

April 2, 1935.

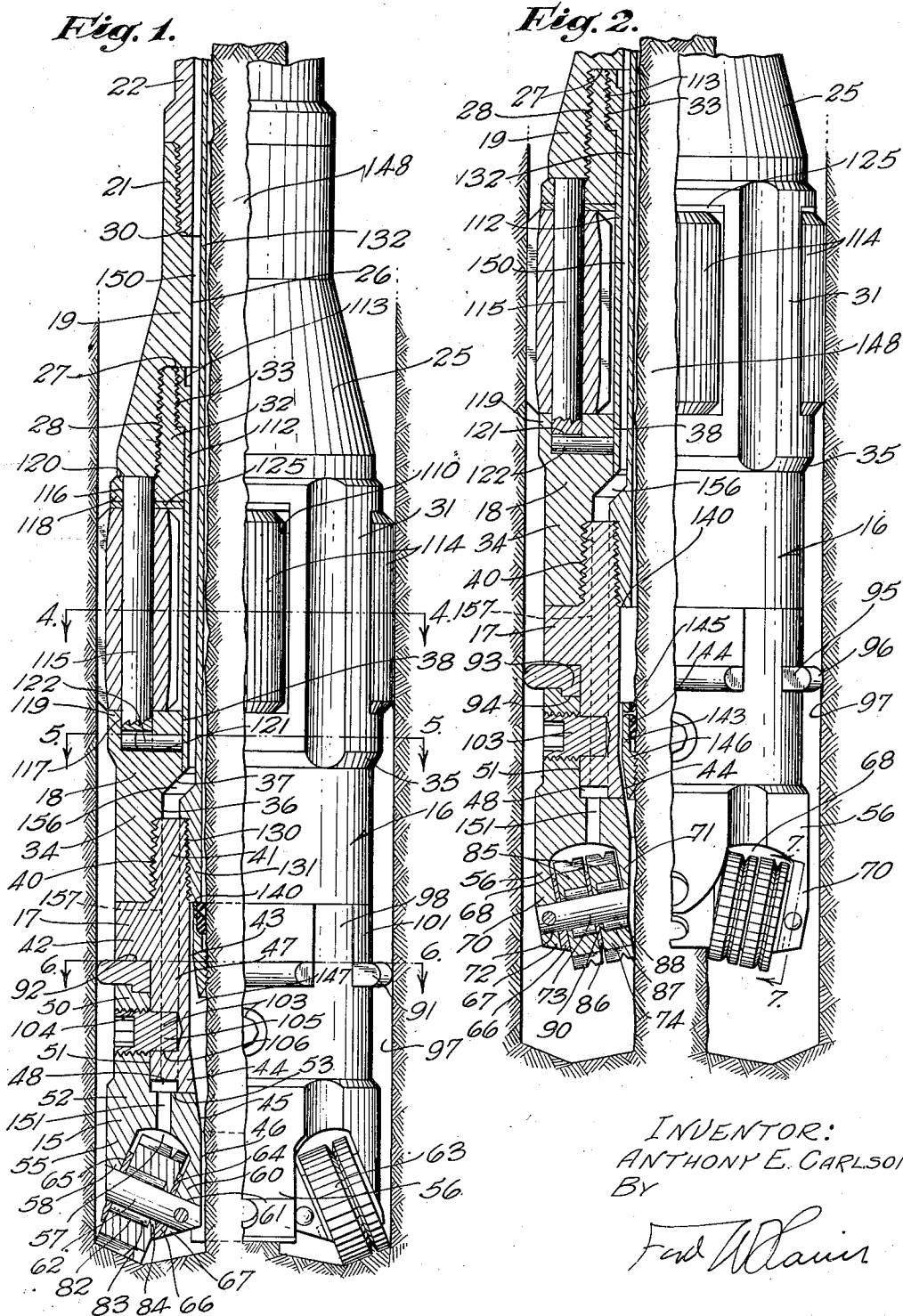
A. E. CARLSON

1,996,322

ROCK DRILLING CORE BIT

Filed July 24, 1931

3 Sheets-Sheet 1



INVENTOR:
ANTHONY E. CARLSON,
BY

Fred Warner

ATTORNEY.

April 2, 1935.

