# United States Patent

**Zuzelo**

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[54] **MULTIPLE GROOVING OF PAVEMENT**


[72] Inventor: **Edward A. Zuzelo,** 652 Broad Acres Road, Narberth, Pa. 19072



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[52] **U.S. Cl.** .....**299/18,** 15/320, 51/264, 51/270, 299/39

[51] **Int. Cl.**.....**E01c 23/09**

[58] **Field of Search** .....299/12, 18, 39; 175/66, 206; 15/320; 51/264, 270



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 3,119,602 | 1/1964 | Johnson | 299/39 UX |
| 2,919,898 | 1/1960 | Marwil et al. | 175/66 |
| 3,407,005 | 10/1968 | Simms et al. | 299/39 |
| 2,680,260 | 6/1954 | Danielsson et al. | 15/320 X |
| 3,572,841 | 3/1971 | Rhodes | 299/39 |
| 3,598,446 | 8/1971 | Hatcher | 299/39 |
| 3,608,968 | 9/1971 | Burnett | 299/39 |
| 2,771,718 | 11/1956 | Gustafson et al. | 51/264 X |
| 2,905,266 | 9/1959 | Pooh | 51/270 X |



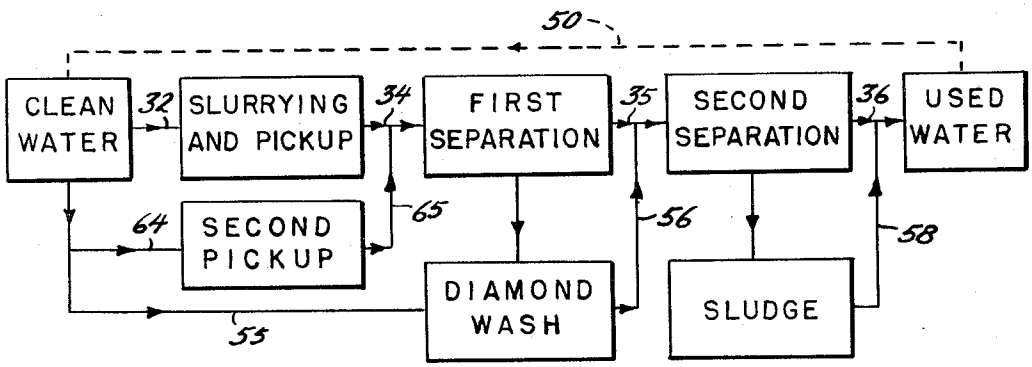
*Primary Examiner*—Ernest R. Purser
*Attorney*—McClure & Millman



[57] **ABSTRACT**

Particles of pavement removed by cutting thereof into multiple grooves to impart antiskid properties thereto are slurried with water and the slurry disposed of remote from the pavement. Particles of cutting material slurried therewith are reclaimed therefrom for reuse, and pavement particles are optionally recovered from the slurry as well. Such reclamation and recovery may be accomplished by centrifugal methods, such as hydrocycloning.


**12 Claims, 5 Drawing Figures**



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SHEET 1 OF 2

Fig. 1.

