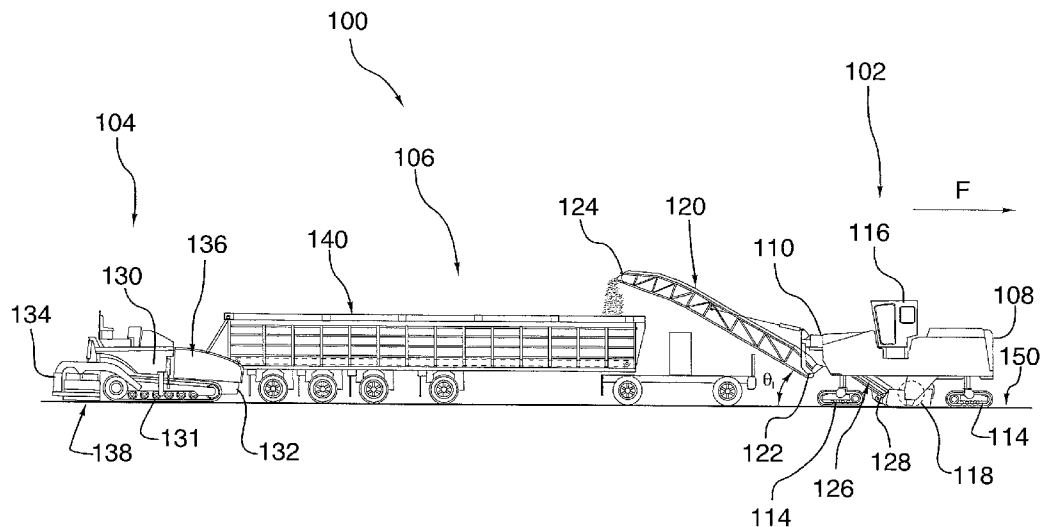




US 20130189032A1

(19) **United States**(12) **Patent Application Publication**  
**BELLEROSE et al.**(10) **Pub. No.: US 2013/0189032 A1**(43) **Pub. Date: Jul. 25, 2013**(54) **MATERIAL MANAGEMENT SYSTEM AND  
METHOD FOR CONTINUOUS COLD  
IN-PLACE RECYCLING OF PAVEMENT**(52) **U.S. Cl.**CPC ..... **E01C 23/065** (2013.01)USPC ..... **404/75; 404/91; 29/426.1**(75) Inventors: **Michel BELLEROSE**, Joliette (CA);  
**Martin Bourgeois**,  
St-Alphonse-Rodriguez (CA)(73) Assignee: **GESTION D'ÉQUIPEMENTS. B.T.  
INC.**, Joliette (CA)(21) Appl. No.: **13/554,608**(22) Filed: **Jul. 20, 2012****Related U.S. Application Data**(60) Provisional application No. 61/570,148, filed on Dec.  
13, 2011.**Publication Classification**(51) **Int. Cl.**  
**E01C 23/06** (2006.01)(57) **ABSTRACT**

There is provided a material management system for continuous cold in-place recycling of pavement, the system comprising a crusher vehicle for crushing pavement on the ground surface, the crusher vehicle comprising a first conveyor for evacuating crushed pavement material rearwardly from the crusher vehicle; a paver vehicle located rearwardly of the crusher vehicle for repaving the ground surface using the crushed pavement material; and a material feeder located between the crusher vehicle and the paver vehicle, the material feeder comprising: a container for receiving the crushed pavement material; and a second conveyor for moving the crushed pavement material rearwardly from the front container end towards the rear container end of the container in order to enable the paver vehicle to repave the ground surface using the crushed pavement material. There is also provided a method for performing cold in-place recycling of pavement and a method for manufacturing the material feeder.



