

Nov. 21, 1944.

F. L. SCOTT

2,363,202

TEETH FOR DRILL CUTTERS

Filed July 19, 1943

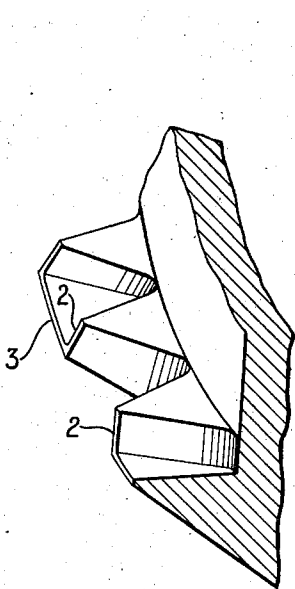


Fig. 2.

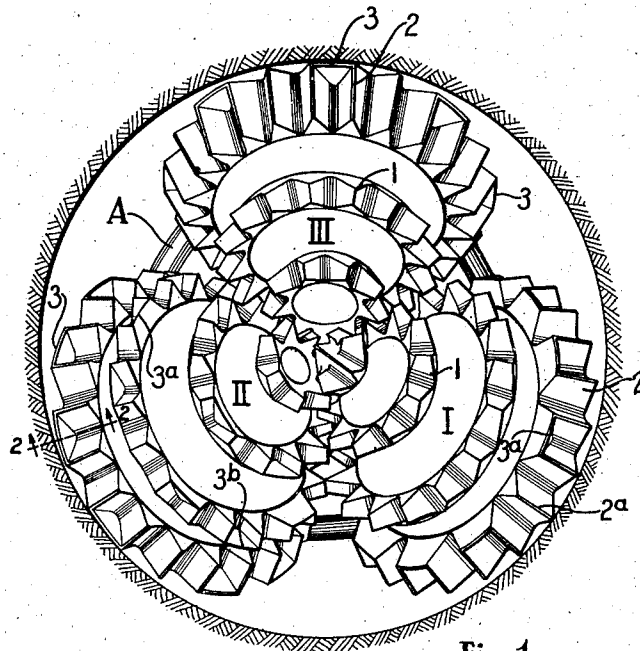


Fig. 1.

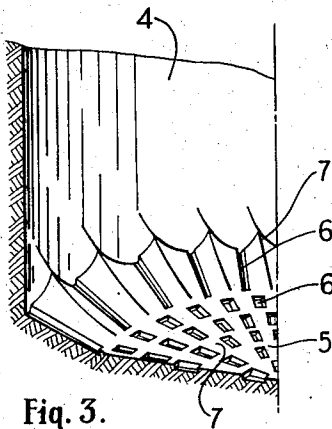


Fig. 3.

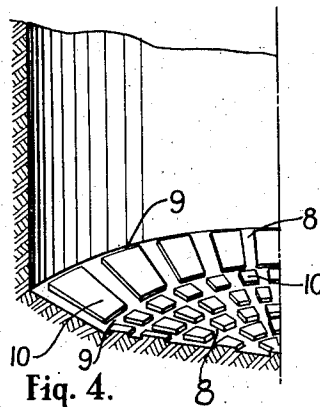


Fig. 4.

Floyd L. Scott
INVENTOR

BY *James R. Stone*
ATTORNEY

UNITED STATES PATENT OFFICE

2,363,202

TEETH FOR DRILL CUTTERS

Floyd L. Scott, Houston, Tex., assignor to Hughes Tool Company, Houston, Tex., a corporation of Delaware

Application July 19, 1943, Serial No. 495,280

7 Claims. (Cl. 255—71)

This invention pertains to the formation of cutters for use on well drills employed in the drilling of deep wells for oil, gas, and the like.

In drilling bore holes in the harder earth formations by the rotary method, rotary rock drills fitted with roller cutters rotatably mounted thereon are employed. The drill is secured to the lower end of a hollow shaft or drill stem rotated from the surface. These cutters roll upon the bottom of the hole with an approximately true rolling motion as the drill stem is rotated and engage and disintegrate the material to be removed. The roller cutters are provided with teeth thereon which are forced to penetrate the bottom of the bore hole by weight from the drill stem, which weight is applied thereon by controls in the hands of the operator.

The cuttings from the bottom and sides of the well are washed away by flushing fluid pumped down from the surface through the hollow rotating drill stem and are carried in suspension in said fluid to the surface. This fluid also cleans and cools the cutters and keeps them clear of accumulated cuttings.

