Dec. 19, 1939. J. A. ZUBLIN 2,184,068

TURBINE DRILL BIT

Filed March 24, 1939 2 Sheets-Sheet 1

Fig. 1.

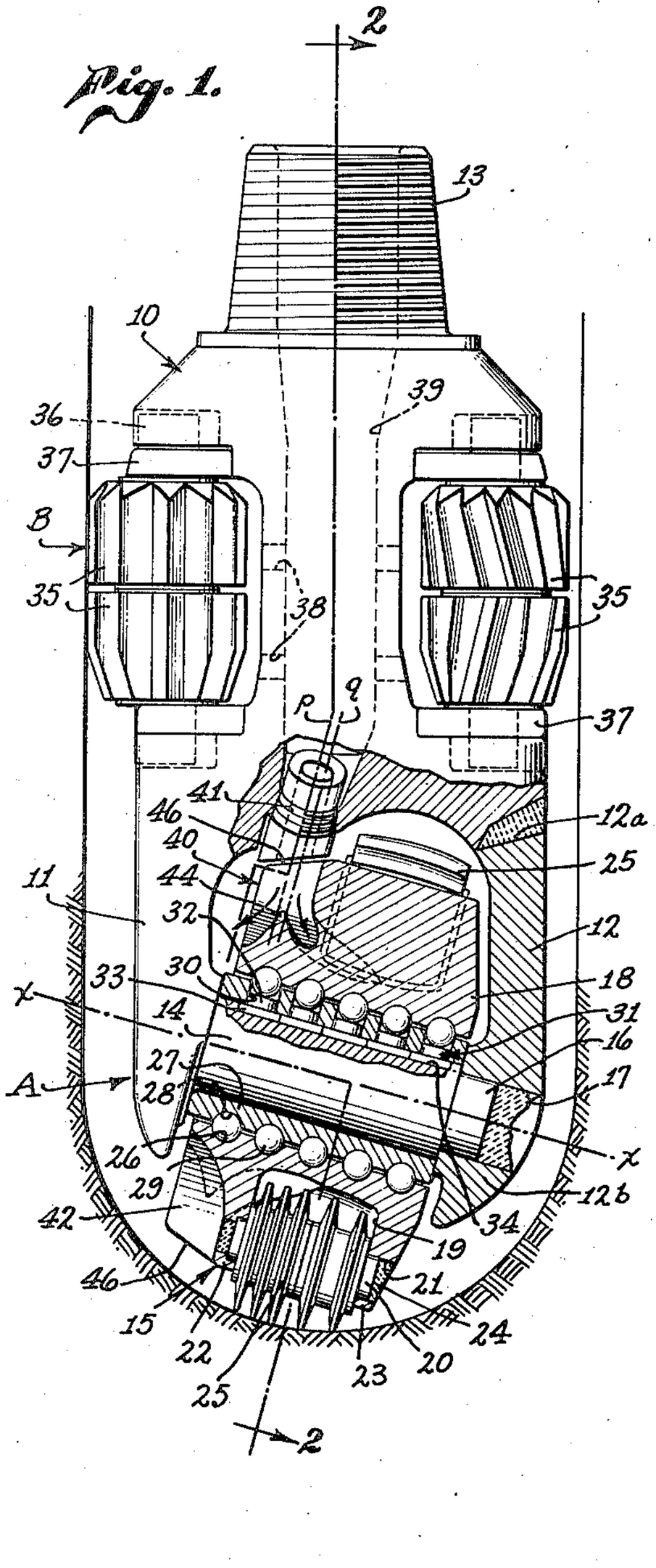
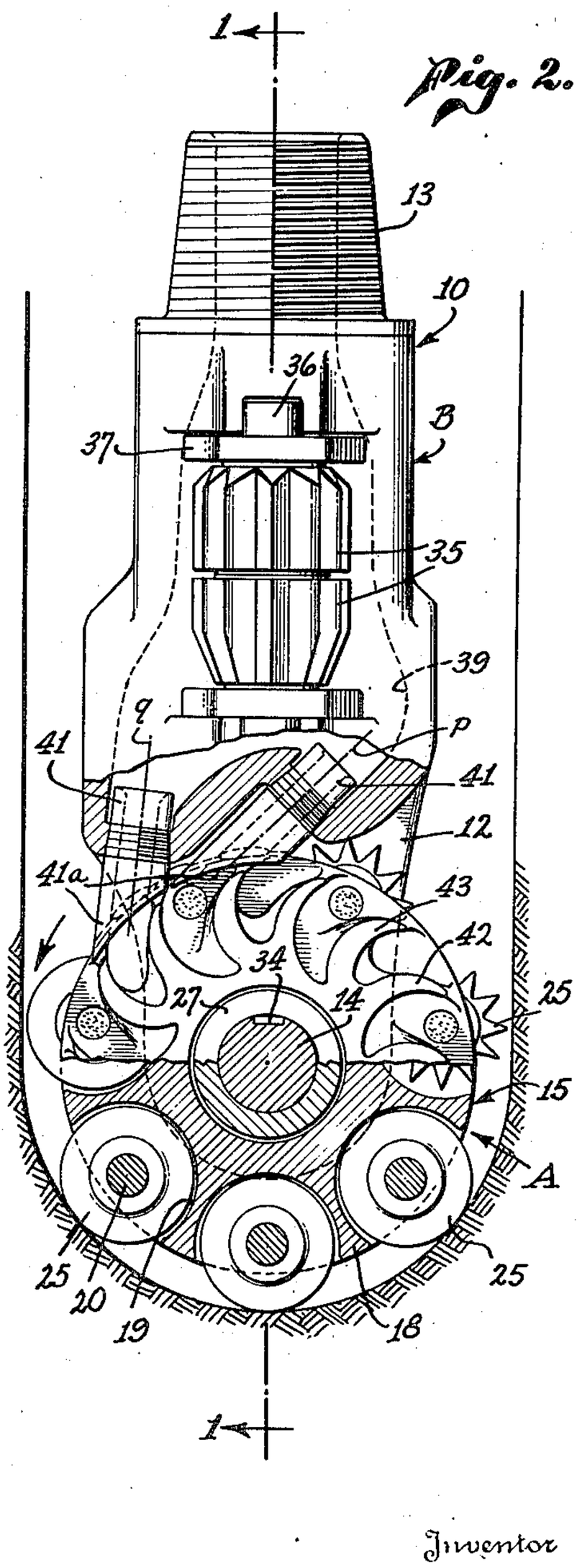


