Nov. 30, 1937. P. C. EFROMSON 2,100,640

CUTTER MOUNTING

Filed Feb. 23, 1937

FIG. 1.

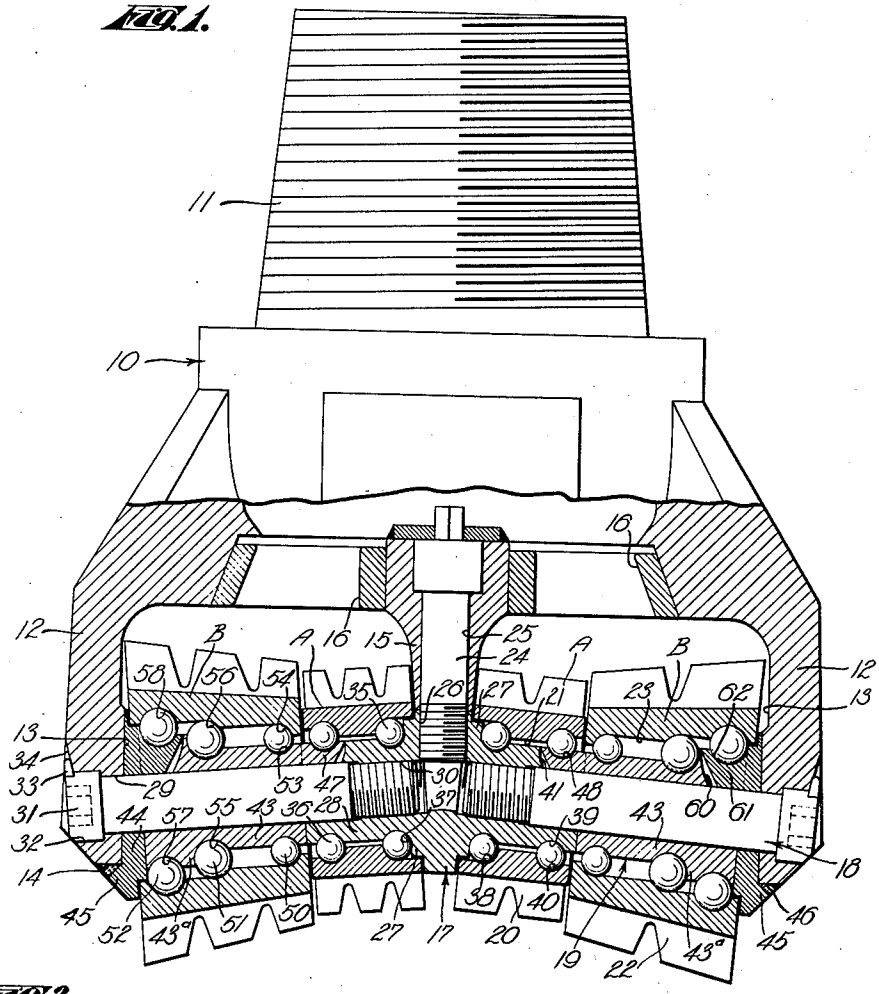


FIG. 3.

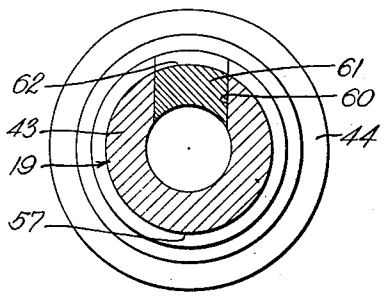


FIG. 2.

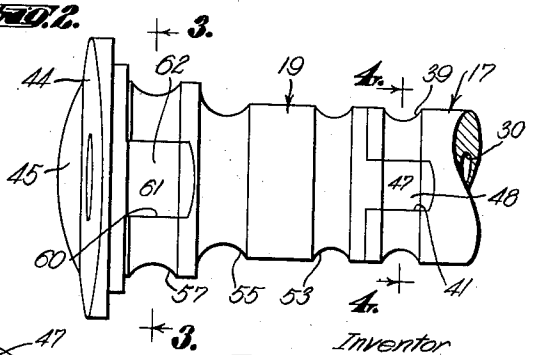
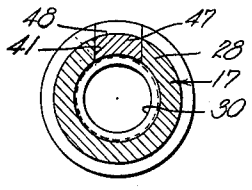


FIG. 4.



