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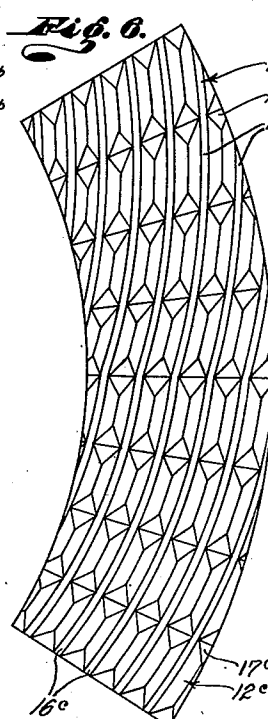
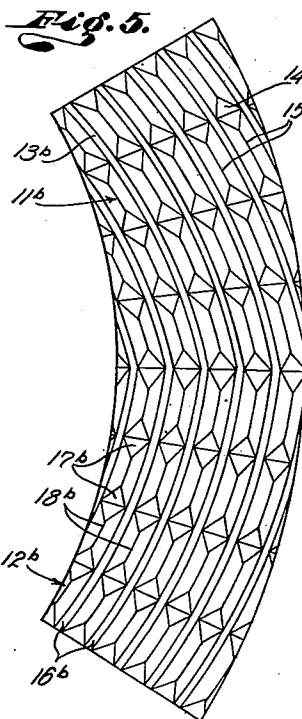
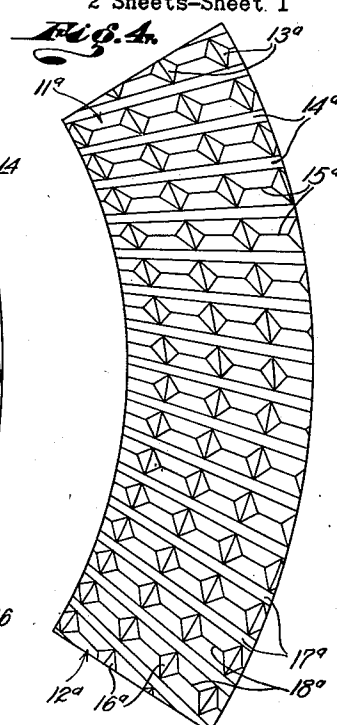
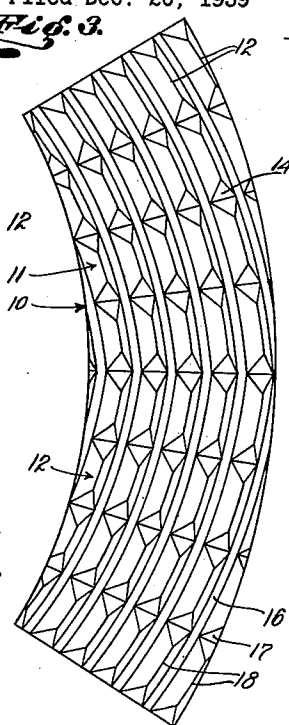
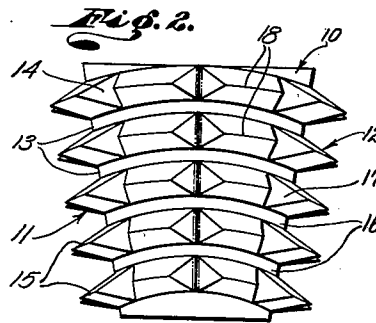
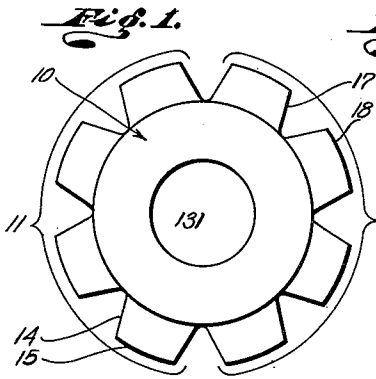
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2,230,569

ROLLER CUTTER

Filed Dec. 20, 1939

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 7.

