

[54] **DRILL BIT**
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Related U.S. Application Data

[63] Continuation of Ser. No. 126,833, March 22, 1971, abandoned.
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[51] Int. Cl. **E21c 13/00**
[58] Field of Search .. 76/108 R; 175/329, 374, 410; 299/91

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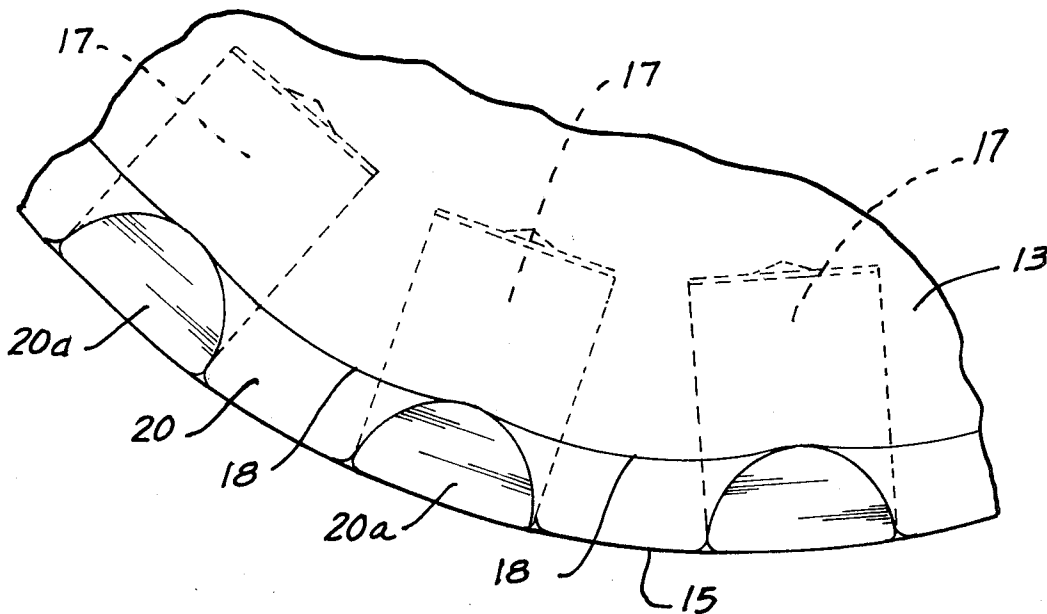
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[57] **ABSTRACT**

A drill bit including a plurality of roller cutters, each cutter having at least one substantially chisel-shaped circumferential web and hardened inserts positioned therein to allow penetration of the web into the formation being drilled, said inserts having one substantially chisel-shaped end and positioned so that the chisel-shaped surfaces of the web and the inserts present a relatively continuous chisel-shaped surface to the formation. This abstract is neither intended to define the invention of the application, which of course is measured by the claims, nor is it intended to be limiting as to the scope of the invention in any way.