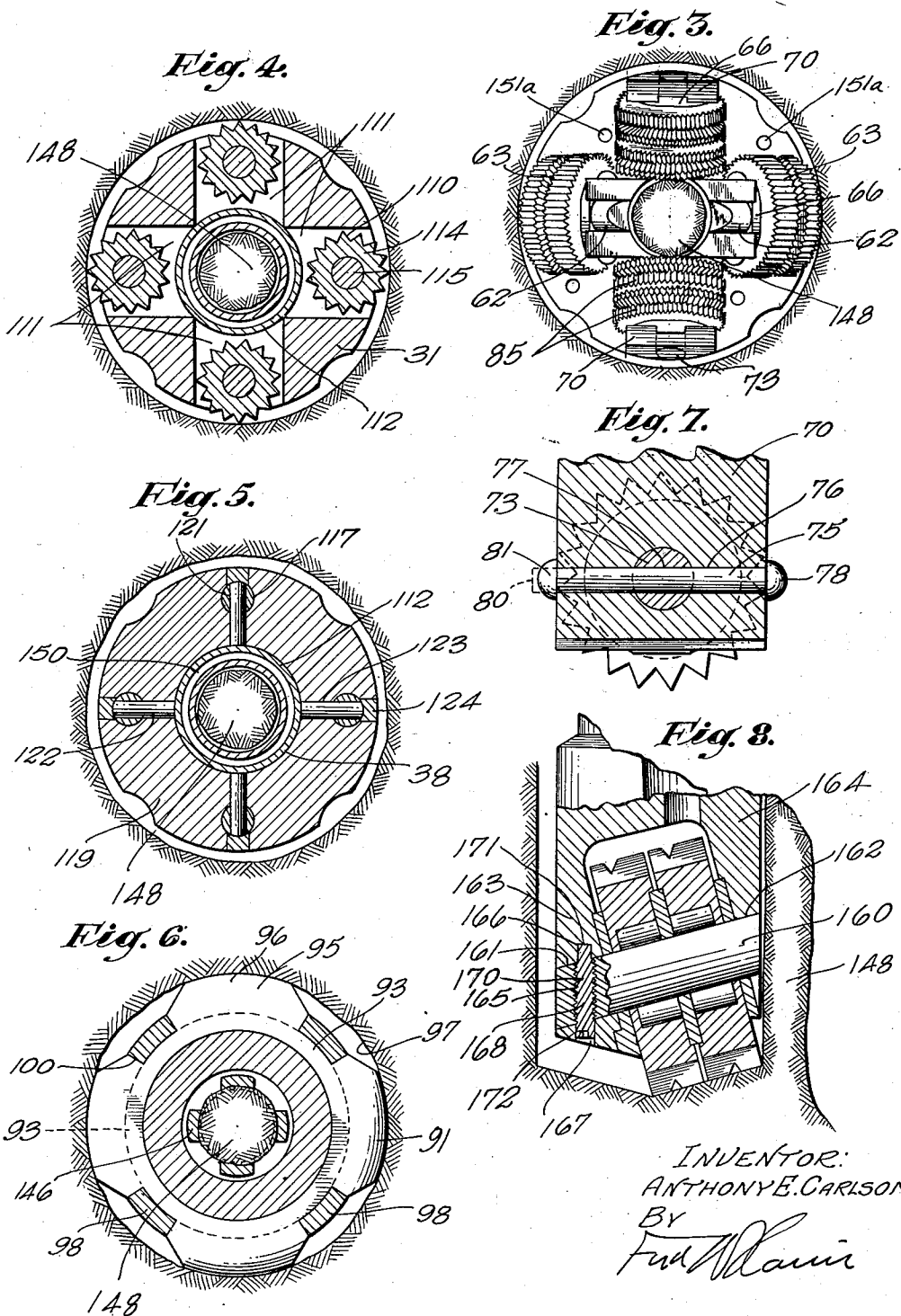
A. E. CARLSON

1,996,322

ROCK DRILLING CORE BIT

Filed July 24, 1931

3 Sheets-Sheet 2



INVENTOR:
ANTHONY E. CARLSON,
BY
Fred Maurer
ATTORNEY.

April 2, 1935.

A. E. CARLSON

1,996,322

ROCK DRILLING CORE BIT

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3 Sheets-Sheet 3

Fig. 9.

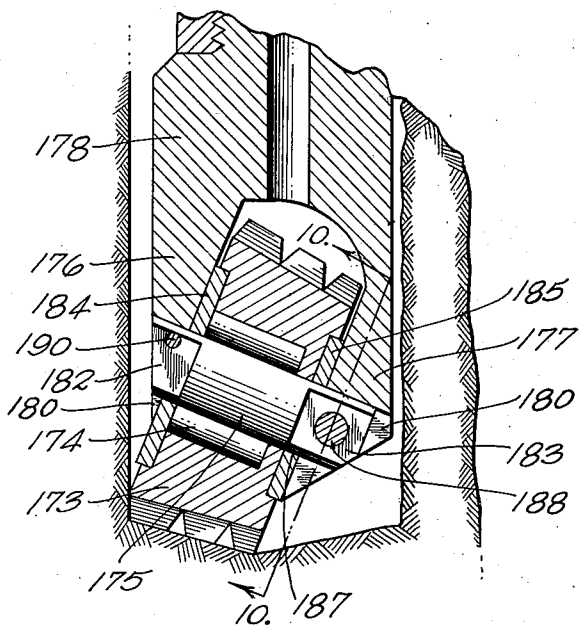


Fig. 12.

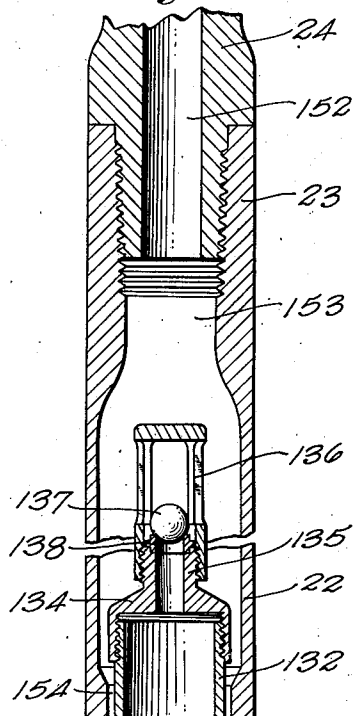


Fig. 11.

