May 24, 1938. J. A. ZUBLIN 2,118,542

DRILL BIT

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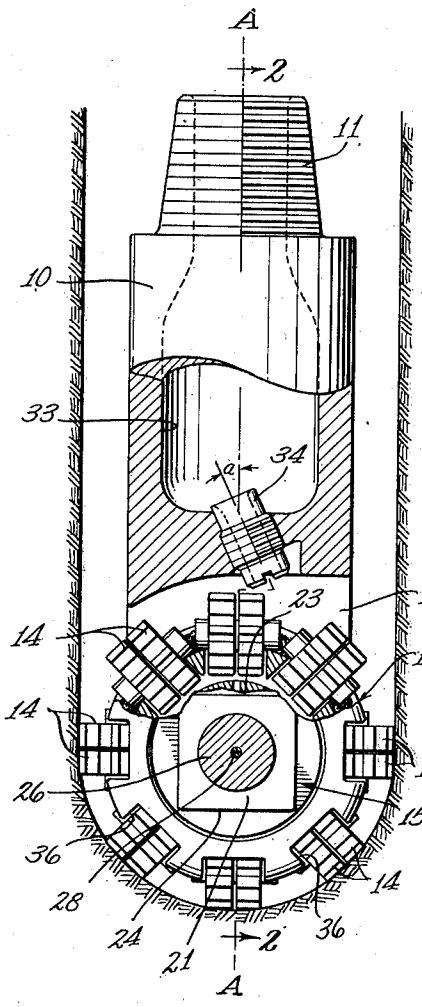


Fig. 1.

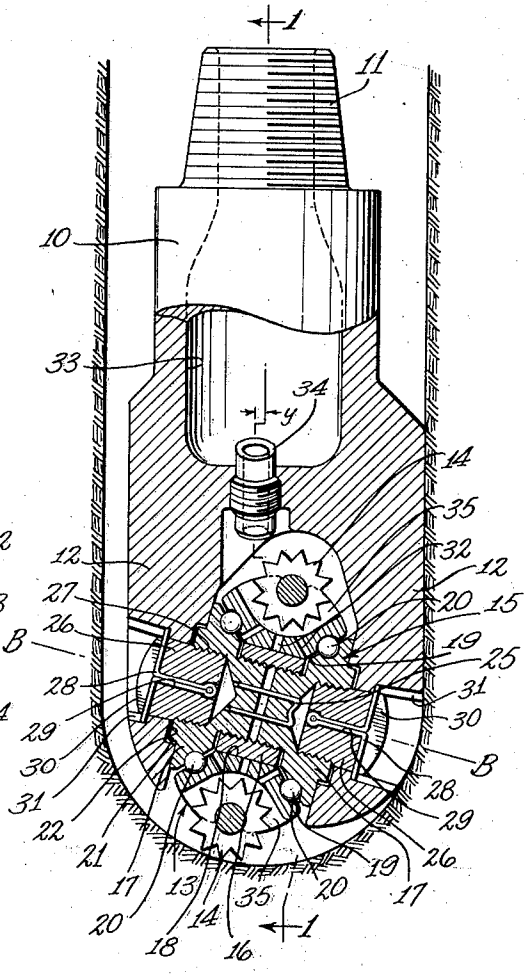


Fig. 2.

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DRILL BIT

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16 Claims. (Cl. 255—71)

The present invention relates generally to rotary well drilling bits used to drill oil wells and the like, particularly to drill bits of the general type described in my prior U. S. Patents 2,050,988 and 2,050,989, issued August 11, 1936; 2,069,795, 2,069,796, 2,069,797, 2,069,798, 2,069,799, issued February 9, 1937; and in my application No. 111,871, filed November 20, 1936, which matured into Patent No. 2,079,142, May 4, 1937. Drill bits of this type are provided with one or more cutter carriers upon which are mounted a number of rotatable cutters. These cutters move over the formation being drilled with a rolling motion that adapts them particularly for drilling hard formations. In hard rock, it is of prime importance that the motion of the cutters be as nearly truly rolling as possible since any twisting or scraping greatly increases the wear on the bit without increasing the rate of drilling.

One of the features of the drill bits described in the above enumerated patents and application resides in the intermittent contact of the cutters with the formation being operated upon. Approximately half of the cutters are in formation contact at any one time, while the remainder are out of contact, being "in reserve". The cutters are caused to move into and out of contact with the formation by reason of the rotation of the carrier, upon which the cutters are mounted, about its own axis. An explanation of the forces causing carrier rotation will be found in my Patent No. 2,050,988, page 3, 2nd column. After the cutters move out of formation contact they are carried away from the sides of the hole being drilled to a position under a fluid nozzle, which discharges fluid under a high pressure against the cutting edges to cleanse them of any adhering matter.