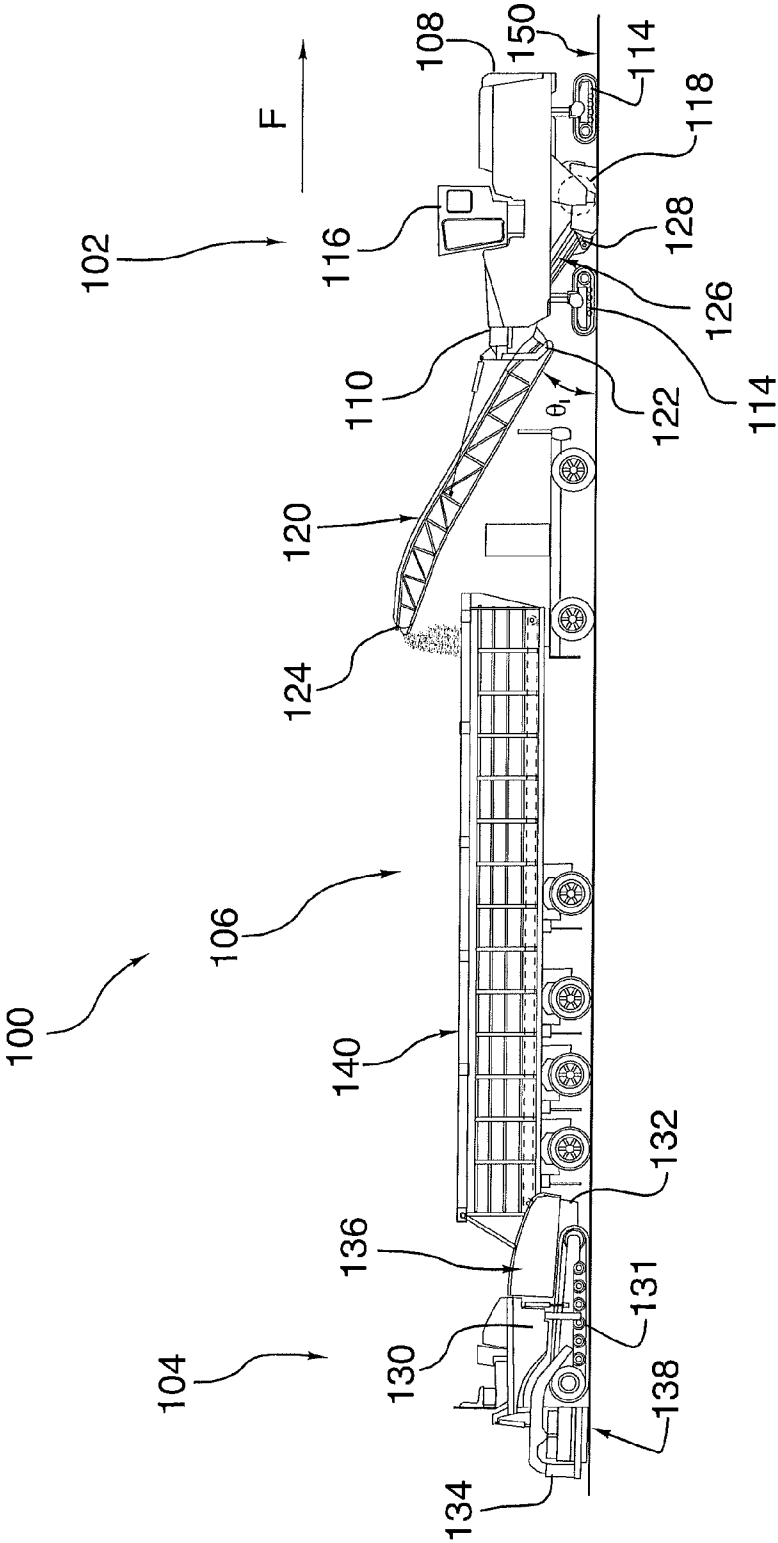


FIG.1

**FIG. 2**

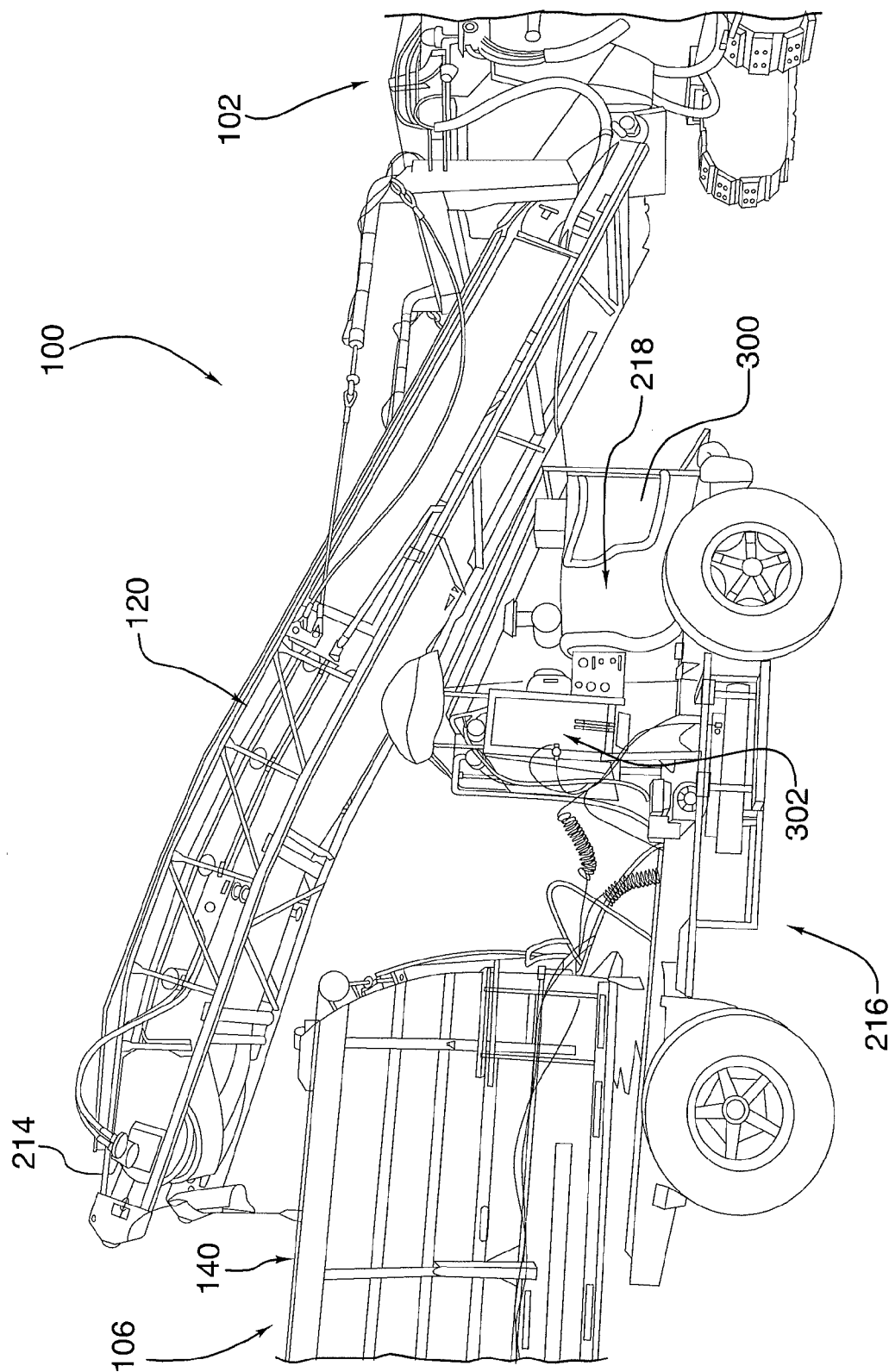


FIG.3

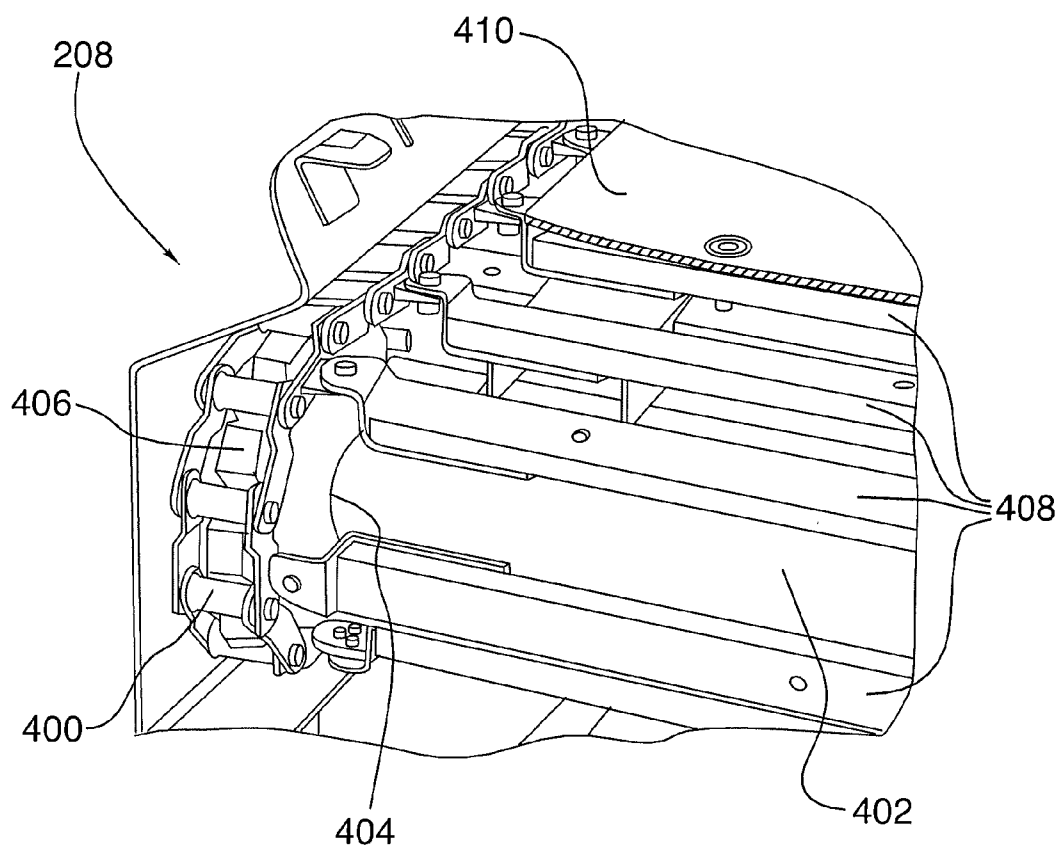


FIG.4

# **MATERIAL MANAGEMENT SYSTEM AND METHOD FOR CONTINUOUS COLD IN-PLACE RECYCLING OF PAVEMENT**

## **CROSS REFERENCE TO RELATED APPLICATION**

**[0001]** This application claims priority of U.S. Provisional Patent Application having Ser. No. 61/570,148, which was filed on Dec. 13, 2011 and is entitled "MATERIAL MANAGEMENT SYSTEM FOR CONTINUOUS COLD IN-PLACE RECYCLING OF PAVEMENT", the specification of which is hereby incorporated by reference.

## **TECHNICAL FIELD**

**[0002]** The invention relates to systems for cold in-place recycling of pavement, and more specifically to material management system for continuous cold in-place recycling of pavement. The invention also relates to a method for performing cold in-place recycling of pavement and to a method for manufacturing a material feeder for a material management system.

## **BACKGROUND**

**[0003]** Roads are usually coated or paved with a coating material such as asphalt to enable them to sustain traffic and to improve their durability.

