April 19, 1932. A. F. POWELL 1,854,623

ROCK DRILLING BIT

Filed June 6, 1928

Fig. 1.

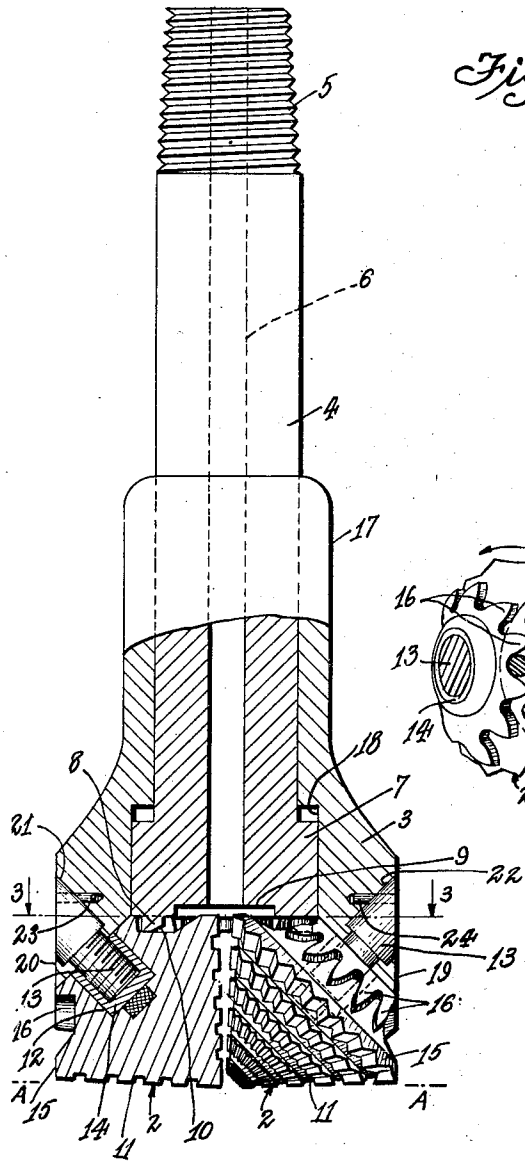
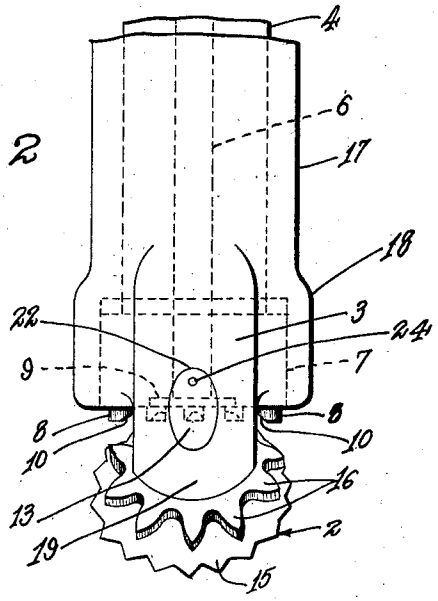


Fig. 2



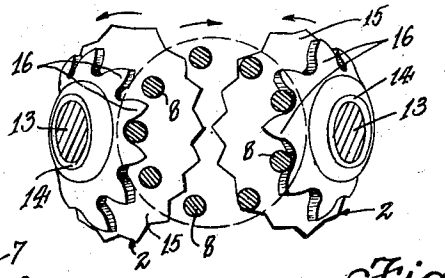


Fig. 3.

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UNITED STATES PATENT OFFICE

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ROCK DRILLING BIT

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This invention relates to a rock drilling bit and refers particularly to a rock drilling bit for use in drilling wells by the hydraulic rotary method.

An object of the present invention is to provide a drilling bit of the class intended for drilling through hard or semi-hard rock, by means of roller cutters in which there is provided a means for imposing the load from the drill pipe directly upon the rolling cutters whereby the pins and bushings employed for rotatably mounting the rolling cutters are, to a considerable extent, relieved from this pressure.

Another object of the present invention is to provide a means for directly driving the roller cutters of the drill bit from the rotation of the drilling pipe so that the drilling torque is transferred directly from the drill pipe to the cutters rather than being imposed upon the pins or bushings employed for rotatably mounting the cutters.

A further object of the present invention is to provide a drilling bit in which the rotation of the roller cutters at the bottom of the well, as well as the planetating movement of the cutters is reduced for the same rotation of the drill pipe over that which is usual in bits of this type.

Various further objects and advantages of the present invention will be apparent from a description of the preferred form or example of a drilling bit employing the invention. For this purpose, reference is made to the accompanying drawings in which there is illustrated the preferred form of drilling bit.

In the drawings:

Figure 1 is an elevation partially in vertical section of the drilling bit.