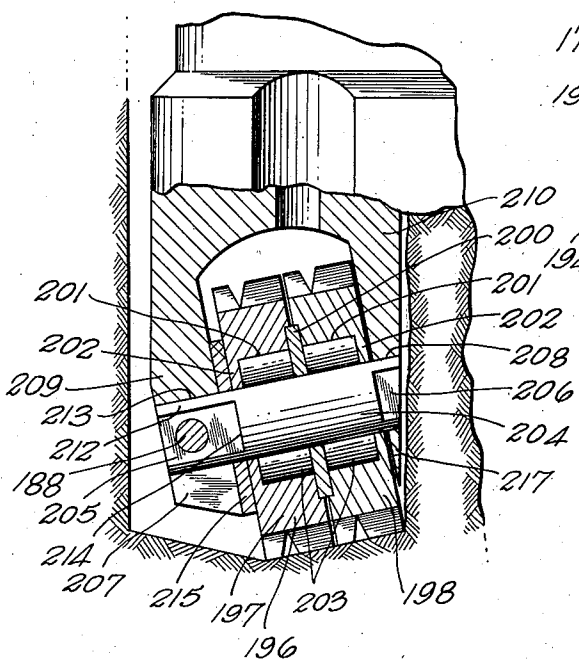
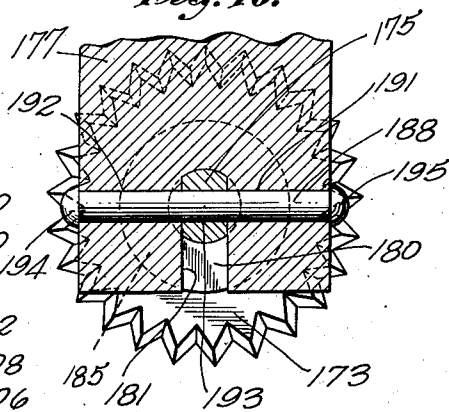


Fig. 10.



INVENTOR:
ANTHONY E. CARLSON.
BY

Frederick W. Harris

ATTORNEY.

UNITED STATES PATENT OFFICE

1,996,322

ROCK DRILLING CORE BIT

Anthony E. Carlson, Los Angeles, Calif.

Application July 24, 1931, Serial No. 552,813

17 Claims. (Cl. 255—72)

My invention relates to rotary well drilling equipment, and relates particularly to a core bit especially suitable for penetrating hard formations.

5 In the past hard formations, such as rock, required the use of roller type drilling bits in which the rollers were provided with sharp teeth which produced a crushing action on the rock, thus slowly disintegrating it to powdered form. The
10 drilling speed of such bits is very slow owing to the fact that the bit is required to break down or cut away a volume of rock equivalent to the volume of the hole drilled through such rock.

My invention comprehends a rock drilling bit
15 which will cut an annular opening so as to leave a core in the center in the same manner as core bits now employed for taking core samples in the drilling of a well. Accordingly, by the use of my bit the speed of drilling a hole of a given diam-
20 eter through a rock formation is greatly increased for the reason that the entire volume of rock material taken from the hole is not disintegrated by the roller cutters of the bit, but the core which is formed is removed in a single piece to the sur-
25 face of the ground when the bit is lifted from the well.

This principle of increasing the drilling speed through rock by drilling an annular opening and bodily removing the core thus formed has been
30 recognized by engineers for some time, but many difficulties in making a satisfactory rock roller core bit have been encountered. In order to prevent lateral oscillation or vibration which repeatedly breaks off the core so that it packs in the core barrel in chunks and interferes with the
35 progress of the drilling operation, such a large number of rollers have been employed that the size of these rollers is reduced to such an extent that the drilling capacity thereof and their useful
40 life in the well are greatly reduced, with the result that even though a core was being formed, the reduced speed and short life of small rollers prevented a material increase in the overall drilling speed as compared with the overall drilling speed
45 of standard roller-type rock bits.

In my new rock core bit a relatively small number of large roller cutters are employed, the number adapted for general use being four, two of which are sloped inwardly and two of which are
50 sloped outwardly. This has been considered too small a number of rollers for use in a rock roller bit, for the reason that a core bit with such a small number of rollers would operate with such lateral oscillation or side-sway as to break off the
55 core in chunks.

It is a feature of my improved rock core bit to employ a small number of large roller cutters and an auxiliary means located above and close to the cutting plane for preventing side-sway or os-
cillation destructive to cores. This stabilizing or
5 guiding means may be in the form of a reamer or a non-cutting guide member which friction-ally engages the wall of the hole at a point close to the cutting plane and wears down periph-
10 erally at about the same rate as the outer parts of the cutters wear so that as the size of the hole decreases due to cutter wear, the diameter of the guide means decreases accordingly, and excessive frictional loads are thereby avoided. The stabil-
15 izer also serves as a centering guide as the bit is moved through a casing set in a well.

It is a further object of my invention to provide a core drilling bit consisting of a tubular head and a sub-head which carries the cutters secured to the lower end thereof. This sub-head
20 is readily removed from and replaced on the main head and holds in place a replaceable stabilizer or guide member of the character above set forth.

It is an object of my invention to provide a core rock bit having four rollers, two of which
25 slope outwardly so as to determine the diameter of the hole, and the remaining two of which slope inwardly and control the diameter of the core. These cutters are of such ample size that
30 massive and amply sized cutting or grinding teeth may be formed thereon so that maximum penetration of the bit through a rock formation may be accomplished.

A further object of the invention is to provide a core bit for rock drilling which, for the purpose
35 of periodically cleaning the cutters, may be raised from the bottom of the hole without danger of breaking off the core. This is accomplished by inclusion in my invention of my improved and
40 novel form of core catcher which adheres to the core and is disposed in a vertically elongated annular space in the lower end of the core bit.

A further object of the invention is to provide a core bit construction in which the waterways
45 may be conveniently formed and in which such waterways effectively distribute the drilling fluid.

A further object of my invention is to provide a bit body having recesses therein in which
50 roller reaming cutters are mounted, this bit body having simple means for holding in place the parts of the reamer assemblies and being of simple and economical construction by reason of the simple and economical manner in which the
55 recesses or chambers for receiving the roller reaming cutters may be formed therein.

A further object of my invention is to provide a bearing construction which will enable the bit to operate with a minimum of friction and to provide a simple bearing and bearing pin construction for the roller cutters and a novel and simple means for securing the bearing pins in place.

