March 11, 1941. C. E. REED 2,234,198

EARTH BORING APPARATUS

Filed March 24, 1939 3 Sheets-Sheet 1

Fig. 1.

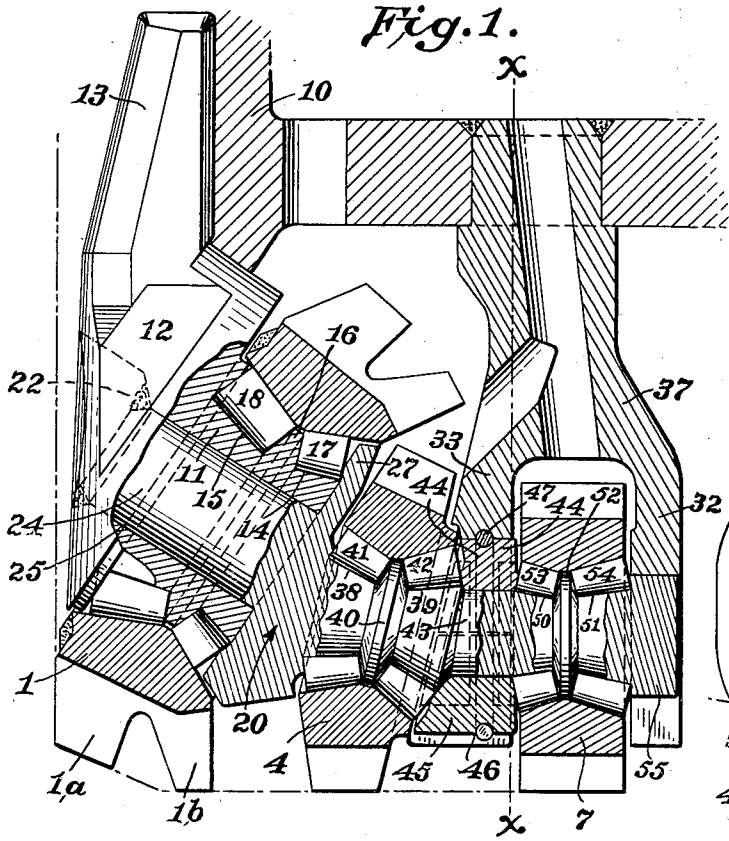
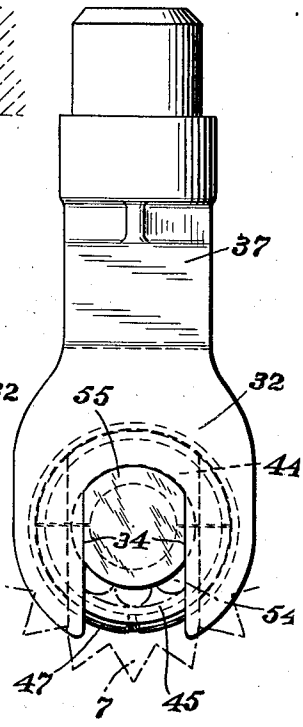


Fig. 2.



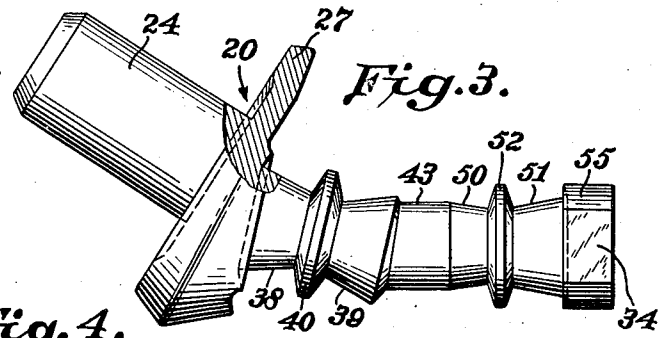


Fig. 3.

Fig. 6.

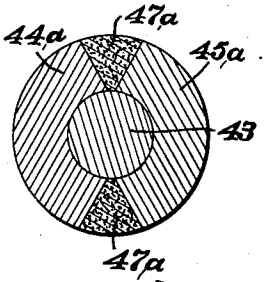


Fig. 4.

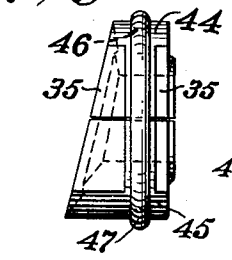
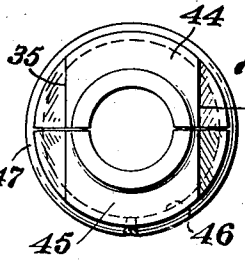


Fig. 5.