Figure 2 is a fragmentary elevation at right angles to Figure 1 and

Figure 3 is a section on the line 3—3 of Figure 1, the ends of the head and pins being removed.

Referring to the drawings, the drilling bit is illustrated as comprising a plurality of rolling cutters 2 rotatably mounted by a head 3, which head in turn is rotatably mounted upon a driving member 4. The drive member 4 is indicated as provided with a tapered pin 5 at its upper end which serves as a means by which the drilling bit may be attached to a string of drill pipe and rotated in the bottom of a well hole. The driving member 4 is shown as preferably provided with an axial passage 6 for conveying the flushing fluid through the driving member to the top of the cutters 2 where the flushing fluid will be discharged between the adjacent faces of the rolling cutters.

The driving member 4 is indicated as having an enlargement 7 at its lower end which serves as a means for holding the head 3 of the bit to the driving member. The driving member is further shown as provided with a plurality of depending pins 8 which may be integral with the head 7, which depending pins 8 serve as means for forming a gear connection between the head 7 of the driving member 4 and the roller cutters 2. The head 7 of the driving member 4 is also preferably provided with a recess 9 at its lower end, to provide clearance between it and the outer cutting edges of the cutting rollers 2. The pins 8 of the driving member are also indicated at 10 as cut away to clear the back surface of the cutting rollers 2.

The cutting rollers of the drilling bit are preferably made with conical or frusto-conical cutting faces 11 which may be cut in any preferred or desired manner into teeth or suitable cutting ridges or projections, and the cutting rollers 2 are disposed on axes which converge substantially at the axis of the drilling bit. The axes of the cutting rollers 2 are preferably at about 45° with the horizontal plane and the preferred form of the bit includes two diametrically opposite cutting rollers. The cutting rollers 2 are further provided at their rear ends with recesses 12 for receiving pins 13 and bushings 14 which serve as a means for rotatably mounting the cutters 2 upon the head 3. The rear faces of the cutting rollers 2 are indicated as provided with a tapered surface 15 of general frustro-conical shape, the apex of which is in the opposite direction to that of the apex of the cutting face of the cutters. The base of the rear frusto-conical portion of the cutter 2 is pro-

vided with gear teeth 16, shaped to coact with the gear pins 8 on the driving member 4 and shaped so that in operating position, the tops of said gear teeth provide bearing faces engaging the bottom of the head 7 of the drive member 4, while the bottoms of the grooves formed by the teeth form additional bearing surfaces engaging the bottoms of the gear pins 8. The taper of the rear face of the cutters 2 and of the top faces of the gear teeth 16 are preferably such that these bearing faces are substantially horizontal when they are rotated to the upper position.

The relationship between the taper of the crushing surfaces of the cutters and the taper of the driving or thrust surfaces of the cutters may also be described by the specification that the generating line of the frusto-conical crushing surface of the cone is parallel to the generating line of the thrust or driving surface of the cone which is on the opposite side of the axis in any section taken through the axis of the cutter. Thus in Figure 1 the generating line of the driving or thrust surface of the cone which corresponds to the section line 3—3 is parallel to the generating line A—A of the crushing surface of the cone which is on the opposite side of the cutter axis.

The drive member 4 and its gear pins 8, and the cutting rollers 2, preferably, are so proportioned relative to each other, that the transfer of pressure from the drive member 4 through the bearing faces described, to the roller 2 take place at points vertically aligned with substantially the midpoint of the cutting faces of the cutters 2 at the bottom of the cutters. By this arrangement of the parts, it will be seen that the drilling pressure is transferred directly from the drive member 4 over the center of the cutting operations without the drilling pressure passing through the pins 13 and bushings 14 rotatably mounting the cutters.

The head 3 of the drilling bit has a neck 17 having a running fit with the driving member 4 above the head 7 of said drive member and the head 3 has its bore enlarged as indicated at 18, to form a running fit with the head 7 of the drive member. The enlargement 18 of the bore of the head 3 is made of sufficient length, as to clear slightly the top of the enlargement 7 of the drive member. Head 3 forms two lugs 19 and 20, having upwardly tapering inner faces against which the rolling cutters 2 bear and the lugs 19 and 20 have openings 21 and 22 receiving the pins 13 which mount the cutters 2. There is also preferably provided lock pins 23 and 24 for locking the bearing pins 13 to the head 3.