It is a further object of the invention to provide a rock core bit of the above character having such construction that the roller cutters thereof cut a large clearance around the body of the bit, this result not being attainable by any of the rock core bits now on the market.

Further objects and advantages of the invention will be made evident throughout the following part of the specification.

Referring to the drawings, which are for illustrative purposes only,

Fig. 1 is an elevational view in quarter-section showing a preferred embodiment of my invention with the inner cutters thereof removed.

Fig. 2 is a partly sectioned side view of Fig. 1 viewing the bit shown in Fig. 1 at an angle of 90° from the line of vision on which Fig. 1 is viewed, the outer cutters being omitted.

Fig. 3 is a bottom plan view corresponding to Fig. 1.

Fig. 4 is a cross-section on a plane represented by the line 4—4 of Fig. 1.

Fig. 5 is a cross-section on a plane represented by the line 5—5 of Fig. 1.

Fig. 6 is a cross-section on a plane represented by the line 6—6 of Fig. 1.

Fig. 7 is an enlarged fragmentary section taken as indicated by the line 7—7 of Fig. 2.

Fig. 8 is an enlarged fragmentary sectional view showing an alternative form of cutter and bearing construction and an improved means for securing the bearing pins in place.

Fig. 9 is an enlarged fragmentary sectional view showing an alternative method of securing the bearing pins in place as applied to an external cutter assembly.

Fig. 10 is a fragmentary section taken as indicated by the line 10—10 of Fig. 9.

Fig. 11 is an enlarged fragmentary sectional view showing an alternative form of bearing pin securing means as applied to an internal cutter.

Fig. 12 is a vertically sectioned view of the upper end of the drill bit, showing the check valve at the upper end of the core receiving liner.

As best shown in Figs. 1 and 2, the preferred embodiment of my rock drilling bit includes a sub-head 15 and a main head 16 comprised of a lower body member 17, a middle body member 18, and an upper body member 19 from the upper end 21 of which a tubular shank 22 extends, this shank 22 being of a length corresponding to the maximum length of core desired to be cut and having a threaded upper end 23, as shown in Fig. 12, for securing it to a drill collar 24. The upper body member 19 has a downwardly converging lower portion 25 equipped with a cylindrical bore 26 and a counterbore 27 provided with internal threads 28. The upper end 21 of the body 19 is cylindrical and is provided with a threaded counterbore 30 into which the shank 22 threads. The middle body member 18 has a central cylindrical wall 31 from which a cylindrical wall 32 of reduced external diameter extends upwardly. This wall 32 is externally threaded so that it will screw into the threads 28 of the counterbore 27 and has in its upper end a threaded counterbore 33. From the lower end of the cylindrical wall 31 a cylindrical extension

34 projects downwardly, this extension 34 having a cylindrical outer face of slightly smaller diameter than the outer face of the wall 31, the outer face of the extension 34 joining the outer face of the wall 31 through a short, upwardly diverging conical face 35. Within the extension 34 a counterbore 36 is formed, the upper portion of this counterbore 36 converging upwardly with a conical face 37 to meet the bore 38 of the cylindrical wall 31. The counterbore 36 is equipped with internal threads 40 adapted to receive an externally threaded cylindrical wall 41 which forms the upper part of the lower body member 17. The central part of the member 17 consists of an annular wall 42, the external diameter of which is substantially the same as the external diameter of the extension 34 adjacent which it operates. The lower body member 17 has a bore 43 which is approximately the same diameter as the bore 38 of the middle body member 18 but is preferably slightly smaller. The bore 43 is preferably about six inches long and has a downwardly converging conical wall 44 at its lower end which meets a downwardly converging wall 45 formed at the upper end of the central bore 46 of the sub-head 15. The lower body member 17 has a lower cylindrical wall 47 surrounding the bore 43 and the conical wall 44. This lower cylindrical wall 47 is approximately half the radial thickness of the annular wall 42 and has a downwardly and outwardly facing annular channel 48 cut in its lower end.

The sub-head 15 has an upper cylindrical wall 50 which is of substantially the same exterior diameter as the annular wall or extension 42, and the bore 51 thereof is of such diameter that it will fit over the downwardly extending wall 47 of the lower body member 17. Downwardly adjacent the cylindrical wall 50, the sub-head 15 has a cylindrical wall 52 of larger external diameter than the wall 50 and has the conical face 45 formed therein. A horizontal shoulder 53 formed by the inner upper portion of the wall 52 fits tightly against the lower end of the wall 47, thus converting the annular channel 48 into an annular passage between the lower end of the wall 47 and the wall 52. Downwardly projecting from the wall 52 are a pair of primary leg formations 55 and a pair of secondary leg formations 56. The primary leg formations 55 are diametrically opposed, and the secondary leg formations 56 are also diametrically opposed on a plane 90° from the diameter defined by the primary leg formations 55. As shown in Fig. 1, the primary leg formations 55 have upwardly and inwardly sloping, tangentially directed notches 57 therein which divide the lower ends of the primary leg formations into outer walls or legs 58 and inner walls or legs 60. Through the legs 58 and 60 pin holes or bores 61 are formed so as to slope downwardly and inwardly in a diametral plane defined by the primary leg formations 55. The angle of slope of the pin openings 61 varies a little in the construction of different sizes of bits, but in general practice it ranges from twenty to twenty-five degrees from horizontal. By means of pins 62 which extend in the pin openings 61, external cutters 63 are secured in the tangential notches 57. To prevent wear against the inner faces of the legs 58 and 60, thrust washers 64 and 65 are provided. Means are provided for preventing rotation of the thrust washers, and, as shown at 66 in Fig. 1, such means may consist of an outwardly projecting wall on the lower portion of a thrust

washer, this projecting wall fitting into a lateral notch 67 formed in the lower end of the leg 60. The secondary leg formations 56, as shown in Fig. 2, each have a downwardly and inwardly sloping tangential notch 68 therein, forming in the leg formations 56 walls or legs 70 and 71. Across the lower portions of the legs 70 and 71, upwardly and inwardly sloping pin holes or bores 72 are formed, and by means of bearing pins 73 internal bearing assemblies 74 are supported in inclined positions in the notches 68.