10 Claims, 4 Drawing Figures



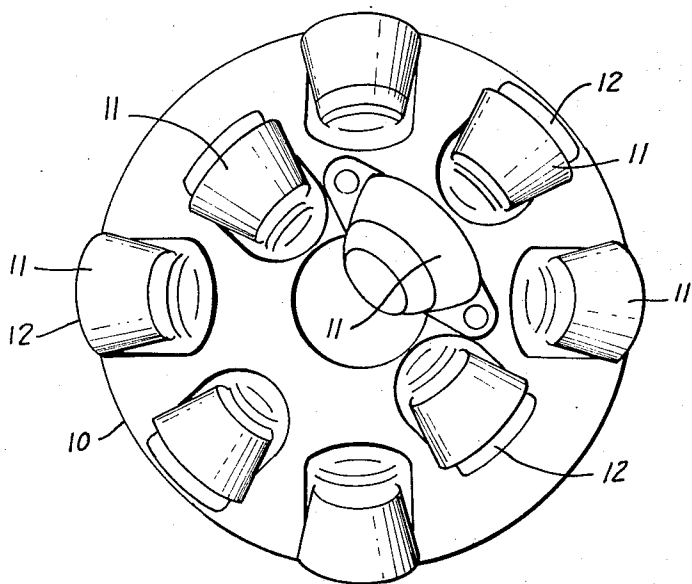


Fig. 1

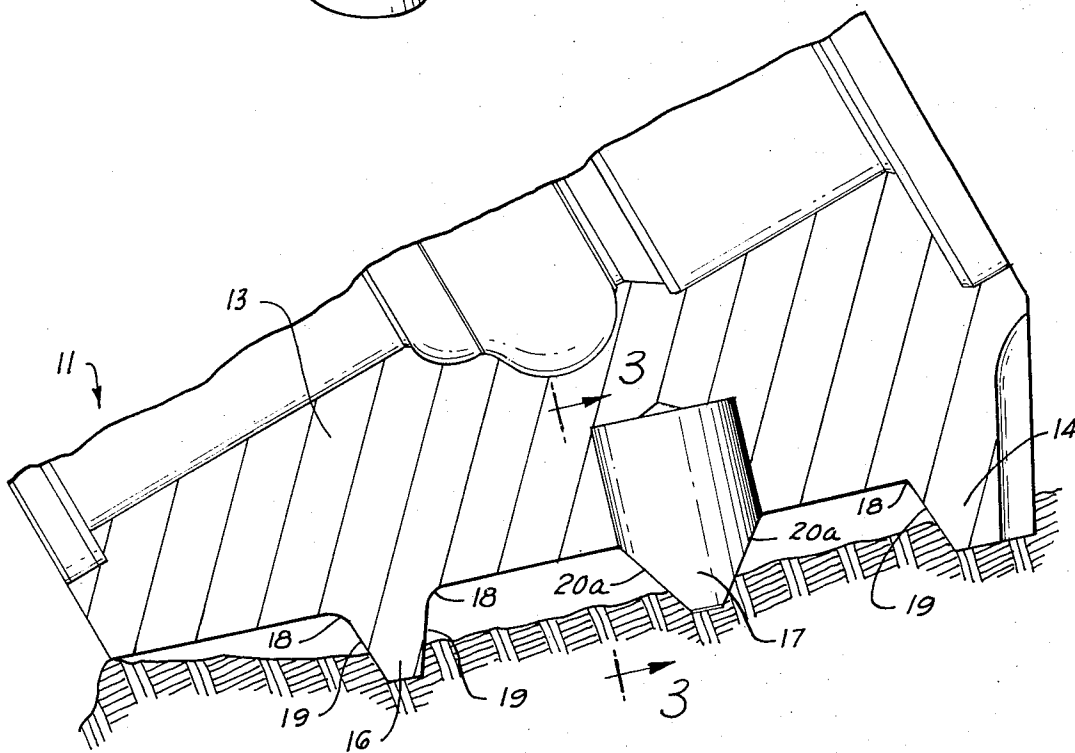


Fig. 2

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Fig. 4

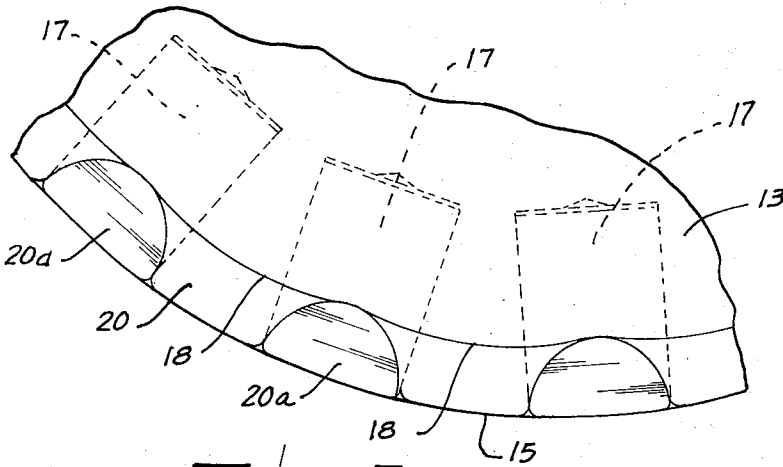
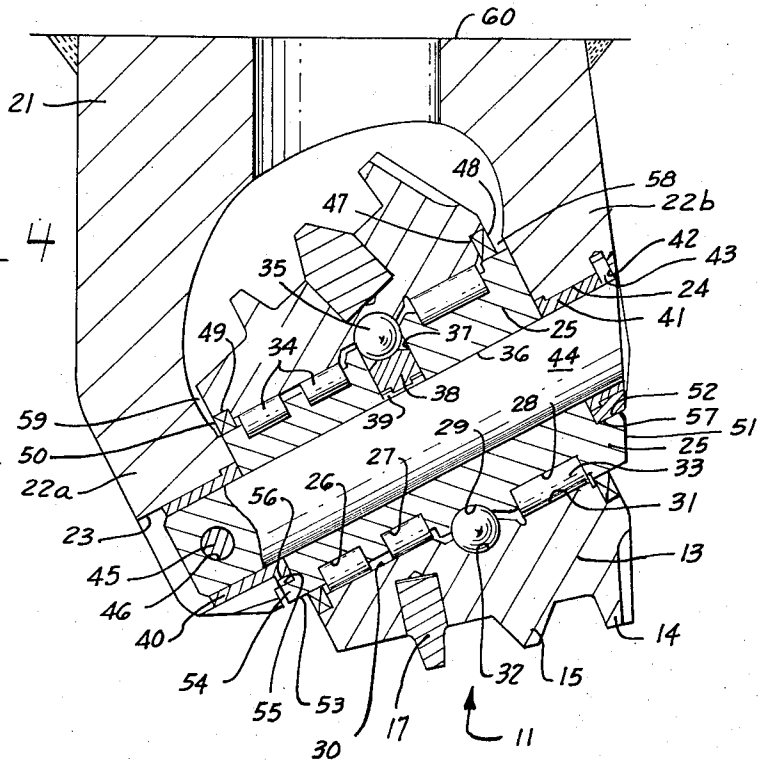