The form and disposition of the teeth upon the cutters have been found to be extremely important. The cutting edges must have a preponderance of cutting crests extending transversely of the direction of rotation in order to obtain sufficient traction to assure continued rotation of the cutter on its bearings. Teeth having cutting crests extending circumferentially of the cutter have very little traction and cannot be relied upon to assist materially in causing rotation. Cutters with circumferentially crested teeth are likely to skid and become ineffective particularly in slick or gummy formations.

Another difficulty arises when a cutter is run upon very hard formations in that the teeth are liable to chip and break off when forced by heavy weights from above into the hard rock on bottom. It has therefore been found desirable to reinforce the cutting teeth ordinarily employed so that they will last longer and cut more hole before the teeth break and wear down and lose their cutting effect.

It is an object of the invention to provide reinforcing webs which connect adjacent teeth together at one of their ends. Said teeth are preferably connected together at their ends in sets of two, as illustrated herein, but obviously the idea is capable of wider application.

It is also desired that the reinforcing web connecting adjacent teeth be of sturdy construction and formed with a cutting crest which will as-

sist in the disintegration of the well bottom and make it easier to prevent the formation of areas of uncut bottom between the tracks cut thereon by the rows of teeth on the different cutters.

Experience has shown that the teeth upon different cutters, as well as the teeth upon the same cutter on different rounds of the well bottom, tend to track in imprints made on the formation on previous rounds of the drill. Between adjacent imprints in each row the rock teeth tend to grow up. Between the circular paths cut on bottom by the rows of teeth on the different cutters, small ridges or projections tend to form which connect the rock teeth on bottom formed by the tracking teeth in each row, to similar teeth in adjacent rows. Thus the rock teeth on bottom are not easily broken off. They are tied to other rock teeth by bonds of rock connecting adjacent rows of rock teeth together. This is particularly noticeable along the wall of the hole. The outer row of rock teeth on bottom is so firmly bound to the wall that it is difficult to break it away.

It is therefore an object to dispose the teeth upon the cutters so that they will form a pattern on the bottom of the hole which will serve to most effectively break up the formation. I desire to so arrange and form the cutter teeth that the rock teeth formed on bottom by the action of the cutters will be separate and disconnected from each other and from the wall of the hole and hence will be more easily broken off by the cutters in the drilling operation. I am to prevent the formation of prominent rock teeth anywhere on bottom so that the bottom of the hole will be comparatively smooth.

In making the connecting webs between adjacent teeth more effective in assisting in the cutting operation, as distinguished from reinforcing the regular teeth, it is an object to so arrange these webs that they will not always track uniformly but will be enabled after two or more rotations to form a continuous circular groove on bottom, said continuous circular groove being cut with the discontinuous cutting crests of the webs.

Referring to the drawing herewith,

Fig. 1 is a bottom plan view of a three-cutter well drill embodying the present invention.

Fig. 2 is a broken sectional detail illustrating the formation of the cutter teeth, this view being taken approximately on the line 2—2 of Fig. 1.

Fig. 3 is a sectional view through a well bore and showing about 90° of the bottom thereof and

indicating the imprints oftentimes formed on bottom by the old style of cutter tooth.

Fig. 4 is a similar quarter section of the well bottom showing the imprints made on bottom by the improved type of well drill where all three cones are webbed.

The main object of the invention is to form the teeth upon the cutters of the well drill in such manner that they will cut the bottom of the well most effectively. In carrying out this invention it is desired that the teeth be reinforced to prevent breakage and also to cut the bottom in such a pattern that the formation will be most easily broken up and disintegrated. The form of well drill upon which the invention has been illustrated is one which has been in common use in the oil fields for many years. It comprises a head A having rotatably mounted on the lower end thereof a plurality of approximately conical shaped cutters, the small ends of the cones being pointed inwardly so that the cutters will have an approximately true rolling motion on bottom.

The cutters, as shown in Fig. 1, have circumferential rows of cutting teeth thereon, the rows of teeth on one cutter being offset to the rows of teeth on the two adjacent cutters, so that each row of teeth, except the outer row, will cut a separate track on bottom as the drill head is rotated. This offsetting of the rows of teeth relative to each other also allows the teeth on one cutter to interfit between the rows of teeth on adjacent cutters, thus enabling each cutter to be slightly larger than it otherwise could be made. As will be noted from Fig. 1 all three cutters are slightly different from each other. The No. I cone at the right has four rows of teeth offset from the three rows of teeth on the three rows on the No. III cutter at the top. The four rows on the No. II cutter has its teeth arranged to interfit with both No. I and No. III.

