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(54) Title: RETREAD PREPARATION

(57) Abstract: A machine, method, and cutting tool comprises a cylindrical body; an annular bevel formed in an end of the cylindrical body forming a circular cutting edge at one of an outer circumferential surface of the cylindrical body and an inner circumferential surface of the cylindrical body; a plurality of grooves formed in one of the outer circumferential surface of the cylindrical body and the inner circumferential surface of the cylindrical body, the plurality of grooves creating a discontinuities in the circular cutting edge; wherein at least two adjacent grooves of the plurality of grooves are spaced about the cylindrical body at a pitch period of 5mm or less.

RETREAD PREPARATION

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The invention relates to a machine and process for machining rubber products such as tire treads.

Description of the Related Art

[0002] Tires are known to comprise a tread consisting of an outer layer of rubber-based mixtures, of greater or lesser thickness, in which are molded various grooves and tread patterns intended, inter alia, to improve the vehicle's grip relative to the ground.

[0003] In certain cases, it is necessary to machine the outer surface of the tire: for example, to prepare for retreading of a worn tire. Another example is to obtain a "worn" tire from a new tire, with a view to performing certain tests on one or more portions of the tire such as the belt, or the carcass, without being hampered by the very considerable heating associated with the thickness of the rubber of the new tread during the tests.

[0004] Typically tire tread machining has been accomplished by various types of abrading devices such as rasps, grinding wheels, and wire brushes. Because such devices rely upon a friction type "wearing" action in order to remove material, substantial amounts of relatively fine dust-like particles are generated which are difficult to contain. Because the process is dependent upon friction for effectiveness, it is difficult to perform at an economical speed of production without the resulting heat becoming excessive to the point of scorching of the underlying surface. Further, the use of rasp blades and the like also tends to produce many cuts or tears in the underlying surface material creating a macro-rough and micro-rough surface texture suitable for retreading, represented by the Rubber Manufacturers Association (RMA) texture plaque, preferably of level 3 or level 4 out of the six levels identified.

[0005] Another process used for tire tread machining is a cutting process. In this process a cylindrical cutter called a "peeler" is typically used. A problem with these cylindrical cutters is that the cutting process leaves a smooth surface on the surface of the tire that often requires a subsequent texturing operation to make the carcass surface suitable for bonding. Also, the cylindrical cutter results in long continuous strips of removed material which can result in a jamming of the machine.

[0006] More recently, a plurality of spaced grooves have been incorporated into the outer cylindrical surface of the cutters in an effort to reduce the length of these cut strips, however, these cutters still result in a smooth cutting surface. The cut strip length also remains a problem.

SUMMARY OF THE INVENTION

[0007] A particular embodiment of the present invention includes a cutting tool comprising: a cylindrical body; an annular bevel formed in an end of the cylindrical body forming a circular cutting edge at one of an outer circumferential surface of the cylindrical body and an inner circumferential surface of the cylindrical body; a plurality of grooves formed in one of the outer circumferential surface of the cylindrical body and the inner circumferential surface of the cylindrical body, the plurality of grooves creating a discontinuities in the circular cutting edge; wherein at least two adjacent grooves of the plurality of grooves are spaced about the cylindrical body at a pitch period of 5mm or less.

[0008] Another particular embodiment of the present invention includes a machine for machining tire treads, comprising: a frame; a drum for supporting the tire and rotating it about its axis; a cutting tool comprising a cylindrical body, an annular bevel formed in an end of the cylindrical body forming a circular cutting edge at one of an outer circumferential surface of the cylindrical body and an inner circumferential surface of the cylindrical body, a plurality of grooves formed in one of the outer circumferential surface of the cylindrical body and the inner circumferential surface of the cylindrical body, the plurality of grooves creating a discontinuities in the circular cutting edge, wherein at least two adjacent grooves of the plurality of grooves are spaced about the cylindrical body at a pitch period of 5mm or less.

[0009] Another particular embodiment of the present invention includes a method for cutting the tread of a tire; the method comprising the steps of: rotating a tire on a drum; cutting a portion of an outer circumferential surface of the tire with a rotating cylindrical cutting tool; interrupting the cutting process with a plurality of grooves formed in a cutting edge of the cylindrical cutting tool, the interruption step occurring approximately every 5mm or less of rotation of the cutting edge of the cylindrical cutting tool.