Fig. 2.



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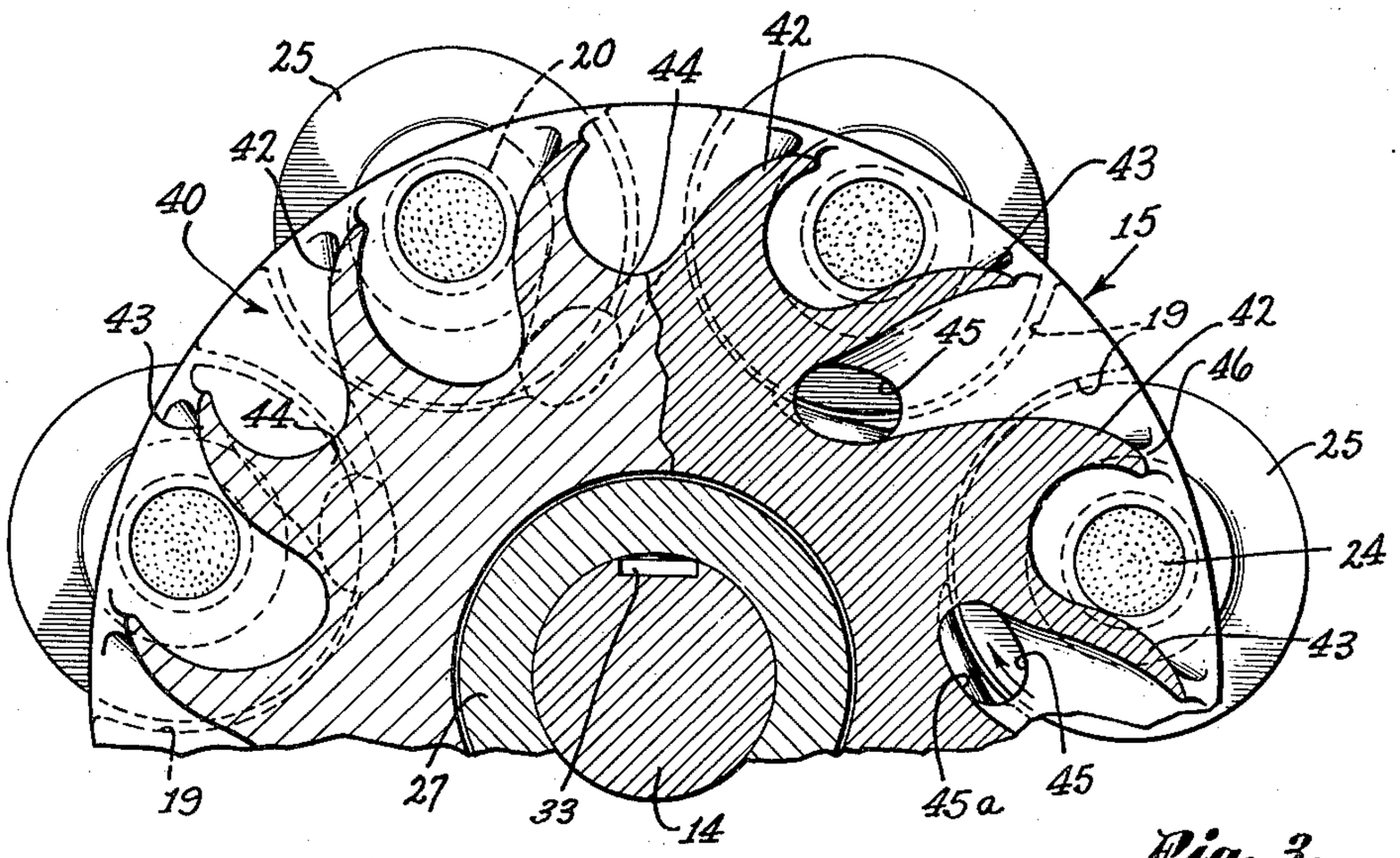