The present invention consists in reinforcing adjacent teeth in the rows by connecting the adjacent elemental teeth 2 together at one of their ends by a web of steel 3. Such a web reinforces the teeth at their ends and prevents them from breaking down and chipping off as they otherwise tend to do when forced into the hard rock which is being drilled. As illustrated in the drawing, the web 3 may join the outer end of the two adjacent teeth together in the row, or, as shown at 3a, the web may join together the inner ends of the two adjacent teeth in the row. It will be noted that the two teeth thus joined together form a cutting structure having a channel-shaped cross section. This structure we may call a cutting element. The web 3 which connects the two adjacent teeth widens at the base and is formed with a cutting crest so that it may assist in disintegrating material on bottom. This web therefore performs the function of strengthening the teeth and thus prolonging their life and also it has the function of helping to cut the formation on the bottom of the well.

To illustrate the manner in which teeth formed in this way may cut the bottom of the hole it is to be understood that where this invention is not employed the bottom is cut as shown in Fig. 3. In this view the side wall of the hole is shown at 4 and the bottom of the hole is indicated at 5. The teeth of the cutters when formed without the connecting web tend to form imprints on bottom, as indicated at 6. These imprints are formed by the teeth engaging the bottom and penetrating the formation to leave imprints approximately the shape of the teeth. These im-

prints are spaced apart and the material indicated at 7 between adjacent imprints is connected together by bonds of rock throughout the bottom. The cutter teeth by deepening the imprints on successive rounds will finally loosen the material and cause the intervening formation to crack off into the form of chips which are carried away in the flushing fluid. Adjacent the wall of the hole where the formation between adjacent imprints 6 is bound to the wall of the hole by connecting bonds of rock teeth 7, the cutter teeth wear to a maximum degree. It is found that the material at the wall is not easily broken off and severed from the wall and the teeth at the gage surface become worn so that prominent rock teeth on bottom, such as shown at 7, are formed. These rock teeth are difficult to disintegrate and tend to cause excessive wear on the cutter teeth at the gage. It will be understood, of course, that the showing in both Figs. 3 and 4 is diagrammatic and also largely idealistic. The bottom is not formed in smooth imprints on bottom but the imprints are rough and irregular. The pattern is, however, approximately as is shown in these figures.

The difficulty caused by the use of teeth without the connecting webs is largely eliminated when the reinforcing webs are used and a different pattern on bottom is formed. The webs formed in connecting adjacent teeth in the manner described are arranged so that the connecting web on one round of the well bottom will form imprints of general rectangular U-shape. The cutting elements are arranged to reduce the tendency to track in the same imprints on bottom by making the teeth of an uneven number. Thus on subsequent rounds of the cutter the web will tend to engage in a different place on bottom. The elemental teeth 2 tend to track in similar imprints formed in prior rotation to the cutter but the teeth joined by the connecting webs will tend not to engage in exactly the same track. This is assured by separating the pairs of teeth connected by the webs at some point on the circumference of the cutter by a tooth 2a, which is not reinforced. By making the number of teeth in the row uneven, we assure that cutter teeth will tend to creep relative to bottom approximately to the extent of one impression per revolution. The resulting pattern on bottom is shown in Fig. 4. The imprints formed by the cutter teeth 2 adjacent the gage are indicated by the numeral 8. The track cut by the outer web 3 will be seen at 9. The webs may be formed on the different cutters at different ends of the teeth. Thus in Fig. 1 the upper and left hand cutters have the teeth joined at the outer ends and the teeth of the righthand cutter are joined at their inner ends. On the inner rows it is desired that some of the teeth be joined at their inner ends, as shown at 3a, and others joined at their outer ends, as shown at 3b. The webs at the adjacent ends of the different teeth will thus cut on bottom circumferential rows 9, which tend to break up the formation between the adjacent rock teeth 10 left on bottom by the adjacent tooth imprints 8. It will thus be seen that the rock teeth left on bottom by the imprints cut by the teeth and by the web will be disconnected on bottom from the rock teeth in adjacent rows. The rock teeth will thus stand up from bottom entirely separate from each other and be more easily broken away by continued action of the cutter teeth as the drill advances. The rock teeth 10 will be seen to be entirely severed from the wall

of the hole by the continuous outer groove or track cut by the webs 3 on the outer rows of teeth. The pattern on bottom is shown in Fig. 4, it being understood that this is very diagrammatic and at the bottom will not be smooth but will be broken up in somewhat irregular rock teeth, said teeth being, however, separated from other rock teeth on bottom by circumferential tracks cut by the web joining adjacent teeth.

