A rumble strip milling machine (101) has a plurality of cutting wheels (309, 310, 311, 312) mounted on an associated axel (321). Each cutting wheel has one row of cutting teeth (317), which are oriented 90 degrees out of phase (e.g., 6, 9, 12, 3 o'clock). Each cutting tooth (317) has a cutting tip (323).
A rumble strip milling machine (101) has a plurality of cutting wheels (309, 310, 311, 312) mounted on an associated axle (321). Each cutting wheel has one row of cutting teeth (317), which are oriented 90 degrees out of phase (e.g., 6, 9, 12, 3 o’clock). Each cutting tooth (317) has a cutting tip (323).
RUMBLE STRIP CUTTER

FIELD OF THE INVENTION

This invention relates to an apparatus for cutting rumble strips into asphalt or cement pavement.

BACKGROUND OF THE INVENTION

Rumble strips are typically installed in new asphalt pavement by pressing depressions perpendicular to forward direction of travel when it is still hot during installation of the pavement. This is accomplished by a roller with steel bars of suitable size and spacing with adequate weight to form the depressions.

It is often desirable to install rumble strips in asphalt that is already installed, or to increase the width of the rumble strip depressions to increase the magnitude of rumble effect. To this end, machines have been designed and built to mill wider depressions in cold asphalt pavement along the shoulder of roads. These rumble strip milling machines typically use the same type of cutting teeth used on large asphalt milling machines. The teeth are mounted on a cylindrical cutting head, with a diameter the same as the arch of the depressions to be milled. As the milling machine moves forward, the cutting or milling head is rotated at a rapid rate against the forward motion of the milling machine to cut into the pavement. Since the cutting must be periodic and not continuous to form a rumble strip, the cutting head is raised and lowered at regular intervals to leave unmilled areas between the milled depressions. Accordingly, during the forward travel of the milling machine it is necessary to continuously move the cutting head up and down in a regular periodic motion. This up and down motion must be carefully coordinated with the forward speed of the milling machine. This coordinated motion severely limits the forward speed of the milling machine. Typically the forward speed of these rumble strip cutters can be no greater than one or two miles per hour, making the process a relatively slow procedure.

The up and down motion of the cutting head not only limits the speed of the milling machine, but adds significantly to the mechanical complexity and cost of the machine. Accordingly, there is a continuing need in the art to a rumble strip cutting system that not only permits a faster cutting speed but also is a mechanically simpler method than existing systems. A desirable system would be mechanically simpler, and thus more reliable and allow for a faster forward speed of the milling machine.
Objects of the Invention

It is, therefore, an object of the invention to provide a rumble strip milling apparatus that can cut rumble strips while traveling significantly faster that prior-art systems.

Another object of the invention is a rumble strip milling apparatus that is mechanically simpler than existing systems.

Further objects of the invention will become evident in the description below.

BRIEF SUMMARY OF THE INVENTION

The present invention involves a milling machine and method for cutting rumble strips into pavement, such as asphalt and Portland cement. The present invention involves a cutting wheel with alternating rows of cutting teeth. The cutting wheel is mounted with the cutting rows transverse to the direction of travel and it is rotated at a fixed distance above the pavement to move the cutting rows in and out of cutting position as the milling machine moves forward.

As the teeth on the cutting wheel are rotated in and out of cutting position, the forward motion of the machine provides the cutting force as the row of cutting teeth are dragged along the pavement to cut a depression in the pavement. The cutting row is then rotated from cutting into the pavement, leaving an uncut portion as the machine continues its forward motion. In this manner periodic cut and uncut portions are provided, which together form a rumble strip.

The invention is contrary to prior-art practice where the cutting wheel is rotated rapidly to provide the cutting force for the wheel and the wheel is moved up and down as the machine moves forwards.

Since the rotating of the cutting wheel enables the milling machine to form the periodic cuts, it is not necessary to move the cutting wheel up and down. Accordingly, the cutting wheel rotates at a fixed distance above the pavement, such that the cutting rows cut into the pavement when they are at the bottom of the cutting wheel, and an uncut portion is left when the non-cutting surface is at the bottom of the cutting wheel.

