

May 11, 1937.

C. A. DEAN

2,080,116

DRILL

Filed Aug. 5, 1933

2 Sheets-Sheet 1

Fig. 2.

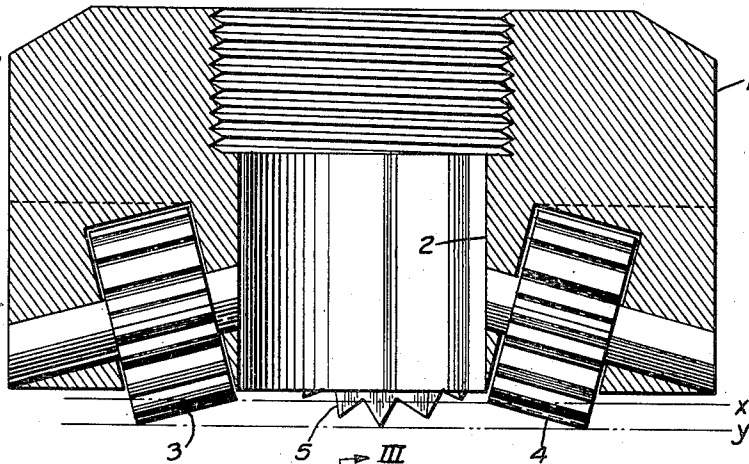
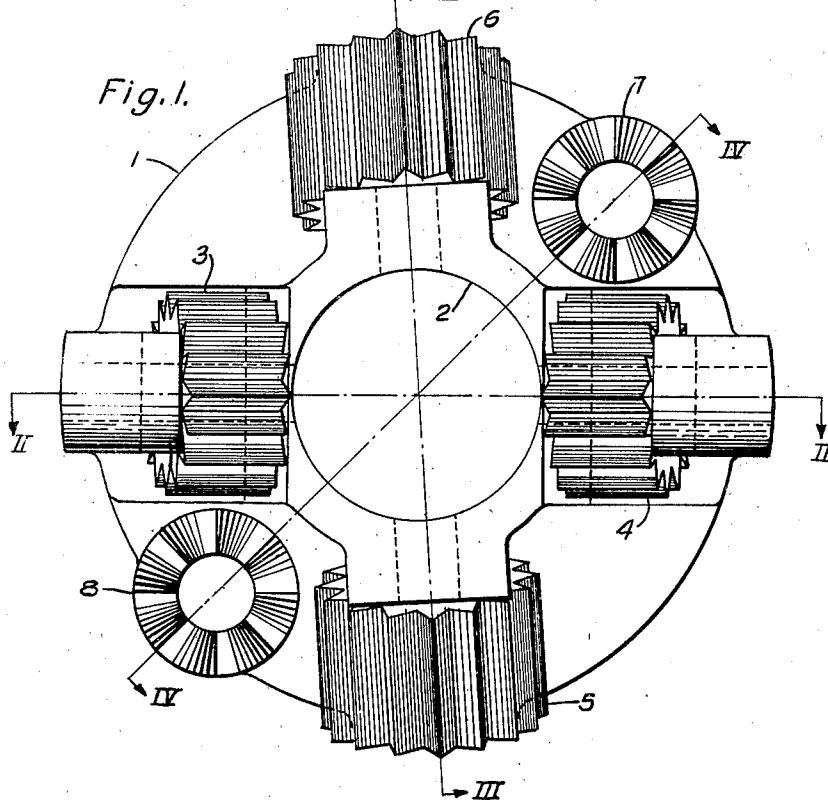


Fig. 1.



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Fig. 4.