In my invention I provide a novel and simple means for securing the bearing pins 62 and 73 in place in such a manner that they cannot become lost during operation of the bit but may be readily removed when replacement of the bearing pins and cutter assemblies is desired. Such means consists, as best shown in Fig. 7, of a rivet 75 extended through an opening 76 in a supporting leg, such as a leg 60 or 70, and through an opening 77 through the bearing pin 62 or 73 which extends through the leg 60 or 70. The rivet 75 initially has a head 78 on one end, and after it is placed in position in the openings 76 and 77, the opposite end 80 thereof is peened over to form a head 81. The rivet cannot be lost from the opening 76, and consequently the pin 62 or 73 cannot be lost. When it is desired to remove a pin, either head 78 or 81 may be cut from the rivet 75 and the rivet driven out. Each cutter 63 has a bore 82 adapted to receive a complement of bearing rollers 83 placed around a pin 62. At the inner end of each bore 82 an annular wall or flange 84 extends inwardly so as to substantially fill the space surrounding the pin 62 at the inner end of the bore 82. This annular wall 84, being a part of the cutter 63, rotates therewith in the direction of movement of the bearing rollers 83 which tend to creep inwardly along the pin 62 so that they engage the face of the annular wall 84. The bearing rollers 83 are thereby prevented from forcible end engagement with a stationary wall and instead are caused to engage a moving wall, thereby keeping at a minimum the retarding action due to end engagement of the bearing rollers. The internal cutter assemblies 74 each consist of a pair of cutters 85 separated by an annular washer 86. Each of these cutters has a bore 87 for receiving a bearing roller 88 and an inwardly directed flange 90 at the lower end of the bore for receiving the end thrust of the bearing roller 88. In the form of my invention shown in Figs. 1 and 2, the cutters and cutter assemblies 63 and 74 have been respectively termed "external" and "internal", this being for the reason that the cutters 63 form the outer or external portions of the annular bore and the cutters 85 cut the internal or inner portion of the bore. The cutters 63 and 85 are shown cylindrical in form, but in the practice of the invention these cutters may be readily made conical, as conditions of operation may require and as will hereinafter be illustrated in conjunction with other features of my invention.

To prevent side-sway or oscillation of the bit so as to avoid breaking off of the core 90 formed thereby, I provide a stabilizer or guide member 91 which fits between the upper end of the wall 50 and a shoulder or face 92 at the lower end of the annular wall 42. As shown in Figs. 1, 2, and 6, the stabilizer 91 consists of a ring 93, the lower portion of which fits into an annular channel 94 formed in the upper end of the wall 50. Projecting outwardly from the ring 93 are a plurality of radially extending webs 95, the periph-

eral edges 96 of which are vertically rounded, as shown in Figs. 1 and 2, and are circumferentially curved, as shown in Fig. 6, to fit the bore 97 cut by the cutters of the bit. From the outer edge of the wall 50, posts 98 of arcuate form project upwardly through spaces or notches 100 between the webs 95 and extend into vertical recesses 101 properly positioned in the outer face of the wall 42, these posts 98 providing means for transmitting torque from the main head 16 to the sub-head 15. The sub-head 15 is secured to the main head 16 by screws 103 which are threaded into openings 104 in the wall 50 and have inner cylindrical ends 105 which seat in recesses 106 in the wall 47. The extending of the lower portion of the ring 93 into the annular channel 94 and behind the posts 98 will effectively prevent loss of any part of the stabilizer 91 should it become broken radially. The peripheral edges 96 of the stabilizer 91 engage the bore 97 during the operation of the bit and maintain the bit in centralized position. Engagement of the edges 96 with the bore 97 results in an abrading thereof so that the diameter of the stabilizer 91 is reduced. In the stabilizer 91 the amount of metal disposed for engagement with the bore 97 may be so proportioned that the reduction in diameter of the stabilizer will be proportionate to the reduction of the bore due to wear of the outer portions of the cutters.

My new reamer construction embodied in the middle body member 18 is placed close to the lower end of the tool so that it will also have a pronounced stabilizing action supplementing the stabilizing action of the member 91. Where the reamer is employed, the stabilizer 91 may be omitted and the reamer depended on for preventing lateral side-sway or oscillation. The construction of this reamer assembly is of especial importance to my invention as it may be readily incorporated in my bit structure without exorbitant cost. In its construction blind recesses 110 are formed in the cylindrical wall 31 by cutting openings 111, as shown in Fig. 4, through the wall 31 to the bore 38 thereof, and after the cutting of these openings, the inner ends thereof are closed by a steel sleeve 112 having an enlarged, externally threaded upper end 113 which screws into the threaded counterbore 33 in the upper end of the wall 32. The sleeve 112 extends entirely through the bore 38 of the cylindrical wall 31 and effectively closes the inner ends of the openings 111, changing the openings 111 to pockets or recesses in which roller-type reaming cutters 114 are mounted on substantially vertical shafts 115. The shafts 115 are replaceable, and the upper and lower ends thereof are received in openings 116 and 117 in the walls 118 and 119 forming the upper and lower ends of the recesses 110. The openings 116 open onto the horizontal face or shoulder 120 formed between the upper edge of the wall 31 and the lower end of the wall 32. Therefore, there is an open space at the outer ends of the openings 116, when the middle body member and upper body member are separated, through which the shafts 115 may be passed into the openings 116 and into engagement with the openings 117. When the middle body member 18 and the upper body member 19 are reassembled, the lower end of the upper body member 19 closes the upper ends of the openings 116 and prevents removal of the shafts 115. The shafts 115 are held from rotation by the engagement of notches 121 in their lower ends with horizontal pins 122 which extend diametrically across

