

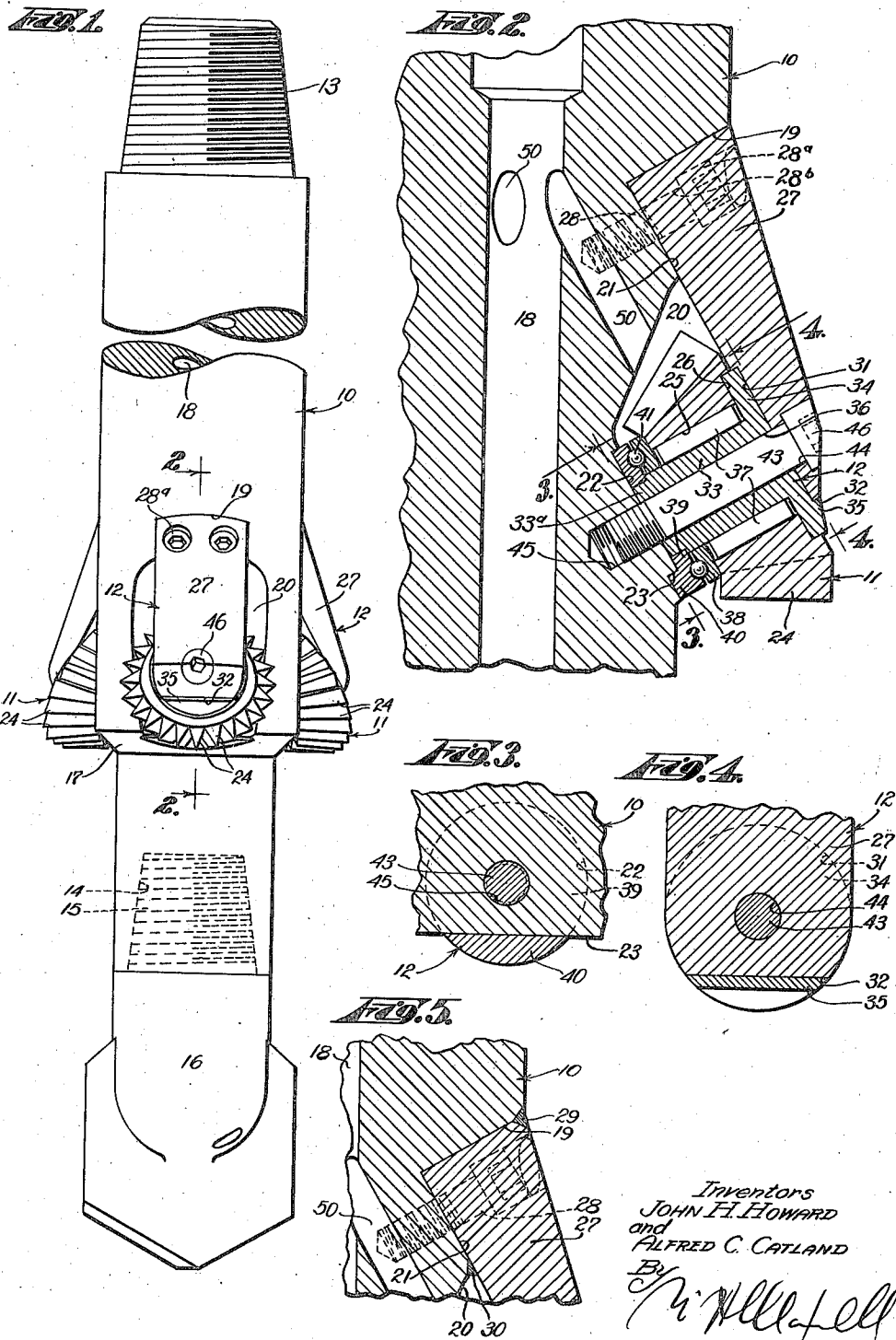
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WELL REAMER

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WELL REAMER

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This invention relates to a well tool and relates more particularly to a reamer for use in the rotary method of well drilling. A general object of this invention is to provide an improved well reamer embodying practical effective means rotatably mounting the roller reaming cutters.

Another object of this invention is to provide a well reamer embodying a plurality of roller reaming cutters positioned and mounted to be operable to enlarge a well bore to a substantial extent whereby the reamer is well adapted for enlarging the pilot bore or rat-hole of a deep well.

Another object of this invention is to provide a well reamer of the character mentioned in which the roller cutters are dependably mounted for rotation in a manner so that they cannot become displaced or lost when the tool is in operation.