In order that the forward motion provide the cutting force for the teeth in the cutting rows, the teeth must be dragged across the pavement, i.e., the peripheral speed of the cutting wheel is slower than or opposite the speed of the pavement under a cutting row as it cuts. There are several ways of accomplishing this end, One method, as illustrated in
Example I, is to provide a cutting wheel that turns at the same RPM rate and in the same
direction as a drive wheel of the machine, but where the cutting wheel has a smaller
diameter. In this instance the forward side of the wheel is turning down, like the drive
wheel, but because the peripheral speed of the cutting wheel is lower, its cutting rows are
dragged along the pavement when in cutting position. Another method, as illustrated in
Example II, is to provide cutting wheels that turn opposite the forward motion.

In any case, it is important that the cutting wheels function to present and
withdraw a cutting row for cutting. In addition, the arc and spacing of the depression must
be correct. Accordingly, the cutting wheel diameter, the number of cutting rows on the
cutting wheel, rotation speed and direction, must be chosen to achieve the desired ends. In
addition, the peripheral speed of the cutting wheel and the forward motion must be
proportionally coordinated in order to provide a strip of regular periodic cut depressions.

Coordinating the forward speed and cutting wheel speed together proportionally is
mechanically simpler and more trouble free than coordinating the up and down motion of a
cutting wheel and its drive mechanism. Without the requirement of a up and down motion
of cutting wheels, it is possible for the apparatus of the present invention to travel much
faster than prior-art systems, up to 20 to 30 miles per hour. The order of magnitude
increase in speed, and the overall simplicity of the present system, over prior-art systems,
allows for a significant savings in capitol and operating costs.

In another embodiment, as illustrated in Example III, the cutting wheel is rotated
such that forward speed of the teeth on the cutting wheel, as they travel under the wheel
and cut into the pavement, exactly compensates for the forward speed. Relative to the
milling apparatus, the speed of the teeth as they cut into the pavement is the same
magnitude and opposite from that of the forward motion of the milling apparatus.
Accordingly, relative to the pavement the teeth are not moving forward or backward, and
there is no cutting force along the axis of travel. Instead a lateral motion perpendicular to
the forward motion is imparted to the teeth to cut lateral grooves. This is provided by
placing the rotational axis of the cutting wheel at a non-perpendicular angle to the forward
motion. Thus, in summary, the rotational speed is coordinated to null out any forward or
backward motion of the teeth as they cut into the pavement, and the cutting wheel is
placed at an angle to provide a lateral motion to the teeth for cutting lateral grooves.

If the rotational axis is perpendicular, no lateral motion to the teeth can be
provided, and near perpendicular, the length of the cut grooves is very short. If the
rotational axis is zero, the forward speed of the teeth cannot be coordinated as described above. At small angles near zero, the speed of the cutting wheel must be very high in relation to forward speed, rendering coordination impractical. Preferably the angle is near 45°, because at that angle the length of the groove cut by an individual tooth is reasonable, and the above describe speed coordination is straightforward. However, any angle is suitable where one can provide simultaneously null out the forward and backward motion and provide the lateral cutting motion of the teeth in the pavement, as described above. Mathematical evaluation of an angled cutting wheel indicates that the structure can be described by the following formula;

$$D_D = D_C R \sin(A)$$  \hspace{1cm} (1)

where \(D_D\) is the diameter of a controlling wheel of the milling machine, \(D_C\) is the diameter of the milling wheel from tooth tip to tooth tip, \(R\) is the rotation ratio of the cutting wheel to the controlling wheel, and \(A\) is the angle of the rotational axis of the cutting wheel to the axis of the forward motion of the milling apparatus. The controlling wheel is a wheel that rolls along the pavement as a driven or non-driven wheel. \(R\) can be provided by any suitable structure, such as a gear train or differential that provides the suitable ratio.

The teeth are disposed on the cutting wheel such that lateral grooves cut by the various teeth are lined up with each other such that a continuous groove is cut across the pavement under the cutting wheel. This is provided by placing the cutting teeth along a helical path around the circumference of the cutting wheel. Thus, as a first cutting tooth finishes cutting a lateral groove and is raised by rotation of the wheel, an adjacent second tooth begins its cut in the just cut groove near the end, and continues cutting along the same lateral axis on the pavement. The second tooth is placed to come in cutting position at a time after the first tooth, and is displaced toward the trailing end of the cutting wheel to compensate for the forward motion of the milling machine. Thus, the first and second teeth form the beginning of a helical row of teeth around the cutting wheel. Looking at an end of a cutting wheel that has a leading edge on the right, the helical row rotates in a counter-clockwise direction as it travels toward the other end.

