

Aug. 9, 1938.

C. E. REED

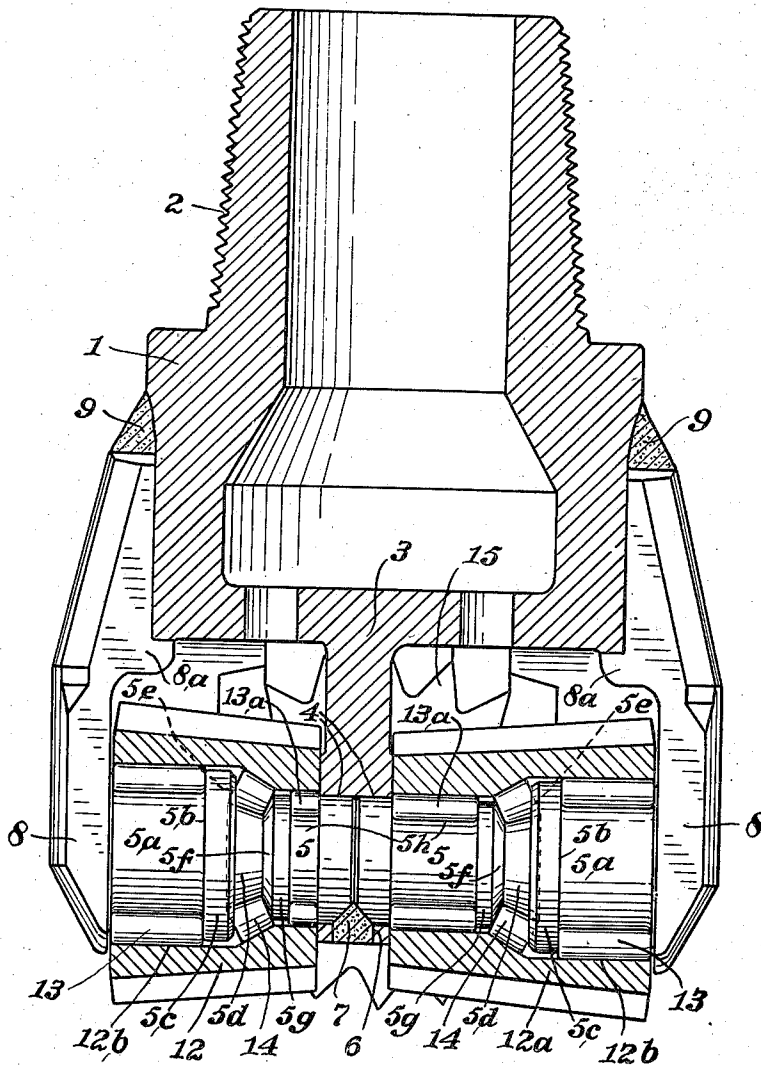
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EARTH BORING DRILL

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3 Sheets-Sheet 2

Fig. 2.