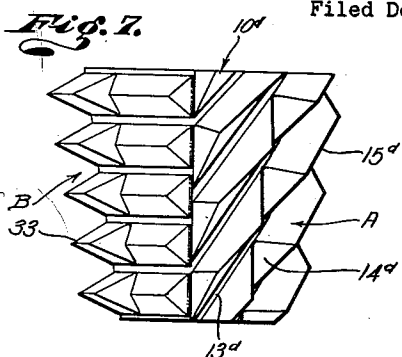


Fig. 8.

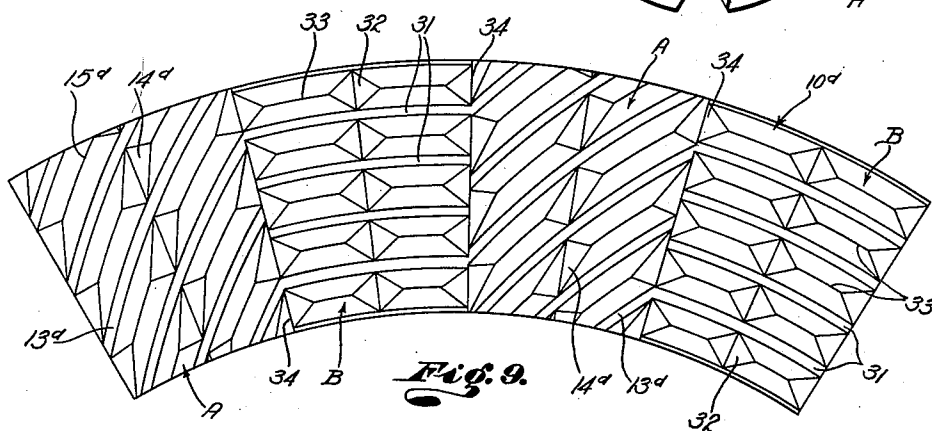
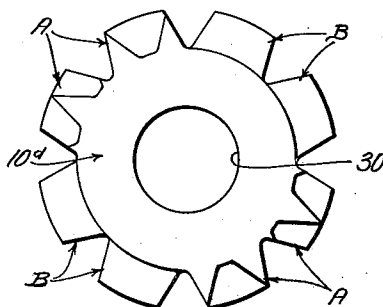


Fig. 9.

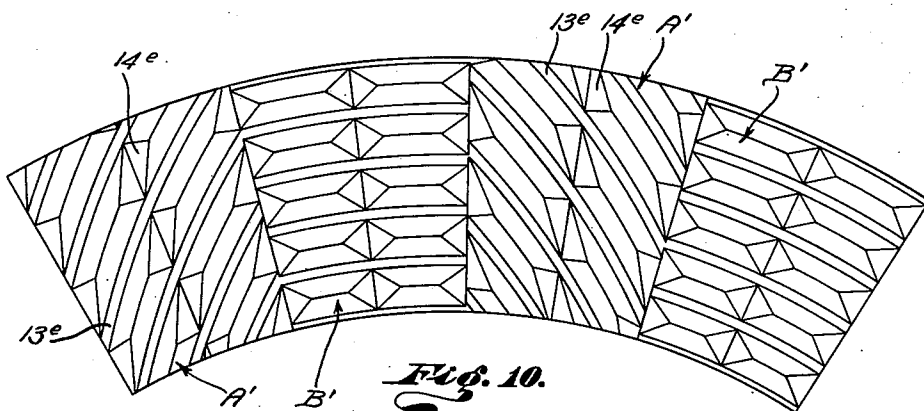


Fig. 10.

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UNITED STATES PATENT OFFICE

2,230,569

ROLLER CUTTER

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Application December 20, 1939, Serial No. 310,186

10 Claims. (Cl. 255—71)

This invention relates to cutting elements and relates more particularly to roller cutters for use on well drilling tools and to methods of making the same. A general object of the invention is to provide practical, effective, roller cutters whose teeth are formed and related so that they do not track in their engagement with the earth formation and to provide simple, inexpensive methods for making such cutters.

10 In designing well tools embodying roller cutters it is necessary to provide cutters whose teeth will not track in their engagement with the earth formation. The usual practice is to make one cutter with teeth pitched in a right-hand direction and the other cutter with teeth pitched in a left-hand direction, so that the teeth of the two cutters cannot track. In other cases the cutters have teeth arranged in different patterns or one cutter is formed to have a different number of teeth than the other. Thus it is necessary to manufacture dissimilar cutters for the tool, adding to the cost of manufacture.