Fig. 3.

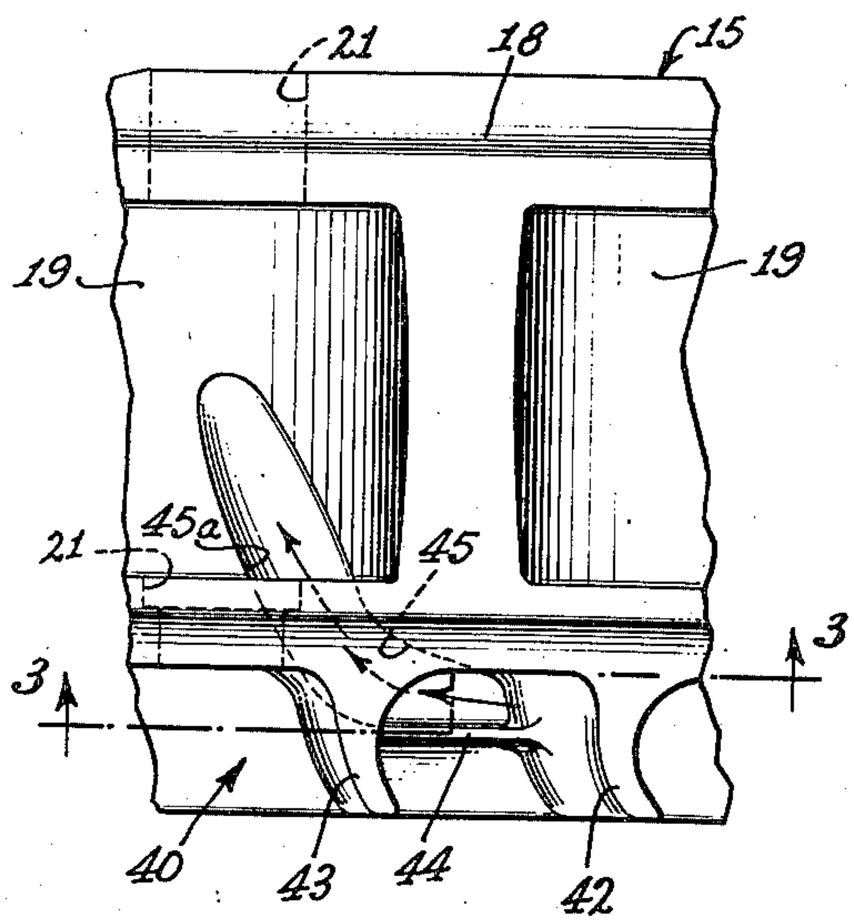

Fig. 4.

