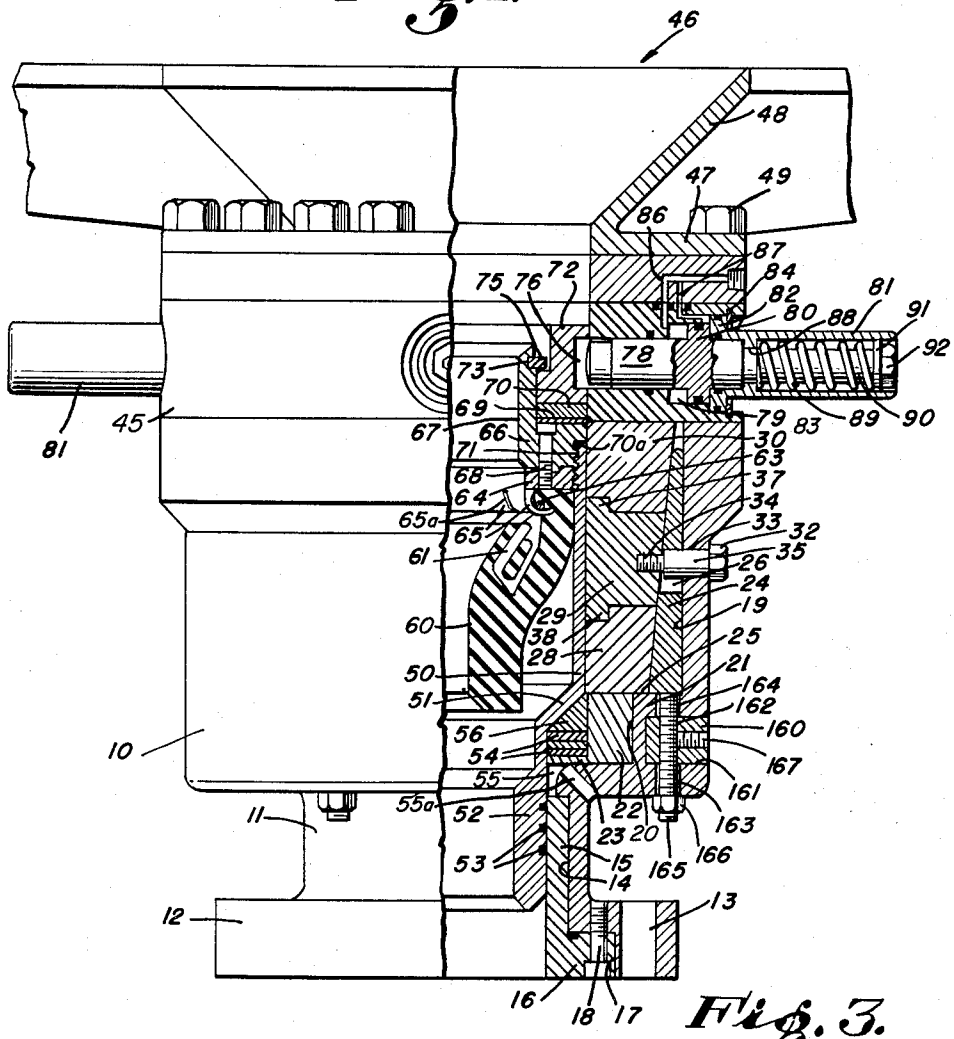


Fig. 3.

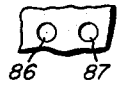
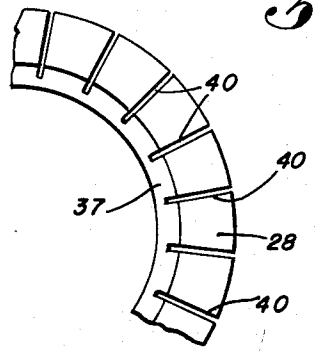


Fig. 2.



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DRILLING HEAD

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This invention relates generally to drilling equipment, and relates more particularly to rotary drilling equipment for drilling wells in underwater formations.

While the present invention has particular utility in the underwater drilling of wells for the recovery of oil and gas, and is shown and described in such connection, it is to be understood, of course, that its utility is not confined thereto.

There are many problems involved in underwater drilling operations. For example, contamination of the drilling mud must be prevented as well as the escape into the water of undesirable fluids from the well.

It is, therefore, an object of the present invention to provide a submarine drilling head that will prevent such contamination of the drilling mud and the release into the water of undesirable well fluids.