Another object of this invention is to provide a well reamer of the character mentioned embodying simple, dependable means for removably or replaceably mounting the rotatable roller cutters.

Another object of this invention is to provide a well reamer of the character mentioned in which the roller cutters and their bearings may be handled and easily arranged in position on the shank as units.

Another object of this invention is to provide a reamer of the character mentioned in which the bearings of the roller cutters directly transmit practically all of the operating thrusts and pressures directly to the body or shank thus relieving the pins of these forces.

Another object of this invention is to provide a well reamer of the character mentioned in which the legs or caps for supporting the outer ends of the cutter mounting pins may be easily and quickly replaced when worn.

A further object of this invention is to provide a well reamer of the character mentioned that is simple and inexpensive to manufacture and to recondition after use.

The various objects and features of our invention will be readily understood from the following detailed description of typical preferred forms and applications of the invention, throughout which description reference is made to the accompanying drawing, in which:

Fig. 1 is a side elevation of the reamer provided by this invention showing it mounted above a pilot bit. Fig. 2 is an enlarged fragmentary vertical detailed sectional view taken substantially as indicated by line 2—2 on Fig. 1. Figs. 3 and 4 are fragmentary detailed sectional views taken as indicated by lines 3—3 and 4—4, respectively, on

Fig. 2 and Fig. 5 is a fragmentary vertical detailed sectional view showing a leg or cap welded to the body.

The improved reamer provided by the present invention includes, generally, a shank or body 10, a plurality of roller reaming cutters 11 and means 12 rotatably mounting the cutters 11 on the body 10.

The body 10 is an elongate structure or member adapted to be connected in a well drilling string. In practice where the reamer is to be employed for the purpose of enlarging a well having a pilot bore the shank 10 may be connected with the lower end of a drilling string and may be provided at its lower end with a pilot bit. Suitable connecting means are provided at the opposite ends of the body 10. In the particular case illustrated in the drawing a tapered screw threaded pin 13 is provided on the upper end of the body 10 to facilitate its connection with the drilling string and a socket 14 is provided in the lower end of the body. Fig. 1 of the drawing shows a pin 15 of a pilot bit 16 threaded in the socket 14 of the body 10. The bit 16 is in the nature of a drag type bit and is adapted to operate in a rat-hole or pilot bore to guide the reamer. The body 10 may be cylindrical in its general configuration. In the preferred construction the lower portion of the body 10 is reduced in diameter to provide the body with a downwardly facing annular shoulder 17. The shoulder 17 is spaced some distance above the lower end of the body 10. A central longitudinal fluid passage 18 extends through the body 10 from one end to the other to conduct the circulation fluid.

The shank or body 10 is formed and shaped to receive the cutters 11 and the cutter mounting means 12. Sets or pairs of recesses 19 and 20 are provided in the exterior of the body 10 for this purpose. In the reamer illustrated there are three cutters 11 and the body 10 has three circumferentially spaced pairs of recesses 19 and 20. The recesses 19 and 20 are provided in the exterior of the body 10 above its shoulder 17. The recesses 19 are the uppermost recesses and have flat upper walls inclined downwardly and inwardly relative to the central longitudinal axis of the reamer. The inner walls 21 of the recesses 19 are preferably flat and are inclined downwardly and outwardly being normal to the upper walls of the recesses. A recess 20 is provided immediately below each recess 19. The recesses 20 are somewhat larger than the recesses 19 and extend downwardly to the body shoulder 17. The upper

walls of the recesses 19 are inclined downwardly and inwardly with respect to the central longitudinal axis of the tool while the inner walls of the recesses 20 are inclined downwardly and outwardly and die out or terminate at their lower ends at the shoulder 17. A partially cylindrical depression 22 is provided in the inner wall of each recess 20. The walls of the depressions 22 are ground or machined to receive bearing parts of the means 12 as will be hereinafter described.

Flat angular shoulders 23 are provided on the body 10 at the lower ends of the depressions 22. The cutters 11 are in the nature of roller cutters and are alike in size and shape. The cutters 11 are frusto-conical having pitched or inclined peripheries and flat normal ends. Peripheral cutting teeth 24 are provided on the cutters 11. The teeth 24 may be straight or spiralled as desired. It may be preferred to have the teeth 24 of one cutter 11 straight, the teeth 24 of the second cutter spiralled in a right hand direction and the teeth 24 of the third cutter spiralled in a left-hand direction whereby the teeth of the several cutters cannot track in their engagement with the earth formation. The ends of the cutting teeth 24 are preferably bevelled off at the large ends of the cutters 11. Each cutter 11 is provided with a central longitudinal opening 25. A counterbore or socket 26 is provided in the outer end of each cutter 11.