In general the angle (B) of the helical row to a longitudinal axis of the cutting wheel is \(B = 90 - A\). The tooth spacing in a helical row is such that the grooves cut by the individual teeth in the row combine or overlap sufficiently to provide continuous cut groove across the pavement. The exact spacing depends upon the various factors.
including cutting wheel diameter, the cutting depth, and mounting angle of the cutting head, and can be determined by a practitioner of ordinary skill.

There may be one or more helical rows, depending upon the desired spacing of successive grooves cut in the pavement. Because of the manner in which the motion of the cutting wheel is coordinated, the wheel makes one rotation for a forward travel distance calculated by;

\[ d_t = \frac{D}{2} \cos(\alpha). \]  

(2)

Accordingly, a 10 inch cutting wheel at a 45° angle with one helical row will cut successive grooves about 22 inches apart. With four helical rows the spacing will accordingly be about 5.5 inches.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is schematic side view of an apparatus of the invention.

Figure 2 is a schematic of the cutting wheels of the apparatus in Figure 1, illustrating the motion of the cutting wheels relative to the forward motion of the apparatus.

Figure 3 is a schematic of an alternate apparatus of the invention.

Figure 4 is a schematic showing in greater detail the cutting wheels of the apparatus of Figure 3.

Figure 5 is a schematic illustrating the motion of the cutting teeth relative to the forward motion of the apparatus of Figure 3.

Figure 6 is a plan view of another embodiment of the invention with the cutting wheel placed at an angle to the direction of travel.

Figure 7 is a perspective view of a cutting wheel with a helical row of teeth used in the embodiment of Figure 6.

Figure 8 is a view of a cutting wheel illustrating the helical path of the cutting teeth.

Figure 9 is an end view of a cutting wheel, as in Figure 7, showing on row of cutting teeth.

Figure 10 is an end view of a cutting wheel, as in Figure 7, showing the ends of four rows.

Figure 11 is a schematic diagram illustration the cutting action of a single tooth.
Figure 12 is a cross-sectional schematic showing the cut groove from a tooth overlapping a previously cut groove, to form a longer continuous groove.

Figure 13 is a schematic diagram illustrating the cutting action of a single tooth.

Figure 14 is a cross section of a cutting tooth used on a cutting wheel of the invention.

Index of Reference Numbers

Figures 1 and 2

101 apparatus of the invention
103 truck
105 rear drive axle
107 air bags
109 forward cutting wheel
111 rear cutting wheel
113 transfer case
115 drive wheels
117 cutting teeth
119 radius lines
121 center of cutting wheel
123 tip of cutter
125 pavement
127 wheel center locations
129 cutting tip locations

Figures 3, 4 and 5

301 apparatus of the invention
303 truck
305 rear drive axle
309 cutting wheel
310 cutting wheel
311 cutting wheel
312 cutting wheel
315 drive wheels
317 cutting teeth
319 radius lines
321 center of cutting wheel
323 tip of cutter
325 pavement
327 wheel center locations
329 cutting tip locations

Figures 6 to 15

401 milling apparatus
402 cutting wheel
403 rear axle assembly
405 controlling wheel
407 shaft
408 transverse grooves
409 differential assembly
411 cutting tooth
413 helical row of teeth
415 lines showing path of helical row
417 pavement
419 phantom cutting wheel
421 cutting tooth assembly
423 mounting bracket
425 underside of mounting bracket
427 spring clip

25 DETAILED DESCRIPTION OF THE INVENTION

Example I

Reference is now made to Figure 1, which a schematic diagram of a rumble strip milling machine of the invention 101. A large truck 103 with a suitable wheelbase and at least one rear drive axle 105 provides a forward motion to the apparatus. The truck is equipped with air bags 107 over the rear axle 105 to raise and lower the frame of the truck. Forward and trailing cutting wheels 109, 111 are mounted behind the drive axle.
Two cutting wheels 109, 111 are mounted on two truck axles with the same gear ratios as the drive axle for the drive wheels of the truck. The cutting wheels 109, 111 are driven through a transfer case 113 to allow engagement or disengagement of the cutting wheels. The diameter of the cutting wheels 109, 111 is one half the diameter of the drive wheels, so that the peripheral speed of the cutting wheels 109, 111 is one-half of the drive tire or ground speed.