Fig. 3

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DRILL BIT

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of my prior co-pending application, Ser. No. 126,833, filed Mar. 22, 1971, now abandoned.

SUMMARY

This invention relates generally to drill bits and more particularly to drill bits for drilling earth formations.

An object of the invention is to provide a new and improved drill bit which efficiently drills hard formations and which is especially useful in drilling a large diameter hole.

Another object of the invention is to provide a bit having new and improved roller cutters which cuts kerfs in the formation and which breaks the portions of the formation between the kerfs.

A still further object of the invention is to provide a new and improved kerf-cutting roller cutter which presents at least one relatively continuous chisel-shaped cutting surface to the formation.

Another object of the invention is to provide a new and improved kerf-cutting roller cutter which has strengthened cutting surfaces and longer useful life.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred embodiment of the invention is illustrated by the accompanying drawings wherein:

FIG. 1 is a plan view of the cutter end of a drill bit embodying the invention;

FIG. 2 is a fragmentary sectional view of a roller cutter in engagement with the formation;

FIG. 3 is a fragmentary sectional view of a portion of a roller cutter taken along line 3—3 in FIG. 2 (the formation not being shown); and

FIG. 4 is a sectional elevation of the roller cutter illustrating its mounting in the head.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In cutting kerfs in formations with roller cutters having relatively continuous circumferential cutting surfaces, it has been found that a desirable shape of the cutting surface is substantially chisel-shaped. A chisel-shaped cutting surface cuts kerfs in the formation and acts as a wedge in such kerfs to break out the portions of the formation between kerfs. Construction of such a roller cutter with at least one substantially chisel-shaped circumferential web extending outwardly from the body of the roller cutter operates satisfactorily if the formation is not very abrasive. But if the formation is too abrasive, hardened cutting elements or inserts are preferably positioned in the cutting surface. A roller cutter according to this invention provides at least one circumferential web having hardened cutting elements or inserts positioned therein. The web is shaped to surround in supporting relationship substantially all portions of each insert except the cutting faces thereof. The web and the inserts therein present a relatively continuous chisel-shaped cutting surface to the formation. The roller cutter is thereby provided with strengthened cutting surfaces and has a longer useful life.

The drill bit as shown in FIG. 1 is provided with a head 10 which has a suitable means (not shown) for connecting the head to the drill string or other device which is to support and rotate the head. Attached to the cutting side of the head 10 are a plurality of roller cutters 11, each of which is rotatably mounted on the head 10. The roller cutters are shown to be frusto-conical in shape and the axis of each of the cutters 11 extends inwardly and away from the head 10 in a direction toward the longitudinal axis or center of rotation of the head 10. The large-diameter base 12 of each cutter 11 is the outermost portion of the cutter with respect to the axis of rotation of the head 10. However, the shape and location of the cutters 11 may vary.