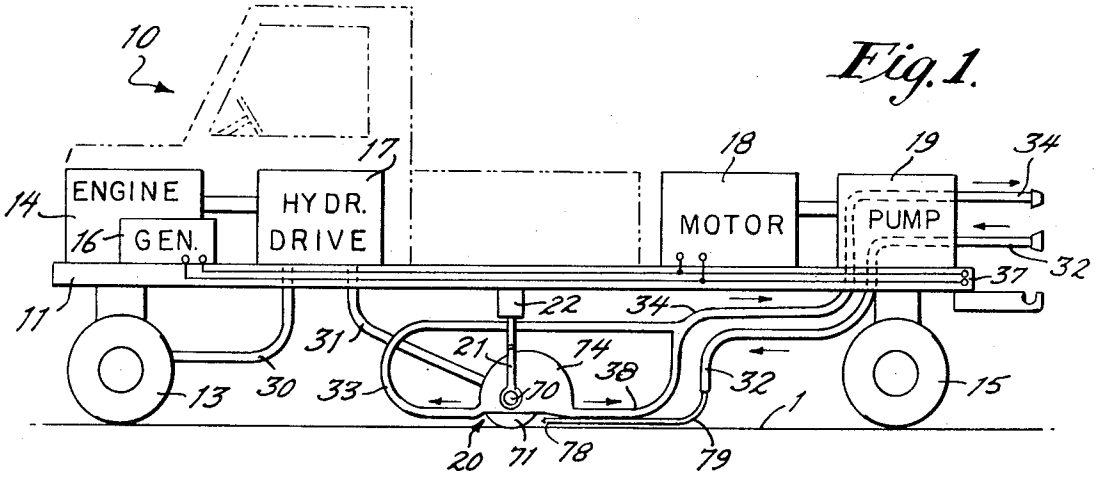
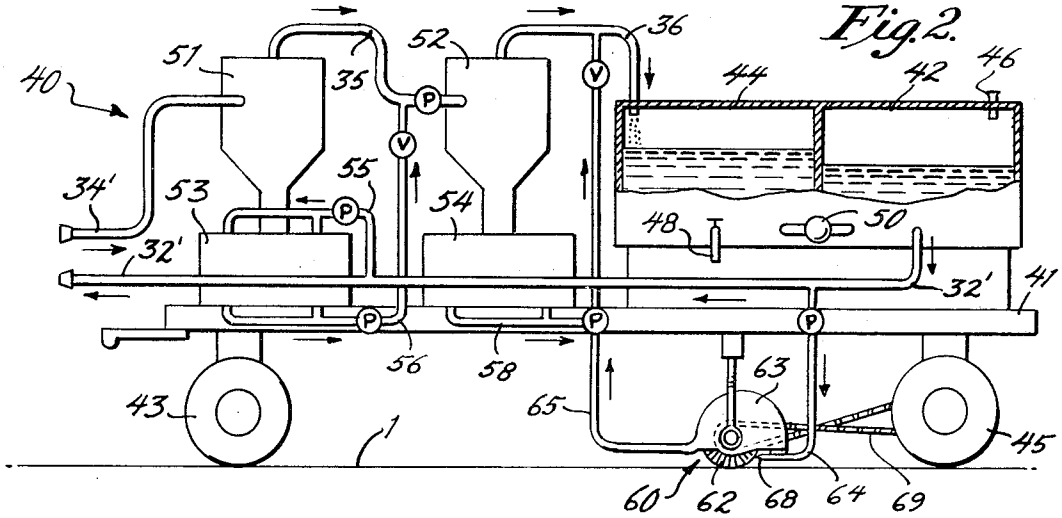



Fig. 2.