**[0004]** To pave a road, one may use a road-paving technique called "Cold In-Place Recycling" (CIR), in which the damaged pavement on a paved surface is recycled and mixed with new material before being used to repave the road.

**[0005]** Usually, this technique is performed by a crusher vehicle, also known as an asphalt milling machine or a cold planer, which "crushes" (i.e. breaks up) the existing pavement. The crusher vehicle may comprise a conveyor which evacuates the crushed pavement material forwardly or rearwardly, typically towards a dump truck, which keeps the material until needed by a paver vehicle. A paver vehicle is a vehicle which uses the used crushed pavement material and/or new pavement material to repave the road.

**[0006]** The crushing and the paving may be performed in separate operations, or the crushed pavement material may directly be dumped in or in front of the paver vehicle. Unfortunately, the rate at which pavement material is crushed and dispensed to the paver vehicle may not exactly match the quantity of pavement material needed to repave the road.

**[0007]** Furthermore, when the paver vehicle requires more crushed pavement material to repave the road, it may be necessary to resupply the paver vehicle using a dump truck containing crushed pavement material. In this case, the operator may need to stop the paver vehicle until resupplying is completed, which is time consuming and generally undesirable.

**[0008]** Alternatively, a "buggy" may be used to resupply the paver vehicle with crushed pavement material. The buggy goes back and forth between the paver vehicle and the crusher vehicle located further in front of the paver vehicle, or another external source of crushed pavement material. Once again, the operator may need to stop the paver vehicle until resupplying is completed, which is time consuming and generally undesirable.

**[0009]** There is therefore a need for a system and a method which would overcome at least one of the drawbacks identified above.

**[0010]** Features of the invention will be apparent from review of the disclosure, drawings and description below.

## **BRIEF SUMMARY**

**[0011]** According to one aspect, there is provided a material management system for continuous cold in-place recycling of pavement, the system comprising: a crusher vehicle for crushing pavement material on a paved ground surface, the crusher vehicle comprising a first conveyor extending rearwardly from the crusher vehicle for continuously evacuating crushed pavement material rearwardly from the crusher vehicle; a paver vehicle located rearwardly of the crusher vehicle for repaving the ground surface using the crushed pavement material; and a material feeder located between the crusher vehicle and the paver vehicle for supplying the paver vehicle with the crushed pavement material from the crusher vehicle, the material feeder comprising a container for receiving and temporarily storing the crushed pavement material, the container having an open top container end and a closed bottom container end, the container further having a front container end located near the first conveyor and a rear container end in communication with the paver vehicle, and a second conveyor extending between the front container end and the rear container end for continuously moving crushed pavement material rearwardly from the front end towards the rear end in order to enable the paver vehicle to repave the ground surface the crushed pavement material.

**[0012]** In one embodiment, the crusher vehicle extends between a front end and a rear end; further wherein the first conveyor comprises a first conveyor end connected to the rear end of the crusher vehicle and a second conveyor end located rearwardly and upwardly relative to the first conveyor end.

**[0013]** In one embodiment, the second conveyor end is located above the open top container end, near the front container end to enable crushed pavement material to fall from the first conveyor into the container through the open top container end.

**[0014]** In one embodiment, the second conveyor end is located rearwardly of the front container end when the front container end is near the crusher vehicle.

**[0015]** In one embodiment, the material feeder comprises a live bottom truck including a trailer mounted on wheels for receiving the container and a mover vehicle mounted on powered wheels and coupled to the trailer for displacing the live bottom truck.

**[0016]** In one embodiment, the live bottom truck comprises a controller secured to the mover vehicle forwardly of the container, the controller being operatively connected to the second conveyor to enable adjusting a conveying speed of the second conveyor.

**[0017]** In one embodiment, the controller is sized and shaped to fit under the first conveyor while remaining spaced from the first conveyor.