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UNITED STATES PATENT OFFICE

2,100,640

CUTTER MOUNTING

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15 Claims. (Cl. 255—71)

This invention relates to well drilling tools and relates more particularly to anti-friction bearings or mountings for the cutters of rotary well drilling tools. A general object of this invention is to provide practical, improved and long wearing cutter mountings.

Another object of this invention is to provide cutter mountings for adjacent roller cutters of a well bit in which each cutter and its bearing elements are assembled as a unit to facilitate the manufacture and the assemblage of the same.

Another object of this invention is to provide ball bearing cutter mountings each embodying a plurality of rows of balls and each having at least one row of balls operating to definitely position its cutter and to take the end thrusts in both directions as well as the radial thrusts.

Another object of this invention is to provide cutter mountings of the character mentioned in which each row of balls may assume end thrusts in at least one direction as well as assume the radial thrusts from the cutter.

Another object of this invention is to provide cutter mountings of the character mentioned in which the races or grooves receiving the balls that transmit end thrusts in both directions are deep and present large surfaces for contact by the balls and, therefore, are long wearing.

Another object of this invention is to provide cutter mountings of the character mentioned embodying novel interfitting parts for preventing rotation of the race elements and for definitely positioning the elements.

A further object of this invention is to provide anti-friction cutter mountings of the character mentioned that may be easily and quickly assembled with the assurance that the parts are properly positioned.

The various objects and features of my invention will be fully understood from the following detailed description of a typical preferred form and application of the invention, throughout which description reference is made to the accompanying drawing, in which:

Fig. 1 is a side elevation of a bit embodying the present invention with the lower portion broken away to illustrate the cutter mountings and cutters in vertical cross section. Fig. 2 is an enlarged plan elevation of the assembly of a washer, a race member, and a race projection removed from the bit and Figs. 3 and 4 are transverse sectional views taken as indicated by lines 3—3 and 4—4, respectively, on Fig. 2.

The cutter mounting means of the present invention may be embodied in well drilling tools of various characters. In the following detailed description I will describe one form of the invention as embodied in a rotary rock bit having two diametrically opposite sets of inner roller cutters. It is to be understood that the invention is not to be construed as limited or restricted to the specific form or application about to be described.

The rotary rock bit illustrated in the drawing includes a shank or body 10 adapted to be connected with the lower end of a rotary well drilling string. The body 10 has a threaded pin 11 or its equivalent for connecting with the lower end of the drilling string. Two diametrically opposite legs 12 project downwardly from the lower end of the body 10. The legs 12 have flat substantially vertical bearing faces 13 on their inner sides. The lower ends 14 of the legs 12 may be flat and substantially horizontal and the lower outer corners of the legs may be bevelled off as illustrated. A substantially vertical web 15 projects downwardly from the lower end of the bit body 10. The lower end of the web 15 is some distance above the plane of the lower ends 14 of the legs 12 and is preferably flat and horizontal. Suitable ports 16 are provided in the lower end of the body 10 to discharge the circulation fluid downwardly against the cutters.

The present invention includes, generally, the combination of two like sets of roller cutters A and B and means for rotatably mounting the cutters A and B comprising a central support 17 on the body web 15, pins 18 carried by the legs 12 and the support 17 and ball and race means 19 rotatably supporting the cutters A and B on the pins 18.