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EARTH BORING APPARATUS

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Fig. 7.

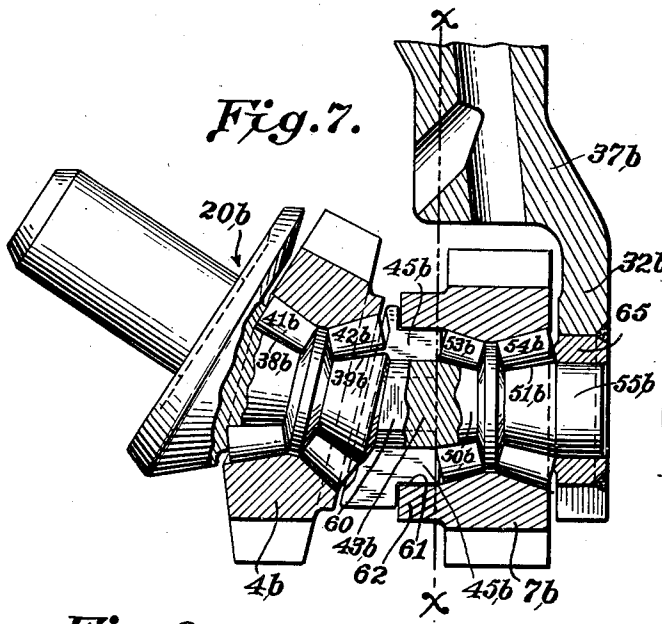


Fig. 8.

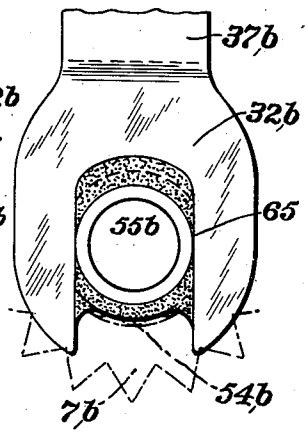


Fig. 9.

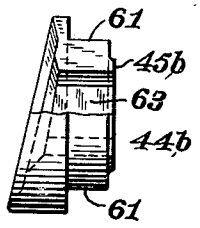


Fig. 11.

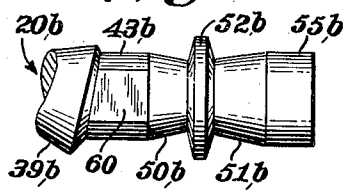


Fig. 10.

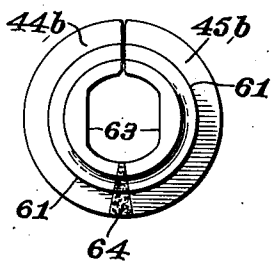


Fig. 12.

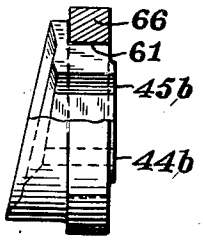
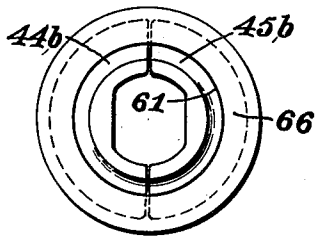


Fig. 13.



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EARTH BORING APPARATUS

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Fig. 14.