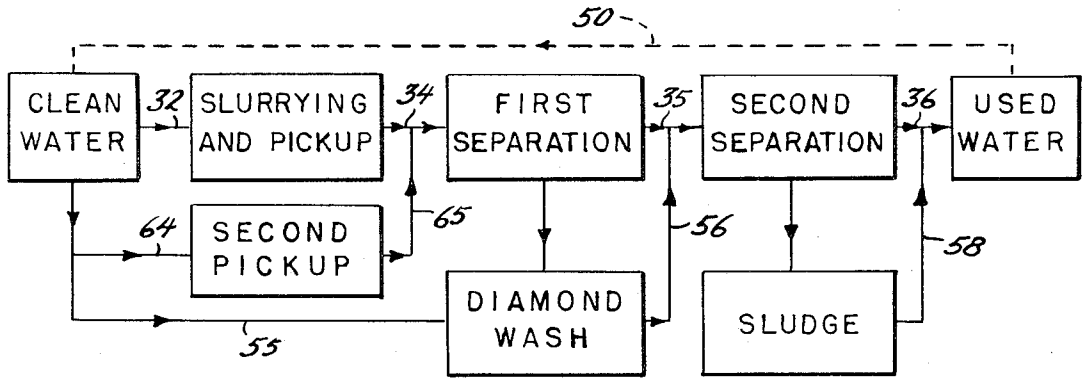
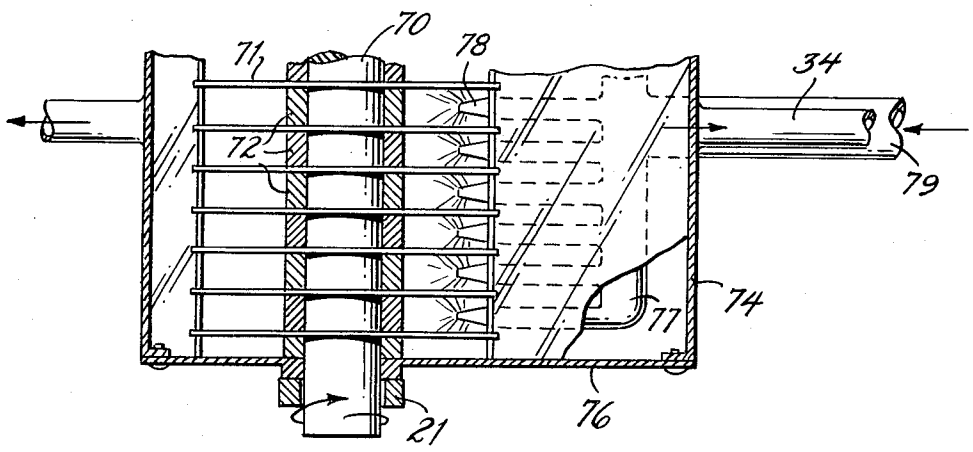




Fig. 5.

INVENTOR.
EDWARD A. ZUZELO
BY McCurdy, Wiser & Milman
ATTORNEYS.

Fig. 4.



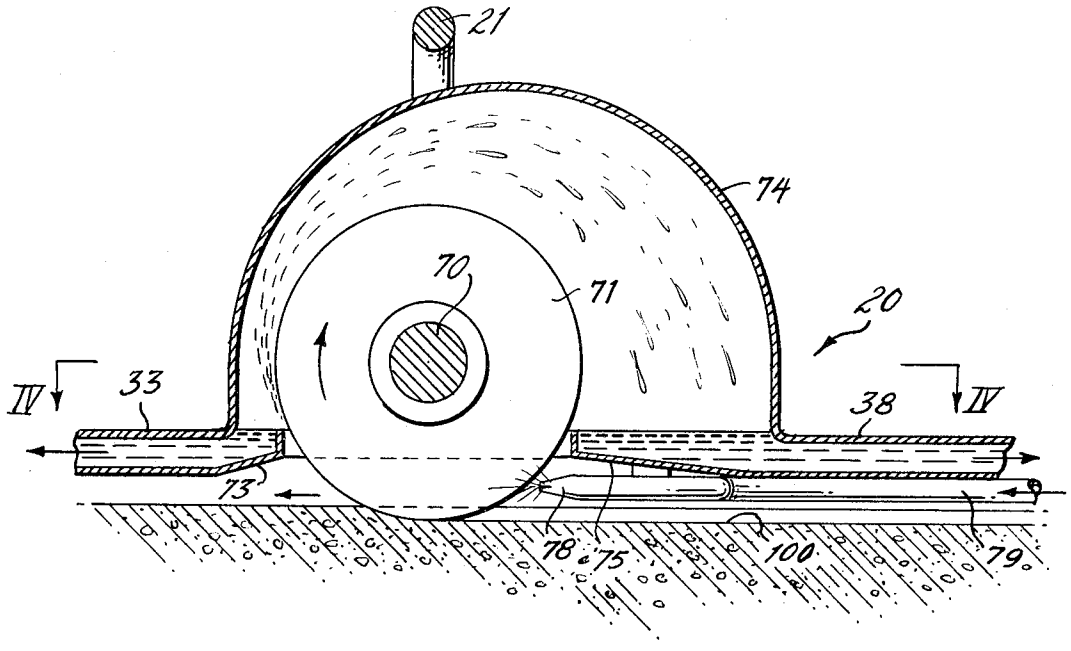




Fig. 3.