25 Another object of this invention is to provide a roller cutter having teeth formed and related so that they cannot track in their own paths in co-operating with the earth formation. In the cutters of the present invention each cutter has teeth so related that they cannot track in their own paths or in the paths of the teeth of the other cutters, and the several cutters operating in a given zone or circular path at the bottom of the well may be identical without the possibility of the teeth of one cutter engaging the same points as the teeth of another cutter. The present invention makes it possible to employ similar or identical cutters for operating in a given annular zone thereby greatly reducing the cost of manufacturing of the well tools.

40 Another object of this invention is to provide roller cutters of the character mentioned embodying cutting teeth that are rapid and efficient in their drilling or cutting action.

45 Another object of this invention is to provide cutters of the character mentioned in which the teeth may have their cutting edges disposed either circumferentially or axially of the cutter, as desired, and the teeth may have a shape or formation recognized as most effective for use in any particular type of earth formation.

50 Another object of this invention is to provide a roller cutter for use on a well tool provided with areas or groups of teeth of dissimilar pitch or direction so that the teeth of one group cannot

track the teeth of the other group in their action on the earth formation.

A further object of this invention is to provide practical, rapid and economical methods for manufacturing cutters of the character mentioned above:

The various objects and features of our invention will be fully understood from the following detailed description of typical preferred forms of apparatus and manners of carrying out the methods of the invention, throughout which description reference is made to the accompanying drawings, in which:

Fig. 1 is an end view of one form of roller cutter of the invention. Fig. 2 is a side view of the cutter illustrated in Fig. 1. Fig. 3 is a development of the toothed surface of the cutter illustrated in Fig. 1. Fig. 3^a is a diagrammatic view illustrating a manner in which the circumferentially extending rows of teeth may be pitched or contoured. Fig. 4 is a development of the toothed surface of another form of cutter of the invention. Fig. 5 is a development of the toothed surface of another type of cutter of the invention. Fig. 6 is a development of the toothed surface of another embodiment of the invention. Fig. 7 is a side elevation of another form of cutter of the invention. Fig. 8 is an end view of the cutter illustrated in Fig. 7. Fig. 9 is a development of the toothed surface of the cutter illustrated in Fig. 7, and Fig. 10 is a development of the toothed surface of still another form of the invention.

In the drawings we have illustrated several different forms of cutters of the invention suitable for use on rotary rock bits, rock core drill heads, reamers, etc., used in well drilling operations. The cutters illustrated are of typical shape and proportions, it being understood that the invention may be embodied in cutters varying considerably in shape, proportions, and intended use. The roller cutters with which the invention is concerned are intended to be rotatably supported on a rotary well drilling tool to bodily rotate with the tool when the same is operating in the well and to independently rotate on their individual axes through rolling contact with the earth formation.

The cutter of the invention illustrated in Figs. 1, 2 and 3 may be said to comprise, generally a cutter body 10, a group of teeth 11 pitched in one direction and occupying a portion of the periphery of the body 10, and a group of teeth 12 pitched in the other direction and occupying the remainder of the periphery of the body 10.

The body 10 is an elongate element of generally frusto-conical configuration having flat ends normal to its longitudinal axis and having a pitched periphery. The cutter body 10 is provided with a central longitudinal opening 131 for receiving the shaft or rotatable mounting of the cutter. As initially formed the cutter body 10 is a plain, frustoconical member and the teeth 11 and 12 are formed by making intersecting grooves in its periphery, as described below.

The teeth 11 and 12 project from the periphery of the body 10 and are provided to act on or cut away the earth formation as the cutter rolls the wall or bottom of the well. In the form of the invention being described the teeth 11 are arranged in a group which occupies one half of the periphery of the body 10 and the teeth 12 are arranged in a group that occupies the other one half of the body's periphery. The teeth 11 and 12 are constructed to extend circumferentially of the cutter body 10, that is, the teeth are formed so that their cutting edges extend circumferentially of the body.