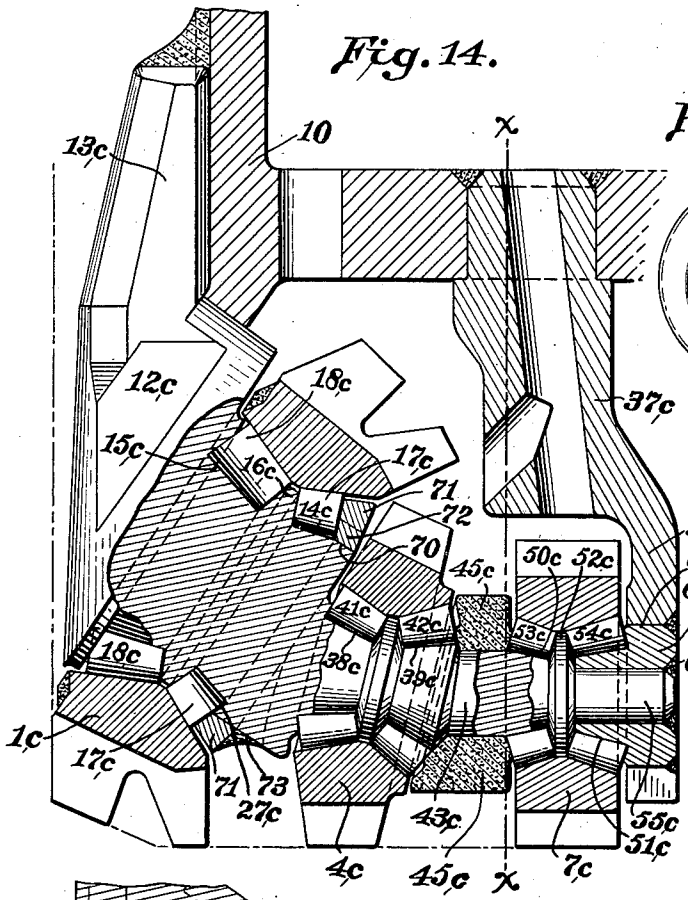


Fig. 19.

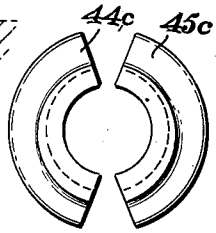


Fig. 20.

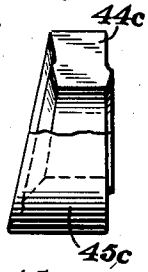


Fig. 15.

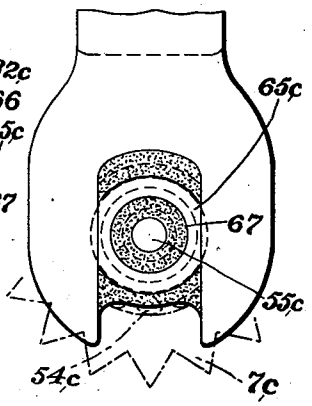


Fig. 16.

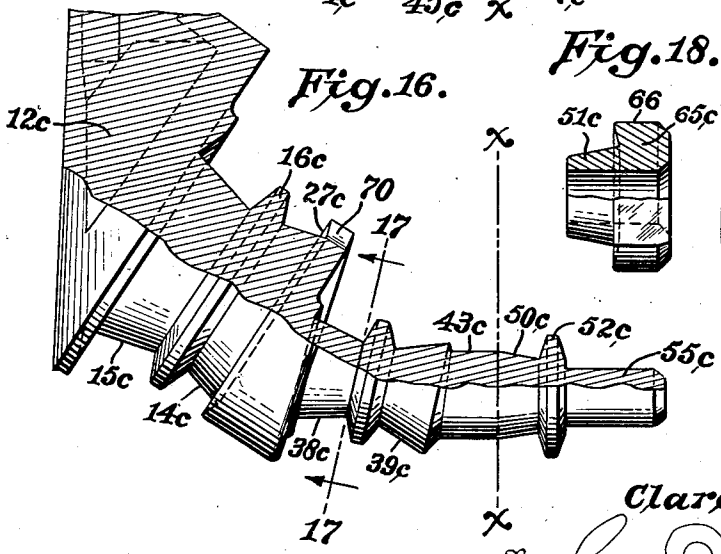
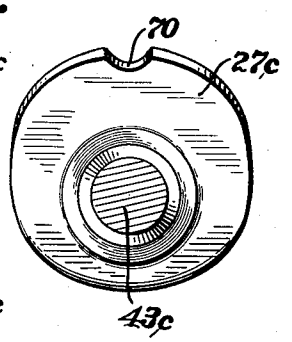


Fig. 18.

Fig. 17.



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Patented Mar. 11, 1941

2,234,198

UNITED STATES PATENT OFFICE

2,234,198

EARTH BORING APPARATUS

Clarence E. Reed, Wichita, Kans., assignor to Chicago Pneumatic Tool Company, New York, N. Y., a corporation of New Jersey

Application March 24, 1939, Serial No. 263,973

24 Claims. (Cl. 255—71)

This invention relates to earth boring tools of the type in which a plurality of independently rotatable cutters are mounted upon the under side of the bit head.

The invention contemplates the provision of a cutter support for certain of these independently rotatable cutters which may be made in one piece. In this respect, the general relationship between the cutters to be supported is illustrated in the copending application 245,507 of Clarence E. Reed, filed on December 13, 1938. Instead of the separate cutter bearing supports of this copending application, which have to be assembled to form a unit, the one piece support of the present invention provides a more rigid structure and one which may be more easily fabricated.