INVENTOR.
EDWARD A. ZUZELO
BY McPherson, Weiser & Millman
ATTORNEYS.

# MULTIPLE GROOVING OF PAVEMENT

This invention relates to grooving of pavement to improve traction for vehicles thereon, such as cars on roadways and airplanes on runways, in the interest of improved safety.

It is known to produce, as by abrasive cutting, closely spaced parallel grooves of relatively shallow depth in the pavement of roadways (usually longitudinally) and runways (usually transversely) to improve directional control and stopping ability, especially during wet weather when the wheels of cars and airplanes tend to hydroplane or slide on a thin film of water on the pavement. The grooves not only reduce the amount of water standing on the pavement surface but also provide ready escape paths for such water when encountered by the vehicle wheels. Unfortunately there are potential safety hazards inherent in the grooving operation itself and its aftermath.

A primary object of the present invention is elimination of safety hazards attendant upon or consequent to multiple grooving of pavement.

Another object is improvement in efficiency of multiple grooving of pavement.

A further object is more economical multiple grooving of pavement.

Other objects of this invention, together with means and methods for attaining the various objects will be apparent from the following description and the accompanying diagrams.

FIG. 1 is a partially schematic side elevation of a machine useful according to the present invention in the multiple grooving of pavement;

FIG. 2 is a similar view of auxiliary apparatus shown in trailer form;

FIG. 3 is an enlarged side sectional elevation of a detail of FIG. 1;

FIG. 4 is a sectional plan taken at IV—IV of FIG. 3; and

FIG. 5 is a schematic flow diagram applicable to the foregoing in the practice of this invention.

In general, the objects of the present invention are accomplished, in multiple grooving of pavement to improve traction thereon when wet, wherein particles of pavement material and cutting material result from grooving engagement of cutting means with the pavement at a cutting location, by slurrying such resulting particles with water supplied to the cutting location, collecting such slurry, and reclaiming reusable cutting particles therefrom. Before disposing of at least part of the slurry at a remote location, particles of cutting material slurried therewith are recovered therefrom for reuse, and preferably centrifugally, pavement particles are optionally recovered centrifugally from the slurry as well.

FIG. 1 shows steerable machine **10** having a set of front wheels **13** and a set of rear wheels **15** (only one of each being visible) on pavement **1** and having frame **11** supported by the wheels and carrying thereon additional components. Shown in block form on the frame at the front are engine **14** and, driven directly by the engine, generator **16** and hydrostatic drive **17**. Connected to the generator by suitable electrical leads is motor **18**, which drives pump **19**, shown in block form on the frame at the rear of the machine. Suspended under the midportion of the frame on retractable support **21** is cutting assembly **20**, which is shown fragmentarily in greater detail in FIGS. **3** and **4**. Blocked out above the midportion of the frame is a region in which mechanism for retracting and extending or otherwise moving the cutter assembly is located; such mechanism is not shown because it does not form any part of the present invention, and such conventional mechanism as a handwheel worm arrangement may be used to raise and lower the cutter assembly. Alternatively, more sophisticated mechanism for raising or retracting and for lowering or extending the cutter assembly may be employed in conjunction with this invention.



Hydrostatic drive **17**, which is shown connected to the front wheels by fluid line **30**, preferably is of dual-speed type, such as is well known, capable of providing a suitable over-the-road speed for transport between working sites and a crawl speed for on-site operation. Fluid line **31** connects the hydrostatic drive to the cutter assembly to rotate the cutting discs or blades. Suitable hydraulic motors to which lines **30** and **31** connect to drive the machine and the cutter assembly, respectively, are not shown but are constructed and connected to the wheel axle and the cutter shaft as is well known in the art. Alternatively, the machine may be driven by mechanical coupling to the engine through suitable reduction gearing, and the cutter assembly may be rotated by similar mechanical interconnection; or, if desired, either or both drives may be electric, from one or more engine-driven generators or alternators. It will be apparent, of course, that although front-wheel drive is indicated for the machine itself, that the rear wheels may be driven instead of or in addition to the front wheels. This invention is independent of any particular form of drive of the machine itself or of the cutter assembly, being useful with any suitable forms of drive.