In accordance with the invention the teeth 11 occur in longitudinal rows and are spirally or helically pitched. The teeth 11 are formed or defined by helically pitched grooves 13 and circumferentially spaced longitudinal serrations or grooves 14 intersecting the grooves 13. The circumferentially extending grooves 13 are equally spaced apart and have pitched or outwardly diverging side walls. The side walls of the adjacent circumferential grooves 13 converge outwardly to form the cutting edges 15 of the teeth 11. In the construction illustrated in Figs. 1, 2 and 3, the circumferential grooves 13 extend only 180° around the body 10 and the several grooves 13 have their ends or termini in common longitudinal planes that are substantially diametrically opposite. Due to the helical pitch of the grooves 13 certain of the grooves may die out at the opposite ends of the body 10. The circumferential grooves 13 are pitched in a righthand direction and in accordance with the invention may be of any selected spiral or helical pitch. The longitudinal serrations or grooves 14 define or provide the opposite ends of the teeth 11 and serve to reduce the amount of the cutting edges 15 that may engage the wall of the well at any one time. The longitudinal grooves 14 are preferably, though not necessarily, equally spaced and extend between the opposite ends of the body 10 to intersect the several circumferential grooves 13. As illustrated in the drawings the longitudinal grooves 14 have pitched or outwardly diverging walls to provide the teeth 11 with bevelled ends.

The teeth 12 are similar in shape and construction to the teeth 11 but are pitched in the opposite direction. The cutting teeth 12 are formed or defined by a plurality of spaced helically pitched circumferential grooves 16 and spaced longitudinal serrations or grooves 17. The circumferential grooves 16 have side walls that slope or diverge and the side walls of the adjacent grooves 16 diverge outwardly to provide the teeth 12 with their cutting edges 18. The cutting edges 18 being formed by the side walls of the circumferential grooves 16 extend circumferentially of the cutter body 10 and have the same helical pitch as the grooves 16. Where the grooves 13, defining the sides of the teeth 11, have a righthand pitch, the grooves 16 have a lefthand helical pitch so that the teeth 13 are pitched in a lefthand direction. Because of the helical or spiral pitch certain of the grooves 16 and certain of

the teeth 12 may die out at the ends of the body 10. The longitudinal grooves 17 extend between the opposite ends of the body 10 to cross or intersect the several spaced grooves 16. As described above, each group of teeth 11 and 12 occupies substantially 180° of the periphery of the body 10 and, therefore, the opposite ends of the groups of teeth are in adjacent or opposed relation. It is preferred to have the teeth 11 aligned with or substantially oppose the teeth 12 where the two groups adjoin or meet. In the embodiment of the invention illustrated in Figs. 1, 2 and 3 the helical pitch of the teeth 12 is equal to but opposite that of the teeth 11. It will be observed that the teeth 11 and 12 are alike in shape and construction and differ only in the direction of their helical pitch.

In manufacturing the cutter illustrated in Figs. 1, 2 and 3 the blank or body 10 is first formed to have the desired shape and proportions. As initially formed the body 10 may have a plain pitched periphery. The periphery of the cutter blank or body 10 is machined or grooved to form the teeth 11 and 12. If desired, the circumferential grooves 13 and 16 may first be cut in the body 10. It will be understood how the grooves 13 and 16 may be readily formed by milling cutters, or the like, operated in the well known manner. In forming the grooves 13 and 16 the cutter or cutters may traverse a continuous path, it being necessary to change the lead or pitch of the cutter or cutters when they have advanced 180° around the body 10, this change in pitch being made at each side of the body 10 so that the grooves 13 and 16 are pitched in a righthand and lefthand direction, respectively. This mode of operating the cutter or cutters in the formation of the grooves 13 and 16 brings the cutters 11 and 12 into substantial alignment at the adjoining ends of the groups of teeth 11 and 12. Following the formation of the grooves 13 and 16 the grooves 14 and 17 are formed. The grooves 14 and 17 may be identical and may be equally spaced throughout the circumference of the body 10. The cutting of the grooves 13 and 16 and 14 and 17 completes the formation of the cutter.