The cutters A and B are provided in sets, each set being carried by a pin 18 through the medium of the ball and race means 19 to be subsequently described. In the form of the invention illustrated each set of cutters includes a cutter A and a cutter B. The cutters A and B are roller cutters and the cutters of each set are alike. The cutters A are substantially cylindrical and are located adjacent the central vertical axis of the bit to act on the central portion of the well. Peripheral cutting teeth 20 are provided on the cutters A. In the case illustrated the teeth 20 are axial and are notched. The opposite ends of the inner cutters A are preferably flat as illustrated. Each cutter A has a central longitudinal opening 21. The cutters B are frusto-conical having pitched or tapered peripheries. The cutters B are arranged with their small ends facing inwardly toward the central axis of the bit. In the preferred construction the cutters B are larger than the cutters A,

the small ends of the cutters B being larger in diameter than the cylindrical cutters A and the cutters B having a greater length than the cutters A. Peripheral cutting parts or teeth 22 are provided on the cutters B. The teeth 22 may be straight and axial and may be notched as illustrated. A central longitudinal opening 23 extends through each cutter B.

The central support 17 is secured to the body web 15 to carry the inner ends of the pins 18. The support 17 is a block-like member and constitutes a race element of the means 19 as will be subsequently described. The support 17 bears upwardly against the web 15 having a flat upper end engaging against the flat lower end of the web. A cap screw 24 is arranged through an opening 25 in the web 15 and is threaded in an opening 26 in the support 17 to secure the support to the web. The opposite sides of the support 17 are preferably inclined downwardly and inwardly toward the central axis of the bit. Cylindrical bosses 27 project from the opposite sides of the support 17. Tubular extensions or race projections 28 extend outwardly from the bosses 27 toward the legs 12. The race projections 28 are integral with the support 17 and constitute bushings or bearing shafts for the inner cutters A as will be hereinafter described. The bosses 27 and the race projections 28 extend into the openings 21 of the cutters A and are inclined downwardly and outwardly relative to the vertical axis of the bit body 10. The race projections 28 are of sufficient length to project outwardly to or beyond the outer ends of the cutters A. The projections 28 have cylindrical peripheries and extend through the cutter openings 21 with suitable clearance.

The pins 18 extend between the legs 12 and the support 17 to tie the legs to the support, to carry the cutters B and their bearing means, and to assist in supporting the projections 28 and the cutters A carried thereby through the means 19. The pins 18 are in the nature of screws or bolts passed inwardly through openings 29 in the legs 12 and threaded into the inner portions of the openings 30 in the tubular projections 28. Heads 31 are provided on the outer ends of the pins 18 and are received in sockets 32 in the outer sides of the body legs 12. Portions 33 of the pin heads 31 are peened into notches 34 in the outer sides of the legs 12 to lock the pins 18 against turning and unthreading. The longitudinal axes of the pins 18 are inclined downwardly and outwardly with respect to the vertical axis of the bit. The pins 18, of course, extend through the cutters A and their mountings.

The ball and race means 19 for rotatably supporting or mounting the pairs of cutters A and B may be identical and I will proceed with a detailed description of one means 19 for supporting one pair of cutters A and B, it being understood that this description is equally applicable to the other means 19.

The ball and race means 19 includes the above described race projections 28 extending into the cutters A from their inner ends. A plurality of sets or rows of balls rotatably supports the cutter A on its respective race projection 28. In the simple form of the invention illustrated two spaced rows of balls 35 and 36 rotatably support the cutter A on its race projection 28. The annular series of balls 35 cooperates with an annular groove 37 in the projection 28 and a race or groove 38 on the wall of the cutter opening 21. The groove 37 is provided in the corner occurring between the boss 27 and the projection 28 and is preferably comparatively deep to extend into the body of the projection 28 proper. The inner portion of the cutter opening 21 is enlarged in diameter to freely receive the boss 27 and the inner wall of the socket thus formed in the cutter A is concaved to constitute the groove 38 for receiving the balls 35. Thus the groove 38 faces radially toward the axis of rotation of the cutter A and inwardly toward the central vertical axis of the bit. The grooves 37 and 38 are partially circular in transverse cross section to properly receive the spherical balls 35. It will be noted that the race groove 38 facing inwardly and radially provides for the transmission of inward end thrusts from the cutter A through the balls 35 as well as the radial thrusts from the cutter.