As an example, if the drive wheel is 42 inches in diameter, the diameter of the cutting heads (from the tips of the cutters) is 21 inches. Usually the spacing between rumble strips is 12 inches. Therefore, the spacing between the cutting teeth rows on the milling head must be 6 inches. The cutting head has a circumference of about 66 inches, thus 11 rows of cutting teeth are spaced around the circumference of the wheel, at about 6 inch intervals.

During operation of the milling machine the cutting wheels are lowered to the pavement surface by deflating the air bags 107 to dead axle. The apparatus is driven forward and the cutting wheels 109, 111 are dragged or pulled over the surface while being rotated forward, as indicated by the arrows. To provide weight in the cutters so that they will cut into the pavement, the vehicle may be weighted by any suitable means, for example, by a water tank. Auxiliary equipment used in pavement milling machines may also be provided, such as, for example, spray bars over the cutters, covers over the cutting wheels, compressed air for cleaning, noise suppression devices, and the like.

Reference is now also made to Figure 2, which is a schematic illustrating the cutting wheels 109, 111. The cutting wheels 109, 111 comprise rows of cutting teeth 117 (only one tooth in each row is shown for clarity) with spaces 119 without cutting teeth between the rows. To illustrate the motion of the cutting teeth rows as the wheel rotates and moves forward radius lines 119 are shown below between the center of the cutting wheel 109, 111 and the tip of a cutter 123 cutting into pavement 125. The cutting wheel moves forward at a constant speed as shown by the equal spacing of the wheel center locations 127. However, the speed of a cutting tip is less, by one-half in this example, when it is cutting into the pavement. This is shown by the spacing between the corresponding cutting tip locations 129. As a result of the lower speed of the cutting wheel the cutting teeth are dragged along the pavement, which provides the cutting force for the milling of the depression by the teeth 117. Thus, although the wheel is rotating forward side down, the cutting teeth 117 are set to cut up.
Example II

Reference is now made to Figure 3, which a schematic diagram of an alternate rumble strip milling machine of the invention 301. A truck 303 with a suitable wheelbase and at least one rear drive axle 305 provides a forward motion to the apparatus. Four cutting wheels 309, 310, 311, 312 are mounted behind the drive axle. The truck is equipped with suitable means to raise and lower the cutting wheels (not shown).

With driving wheels 315 on the machine of about 30.56 inches in diameter, and the cutting wheel one-fourth of that diameter (from tips of teeth - 7.64 inches) a ratio of 8:1 would turn cutting teeth on the cutting heads twice as fast as the forward motion of the milling apparatus. The circumference of the cutting heads is about 24 inches which means that the teeth would travel 24 inches in a circular motion for every 12 inches of forward motion. Using four cutting wheels mounting 15 inches apart, each cutting wheel having one row of cutting teeth. In the four cutting wheels, the cutting rows are oriented 90° out of phase (e.g., 6, 9, 12, and 3 o’clock).

During operation of the milling machine the cutting wheels are lowered, and the apparatus is driven forward and the cutting wheels 309, 310, 311, 312 are dragged or pulled over the surface while being rotated forward, as indicated by the arrows.

Reference is now also made to Figure s 4 and 5, which are, respectively, a schematic illustrating the cutting wheels 309, 310, 311, 312, and a schematic showing radius lines of a moving wheel. The cutting wheels comprise a row of cutting teeth 317 with a space 319 without cutting teeth. To illustrate the motion of the cutting teeth rows as the wheel rotates and moves forward (See Figure 5) are radius lines 319, i.e., the lines between the center 327 of a cutting wheel and the tip 329 of a cutter cutting into pavement 325. The cutting wheel moves forward at a constant speed as shown by the equal spacing of the wheel center locations 327. However, the speed of a cutting tip 329 is faster the wheel center when it is cutting into the pavement. This is shown by the corresponding cutting tip locations 329.