In cutting the grooves 13 and 16 and in forming the pitched grooves in the other forms of the invention it may be desired to employ a cam controlled machine. A cam controlled machine is not capable of turning or directing its cutter through a sharp corner and where the grooves 13 and 16 join the change from one angle to the other will not be abrupt but will follow a smooth curve as at X in Fig. 3^a. The length of the curve X depends upon the angular relationship of the oppositely pitched grooves 13 and 16, that is where the change in direction of the cutter is great the curve X is of substantial length and where the change in direction of the cutter is smaller the curve X is shorter. The curves X, of course, occur at the opposite ends of the several grooves 13 and 16. The continuous groove, composed of the grooves 13 and 16 joined at the curves X, has sine wave curvature or a modified sine wave curvature superimposed on the helical pitch as shown in Fig. 3^a.

Fig. 4 of the drawings illustrates a slight modification of the cutter illustrated in Figs. 1, 2 and 3. In the construction shown in Fig. 4, there are two groups of teeth 11^a and 12^a cut or provided on the periphery of the cutter, each group occupying 180° of the periphery. The teeth 11^a and 12^a are of the same shape and arrangement and differ in that the teeth 11^a are arranged in helical

rows pitched in the opposite direction to the helical rows of teeth 12^a. The teeth 11^a are defined or formed by spaced circumferential serrations or grooves 13^a and spaced longitudinal grooves 14^a and the teeth 12^a are defined by spaced circumferential grooves 16^a and spaced longitudinal grooves 17^a. The grooves 14^a and 17^a may be slightly pitched and may be identical and cross or intersect the circumferential grooves 13^a and 16^a. The grooves 13^a are pitched in a righthand direction while the grooves 16^a are pitched in a lefthand direction.

The teeth 11^a and 12^a differ from the above-described teeth 11 and 12 in the direction or disposition of their cutting edges 15^a and 18^a. The grooves 14^a have outwardly diverging side walls and the side walls of the adjacent grooves 14^a diverge to form the cutting edges 15^a of the teeth 11^a. In a like manner the grooves 17^a have outwardly diverging side walls and the walls of the adjacent grooves 17^a provide the cutting edges 18^a of the teeth 12^a. The circumferential grooves 13^a and 16^a define the opposite ends of the longitudinally disposed teeth 11^a and 12^a and, as illustrated, the side walls of these grooves may be outwardly divergent to provide the teeth with bevelled ends.

The cutter illustrated in Fig. 4 may be constructed in substantially the same manner as the cutter of Figs. 1, 2 and 3. The grooves 13^a, 16^a, 14^a and 17^a may be formed or cut in the periphery of the cutter blank by milling cutters, or the like, to provide the cutter with the teeth 11^a and 12^a. The grooves 14^a and 17^a may be alike and equally spaced throughout the circumference of the cutter to be readily cut. In forming the grooves 13^a and 16^a the cutter may travel for 180° while pursuing a helical path pitched in a righthand direction and may then be set to travel the remaining 180° in a helical path pitched in a lefthand direction, and this procedure may be continued to provide the oppositely pitched circumferentially extending grooves 13^a and 16^a.

In the operation of the cutters illustrated in Figs. 1, 2 and 3 and Fig. 4, the cutters may be rotatably supported on the well tool in the usual manner to have their toothed peripheries come into rolling engagement with the wall or bottom of the well. As the well tool is rotated in the well the cutter rolls along the wall or bottom of the well to rotate on its own axis. Referring now to the cutter shown in Figs. 1, 2 and 3, it will be seen that the groups of cutters 11 and 12 alternately or successively come into engagement with the earth formation. Because of the opposite helical pitch of the teeth 11 and 12 the teeth of the two groups cannot track one after the other in their engagement with the formation. The bit or well tool may be provided with two or more cutters of the kind shown in Figs. 1, 2 and 3 to operate in the same circular path. Where the teeth 11 and 12 of each individual cutter do not track in their engagement with the formation it will be seen that the teeth of the different cutters cannot engage the same points or track. The cutter of Fig. 4 operates in the same manner except that its cutting edges 15^a and 18^a, being disposed longitudinally of the cutter, have a slightly different action on the earth formation.