the lower ends of the openings 117. For installation of the pins 122, radial openings 123 may be drilled radially inwardly through the wall 119 in position to diametrically close the lower portions of the holes 117. The outer ends of the openings 123 may be then closed, as indicated at 124, by filling in a wall of metal by welding. The pins 122 may be inserted in the openings 123 through the bore 38 before the sleeve 112 is installed, the lower end of the sleeve 112 after its installation preventing movement of the pins 122 from the openings 123. At the upper ends of the recesses 110 rectangular thrust washers 125 are placed so as to receive the wear of the upper ends of the cutters 114. From the foregoing, the simple making of a reamer body by first cutting holes through a cylindrical wall and then closing the inner ends thereof will be perceived. The holes 111 may be cut with an oxyacetylene torch slightly undersize and then trimmed to finished size, which is very economical as compared to the cutting of a recess of the same size as the recess 110 by the use of milling tools.

The wall 41 of the lower body member 17 is provided with internal threads 130 which receive the lower threaded end 131 of a core receiver or barrel 132 which extends upwardly through the middle body member 18, the upper body member 19, and the shank 22. On the upper end of the core receiver 132 a reducing fitting 134 is secured, and threaded onto the reducing end 135 thereof is a valve cage 136 adapted to hold a valve ball 137 in position for cooperation with a valve seat 138, thus providing the upper end of the core receiver 132 with a downwardly closing check valve for preventing entrance of drilling fluid into the upper end of the core receiver 132, as shown in Fig. 12. The lower end 131 of the core receiver 132 forms a shoulder 140 at the upper end of the bore 43 of the lower body member 17, this shoulder 140 serving as a stop for the upward movement of my improved core catcher 143. This core catcher 143 consists of a contractile encircling member or ring 144 which may be conveniently formed from rubber. Secured to the ring 144, by such means as rivets 145, are a plurality of downwardly projecting jaws 146. The ring 144, which may be also made of spring steel, is adapted to resiliently engage the exterior of the core 148 so as to tend to remain stationary on the core until engaged by the shoulder 140 and then to be forced downwardly as the drilling operation progresses. During the downward movement of the drilling bit, the core catcher 143 assumes the position in which it is shown in Fig. 1 at the upper end of the cylindrical space 147 formed between the bore 43 and the adjacent exterior surface of the core 148. The bit may be raised, without applying any breaking strain on the core 148, until the downwardly converging face 44 engages the jaws 146. The bit may be raised from the drilling position in which it is shown in Fig. 1 to the raised position shown in Fig. 2 without the face 44 engaging the jaws 146, and the bit may be rotated in this raised position for the purpose of running free and cleaning the cutters, which is accomplished by the drilling fluid which passes down through the watercourse 150 and is issued through discharge openings 151 and 151a. The watercourse 150 includes the opening 152 of the drill collar 24 leading into the upper end 153 of the shank 22, the annular space 154 within the shank 22, the upper body member 19, and the middle body member 18, and surrounding the core receiver 132; an annular space 156 adjacent

the conical face 37 of the wall 34; vertical holes 157 drilled vertically through the wall 41, the inner portion of the wall 42, and the wall 47 of the lower body member 17; the annular space 48 communicating with the lower ends of the holes 157; and the discharge passages 151.

The effective diameter of the bit may be readily varied within small limits by changing the thickness of the washers 65 so as to change the positions of the cutters 63. The effective diameter of the bit may also be readily varied by replacing the sub-head 15 with one of larger diameter, replacing the stabilizer 91 to correspond with the size of the hole cut by the outer cutters 63 of the larger size head, and increasing the diameters of the reaming cutters 114, this making it possible to use a single main head assembly for several sizes of bits.

In Fig. 8 I show an alternative method of securing a bearing pin 160 in holes 161 and 162 formed in supporting legs 163 and 164. In this construction the pin 160 is equipped with a threaded opening 165 which is aligned with openings 166 and 167 in the supporting leg 163. A locking screw 168 has a central threaded shank 170 of a size to fit the threaded opening 165. On the inner or upper end of the screw 168 is an end or extension 171, the diameter of which is no greater than the root diameter of the threads on the shank 170. On the lower outer end of the shank a head 172 is formed which has a diameter no smaller than the root diameter of the threads of the opening 165. It will be perceived that the screw 168 has threaded engagement only with the bearing pin 160 and that the cylindrical ends 171 and 172 fit into cylindrical openings. In replacing the pin 160, a new threaded opening to receive the screw 168 is provided in the new pin, and, if desired, the screw 168 may be also replaced. In this construction there are no threaded openings in the permanent supporting structure formed by the leg 163, and accordingly there are no permanent threads which may become worn so as to hold a locking screw loosely. By replacing one or both of the parts 160 and 168 when the cutters are replaced, it is made possible to maintain a tight fit between the locking screw and the threaded opening into which it fits.

