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TURBODRILL THRUST BALANCING APPARATUS

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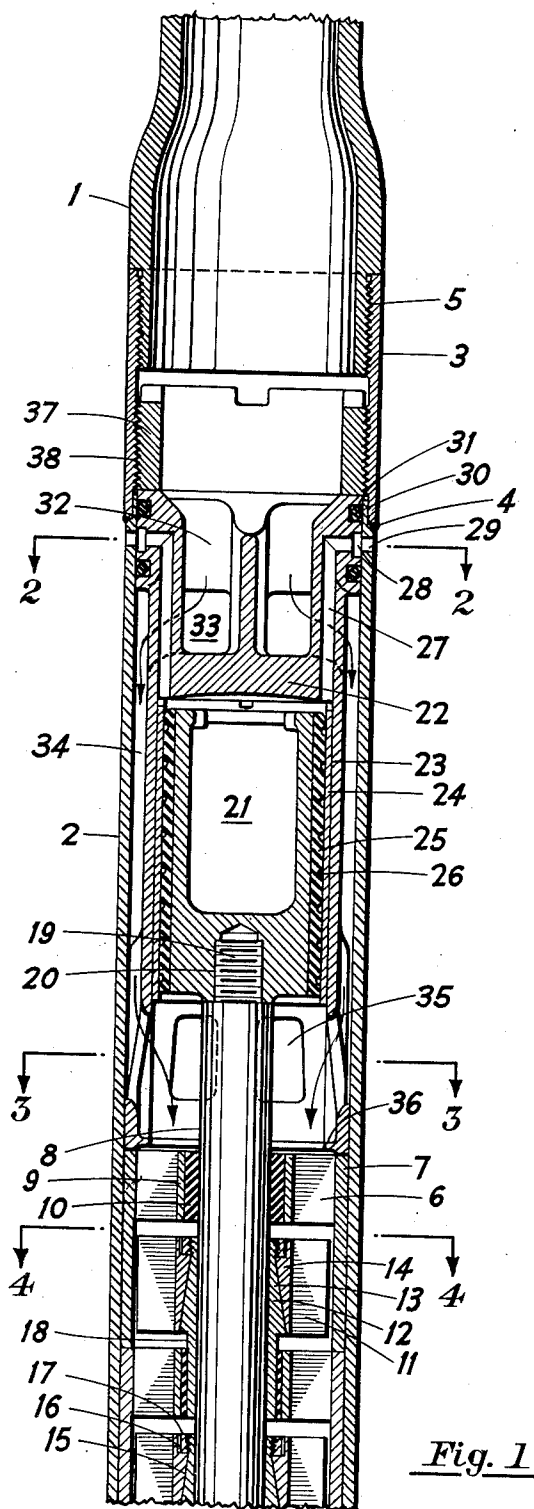


Fig. 1

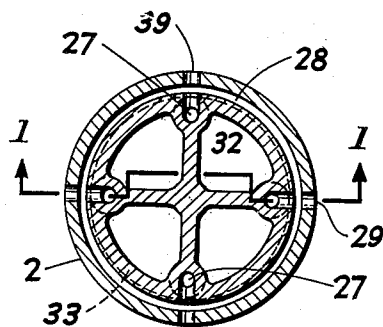


Fig. 2

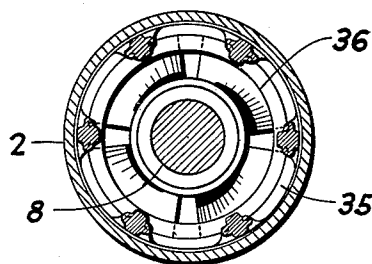


Fig. 3

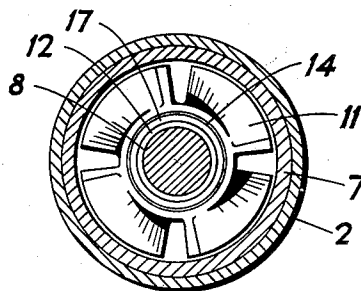


Fig. 4

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TURBODRILL THRUST BALANCING
APPARATUS

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1 Claim. (Cl. 253—3)

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The present invention relates to well drilling units of the fluid driven turbine type and more particularly to axial thrust balancing means for such turbines.