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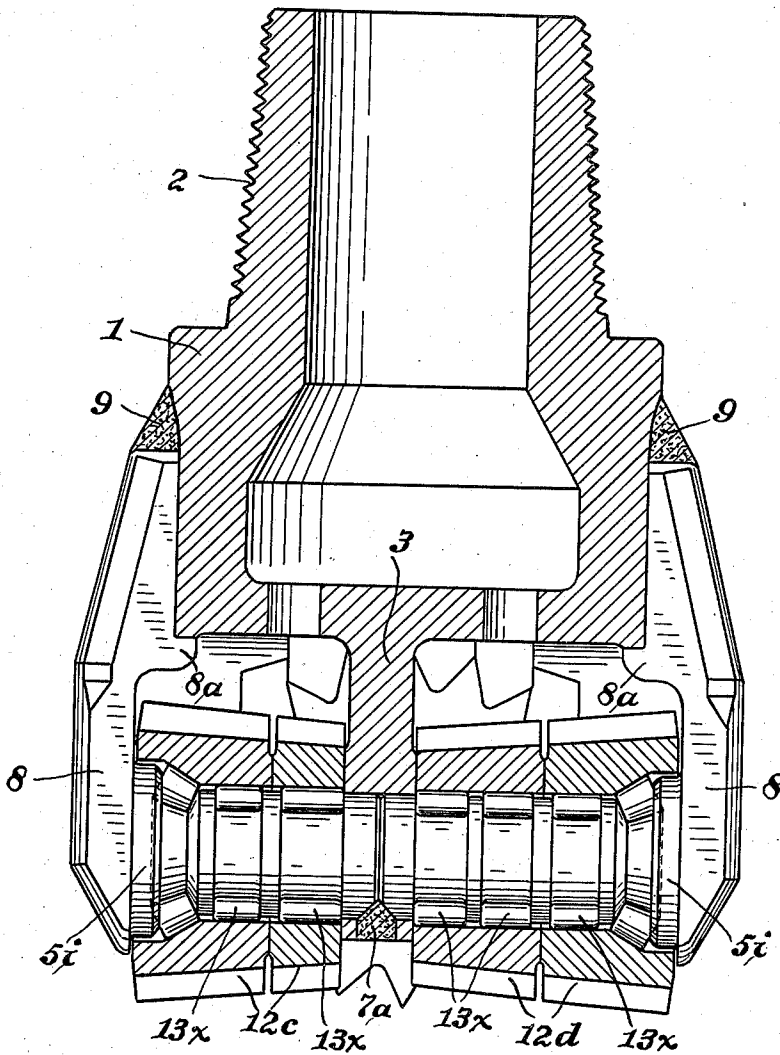
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Fig. 3.



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EARTH BORING DRILL

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15 Claims. (Cl. 255—71)

The invention concerns an earth boring drill of the cross roller type involving roller cutters arranged in a set across the lower face of the bit head in the same diametrical vertical plane together with inclined side roller cutters arranged in a diametrical vertical plane perpendicular to the diametrical plane first mentioned.

The invention consists in the features and combination and arrangement of parts hereinafter described and defined in the appended claims.

In the drawings:

Figure 1 is a view partly in side elevation and partly in central vertical section of a bit head embodying the invention.

Fig. 2 is a central vertical section in a plane at right angles to the sectional plane of Fig. 1.

Fig. 3 is a view similar to Fig. 2 of a modification.

The bit head 1 has a screw threaded portion 2 for attachment to the drill stem or pipe. A strut 3 integral with the bit head depends from its lower face and off to one side of the vertical center thereof.

This strut is perforated at 4 and receives therein the adjacent ends, preferably abutting, of the spindles 5, 5 which are horizontally disposed and are axially in alignment. An opening 6 is provided in the lower side of the strut and this enables welding together of the abutting ends of the cross roller spindles as indicated at 7. The outer ends of the spindles are integrally connected with shanks or hangers 8 which extend upwardly and are welded to the outer sides of the bit head as indicated at 9. The outer side of the bit head is provided with recesses 10 between pairs of flanges 11 disposed thereabout. These shanks extend into these recesses and in a direction generally upward at right angles to the axis of the cross roller spindles. Each hanger has a projection at 8a bearing on the under face of the bit head, to take up thrust of the cross rollers.

Cross roller cutters 12, 12a are mounted on the spindles 5 at the sides of the strut 3. These cross roller cutters are of frusto-conical form, their larger diameter ends being outermost, and located adjacent the shanks or hangers 8.

The spindles 5 have large diameter cylindrical portions 5a at their outer ends adjacent the hangers 8, providing raceways for cylindrical roller bearings 13 which find complementary cylindrical raceway surfaces at 12b at the outer portions of the cross roller cutters. These cylindrical raceways are defined at their inner ends

by shoulders 5b provided by flanges 5c of larger diameter than the cylindrical raceways 5a. Next to these flanges, towards the vertical axis of the drill, are frusto-conical surfaces 5d providing raceways for frusto-conical roller bearings 14. These are disposed with their larger end faces contacting the inner faces of the flanges 5c, which faces, as indicated at 5e, are provided by undercutting the inner side of the flange 5c. The smaller diameter ends of the frusto-conical bearing rollers 14 engage a frusto-conical surface 5f of a flange 5g integral with the spindle, and between this flange 5g and the vertical plane of the side of the strut 3, a cylindrical spindle portion 5h is provided of smaller diameter than the raceway portion 5a, and this smaller diameter cylindrical portion provides a raceway for cylindrical roller bearings 13a. The frusto-conical roller cutter 12, located at the left of Fig. 2, is of less length than that shown at 12a at the right of the strut 3, and the cylindrical bearings 5h at the opposite sides of the strut are of different length in order to conform to the difference in the length of the frusto-conical roller cutters.