[0010] These and other advantages will be apparent upon a review of the detailed description of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 is a schematic view of a tire machining machine according to an embodiment of the invention;

[0012] FIG. 2 is a perspective view of an embodiment of a cylindrical cutter tool;

[0013] FIG. 3 is an axial view of the cutter tool of FIG. 2;

[0014] FIG. 4 is a detail axial view of the cutting edge and grooves formed in the cutter tool of FIG. 2;

[0015] FIG. 5 is a side elevational view of the cutter tool of FIG 2;

[0016] FIG. 6 is a detail cross-sectional view of the cutter tool of FIG. 2 cutting the outer surface of a tire;

[0017] FIG. 7 is an axial view of another embodiment of a cylindrical cutter;

[0018] FIG. 8 is a cross-sectional view of the cutter of FIG 7; and

[0019] FIG. 9 is a side view of still another embodiment of a cylindrical cutter.

DETAILED DESCRIPTION OF THE DRAWINGS

[0020] FIG. 1 is a schematic view of a machine 110 for machining tire treads in accordance with an embodiment of the invention. The machine 110 comprises a first fixed frame 112 supporting a drum 140 on which is mounted a tire 120. The machine 110 also comprises a mobile frame 114 supporting a tool holder 116. The mobile frame 114 is mounted on a fixed base 117 by means of two pairs of rails 118. The rails 118 are oriented perpendicularly to the axis of rotation 122 of the tire 120 and permit translational movement of the mobile frame 114 towards or away from the tire 120. The rails 115 are oriented parallel to the axis of rotation 122 of the tire 120 and permit translational displacement of the mobile frame 114 parallel to the axis of rotation 122 of the tire 120. The combination of these two translational movements allows the cutting tool holder to follow all the conventional tire profiles. The mobile frame 114 also allows vertical displacement of the tool holder 116, due to conventional means which are not shown. The machine additionally comprises means (not shown) of setting the tire 120 in rotation, of reversing its direction of rotation, and of controlling the displacements of the mobile frame 114 and the vertical position of the tool holder 116. The machine 110 as described is presented for example only and is not intended to be limiting on the present invention.

[0021] The tool holder 116 is intended to hold a cutting tool comprising at least one cylindrical cutting tool 10. FIG. 1 shows the cutting tool 10 in position for machining the tire 120. The tool holder 116 may swing vertically about the horizontal axis 125 in order, as described below, to bring the cutting edge 20 of the cutting tool 10 into contact with the tire 120. The cutting machine 110 may further comprise a sharpening tool 145, typically a stone or grinding wheel that engages the cutting tool 10 to keep the cutting tool sharpened.

[0022] Referring now to FIGS. 2-5, the cutting tool 10 comprises a cylindrical body 12 having an annular bevel 14 formed in an end 16 of the cylindrical body 12. The annular bevel 14 forms a circular cutting edge 20 at an outer circumferential surface 18 of the cylindrical body 12. The cylindrical body diameter, d, may be of the order of 150 mm, for example. The cutting tool 10 further comprises a plurality of grooves 30 formed in the outer circumferential surface 18 of the cylindrical body 12 the plurality of grooves 30 creating a discontinuities in the circular cutting edge 20.

[0023] As best shown in FIG. 4, a pair of adjacent grooves 32 of the plurality of grooves 30 are spaced about the cylindrical body 12 at a pitch period, P, and at least one groove 32 has a circumferential width, W, a radial depth, D. In, one embodiment of the cutting tool 10, the pitch period P of the grooves 32 is less than 5mm. It should be noted that there is no requirement for the pitch period P to be constant but may vary if desired.

[0024] In one embodiment of the cutting tool 10, the circumferential width W of the groove 32 is 2 mm or less. In one embodiment of the invention, the radial depth D of the groove 32 is 2 – 5 mm and a corresponding radial thickness or the cutting tool 10 generally at 5 – 10 mm. The annular bevel 14 forms an acute angle, θ, with a cylindrical axis 13 of the cylindrical body 12. In one embodiment, the angle θ is about 18 to 45 degrees; in a further embodiment, the angle θ is about 25 to 45 degrees. While measurements relating to the cutting tool have been provided, these are intended as examples and are not contemplated to be limiting the invention in any way.