In the drilling of oil wells by means of fluid driven turbines located adjacent the drilling bit in the bore hole, the chief factor limiting the successful operation of the turbine over an extended period of time has been the thrust bearings provided for such turbines. The reason for this difficulty has been that in using drilling fluid for driving the turbine, it is customary for the drilling fluid to act as a conveying medium for carrying the cuttings from the drill bit to the surface and then recirculating the return fluid. In this process the drilling fluid very soon becomes contaminated with sand or other abrasive material in the cuttings, and even with elaborate means for cleaning the drilling fluid a great deal of this material is recirculated with the drilling fluid. In passing through the turbine this material acts as an abrading substance on the elements of the turbine. This abrading action is especially severe upon the bearings of the turbine which are usually lubricated by the drilling fluid. In order to compensate for the abrading action of the drilling fluid, it has heretofore been proposed to use extremely hard ball bearings to absorb the normal thrust produced on the turbine shaft by the reaction of the drilling fluid pressure on the vanes or buckets mounted on the turbine shaft. While it has been proposed to isolate the bearings of the turbine as in regular turbines, well drilling turbines are subject to space limitations not encountered in any other type of turbine and due to the inaccessibility of the unit during operation, the turbine must be maintained as simple in construction as possible.

It is an object of the present invention to provide thrust balancing means which will adequately balance the axial thrust on the turbine shaft produced by the drilling fluid pressure acting against the rotatory vanes of the turbine shaft.

It is a further object of this invention to provide a longer wearing axial thrust balancing means for a turbodrill unit.

A still further object of this invention is to provide a turbodrill thrust balancing means of simple and rugged construction and inexpensive in both initial outlay and upkeep cost during the life of the turbine unit.

Further objects and advantages of the present invention will become apparent from the following description taken in conjunction with the accompanying drawing.

In the drawing:

Fig. 1 is a cross-sectional view of a turbodrill unit connected to a drill casing having axial thrust balancing means according to the present invention.

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Fig. 2 is a cross-sectional view in the direction of arrows 2—2 in Fig. 1.

Fig. 3 is a cross-sectional view in the direction of arrows 3—3 in Fig. 1.

Fig. 4 is a cross-sectional view taken in the direction of arrows 4—4 in Fig. 1, showing the turbine buckets or vanes of the turbine rotor.

As shown in the drawing a drill casing 1 is connected to a turbine housing 2 by means of a coupling 3 which is welded to the turbine housing 2 by means of a weld 4. Coupling 3 is connected to casing 1 by means of a threaded section 5 so that the turbine housing 2 may be easily disconnected from drill casing 1, but rigidly connected during the operation of the turbine in the well. In order to control the spacing of the stationary vanes 6 in the turbine, vanes 6 are mounted upon sleeve members 7 which have an outside diameter adapted to closely engage the inside diameter of the turbine housing 2, and as shown, any number of turbine stages may be provided by merely assembling a plurality of sleeves 7 which carry the vanes 6 within housing 2. The vanes 6 in turn provide support for radial bearings of the turbine shaft 8 by an annular ring 9 which supports a rubber sleeve 10. Turbine shaft 8 is provided with a plurality of rotating vanes, or buckets, 11, which are rotatably mounted on shaft 8 by means of a hub section 12 which has a conically tapered section 13 adapted to mate with a conical bore 15 in hub 14 of the vanes 11. Hub 14 is provided with an annular groove 16 adjacent the upper end of the vanes 11 which is adapted to receive a retaining ring 17. Ring 17 has a threaded section adapted to engage a corresponding threaded section on the upper end of hub 12. In order to protect the shaft 8 from undue wear, hub 12 is provided with an axially extending section 18 adapted to provide the journal surface with rubber sleeve 10.

It will be understood by those skilled in the art that in the operation of a turbodrill unit, drilling fluid is introduced to the turbine through casing 1 and then passes through the turbine housing 2 to the first stage of the stationary vanes 6. Vanes 6 direct the flow of fluid to the vanes or buckets 11 which are rigidly mounted for rotation upon the turbine shaft 8. After fluid passes vanes 11, wherein a portion of the fluid pressure on the fluid is converted to rotational energy, the fluid passes to succeeding stages of stationary vanes 6 and rotating vanes 11. The number of succeeding stages is entirely dependent upon the designed power rating of the turbine unit and does not form any part of the present invention. It will be appreciated that the action of the fluid pressure upon vanes 11 will tend to exert a downward axial thrust upon shaft 8 so that the shaft is unbalanced in a downward direction. In the usual arrangement a thrust bearing is provided between shaft 8 and hous-