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TURBINE DRILL BIT

John A. Zublin, Los Angeles, Calif.

Application March 24, 1939, Serial No. 263,872

19 Claims. (Cl. 255—71)

This invention relates to drilling tools, and more particularly to tools used in the rotary drilling of bore holes, such as oil wells. In its general aspects, the invention is directed to fluid operated drill bits of the characters described and claimed in my copending application, "Fluid operated drilling bits," Serial No. 219,356, filed July 15, 1938; "Combined fluid and rotary driven drilling bits," Serial No. 219,357, filed July 15, 1938; "Fluid operated rotary drilling bits," Serial No. 227,277, filed August 29, 1938, now Patent No. 2,154,553, granted April 18, 1939; and "Fluid operated drilling tools," Serial No. 227,279, filed August 29, 1938. In its specific constructional details, the present invention is more closely allied with the second and third mentioned applications.

It is a general object of this invention to provide an improved roller drill bit of the fluid operated type.

Another object of the invention is to provide a fluid operated drill bit capable of developing a greater torque and horsepower.

A further object of the invention is to provide a turbine type of drill bit having an improved blade design.

The invention also contemplates a turbine type of drill bit in which the exhaust fluid is directed against the roller cutters to clean them of adhering matter, the fluid preferably being directed substantially longitudinally of the cutter teeth and having a tangential thrust component urging rotation of each cutter in the same direction as induced by its contact with the formation.

It is a further object of the invention to provide a turbine type of drill bit capable of producing a turbulent action of the fluid at the bottom of the hole to keep it free from cuttings. This object is preferably attained by creating the turbulence through the agency of turbine blades or impellers forming part of the bit.

Still another object of the invention is to provide a turbine type of drill bit in which end thrusts are counteracted by the manner in which fluid acts upon the turbine blades.

Yet another object of the invention is to eliminate the erosive action of impelling fluid on the roller cutters of a turbine type of drill bit by eliminating the direct application of driving effort to those cutters.

Another object of the invention is to stagger the lines of action of a plurality of nozzles upon turbine blades so as to distribute erosive wear and decrease interference between the fluid jets issuing from the nozzles forming part of a drill bit.

It is a further object of the invention to provide a turbine type of drill bit of simpler construction than heretofore developed which can be manufactured at lesser cost.

This invention possesses many other advantages and has other objects that will become apparent from a consideration of one embodiment of the invention. For this purpose, a form is shown in the drawings accompanying and forming part of the present specification, which embodiment will now be described in detail, illustrating the general principles of the invention. However, it is to be understood that this detailed description is not to be taken in a limited sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is an elevation of a drill bit with its lower portion shown in section taken generally along the line 1—1 of Figure 2;

Figure 2 is a partially sectional view of the drill bit, taken generally along the line 2—2 of Figure 1;

Figure 3 is a combined section of the turbine wheel and blades, as seen along the line 3—3 of Figure 4; and

Figure 4 is an enlarged side elevation of a fragment of the turbine wheel.

In general, the drill bit includes a lower cutting portion A and an upper reaming portion B, this general combination being described and claimed in my Patents Nos. 2,151,544 and 2,151,545, granted March 21, 1939.

The lower portion A of the bit includes a plurality of depending legs 11, 12 extending from the shank body 10, the upper end of which carries the usual threaded pin 13 for connecting the drill bit with a string of drill pipe (not shown). One of the legs 11 has formed integrally therewith a bearing supporting member 14 adapted to carry the cutter assembly 15, to be described hereafter. The end of the bearing supporting member is provided with a reduced extension 16 fitting into a bore 17 formed in the leg 12 of the shank, which leg, after the cutter assembly has been placed on the bearing supporting member, can be welded at its upper end 12*a* to the shank body proper and at its lower region 12*b* to the reduced extension 16.

The cutter assembly 15 includes a cutter carrier 18 provided with a plurality of circumferentially spaced slots 19 bridged by bearing pins 20 fitting in holes 21 in the side members

22, 23 of the carrier, with welding material 24 integrating the pins to the carrier. Each pin 20 carries a formation contacting roller 25.