In the accompanying drawings—

Figure 1 is an elevation partly in section of a preferred embodiment of the invention.

Fig. 2 is an elevation of the righthand end of Figure 1, the cutter being indicated in dotted lines.

Fig. 3 is an elevation of the integral spindle member of Figure 1.

Fig. 4 is a side elevation of the cutter separating collar.

Fig. 5 is an end elevation of Fig. 4.

Fig. 6 is a section through a modified collar.

Fig. 7 is a side elevation similar to a portion of Figure 1 illustrating a modification thereof.

Fig. 8 is an elevation of the righthand end of Fig. 7.

Fig. 9 is a side elevation partly in section of the cutter separating collar of Fig. 7.

Fig. 10 is an end elevation of Fig. 9.

Fig. 11 is an elevation of the end portion of the integral spindle member of Fig. 7.

Fig. 12 is a modification of the retaining means for the cutter separating collar of Fig. 7.

Fig. 13 is an end elevation of Fig. 12.

Fig. 14 is a side elevation similar to Figure 1 illustrating a further modification of the invention.

Fig. 15 is an elevation of the lower portion of the righthand end of Fig. 14.

Fig. 16 is a side elevation of the integral cutter supporting spindle of Fig. 14.

Fig. 17 is a section on the line 17—17 of Fig. 16.

Fig. 18 is a side elevation partly in section of the collar upon the end of the spindle of Fig. 14.

Fig. 19 is an end elevation of the cutter separating collar of Fig. 14.

Fig. 20 is a side elevation partly in section of Fig. 19.

Referring first to the embodiment of the invention illustrated in Figures 1 to 5, inclusive, the cutters 1, 4, and 7 are similar to the correspondingly numbered cutters illustrated in application Serial No. 245,507. The cutter 1 is intended to operate at the side of the hole to be cut, and teeth 1*a* cut clearance for the bit head. The cutter 7 is intended to cut an area around the center of the hole, and the cutter 4 is intended to cut an area between the areas cut by cutters 1 and 7, an uncut space being left between the area cut by 4 and the areas cut by 1 and 7. It is intended that with these cutters 1, 4, and 7 shall be associated the cutters 2, 3, 5, and 6 illustrated in application Serial No. 245,507, so that the uncut areas between cutters 1, 4, and 7 will be disintegrated.

The axes of rotation of cutters 1, 4, and 7 are all disposed in a common vertical plane containing the vertical axis *x*—*x* of the bit head 10. Cutter 4 is of smaller diameter than cutter 1, and is located lower than cutter 1, so that it operates upon substantially the same horizontal area with the tooth portion 1*b* of cutter 1. Cutter 7 preferably is of still smaller diameter, and by being located still lower, operates upon the horizontal plane cut by the teeth of cutter 4 and teeth 1*b*. Cutter 7 rotates upon a substantially horizontal axis, whereas cutters 4 and 1 rotate upon axes inclined to the horizontal, and which are acute with respect to each other. As a result of this arrangement, the cutters 1, 4, and 7 converge upwardly within the bit head.

Cutter 1 is rotatably mounted upon a spindle 11, which projects laterally from a carrier 12, having a stem portion 13 for attachment to the side of the bit head 10. Upon the spindle portion 11 are formed raceways 14 and 15 which are separated by a flange 16. Roller bearings 17 and 18 are rotatable respectively upon the raceways 14 and 15, and cooperate with raceways formed within the interior of the cutter 1.

A spindle member 20 is provided to support the roller cutters 4 and 7, this spindle member, as a feature of the invention, being made entirely in one piece. The spindle member 20 includes a stem portion 24 which may be inserted within a bore hole 25 through the spindle portion 11 of carrier 12. Welding may be applied at 22 to retain the stem 24 within the bore hole 25.

Adjacent the base of stem 24 is a flange 27, which is of a size to overlie the ends of roller

bearings 17 and retain them upon raceway 14. In this manner, the cutter 1 is retained upon the spindle portion 11.

On the other side of flange 27 from the stem 24 are formed raceways 38 and 39 separated by a flange 40. These raceways are intended to receive roller bearings 41 and 42 respectively within raceways formed within the interior of the cutter 4.