[0025] Referring back to FIG. 1, the tool holder 116 is mounted rotationally about a horizontal axis 125 substantially parallel with the rotational axis 122 of the tire 120, which allows adjustment (due to means which are not shown) of the rake angle. Referring now to FIG. 6, a detail view of the cutting tool 10 is shown cutting the tire 120. It is noted that the rake angle, Φ, is produced by positioning the cutting tool 10 at a predetermined position. Having the proper rake angle helps determine the final surface roughness of the tire. In one embodiment of the present invention, it is contemplated that the rake angle Φ is 50 degrees or less; however the same is for example only and it not intended to limit the invention.

[0026] In operation, the method for cutting the tread of a tire comprises the steps of: rotating a tire 120 on a drum 140 of a tire cutting machine 110; cutting a portion of an outer circumferential surface of the tire 120 with a rotating cylindrical cutting tool 10; and interrupting the cutting process with a plurality of grooves 30 formed in a cutting edge 20 of the cylindrical cutting tool 10, the interruption step occurring approximately every 5mm or less of rotation of the cutting edge 20 of the cylindrical cutting tool 10. In operation, the grooves 30 allow the cut rubber strip to be divided into short portions and thus prevent a jam from forming in the cutting path. In addition, the inclusion of these grooves 30 (subsequently occurring teeth on the cutting edge 20) increase the surface area over the nominal surface of the tire making the surface more robust for subsequent bonding with a bonding agent, such as an uncured rubber layer. For example, with a speed of tire rotation of the order of 30 rev/min, a tire diameter of the order of 1 m and a speed of tool rotation of the order of 200-500 rev/min, cut rubber portions are obtained which are approximately 2mm in length, instead of 10mm to several meters as in the prior art. The cutting tool 10 is translated in a direction laterally across the tread of the tire 120 (axially with respect to the tire) to provide complete coverage of the tire 120. The tread cutting may be accomplished by several passes according to the amount of material being removed with each pass. For example, the tread cutting depth may be set to 5mm per pass until the desired amount of tread is removed. An additional tread removal pass at a smaller depth, for example 0.5mm, can then be made to further increase the surface roughness. The method described is an example only and is not intended to limit the invention in any way.

[0027] As previously mentioned above, an example of suitable roughness is provided in the art by the reference plaques provided for retreading tires by the Rubber Manufacturers

Association (RMA). These reference surfaces are based upon machining by buffing, or using a brushing process after machining by cutting. These reference surfaces are ranked by the RMA as RMA1 through RMA6, representing smooth to very rough, respectively. The RMA recommends a roughness of RMA3 or RMA4 for the tire casing surface. Typically, a cutting tool produces a smooth surface classified as RMA1. Using the method and cutting tool 10 of an embodiment of the present invention, a resulting surface roughness that is classified as an RMA2 to RMA3 is typically achieved. However, the RMA surface roughness is based primarily on a macro roughness classification of the surface. The method and cutting tool 10 of an embodiment of the present invention provides a micro roughness that is suitable for retreading even though the macro-surface roughness provided by the process may be classified as an RMA2. This allows the present invention to provide both cutting and surface roughness in a single effective operation without requiring a secondary roughening step with wire brushes or other abrasive means.

[0028] In another embodiment of the cutting tool 10' as shown in FIGS. 7-8, the annular bevel 14' is formed in an end 16' of the cylindrical body 12' forming a circular cutting edge 20' at an inner circumferential surface 19 of the cylindrical body 12'. The cutting tool 10' further comprises a plurality of grooves 30' formed in the inner circumferential surface 19 of the cylindrical body 12', the plurality of grooves 30' creating discontinuities in the circular cutting edge 20'.

[0029] Still another embodiment of the cutting tool 10" is shown in FIG. 9. In this embodiment, the grooves 30" are helically formed, whereas the grooves 30, 30' of the previous embodiments were generally formed axially. Each groove 32" thus has inclined edges instead of normal edges, as is the case with the cutting tools 10, 10'. This effectively provides the cutting edge 20" of the cutting tool 10" with a leading edge and a trailing edge, which may facilitate severing of the cut strips.