In Fig. 9, I disclose an external or outwardly sloping cutter 173 of conical form having bearing rollers 174 therein which turn on a bearing pin 175. Disposed in conjunction therewith is a simple and effective means for securing the bearing pin 175 in supporting legs 176 and 177 of a supporting structure 178. The feature of this construction is that notches 180 are formed in the lower ends of the legs 176 and 177, these notches 180 having parallel side walls 181, as shown in Fig. 10. The ends 182 and 183 of the pin 175 are flattened to such width that they will slide upwardly in the notches 180 in close engagement with the side walls 181. The flattened ends 182 and 183 extend inwardly a sufficient distance to receive wear plates or thrust washers 184 and 185 thereon, these washers 184 and 185 having openings 187 therein which are of the same shape as the ends 182 and 183 and are therefore prevented from rotation with the deformed ends of the pin 175. In order to make these thrust washers 184 and 185 massive, they may be countersunk into the ends of the cutter 173, as shown. To hold the pin 175 in the open notches 180, rivets 188 and 190 are passed through holes in the legs 176 and 177 and in the ends of the pin 175. Illustrative of this, I show in Fig. 76

10 openings 191, 192, and 193 through which the rivet 188 is passed, whereupon the projecting end of the rivet may be peened over so that there will then be heads 194 and 195 on the exposed ends of the rivet which will prevent removal of the rivet, but either of which heads may be cut off with a chisel to permit the rivet to be driven out. In Fig. 11, I show an internal cutter assembly 196 consisting of a pair of cutters 197 and 198 which are separated by a separating washer 200. The cutters 197 and 198 have bearing bores 201 which face toward the separating washer 200 and have radially projecting flanges 202 closing their outer ends. Bearing rollers 203 which operate in the bores 201 have their ends abutting walls which rotate with the cutters 197 and 198. The cutter assembly 196 is mounted on a bearing pin 204 which, like the bearing pin 175 of Fig. 9, has flattened ends 205 and 206 which slide upwardly into notches 207 and 208 formed respectively in supporting legs 209 and 210. For securing the bearing pin 204, the rivet 188 is passed through the end 205 in the manner described relative to Fig. 10. By this rivet the upper face 212 of the end 205 is held against the upper wall 213 of the notch 207 so that the bearing pin 204 cannot rotate downwardly. This holding effect is also aided by the engagement of shoulders 214 of the bearing pin 204 which engage a thrust washer 215. If desired, the end 206 may be secured by placing a small weld in the lower portion of the notch 208 adjacent the lower portion of the end 206, as indicated at 217 in Fig. 11.

I claim as my invention:

35 1. A rotary rock core bit of the character described, including: a cylindrical member having a bore therethrough and a counterbore at the lower end of said bore; a lower cylindrical part secured to said cylindrical member and having an internally threaded, cylindrical wall extending into said counterbore; a core receiver having its lower end threaded into the threads of said cylindrical wall and its upper portion projecting through said cylindrical member so as to form an annular drilling fluid passage between said core receiver and said cylindrical wall, the upper end of said lower cylindrical part forming a lower end wall for said annular drilling fluid passage and said lower cylindrical part having a plurality of fluid passages leading down from the lower end of said annular passage; a tubular wall projecting downwardly from said lower cylindrical part, said tubular wall being of smaller external diameter than said lower cylindrical part; a sub having an upwardly projecting cylindrical wall adapted to fit over said tubular wall; means for locking said sub to said tubular wall, said sub having tangential notches in the lower end thereof adapted to receive roller cutters, there being an annular channel formed between said sub and said lower cylindrical part connected to said fluid passages of said lower cylindrical part and fluid discharge openings extending downwardly from said annular channel; and roller rock cutters secured in said notches in position to cut an annular opening leaving a core projecting up into said rock bit.

2. A bearing for a roller cutter of the character described, comprising: a shaft; a cutter body on said shaft, said cutter body having a bearing bore of larger diameter than said shaft and an inwardly projecting radial flange at an end of said bearing bore, the inner portion of said flange approaching close to the surface of said shaft; and bearing rollers in said bearing

bore, there being a plate closing the open end of said bearing bore.

3. A bit of the character described, including: a body adapted to be secured to the lower end of a string of drill pipe, said body having a slot formed between inner and outer walls; a cutter shaft extended across said slot between said inner and outer walls; and a roller cutter mounted on said shaft, said roller cutter having a bore of a size to closely fit said shaft and having a counterbore extending from one end of said roller cutter to a point near the opposite end thereof, there being bearing rollers disposed around and in engagement with said shaft within said counterbore.

4. A bit of the character described, including: a body adapted to be secured to the lower end of a string of drill pipe, said body having a slot formed between inner and outer walls; a cutter shaft extended across said slot between said inner and outer walls; a roller cutter mounted on said shaft, said roller cutter having a bore of a size to closely fit said shaft and having a counterbore extending from one end of said roller cutter to a point near the opposite end thereof, there being bearing rollers disposed around said shaft within said counterbore; and a thrust plate on said shaft in position to close the open end of said counterbore and to receive the wear of the ends of said bearing rollers.

5. A bit of the character described, including: a body adapted to be secured to the lower end of a string of drill pipe, said body having a groove formed between inner and outer walls, there being channels formed in the lower ends of said inner and outer walls on a plane crossing said groove, and there being a rivet opening in the lower end of one of said walls in position to intersect the channel in such wall; a roller cutter in said groove; a thrust plate adjacent an end of said roller cutter, said thrust plate having a non-circular opening therein; a shaft for holding said cutter and said thrust plate in said groove, the ends of said shaft being received in said channels, and the end of said shaft cooperating with said thrust plate, being of non-circular cross section, whereby to engage said thrust plate and one of said channels in a non-rotative manner, there being a rivet opening through one end of said shaft; and a rivet extended through said rivet openings whereby to hold said shaft in said channels, said rivet having an exposed head on one end thereof adapted to be cut off to permit removal of said rivet.

6. A bearing for a roller cutter of the character described, comprising: a shaft; a cutter body on said shaft, said cutter body having a bearing bore of larger diameter than said shaft and an inwardly projecting radial flange at an end of said bearing bore; and bearing rollers in said bearing bore, there being a plate closing the open end of said bearing bore.