Next to the raceway 39 is a cylindrical portion 43 which is intended to receive the cutter separating collar made up of segments 44 and 45. As is shown in Fig. 4, one side of the collar formed by these segments is intended to bear against the ends of rollers 42 to retain them upon their raceways 39, and to thereby retain cutter 4 in position. To secure the segments 44 and 45 upon the spindle portion 43, their periphery is formed with a groove 46 in which lies a band 47 which encircles the segments and is welded at its ends.

Next in order along the spindle member 20 are raceways 50 and 51 which are separated by a flange 52. Upon these raceways are roller bearings 53 and 54 respectively, and which are within corresponding raceways of the cutter 7. The rollers 53 are retained in position by the adjacent side of the cutter spacing collar made up of segments 44 and 45. The bearings 54 are retained in position by a flanged enlargement 55 of the spindle member 20.

To support the end of the cutter member 20, which is adjacent the cutter 7, a central hanger 37, which may be attached centrally of the bit head, is provided. The lower end of hanger 37 is forked, so that one portion 32 will receive the flanged enlargement 55, and the other portion 33 thereof will receive the exterior of the collar segment 44. It is desirable that the opposite vertical sides of flanged enlargement 55 be flattened to form faces 34, and that the interior of the forked end 32 be correspondingly flattened to thereby prevent rotation of the spindle. In like manner, it is desirable that the exterior of the collar segments 44 and 45 be formed with flattened faces 35 which will bear against correspondingly formed flattened faces within the forked portion 33 to thereby prevent rotation of the collar segments about the portion 43 of spindle member 20.

In assembling this cutter arrangement, the roller bearings 18 would first be placed upon their raceway 15, and the cutter 1 would thereafter be placed in position over them. Rollers 17 would next be placed in position upon raceway 14, and the stem 24 of spindle member 20 would be inserted in bore hole 25, and the welding 22 applied to retain flange 27 against the end of spindle portion 11. The bearings 41 would next be placed upon their raceway 38, and the cutter 4 would be brought into position upon them by passing the cutter over the flanged enlargement 55 and over the flange 52. For this reason, it is important that the flanged enlargement 55 and the flange 52 be of smaller diameter than the interior portion of cutter 44, which is to lie adjacent to the flange 40.

The cutter 7 is next passed over the end of the spindle member 20, and inasmuch as the flanged enlargement 55 is of the same diameter as, or is smaller than, the flange 52, such positioning of the cutter 7 is made possible. This cutter 7 is moved close to cutter 4, so that the bearings 54 may be placed upon raceway 51. The cutter 7 is then moved in position over rollers 54, and it is apparent that these rollers are held in position by the flange 52 and the flanged enlargement 55 on opposite sides of them. The bearings 53 are next placed in position on raceway 50, and the bearings 42 are placed in position upon raceway 39. Such positioning of the bearings 42 and 53 is readily possible because of the wide spacing between the cutters 4 and 7 due to the absence of the collar segments 44 and 45, and due to the length of and the small diameter of the portion 43 of the spindle member 20. The collar segments 44 and 45 are next placed in position upon their receiving portion 43, and the retaining band 47 is placed about them and welded to prevent their separation.

This assembly is then placed in position in the bit head, and due to the cooperating relationship between the flat faces 35 and the inner faces of the forked end 33, rotation of the collar segments 44 and 45 will be prevented, as above noted.

Instead of the collar segments 44 and 45, which have been discussed, the collar segments 44*a* and 45*a* of Fig. 6 may be provided. These segments 44*a* and 45*a* are similar in general shape to the segments 44 and 45, but their meeting faces are inclined so as to receive welding material 47*a*. These meeting faces should be so widely separated that the welding material 47*a* will extend to the spindle portion 43 to thereby prevent rotation of the segments 44*a* and 45*a*. The manner of assembly with the use of these collar segments is the same as with the collar segments 44 and 45.

In the embodiment of Figs. 7 to 11, inclusive, a somewhat different manner of retaining the cutter spacing collar in position and of retaining the cutter 7 in position is utilized. In this arrangement, the raceways 38*b* and 39*b*, the cutter 4*b*, and its manner of mounting upon the spindle member 20*b*, are similar to that of cutter 4 of Fig. 1. This includes the bearings 41*b* and 42*b* which rotate upon the raceways 38*b* and 39*b*.

The cutter separating collar receiving portion 43*b* is similar to portion 43 of Fig. 3, with the exception that this preferably is formed with the flattened sides 60.