[0030] It is further noted that the shape of grooves 30, 30', 30" is not limited to the geometry shown herein. It is contemplated that the grooves could also be triangular, saw-tooth, partially curved, or any other appropriate shape for providing a discontinuity in the cutting edge 20, 20', 20".

[0031] While this invention has been described with reference to preferred embodiments thereof, it shall be understood that such description is by way of illustration and not by way of limitation. Accordingly, the scope and content of the present invention are to be defined only by the terms of the appended claims.

CLAIMS

What is claimed is:

1. A cutting tool comprising:

a cylindrical body having a circular cutting edge formed in an end of the circular body, wherein the cutting edge is formed between an outer and an inner circumferential surfaces of the circular body;

a plurality of grooves formed in the outer circumferential surface of the cylindrical body and the inner circumferential surface of the cylindrical body, the plurality of grooves creating discontinuities in the circular cutting edge, wherein at least two adjacent grooves of the plurality of grooves are spaced about the cylindrical body at a pitch period of 5 mm or less.

2. The cutting tool of claim 1, wherein at least one groove has a radial width of 2 mm or less.

3. The cutting tool of claim 1, wherein at least one groove has a radial depth of 5 mm or less.

4. The cutting tool of claim 1, further comprising:

an annular bevel formed in the end of the cylindrical body forming the circular cutting edge.

5. The cutting tool of claim 4, wherein the bevel forms an acute angle with a cylindrical axis of the cylindrical body of about 18 to 45 degrees.

6. The cutting tool of claim 4, wherein the bevel forms an acute angle with a cylindrical axis of the cutting tool of about 28 to 40 degrees.

7. The cutting tool of claim 4, wherein the cutting edge is formed at the intersection of the bevel surface and the outer circumferential surface of the cylindrical body.

8. The cutting tool of claim 4, wherein the cutting edge is formed at the intersection of the bevel surface and the inner circumferential surface of the cylindrical body.

9. A machine for machining tire treads, comprising:

a frame;

a drum for supporting the tire and rotating it about its axis;

a cutting tool comprising a cylindrical body, an annular bevel formed in an end of the cylindrical body forming a circular cutting edge at one of an outer circumferential surface of the cylindrical body and an inner circumferential surface of the cylindrical body, a plurality of grooves formed in one of the outer circumferential surface of the cylindrical body and the inner circumferential surface of the cylindrical body, the plurality of grooves creating a discontinuities in the circular cutting edge, wherein at least two adjacent grooves of the plurality of grooves are spaced about the cylindrical body at a pitch period of 5mm or less.

10. The machine of claim 8, wherein the cutting tool is selectively positionable to a position where the cutting tool has a positive rake angle of 50 degrees or less with respect to a circumferential surface a tire mounted on a drum.

11. The machine of claim 8, further comprising a sharpener selectively positionable to abrade the bevel surface of the cutting tool.

12. A method for cutting the tread of a tire; the method comprising the steps of:

rotating a tire on a drum;

removing a portion of an outer circumferential surface of the tire with a rotating cylindrical cutting tool; and essentially simultaneously

roughening a surface exposed under the removed portion of the outer circumferential surface of the tire with the rotating cutting tool.

13. The method of claim 12, wherein the step of interrupting the cutting process further comprises:

roughening the outer circumferential surface of the tire to correspond to an RMA reference surface of RMA 2 or rougher.

14. The method of claim 12, wherein the step of rotating a tire on a drum is accomplished at a rotation of at least 30 rev/min.

15. The method of claim 12, wherein the step of cutting a portion of an outer circumferential surface of the tire with a rotating cylindrical cutting tool is accomplished by rotating the cutting tool at a rotation of at least 200 rev/min.

16. The method of claim 12, wherein the step of cutting a portion of an outer circumferential surface of the tire with a rotating cylindrical cutting tool is accomplished by cutting at a cutting depth of 10mm or less.

17. The method of claim 12, further comprising the step of:

cutting a further portion of an outer circumferential surface of the tire with a rotating cylindrical cutting tool cutting at a cutting depth of 1mm or less.