The balls 36 cooperate with an annular groove 39 in the outer portion of the race projection 28 and an annular race or groove 40 in the wall of the cutter opening 21. The groove 39 is adjacent the outer end of the projection 28 and is of substantial depth to receive substantial portions of the balls 36. The groove 40 is likewise of substantial depth to receive substantial portions of the balls 36 and directly radially opposes the groove 39. The grooves 39 and 40 are partially circular in transverse cross section to properly receive the balls 36. The grooves 39 and 40 shaped and related as just described receive the balls 36 for the transmission of end thrusts from the cutter in both directions, as well as the radial thrusts from the cutter. The balls 36 cooperating with the grooves 39 and 40 definitely locate or position the cutter A.

It is believed that it will be understood how the annular series of balls 35 may be readily arranged in the groove 37 when the cutter A is slid into position over the race projection 28. The enlarged inner portion of the cutter opening 21 permits the easy assembly of the balls 35 in the grooves 37 and 38. The invention provides novel means for facilitating the arrangement of the balls 36 in the grooves 39 and 40. In accordance with the invention a slot or notch 41 is provided in the outer end of the race projection 28. The notch 41 is flat sided and extends inwardly to or beyond the groove 39. The notch 41 is provided to permit the easy insertion of the balls 36 in the grooves 39 and 40. The balls 36 may be easily inserted through the notch 41 until the registering grooves 39 and 40 are full, whereupon a part on the bushing or race element of the cutter B is inserted in the notch 41 to prevent the loss of the balls 36. This part or element for occupying the notch 41 will be subsequently described.

The means 19 includes a bushing or race 43 on the pin 18 for extending through the cutter B. The race 43 is a tubular element arranged on the pin 18 to have its inner end in cooperation with the outer end of the race projection 28. The inner portion of the race 43 may be of the same diameter as the projection 28. The outer portion 43a of the race 43 is enlarged in diameter and is received in an enlarged outer portion of the cutter opening 23. The race 43 extends through the cutter opening 23 with substantial clearance. The outer end of the race 43 is adjacent or slightly inward of the outer end of the cutter B. A washer 44 is arranged on the pin 18 between the outer end of the race 43 and the bearing surface 13 of the leg 12. The washer 44 holds the race 43 against endwise movement. The washer 44 may be partially re-

ceived in the cutter opening 23 but is not engaged by the cutter. A lug 45 is provided on the lower end of the washer 44 and may be welded to the lower end 14 of the leg 12 at 46. The welding 46 definitely holds the washer 44 against rotation and prevents chattering of the washer and the other bearing parts. A tongue 47 projects axially from the inner end of the race 43 and fits the above-described notch 41. The tongue 47 is the element mentioned above which prevents the loss of the balls 36 from the grooves 39 and 40. A groove 48 is provided in the outer side of the tongue 47 and registers with the groove 39 to complete the groove so that it properly receives the balls 36. The tongue 47 fitting the notch 41 retains the balls 46 in place and prevents relative turning between the race 43 and the race projection 28.

The means 19 includes a plurality of spaced series of balls 50, 51 and 52 cooperating with the interior of the cutter B and with the race 43 to rotatably support the cutter on the race. The balls 50 are within the inner portion of the cutter B while the balls 51 and 52 are within the outer portion of the cutter. The balls 50 cooperate with an annular groove 53 in the inner portion of the race 43 and an annular shoulder 54 on the wall of the cutter opening 23. The groove 53 is of sufficient depth to receive substantial portions of the balls 50. The shoulder 54 is concaved and shaped to partially receive the balls 50. In accordance with the invention the shoulder 54 faces radially inward toward the axis of rotation of the cutter B and outwardly toward the outer end of the cutter and is related to the groove 53 so that the balls 50 assume the outward end thrusts on the cutter B as well as the radial thrusts on the cutter. The portion of the cutter opening 23 extending outwardly from the shoulder 54 is sufficiently large in diameter to allow the necessary relative movement between the cutter B and the race 43 when the balls 50 are in the groove 53 to permit the shoulder 54 to be brought to its proper position in engagement with the balls 50. It will be observed that the balls 50 dependably rotatably support the inner end of the cutter B and assist in transmitting the outward end thrusts from the cutter to the race 43.