The cutter illustrated in Fig. 5 is similar to the cutter of Figs. 1, 2 and 3, having two groups of teeth 11^b and 12^b with the teeth of one group helically pitched in the opposite direction to the teeth of the other group. Thus the teeth 11^b are pitched in a righthand direction and the teeth

12^b are pitched in a lefthand direction. The teeth 11^b are formed or defined by longitudinally spaced circumferential grooves 13^b and spaced longitudinal grooves 14^b and the teeth 12^b are defined by spaced circumferential grooves 16^b and spaced longitudinal grooves 17^b. The grooves 13^b are spirally or helically pitched in a righthand direction and the grooves 16^b are spirally or helically pitched in a lefthand direction. The side walls of the grooves 13^b and 16^b diverge and the walls of adjacent grooves define the cutting edges 15^b and 18^b, respectively, of the teeth 11^b and 12^b. The grooves 14^b and 17^b extend from one end of the cutter to the other to intersect or cross the circumferential grooves 13^b and 16^b. The grooves 14^b and 17^b define the ends of the teeth 11^b and 12^b and may have outwardly diverging walls so that the ends of the teeth are bevelled. The grooves 14^b and 17^b may be identical and may be of equal spacing.

The cutter of Fig. 5 differs from the cutters of Figs. 1, 2 and 3 in that the teeth 11^b have a different helical angle or helical pitch than the teeth 12^b. Thus, in the case illustrated, the grooves 13^b have a greater helical pitch than the grooves 16^b so that the teeth 11^b pitched in the opposite direction to the teeth 12^b have a greater helical angle than the teeth 12^b. The groups of teeth 11^b and 12^b may each occupy about one half of the peripheral surface of the cutter and the ends of the groups of teeth adjoin. It is preferred to have the ends of the helical rows of teeth 11^b and 12^b opposed or aligned so that the grooves 13^b and 16^b are easy to cut or form. Accordingly, it is preferred to relate the pitches of the groups of teeth 11^b and 12^b so that the sum of the two spirals divided by two is an even number. With the pitches of the groups of teeth related in this manner the milling cutter forming the groups 13^b and 16^b may follow a continuous path with appropriate adjustment in the angle of cut.

The cutter of Fig. 5 may be manufactured in the same manner as the cutter of Figs. 1, 2 and 3, except that the degree of the helical pitch as well as the direction of the pitch of the milling cutter is changed as the grooves 13^b and 16^b are cut. While we have shown the teeth 11^b and 12^b formed with circumferentially extending cutting edges 15^b and 18^b it is to be understood that the width and arrangement of the grooves defining the teeth 11^b and 12^b may be such that the cutting edges of the teeth extend axially of the cutter, as in Fig. 4. The cutter of Fig. 5 operates in substantially the same manner as the cutters of Figs. 1, 2 and 3. The teeth 11^b and 12^b being pitched in opposite directions and having different helical pitches cannot track one after the other in their engagement with the earth formation.

Fig. 6 of the drawings illustrates a form of cutter of the invention having two groups of teeth 11^c and 12^c with the teeth in the two groups pitched in the same direction but at a different helical pitch.

The group of teeth 11^c may occupy substantially one-half of the periphery of the cutter and the group of teeth 12^c may occupy the other half of the cutter surface. The teeth 11^c are formed or defined by helically pitched circumferential grooves 13^c and spaced longitudinal grooves 14^c and the teeth 12^c are defined by helically pitched circumferential grooves 16^c and longitudinal grooves 17^c. The longitudinal grooves 14^c and 17^c may be of equal spacing and of the same size

and shape. The grooves 13° and 16° are pitched in the same direction, that is, the two sets of grooves may be pitched in the righthand direction or the lefthand direction. In the particular case illustrated the grooves 13° and 16° are pitched in a lefthand direction. In accordance with the invention the circumferential grooves of one set or group of teeth 11°, or 12° has a greater helical angle than the grooves of the other group. Thus in the case illustrated the grooves 13° are pitched at a greater helical angle than the grooves 16°. It is preferred to bring the ends of the helical rows of teeth 11° and 12° in substantial alignment to facilitate the manufacture of the cutter. To accomplish this the pitch of one group of teeth should be an even multiple of the pitch of the other group of teeth.