The carrier 18 is provided with a plurality of ball bearing raceways 26 in an inner bore, which are adapted to cooperate with an inner bearing race 27 containing complementary toric raceways 28. Between the raceways are provided balls 29 which will serve to transmit bearing loads between the carrier and inner race. The balls can be placed in their respective raceways through holes 30 formed in the inner race 27 and communicating with respective raceways. After placing the balls in their proper positions, buttons 31 having an upper cylindrical portion 32 are inserted into the bores, serving to prevent the balls from falling from the raceways while at the same time providing a substantially continuous path on which the balls can roll as the carrier rotates. The lower portion 33 of each button is made rectangular in shape so as to be capable of riding in a keyway 34 formed in the bearing supporting member 14, and thus serving to lock the inner race from rotating with respect to the bearing supporting member. The general cutter organization and bearing assembly just described forms the subject matter of my copending application "Compact roller drilling bits," Serial No. 191,622, filed February 21, 1938.

The upper part B of the drilling tool constitutes a reamer, described in detail and claimed in my copending application "Reamer," Serial No. 227,278, filed August 29, 1938 now Patent No. 2,156,444, granted May 2, 1939. For the purpose of this application it is sufficient to merely call attention to the reamer roller cutters 35 rotatably mounted on the bearing supporting pins 36 welded to the plates 37 which, in turn, are welded to the shank 10. The cutters 35 are kept free from cuttings by jets of fluid issuing through the nozzles 38 communicating with the passageway 39 in the shank.

This invention contemplates the operation of the drilling bit through the placing of the prime mover mechanism in the bit itself, so as to obviate the need for transmitting the entire driving effort from the surface of the bore being produced through a long and relatively flexible string of drill pipe.

This prime mover mechanism is a hydraulic turbine, the rotor 40 of which is preferably formed integrally with the carrier 18 so that fluid under pressure passing through nozzles 41, 41 communicating with the shank passageway 39 can act upon the rotor blades 42, 43 and produce rotation of the carrier on its main bearing support about the axis x—x of the carrier. This rotation will be imparted to the roller cutters 25 by virtue of their reaction with the formation. These cutters are preferably mounted on the carrier with their respective rotational axes parallel to the main bearing and carrier axis x—x in order that a rolling action of the cutters on the formation can be obtained for effective production of a bore of the required diameter. The cutters can assume various shapes, the specific embodiment disclosed in the drawings being both discs and toothed rollers. The latter can be formed with straight and inclined teeth in order to avoid tracking.

The nozzles 41, 41 and the blades 42, 43 on the rotor are preferably so arranged and shaped as to provide a hydraulic turbine of the combined radial, axial and tangential types. The velocity energy of the fluid leaving the nozzles will exert a turning effort on the carrier or wheel by reason of fluid impact with the blades.

More specifically, a plurality of nozzles 41, 41 is threadedly attached to the shank body proper 10 with their axes or lines of discharge p, q being generally tangential of the rotor portion 40 of the carrier 18. Fluid under pressure will pass from the shank passageway 39 through the nozzles from where it will act upon the concave faces of the blades 42, 43 to impart its velocity energy to the rotor and produce its turning. These blade faces will also guide the fluid to the exit portions of the blades, during which passage a reversal of the fluid will occur to produce a reactive thrust upon the guiding face of each blade to turn the rotor in the proper direction. The blades are formed around the entire circumference of the rotor so that continuous turning effort is applied by the fluid issuing from the nozzles; while a plurality of nozzles is used to multiply the horsepower developable by this turbine bit.

Part of the fluid exhausting from the blades is employed to keep the rollers 25 free from cuttings. Alternate blades 43 are preferably formed so as to deflect the fluid jets in two planes. Each of these blades is formed with a median splitter 44 which will direct part of the fluid outwardly from the rotor and another portion of the fluid inwardly through an opening 45 and guide groove 45a communicating with the carrier slot 19 in which a cutter rotates. This latter exhausting stream will act upon the cutter teeth or discs to clean them of any adhering matter so that their formation penetration efficiency is maintained at a maximum. This exhausting fluid is also directed against the cutter teeth or discs in such manner as to produce rotation of the cutter and insure that all of its teeth are clean. The exhaust stream is preferably directed to rotate the cutter in the same sense as is produced by its reaction with the formation to eliminate any sudden shocks or jars on the cutters as they move into formation contact while the carrier or wheel rotates on its main bearing.