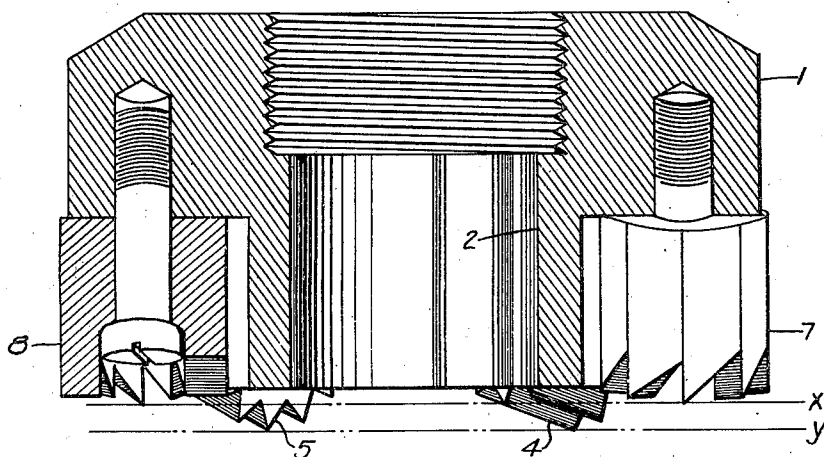
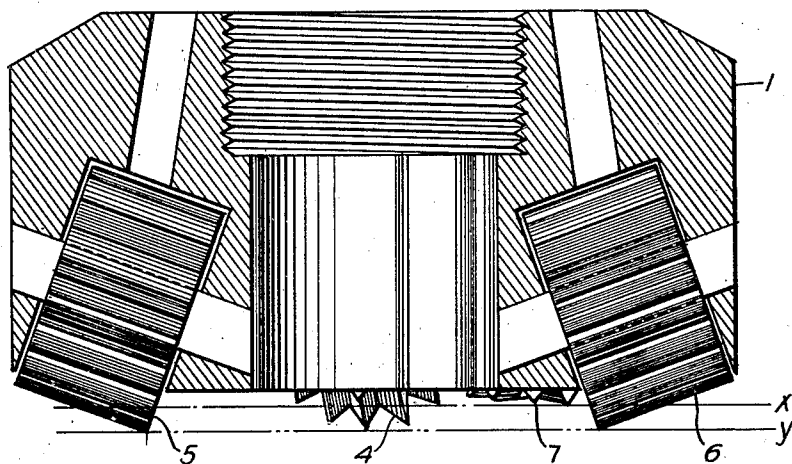


Fig. 3.



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2,080,116

DRILL

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12 Claims. (Cl. 255—72)

This invention pertains to earth drills adapted to form core samples by means of roller cutters.

As core drilling proceeds into rocky formations the increased burden on the cutters aggravates any lack of balance in action of the drill. Defects become cumulative. Vibration of the cutting head is accentuated by the length, weight and flexibility of the drill stem. At depths of several thousand feet deflections of the drill only a fraction of an inch in magnitude often ruin core samples.

Many problems of coring hard formations originate from wear of the cutters. The drill hole gradually becomes smaller until attempts to introduce new cutters of full size in replacement of worn cutters often result in jamming the new cutters out of proper alignment, and impairing both the cutters and their supporting shafts. Cutters thus deflected wear unevenly and often bind on their shafts, with resulting further impairment of the cutting face.

Attempts to improve conditions have included specially designed cutters of conical shape, or special mountings such as those for expanding action of cutters. But proposals heretofore made impose excessive burden on narrow cutting edges, entail severe and often unbalanced wear on the cutters or their supporting structure, flatten the cutters and cause them to bind on their shafts.

Objects of this invention are to improve the efficacy of drills for coring rock formation, to minimize tendencies of such drills to deviate, to eliminate vibration and whipping of the drill head, and to assure preservation of the core being cut.

An object also is to provide balance of action in a core drill having a plurality of cutters, so as to increase the effectiveness and useful life of the cutters and decrease the necessity for replacement.

A further object of this invention is to improve the efficacy of roller cutters for coring hard formations, and to permit the use of roller cutters having extensive cutting edges relatively to the radius of the roller.

Particular objects are to protect the cutters that shape the core, to maintain full diameter of the drill hole substantially at the cutting face, and to preserve effectiveness of full-size replacement cutters.

Further objects appear in the present description and in the accompanying drawings illustrative of preferred embodiments of this invention.

This invention is predicated on my discovery of

an improved arrangement and mounting of a plurality of cutters to accomplish these and other objects. Preferably the drill comprises a combination of bottom-cutting rollers mounted on inclined shafts, with peripheral roller cutters mounted on longitudinal shafts to protect the outer edges of the bottom cutters.

In the drawings, illustrating a preferred embodiment of this invention,

Figure 1 is a bottom plan view of the core drill showing a general arrangement of pairs of cutters,

Fig. 2 is a vertical section of the drill head along the line II—II of Fig. 1, showing an arrangement of bottom cutters to shape the core.

Fig. 3 is a vertical section of the drill head along the line III—III of Fig. 1, showing an arrangement of hole bore cutters,

Fig. 4 is a vertical section of the drill head along the line IV—IV of Fig. 1, showing an arrangement of peripheral cutter protecting the edges of the bottom cutters.

Referring more particularly to the drawings, Fig. 2 shows a core drill cutter head adapted to be secured to a rotatable drill stem and having a central bore 2 for reception of a core sample as it is cut during progression of the drill hole. Roller cutters 3 and 4 are mounted to form the core to suitable diameter for the drill and to cut the hole bottom adjacent the core. As shown, these inner cutters preferably are cylindrical and are mounted to rotate on shafts inclined inwardly and upwardly at angles up to approximately thirty degrees, but preferably about fifteen degrees. These cutters have cutting edges substantially parallel to the axes of their shafts. The cutting edges are at least as great, and preferably exceed, the radius of the rollers. Thus the working stresses are well distributed along the shafts with a tendency to balance the radial thrusts and to keep each cutter close to the core and constantly in alignment to cut the core smoothly and gradually to size.

