

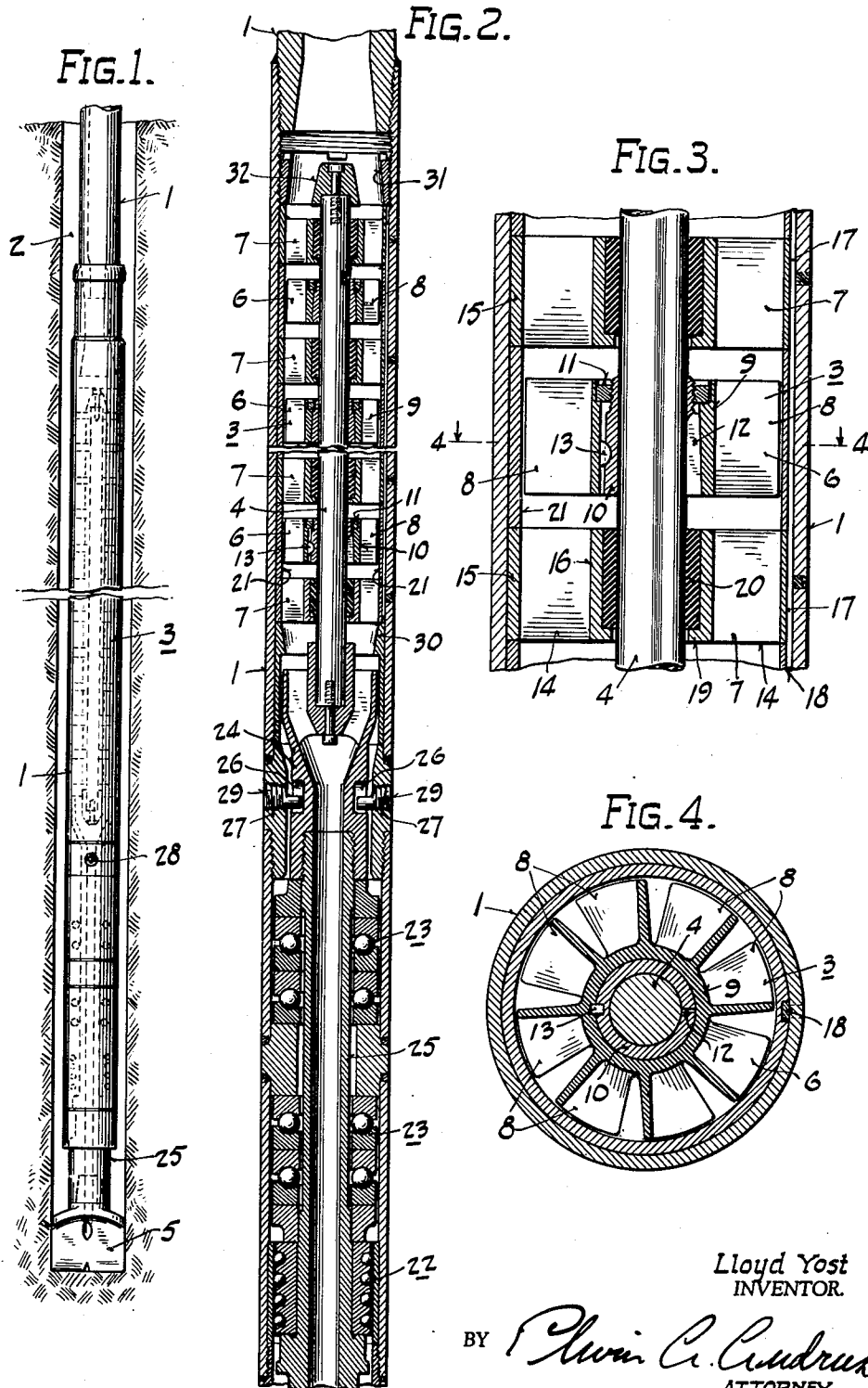
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MUD TURBINE AND METHOD OF ASSEMBLING THE SAME

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MUD TURBINE AND METHOD OF ASSEMBLING THE SAME

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3 Claims. (Cl. 253—152)

This invention relates to a mud turbine and method of assembling the same and has been applied to the construction of turbines for driving well drills at the bottom of a well and which are driven by the flow of mud pumped down from the top of the well and utilized, after passing through the turbine, for the purpose of removing the spoil from drilling operations and preventing cave in of the well.

Heretofore in attempting to design and construct such turbines, it has been assumed that the blades of the runners and guides should be fairly close together to obtain the maximum torque values. Furthermore, the construction was such that the runners and guides had to be assembled on the shaft prior to insertion in the casing, and to do this, the guides were interlocked with outer spacer rings, and the runners were similarly interlocked with inner spacer rings. The guides were secured to the casing at the end of the structure and the runners were secured to the shaft at the ends of the structure.