Pump **19** is of dual type, pumping water from a source (located separately) to the cutter assembly through line **32** and pumping resulting slurry from the cutter assembly through return line **34** to a storage location (also located separately) as indicated by arrows. FIG. **2** shows trailer **40** with bed **41** supported on front wheels **43** and rear wheels **45** (only one of each being visible) and carrying reservoir or source tank **42** with inlet **46** for clean water and storage tank **44** with outlet **48** for the slurry or more specifically for used water from the slurry. Normally closed valve **50** may be opened to interconnect the source tank and the storage tank if and when desired. Lines **32'** from the clean water source tank and return line **34'** to the storage tank are readily attachable to and detachable from respective lines **32** and **34** on the machine of FIG. **1** by means of the fittings shown terminating the lines. Interposed between the return line and the storage tank are two centrifugal separators of conventional hydrocyclone type.

First separator **51** receives slurry from the cutter assembly through line **34'**, which constitutes the hydrocyclone feed line; the hydrocyclone underflow passes into compartment **53** thereunder, while the overflow passes through line **35** (containing an appropriate pump) to second separator **52**, for which it constitutes the hydrocyclone feed line. The underflow from the second separator passes into compartment **54** thereunder, while the overflow passes through line **36** into storage tank **44**. First compartment **53** has line **55**

(with pump) for fresh water from source tank **42** entering the top and has line **56** (with pump and check valve) for used water leaving the bottom and joining line **35** leading to the second separator. Second compartment **54** has line **58** from the bottom joining line **65** (with dual pump at the junction), which in turn (with check valve) joins line **36** leading to storage tank **44**. The respective compartments are openable on the opposite side (not shown) and optionally on the visible side also to facilitate removal of the underflow materials accumulated therein.

Supported underneath the midportion of trailer bed **41** is brush assembly **60**, comprising cylindrical rotary brush **62** protruding into contact with the pavement underneath surrounding shroud **63**. Line **64** (with pump) leads to jets **68** (one visible) directed from the rear toward the conjunction of the brush with the pavement, while return line **65** from a trough (not visible) formed by the bottom of the shroud joins line **58** (at the last mentioned dual pump) and then joins line **36** leading to the storage tank as aforementioned. Drive chain (or belt) **69** from the rear wheels to the brush rotates it in a direction opposite to the direction of travel of the trailer. It will be understood that the trailer is designed to be detachably secured, as by the indicated mating hitches, to machine **10** to be pulled thereby. The various pumps on the trailer are provided with electrical leads (not shown) to connect with connectors **37** located at the rear of frame **11** of the machine and terminating the illustrated electrical leads from the generator.

FIGS. **3** and **4** show cutter assembly **20** of FIG. **1** on an enlarged scale, in side sectional elevation and sectional plan, respectively. Horizontal shaft **70** is supported at its ends by yoke **21** and carries, spaced equally along the shaft and transversely of the machine itself, a multiplicity of cutting discs or blades **71** detachably secured thereto between spacers **72**. Shroud **74** of generally involute cross-sectional form has end plate **76** and surrounds the blades except at the bottom, being closer to the blades at the front and further therefrom at the rear. Except directly under the blades the shroud is closed underneath at the front by relatively small sloping trough **73** connected to return line **33**, and at the rear by relatively large sloping trough **75** connected to return line **38**. Underneath the rear trough is a multiplicity of jet nozzles **78** fed from manifold **77**, which is connected by line **79** to clean water line **32**. The nozzles are spaced under and between adjacent blades and direct the water sideways and forward against the blades and toward the cutting junction of the blades with pavement **1**, in which they are forming multiplicity of grooves **100** (one visible). It will be understood that the rotation of the blades against the forward direction of movement of the machine carries the water (and particles of pavement and of cutter material, which become slurried therewith) forward at the bottom and upward and toward the rear within the shroud to collect mostly in the rear trough and to a lesser extent in the front trough, from both of which the collected slurry is pumped to the first separator for centrifugal treatment therein.