In Fig. 3 are shown roller cutters 5 and 6, adapted to cut the bottom of the bore hole outwardly from the core cutters 3 and 4. The bore cutters 5 and 6 preferably are cylindrical with extensive cutting edges substantially parallel to the axes of their shafts. These cutters are mounted on shafts inclined outwardly and upwardly at angles up to about thirty degrees but preferably about twenty degrees. Their cutting edges preferably exceed the radius of the rollers. Their inner edge cuts to substantially the same depth as the outer edge of core cutters 3 and 4. As shown in Fig. 1, the bore hole cutters 5 and

6 are mounted alternately and symmetrically around the drill with respect to inner cutters 3 and 4, to afford balance in the drill head. In practice these inner and outer cutters operate well at an angle of about 150°, but this may be varied with conditions.

In order that the core cutters 3 and 4 may retain constant alignment to assure a suitable core, it is desirable that the outer cutters 5 and 6, which operate on a longer radius from the drill center, be relieved of some of their burden, and that they be kept from wearing rapidly to a smaller size or to an irregular cutting face. These bottom roller-cutters have cutting edges preferably extending approximately to diameter of the bithead.

To co-operate particularly with the outer faces of cutters 5 and 6, cylindrical cutters 7 and 8 are mounted for rotation on longitudinal studs with relatively long cutting edges parallel to their axis of rotation. These rollers have cutting teeth on their bottom ends. The side cutting edges of longitudinal cutters 7 and 8 extend to the full diameter of the bore hole, flush or slightly beyond the cutters 5 and 6. They establish a long line of contact along the side wall. This edge not only reams the wall adequately and minimizes wear of these peripheral cutters, but steadies them, and indeed the entire drill head, against deflection and vibration.

The bottom teeth of reamer cutters 7 and 8 extend down to a level preferably intermediate those of the inner and the outer faces of inclined bottom cutters 5 and 6. This is illustrated in Figs. 3 and 4. As shown, the reamer teeth cut the bottom down to about the same depth as the outer half of outer cutters 5 and 6. They thus overlap the peripheral area of these outer radial cutters and relieve them of considerable burden and wear by cooperating to eliminate débris and by providing annular clearance. The reamer elements conjointly cut the side walls full size for the bithead and cut the edge of the bore below the outer edge of the outer bottom cutters. Thus the hole is reamed to the bottom as the bottom wall is formed and as the central cutters are advancing the inner portion of the bore. The burden on the peripheral cutters nevertheless is a minimum. During cutting and also on insertion of new cutters, the various surfaces of contact and of support move freely in proper alignment with preceding cuts. They operate with a long period of usefulness. Jamming and distortion and unequal wear are avoided. There is strength in the mounting of the peripheral reamers and there are no frangible elements to break or cause inadvertent jamming in lowering the drill through a casing.

It is of advantage that the position of each cutter remains fixed relatively to the others, each with an extensive cutting edge substantially parallel to its bearing support, and with angular thrusts balanced and minimized. This arrangement makes it feasible to mount the cutters on roller bearings. In form and mounting of cutters nevertheless the drill is notably simple.

A preferred modification of mounting the longitudinal reamer cutters 7 and 8 is shown in Fig. 4, in that their supporting studs are inclined slightly forward so that each forward bottom tooth leads in contacting the bottom of the hole. Their inclination is preferably about five or ten degrees. The purpose is to assure rotation of the reamers, with consequent improved cutting action and minimum wear. Such mounting also

strengthens the bearing support of these rollers, and the rigidity of the entire cutting head in drilling.

The shape and arrangement and slopes of the several cutters may be varied to meet particular requirements without departing from the principles of this invention. A greater number of cutters may be utilized either for large size drills or where the more nearly chiseling action of small diameter rollers is desirable. In accordance with the patent statutes, I have described what I now regard as the preferred embodiment of this invention, but within the terms of the appended claims various modifications and adaptations of this invention will now become apparent to those skilled in the art.

I claim as my invention:

1. A rotary core drill comprising a bithead having an axial opening to receive a core, a plurality of roller core cutters mounted in the head and adapted to cut bottom about a core to approximately full diameter of the bithead, and a rotatable cutter to ream the sidewalls journalled substantially longitudinally of the head and having bottom teeth extending below the outer periphery of the bottom roller cutters to cut the bore bottom peripherally to size of the bithead.