It has been found that the position of the discharge orifice for the circulating fluid in a plane including the axis of rotation of the carrier, while cleansing each cutter thoroughly, yet provides a barrier to rotation of the carrier about its own axis. This is occasioned by the high pressure of fluid and also by the substantially radial direction of the fluid against the carrier. The barrier thus set up retards rotation of the carrier. Furthermore, increasing wear on the cutting teeth will be associated with their increasing slippage on the formation, making the carrier rotation less positive, until a condition is reached wherein the reactive force of the cutters on the formation, tending to turn the carrier, will be insufficent to overcome the resistance to rotation introduced by the fluid barrier. The result is obviously zero rotation of the carrier about its own axis. The desirable effect of having cutters "in reserve" is thereby lost since intermittent contact with the formation is not possible unless the carrier can rotate.

It has been found that the directing of the fluid substantially tangentially against each roller cutter results in excessive wear on its bearing surfaces. This is caused by the fact that the fluid contains solid substances such as sand, mud, clay, foreign matter, etc., that contact with the bearing surfaces and act as abrasives when the cutters are rotated by the turbine action of the fluid on their teeth. Although a thorough cleansing action is obtainable, yet the high speed of rotation imparted to each roller cutter produces an abnormal abrading action by the solid substances on the bearing surfaces before the useful life of the cutting teeth is ended.

Accordingly, it becomes a general object of my present invention to assist, rather than retard, the rotation of the carrier about its own axis.

It is a further object of my invention to decrease the wear, and consequently, increase the life of each roller cutter.

It is a further object of my invention to insure thorough cleansing and proper lubrication of all parts of the drill bit.

How these objects and others are obtainable will be understood by referring to the following description and the annexed drawing in which:

Fig. 1 is a partial section on the line 1—1 of Fig. 2; and

Fig. 2 is a partial section on line 2—2 of Fig. 1.

In the figures is illustrated a drill bit provided with a shank 10, having on its upper end a threaded portion 11, by means of which the shank is attached to a drilling string for rotation about a generally longitudinal axis A—A. As described in my prior patents, and particularly in Patent No. 2,069,799 and in application No. 111,871, the lower portion of the shank is provided with two depending legs 12 carrying between them a cutter carrier 13. About the periphery of the cutter carrier is rotatably mounted a plurality of roller cutters 14.

As described in application No. 111,871, the carrier is rotatably mounted between the shank legs by means of bearing member 15, which consists of a central cylindrical sleeve 16 and flanges 17 screwed into each end of the bearing sleeve. The carrier has an inner cylindrical surface 18 rotatably mounted on the sleeve, and inclined surfaces 19 complementary to the flanges. Between the flanges and these inclined surfaces are

ball bearings 28 which serve to transmit part of the radial load on the carrier and all of the axially parallel loads. On the outer surface of each flange is provided a raised boss 21 which is inserted into a transverse slot 22 in each of the legs of the shank. The bosses are flattened across their top and bottom sides 23, 24 in order that they can be slid into the slots in the legs and be held from rotating relatively thereto. Relative rotation between the flanges is prevented by means of a locking pin 25. The entire bearing assembly is attached to the legs of the shank and held in proper position by tapered pins 26 which are externally threaded at 27, cooperating threads being supplied in each flange. Removal of the tapered pins is prevented by inserting cotter keys 28 through a bore 29 in each pin, the legs of each key being bent back to engage with castellations 30 in each pin and with slots 31 in the shank.

To lubricate the bearing surfaces passage ways 32 for the circulating fluid are supplied at intervals around the carrier. These passage ways will convey the fluid from each roller cutter to the bearing surfaces.

The upper end of the shank is provided with an internal fluid passage 33, at the lower end of which is threaded a discharge orifice or nozzle 34. To eliminate the possibility of the stream issuing from the nozzle from impeding rotation of the carrier about its own axis, the nozzle is inclined to the vertical by angle a so as to effect a discharge in the direction of carrier rotation. The fluid will be directed against the sides 35 of the carrier defining the slots 36 in which the roller cutters are mounted, and exert a force causing carrier rotation, in much the same manner as a stream issuing from a fluid nozzle will rotate a water wheel by impinging on its buckets, or a turbine disc by impact and reaction on its blades.

Inclining the nozzle has an additional effect of impinging the circulating fluid against the teeth of each roller cutter with a combined tangential and longitudinal direction. While the fluid will cause rotation of each cutter, its spinning action will not be as great as when the discharge is entirely tangentially of the cutter with its total force being spent in turning effort. Despite this decreased roller rotation, the cleansing action will be greatly increased due to the fact that the longitudinally moving stream engages all parts of each tooth face with substantially undiminished velocity.

By referring to Fig. 2, it will be noticed that the nozzle is offset somewhat by distance y with respect to a plane including the shank axis. This design provides an unobstructed path of part of the fluid stream to the sides of the carrier slots, while the remainder of the flow engages the cutter teeth. Part of this latter flow will be deflected from the teeth and also will strike against the sides of the slots.

It will be noted further that as wear occurs on the cutting teeth a greater area on the carrier is exposed to the direct action of the fluid stream issuing from the discharge orifice. Consequently, a greater force is being exerted by the nozzle to cause carrier rotation. This compensates to a great extent for the decreased rotation of the carrier due to a lessened penetration in the formation by the teeth as they wear. Ordinarily, as bluntness of the teeth increases, a greater amount of slipping will occur, and the carrier will not rotate to the same extent as previously. By the above described design the decreased action of rotation of the carrier caused by formation contact of the cutting teeth is compensated for by the increased turning effect produced by the discharge orifice.