The teeth 11° and 12° are formed or cut in the same manner as in the preceding forms of the invention, that is, the pitched grooves 13° and 16° are formed by a milling cutter, or the like, to define the sides of the teeth and the longitudinal grooves 14° and 17° are milled in the cutter blank to define the ends of the teeth. When the cutter of Fig. 6 is in operation the teeth 11° and 12° successively come into rolling engagement with the earth formation and because of the difference in the helical pitch of the teeth, the teeth of one group cannot track the teeth of the other group.

The cutter of the invention illustrated in Figs. 7, 8 and 9 may be said to comprise, generally, a frusto-conical cutter body 10^d, spaced groups of teeth A on the body 10^d, having a helical pitch and groups of straight teeth B between the spaced groups of teeth A.

The cutter body 10^d, as initially formed, may be a frusto-conical member having flat normal ends. A central longitudinal opening 30 extends through the body 10^d to receive the shaft or support of the cutter.

The cutting teeth A are provided or formed on the periphery of the body 10^d and are arranged in spaced sets or groups. In the preferred arrangement illustrated there are two equally spaced groups of teeth A. In accordance with the invention the teeth A are spiralled or pitched. It is preferred to give the teeth A a substantial helical pitch. As illustrated the teeth A may have a helical pitch of substantially 45°. The pitched teeth A are formed or defined by spaced helical grooves 13^d and spaced longitudinal grooves 14^d. The side walls of the grooves 13^d are outwardly divergent and the walls of the adjacent grooves 13^d join to form the cutting edges 15^d of the teeth A. The longitudinal grooves 14^d extend from one end of the cutter to the other and may be straight, that is, they may lie in longitudinal planes which include the longitudinal axis of the cutter. The side walls of the grooves 14^d are preferably divergent so that the ends of the teeth A are bevelled. In the particular form of the invention illustrated in Figs. 7, 8 and 9, the teeth A of the two spaced groups are pitched in the same direction.

The teeth B are arranged in sets or groups occurring between the circumferentially spaced groups of teeth A. The teeth B are preferably straight circumferential teeth and are formed or defined by spaced circumferential grooves 31 and longitudinal grooves 32. The grooves 31 may be equally spaced and may be straight grooves. In the construction illustrated the flaring side walls of the grooves 31 join to form the cutting edges 33 of the teeth B. The teeth B of the two spaced

groups may be identical. The adjacent or adjoining groups of teeth A and B may be spaced or separated by longitudinal grooves 34 that form the ends of the end teeth of the groups.

The teeth A and B may be readily formed by suitably machining or milling the cutter body 10^d. In the use or operation of the cutter the teeth A and B successively come into engagement with the earth formation as the cutter rolls along the bottom of the well. As the teeth A have a sharp helical pitch and the teeth B are without such a pitch the teeth cannot track or follow one another in their action on the formation.

Fig. 10 of the drawings illustrates a form of frusto-conical roller cutter resembling the cutter of Figs. 7, 8 and 9. The cutter shown in Fig. 10 has spaced groups of pitched teeth A' and spaced groups of straight teeth B'. The teeth A' may be similar in shape and construction to the teeth A described above. Sharply pitched helical grooves 13° and straight longitudinal grooves 14° may be formed in the cutter body to define the teeth A'. In this form of the invention the teeth A' of one group is pitched in the opposite direction to the teeth A' of the other group. The helical angle of the oppositely pitched teeth may be the same or may be dissimilar, as desired. The cutting teeth B' occur in groups between the spaced groups of teeth A' and are straight circumferential cutting teeth. In practice the straight teeth B' may be identical with the teeth B described above.

In the operation of the cutter illustrated in Fig. 10 the groups of teeth A' and B' successively come into active contact with the wall or bottom of the well as the cutter rotates. The pitched teeth A' cannot track or follow the straight teeth B' in their engagement with the earth formation and as the spaced groups of teeth A' have an opposite pitch the teeth of these groups cannot track.