Operation of the described and illustrated apparatus to practice the present invention is readily understood, especially with further reference to the simplified flow diagram of FIG. **5**, in which the blocks represent process steps or stations and the interconnecting lines are numbered in accordance with the foregoing. Thus, the machine is operated to move forward slowly and to rotate the blades relatively rapidly to cut a multiplicity of shallow parallel grooves closely spaced and extending in the longitudinal direction of machine movement. Clean water is supplied to the cutting location, where it is slurried with particles of pavement removed by the abrasive cutting and with particles of cutting material (chiefly diamonds) dislodged from the blades themselves. The resulting slurry is picked up and forwarded to the first stage of centrifugal separation, wherein the diamond or other dense particles of cutter material are largely segregated in the underflow, while the overflow slurry of pavement particles passes out the overflow. The underflow is washed with additional clean water in a conventional filtration compartment, optionally with mechanical agitation of the filter elements (usually fine metallic screens), after which the wash water is added to the overflow from the first separation, which then constitutes the feed for the second separation. Of course, the diamonds are recovered manually at suitable intervals for reuse in manufacture of additional cutter blades or for other appropriate use.

In the second centrifugal separation the pavement particles are largely segregated in the underflow, which has a dense ropy consistency and accumulates in the form of a damp sludge, from which some water may be pumped away to the used water storage, which is where the overflow from the second separation also goes. The accumulated sludge is removed manually at appropriate intervals for disposal at a remote site either wet or after drying, whereupon the resulting caked powder is suitable for use as a filler in various cementitious construction materials or the like. Particulate material not picked up at the cutting location is subjected to a second pickup step, as the trailer passes thereover, through the brushing action and supplying of additional slurrying water to the brushing location. The resulting slurry is fed to storage tank **44** via connection with line **65**, as already indicated by reference to FIG. **2**, but in the event of an appreciable diamond concentration at the brushing location the slurry is optionally fed by alternative connection with line **34**, **34'** (as in FIG. **5**) to the first separation step along with the slurry from the cutting location.

The entire process is continuous and can continue until all the clean water has been used, whereupon most of it will have collected in the storage tank in the form of used water, i.e., containing unseparated pavement particles and perhaps a slight amount of cutter material in particulate form, together with oil, rubber, soil and the like removed from the pavement surface. At such time the trailer may be detached from the machine and be replaced by another trailer having a full tank of clean water and an empty tank for used water, as well as clean compartments for diamonds and for sludge. Alternatively, especially where the pavement being grooved is sufficiently new not to have been coated heavily with oil, rubber, soil, etc., the clean water and used water tanks may be interconnected by opening the valve therebetween (as suggested by the broken line in FIG. **5**), in which event the overall

process can be practiced as a closed system, subject to gradual loss of water because of incomplete pickup and gradual increase in unseparated solids concentration. If desired, additional stages of separation may be added to facilitate such recycling, as is especially useful where it is inconvenient, uneconomical, or otherwise impracticable to exchange trailers. In some locations, for example, a source of clean water or an appropriate disposal location for sludge or used water may be too remote to permit single cycling of the water.

Regardless of whether operated in single-cycle or recycle fashion, the present invention avoids flooding the pavement being grooved, and possibly an adjoining traveled lane of pavement to which the water would drain, which is hazardous to traffic. It also avoids leaving an incrustation of pavement particles, such as impairs the effectiveness of the grooving and also presents a hazard when dislodged subsequently, as by jet engines. Economy of operation is effected by recovery of diamonds or other valuable components of the cutter material, as well as by possible use of byproduct particulate pavement material. Other advantages and benefits thereof will accrue and become apparent to those undertaking to practice the invention.

Although a preferred embodiment and certain modifications thereof have been illustrated and described, it will be understood that other modifications may be made therein, as by adding, combining, or subdividing parts or steps, while retaining at least some of the advantages and benefits of this invention. The invention itself is defined in the following claims.