The balls 51 which are somewhat larger than the balls 50 cooperate with an annular groove 55 in the race 43 and a shoulder 56 on the wall of the cutter opening 23. The groove 55 occurs in the corner between the body of the race 43 and the enlarged race portion 43a and is sufficiently deep to extend radially into the body of the race proper. The shoulder 56 occurs at the inner end of the enlarged outer portion of the opening 23 and faces inwardly toward the axis of rotation of the cutter B and outwardly toward the outer end of the cutter. The shoulder 56, of course, surrounds or opposes the groove 55. The groove 55 and the shoulder 56 are related so that the balls 51 cooperate with them to transmit the outward end thrusts from the cutter B to the race 43 and the radial thrusts from the cutter to the race. The portion of the cutter opening 23 extending outwardly from the shoulder 56 is sufficiently large in diameter to allow relative movement between the race 43 and the cutter B to bring the shoulder 56 in engagement with the balls 51 when the parts are being assembled.

The balls 52 cooperate with an annular groove 57 in the enlarged outer end portion 43a of the race 43 and an annular groove 58 in the wall of the cutter opening 23. The grooves 57 and 58 are directly opposite one another and are adjacent the outer end of the cutter B. Both grooves 57 and 58 are of substantial depth to receive substantial portions of the balls 52. With the above described formation of the grooves 57 and 58 the balls 52 are operable to transmit end thrusts in both directions from the cutter B to the race 43 as well as transmit the radial thrusts from the cutter to the race. The balls 52 cooperating with the grooves 57 and 58 also definitely position the cutter B on the race 43.

A longitudinal notch 60 is provided in the outer end portion 43a of the race 43 and extends inwardly beyond the groove 57. The notch 60 is provided to facilitate the insertion of the balls 52 in the grooves 57 and 58. When the grooves 57 and 58 are fully occupied by the series of balls 52 a tongue 61 on the washer 44 is inserted in the notch 60 to prevent the displacement of the balls. A suitably shaped groove 62 is provided in the outer surface of the tongue 61 to register with the groove 57 so that the groove 57 in effect constitutes a continuous or annular groove to properly carry the balls 52. It will be observed that the cutter B is rotatably supported by the longitudinally spaced series of balls 50, 51 and 52. The balls 50 and 51 are operable to transmit the outward end thrusts from the cutter B to the race 43 as well as the radial thrusts. The series of balls 52 cooperating with the grooves 57 and 58 are operable to transmit both the inward and outward end thrusts from the cutter B to the race 43 of the radial thrusts on the outer portion of the cutter.

To assemble one set of cutters A and B and its bearing means 19 the balls 35 are first arranged in the groove 37 and the cutter A and the race projection 28 are moved relative to one another to bring the grooves 37 and 38 in proper cooperation with the balls. The balls 36 are then inserted through the notch 41 to occupy the registering grooves 39 and 40. The notch 41 is such that the balls 36 may be easily inserted into the registering grooves 39 and 40. The balls 50 are then arranged in the groove 53 and the balls 51 are arranged in the groove 55. The balls 50 and 51 are arranged in place before the groove 53 is moved inwardly past the shoulder 56. When the balls 50 and 51 are properly positioned the race 43 is moved into the cutter B to bring the balls 50 in proper contact with the shoulder 54 and to bring the balls 51 in proper cooperation with the shoulder 56. This brings the tongue 47 in position for insertion in the notch 41. The pin 18 is not in place and the assembly of the cutter B and the race 43 may be moved laterally relative to the cutter A and the race projection 28 so that the tongue 47 is first received in the opening 30 and is then moved outwardly into the notch 41 to its final position. The tongue 47 is adapted to completely occupy the notch 41 and its groove 48 registers with the groove 39 to properly cooperate with the balls 36. The balls 52 are then inserted in the registering grooves 57 and 58 through the notch 60. When the balls 52 have been properly positioned the washer 44 is arranged in place so that its tongue 61 occupies the notch 60. The groove 62 in the tongue 61 completes the groove 58 and cooperates with the balls 52. The assembly may then be positioned on the bit and the pin 18 may be inserted through the opening 29 and threaded into the opening 30 to secure the assembly in place. It is to be understood that the two sets of cutters and their

respective mountings may be simultaneously assembled on the bit body 10.