Because of the illustrated arrangement, the tendency of the fluid stream to retard motion of the carrier is not only eliminated, but the stream is so directed as to insure and tend to increase rotation of the carrier. As a result, all of the advantages of drill bits of this type are maintained throughout the entire life of the cutting teeth. Primarily, these include intermittent contact of the formation by the roller cutters, a consequent "reserve" of cutters at all times, and thorough cleansing of all of the parts.

Although the improved nozzle arrangement has been described in connection with an inclined carrier, it is to be understood that the same principles of operation, and general constructional features are applicable to the embodiments described in the other patents and also to other types of cutter carriers, such as in roller cones and disc bits; and in certain respects to any type of cutting tool.

While I have described a specific application of my invention, it will be understood that changes may be made in its construction and the arrangement of its parts without departing from the intent and scope of my invention, and that the foregoing description is to be considered illustrative of rather than restrictive upon the following claims.

I claim:—

1. An earth boring tool comprising supporting means, means including a carrier supported by said means, and fluid discharge means on said supporting means, the center line of said discharge means passing to one side of the carrier axis, whereby impinging fluid against at least part of said second mentioned means will cause its rotation.

2. An earth boring tool comprising supporting means adapted for rotation about the axis of the bore, means including a carrier supported by said means, and fluid discharge means on said supporting means, said discharge means being inclined relatively to the axis of the supporting means, whereby impinging fluid against at least part of said second-mentioned means will urge its rotation.

3. An earth boring tool comprising supporting means adapted for rotation about the axis of the bore, means including a carrier supported by said means, and fluid discharge means on said supporting means, said discharge means being inclined relatively to the axis of the supporting means and being noncoplanar therewith.

4. An earth boring tool comprising supporting means; carrier means rotatably supported by said means, said carrier means including projections; and fluid discharge means on said supporting means; the center line of said discharge means passing to one side of the carrier axis, whereby impinging fluid against said projections will cause rotation of said carrier means about its axis.

5. An earth boring tool as in claim 4, wherein said projections define slots in the periphery of the carrier means.

6. An earth boring tool as in claim 4, wherein said projections are spaced around the periphery of the carrier means.

7. An earth boring tool comprising supporting means, a carrier rotatably supported by said means, projections defining slots spaced around

the periphery of said carrier, roller cutters supported in the slots between adjacent projections, and fluid discharge means on said supporting means, said discharge means being so positioned as to impinge fluid against said projections and cause rotation of the carrier.

8. An earth boring tool as in claim 7, wherein said discharge means is positioned to impinge fluid also against the roller cutters.

9. An earth boring tool as in claim 7, wherein the position of said discharge means is inclined relatively to the axis of the supporting means.

10. An earth boring tool as in claim 7, wherein the position of said discharge means is inclined relatively to the axis of the supporting means and being non-coplanar therewith.

11. An earth boring tool comprising a shank, a carrier rotatably supported by said shank, generally radial slots in the periphery of said carrier, cutters rotatably mounted in said slots, a fluid nozzle in said shank mounted outwardly of the periphery of the carrier and inclined to the shank axis, whereby impinging fluid on the cutters and carrier will cause their rotation.

12. An earth boring tool comprising a shank, a carrier rotatably supported by said shank, generally radial slots in the periphery of said carrier, cutters rotatably mounted in said slots, a fluid nozzle in said shank mounted outwardly of the periphery of the carrier, said nozzle being inclined to the shank axis and offset with respect thereto.

13. An earth boring tool comprising a shank, a carrier rotatably supported by said shank, generally radial slots in the periphery of said carrier, cutters rotatably mounted in said slots, a fluid nozzle in said shank mounted outwardly of the periphery of the carrier and inclined to its plane of rotation, said nozzle also being inclined to the shank axis and offset with respect thereto.

14. An earth boring tool comprising a shank, a carrier rotatably supported by said shank, generally radial slots in the periphery of said carrier, cutters having teeth rotatably mounted in said slots, and a fluid nozzle in said shank, the line of action of said nozzle being partially longitudinally of the cutter teeth and intersecting the sides of the slots, whereby rotation of the cutters and carrier will be caused by impinging fluid.

15. An earth boring tool comprising a shank adapted for attachment to a drilling string, a carrier supported by said shank for rotation with respect thereto, one or more earth contacting cutters rotatably mounted on said carrier, and means on the shank cooperating with said carrier and cutters for urging rotation of said carrier about its axis during both contact of said cutters with the earth and non-contact of all of said cutters therewith.

16. An earth boring tool comprising a shank adapted for attachment to a drilling string, a carrier supported by said shank for rotation with respect thereto, one or more earth contacting cutters rotatably mounted on said carrier, and means on the shank cooperating with said carrier for urging rotation of the carrier about its axis during both contact of said cutters with the earth and non-contact of all of said cutters therewith.

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