The means 12 rotatably mount the cutters 11 in the recesses 20 for rotation about downwardly and inwardly inclined axes. The means 12 include legs or caps 27 projecting downwardly and outwardly from the upper end of each body recess 20. The caps 27 have their upper portions received in the recesses 19. The upper ends of the caps 27 are flat and bear upwardly against the upper walls of the recesses 19 and flat inner surfaces of the caps bear against the inner walls 21 of the recesses 19. The opposite sides of the caps 27 are parallel and cooperate with the side walls of the recesses 19 to prevent lateral movement of the caps. The caps 27 may be connected with the body 10 for easy replacement when worn. In the structure illustrated in Figs. 1 and 2 of the drawing the caps 27 are secured to the body 10 by screws 28. The screws 28 are inserted through openings 28^b in the caps and are threaded in suitable openings in the body 10. The heads 28^a of the screws are countersunk or recessed in the outer sides of the caps. The heads 28^a are preferably socketed to permit the easy threading and unthreading of the screws. The screws 28 dependably and rigidly secure the caps 27 to the body 10.

If desired the caps 27 may be welded to the shank 10, as illustrated in Fig. 5 of the drawing to, in effect, constitute extensions or continuations of the body. When the caps 27 are welded to the body 10 they may be welded at their outer sides as well as their inner sides as at 29 and 30 in Fig. 5. In addition to the welding at 29 and 30 the screws 28 may also be employed to assist in securing the caps to the body. The inner sides of the caps 27 are flat and substantially parallel with the inner walls of the body depressions 22. The outer lower corners of the caps 27 are preferably bevelled away. Partially circular or cylindrical depressions 31 are provided in the inner sides of the caps 27. The lower ends of the depressions 31 are open at the lower ends of the caps 27. The inner or principal walls of the depressions 31 are parallel with the principal walls of the depressions 22. Flat downwardly

facing surfaces 32 are provided on the lower ends of the caps 27 at the lower ends of the depressions 31.

The means 12 for rotatably mounting the cutters 11 further include bushings or bearings 33 arranged in the recesses 20. The bearings 33 are generally cylindrical and extend through the openings 25 of the cutters 11. A radially projecting annular flange 34 is provided on the outer end of each bearing 33. The flanges 34 cooperate with the depressions 31 in the caps 27. The outer surfaces of the flanges 34 are adapted to bear on the bottom or principal walls of the depressions 31 while the peripheries of the flanges cooperate with the curved peripheral walls of the depressions. The flanges 34 are sufficiently thick to project inwardly from the inner sides of the caps 27. Extensions or lugs 35 are provided on the lower parts of the flanges 34 and cooperate with the surfaces 32. The cooperation of the lugs 35 with the surfaces 32 holds the bearings 33 against rotation and assists in the transmission of thrusts from the bearings to the caps 27. The inner ends of the bearings 33 are adapted to cooperate with the bottom or principal walls of the body depressions 22. A central longitudinal opening 36 is provided in each bearing 33. A portion 33^a of reduced diameter is provided on the inner end of each bearing 33.

The cutters 11 may be rotatably supported on the bearings 33 through suitable anti-friction bearings. In the particular case illustrated series of anti-friction rollers 37 rotatably support the cutters 11 on the bushings or bearings 33. The cutters 11 are arranged with their large ends outwardly. The sockets 26 in the large ends of the cutters 11 partially receive the flanges 34. The flanges 34 operate to space the outer ends of the cutters 11 from the inner sides of the caps 27. The cutters 11 are rotatably supported on the bearings 33 so that their teeth 24 project downwardly beyond the lower ends of the caps 27 to contact the shoulder of earth formation at the upper end of the pilot bore or rat-hole.