**[0018]** In one embodiment, the first conveyor extends upwardly and rearwardly from the crusher vehicle, the first conveyor thereby defining a first conveyor angle relative to the paved ground surface.

**[0019]** In one embodiment, the material feeder further comprises a guard plate extending above the controller, the guard plate being angled relative to the paved ground surface at the same angle as the first conveyor angle.

**[0020]** In one embodiment, the controller is operatively connected to the powered wheels of the mover vehicle.

[0021] In one embodiment, the live bottom truck further comprises a steering system operatively connected to at least one of the wheels of the trailer and the powered wheels of the mover vehicle, the controller being operatively connected to the steering system to enable an operator to steer the live bottom truck using the controller.

[0022] In one embodiment, the second conveyor comprises: a plurality of axles rotatably mounted to the container, near the closed bottom container end, the plurality of axles extending transversely relative to the container, each axle having a first axle end, a second axle end and a pair of sprockets, each sprocket being secured to one of the first and second axle ends; spaced-apart left and right chains, each chain engaging the sprocket secured at a corresponding one of the first and second axle ends of each one of the plurality of axles; a plurality of transverse members extending between the left and right chains, the plurality of transverse members being spaced from each other to form a support structure; and a belt received on the support structure.

[0023] According to another aspect, there is also provided a method for performing cold in-place recycling of pavement comprising: providing a crusher vehicle comprising a first conveyor extending rearwardly from the crusher vehicle; providing a material feeder comprising a container having an open top container end and a closed bottom container end, the container further having a front container end and a rear container end, and a second conveyor extending between the front container end and the rear container end; locating the front container end near the first conveyor; locating a paver vehicle near the rear container end such that the rear container end is in communication with the paver vehicle; crushing pavement material on a ground surface using the crusher vehicle; continuously moving crushed pavement material from the crusher vehicle into the container using the first conveyor; continuously moving crushed pavement material from the container to the paver vehicle using the second conveyor; repaving the ground surface with the paver vehicle using the crushed pavement material supplied to the paver vehicle.

[0024] In one embodiment, the method further comprises adjusting a debit of crushed pavement material supplied to the paver vehicle according to a forward travel speed of the paver vehicle.

[0025] In one embodiment, adjusting the debit of crushed material comprises adjusting a conveying speed of the second conveyor.

[0026] In one embodiment, the method further comprises, after crushing pavement material on the ground surface, mixing the crushed pavement material with a binder material.

[0027] According to yet another aspect, there is also provided a method for manufacturing the material feeder of the material management system, the method comprising: providing a live bottom truck comprising a container and a cab located forwardly of the container; removing the cab from the live bottom truck; securing a controller to the live bottom truck forwardly of the container to thereby form the material feeder, the controller being sized and shaped to fit under the first conveyor when the front container end is near the crusher vehicle; operatively connecting the controller to the second conveyor to enable controlling a conveying speed of the second conveyor.

[0028] In one embodiment, the method further comprises operatively connecting the controller to powered wheels of the live bottom truck.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0029] In order that the invention may be readily understood, embodiments of the invention are illustrated by way of example in the accompanying drawings.

[0030] FIG. 1 is a side elevation view of a material management system for continuous cold in-place recycling of pavement, in accordance with one embodiment.

[0031] FIG. 2 is a longitudinal cross-section view of the material management system shown in FIG. 1.

[0032] FIG. 3 is an enlarged side elevation view of the material management system shown in FIG. 1, to better show the controller of the material feeder.

[0033] FIG. 4 is an enlarged perspective view, partially cut away, of a feeder conveyor for the material management system shown in FIG. 1.

[0034] Further details of the invention and its advantages will be apparent from the detailed description included below.

#### DETAILED DESCRIPTION

[0035] In the following description of the embodiments, references to the accompanying drawings are by way of illustration of an example by which the invention may be practiced. It will be understood that other embodiments may be made without departing from the scope of the invention disclosed.