The present invention is directed to the use of an adjustable runner and to a more simple assembly procedure in which the runners and guides of a multiple stage turbine are assembled with the shaft in the casing and individually secured to the shaft and casing, respectively. It takes into account that the motive fluid employed is mud which has a high viscosity as distinguished from water or vapor, and the runners and guides are spaced apart a substantial distance.

One of the objects of the invention is to provide a turbine in which each runner is located specifically with respect to its adjacent guide.

Another object is to increase the working life of a turbine of the kind referred to.

A further object is to simplify the construction and assembly of such a turbine.

These and other objects are accomplished by providing the construction hereinafter described and illustrated in one embodiment in the accompanying drawing.

In the drawing:

Figure 1 is a vertical section of a well showing the turbine of this invention in place;

Fig. 2 is an enlarged vertical section of the turbine on the longitudinal center line with parts broken away;

Fig. 3 is a still further enlarged section of a runner and the two adjacent guides; and

Fig. 4 is a transverse section on line 4—4 of Fig. 3.

The embodiment illustrated in the drawing is

utilized in the drilling of deep oil wells in which the relatively non-rotating drill casing 1 extends downwardly from the top of the well and is of smaller diameter than the hole 2 being drilled. At the lower end of the casing is the turbine 3, the vertical rotating shaft 4 of which extends downwardly to rotate the drill 5 at the bottom of the well.

The turbine 3 is of the multiple stage type in order to develop the power necessary in the small diameter available. Usually a twenty or thirty stage turbine is employed depending somewhat upon the design of the runners and guides and the requirements.

The motive fluid employed is mud which may be of the usual mud composition employed in drilling oil wells for cleaning the well and preventing cave in. The mud is pumped down through casing 1, turbine 3 and out at or near the drill 5 from whence it passes upwardly outside of casing 1 to the top of the well. It is then reclaimed and used over again. Normally this flow of mud is at a very high rate.

In the turbine illustrated there are alternate runners 6 secured to the shaft 4 and guides 7 keyed to the casing 1. The runners 6 and guides 7 are usually from about two and one-half inches to about four inches in height, and according to the invention, they are spaced apart a distance of from one to one and a half inches.

It was at first assumed that so great a spacing of the runners and guides would destroy the efficiency of the turbine. However, in constructing one with fairly small clearance between the runners and guides, it was discovered that the thick mud employed for motive power quickly cut or wore away the metal of the blades at the top and also bottom of the runners and guides. Such a turbine did not stand up for even the minimum number of hours necessary for continuous service in a commercial operation.

By providing about a one and one-quarter inch clearance between runner and guide blades, the wear on the edges of the blades is kept at about the minimum without sacrificing efficiency. Thicker mud may make it possible and desirable to employ greater clearance, while a thinner motive fluid will require closer spacing to maintain the efficiency.

Each runner 6 comprises the usual blades 8 radiating from a hub 9 having a frusto-conical inner surface. The runner is secured to the shaft by the wedge action of an intermediate split adapter sleeve 10 which is tapered complementary to the taper of the inner surface of hub 9.

The sleeve 10 is tightened in place by means of a nut 11 disposed in a recess in the upper edge of hub 9 and threaded to the sleeve at its thinner end. Preferably, the tapered or wedge portion of sleeve 10 is split as at 12 to allow contraction for tightening on shaft 4 under the wedging action.

The sleeve 10 is preferably keyed to hub 9 by a suitable key 13 which prevents loosening of the nut 11 caused by the tendency for relative rotation between the sleeve and hub.

The construction of the runner 6 allows it to be secured to the smooth shaft at any adjusted position, and runners will not disturb the balance of the rotating parts as would be the case with keys or other forms of interlock with the shaft.

The guides 7 comprise the guide vanes 14 spaced around the circumference and held in place by an outer cylindrical web 15 and an inner cylindrical web 16. The outer web 15 has a slot 17 in its outer surface to receive a key 18 secured to the inside of casing 1 and which holds all of the guides locked against rotation relative to each other and to the casing. The inner web 16 has its inner surface substantially spaced from the shaft 4 and it has a flange 19 at its lower edge extending inwardly toward the shaft 4.

A rubber or other suitable bearing 20 is supported on the flange 19 in the space between web 16 and shaft 4. Preferably this bearing is of the fluted type to provide for self cleaning from mud and prevent excessive wear on the shaft. The bearing 20 helps to keep the shaft and casing concentric at all times and prevents any misalignment of parts due to uneven side pressure. Although in some instances it might not be necessary to place a bearing at each guide, it is advisable to do so since it has been found that longer continuous service can be obtained in this way.