Thrust bearings or thrust washers are provided on the bearings 33 at the inner ends of the cutters 11. In accordance with the invention two washers 38 and 39 are provided at the inner end of each cutter 11. The washers 38 surround the bearings 33 to cooperate with the inner ends of the cutters 11. The washers 39 are arranged on the reduced portions 33^a of the bearings 33 to cooperate with the depressions 22 in the body 10. The outer sides of the washers 39 cooperate with the inner or principal walls of the depressions 22 while the peripheries of the washers engage the peripheral walls of the depressions. Flat surfaced lugs 40 are provided on the washers 39 and cooperate with the faces 23 to hold the washers against rotation. Anti-friction ball bearings 41 may be provided between the opposing surfaces of each pair of washers 38 and 39. The ball bearings 41 may cooperate with suitable races in the washers 38 and 39. It is to be understood that the ball bearings 41 are not essential and that the opposing surfaces of the washers 38 and 39 may have direct contact.

It is an important feature of the invention that the cutters 11, the bearings 33 and 37 and the washers 38 and 39 may be arranged in the recesses 20 as units. The washers 39 are pressed on the reduced portions 33^a of the bearings 33 and the frictional cooperation of the washers 39 with the said reduced portions is sufficient

to retain the washers 38, the cutters 11 and the roller bearings 37 on the bearings 33 so that the cutter assemblies may be handled and mounted as individual units. It is to be understood that while the washers 39 are pressed on the bearing portions 33^a to retain the various other parts of the cutter assemblies on the bearings they may be readily removed when desired.

Shafts or pins 43 are provided to retain the bearings 33 and the parts carried thereby in the recesses 20. The pins 43 are passed inwardly through openings 44 in the caps 27 and extend through the openings 36 of the bearings 33. The inner end portions of the pins 43 are threaded in openings 45 in the body 10. The openings 44 and 45 are inclined downwardly and inwardly relative to the longitudinal axis of the reamer. The inclination of the openings 44 and 45 is such that the teeth 28 of the frusto-conical cutters 11 are substantially horizontal when they come into engagement with the shoulder of earth formation in the well. Heads 46 are provided on the outer ends of the pins 43 and are recessed in the outer sides of the caps 27. The inner portions of the pins 43 are threaded in the openings 45 and the heads 46 of the pins bear on the caps 27 so that the pins serve to tie the lower portions of the legs 27 to the body 10. Ports 50 are provided in the body 10 and extend from the fluid passage 18 to the upper walls of the recesses 20. The ports 50 operate to discharge circulation fluid downwardly against the cutters 11 to flush them of mud and cuttings.

It is believed that the operation of the reamer provided by this invention will be readily apparent from the foregoing detailed description. The cutters 11 are rotatably mounted to be rapid and efficient in their engagement with a shoulder of earth formation in a well bore. The cutters 11 present cutting edges of substantial length and, therefore, are operable to enlarge the bore to a substantial extent. The means 12 rotatably mount the cutters 11 for free independent rotation about downwardly and inwardly inclined axes. The cutters are mounted or supported so that they cannot become lost or displaced during operation of the reamer. The flanges 34 cooperate with the depressions 31 and the washers 39 cooperate with the depressions 22 to transmit a large part of the thrusts and operating forces directly to the body 10 and caps 27. Accordingly, the pins 43 are not subjected to excessive strain. The cutting parts 24 of the cutters 11 project downwardly and outwardly from the lower ends of the caps 27 so that the caps are not worn through engagement with the earth formation. The caps 27 are rigidly and securely attached to the body 10. The screws 28 serve to securely attach the upper portions of the caps to the body while the cutter carrying pins 43 connect the lower portions of the caps with the body.

The cutter assemblies may be quickly arranged in position in the recesses 20 as units to be secured to the body by the pins 43. The cutters 11, the roller bearings 27 and the washers 38 and 39 with the ball bearings 41 may be assembled on the bearings 33. The frictional engagement of the washers 39 on the reduced bearing portions 33^a is such that the washers serve to retain the other parts of the assemblies on the bearings 33. The cutter assemblies may be readily shipped and handled as individual units for mounting on the body 10. When the parts become worn they may be easily and quickly re-

placed. Upon the removal of a pin 43 the cutter assembly carried by that pin is free for removal from the body. The assembly may be readily moved out of the lower end of the recess 20. A new or replacement cutter assembly is then arranged in the recesses and is secured in place by the pin 43. When the caps 27 become worn they may be easily removed for replacement. If the legs 27 are welded to the body 10 as shown in Fig. 5, the welding at 29 and 30 must be removed with an acetylene torch or other means before disconnecting the legs from the body. The reamer provided by the present invention is effective in operation and is inexpensive to manufacture and repair.