In the operation of the tool the cutters A and B act on the bottom wall of the well bore and their engagement with the earth formation results in their independent rotation. The cutters A and B are supported for free independent rotation by the anti-friction ball bearing means. The cutter A is supported by the spaced series of balls 35 and 36, the balls 36 assuming radial thrusts and end thrusts in both directions and the balls 35 assuming radial thrusts and inward end thrusts. The longitudinally spaced series of balls 35 and 36 dependably support the cutter A for free rotation. The three longitudinally spaced series of balls 50, 51 and 52 rotatably support the cutters B. The balls 50 and 51 assume radial thrusts and outward end thrusts while the balls 52 assume radial thrusts and end thrusts in both directions. The cutters A and B are both entirely supported by spaced sets of ball bearings and thrust washers or the like are not required. The grooves 37, 39, 40, 53, 55, 57 and 58 are deep and present extensive surfaces for contact by the cutter supporting balls and, therefore, are very long wearing. The ball engaging shoulders and grooves on the interiors of the cutters A and B have relatively large circumferences and, therefore, are long wearing. The tongues 47 serve to dependably retain the balls 36 in their grooves 39 and 40 and the tongues 61 occupy the notches 60 to prevent the loss of the balls 52. The cutters A are definitely positioned by the balls 36 cooperating with the deep grooves 39 and 40 and the cutters B are definitely positioned by the balls 52 cooperating with the deep grooves 57 and 58. The cutter mounting means of the present invention is dependable and long wearing and supports the cutters for free rotation.

Having described only a typical preferred form and application of my invention I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claims:

Having described my invention, I claim:

1. A cutter assembly for a well drill comprising, a support, adjacent cutters surrounding the support, a race member on the support and within one cutter, the race member and said cutter having opposing annular grooves, balls in the grooves, a race member on the support within the other cutter, and a part on the second mentioned race member preventing displacement of said balls.

2. A cutter assembly for a well drill comprising, a support, adjacent cutters surrounding the support, a race member on the support and within one cutter, the race member and said cutter having opposing annular grooves, the race member having an opening communicating with the groove in the member, balls inserted into the grooves through said opening, a race member on the support and within the other cutter, and a part on the second mentioned member extending into said opening to prevent the escape of the balls.

3. A cutter assembly for a well drill comprising, a support, adjacent cutters surrounding the support, a race member on the support and within one cutter, the race member and said cutter having opposing annular grooves, the race member having an opening communicating with the groove in the member, balls inserted into the grooves through said opening, a race member on the support and within the other cutter, and an axially projecting tongue on the second mentioned member occupying said opening to prevent the escape of the balls.

4. A cutter assembly for a well drill comprising, a support, adjacent cutters surrounding the support, a race member on the support and within one cutter, the race member and said cutter having opposing annular grooves, the race member having an opening communicating with the groove in the member, balls inserted into the grooves through said opening, a race member on the support and within the other cutter, and a part on the second mentioned member extending into said opening to prevent the escape of the balls.

5. A rotary well drilling bit comprising a body, a support carried by the body, a rotatable cutter surrounding the support, a race member on the support within the cutter, and a plurality of spaced series of balls rotatably supporting the cutter on the race member, at least one series of balls transmitting end thrusts in both directions from the cutter to the member.

6. A rotary well drilling bit comprising, a body, a support carried by the body, a rotatable cutter surrounding the support, a race member on the support within the cutter, and a plurality of spaced series of balls rotatably supporting the cutter on the race member, one series of balls transmitting end thrusts in both directions from the cutter to the member, and at least one series of balls transmitting end thrusts in one direction from the cutter to the member.