Another object of the invention is to provide a drilling head of this character that will provide an effective seal about the drilling string.

Still another object of the invention is to provide a drilling head of this character so constructed and arranged as to reduce to a minimum wear on the seal for the drill string.

A further object of the invention is to provide a device of this character having effective bushing means for the rotatable sleeve of said device.

A still further object of the invention is to provide a device of this character having novel means for adjusting the bushings.

Another object of the invention is to provide a device of this character having means for guiding the lower end of the drill string, which carries the drill, into the head.

Still another object of the invention is to provide a device of this character that is relatively simple in construction and that is reliable in operation.

A still further object of the invention is to provide a device of this character that may be readily serviced at relatively low cost.

The characteristics and advantages of the invention are further sufficiently referred to in connection with the following detailed description of the accompanying drawings with respect to one arrangement. After considering this example, skilled persons will understand that variations may be made without departing from the principles disclosed, and any structures, arrangements or modes of operation that are properly within the scope of the appended claims are contemplated.

Referring to the drawings:

FIG. 1 is a side elevation of a submarine drilling head embodying the present invention with portions broken away to show the interior construction thereof;

FIG. 2 is a fragmentary top view of one of the bushing or bearing elements; and

FIG. 3 is a fragmentary side view showing the tapped openings for fluid pressure connections to the passages for actuating the locking pins.

Referring more particularly to the drawings, the submarine drilling head comprises a hollow body **10** from which depends a reduced diameter portion **11** terminating at its lower free end in an attaching flange **12** having the usual bolt receiving holes **13** whereby said head may be attached to other apparatus below same.

The portion **11** has an internal bore **14** in which is received a sleeve **15** having a radially extending annular flange **16** at its outer or lower end, said flange **16** being received in an enlarged annular counterbore **17** at the outer end of said bore **16**. Screws **18**, received in openings provided therefor in the flange **16** and aligned tapped bores in said flange **12**, secure the sleeve **15** within said reduced diameter portion **14**.

The interior of the body **10** comprises a cylindrical chamber **19** extending longitudinally of said body and at the bottom of said chamber there is a reduced diameter portion **20** defined by an enlargement or thickened wall portion **21**. Within the chamber **20** there is disposed an annular thrust bearing race **22** having an annular flange **23** extending radially inwardly at the lower end of said member.

Within the chamber **19** there is disposed an annular bushing adjusting collar **24** which is wedge shaped in longitudinal section, the base or thickest end portion being disposed at the bottom and adapted to seat on the upper surface **25** of the wall portion **21**, said surface **25** being normal to the axis of the body. It is to be noted that the collar **24** does not extend to the top of the body **10** and there are elongated slots **26** annularly spaced apart in said collar intermediate the ends thereof.

The interior of the collar **24** flares outwardly from the lower end to the upper end and within said collar are a plurality of bearing or bushing elements **28**, **29** and **30**, said elements being annular and formed of fibre or other suitable material. Element **28** is at the bottom with the element **29** at the upper end thereof and the element **30** at the upper end of said element **29**, the upper surface of the element **30** being in substantially the same plane as the upper end of the housing **10**. The outer peripheral surfaces of the bushing elements **28**, **29** and **30** have substantially the same taper as the taper of the inside of the collar **24** and the peripheral surfaces of said elements seat on the internal surface of said collar. Bushing retaining screws **32** are provided and are received in openings **33** provided therefor in the cylindrical wall of the body **10**, said openings **33** being aligned with the respective slots **26** and tapped openings adapted to receive externally threaded reduced diameter end portions **34** of said screws **32**, the body portions **35** of said screws **32** being normally disposed in the upper end portions of the slots **26**.

The intermediate bearing or bushing element **29** is in the shape of a T in cross section with the T on its side and with the crossed portion at the interior of said bushing so as to provide upwardly and downwardly extending annular flanges **37** and **38**. The lower bushing element **28** has a notch in the upper interior corner portion thereof for reception of the flange **38**, and the upper bushing **30** is provided with a notch in the lower interior edge for reception of the flange **37**.

The bushings **28**, **29** and **30** are provided with radial slots **40** annularly spaced apart thereabout and extending from the top to the bottom thereof. The purpose of this arrangement will be described hereinafter.