7. A bit of the character described, including: a body adapted to be secured to a string of drill pipe, said body having a cutter recess formed between relatively inner and outer walls, there being slots across the outer ends of said walls on an axis crossing said recess; a roller type cutter in said recess; a shaft for said cutter having its ends in said slots, one end of said shaft being of flattened form so as to engage its cooperating slot in non-rotative relation; and a rivet extending through one of said walls and across the slot therein in position to prevent removal of said shaft, said rivet having a head formed on one end

thereof adapted to be removed to permit removal thereof.

8. A bit of the character described, including: a body adapted to be secured to a string of drill pipe, said body having a cutter recess formed between relatively inner and outer walls, there being slots across the outer ends of said walls on an axis crossing said recess, one of said slots having substantially parallel side walls; a roller type cutter in said recess; a shaft for said cutter having its ends in said slots, one end of said shaft being of flattened form to provide parallel faces adapted to engage said substantially parallel slot walls, and said shaft having shoulders formed thereon to transmit lateral forces from said shaft to said body; and a rivet extending through one of said walls and across the slot therein in position to prevent removal of said shaft, said rivet having a head formed on one end thereof adapted to be removed to permit removal thereof.

9. A bit of the character described, including: a body adapted to be secured to a string of drill pipe, said body having a cutter recess formed between relatively inner and outer walls, there being slots across the outer ends of said walls on an axis crossing said recess, one of said slots having substantially parallel side walls; a roller type cutter in said recess having a shaft opening therethrough; a shaft for said cutter comprising a cylindrical bar with the end portions thereof flattened and resting in said slots in a non-rotatable manner; and a rivet extending through one of said walls and the slot therein in a position to hold the end of said shaft in said slot in close proximity to the upper wall of said slot, said rivet having a head formed on one end thereof adapted to be removed to permit removal thereof.

10. A bit of the character described, including: a body adapted to be secured to a string of drill pipe, said body having a cutter recess formed between relatively inner and outer walls, there being slots across the outer ends of said walls on an axis crossing said recess, one of said slots having substantially parallel side walls; a roller type cutter in said recess having a shaft opening therethrough; a shaft for said cutter comprising a cylindrical bar with the end portions thereof flattened and resting in said slots in a non-rotatable manner, there being shoulders formed on said shaft to transmit forces from said shaft to said body in a direction essentially parallel to the axis of said shaft; and a rivet extending through one of said walls and the slot therein in a position to hold the end of said shaft in said slot in close proximity to the upper wall of said slot, said rivet having a head formed on one end thereof adapted to be removed to permit removal thereof.

11. An earth boring roller cutter of the character described for use with a bit body having a cylindrical bearing member and roller members disposed around said bearing member, comprising a circular body having peripheral cutting means and a bore to receive said bearing member, there being a counterbore extending from one end of said circular body to a point near the opposite end thereof to receive said roller members.

12. A bearing for a roller cutter of the character described, comprising: a shaft; a cutter body on said shaft, said cutter body having a

bearing bore of larger diameter than said shaft and an inwardly projecting radial flange at an end of said bearing bore, the inner portion of said flange approaching close to the surface of said shaft; and bearing rollers in said bearing bore abutting the inner radial face of said flange, there being a plate closing the open end of said bearing bore.

13. A bit of the character described, including: a body adapted to be secured to the lower end of a string of drill pipe, said body having a slot formed between inner and outer walls; a cutter shaft extended across said slot between said inner and outer walls; and a roller cutter mounted on said shaft, said roller cutter having a bore of a size to closely fit said shaft and having a counterbore extending from one end of said roller cutter to a point near the opposite end thereof, there being bearing rollers disposed around and in engagement with said shaft within said counterbore and abutting the inner end wall of said counterbore.

14. A bit of the character described, including: a body adapted to be secured to the lower end of a string of drill pipe, said body having a slot formed between inner and outer walls; a cutter shaft extended across said slot between said inner and outer walls; a roller cutter mounted on said shaft, said roller cutter having a bore of a size to closely fit said shaft and having a counterbore extending from one end of said roller cutter to a point near the opposite end thereof, there being bearing rollers disposed around and in engagement with said shaft within said counterbore and abutting the inner end wall of said counterbore; and a thrust plate on said shaft in position to close the open end of said counterbore and to receive the wear of the ends of said bearing rollers.

15. A bearing for a roller cutter of the character described, comprising: a shaft; a cutter body on said shaft, said cutter body having a bearing bore of larger diameter than said shaft and an inwardly projecting radial flange at an end of said bearing bore; and bearing rollers in said bearing bore abutting the inner face of said flange, there being a plate closing the open end of said bearing bore.

16. An earth boring roller cutter of the character described for use with a bit body having a cylindrical bearing member and roller members disposed around said bearing member, comprising a circular body having peripheral cutting means and a bore to receive said bearing member, there being a counterbore extending from one end of said circular body to a point near the opposite end thereof to receive said roller members, the radial depth of said counterbore being at least half the diameter of one of said roller members.

17. An earth boring roller cutter of the character described for use with a bit body having a bearing member and bearing rollers disposed around said bearing member, comprising a circular body having peripheral cutting means, a bore to receive said bearing rollers, and a radial flange projecting inwardly at one end of said bore for limiting axial movement of said bearing rollers in one direction.

ANTHONY E. CARLSON.

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CERTIFICATE OF CORRECTION.

Patent No. 1,996,322.

April 2, 1935.

ANTHONY E. CARLSON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 5, second column, line 27, claim 4, after "around" insert the words and in engagement with; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 21st day of May, A. D. 1935.

Leslie Frazer

Acting Commissioner of Patents.

(Seal)