The claimed invention:

1. Procedure for producing multiple parallel grooves in pavement to improve traction thereon when wet, comprising the steps of rotating cutting means in grooving engagement with the pavement at a multiplicity of laterally spaced locations and simultaneously moving the rotating cutting means in the grooving direction, thereby dislodging particles of pavement material and denser particles of reusable cutting material from the cutting means during groove formation; supplying water thereto and thereby forming a slurry of such particles, and collecting such slurry; scrubbing the grooved pavement subsequent to such original slurry formation and subjecting water used in such subsequent scrubbing step to a hydrocycloning step, concentrating particles of reusable cutting material by hydrocycloning the slurry, and so recovering particles of reusable cutting material therefrom; and disposing of the residual slurry containing component particulate pavement material at a remote location.

2. In multiple grooving of pavement to improve traction thereon when wet, including rotating cutting blades comprising diamond particles in contact with the pavement at a cutting location and thereby dislodging particles of pavement material from the pavement and reusable diamond particles from the cutting blades, the improvement comprising reclaiming dislodged diamond particles for subsequent reuse, including subsequently scrubbing the pavement at the former cutting location, thereby forming a slurry of dislodged particles in water, and collecting such slurry for reclamation of diamond particles therefrom.

3. Process according to claim 2, including performing the scrubbing step while the pavement is wet from slurrying performed previously in the vicinity of the cutting location.

4. In multiple grooving of pavement utilizing cutting material comprising diamonds, wherein particles of pavement material are dislodged from the pavement and reusable diamonds are dislodged from the cutting material and the various particles are slurried together with water, the improvement comprising recovering some of the slurried particulate material in the immediate vicinity of the cutting operation, thereafter scrubbing the grooved pavement, and recovering residual particulate material left thereon by the cutting operation.

5. Process according to claim 4, including the subsequent steps of separating from the recovered material predominantly liquid and predominantly solid fractions.

6. Process according to claim 5, including the further step of separating from the predominantly solid material a first fraction consisting essentially of pavement material and a second fraction consisting essentially of cutting material.

7. Process according to claim 6, including the step of reclaiming diamonds from the fraction consisting essentially of cutting material.

8. Process according to claim 4, wherein water is supplied to the scrubbing location.

9. Process according to claim 8, including the step of brushing the grooved pavement at the scrubbing location.

10. Procedure for producing multiple parallel grooves in pavement to improve traction thereon when wet, comprising the steps of rotating cutting means in grooving engagement with the pavement at a multiplicity of laterally spaced locations and simultaneously moving the rotating cutting means in the grooving direction, thereby dislodging particles of pavement material and denser particles of reusable cutting material from the cutting means during groove formation; supplying water thereto and thereby forming a slurry of such particles, and collecting such slurry; scrubbing the grooved pavement subsequent to such original slurry formation and subjecting water used in such subsequent scrubbing step to a separation step, concentrating particles of reusable cutting material, and so recovering particles of reusable cutting material therefrom; and disposing of the residual slurry containing component particulate pavement material at a remote location.

11. In multiple grooving of pavement to improve traction thereon when wet, including rotating cutting blades comprising reusable abrasive particles in contact with the pavement at a cutting location and thereby dislodging particles of pavement material from the pavement and reusable abrasive particles from the cutting blades, the improvement comprising reclaiming dislodged abrasive particles for subsequent reuse, including subsequently scrubbing the pavement at the former cutting location, thereby forming a slurry of dislodged particles therefrom.

12. In multiple grooving of pavement utilizing cutting material comprising diamonds or similar abrasive particles, wherein particles of pavement material are dislodged from the pavement and reusable abrasive particles are dislodged from the cutting material and

the various particles are slurried together with water, the improvement comprising recovering some of the slurried particulate material in the immediate vicinity of the cutting operation, thereafter scrubbing the grooved pavement, and recovering residual particulate material left thereon by the cutting operation.

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