The frusto-conical roller bearings 14 find frusto-conical raceway surfaces within the bearings of the frusto-conical roller cutters, and these frusto-conical roller bearings take upon their peripheries end thrusts of the roller cutters in a direction outwardly from the vertical axis of the drill towards the shanks or supports 8, and thereby relieve the cylindrical roller bearings 13 and 13a of end thrust, which otherwise would be imposed upon them by the peripheral contact therewith of the rotary cutters. As a result the cylindrical roller bearings will have a true rolling action upon the cylindrical raceway of the spindles because the outer end faces of the cylindrical roller bearings will be prevented from having undue frictional contact upon the shoulder at the outer end of the spindles adjacent the supports 8. Furthermore, the cylindrical roller bearings 13a also will be relieved of end thrust of the roller cutters in a direction outwardly from the vertical axis of the drill towards the side of the bore hole, which end thrust otherwise would result from the frictional contact of the roller cutter upon the peripheries of the cylindrical roller bearings.

Side roller cutters 15 are shown in Fig. 1, inclining downwardly and outwardly in a direction from the vertical axis of the drill to the sides of the bore hole, these side cutters cutting an annular path adjacent the side wall of the bore hole, including clearance for the bit head. These cut-

ters, of which there are two, track each other, and their axes lie in the same vertical plane passing through the vertical axis of the drill at right angles to the diametrical vertical plane in which the axes of the cross roller cutters above mentioned lie. Each of these inclined side roller cutters is mounted upon a spindle 16 inclining downwardly and inwardly towards the vertical axis of the drill, and supported at its outer end by one of the shanks or hangers 8x, extending substantially vertically and welded within a recess at the outer side of the drill. The spindle and its support 8x are in one piece.

There is a flange 8b on the body of the support which engages a seat surface on the depending arm 1b of the bit head, and there is a shoulder on the body of the spindle support at 8c which finds a bearing on a cross wall 1c at the top of a notch in the depending arm 1b. These flanges and shoulders 8b, 8c take thrusts upwardly from the roller cutter and the flange 8b also sustains thrusts outwardly of the bit head. The spindle 16 is provided with a frusto-conical surface providing a raceway for frusto-conical bearing rollers 17 which engage at their outer-larger diameter faces the undercut surface 16b of the flange 16c. The frusto-conical bearing rollers at their inner faces engage an inclined annular surface 16d of the flange 16e which is integral with the spindle 16. The whole spindle unit is integral with the hanger 8x and the body thereof.

A second set of frusto-conical bearing rollers 18 are arranged in a raceway 19 of a block 20 which is mounted on the inner portion of the spindle 16 and has an inclined face 21 bearing upon the edge of the strut 3 which has a correspondingly downwardly and outwardly inclined face to receive the said block 20. This block may be welded to the spindle 16 at 22. The frusto-conical bearing rollers 18 are on inclined axes in respect to the axis of the spindle 16, the smaller ends of said frusto-conical rollers 20 being directed outwardly while the smaller ends of the frusto-conical rollers 17 are directed inwardly towards the vertical axis of the drill. The side roller cutter is provided with raceway surfaces 15a and 15b which are oppositely inclined to be complementary to the peripheries of the frusto-conical bearing rollers 17 and 18 respectively. The frusto-conical bearing rollers 17 take end thrusts of the roller cutter 15 in a direction outwardly from the vertical axis of the drill, and the frusto-conical bearing rollers 18 take end thrusts of the side roller cutters in a direction inwardly of the bit head towards the vertical axis thereof. The bearing block 20 is welded to the strut 3 at 23.