On top of the body **10** there is disposed a cage **45** and above said cage there is a bit guide, indicated generally at **46**, having an annular flange **47** from which extends an upwardly and outwardly flaring part **48**. Suitable aligned bolt holes are provided in the flange **47**, cage **45** and the upper end of the body **10** for reception of bolts **49** whereby the body **10**, cage **45**, and guide **46** are secured together.

Within the bearings **28**, **29** and **30**, there is disposed a rotatable sleeve **50** having an inwardly and downwardly inclined portion **51** at the lower end thereof, and at the lower end of the inclined portion **51**, there is a depending part **52**, the lower end portion of which is operably received within the wear sleeve **15**, there being a plurality of O-rings **53** disposed in grooves pro-

vided therefor in the portion 52 to provide a seal between said portion 52 and sleeve 15. On the flange 23 of the thrust bearing race 22 are stacked a plurality of annular thrust bearings 54 and on the upper end of said thrust bearings is disposed a thrust bearing spacer 56 which is annular and is triangular in cross sectional shape and has an inclined face engageable with the lower inclined side of the part 51 of the rotatable sleeve 50. Below the thrust bearings 54 is an annular chamber 55 from which a drain hole 55*a* extends to the exterior of the body 10.

Within the sleeve 50 there is an annular stripper rubber 60 having a plurality of plates 61 disposed adjacent the upper end thereof and spaced apart about said rubber. The upper ends of said plates are provided with openings for reception of a wire retainer 63 extending annularly within the stripper rubber 60 adjacent the upper end thereof. There is a mounting ring 64 having a plurality of depending fingers 65 which curve outwardly and slightly upwardly and support the wire 63. The fingers 65 are spaced apart and the mounting plates 61 are operably received in the respective spaces 65*a* between said fingers 65.

The mounting ring 64 is secured to an outwardly extending flange portion 66 at the bottom of a rotatable sleeve 67 by means of screws 68. The mounting ring 64 and the flange 66 are externally threaded for screwing into the internally threaded upper end portion of sleeve 50, there being a shoulder 70*a* on said flange to limit inward screwing of said ring and flange into said sleeve 50.

Disposed on the upper surface of the flange 66 is an annular, upper thrust bearing protector plate 69 on which is disposed an annular upper thrust bearing 70 secured in position by a locking ring 72 which in turn is secured against upward displacement by a snap ring 73 received in a groove provided therefor in the sleeve 67 and extending outwardly of said sleeve so as to engage a shoulder 75 at the inner side of the locking ring 72. The locking ring 72 has an external annular groove 76 thereabout for reception of the inner ends of locking pins 78 slidable in radial bores provided therefor in the cage 45. At the outer ends of each of said bores there is an axially aligned cylinder 79 of greater diameter than said bore, in which is slidably received a piston 80 formed integrally on the pin 78. A cap 81 is provided for each of the locking pins 78 and each cap is axially aligned with a respective locking pin and is provided with an outwardly or radially extending flange 82 at the inner end thereof which seats against a shoulder 83 at the outer end of the cylinder 79 and is secured in position by a snap ring 84 provided for this purpose and received in an annular groove provided therefor. There are a pair of passages, 86 and 87, adapted to be connected to pressure fluid lines. The passage 86 communicates with one end of the cylinder 79 so that pressure therefrom will urge the piston 80 and the pin 78 outwardly. The pressure line 87 is connected to the opposite end of the cylinder 79 and pressure therefrom urges the piston 80 and pin 78 inwardly into locking position. The cap 81 is provided with an internal flange 88 which limits outward movement of the pin 78 and also serves as a seat against which the inner end of a spring 89 abuts, said spring being disposed on a reduced diameter portion 90 of the pin 78. At the outer end of said reduced diameter portion 90 there is a washer 91 disposed on a further reduced diameter portion, not shown, of the pin 78, said further reduced diameter portion being externally threaded for reception of a nut 92 which holds the washer 91 on the pin. The spring 89 urges the pin 78 to the released position, said pin being held in the locking position by the fluid pressure transmitted to the right hand side or outer side of the piston 79.