The guides 7 are spaced apart by guide spacer sleeves 21 each of which corresponds in height to the height of a runner plus the clearance provided above and below the runner. The sleeves 21 are preferably separate pieces, although they may be made integral with the webs 15 of the respective guides.

Suitable radial and thrust bearings 22 and 23 respectively may also be provided. The bearings shown constitute the subject matter of co-pending applications Serial No. 391,335, filed May 1, 1941, for Ball thrust bearing for well drilling units, and 391,339 filed the same date, for Radial ball bearing, and issued to Patent No. 2,286,528 by the present inventor.

The lower end of the rotor shaft 4 is supported by an adapter coupling 24 which rests on thrust bearing 23 and to which the drill shaft 25 is secured. The adapter 24 serves to direct the mud being discharged from the turbine into the center of the hollow drill shaft 25, and has two diametrically opposed circular recesses 26 in its outer surface. The casing 1 has threaded openings 27 corresponding to the recesses 26 and which are normally sealed by plugs 28.

In assembling the turbine, prior to attaching the bearings 22 and 23 and before the openings 27 are sealed, special pins 29 are inserted in the openings 27 to extend into the respective recesses 26. The shaft 4 is then lowered until the adapter coupling 24 rests on the pins 29. In practice, this lowering will be exactly equal to the amount of clearance desired between each runner and its next adjacent lower guide.

A guide 7 is then lowered over the top end of the shaft until it rests on a stationary shelf 30 provided in casing 1 just above the coupling 24. A runner 6 is then dropped over the top end of shaft 4 and lowered until it rests on the first guide 7. An appropriate tool is inserted from the top to engage the nut 11 and to turn it relative to the adapter sleeve 10. Threading of the nut on the adapter sleeve tends to push the runner 6 downwardly and may pull the sleeve 10 slightly upward until all parts are tight.

After the first runner 6 is thus positioned, a guide spacer ring 21 is dropped down in the casing 1 and a guide 7 is lowered upon it. Then another runner 6 is applied in the same manner as that described for the first runner, and so on, until all of the runners and guides are in place. The upper guide 7 is held in place by an annular nut 31 threaded to the casing 1 and pressing down on the guide. A cap 32 is then secured to the upper end of the shaft to guide the mud towards the outer circumference of the casing where it enters the turbine blades.

The structure is then laid horizontal and the pins 29 removed from openings 27. The plugs 28 are then applied to seal openings 27 and the bearings 22 and 23 are attached to the lower end of the turbine, the shaft 4 being raised to normal operating position with the desired clearance between each runner and its next adjacent lower guide.

The guides 7 are supported on casing 1 by the sleeve 30 and the shaft 4 with its runners 6 is supported through coupling 24 on the thrust bearing 23. The guides 7 are prevented from rotation by the key 18 while shaft 4 and its runners are free to rotate. The upper end of the drill shaft 25 is secured to the shaft 4 after assembly.

The invention provides for the locating of each runner independently relative to its next lower guide so that all clearances are substantially alike in the finished structure. Various embodiments of the invention may be employed within the scope of the accompanying claims.

The invention is claimed as follows:

1. In a turbine of the class described, a runner mounted on a rotary shaft and comprising a circular web carrying a series of blades, and having a frusto-conical inner surface spaced from said shaft, an adapter sleeve intermediate the web and shaft and having an outer frusto-conical surface complementary to the inner surface of the web, a nut threaded upon the thinner end of said adapter sleeve and pressing against said web to bias the two in opposite directions and wedge said sleeve in said web and upon said shaft, said sleeve being split in the thicker end to provide for its contraction upon said shaft, and a key interlocking said web and said adapter sleeve to prevent relative rotation therebetween.

2. In the assembly of a turbine of the class described, the method of first locating the rotor shaft below its normal operating position in the casing by a distance substantially equal to the clearance to be provided between each runner and its next adjacent lower guide, assembling the runners and guides alternately with the guides spaced apart to accommodate the runners and provide clearance between the runners and adjacent guides securing each runner to the rotor shaft as the same is placed against its next adjacent lower guide, thereafter moving the shaft and its attached runners upwardly rela-

tive to the casing an amount equal to the clearance to be provided between the respective runners and their next adjacent lower guides, and securing the shaft for rotation in its final operating position.

3. In the assembly of a turbine of the class described, the method of first locating the rotor shaft below its normal operating position in the casing by a distance substantially equal to the clearance to be provided between each runner and its next adjacent lower guide, assembling the runners and guides alternately and disposing spacing members between the guides to space

the same apart to accommodate the runners and provide clearance between the runners and adjacent guides, securing each runner to the rotor shaft as the same is placed against its next adjacent lower guide, thereafter moving the shaft and its attached runners upwardly relative to the casing an amount equal to the clearance to be provided between the respective runners and their next adjacent lower guides, and securing the shaft for rotation in its final operating position.

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