[0036] With reference to FIG. 1, there is provided a material management system 100, which allows continuous cold in-place recycling of pavement covering a paved ground surface, such as a road 150. A certain amount of pavement is first removed from the road 150, and then may be processed before being reapplied on the road to form a new paved surface. Alternatively, instead of a road, the paved ground surface may comprise any other paved surface such as a paved surface of a parking lot or the like.

[0037] In the illustrated embodiment, the system 100 comprises a crusher vehicle 102, a paver vehicle 104 located rearwardly of the crusher vehicle 102 and a material feeder 106 located between the crusher vehicle 102 and the paver vehicle 104.

[0038] It will be understood that the terms “rearwardly” and “forwardly”, as used herein, are relative to a forward travel direction, indicated by reference arrow F, of the paver vehicle 104, the crusher vehicle 102 and the material feeder 106.

[0039] During a paving operation, the paver vehicle 104, the crusher vehicle 102 and the material feeder 106 move in the forward travel direction F, while remaining substantially close to each other. The crusher vehicle 102 crushes pavement on the road 150 and evacuates or moves the crushed pavement rearwardly towards the material feeder 106. The material feeder 106 supplies the paver vehicle 104 with crushed pavement material from the crusher vehicle 102, and the paver vehicle 104 repaves the road 150 using the crushed pavement material.

[0040] Since the crushed pavement material is first removed from the road before being reapplied in a subsequent operation, the system requires little, if any, crushed pavement material to be provided by an external source such as a supply truck. This advantageously enables the system to operate continuously, i.e. without stopping, over relatively great distances, because it does not have to stop in order to be resupplied.

[0041] Furthermore, the material feeder 106 acts as a buffer between the crusher vehicle 102 and the paver vehicle 104. The material feeder 106 may be used to temporarily store the crushed pavement material and to provide a desired amount of the crushed pavement material to the paver vehicle 104, as required by the paving operation performed on that location of the road 150. For instance, if more pavement material is removed from the road than is needed to repave the road, the material feeder 106 will accumulate a reserve of crushed pavement material. If more pavement material is needed to repave the road than is currently removed from the road, then the material feeder 106 will draw on its reserve to still provide to the paver vehicle 104 the desired amount of crushed pavement material to repave the location of the road 150 over which the paver vehicle 104 is travelling at that moment.

[0042] In the illustrated embodiment, the material feeder 106 is located rearward of the crusher vehicle 102, and the paver vehicle 104 is located rearward of the material feeder 106 such that the crusher vehicle 102, the material feeder 106 and the paver vehicle 104 form a single file during a paving operation. Still in this embodiment, the crusher vehicle 102, the material feeder 106 and the paver vehicle 104 each have a width which is substantially similar to the width of a single lane of the road. This configuration advantageously enables the system 100 to occupy only a single lane of the road, thereby preventing the system 100 from blocking traffic in two or more lanes during a paving operation.

[0043] In one embodiment, a binder material may further be mixed with the crushed pavement material before the crushed pavement material is applied to the road, in order to bind together the crushed pavement material and thereby form a new paved surface. The binder material may comprise emulsified bitumen, foamed bitumen or any other binder material deemed appropriate by the skilled addressee.

[0044] Now referring to FIGS. 1 and 2, the crusher vehicle 102 extends between a front end 108 and a rear end 110 and comprises a frame 112 mounted on continuous tracks 114. It will be appreciated that instead of the continuous tracks 114, the frame 112 of the crusher vehicle 102 may alternatively be mounted on wheels or on any other type of support means which would enable the crusher vehicle 102 to move forward.

[0045] The crusher vehicle 102 further comprises a cab 116 mounted on the frame 112 between the front end 108 and the rear end 110 to receive an operator of the crusher vehicle 102 and a crushing drum or cutter drum 118 extending downwardly from the frame 112 so as to be able to contact the road 150. The cutter drum 118 is configured to crush the pavement material on the road 150 when the cutter drum 118 contacts the road 150 during a paving operation.

