Sept. 17, 1940. R. P. FISHER 2,215,264

ROTARY DRILL BIT

Filed Nov. 16, 1938

Fig. 1.

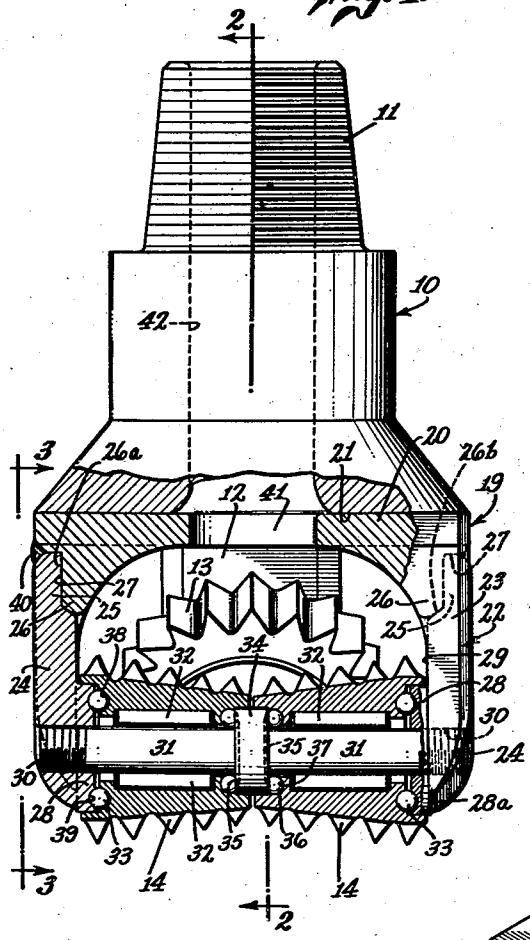
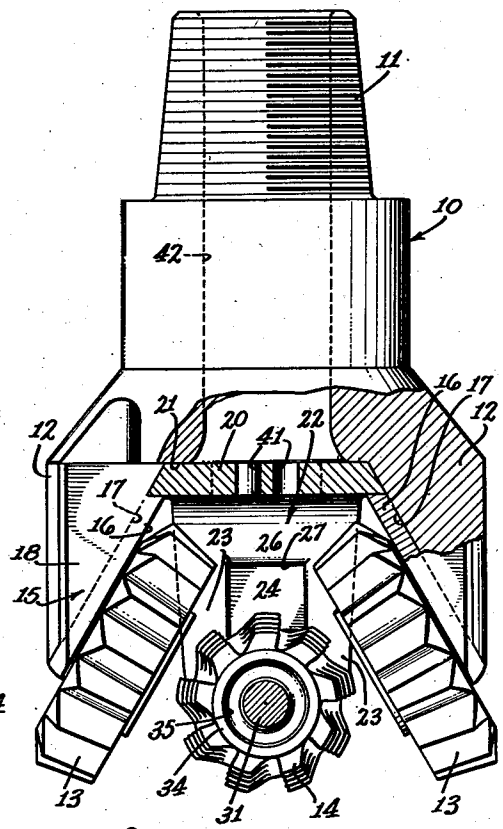


Fig. 2.



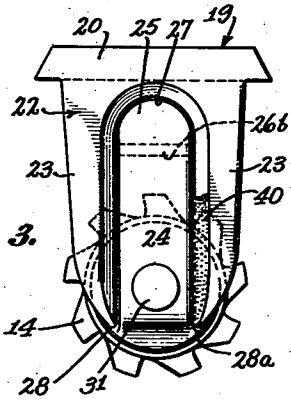


Fig. 3.

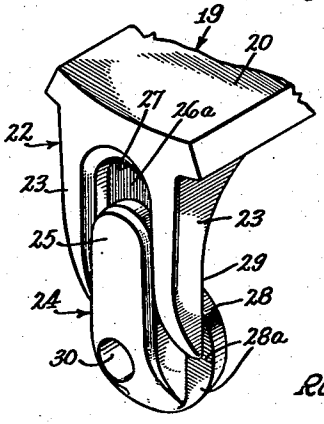


Fig. 4.

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Patented Sept. 17, 1940 2,215,264

UNITED STATES PATENT OFFICE

2,215,264

ROTARY DRILL BIT

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Application November 16, 1938, Serial No. 240,677

13 Claims. (Cl. 255—71)

This invention relates to drill bits for the rotary drilling of bore holes, such as oil wells, being particularly concerned with the manner in which the cutters are rotatably mounted and carried by the bit structure.