Means for adjusting the bearings or bushings of the device comprises a bearing adjusting nut 160 received in a recess 161 in the part 21 of the body 10, said nut being held against rotation in said recess. The nut 160 is provided with a tapped bore 162 aligned with bores 163 and 164 in the part 21 below and above the recess 161. An adjusting screw 165 is threaded into the tapped bore 162 and extends through the bores 163 and 164 so that the upper end of said screw engages the lower end of the bearing compression ring 24. Screwing the bolt 165 upwardly will cause said bearing compression ring to be forced upwardly to thereby compress the bearings 28, 29 and 30 against the sleeve 50, which action is aided by the slots 40 in said bearings. Bolt 165 is provided with a lock nut 166. The adjusting nut 160 may also have a horizontal, tapped bore extending inwardly from the outer surface for reception of a set screw 167, the inner end of which is screwed against the side of the bolt 165.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description and it is thought that it will be apparent that various changes may be made in the form, construction and arrangement of the parts of the invention without departing from the spirit and scope thereof or sacrificing all of its material advantages, the arrangement hereinbefore described being merely for illustrative purposes.

We claim:

1. A rotary drilling head for underwater drilling operations: a cylindrical body having a thickened wall portion adjacent the lower end thereof to define a shoulder at the top and a coaxial cylindrical portion of reduced diameter, and a reduced diameter portion depending from the lower portion of the body and terminating at the lower end in a radial flange for attachment to an adjacent piece of equipment; a fixed sleeve secured in said depending reduced diameter portion of said body; a locking pin cage at the upper end of said body; a funnel shaped upwardly opening drill guide above said cage; means for securing together said drill guide, cage and body in an assembly; a rotatable sleeve disposed within said assembly, said sleeve including an upper portion of less external diameter than the internal diameter of the body, a reduced diameter portion rotatably received within the fixed sleeve, and a downwardly and inwardly inclined annular connecting portion; a bearing compression ring disposed within the body and tapering upwardly and outwardly in cross section with the base thereof resting on the shoulder of the enlarged wall portion of the body; means holding said compression ring against rotation relative to said body but permitting longitudinal movement; a plurality of annular fibre bearing elements disposed within the space between the compression ring and the rotatable sleeve, said bearing rings having complementary tapered outer surfaces engaging the inner tapered surface of said compression ring, said bearing rings having slots extending radially from the outer periphery part way through the respective rings; means for moving said compression ring upwardly; a lower thrust bearing means operably engaging said rotatable sleeve; an annular stripper rubber operably disposed within said sleeve; an upper thrust bearing operably associated with said rotatable sleeve; and means including a plurality of hydraulically actuated locking means, for releasably securing the rotatable sleeve and stripper rubber within said assembly.

2. In a rotary drilling head for underwater drilling operations, including: a cylindrical body having a thickened wall portion adjacent the lower end thereof to define a shoulder at the top and a coaxial cylindrical portion of reduced diameter, and a reduced diameter portion depending from the lower portion of the body and terminating at the lower end in a radial flange for attachment to an adjacent piece of equipment; a fixed sleeve secured in said depending, reduced diameter portion of said body; a locking pin cage at the upper end of said body; a funnel shaped upwardly opening drill guide above said cage; means for securing together said drill guide,

cage and body in an assembly; a rotatable sleeve disposed within said assembly, said sleeve including an upper portion of less external diameter than the internal diameter of the body, a reduced diameter portion rotatably received within the fixed sleeve, and a downwardly and inwardly inclined annular connecting portion; a bearing compression ring disposed within the body and tapering upwardly and outwardly in cross section with the base thereof resting on the shoulder of the enlarged wall portion of the body; means holding said compression ring against rotation relative to said body but permitting longitudinal movement; a plurality of annular fibre bearing elements disposed within the space between the compression ring and the rotatable sleeve, said bearing rings having complementary tapered outer surfaces engaging the inner tapered surface of said compression ring, said bearing rings having slots extending radially from the outer periphery part way through the respective rings; means for moving said compression ring upwardly; a lower thrust bearing means operably engaging said rotatable sleeve; and an annular stripper rubber operably disposed within said sleeve.

3. A rotary drilling head for underwater drilling operations, including: a housing assembly including a cylindrical body having a reduced diameter portion depending from the lower portion of the body and terminating at the lower end in a radial flange for attachment to an adjacent piece of equipment; a funnel shaped upwardly opening drill guide secured to the upper end of said assembly; a rotatable sleeve operably disposed within said assembly; an annular bearing compression ring disposed within the body and having the inside tapering upwardly and outwardly with the base thereof at the bottom; means supporting said compression ring from the bottom thereof; means holding said ring against rotation but permiting longitudinal movement thereof; a plurality of annular fibre bearing elements disposed between the compression ring and the rotatable sleeve, said bearing rings having complementary tapered outer surfaces with respect to said compression ring and abutting same, said bearing rings having slots extending radially from the outer periphery part way through the respective rings; an annular lower thrust bearing means for said rotatable sleeve; an annular stripper rubber operably disposed within said sleeve; an upper thrust bearing means for said rotatable sleeve; means, including hydraulic means, for releasably securing said rotatable sleeve in said assembly; and means for moving said compression ring upwardly to compress the bearing elements against the adjacent exterior surface of said rotatable sleeve.