It will be seen from the above that the roller cutter spindle and anti-friction bearing organization involves cross roller spindles, each having an upwardly extending support connected exteriorly of the bit head and side roller cutters each associated with a spindle having an upwardly extending shank with a support which is also exteriorly secured to the bit head, and the anti-friction roller organization includes each a row of frusto-conical rollers which take end thrust of the cutters in a direction outwardly from the vertical axis of the drill.

In Fig. 3 I show a modification of the cross roller organization in which there is a pair of roller cutters at each side of the strut 3, the members of each of these pairs being designated 12c and 12d. The frusto-conical roller bearings

in this modification are arranged near the outer end portions of the spindles on axes inclining towards the axes of the spindles, and with their outer end faces bearing on the undercut portions of a flange 5i adjacent the spindle support 8 and integral therewith. In this modification there are a series of cylindrical roller bearings disposed at different points along the spindles as indicated at 13x. These roller bearings at their ends contact with suitable flanges or shoulders on the spindles, and end thrusts of the roller cutters outwardly from the vertical axis of the drill are taken by the frusto-conical rollers on their peripheries and thus relieve the cylindrical roller bearings of end thrusts outwardly from the vertical axis of the drill which otherwise would be imposed by the roller cutters on the peripheries of these cylindrical bearing rollers. In this form, like in the form first described, the inner ends of the spindles fit into an opening in the depending strut 3 wherein they are welded as indicated at 7a.

The arrangement of a set of frusto-conical rollers between a cutter and spindle in such way that the larger ends of the rollers are positioned toward the axis of rotation of the drill bit is claimed more broadly in applicant's copending application Ser. No. 113,071, filed November 27, 1936.

I claim:

1. A roller cutter bit for earth boring drills comprising a bit head having means for attaching it to a drill pipe, and having a strut depending from its lower portion, cross roller cutter units, one on each side of said strut and each comprising a spindle having its inner end mounted in the strut and its outer end integral with an upwardly extending shank fixed to the exterior of the bit head, rotary cutter means on the spindles, and inclined side roller cutter units comprising downwardly and inwardly inclined spindles supported at their inner ends by said strut and having at their outer ends integrally connected shanks extending upwardly and fixed to the exterior of the bit head, and roller cutters on said inclined spindles, said cutters inclining downwardly and outwardly and cutting an annular area adjacent the wall of the bore hole with clearance about the bit head, substantially as described.

2. Apparatus according to claim 1 in which the strut is provided with an opening in its bottom face adjacent the ends of the spindles with material therein welding the spindles to the strut, substantially as described.

3. An earth boring drill according to claim 1 in which the strut has an opening therethrough, and the spindles of the cross roller units have their adjacent ends lying in said opening and welded to the strut, substantially as described.

4. An earth boring drill having a downwardly extending strut, cross roller cutter means on each side of said strut, spindles therefor on opposite sides of said strut, having their inner adjacent ends supported by said strut, supports at the outer ends of the spindles connected with the bit head, each of said spindles having a frusto-conical raceway tapering towards the strut, frusto-conical roller bearings on said raceways engaged by complementary frusto-conical raceway surfaces of the cross rollers, said frusto-conical bearing rollers taking upon their peripheries end thrust of the cross roller cutters in a direction outwardly from the strut towards the spindle supports, said spindles having shoulders against

which the larger end faces of the frusto-roller cutters bear, and cylindrical roller bearings between the spindles and the cross roller cutters, taking radial loads imposed on the cutters, substantially as described.

5 5. An earth boring drill according to claim 4 in which there are a plurality of cross roller cutters on each spindle and a plurality of rows of cylindrical roller bearings between the cross roller cutters and the spindles, shoulders on the spindles against which the end faces of the cylindrical rollers bear, the said frusto-conical roller bearings being located at the outermost ends of the spindles, the cross roller cutters of each spindle having their adjacent side faces in contact, substantially as described.