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ing 2 to counterbalance this axial thrust. However, by the present invention means are provided for counterbalancing the axial thrust without the inherent limitations presented by the usual ball thrust bearings when the drilling fluid contains abrasive material. To provide the desired counterbalancing axial thrust upon the shaft 8 a threaded section 19 is provided on the end of shaft 8 which is adapted to engage a threaded bore 20 in a piston means 21. When piston means 21 is thus assembled, it is adapted to rotate with shaft 8. Piston 21 in turn is adapted to engage a cylinder means 22 which extends axially above the first stage of the turbine. Cylinder means 22 is provided with a bore 23 concentric with casing 2, and preferably, but not necessarily, a cylinder lining member 24 of a wear-resisting material may be inserted in the bore 23. Piston means 21 may be provided with a rubber sleeve 25 so that the wear between the cylinder and piston will be between rubber sleeve 25 and the cylinder lining 24. In order to lubricate sleeve 25 and lining 24, rubber sleeve 25 may be provided with either a single or double helical groove 26 cut in the surface thereof and extending along the length of sleeve 25.

In order to maintain substantially the same pressure differential across piston 21 as the pressure differential across the turbine, the top of bore 23 is provided with vent conduit means to the outside of the turbine housing by four bore holes 27 which communicate with an annular ring 28 cut in the external diameter of cylinder means 22 which in turn communicates with four holes 29 in the turbine housing 2. In order to seal the vent conduit means from the high pressure fluid a pair of annular seals 30, which may be O-rings, are provided in grooves 31 cut on either side of the annular groove 28. Conduiting of the high pressure fluid from casing 1 to the turbine vanes is provided by passages 32 in cylinder means 22, as shown in Fig. 2, which in turn communicate through passageways 33 to the annular space 34 between casing 2 and cylinder means 22. Flow of fluid is axial along the length of the piston and cylinder in annular space 34 and then is admitted to the turbine vanes through six openings 35 above ring 36 which serves as the lower support of the cylinder means 22. Ring 36 engages the inner diameter of the turbine housing 2 so that cylinder means 22 is concentrically located within housing 2. A ring member 37 having a threaded portion 38 adapted to engage a threaded portion of coupling 3 and supporting ring 7 on the first stationary vanes serve to locate cylinder means 22 axially. It will be understood that suitable means will be provided at the lower end of the turbine housing to hold the successive rings 7 and cylinder means 22 in abutting relationship. It will also be understood that a thrust bearing will be provided at the lower end of the turbine between shaft 8 and housing 2.

In operation the drilling fluid is introduced through casing 2 to fluid passages 32 in the cylinder means, and then through openings 33 to the annular space 34 defined by casing 2 and cylinder means 22 and through the openings 35 in supporting ring 36 to the first stage of the turbine. However, since the lower end of piston means 21 is likewise open to the high pressure fluid, the fluid pressure will not only act downward upon the rotating vanes 11 but will also exert an upward axial thrust upon the face of piston means 21. As mentioned hereinbefore, the

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cylinder head pressure is maintained at substantially the pressure at the lower end of the turbine by means of vent holes 27 and the annular passage 28 which is in communication with holes 29 through the turbine housing 2.

While the present invention does not necessarily eliminate the thrust bearing in this type of turbine unit, it will be apparent that since the major thrust upon the shaft is balanced by the rotating piston means, the thrust bearing may be constructed of cheaper materials and greater manufacturing and operating tolerances are permissible in the turbine. Accordingly, substantial savings may be effected in the initial cost and due to the greater durability of the thrust bearing under reduced loading the maintenance cost of the turbine is greatly reduced.

It will be apparent to those skilled in the art that various changes and modifications may be made for conduiting the operating fluid from above the cylinder means to the first stage of the turbine. In particular it would be possible to introduce the fluid through the shaft of the turbine and locate the cylinder and piston adjacent the periphery of the turbine housing. In this arrangement it would be possible to obtain a greater surface for the fluid to act against since the effective area of the piston face could be increased due to the greater diameter of the piston that could be acted upon. However, this is entirely a matter of choice and will be determined by the number of stages through which the fluid must pass in the turbine and the total pressure differential across the turbine to be balanced by the piston.

Further changes and modification in the present invention may be made without departing from the spirit thereof, and I therefore intend to limit the invention only within the scope of the appended claim.

I claim:

A thrust balancing cylinder for an axial flow drilling mud fluid driven turbine with a vaned shaft mounted in a ported tubular housing and having a piston secured to the top of said turbine shaft, comprising a cylindrical member secured in the drilling fluid inlet of said tubular housing, a bore in said member closed at one end and open at the opposite end to receive said piston, centering means at each end of said cylinder to align it in said housing, means on said cylinder cooperating with said housing to form a drilling fluid bypass from the upper end of said cylinder to the lower end thereof independently of said bore, means forming a passage from the closed end of said bore to a port of said housing, and sealing means for said last-named passage-forming means.

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