18. The method of claim 11, further comprising the step of:

cutting a further portion of an outer circumferential surface of the tire with a rotating cylindrical cutting tool cutting at a cutting depth of 0.5mm or less.

19. The method of claim 11, further comprising the step of:

positioning the cutting tool to create a positive rake angle of 50 degrees or less with respect to the outer circumferential surface of the tire mounted on the drum.

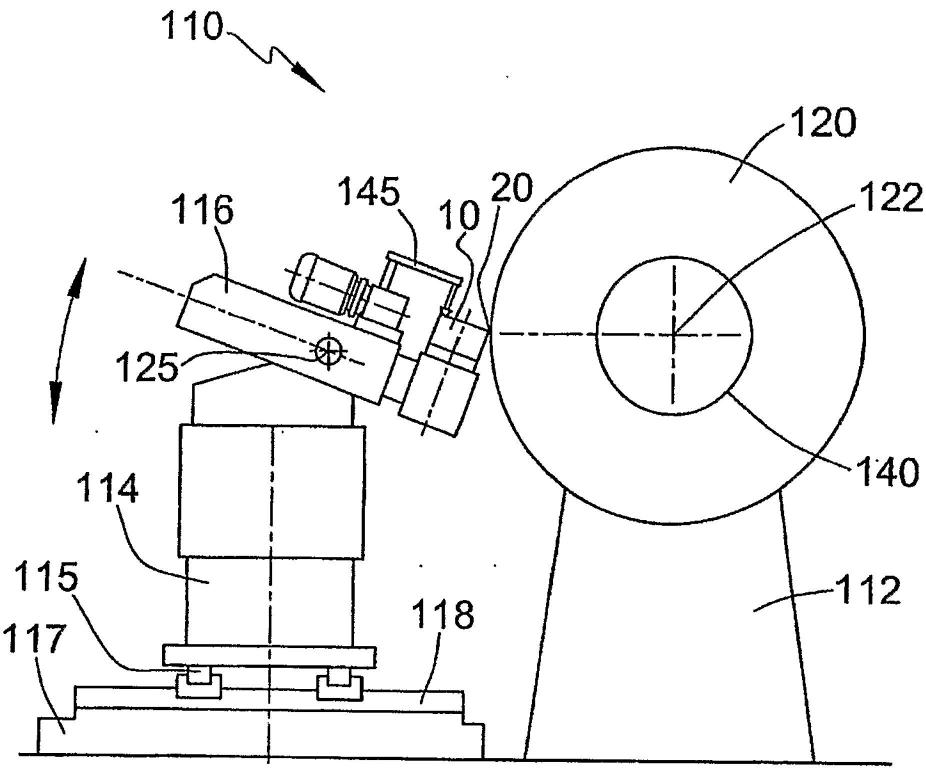
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FIG. 1