Each of the roller cutters 11 is designed to cut at least one kerf or groove in the face of the formation. Referring to the form of roller cutter illustrated in FIGS. 2, 3 and 4, the roller cutter 11 includes a body 13 which is shaped suitably for rotational mounting to head 10. The body 13 has three outwardly extending, circumferential webs or lands 14, 15 and 16. Each of said webs is substantially chisel-shaped and functions as a cutting surface to cut kerfs. The web may have either flat (as shown in FIG. 2), concave or convex surfaces, so long as it remains substantially chisel-shaped.

It is preferred that the entire roller cutter 11, including body 13 and webs 14, 15 and 16, be carburized except for the fillets 18 existing between the body and the webs. The fillets are preferably not carburized in order to prevent them from becoming brittle and to minimize cracking of the body at the fillets.

It is preferable that the bisector of the included angle of the faces 19 of the chisel-shaped web be substantially perpendicular to the outer surface of the body 13 of the roller cutter.

A plurality of hardened, crushing cutting elements or inserts 17, such as tungsten carbide inserts, are positioned in each web. These inserts 17 function to strengthen the cutting surface presented to the formation. The end of the insert presented to the formation is substantially chisel-shaped with its faces 20 shaped substantially similar to the web in which it is positioned. Each insert is positioned in the web so that the cross-sectional shape of the web and the insert have substantially the same included angle. Because webs 14 and 16 have a shape similar to the inserts positioned therein, the inserts in said webs are hidden in FIG. 2. Likewise, insert 17 hides web 15. The web and the inserts act in conjunction to present a relatively continuous chisel-shaped cutting surface to the formation so that on rotation of the body of the roller cutter, a circular kerf is cut in the formation.

In the preferred embodiment of the roller cutter, the portion of the insert positioned in the web and body is round and each insert is pressed into a round hole drilled into the web and body of the roller cutter. The inserts are secured in such holes by a suitable interference fit. It is preferred that the interference fit be from 0.005 to 0.010 inch in order to prevent cracking of the hole. Normally the interference fit and the forces exerted by the formation prevent the inserts from turning in the holes and becoming misaligned. If desired, however, the inserts may be suitably "keyed" at their inner ends to the body of the roller cutter.

In order to present a relatively continuous chisel-shaped cutting surface to the formation, it is preferable that the inserts 17 be positioned in the web and body

so that the bisector of the included angle of the faces 20 of the chisel-shaped end of the insert also be substantially perpendicular to the body 13 of the roller cutter.

The precise chisel-shape of each web and the inserts therein may vary from web to web on the same roller cutter. For example, in the roller cutter illustrated in FIG. 2, the faces 19 of web 16 and the faces of the inserts therein form a more acute included angle than do the faces 20 of web 15 and the faces 20a of the inserts therein.

As can best be seen in FIG. 3, web 15 has a shape so as to surround in supporting relation substantially all portions of each insert 17 positioned therein except the cutting faces 20a thereof. This strengthens the cutting element and lengthens the useful life of the roller cutter. The cutting faces 20 of the web 15 form a substantially continuous surface with the cutting faces 20a of the inserts 17 positioned therein. Accordingly, the web and the inserts therein present a relatively continuous chisel-shaped cutting surface to the formation.

A detailed sectional view of the cutter assembly is shown in FIG. 4. The roller cutter assembly 11 is shown comprising a cutter support 21 having an inner support leg 22a and an outer support leg 22b spaced from said inner support leg. The inner support leg 21 has a hole 23 therethrough, and the outer support leg 22 has a hole 24 therethrough. A bearing journal 25 extends between the support legs 22a and 22b and has a roller race 26, another roller race 27, an outer roller race 28 and a ball race 29. The roller cutter 11 is provided with an inner roller race 30, an outer roller race 31 and a ball race 32. Roller bearings 33 are provided in the outer roller raceways; roller bearings 34 are provided in the inner roller raceways; and ball bearings 35 are provided in the ball raceways. The journal 25 has a bore 36 extending axially therethrough and a ball-loading hole 37 extending from the bore 36 through the ball raceway 29 so that the balls 35 may be installed in the raceway. When a full complement of ball bearings 35 has been supplied to the raceway, a ball-retaining plug 38 is inserted into the ball-loading hole 37, and a snap ring 39 frictionally retains the ball-retaining plug in place in the journal.