Cutter 7*b* is rotatable upon bearings 53*b* and 54*b* which rotate upon raceways 50*b* and 51*b* of the spindle member 20*b*, and in this respect is similar to the mounting of cutter 7 of Fig. 1. At the end of spindle member 20*b* is a cylindrical portion 55*b* preferably having the same diameter as the largest part of raceway 51*b*.

The collar between cutters 4*b* and 7*b* is made up of segments 44*b* and 45*b*. The exterior of segments 44*b* and 45*b* is formed with a cylindrical surface 61, which is concentric with the axis of rotation of cutter 7*b*. Projecting from the side of cutter 7*b*, which is adjacent the collar segments 44*b* and 45*b*, is a hub or ring-like member 62 formed integrally with the cutter 7*b*, and the interior of which closely fits the surface 61. In this manner, the collar segments 44*b* and 45*b* are prevented from separation and are retained in position upon portion 43*b* of spindle member 20*b*. The interior of collar segments 44*b* and 45*b* is formed with flat faces 63 which fit against the flat faces 60 of portion 43*b*, and thereby prevent rotation of these collar segments. If desired, welding may be applied at 64 to firmly secure the segments to the spindle portion 43*b*, but the hub 62 of cutter 7*b* will serve to prevent separation of the collar

segments 44b and 45b in the event that this welding 64 is not applied, or becomes fractured.

Upon the end portion 55b of spindle member 20b is intended to be affixed a retaining collar 65. This retaining collar 65 may be welded directly to the spindle, or, as is here shown, is welded to the lower end 32b of central hanger 37b, and in this manner is held in place.

To assemble the collars of Fig. 7, the bearings 41b are first placed upon raceway 38b, and the cutter 4b is then passed over the end of spindle member 20b in place upon these rollers. To permit this positioning of cutter 4b, it is necessary that the flange 52b between raceways 50b and 51b be smaller than the smallest diameter inside of cutter 4b. The bearings 42b are next placed in position within the cutter 4b and upon raceway 39b, and the collar segments 44b and 45b are next placed upon the spindle portion 43b.

With the collar segments 44b and 45b held in position, as by the welding material 64, the bearing rollers 53b are placed in position upon raceway 50b, and the cutter 7b is then passed over and upon these rollers. Rollers 54b are next placed upon their raceway 51b, and the retaining collar 65 is then placed upon the projecting end 55b of the spindle. This cutter assembly may be secured to a carrier similar to the carrier 12 of Figure 1 for insertion in a bit head.

Instead of utilizing a hub portion 62 of the cutter 7b to retain the collar segments 44b and 45b in position, a separate ring member 66 may be placed upon the surface 61 of these collar segments. This ring 66 would be placed upon the collar segments immediately before the cutter 7b is placed in position upon its bearings 53b, and in all other respects the assembly of this arrangement would be similar to that of the arrangement of Fig. 7.

In the embodiment of Figs. 14 to 20, inclusive, the cutters 1c, 4c, and 7c are supported upon a spindle which is integral throughout its length, and which is formed in one piece with the carrier 12c. Adjacent the base portion 12c of this carrier are formed the raceways 15c and 14c to receive the bearings 18c and 17c respectively.

The flange 27c, which is next in order along the spindle, should be the same or slightly smaller in diameter than the flange 16c between the raceway 14c and 15c. This relationship is important, because with this embodiment of the invention, the cutter 1c is to be located in its proper position by passing it over the free end of the spindle, and over the flange 27c.

At a point around the periphery of flange 27c is formed a notch 70 which should extend inwardly of the flange as far as the largest diameter of the raceway 14c. This notch should be large enough to permit the insertion through it of the roller bearings 17c when the cutter 1c is in position upon the rollers 18c. To close the notch 70 after all of the rollers 17c are thus placed in position, a ring member 71 having a lug 72 on its interior may be placed upon the periphery of flange 27c. The lug 72 serves as a closure for the notch 70, so that the surface of flange 27c against which the rollers 17c bear is uninterrupted.

The cutter 4c is rotatable upon roller bearings 41c and 42c which bear upon raceways 38c and 39c. Next to raceway 39c is a portion 43c intended to receive collar segments 44c and 45c, which are similar to the segments 44a and 45a of Fig. 6 in that they are to be welded together, and by this welding material are to be held upon the spindle portion 43c.

A raceway 50c is formed upon the spindle similarly to the raceway 50 of Fig. 3, and next to this raceway 50c is a flange 52c. From the flange 52c the spindle is formed with a reduced extension 55c, this reduced extension being of a length to extend beyond the side face of cutter 7c. Upon this reduced extension 55c is intended to be placed a member 65c which has a portion 51c thereof providing a raceway for bearings 54c for the roller cutter 7c, and another portion 66 which serves as a flange to retain the rollers 54c in position.