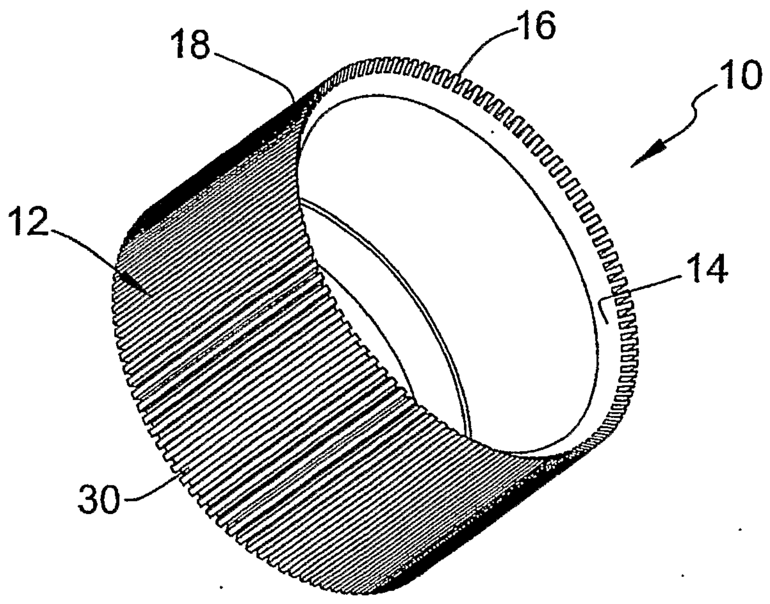
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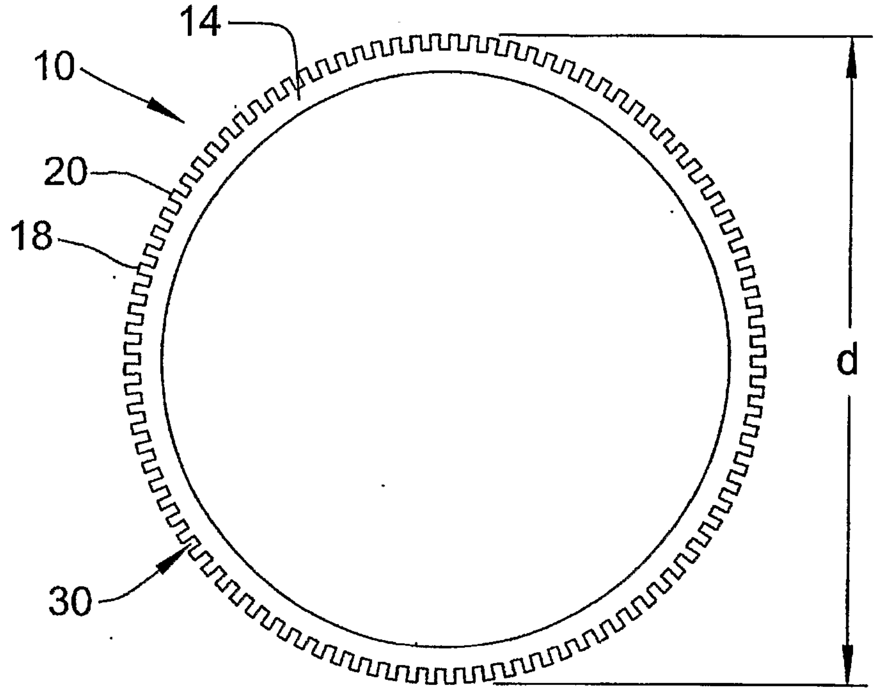
FIG. 2



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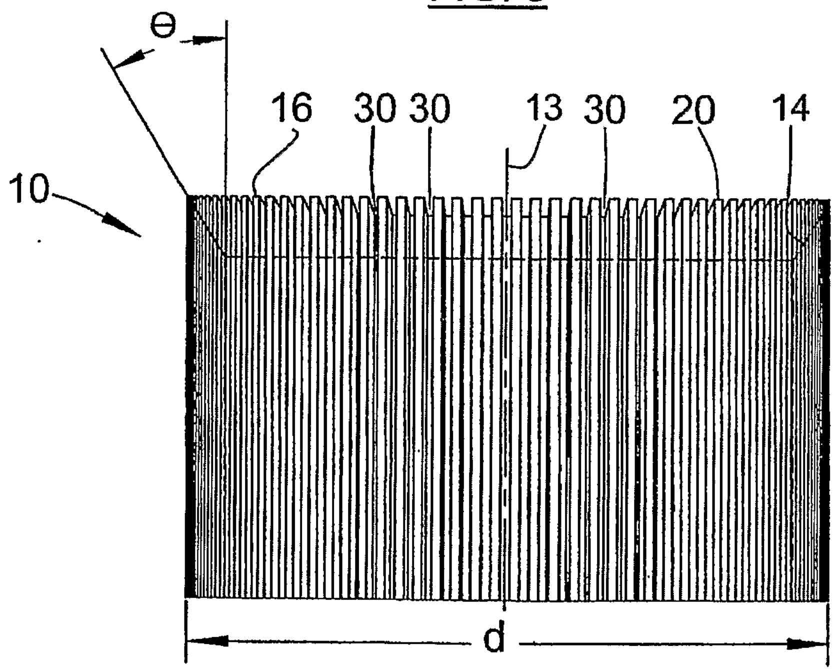