Although alternate blades 43 have been shown with splitters 44 to deflect the streams in two directions, it is to be understood that if deemed expedient all of the blades, or any other number, can be thus shaped. It is to be noted that in addition to producing a cleaning action on the cutters, the dividing of the fluid streams to pursue two paths in opposite directions produces a counterbalancing effect of the end thrusts on the wheels, which will decrease the axial thrust loads that the main ball bearings 29 must transmit, and consequently leads to their increased effective life.

Windage and eddying losses are decreased by shaping the exit 41a of each nozzle 41 to conform closely to the periphery of the rotor blades 42, 43. Interference between the jets leaving the nozzles is minimized by placing their respective lines of action p, q in different planes, which will also distribute any erosive wear on different parts of the turbine blades. As will be clear from Figure 1, the exit portions 41a of the nozzles are inclined to the carrier axis to conform closely to the beveled periphery 46 of the rotor blades, which beveling is necessitated by the need for providing the necessary clearance between the rotor and the curved bottom of the hole.

It will be noted further that there is no erosive wear due to the action of the fluid jets on the

roller cutters, as in my other applications referred to, all of the cutter teeth or discs having a maximum of life for effecting formation removal. The exhaust cleaning fluid is directed primarily longitudinally of the cutters, its tangential turning component being relatively small so as to avoid excessive rotation of the cutters while they are in their upper positions and out of formation contact. The provision of a separate rotor 40, besides preventing this erosive wear on the roller cutters also produces a bit in which the blades can churn the fluid and cuttings at the bottom of the hole, creating a turbulent effect that will insure removal of the cuttings from the hole bottom and their conveyance to the surface of the bore.

The instant invention has a further advantage over prior constructions since a greater torque and horsepower can be developed for the same size drilling bit by reason of a greater turning radius with which the fluid streams act upon the rotor blades.

When in operation, the carrier 18 will be rotated by the action of the fluid stream, producing rotation of the cutters 25 by virtue of their contact with the formation. However, although the rolling of the cutters on the formation will effect its removal, it will also tend to produce a groove of semi-circular longitudinal section substantially equal in length to the roller cutters. For the purpose of insuring that a full gauge hole will be produced, the string of drill pipe (not shown) and the shank 10 attached thereto are also rotated so that the cutters 25 assume an infinite number of planes of rotation to produce a corresponding number of semi-circular grooves, all combining to produce a hemispherical hole bottom of the proper radius. Rotation of the string of drill pipe will also prevent its freezing in the bore.

I claim:

1. A drill bit including a shank, a carrier rotatably carried by said shank, a plurality of cutters rotatably carried by said carrier, and means including a rotor on said carrier having turbine blades exteriorly of said cutters for producing rotation of said carrier with respect to said shank.

2. A drill bit including a shank, a carrier rotatably carried by said shank, a plurality of cutters rotatably carried by said carrier, a fluid rotor on said carrier, and means on said shank externally of said carrier for discharging fluid upon said rotor to produce rotation of said carrier with respect to said shank.

3. A drill bit including a shank, a carrier rotatably carried by said shank, a plurality of cutters rotatably carried by said carrier, a fluid rotor having turbine blades on said carrier, and an external nozzle on said shank adjacent said rotor for directing a fluid stream against said blades to produce rotation of said carrier with respect to said shank.

4. A drill bit including a shank, a carrier rotatably carried by said shank, a plurality of cutters rotatably carried by said carrier, a plurality of blades on a side of said carrier, and an external nozzle on said shank adjacent said blades for directing a fluid stream thereagainst to produce rotation of said carrier with respect to said shank.

5. A drill bit including a shank, a carrier rotatably carried by said shank, a plurality of cutters rotatably carried by said carrier and circumferentially arranged therearound, a plurality of blades circumferentially arranged around said carrier to one side of said cutters, and a nozzle on said shank adjacent said blades for directing a fluid stream thereagainst to produce rotation of said carrier with respect to said shank.