To assemble the cutter of Fig. 14 in place, the rollers 18c would first be placed upon their raceway 15c, and the cutter 1c, by passing along the entire length of the spindle, would be brought in position upon these rollers. Thereafter bearings 17c would be inserted in place upon the raceway 14c by passing them through the notch 70 of flange 27c. The ring member 71 would then be located on flange 27c with the lug 72 thereof within the notch 70, and welding material would be applied at 73 to retain this ring member in place. The bearings 41c would next be placed upon raceway 38c, and the cutter 4c would be passed over the end of the spindle and upon these rollers. The rollers 42c would next be placed upon raceway 39c and within the cutter 4c. The bearings 53c should next be placed upon the raceway 50c, and the cutter 7c be passed over the end of this spindle and in position upon them. Thereafter the collar segments 44c and 45c would be affixed by welding upon the spindle portion 43c. The rollers 54c would next be placed within the cutter 7c, and the member 65c would be passed over the projecting portion 55c of the spindle to bring its raceway portion 51c within the rollers 54c, and to bring the flange portion 66c thereof against the ends of these rollers 54c. By then welding the member 65c to the spindle, as at 67, all of the cutters will be retained in place upon the spindle. This spindle assembly may then be attached to a bit head by welding the stem 13c to the side of the bit head, and by welding the member 65c to the fork 32c of the central hanger 37c.

It will be understood that departures may be made from the details illustrated in the drawings, and that details illustrated in connection with one embodiment of the invention may be substituted for the corresponding detail of another embodiment. For example, instead of the retaining member 65 of Fig. 7, it would be possible to substitute a member 65c of Fig. 14, which would provide both the raceway and the retaining flange for the roller 54b of Fig. 7.

All of the roller bearings mentioned in the foregoing description preferably are frusto-conical in shape. There are two sets for each cutter and arranged with their smaller diameter ends adjacent each other, and bearing upon the inclined faces of the flanges on the spindle organization, such, for instance, as in Fig. 1, where the smaller diameter ends of the roller bearings 17 and 18 face each other, but bear on the inclined annular faces of the intermediate flange 16. One set of these frusto-conical roller bearings, such as 18, in Fig. 1, take end thrust of the cutter to which they belong in a direction outwardly from the vertical axis of the drill, while the companion set of roller bearings take end thrusts of the cutter in a direction inwardly towards the vertical axis of the drill. A like ar-

rangement preferably is provided for each cutter.

As before stated, the cutter and spindle assembly described is intended to be used in combination with other roller cutters, such as 2, 3, 5, and 6 of application Serial No. 245,507, providing cutter groups whose axes are spaced apart 120° about the vertical axis of the drill.

I claim:

1. A cutter assembly for an earth boring drill comprising a spindle having in the following order a bearing surface for a side roller cutter, a flange, a bearing surface for an intermediate roller cutter, a portion for receiving a cutter separating collar, and a bearing surface for an adjacent roller cutter; roller cutters upon said bearing surfaces; a collar upon said portion; and retaining means at one end of the spindle for retaining the adjacent cutter in place on the spindle, said collar receiving portion being of a diameter not greater than the smallest internal diameter of the intermediate cutter, and the bearing surfaces for the intermediate and adjacent cutter being upon parts of the spindle which are integral with the collar receiving portion.

2. A cutter assembly according to claim 1 in which said flange is integral with said integral parts of the spindle to form a unit removably attached to the shank portion of the support.

3. A cutter assembly according to claim 1 in which the entire spindle and shank constitute an integral support, and said flange and remaining parts of the spindle away from the shank are of a diameter not greater than the smallest internal diameter of the side cutter.

4. A cutter assembly according to claim 1 in which said flange and said retaining means are integral with said integral parts of the spindle to form a unit removably attached to the shank portion of the support, and roller bearings are between the cutters and their respective bearing surfaces, said portion of the spindle for receiving a cutter separating collar being of a length to permit insertion of the bearings within the central cutter, and said collar is segmental.

5. A cutter assembly according to claim 1 in which the spindle includes a free end portion projecting beyond the central cutter, and upon which said retaining means is removably attached.

6. A cutter assembly according to claim 1 in which the spindle includes a free end portion projecting beyond the central cutter, and upon which said retaining means is removably attached, said retaining means including a portion lying within and providing a bearing surface for the central cutter.