In operation of the bit herein described, the drive member 4 is continuously rotated under a downward pressure from the drill pipe while a flushing fluid is continuously circulated through the passage 6. The gear connection between the drive member 4 and the roller cutters 2 synchronizes the rotation of the cutters and causes the roller cutters 2 to planetate in the bottom of the well hole rolling upon the formation, so that the cutting teeth, ridges or projections thereof, penetrate the rock formation. In the drilling operations, due to the direct imposition of both the turning torque and vertical load upon the cutters 2, the bushings 14 and bearing pins 13 of the cutters are relieved from any material stresses so that the wear takes place almost exclusively upon the cutting faces and projections of the cutters. In operation, this is found to prevent the cutters from wearing the pins so that the cutters will be moved into interlocking position and also further to prevent any twisting or bending of the supporting pins and further, to prevent the cutters from being moved inwardly and changing the diameter of the well bore. It is further found in operation, that a less torque is placed on the drill pipe with the bit of the present invention than is customary in previous forms of bits, decreasing the hazards of twisting the bit off in the well hole.

Another important advantage of the present invention resides in the fact that due to the direct imposition of torque and vertical load on the cutters, a greater vertical load may be applied to it in operation than is customary.

A bit of the present invention is found to drill more rapidly in a well hole because of the fact that greater vertical pressure may be placed on the bit and a slower speed of rotation of the cutters employed, which results in a more rapid rate of drilling with less wear of the drilling cutters.

While the form of drilling bit herein described is well adapted for carrying out the objects of the present invention, it is understood that various modifications and changes may be made without departing from the principles of the invention and the invention includes all such changes and modifications as come within the scope of the appended claims.

I claim:

1. A drilling bit comprising: a drive member; roller cutters; a head rotatably mounted on said drive member and rotatably mounting said roller cutters; means for driving said roller cutters with the rotation of said drive member; and means for imposing vertical load directly from the drive member to each of said roller cutters at a point vertically aligned with the approximate center of the portions of the cutting faces of the cutters occupying the lower position.

2. A drilling bit comprising: a drive and supporting member; a plurality of cutting rollers including cutting teeth and separate gear teeth; a head swiveled upon said drive member and revolvably mounting said cutting rollers; and gear means carried by said

drive member and engaging the gear teeth of said cutting rollers.

3. A drilling bit comprising: a drive member; a plurality of cutting rollers having cutting teeth and separate gear teeth; a head swiveled upon said drive member and revolvably mounting said cutting rollers; and gear means between said drive member and said cutting rollers, said gear means being arranged to serve as a means for transferring vertical load from the drive member to the cutters.

4. A drilling bit comprising: a drive member; a plurality of cutting rollers; a head swiveled upon said drive member and revolvably mounting said cutting rollers; and gear means between said drive member and said cutting rollers, said cutting rollers having thrust receiving surfaces and cutting surfaces, said surface being arranged so that the uppermost portions of the thrust receiving surface are at all times disposed directly above the lowermost portions of the cutting surface, said gear means being thus arranged to serve as means for transferring vertical load to said cutting rollers as well as turning torque.

5. A drilling bit comprising: a head; cutting rollers having conical cutting faces, the axes of which substantially converge at the axis of the bit, said cutting rollers being revolvably mounted by said head, said cutting rollers having rear faces angled relative to the conical cutting faces, the rear faces of said cutting rollers forming bearing surfaces; a drive member extending through said head and engaging said bearing surfaces for directly transferring vertical load to said cutting rollers; and gear means between said cutting rollers and said drive member.

6. A drilling bit comprising: a head; cutting rollers rotatably mounted by said head on axes converging substantially at the axis of the bit, the cutting rollers having frusto-conical shaped cutting faces and having rear bearing faces angled relative to the cutting faces; a drive member on which said head is swiveled; and gear means between said drive member and said cutters, said gear means operating to transfer the vertical load directly from the drive member to the cutting rollers in vertical alignment with the approximate center of the lower portions of the cutting surfaces of the rollers which occupy momentarily the cutting positions.

7. A cutter for a drilling bit having a conical cutting face at one end end a conical bearing face on the other end, the apex of the cutting face being towards the forward end of the cutter and the apex of the bearing face being towards the rear end of the cutter, said bearing face including gear teeth.

8. A drilling bit comprising: a drive member having an axial water course; a head swiveled on the drive member; cutting rollers rotatably mounted on said head in position to have their cutting faces cleaned by fluid from said passages; and means for directly transferring vertical load and torque from the drive member to the cutting rollers.

9. A well drilling bit comprising: a plurality of cutting members; a head upon which said members are rotatably mounted; a main rotatable driving and supporting member upon which said head is swivelled; means for driving said cutting members with the rotation of said driving and supporting member; and means for transmitting vertical load directly from the main driving and supporting member to said cutters.

10. A rolling cutter for a well drilling bit, said rolling cutter having a main crushing surface with crushing projections and an integral thrust receiving surface including gear teeth, said surfaces being arranged so that the uppermost portions of the thrust receiving surface will at all times be disposed directly above the lowermost portions of the cutting surface.