2. A rotary rock drill comprising a head having an axial opening to receive a core, a roller core cutter mounted in the bottom of the head to rotate about an upwardly and inwardly inclined axis to cut bottom adjacent the core substantially parallel to the said axis, and an outer roller cutter mounted in the bottom of the head to rotate about an upwardly and outwardly inclined axis to cut bottom substantially parallel to the said axis, and a cylindrical roller cutter journalled generally longitudinally of the head to ream the side walls, and bottom teeth on the reaming cutter extending below the outer peripheral edge of the outer roller bottom cutter to cut bottom to size peripherally in a portion of the formation traversable by the radial bottom cutters.

3. A rotary rock drill comprising a head having an axial opening to receive a core, a roller core cutter mounted in the bottom of the head and adapted to effect an upwardly and inwardly inclined cut in the bottom adjacent the core, an outer roller cutter mounted in the bottom of the head and adapted to effect an upwardly and outwardly inclined cut in the bottom, and a roller cutter journalled generally longitudinally of the head to ream the side walls, the longitudinal roller having bottom teeth extending below the outer peripheral edge of the outer cutter to cut bottom to size peripherally in a portion of the formation traversable by the radial bottom cutters, the longitudinal roller being of sufficient diameter to track the outer bottom cutter and a portion of the inner bottom cutter.

4. A rotary rock drill comprising a head having an axial opening to receive a core, a roller core cutter mounted in the bottom of the head and adapted to effect an upwardly and outwardly inclined cut in the bottom, and a roller cutter journalled generally longitudinally of the head to ream the side walls, the longitudinal roller having bottom teeth extending below the outer peripheral edge of the outer cutter to cut the bottom to size in a portion of the formation traversable by the radial bottom cutter, the longitudinal cutter being mounted to rotate about an axis having a slight upward and forward inclination.

tion for leading contact of the forward teeth with the bore bottom.

5. A rotary core-drill comprising a bit-head carrying roller-cutter elements to cut bottom and reamer elements rotatable about axes substantially longitudinal of the bit-head, the reamer elements being adapted to make cuts outwardly of the bit-head and overlapping and lower than the outermost cutting portion of the bottom roller-cutter elements.

6. A rotary core-drill comprising a bit-head carrying a bottom roller-cutter, and a rotatable reamer having side-wall cutting elements extending beyond the bit-head and bottom teeth extending below the outermost cutting portions of the bottom roller cutter, the reamer being rotatable on an axis extending substantially longitudinally of the bit-head.

7. A rotary core-drill comprising a bit-head carrying a bottom roller-cutter, and a rotatable reamer having side-wall cutting elements extending beyond the bit-head and bottom teeth extending below the outermost cutting portion of the bottom roller-cutter, the reamer being rotatable on an axis slightly inclined, longitudinally of the bit-head to afford preponderantly outward rotational thrust of the bore bottom against the bottom teeth.

8. A rotary core-drill comprising a bithead having mounted therein roller-cutter elements to cut bottom about a core comprising cutting elements inclined to the longitudinal axis of the bithead and additional elements to penetrate the bottom of the bore mounted in peripheral portions of the bithead and projecting across a portion of the bottom below and in the track of the outer cutting portion of the said inclined bottom cutter elements to effect a leading cut in said inclined bottom portion of a bore.

9. A rotary core-drill comprising a bithead having roller cutters for cutting bottom about the core mounted to rotate about axes disposed substantially in radial planes and a roller cutter mounted to ream the sidewalls and to rotate about

an axis substantially longitudinal of the head and elements for cutting the periphery of the bore bottom mounted to rotate about an axis common to themselves and to project below and in the track of the outer portion of the aforesaid bottom cutter elements.

10. A rotatable earth drill comprising a bit-head, roller cutters mounted therein to cut bottom having cutting surfaces inclined to the axis of the bithead, and a cylindrical rotatable reamer adapted to ream the sidewall having its axis generally longitudinal of the bithead and having cutting surfaces parallel to the axis of the bithead and extending down the side of the bithead to at least the cutting surfaces of the bottom cutters, to stabilize the drill and facilitate clearance at the periphery of the drill bottom.

11. A rotatable earth drill comprising a bit-head, roller cutters mounted therein to cut bottom having cutting surfaces extending radially to substantially the size of the bithead and inclined to the axis of the bithead, and a cylindrical rotatable reamer adapted to ream the sidewall having its axis generally longitudinal of the bithead and having cutting surfaces parallel to the axis of the bithead and extending down the side of the bithead to at least the cutting surfaces of the bottom cutters, the bottom of said cylindrical reamer being toothed, to stabilize the drill and facilitate clearance at the periphery of the drill bottom.

12. A roller bit for earth drilling comprising a head having in combination a cross-roller cutter mounted therein and having cutting elements positioned to cut bottom with a cut inclined to the axis of the drill, and a roller cutter mounted therein with its axis generally longitudinal of the bit and having cutting teeth extending across a portion of the bottom and positioned and adapted to effect a leading cut into the inclined bottom formation left below the cut of the said cross-roller cutter.

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