4. A rotary drilling head for underwater drilling operations, including: a housing assembly including a tubular body open at the upper end and having means at the lower end for attachment to an adjacent piece of equipment; a rotatable sleeve operably disposed within said assembly; a bearing compression ring disposed within the body and having its inside wall tapering upwardly and outwardly; means for supporting the base of said ring; three axially aligned, annular fibre bearing elements disposed between the compression ring and the rotatable sleeve, said bearing elements having complementary tapered outer surfaces with respect to said compression ring and abutting same, said bearing elements having slots extending radially from the outer periphery part way through the respective elements, the intermediate element being in the shape of a T in cross section with the T on its side and with the crossed portion at the interior of said element, the adjacent elements having annular recesses snugly receiving the free end portions of the crossed portion of the key; an annular stripper rubber operably disposed within said sleeve; means for releasably securing said sleeve in said assembly; and means for moving said compression ring upwardly to compress the bearing elements against the adjacent exterior surface of said rotatable sleeve.

5. A rotary drilling head for underwater drilling operations, including: a housing assembly including a cylindrical body open at the top and having means at the lower end, for attachment to an adjacent piece of equipment; a rotatable sleeve operably disposed within said assembly; a bearing compression ring disposed within the body generally triangular in cross section with the base thereof at one end of said ring; three axially aligned, annular fibre bearing elements disposed within the space between the compression ring and the rotatable sleeve with a complementary tapered outer surface engaging the adjacent surface of said compression ring, each of said bearing elements having slots extending inwardly from the outer periphery, part way therethrough, the intermediate bearing element having oppositely arranged axially extending annular flanges, the adjacent elements having annular recesses in which respective flanges are received; an annular stripper rubber operably disposed within said sleeve; and means for moving said compression ring longitudinally to compress said bearing element against the adjacent exterior surface of said rotatable sleeve.

6. A rotary drilling head for underwater drilling operations, including: a housing assembly including a cylindrical body open at the top and having means at the lower end for attachment to an adjacent piece of equipment; a rotatable sleeve operably disposed within said assembly; a bearing compression ring disposed within the body generally triangular in cross section with the base thereof at one end of said ring; a plurality of axially aligned, interlocked annular fibre bearing elements disposed within the space between the compression ring and the rotatable sleeve with complementary tapered outer surfaces engaging the adjacent surface of said compression ring, each of said bearing elements having slots extending inwardly from the outer periphery, part way therethrough; and means for moving said compression ring longitudinally to compress said bearing elements against the adjacent exterior surface of said rotatable sleeve.

7. In a rotary drilling head for underwater drilling operations: housing means; a rotatable sleeve operably disposed within said housing means; annular compressible bearing elements disposed about said rotatable sleeve, said bearing means having slots extending outwardly from a point spaced outwardly of the inner surface thereof and also extending the full length of said elements; and means for exerting external pressure on said bearing means to compress same.

8. In a bearing: an assembly of axially aligned annular bearing elements of compressible fiber material, one of said elements being in the shape of a T in cross section with the T on its side and with the crossed portion at the interior of said element so as to provide upwardly and downwardly extending annular flanges, and other bearing elements being on opposite sides of said one bearing element abutting said one element, and conforming to the abutted sides of said one bearing element, the outer peripheral surfaces of said axially aligned elements tapering from one end of the assembly of elements to the other end, there being slots extending radially from the outer periphery of said elements part way through same.

9. The invention defined by claim 8 including an annular collar which is wedge shaped in longitudinal section and in which are disposed said bearing elements with the outer surfaces thereof in engagement with the inner surface of said collar.

10. In bearing means for rotary drilling heads: a plurality of compressible bearing elements adapted to be disposed on a rotatable drilling head sleeve to serve as a bearing means therefor, said bearing elements having means for interconnecting same; and means for exerting simultaneously and circumferentially external pressure

about said bearing elements transversely of the longitudinally axis of said sleeve to compress said elements against said sleeve.

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