In a widely used type of roller drill bit, depending arms are provided to support a transversely extending shaft device carrying roller cutting elements designed to remove the central portion of the formation being operated upon. Detrimental deflection of the shaft device has been avoided heretofore by providing an intermediate bridge support. However, such constructions reduce the digging effectiveness of the bit since the cutters do not extend along the whole length of their shaft device, being interrupted by the bridge and either leaving a core at the center of the hole, which retards drilling progress, or requires that one cutter do the major share of the digging, as in constructions in which the bridge is offset to one side of the center line of the bit.

It is an object of this invention to provide a bit having a transversely extending shaft device free from detrimental deflection, such freedom being obtainable without the use of an intermediate supporting bridge.

A further object of the invention is to provide a rigid shaft construction in a drill bit having cutters extending substantially along the entire length of the shaft; thus preventing the production of a core in the hole, and equalizing the work done by the cutters.

Still another object of the invention is to provide an improved bearing mounting for the cross cutters of a rotary drill bit.

Another object of the invention is to eliminate lost motion or end play between roller bit cutters and their supporting bearing parts.

A further object of this invention is to provide a simple expedient for insuring snug bearing engagement between rolling bearing elements and the cutters of a drill bit.

Another object of the invention is to provide a sturdy rotary bit construction, economical to manufacture, and easily assembled and disassembled.

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

Referring to the drawing:

Figure 1 is a sectional view, parts being shown in elevation, of a roller drill bit embodying the invention;

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

Figure 3 is a front elevation as seen along the plane 3—3 of Figure 1; and

Figure 4 is a perspective of part of the bit device, elements being shown separated for purposes of clarity.

The drill bit disclosed in the drawing includes a main supporting body or shank 10 having a threaded pin 11 at its upper end for attachment of the tool to a drilling string (not shown). Depending from the shank are a pair of integral legs 12, 12 rotatably carrying side cutter rollers 13, 13 which can remove the outer portion of the formation in the hole being operated upon. The shank 10 also carries the cross roller cutters 14, 14 through suitable supporting and bearing mechanism to be described hereinafter. These cutters serve to remove the remaining, central portion of the formation material at the bottom of the hole.

The side roller cutters 13, 13 are rotatably supported on bearing supporting members 15, 15, each having a web 16 abutting an inclined thrust surface 17 on a cooperative leg 12, with side wings 18 cooperating with the sides of these legs. The outer ends of the wings 18 can be welded to the outer surface of each leg to secure the bearing supporting member to the shank. Details of construction of this portion of the bit are both claimed and described in my co-pending applications Rotary drill bit, Serial No. 190,444, filed Feb. 14, 1938; Rotary drill bits, Serial No. 201,750, filed April 13, 1938; and Roller bit bearing, Serial No. 226,950, filed Aug. 26, 1938. It is to be understood, however, that other modes of mounting and supporting the side roller cutters 13 than the one specifically indicated can be used without affecting the scope of the invention now to be described.

The cross cutter rollers 14, 14 are supported from a cutter carrier 19 having an upper plate portion 20 abutting against a surface 21 of the shank extending between a recess partly defined by the depending integral legs 12, 12. Depending from the abutting shank portion of the cutter carrier are a pair of arms 22, 22 each of which is bifurcated to provide branches 23, 23 between which are received a supplementary arm or bracket 24. The upper end 25 of each bracket 24 is stepped to overlap an arm rib 26 extending between the bifurcations 23, 23 and forming with those portions a recess 27 receiving the stepped bracket portion 25. The lower end of the bracket is provided with a generally cylindrical end thrust bearing or boss 28 abutting against the side surfaces 29 of the bifurcations 23. The upper part 25 of the bracket therefore engages

with an outwardly directed arm surface while the lower portion 28 engages with inwardly directed arm surfaces.

The lower end of each bracket is provided with a bore 30 threadedly receiving an end of a transverse bearing shaft 31. This shaft carries the cross cutter rollers 14, radial bearing loads between the cutters and the shaft being transmitted through the roller bearings 32, while outwardly directed end thrusts or axial loads are transmitted between the cutters and the bosses 28 through the intermediate bearing balls 33. Inwardly directed end thrusts are transmitted from the cutters to the transverse shaft by providing an enlarged central flange 34 on the shaft which has formed in its outer faces raceways 35 for receiving the bearing balls 36, the latter also being rollable in complementary raceways 37 formed at the inner ends of the cross roller cutters.