The hole 23 in the inner support leg 22a and the hole 24 in the outer support leg 22b are aligned. A bushing 40 is supplied within the hole 23, and a bushing 41 is supplied within the hole 24. The bushing 41 has a slot 42, and a roll pin 43 is provided within the slot 42 and in the outer support leg 22b to prevent the bushing 41 from turning about its axis. A bearing pin 44 extends through the bushings 40 and 41 and the journal 25 and is retained in place by means of a cap screw 45, which is inserted into the inner support leg 22a through the bushing 40 and the pin 44 and is threaded into the hole 46.

The outer end of the roller cutter 11 has a counterbore 47 therein adjacent to the outer roller race 31, and a seal 48 is pressed or otherwise secured within said counterbore. The other end of the roller cutter 11 has a counterbore 49 into which is pressed or otherwise secured a seal 50. The outer portion of the journal 25 has a cylindrical section with axial projection or boss 51 extending therefrom. The axial projection has a radially inwardly facing flat surface 52. The journal 25 also has an inner cylindrical portion 53 which has an axial projection or boss 54, which projection has a radi-

ally inwardly facing flat surface 55. The lower portion of the inner support leg 22a has a flat 56 thereon. The lower portion of outer support leg 22b also has a flat 57 thereon.

Thus, when the journal 25 is installed between the inner and outer support legs 22a and 22b, the flat surface 52 of the journal 25 is located by and registers with the flat surface 57 of the outer support leg 22b, and the flat surface 55 of the journal 25 is located by and registers with the flat surface 56 of the lower portion of support leg 22a. In this manner, the journal is accurately located and the flats just described prevent torque being applied to the pin 44 during operation of the drill bit. This arrangement of the flats also prevents the journal 25 from turning about its own axis during the drilling operation.

As can be seen in FIG. 4, the disposition of the roller cutter 11 on the journal 25 and the positioning of the journal 25 between the inner and outer support legs 22a and 22b provide a gap 58 between the outer face of the roller cutter 11 and the inner face of the outer support leg 22b. The surfaces of the roller cutter 11 and the support leg 22b define a substantially parallel gap. The arrangement of the gap so described tends to alleviate the accumulation of cuttings between the roller cutter and its associated support in order to keep detritus from abrading away the outer seal 48. As will also be apparent, as the roller cutter rotates, the seal (being pressed or tackwelded into the cutter) also rotates, and as a given portion of the seal 48 approaches the bottom of the bore hole being drilled, it leaves the cutter support leg 22b and is exposed to the exterior of the bit. With this arrangement the trappings of cuttings or detritus between the bit and its associated support is alleviated. A similar gap 59 is provided between the inner end of the roller cutter 11 and the inner support leg 21 for the purpose just described.

The surface 60 of the cutter support 20, which may be made of a steel casting or the like, may be milled at various angles with respect to the rotating axis of the cutter, so that it can be mounted, as by welding, to the bottom of the pit head 10 in accordance with the bottom hole configuration desired.

The mounting of the roller cutter 11 as described allows the roller cutter to rotate freely when in engagement with a formation, and rotation of the bit head causes each of the cutters to rotate therewith while rotating on the axis of the pin 44 to cut kerfs in the formation. The parts of the formation between the kerfs are broken out in relatively large pieces to complete the boring with the drill bit of the present invention.

A drill bit using the kerf-producing cutters of the present invention will be particularly useful in cutting large diameter holes. It is particularly advantageous since not all of the formation removed has to be cut.

As can be seen, the arrangement and spacing of the webs on the cutters is such that the formation is not apt to "ball up" the cutters or to clog them with formation cuttings since the groove between the webs is relatively wide and may be from one-half inch to more than 1 inch wide. The depth of the groove between the webs is preferably at least one-half inch. The ridges of uncut formation remaining between the kerfs produced by the cutters of the invention may be on the order of three-fourths inch in width or more.

The arrangement and spacing of the webs and the cutters are such that enhanced drilling performance is produced by the bit of the invention.