Example III

Reference is now made to Figures 6 to 13, which show a milling apparatus 401 of the invention in which the cutting wheel 402 is placed at a non-perpendicular angle to the forward direction of travel. Referring to Figure 6, a rear-axle assembly 403, essentially the same as that used on a motor vehicle, with the wheels 405 mounted at an angle is mounted...
on a trailer frame. The assembly is disposed at an angle so that the shaft 407, that in a
motor vehicle would be a drive shaft, extends from the side frame at a non-perpendicular
angle. The wheels 405 and the shaft 407 are connected though a differential assembly
having the appropriate gear ratio. The wheels 405 and the shaft 407 are connected to the
differential assembly 409 with appropriate couplings and u-joints. Disposed on the end of
the drive shaft is a cutting wheel, which disposed at a non-perpendicular angle to the
forward motion of the trailer. If it is desired to cut thin transverse grooves 408 in the
pavement, the angle, diameter for the wheels, the ratio of the differential, and the diameter
of the cutting wheel, are set such that the cutting teeth 411 cut only across, perpendicular
to the forward motion, with no forward or backward cutting motion of the teeth. (for
simplicity, only the teeth at the ends of the cutting wheel are shown in Figure 6.) Applying
Formula (1) above, if the controlling wheels 405 are 41.7 inches in diameter (D_b), and
mounting angle (A) to the direction of travel (shown by the arrow) is 45 degrees, the
differential rotation ratio of cutting wheel to wheel (R) is 4.1:1, the diameter of the cutting
wheel would be 14.3 inches. It is understood that the cutting wheel may be mounted at
any other suitable angle, or even with the outboard end trailing instead of leading as shown
in the figure. As the angle (A) approaches zero, the rotational speed of the cutting head
will usually have to be increased. It may be desirable to have such a rapid cutting speed
where the groove is to be cut into a hard surface, such as concrete.

Referring also to Figure 7, the cutting teeth 411 are mounted in a helical row 413
so that the lateral cuts of the teeth in a row line up to form an essentially continuous
groove in the pavement. Figure 8 also illustrates the helical rows, where the lines 415
show the tip of two of four rows on the cutting wheel. Only the cutting teeth at the ends
of the cutting wheel 402 are shown in Figure 8 for simplicity. Figure 9 shows the end of
the cutting wheel 402 showing one row 413 of helically mounted cutting teeth 411. Figure
10 is also a similar end view, but shows four rows. The numbering (r,t) indicates a row
number (r) and tooth number in the row (t). The cutting teeth 411 may be mounted by any
suitable means. They are preferably mounted in the direction in which they cut as
illustrated.

Reference is not made to Figures 11, 12 and 13. In Figure 11, the cutting tooth
411 has just traveled around and is beginning to cut into the pavement under the cutting
wheel, the cutting tooth as in travels around and touches the pavement. Referring to
Figure 12, the teeth in a helical row are disposed such that the groove being cut will
overlap into the groove cut by the previous tooth. The result is long cut continuous groove.

Referring to Figure 11, as the tooth continues along the cut is travels along a transverse line, as the angle of the cylinder is providing a backwards motion that essentially nulls out the forward motion of the vehicle. Thus, as the tooth cuts, it is moving neither forward nor backward, but makes a transverse or sideways cut in the pavement. The phantom cutting wheel represents the position of the cutting wheel 402 as it was in Figure 11. Due to advancement of the milling machine, the cutting wheel 402 is in a new position. The rotation of the cutting is coordinated to move the cutting tooth around the cutting wheel. The angle of the cutting wheel, and the rotation combine so as to push the cutting tooth transversely perpendicular to the direction of travel. Having no forward or backward motion as it is cutting into the pavement, the groove cut is perpendicular to the direction of travel.

Applying formula (2) to a 14.3 inch cutting wheel, a single helical row of cutters would cut grooves 32 inches apart. Four helical rows would cut grooves about 8 inches apart.

Figure 14 is a cross-section of a cutting tooth 421 assembly that may be used in any of the embodiments of the invention herein described. The holding bracket 423 which is mounted by any suitable means to a cutting wheel at its underside 425. The cutting tooth 411 fits into a machined hole in the bracket, and the tooth is held in place by a spring clip 427. With this construction, when a tooth is worn or broken, it can be easily replaced.

Summary

While this invention has been described with reference to certain specific embodiments and examples, it will be recognized by those skilled in the art that many variations are possible without departing from the scope and spirit of this invention, and that the invention, as described by the claims, is intended to cover all changes and modifications of the invention which do not depart from the spirit of the invention.

For example, the cutting wheel could be mounted with its axis at an angle to the forward motion of the machine. The teeth would then be oriented in helical rows to cut the depressions straight across. The depressions would be similar to those of the above examples, but be parallelogram-shaped. If the speed of the cutting wheel is coordinated to null out forward or backward motion of the teeth as they cut, as in Example III, the
grooves cut by each tooth line up end to end to form a long thin groove, instead of lining up side by side to form a depression.