The cross cutter rollers 14, 14 and their associated bearing and supporting parts can be assembled by placing an inner set of bearing balls 36 on the central flange raceway 35 and a set of roller bearings 32 in one of the cutters. The cutter with the roller bearings in position is then placed over this shaft, its inner raceway 37 abutting the inner set of bearing balls 36. The outer set of bearing balls 33 is then placed in the outer cutter bearing raceway 38 and the supplementary arm or bracket 24 threaded onto the end of the transverse shaft until its raceway 39 engages this outer set of balls and end play or lost motion is eliminated by the snug but freely rolling engagement of the balls with their cooperative raceways. The other cross cutter and its bearings and bracket can be assembled on the other end of the shaft in a similar manner.

This assembly is then placed between the arms 24, 24 of the cutter carrier 19 with the outer surfaces 28*a* of the bearing bosses 28 engageable with the inner portions 29 of the bifurcations and the upper parts 25 of the supplementary arms or brackets 24 abutting against both the outer faces 26*a* and the beveled under faces 26*b* of the ribs. The brackets 24 can then be rigidly secured to the cutter carrier 19 by welding in material 40 in a groove formed between each bracket and the arm bifurcations 23, 23. If deemed essential, the ends of the transverse shaft can also be welded to the supplementary arms 24 at the outer region of the threaded bore 30.

The upper portion 20 of the cutter carrier 19 is provided with slots 41 communicating with a shank passageway 42, in order to direct drilling mud or other liquid upon the cutters to clean them of cuttings.

The construction described permits the cutters 14, 14 to overlap the central flange 34 and extend substantially to the axis of the bit and the hole being produced, eliminating the usual central core and increasing the rate of formation removal by the drilling tool. Despite the omission of the usual central bridge for supporting the transverse shaft 31, the design of the shaft is such as to provide a rigid structure possessing great resistance to bending and deflection. Such resistance is offered by the shaft itself, since the provision of the enlarged central flange 34 makes it possible for the shaft to carry safely a greater bending moment than if the shaft possessed its smaller roller bearing diameter along its whole length. In addition to adding to the resistance to bending, the central flange 34 also offers a simple expedient for transmitting inwardly directed end thrusts directly from the cutters to the shaft, preventing a rubbing action between the end faces of the cross cutters. Outwardly directed end thrusts are transmitted to the bracket bosses 28, from where they will pass directly to the carrier arms 22 in view of the abutting relationship between their inner surfaces 29 and the bosses. Axial motion by the cutter along its shaft in either direction is thereby prevented, increasing the life of the bearings and of the drilling bit as a whole.

I claim:

1. A roller bit for drilling bore holes including a supporting body, a pair of spaced arms depending from said body, a shaft extending between and carried and supported only by said arms, said shaft having a central flange between its ends, cutters rotatably mounted on said shaft along their entire length and supported substantially entirely thereby, and a plurality of balls between each cutter and said flange for transmitting end thrusts therebetween, said cutters overlapping said flange about its entire circumference and substantially along its entire length, whereby said cutters are operative upon the formation at the axis of the bore, the shaft being of ample diameter throughout its length to withstand heavy loads imposed on said cutters, and said flange being of still greater diameter to increase the rigidity of the shaft.

2. A roller bit for drilling bore holes including a supporting body, a pair of spaced arms depending from said body, a shaft extending between and secured to said arms, said shaft having a central cylindrical flange between its ends, a cutter rotatably mounted on said shaft between said flange and one of said arms, a second cutter rotatably mounted on said shaft between said flange and the other arm, rolling bearing elements between said cutters and said flange and also between the outer ends of respective cutters and said arms for transmitting end thrusts, said cutters overlapping said flange about its entire circumference and substantially along its entire length, whereby said cutters are operative upon the formation at the axis of the bore.

3. A roller bit for drilling bore holes including a supporting body, a pair of spaced arms depending from said body, a straight shaft extending between said arms and threadedly secured thereto, said shaft having a central cylindrical flange between its ends, a cutter rotatably mounted on said shaft between said flange and one of said arms, a second cutter rotatably mounted on said shaft between said flange and the other arm, said flange being provided with raceways in its side faces, raceways in the ends of said arms and at both ends of each cutter, and balls in said raceways between the inner ends of said cutters and said flange and also between the outer ends of said cutters and said arms for transmitting end thrusts, the inner ends of said cutters overlapping said flange about its entire circumference and substantially along its entire length, whereby said cutters are operative upon the formation at the axis of the bore.

4. A roller bit including a supporting body, a plurality of spaced bifurcated arms depending from said body, a supplementary arm fixed to each arm and positioned between its bifurcations, a shaft extending between and secured to said supplementary arms, said shaft having a

flange between its ends for increasing its resistance to bending, and cutters rotatably mounted on said shaft between its flange and supplementary arms.