In Fig. 1 of the drawing some of the inner rows of teeth are shown as not connected by webs. On the teeth toward the inner portion of the cone the excessive wear which is undergone by the teeth adjacent the walls of the hole is not so severe and on some of the cutters the web may be omitted on the inner rows, particularly in the semi-hard formations. In some hard formations reinforcing webs may be employed on approximately all the rows of teeth. The use of cutters of this character of reinforcing webs between the ends of adjacent teeth enable the cutters to last materially longer before they become worn out. Furthermore, they assist in cutting the formation in such manner that the formation is more easily broken up and the cutters will drill more hole than is being drilled by the old type cutter and at a faster rate. It is believed that this is due largely to the manner in which the bottom is disintegrated. The hole will need less reaming because a full sized hole is maintained and as the bottom is more efficiently disintegrated the action of the drill is not only more rapid but the life of the drill is longer.

What is claimed as new is:

1. In a roller well drill having rotatably mounted thereon a plurality of approximately conical shaped cutters positioned with their apices inclined downwardly and adapted to rotate on their axes, said cutters having a plurality of circumferential rows of chisel-shaped teeth thereon with the crests thereof extending lengthwise of the cutter and in planes radial to the cutter axis, said rows being spaced apart and, the teeth on all the cutters together, serving to cut the full bottom of the hole; the combination of circumferentially extending webs connecting pairs of adjacent teeth in a row together at one of their corresponding ends to form separate cutting units in the row separated from the adjacent unit on either side in the same row by a space for passage of fluid, said webs acting to reinforce said teeth and also to assist in cutting the bottom of the hole.

2. In a well drill having rolling cutters thereon, said cutters having circular circumferential rows of longitudinally crested teeth thereon lying in planes radial to the axis of the cutters, the improvement comprising a plurality of spaced circumferentially extending webs of approximately the same height on the cutter as said teeth and connecting the adjacent corresponding ends of pairs of said teeth in the same row together to form cutting elements on said cutter having a channel shape.

3. In a well drill cutter having its periphery longitudinally tapered and having a plurality of circumferentially arranged rows of chisel shaped cutter teeth, said rows being spaced apart thereon, with their cutting crests positioned approximately longitudinally of the cutter; the improvement consisting of teeth in a row arranged in sets, each set being connected together by a single reinforcing web extending between and connecting the adjacent corresponding ends of the teeth in the set, said webs being circumferentially disposed and spaced and having cutting crests thereon to assist in cutting the bottom of the hole.

4. In a cutter for well drills having circumferential rows of chisel shaped teeth thereon spaced longitudinally of said cutter with the crests in planes approximately including the axis of rotation; the improvement consisting of connecting and reinforcing webs extending between the corresponding, adjacent ends of pairs of said teeth in a row, each of said pairs being connected by a single web and spaced from other similar pairs in the same row to allow circulation of flushing fluid between them, said webs having circumferentially extending cutting crests assisting in cutting the full bottom of the hole, said rows being formed with an uneven number of cutting teeth in each row.

5. In an approximately conical shaped cutter for well drills having spaced circular circumferential rows of approximately longitudinally crested teeth thereon; the combination of reinforcing webs extending between and connecting the adjacent corresponding ends of sets of said teeth in the same row together, each set having a single web with a cutting crest extending to approximately the same height on the cutter as do said longitudinally crested teeth to assist in breaking up the formation at the well bottom.

6. In a well drill having a plurality of inwardly tapered cutters mounted to project in a downwardly inclined position and roll upon the well bottom, each cutter having a circumferential row of teeth thereon with cutting crests lengthwise of the cutter acting to drill the bottom of the hole; the combination of webs, of the same height as the teeth, connecting sets of said teeth together to form cutting elements, each set having a single web extending between the adjacent corresponding ends of the teeth of the set and leaving spaces between adjacent sets of teeth for fluid circulation, and there being an uneven number of teeth in each row.

7. In a well drill cutter having a tapered cutting periphery and spaced circumferential rows of longitudinally extending cutting teeth thereon, the improvement including a reinforcing web extending between and connecting the corresponding ends of adjacent teeth in a row together, said webs being circumferentially disposed and spaced apart in the row and having cutting crests to cut circular tracks on the well bottom at the ends of the tracks cut by said teeth.

FLOYD L. SCOTT.