An apparatus of the invention may have one or a plurality of cutting wheels. A second cutting wheel may be used to cut in the same depression as a first cutting wheel to finish the shape and texture of the depression, as illustrated in the examples. In addition, a following cutting heads may be disposed to cut in between depressions cut by one or more leading cutting wheels.

Any system for providing and coordinating the peripheral speed of the cutting wheel and the forward motion is contemplated. Preferably, conventional power transfer systems that turn both the drive and cutting wheels at the coordinated speed are used. Other methods of coordinating these speeds is contemplated, using, for example, any combination of synchronized motors, gear boxes, electronic speed controllers and governors, and the like. The only requirement is that the peripheral speed of the cutting wheel be coordinated with the forward speed as recited in the claims.

In addition, the milling apparatus need not be on a motorized truck or be self propelled, as illustrated, but could be towed as a trailer, the requirements being that there by some motor or like for imparting forward motion and that the cutting wheel speed can be proportionally linked with the forward speed. The exact dimensions of the various components of the milling machine, in particular, the drive and cutting wheel diameters, the cutting row spacing, and the ratio between the speeds of the drive and cutting wheels, depends upon the dimensions of the rumble strip, the configuration of the drive mechanism, etc. The exact dimensions and configuration for any particular milling machine of the invention is well within the skill of an ordinary practitioner in the art to determine.
CLAIMS

What is claimed is:

1. A milling apparatus for milling rumble strips into pavement comprising;
   a device for imparting forward motion to the milling apparatus,
   at least one cutting wheel comprising at least one cutting row of pavement cutters
   and non-cutting surface disposed transversely at a periphery of the cutting wheel to
   present alternating cutting and non-cutting surfaces as the cutting wheel rotates,
   a cutting wheel rotator for rotating the cutting wheel at a speed proportional to the
   forward motion and at a fixed distance above the pavement, such that the at least one
   cutting row is in turn presented into a cutting position for cutting into the pavement and
   then withdrawn from the cutting position to present the non-cutting surfaces to form
   periodic cut and uncut portions in the pavement.

2. A milling apparatus as in Claim 1 wherein the cutting wheel rotator rotates the
   cutting wheel in a direction with a forward side moving down.

3. A milling apparatus as in Claim 1 wherein the cutting wheel rotator rotates the
   cutting wheel in a direction with a forward side moving up.

4. A milling apparatus as in Claim 1 wherein the cutting wheel is mounted on a
   rotational axis at a mounting angle less than 90 and greater the 0 degrees to the direction
   of travel and the cutting wheel rotator rotates the cutting wheel in a direction with the
   forward side moving down,
   the rotator coordinating rotation speed of the cutting wheel relative to the forward motion
   such that there is essentially no forward or backward speed difference between movement
   of cutting teeth as they travel under the bottom of the cutting wheel and the pavement
   when the bottom cutting teeth are cutting into the pavement,
   the mounting angle imparting a lateral motion the cutting teeth perpendicular to the
   direction to travel, such that each cutting tooth cuts a lateral groove perpendicular to the
   direction of travel,
   the cutting teeth disposed in one or more helical rows on the cutting wheel at an angle
   relative to a longitudinal axis and at a spacing between adjacent cutting teeth on the row
   such that the adjacent cutting teeth in the helical row cut lateral grooves on a common axis
with overlapping ends to produce an essentially continuous groove in the pavement essentially perpendicular to the direction of travel.

5. A method for forming a rumble strip in pavement, the method comprising; rotating and moving at least one cutting wheel a fixed distance above a pavement surface, the cutting wheel comprising at least one cutting row of pavement cutters and at least one row of a non-cutting surface disposed transversely at a periphery of the cutting wheel to present alternating cutting and non-cutting surfaces as the cutting wheel rotates, the cutting wheel rotating at a speed proportional to the moving of the cutting wheel above the pavement such that the cutting rows are in turn presented into a cutting position for cutting into the pavement and then withdrawn from the cutting position as the non-cutting surfaces are presented to form periodic cut and uncut portions in the pavement.

6. A method as in Claim 5 wherein the cutting wheel rotator rotates the cutting wheel in a direction with a forward side moving down.

7. A method as in Claim 5 wherein the cutting wheel rotator rotates the cutting wheel in a direction with a forward side moving up.