Having described only typical preferred forms and applications of our invention, we do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to ourselves any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claims:

Having described our invention, we claim:

1. A well reamer including, a body having a recess, a cap secured to the body and extending downwardly across the outer side of the recess, opposing depressions in the wall of the recess and inner side of the cap, a cutter assembly comprising a bearing having a flange at one end, a cutter rotatable on the bearing, and a washer forcibly pressed on the other end of the bearing to be rigid therewith whereby the assembly may be handled as a unit, the flange and washer being adapted to cooperate with the depressions, and a pin carried by the body and cap and extending through the bearing to support the assembly.

2. A well reamer including, a body having a recess, a cap secured to the body and extending downwardly across the outer side of the recess, opposing depressions in the wall of the recess and inner side of the cap, a cutter assembly comprising a bearing having a flange at one end, a cutter rotatable on the bearing, and a washer forcibly pressed on the other end of the bearing to be rigid therewith whereby the assembly may be handled as a unit, the flange and washer being adapted to cooperate with the depressions, and a pin extending through the bearing to support the assembly threaded in an opening in the body and having a head engaging the cap to connect the lower portion of the cap in the body.

3. In a well tool the combination of, a bearing, a flange on one end of the bearing, a roller cutter on the bearing having one end engaging the flange, and an anti-friction thrust bearing at the other end of the cutter including a washer on the bearing engaging the other end of the cutter, a thrust washer removably force-fitted on the bearing, and a row of balls between said washers, the cutter being held against displacement by the flange and the thrust bearing whereby the assembly may be handled as a unit.

4. A cutter assembly for a well tool including, a bearing having a portion of reduced diameter at one end, a radial flange on the other end of the bearing, a rotatable cutter on the bearing between said portion and the flange, a thrust washer on the bearing adjacent said reduced portion for cooperating with an end of the cutter, and a second thrust washer removably pressed on said reduced portion to retain the cutter and the first mentioned washer on the bearing whereby the assembly may be handled as a unit.

5. A well reamer including, a body having a recess, a cap extending across the outer side of

the recess, there being opposing depressions in the inner side of the cap and the wall of the recess, a cutter assembly including, a tubular bearing having a flange at one end cooperating
 5 with one of the depressions, a roller cutter on the bearing, and a thrust washer pressed on the bearing to retain the cutter thereon whereby the assembly may be handled as a unit, the washer cooperating with the other depression, and a pin
 10 extending through the bearing and retaining the assembly in the recess.

6. A well reamer including, a body having a recess, a cap extending across the outer side of the recess, means removably securing the cap to
 15 the body, there being opposing depressions in the inner side of the cap and the wall of the recess, a cutter assembly including, a tubular bearing having a flange at one end cooperating with one of the depressions, a roller cutter on the
 20 bearing, and a thrust washer pressed on the bearing to retain the cutter thereon whereby the assembly may be handled as a unit, the washer cooperating with the other depression and a pin extending through the bearing and retaining the
 25 assembly in the recess.

7. A well reamer including, a body having a recess and a notch adjacent the recess, a cap extending across the outer side of the recess, there being opposing depressions in the inner side of
 30 the cap and the wall of the recess, a cutter assembly including, a tubular bearing having a flange at one end cooperating with one of the depressions and a portion of reduced diameter at the other end, a roller cutter on the bearing
 35 having one end cooperating with the flange, a free washer on the bearing adjacent said portion for

cooperating with the other end of the cutter, a washer on said portion of the bearing cooperating with the other depression, and a lug on the last mentioned washer cooperating with the notch
 5 to prevent rotation of the last mentioned washer.

8. A well reamer including, a body having a recess, a cap extending across the outer side of the recess, there being opposing depressions in the inner side of the cap and the wall of the recess, a
 10 cutter assembly including, a tubular bearing having a flange at one end cooperating with one of the depressions and a portion of reduced diameter at the other end, a roller cutter on the bearing having one end cooperating with the flange, a
 15 free washer on the bearing adjacent said portion for cooperating with the other end of the cutter, a non-rotatable washer on said portion of the bearing cooperating with the other depression, and an anti-friction bearing between said
 20 washers.

9. A well reamer including, a body having a recess, a cap integrally joined with the body and extending across the outer side of the recess, there being opposing depressions in the inner
 25 side of the cap and the wall of the recess, a cutter assembly including, a tubular bearing having a flange at one end cooperating with one of the depressions, a roller cutter on the bearing, and a thrust washer pressed on the bearing to retain
 30 the cutter thereon whereby the assembly may be handled as a unit, the washer cooperating with the other depression and a pin extending through the bearing and retaining the assembly in the
 35 recess.

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