Having described only typical preferred forms of apparatus and manners of carrying out the methods 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 roller cutter for a well tool comprising a body, having its periphery pitched relative to its longitudinal axis and two groups of cutting teeth on the periphery of the body, each group extending for substantially 180° around the body, the teeth in said groups being in helically pitched circumferentially extending rows with the corresponding rows of said groups substantially aligned circumferentially of the body, the rows of one group having a different helical angular relation to the longitudinal axis of the body than the rows of the other group and said angular relation being such that the aligned rows of said group have a lead longitudinally of the body.

2. A roller cutter for a well tool comprising a body, having its periphery pitched relative to its longitudinal axis, and two groups of cutting teeth on the periphery of the body, each group extending for substantially 180° around the body, the teeth in said groups being in longitudinally spaced circumferentially extending rows, the rows of one group being helically pitched in the right-hand direction, and the rows of the other group being pitched in the left hand direction.

3. A roller cutter for a well tool comprising a body, having its periphery pitched relative to its

longitudinal axis, and two groups of cutting teeth on the periphery of the body, each group extending for substantially 180° around the body, the teeth in said groups being in longitudinally spaced circumferentially extending rows, the rows of one group being helically pitched in the right-hand direction, and the rows of the other group being pitched in the lefthand direction, the helical pitch of the rows of the two groups being substantially equal.

4. A roller cutter for a well tool comprising a body, having its periphery pitched relative to its longitudinal axis, and two groups of cutting teeth on the periphery of the body, each group extending for substantially 180° around the body, the teeth in said groups being in circumferentially extending rows, the rows of one group being helically pitched in the righthand direction, and the rows of the other group being pitched in the lefthand direction, the helical pitch of the rows of the two groups being unequal.

5. A roller cutter for a well tool comprising a body, having its periphery pitched relative to its longitudinal axis, and adjoining groups of cutting teeth on the periphery of the body, the teeth of said groups being in circumferentially extending rows helically pitched relative to the longitudinal axis of the body with the corresponding rows of said groups substantially aligned circumferentially of the body, the rows of one group being pitched at a different helical angle than the rows of the other group, the helical angular relation of said rows being such the circumferentially aligned rows of said groups have a lead longitudinally of the body so that the teeth in any given set of aligned rows do not track in their contact with the earth formation.

6. A roller cutter for a well tool comprising a body, having its periphery pitched relative to its longitudinal axis, and adjoining groups of cutting teeth on the periphery of the body, the teeth of said groups being in circumferentially extending rows pitched relative to the longitudinal axis of the body with the corresponding rows of said groups substantially aligned circumferentially of the body, the rows of one group being pitched in a righthand direction and the rows of the other group being pitched in a lefthand direction, the angular relation of the rows being such that the circumferentially aligned rows of said groups

have a lead longitudinally of the body so that the teeth in any given set of aligned rows do not track in their contact with the earth formation, said teeth having cutting edges extending circumferentially of the body.

7. A roller cutter for a well tool comprising a body, having its periphery pitched relative to its longitudinal axis, and adjoining groups of cutting teeth on the periphery of the body, the teeth of said groups being in circumferentially extending rows pitched relative to the longitudinal axis of the body and the corresponding rows of said groups being substantially aligned circumferentially of the body, the rows of one group being pitched in a righthand direction and the rows of the other group pitched in a lefthand direction, said teeth having cutting edges extending longitudinally of the body, the pitch of the rows in said groups being different in extent so that the circumferentially aligned rows of said groups have a lead longitudinally of the body.

8. A roller cutter for a well tool comprising a body, having its periphery pitched relative to its longitudinal axis, groups of longitudinal rows of circumferentially extending teeth on the body spaced about the periphery of the body, and groups of helically pitched teeth on the body spaced between the first named groups.

9. A roller cutter for a well tool comprising a body, having its periphery pitched relative to its longitudinal axis, groups of longitudinal rows of circumferentially extending teeth on the body spaced about the periphery of the body, and groups of helically pitched teeth on the body spaced between the first named groups, the teeth of the last named groups being helically pitched in the same direction.

10. A roller cutter for a well tool comprising a body, having its periphery pitched relative to its longitudinal axis, groups of circumferentially extending teeth on the body spaced about the periphery of the body, and groups of helically pitched teeth on the body spaced between the first named groups, the teeth of the last named groups being helically pitched in opposite directions, each of said groups including a plurality of longitudinally extending rows.

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