7. A cutter assembly according to claim 1 in which the axes of rotation of the center and intermediate cutter are at an acute angle with respect to each other, and the opposite faces of said collar are perpendicular to the respective axes, and means is provided to prevent rotation of said collar.

8. A one-piece spindle for rollar cutters of an earth boring tool having between its ends a flange, and on one side of the flange attachment means for securing the spindle in place, and on the other side of the flange and in the following order away therefrom a bearing surface for a roller cutter, a portion for receiving a cutter spacing collar, and a bearing surface for another roller cutter, said collar receiving portion being no larger in diameter than the largest diameter of the bearing surface next to said flange.

9. A one-piece spindle according to claim 8 which includes as an integral part thereof a retaining flange beyond the bearing surface furthest from said flange.

10. A one-piece spindle according to claim 8 having as an integral part thereof a projection extending beyond the bearing surface to receive thereon a cutter retaining member.

11. A one-piece spindle according to claim 8 in which said bearing surface furthest from said flange includes a roller bearing raceway, and said collar receiving portion is at least as long as said raceway.

12. A one-piece spindle according to claim 8 in which said attachment means is a stem projecting laterally from the flange.

13. A one-piece spindle according to claim 8 in which said attachment means is a shank for attachment to the side of a bit head, and another bearing surface is upon said spindle between said flange and said shank.

14. A one-piece spindle according to claim 8 which includes between said flange and said attachment means, a bearing surface with respect to which the said flange is no larger in diameter.

15. A roller cutter assembly comprising a one-piece spindle having a flange and in order away from said flange a bearing surface for a roller cutter, a portion for receiving a cutter spacing collar, and a bearing surface for another roller cutter; roller cutters upon said bearing surfaces; a segmental collar upon said collar receiving portion; means at the end of the spindle beyond the cutter furthest from the flange for retaining that cutter in place, and a ring member encircling the collar to hold its segments in place.

16. A roller cutter assembly according to claim 15 in which said ring member is a continuous, one-piece element.

17. A roller cutter assembly according to claim 15 in which said ring member is an annular hub portion projecting laterally from the side of the cutter furthest from the flange.

18. A roller cutter assembly comprising two cutters, a spindle therefor having a flange outwardly of bearing surfaces thereon for each of said cutters, a portion for receiving a cutter spacing collar, and a segmental collar assembled upon said collar receiving portion.

19. A roller cutter assembly according to claim 18 and roller bearings between the cutters and their respective bearing surfaces.

20. A roller cutter assembly comprising two cutters, a spindle therefor and roller bearings between the cutters and the spindle, some of said bearings being inserted from between the cutters to operating position, and a segmental collar assembled between the cutters.

21. A roller cutter assembly comprising a spindle, a cutter, roller bearings positioned between the spindle and cutter, a flange on the spindle, a gate in the flange and a ring having a lug shaped to fit said gate, said ring being secured to said flange.

22. A cutter assembly for an earth boring drill comprising means for attachment to a drill head and projecting therefrom an integral spindle having therealong in the following order away from the attachment means, a roller bearing surface for an inclined side roller cutter, a flange, a roller bearing surface for an intermediate roller cutter, a portion for receiving a cutter separating collar, and a roller bearing surface for an adjacent

cutter; roller bearings upon said roller bearing surfaces; roller cutters upon said roller bearings; a collar removably mounted upon said portion, and means removably mounted upon said spindle for separately retaining said roller bearings and said cutters on said spindle.

23. A roller cutter unit comprising a side roller cutter, an intermediate roller cutter and a central roller cutter; an integral spindle member for said cutters, double rows of tapered roller bearings between each of the cutters and said spindle, the axes of said cutters being all inclined to each other in the same vertical plane.

24. As an article of manufacture, a spindle for a roller cutter assembly of a rotary earth boring drill, said spindle having a portion for receiving a side roller cutter, a portion for receiving an intermediate roller cutter, a portion for receiving a central roller cutter, and a portion for receiving a separating collar for two roller cutters, said spindle portions and said collar receiving portion being integrally connected together, and each cutter receiving portion having an annular flange integral therewith intermediate of its length separating frusto-conical roller bearing raceways on the spindle, said spindle portions having their axes at an inclination to each other in a vertical plane, the said collar receiving portion of the spindle being of less diameter than the annular flanges of roller cutter receiving portions of the spindle, substantially as described.

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