11. A rolling cutter for a well drilling bit, said rolling cutter having a conical cutting and crushing surface at one end having gear-like crushing projections shaped so that when said cutting surface is moved against a formation with a true rolling motion it will be geared to said formation, the rolling cutter having a conical thrust receiving surface at the other end which surface includes gear teeth, the apex of the conical thrust receiving surface being disposed at the opposite end of the cutter from the apex of the cutting surface, said surfaces being arranged so that the uppermost portions of the thrust receiving surface will at all times be disposed directly above the lower portions of the cutting surface.

12. A drilling bit comprising: a drive member; a head; cutting rollers rotatably mounted by said head on axes converging substantially at the axis of the bit, said head being rotatable and axially slidable on said drive member; bearing surfaces on said cutting rollers, said drive member engaging said bearing surfaces for directly transferring vertical load to said cutting rollers; and gear means between said cutting rollers and said drive member.

13. A rotary well drilling bit comprising: a driving shank; a head rotatable about said driving shank; cutters rotatably mounted on said head and adapted to roll on the formation to be drilled; and gear means connecting said cutters with said driving shank operating as load transmitting means, said cutters having frusto-conical crushing surfaces and frusto-conical thrust surfaces on opposed ends thereof, the generating line of the conical crushing surface being parallel to the generating line of the conical thrust surface on the opposite side of the cutter axes.

14. A rotary well drilling bit comprising: a driving shank; a head rotatable about said driving shank; cutting rollers rotatably mounted on said head; means for driving said cutting rollers with the rotation of said driving shank; and means for imposing vertical load from said driving shank directly upon said cutting rollers at a point vertically aligned with approximately the center of the crushing surfaces of said cutting rollers at the bottom of the drilling bit.

15. A rotary well drilling bit comprising: a driving shank; a head rotatable about said driving shank; rolling cutters rotatably mounted on said head; and means for directly connecting said driving shank and said rolling cutters operative for transmitting the load vertically and drilling torque directly from said driving shank to said rolling cutters.

16. A rotary well drilling bit comprising: a driving shank; a head rotatable about said driving shank; rolling cutters rotatably mounted on said head; and gear means connecting said driving shank and said rolling cutters, said gear means being arranged to serve as vertical load transmitting means between said driving shank and said cutters and being arranged to transmit vertical load to said cutters at points vertically aligned with approximately the center of the crushing surfaces of said cutters which occupy the cutting position.

17. A rotary well drilling bit comprising: a driving shank; a head rotatable about said driving shank; rolling cutters rotatably mounted on said head, said cutters having conical crushing surfaces and axes of rotation substantially converging at the axis of the bit, said cutters having rear conical thrust receiving surfaces; and driving means connecting said driving shank with said rear thrust receiving surfaces of said cutters for directly transmitting vertical load and drilling torque to said rolling cutters.

18. A rotary well drilling bit comprising: a driving shank; a head rotatable about said driving shank; rolling cutters rotatably mounted on said head, said rolling cutters having conical cutting faces, the axes of rotation of said cutters substantially converging at the axis of the bit, the rear faces of said rolling cutters forming bearing surfaces; and gear means connecting said driving shank with said rear faces of said cutting rollers, thereby to transmit directly vertical load and drilling torque from said driving shank to said cutting rollers.

19. A rolling cutter for a rotary well drilling bit, said cutter having a frusto-conical crushing surface with cutting projections and an approximately frusto-conical driving surface, the apices of such frusto cones being on opposite ends of the cutter, the frusto-conical driving surface having recessed gear teeth.

20. A rolling cutter for a well drilling bit, said cutter having a frusto-conical cutting surface with cutting projections, a frusto-conical drive surface integral with the crushing surface, and having its apex at the opposite end of the cutter, the generating line of the crushing surface being parallel to the generating line of the driving surface on opposite sides in any section through the axis of the cutter.

21. In a drill: a substantially conical roller having longitudinal cutting teeth and separate driving teeth; and drive means on said drill meshing with said driving teeth.

22. In a rotary bit of the character described, the combination of: a head; an inclined cutter pivoted on said head, said cutter having an axis intersecting the axis of rotation of said bit; and means rotatable axially of said bit and engaging said cutter to take up non-axial thrust upon said cutter.

23. In a rotary bit of the character described, the combination of: a head; a cutter pivoted on said head, said cutter having cutting teeth and separate driving teeth; and means engaging said driving teeth adapted to synchronize the rotation of said cutter and take up non-axial thrust thereon.

24. In a rotary bit of the character described, the combination of: a head; a plurality of cutters pivoted on said head; said cutters having cutting teeth and separate driving teeth; and means bridging said driving teeth adapted to synchronize the rotation of said cutters and take up non-axial thrust imposed thereon.

Signed at Los Angeles, Calif., this 14th day of May, 1928.

ALFRED F. POWELL.