10 6. An earth boring drill according to claim 4 in which the frusto-conical raceway is arranged substantially midway of the length of the spindle and is defined by an annular shoulder on the spindle at each end of said frusto-conical roller bearings, the cylindrical roller bearings being disposed at opposite sides of the frusto-conical roller bearings and having their adjacent end faces bearing on shoulders on the spindle, the roller cutter means for each spindle comprising a one piece cutter, substantially as described.

15 7. In an earth boring drill and in combination a bit head having a downwardly projecting strut, cross roller cutters having spindles mounted in said strut and in hangers depending from the sides of the bit head, side roller cutters inclining downwardly and outwardly from the vertical axis of the drill, spindles on which said side roller cutters are mounted, each having a frusto-conical raceway surface tapering towards said strut and defined by shoulders on the spindle, frusto-roller bearings on said raceway between said shoulders, a bearing member on the spindle engaging the spindle, a row of frusto-conical bearing rollers in a frusto-conical raceway of said bearing member, said side roller cutters having each a pair of frusto-conical surfaces with their small diameter ends adjacent, said frusto-conical surfaces being complementary to the frusto-conical raceways of the spindle and bearing member, and receiving said frusto-conical roller bearings, substantially as described.

20 8. A roller cutter organization comprising a spindle in sections, each having a frusto-conical raceway convergent towards each other, a roller cutter having complementary frusto-conical raceways and roller bearings between said raceways of the spindle sections and the cutter, substantially as described.

25 9. A roller cutter organization for an earth boring drill provided with a drill head, comprising a spindle in sections, a roller bearing raceway on one section adjacent a support for the spindle, which support is adapted to be attached to the drill head, and another section having a frusto-conical raceway tapering outwardly in relation to the vertical axis of the drill and towards the support, a flange on said spindle between said

raceways, a roller cutter having complementary raceways and roller bearings between said raceways of the spindle sections and the cutter.

10. In a roller cutter organization for an earth boring apparatus revoluble about a vertical axis, a frusto-conical roller bearing positioned with the larger ends of the frusto-conical rollers towards the vertical axis of the apparatus for sustaining end thrusts of the cutter inwardly towards said vertical axis, in combination with a frusto-conical roller bearing positioned with the larger ends of the frusto-conical rollers thereof directed outwardly in respect to said vertical axis sustaining end thrusts of the cutter outwardly of the apparatus, all of said frusto-conical roller bearings sustaining thrusts vertically from the bottom of the hole.

11. A roller cutter for earth boring drills adapted to be mounted on a spindle, said cutter being toothed on its periphery, the interior of the cutter having two frusto-conical roller bearing raceway surfaces diverging toward the ends of the cutter for cooperation with frusto-conical roller bearings.

12. As an article of manufacture a spindle for a roller cutter of an earth boring apparatus having a tapered raceway thereon for roller bearings sustaining radial loads, a flange-like portion between said raceway and another raceway on said spindle, said another raceway being frusto-conical and tapering oppositely from the first mentioned raceway.

13. An earth boring drill comprising a bit head and a roller cutter unit carried thereby to revolve around the vertical axis of the drill including a spindle having two frusto-conical roller bearing surfaces oppositely inclined to the spindle axis, a shoulder on the spindle at one side of each surface, a toothed roller cutter surrounding said spindle and having complementary roller bearing raceway surfaces inclining towards each other, and frusto-conical roller bearings between said surfaces of said spindle and cutter taking end thrust of the cutter both outwardly and inwardly in respect to the vertical axis of the drill as well as radial loads imposed on the cutter.

14. In a roller cutter organization for an earth boring apparatus, a frusto-conical roller bearing positioned with the larger ends of the frusto-conical rollers towards the axis of the apparatus for sustaining end thrusts of the cutter inwardly of the apparatus, and other frusto-conical rollers positioned for sustaining end thrust of the cutter outwardly from the axis of the apparatus.

15. In a roller cutter organization for earth boring apparatus, a spindle, a toothed roller cutter and anti-friction roller bearings between the spindle and the cutter comprising a set of tapered rollers taking radial loads, and a set of frusto-conical rollers arranged with their larger diameter ends towards the vertical axis about which the apparatus rotates taking end thrust of the cutter inwardly towards said vertical axis.

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