7. A rotary well drilling bit comprising, a body, a support carried by the body, a rotatable cutter surrounding the support, a race member on the support within the cutter, axially spaced pairs of opposing annular race surfaces on the member and the interior of the cutter, and balls cooperating with the opposing surfaces to rotatably support the cutter, the surfaces of one of said pairs being depressed below the adjacent surfaces of the member and cutter whereby the balls cooperating therewith are operable to transmit end thrusts in both directions.

8. A rotary well drilling bit comprising, a body, a support carried by the body, a rotatable cutter surrounding the support, a race member on the support within the cutter, axially spaced pairs of opposing annular race surfaces on the member and the interior of the cutter, and balls cooperating with the opposing surfaces to rotatably support the cutter, the surfaces of one of said pairs being depressed below the adjacent surfaces of the member and cutter whereby the balls cooperating therewith are operable to transmit end thrusts in both directions, the surfaces of at least one of said pairs being related so that the balls cooperating therewith are operable to transmit end thrusts in one direction.

9. A rotary well drilling tool including a body, a support carried by the body, rotatable cutters around the support, race members on the support within the cutters, one race member and the interior of the surrounding cutter having opposing annular grooves, and said race member having an opening communicating with its groove, balls in the grooves rotatably supporting the cutter, the balls being inserted through said opening, the grooves being of such depth that the balls transmit axial thrusts in both direc-

tions, and a part on the race member in the adjacent cutter occupying said opening.

10. A rotary well drilling tool including, a body, a support carried by the body, rotatable cutters around the support, race members on the support within the cutters, one race member and the interior of the surrounding cutter having axially spaced pairs of opposing annular grooves, series of balls cooperating with the opposing grooves to rotatably support the said cutter, one pair of grooves being of such depth that the balls cooperating therewith transmit end thrusts in both directions, the said race member having an opening communicating with its groove of said pair through which the balls are inserted in the said pair of grooves, and a tongue on the adjacent race member extending into said opening to prevent the loss of the said balls.

11. A rotary well drilling bit comprising, a body, a support carried by the body, a rotatable cutter surrounding the support, a race member on the support within the cutter, there being opposing annular grooves in the member and the interior of the cutter, the member having an opening extending from one end to its groove, balls inserted through said opening into the grooves to rotatably support the cutter, a washer on the support between said end of the member and an adjacent surface of the body, and a part on the washer extending into said opening to prevent the loss of the balls therethrough.

12. A rotary well drilling bit comprising, a body, a support carried by the body, a rotatable cutter surrounding the support, a race member on the support within the cutter, there being opposing annular grooves in the member and the interior of the cutter, the member having an opening extending from one end to its groove, balls inserted through said opening into the grooves to rotatably support the cutter, a washer rigidly attached to the body, and a part on the washer occupying said opening.

13. A rotary well drilling bit comprising, a body, a support carried by the body, a rotatable cutter surrounding the support, a race member on the support within the cutter, there being opposing annular grooves in the member and the interior of the cutter, the member having an opening extending from one end to its groove, balls inserted through said opening into the grooves to rotatably support the cutter, a washer rigidly attached to the body, and a part on the washer occupying said opening and having a groove registering with and completing the groove in said member.

14. A rotary well drilling bit comprising, a body, a support carried by the body, a rotatable cutter surrounding the support, a race member on the support within the cutter, and a plurality of spaced series of balls rotatably supporting the cutter on the race member, one series of balls transmitting axial thrusts in both directions, the other series of balls each transmitting axial thrusts in one direction.

15. A rotary well drilling tool including, a body, a support carried by the body, rotatable cutters around the support, race members on the support within the cutters, the race members posing ball grooves, balls in said grooves rotatably and cutters having axially spaced pairs of opsupporting the cutters, one pair of grooves in each cutter and member assembly being of such depth that the balls therein transmit axial thrusts in both directions, each member having an axial opening for passing the balls into the said deep grooves, a part projecting from one member and occupying the said opening in the other member, and an element secured to the body and having a part occupying the said opening in the first mentioned member.

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