6. A drill bit including a shank, a carrier rotatably carried by said shank, a plurality of cutters rotatably carried by said carrier and circumferentially arranged therearound, a plurality of blades circumferentially arranged around said carrier to one side of said cutters, and a nozzle on said shank adjacent said blades for directing a fluid stream substantially tangentially thereagainst to produce rotation of said carrier with respect to said shank.

7. A drill bit including a shank, a carrier rotatably carried by said shank, a plurality of cutters rotatably carried by said carrier, a plurality of circumferentially arranged blades on said carrier, and a nozzle on said shank adjacent said blades for directing a fluid stream thereagainst to produce rotation of the carrier with respect to said shank, said blades being shaped to guide the fluid in generally radial and axial directions.

8. A drill bit including a shank, a carrier rotatably carried by said shank, a plurality of cutters rotatably carried by said carrier, a plurality of circumferentially arranged blades on said carrier, and a nozzle on said shank adjacent said blades for directing a fluid stream thereagainst to produce rotation of the carrier with respect to said shank, said blades being shaped to guide the fluid in a generally axial direction.

9. A drill bit as defined in claim 8, said blades guiding said fluid outwardly from said carrier.

10. A drill bit as defined in claim 8, said blades guiding said fluid inwardly to said cutters.

11. A drill bit including a shank, a carrier rotatably carried by said shank, a plurality of cutters rotatably carried by said carrier, a plurality of blades on said carrier, a nozzle on said shank adjacent said blades for directing a fluid stream thereagainst to produce rotation of the carrier with respect to said shank, and means for exhausting fluid from said blades onto said cutters.

12. A drill bit including a shank, a carrier rotatably carried by said shank, a plurality of cutters rotatably carried by said carrier, a plurality of blades circumferentially arranged around said carrier to one side of said cutters, a nozzle on said shank adjacent said blades for directing a fluid stream thereagainst to produce rotation of the carrier with respect to said shank, and openings in said carrier for guiding fluid exhausting from said blades onto said cutters.

13. A drill bit as defined in claim 12, said openings guiding said exhaust fluid partially longitudinally of the cutters and partially tangentially thereof to turn the cutters in their proper rotational direction.

14. A drill bit including a shank, a carrier having a plurality of circumferential slots rotatably carried by said shank, a plurality of cutters rotatably carried in said slots by said carrier, a plurality of blades circumferentially arranged around said carrier to one side of said cutters, a nozzle on said shank adjacent said blades for directing a fluid stream thereagainst to produce rotation of the carrier with respect to said shank, and means defining openings in said carrier between said blades and slots for conducting exhaust fluid from said blades onto said cutters.

15. A drill bit including a shank, a carrier rotatably carried by said shank, a plurality of cutters rotatably carried by said carrier, a plurality

of reaction blades circumferentially arranged around said carrier, and a nozzle on said shank adjacent said blades for directing a fluid stream thereagainst to produce rotation of the carrier with respect to said shank.

16. A drill bit including a shank, a carrier rotatably carried by said shank, a plurality of cutters rotatably carried by said carrier, a plurality of blades on said carrier, fluid discharge means carried by said shank adjacent said blades for directing a fluid stream thereagainst, and splitter means on said blades whereby the fluid is directed in opposite directions.

17. A drill bit including a shank, a carrier rotatably carried by said shank, a plurality of cutters rotatably carried by said carrier, fluid discharge means carried by said shank adjacent said blades for directing a fluid stream thereagainst, splitter means on alternate blades whereby the fluid is guided in opposite directions, and exhaust means for conducting said guided fluid onto said cutters.

18. A drill bit including a shank, a carrier having a plurality of circumferential slots rotatably carried by said shank, a plurality of cutters rotatably carried in said slots by said carrier, a plurality of blades circumferentially arranged around said carrier to one side of said cutters, fluid discharge means carried by said shank adjacent said blades for directing a fluid stream thereagainst, splitter means on alternate blades whereby the fluid is guided in opposite directions, and means defining openings in said carrier between said blades and slots for conducting exhaust fluid from said blades onto said cutters.

19. A drill bit including a shank, cutter means rotatably carried by said shank, a plurality of blades on said means, fluid discharge means carried by said shank adjacent said blades for directing a fluid stream thereagainst, splitter means on alternate blades for guiding said fluid in opposite directions both toward and from said cutter means, said other blades guiding said fluid away from said cutter means.

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