FIG. 5

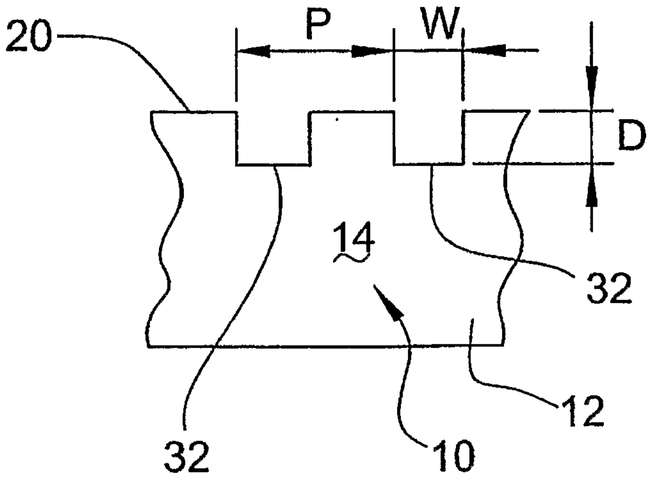

FIG. 4

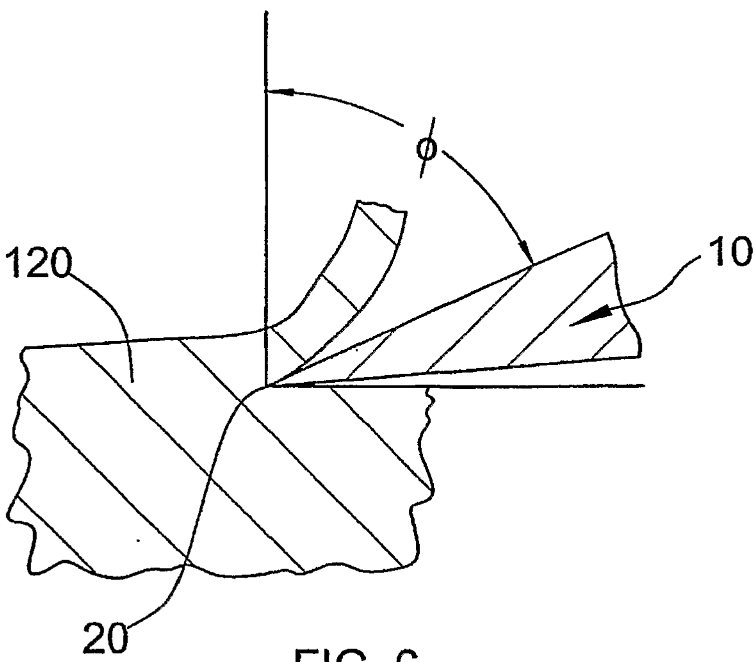

FIG. 6