5. A roller bit including a supporting body, a plurality of spaced bifurcated primary arms depending from said body, a supplementary arm fixed to each primary arm and positioned between its bifurcations, each supplementary arm having an upper portion in overlapping engagement with an outwardly facing primary arm portion and a lower boss in overlapping engagement with inwardly facing primary arm bifurcations, a shaft extending between and secured to said supplementary arms with its ends within said bosses, said shaft having a flange between its ends, cutters rotatably mounted on said shaft, and means for transmitting bearing loads between said cutters and said flange and bosses.

6. A roller bit including a supporting body, a pair of bifurcated primary arms depending from and detachably secured to said body, a supplementary arm fixed to each primary arm and positioned between its bifurcations, a shaft extending between and secured to said supplementary arms, and cutters rotatably mounted on said shaft.

7. A roller bit including a supporting body, a pair of bifurcated primary arms depending from said body, a supplementary arm fixed to each primary arm and positioned between its bifurcations, each supplementary arm having an upper portion in overlapping engagement with an outwardly facing primary arm portion and a lower boss in overlapping engagement with inwardly facing primary arm bifurcations, a shaft extending between said arms with its ends threadedly received within said bosses, said shaft having a central flange between its ends, cutters rotatably mounted on said shaft, said bosses, cutters and flange being provided with end raceways, and rolling elements in said raceways for transmitting bearing loads between said cutters and said flange and bosses.

8. A roller cutter assembly including a shaft having a cylindrical flange intermediate its ends, an arm threaded onto each end of said shaft, each arm having an inwardly directed boss, a cutter rotatably mounted on said shaft between its flange and each boss, raceways in the ends of each boss, cutter and flange, and rolling elements in said raceways for transmitting bearing loads between said cutters and said flange and bosses.

9. A roller bit including a main body, a cutter carrier detachably secured to said body, said carrier having a pair of depending primary bifurcated arms, a supplementary arm fixed to each primary arm and positioned between its bifurcations, each supplementary arm having an upper portion in overlapping engagement with an outwardly facing primary arm portion and a lower boss in overlapping engagement with inwardly facing primary arm bifurcations, a shaft extending between and secured to said supplementary arms with its ends within said bosses, said shaft having a central flange, cutters rotatably mounted on said shaft, and means for transmitting bearing loads between said cutters and said flange and bosses.

10. A roller bit for drilling bore holes including a supporting body, a plurality of arms depending from said body, a shaft extending between and carried and supported only by said arms, said shaft being of sufficient diameter throughout its length to withstand heavy loads imposed thereon, said shaft having a radially enlarged central stiffening flange between its ends and a raceway on each side of said flange extending substantially from said flange to one of said arms, a cutter rotatably mounted on said shaft on each side of said flange and overlapping said flange about its entire circumference and substantially along its entire length, whereby said cutters are operative upon the formation at the axis of the bore, and rolling bearing elements between each shaft raceway and an associated cutter for transmitting substantially all radial bearing loads therebetween.

11. A roller bit including a supporting body, a pair of spaced arms depending from said body, a unitary shaft extending between and carried by said arms, said shaft having a flange between its ends and a radial bearing raceway on each side of said flange extending substantially from said flange to one of said arms, a cutter rotatably mounted on said shaft on each side of said flange, roller bearings between each of said cutters and an associated raceway, and ball bearings between each cutter and flange.

12. A roller bit for drilling bore holes including a supporting body, a plurality of spaced arms depending from said body, a shaft extending between and secured to said arms, said shaft having a central cylindrical flange between its ends and a raceway on each side of said flange extending substantially from said flange to one of said arms, a cutter rotatably mounted on said shaft on each side of said flange and overlapping said flange about its entire circumference and substantially along its entire length, whereby said cutters are operative upon the formation at the axis of the bore, rolling bearing elements between each raceway and an associated cutter for transmitting substantially all radial bearing loads therebetween, rolling bearing elements between the inner end of each cutter and flange for transmitting axial thrust in one direction, and rolling bearing elements between the outer end of each cutter and an adjacent arm for transmitting axial thrust in the other direction.

13. A roller bit for drilling bore holes including a supporting body, a plurality of spaced arms depending from said body, a shaft extending between and secured to said arms, said shaft having a central cylindrical flange between its ends and a roller raceway on each side of said flange extending substantially from said flange to one of said arms, a cutter rotatably mounted on said shaft on each side of said flange and overlapping said flange about its entire circumference and substantially along its entire length, whereby said cutters are operative upon the formation at the axis of the bore, ball bearing elements between the inner end of each cutter and flange, ball bearing elements between the outer end of each cutter and an adjacent arm, and roller bearing elements on each roller raceway between the inner and outer ends of each cutter for transmitting radial bearing loads between said cutter and raceway.

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