The roller cutter of the present invention is greatly strengthened and has a greatly increased life of operation.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. A roller cutter, comprising
 - a body,
 - at least one substantially chisel-shaped circumferential web on said body, and
 - a plurality of hardened, wear-resistant cylindrical inserts,
 - said inserts having a chisel-shaped end and being positioned in recesses defined in said web and extending into said body with their chisel-shaped end being in substantial alignment and conformity with the chisel-shape of said web to provide a substantially continuous formation engaging crest,
 - the recesses defined in said web and body being of a size in relation to said inserts to support said inserts by engagement with substantially the entire cylindrical surfaces of said inserts.
2. A roller cutter, comprising
 - a body,
 - at least one web extending circumferentially around said body, and
 - a plurality of hardened, wear-resistant generally cylindrically shaped inserts,
 - said inserts having a formation engaging end with a chisel-shape defined by two outwardly converging faces, the cylindrical surface of said inserts at each side of said faces extending substantially to the formation engaging crests of said inserts,
 - said inserts being mounted in recesses in said web with the web in supporting relationship to substantially all of the cylindrical surfaces of said inserts at the sides of said faces,
 - said web being chisel-shaped in section and the crest of said web and the crests of said inserts defining a substantially continuous formation engaging crest around said body.
3. A drill bit, comprising
 - a head,
 - a plurality of roller cutters rotatably mounted on said head,
 - at least one of said roller cutters having a body, at least one substantially chisel-shaped circumferential web on said body, and a plurality of hardened, wear-resistant, cylindrical inserts, one end of which is chisel-shaped, each of said inserts being secured in said web with said web being in supporting engagement with substantially all of the cylindrical surfaces of said inserts, and
 - the crests of said web and said inserts defining a substantially continuous formation engaging crest around said body.
4. A roller cutter, comprising
 - a body,
 - at least one web extending circumferentially around said body, and

- a plurality of hardened, wear-resistant generally cylindrically shaped inserts,
 - said inserts having a formation engaging end with a chisel-shape defined by two outwardly converging faces, the cylindrical surface of said inserts at each side of said faces extending substantially to the formation engaging crests of said inserts,
 - said inserts being mounted in recesses in said web with the web in supporting relationship to substantially all of the cylindrical surfaces of said inserts at the sides of said faces,
 - the crest of said inserts being in substantial alignment with the circumferential crest defined by said web.
5. A roller cutter according to claim 4, wherein said recesses extend through said web and substantially into said body.
 6. A drill bit according to claim 4, wherein said body and said web are steel and all of said body and said web is carburized except the fillet existing between said body and said web, and said inserts are tungsten carbide.
 7. A roller cutter, comprising
 - a body,
 - at least one substantially chisel-shaped circumferential web on said body, and
 - a plurality of hardened, wear-resistant, cylindrical inserts, one end of which is chisel-shaped,
 - each of said inserts being secured in said web with said web being in supporting engagement with a substantial portion of the cylindrical surfaces of the chisel portion of said inserts,
 - the crest of said inserts being in substantial alignment with the circumferential crest defined by said web.
 8. A roller cutter, comprising
 - a body,
 - at least one web extending circumferentially around said body,
 - a plurality of hardened, wear-resistant generally cylindrically shaped inserts,
 - said inserts having a chisel-shaped end and being positioned in recesses defined in said web and extending into said body,
 - the sectional shape and size of the chisel portion of said insert being substantially the same as the sectional shape and size of said web,
 - the recesses defined in said web and body being of a size in relation to said inserts to support said inserts by engagement with substantially the entire cylindrical surfaces of said inserts,
 - said supporting engagement of said web extending to a substantial portion of the cylindrical surfaces on the chisel portion of said insert to provide such mutual supporting relationship between said inserts and said web,
 - the crest of said inserts being in substantial alignment with the tract of the crest of said web.
 9. A drill bit, comprising
 - a head,
 - a plurality of roller cutters rotatably mounted on said head,
 - at least one of said roller cutters having a body, at least one circumferential web on said body, and a plurality of hardened, wear-resistant, cylindrical inserts, one end of which is chisel-shaped, each of said inserts being secured in said web with said web

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being in supporting engagement with substantially all of the cylindrical surfaces of said inserts which lie along the axial length of the chisel portion of said inserts,
the crest of said inserts being in substantial alignment with the circumferential crest defined by said web.
10. A drill bit roller cutter, comprising
a body,
at least one row of cutting elements on said body comprising,
substantially chisel-shaped spaced steel teeth having circumferentially extending crests,

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cylindrical wear-resistant inserts mounted in said row between said steel teeth,
said teeth being in engagement to a sufficient portion of the cylindrical surfaces on said inserts to provide mutual support for said teeth and said inserts to assure a long useful life thereof,
said wear-resistant inserts having circumferentially extending cutting crests forming a substantially continuous formation engaging crest with the crests of said steel teeth.

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