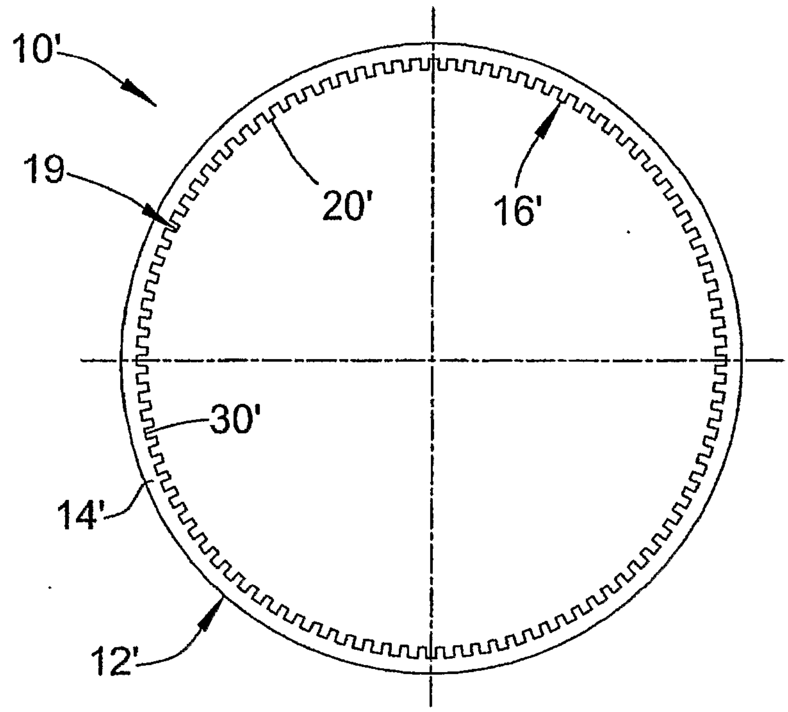

FIG. 7

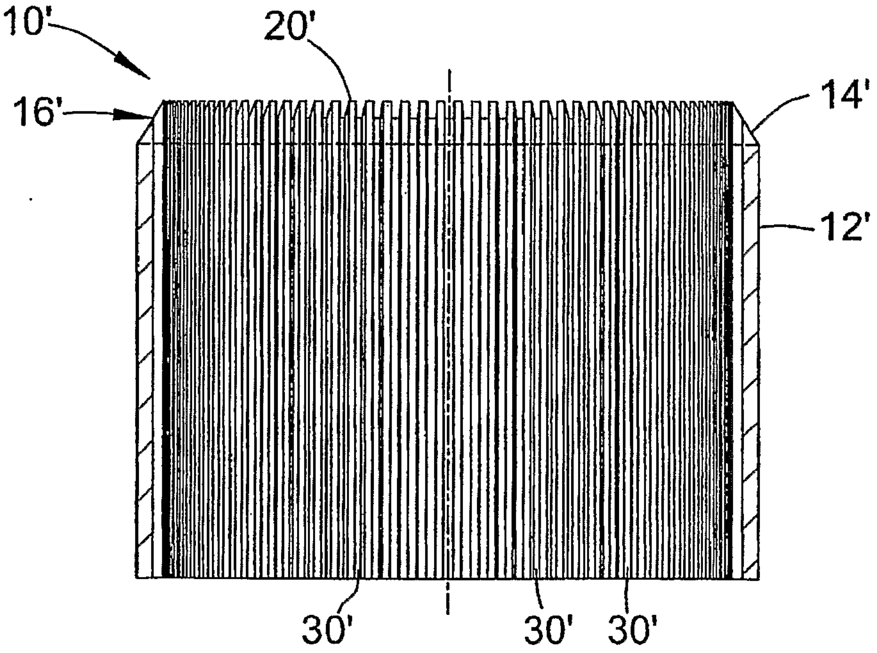

FIG. 8

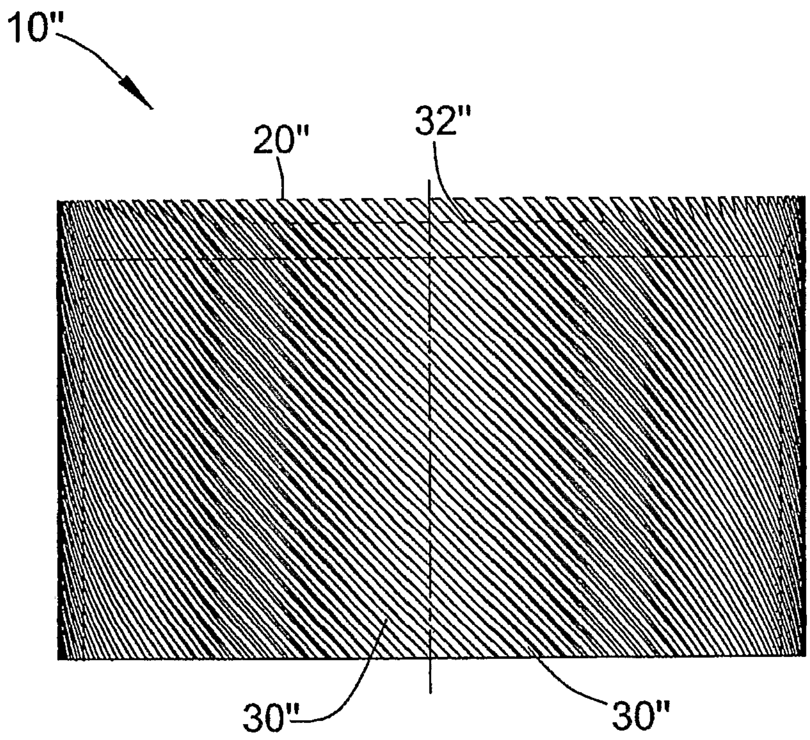

FIG. 9