[0046] In the present embodiment, the cutter drum 118 comprises a plurality of projections or teeth, not shown, and is operatively coupled to a drum actuator, also not shown, which rotates the cutter drum 118 and provides sufficient force to enable the plurality of teeth to crush the pavement material on the road 150. It will be appreciated that the cutter drum 118 may alternatively be configured according to other configurations known to the skilled addressee.

[0047] In the illustrated embodiment, the crusher vehicle 102 further comprises a first conveyor, or evacuation conveyor 120, which extends rearwardly from the crusher vehicle 102 for evacuating the crushed pavement material rearwardly from the crusher vehicle 102. Specifically, the evacuation conveyor 120 comprises a first conveyor end 122 connected to the rear end 110 of the crusher vehicle 102 and a second

conveyor end 124 located rearwardly and upwardly relative to the first conveyor end 122. Still in this embodiment, the crusher vehicle 102 further comprises an intermediate conveyor 126 having a first lower end 128 located near the cutter drum 118 and a second upper end, not shown, located near the first conveyor end 122 of the evacuation conveyor 120 for conveying the crushed pavement from the cutter drum 118 to the evacuation conveyor 120. The intermediate conveyor 126 may comprise a belt conveyor, an endless screw conveyor or other types of conveyors known to the skilled addressee.

[0048] The evacuation conveyor 120 is generally sized and shaped to allow its second conveyor end 124 to be positioned above a desired evacuation location, which, in the present case, is the material feeder 106, as will become apparent below. The first conveyor end 122 of the evacuation conveyor 120 may be hingeably connected to the rear end 110 of the crusher vehicle 102 to allow the second conveyor end 124 of the evacuation conveyor 120 to be selectively raised and lowered, for instance to facilitate storage of the crusher vehicle 102 and/or to facilitate displacement of the crusher vehicle 102 at relatively high speeds from one site to another. In operation, the evacuation conveyor 120 is maintained at a first conveyor angle  $\theta_1$  relative to the road 150, such that the second conveyor end 124 of the evacuation conveyor 120 is located above its first conveyor end 122.

[0049] Furthermore, the evacuation conveyor 120 is operatively connected to a conveyor actuator, not shown, for actuation of the evacuation conveyor 120. The intermediate conveyor 126 may further be operatively connected to this conveyor actuator, or may alternatively be connected to a different actuator.

[0050] In one embodiment, the crusher vehicle 102 further comprises an engine, not shown, operatively coupled to its continuous tracks 114, and may therefore be independently moved. In this embodiment, the cutter drum 118, the evacuation conveyor 120 and the intermediate conveyor 126 may further be operatively connected to the engine, which is selected to provide sufficient power to operate these elements.

[0051] During operation of the crusher vehicle 102, pavement material on the road is crushed using the cutter drum 118. The crushed pavement material is then conveyed upwardly and rearwardly from the road and the cutter drum 118 towards the first conveyor end 122 of the evacuation conveyor 120 via the intermediate conveyor 126. The crushed pavement material is then conveyed via the evacuation conveyor 120 towards the second conveyor end 124 of the evacuation conveyor 120, to be thereby evacuated rearwardly from the crusher vehicle 102.

[0052] In the present embodiment, the evacuation conveyor 120 comprises a belt conveyor. However, it will be appreciated that other evacuation means may alternatively be used to transfer the crushed pavement material from the crusher vehicle 102 to the material feeder 106.

[0053] Still in the illustrated embodiment, the crusher vehicle 102 comprises a cold milling machine such as one of the W-series™ cold milling machines manufactured by Wirtgen GmbH (Winhagen, Germany). It will be appreciated that another type of crusher vehicles may alternatively be used instead.

[0054] In one embodiment, the crusher vehicle 102 further comprises a binder reservoir, not shown, containing binder material for mixing with the crushed pavement material. The mixing of the binder material with the crushed pavement material may be performed as the crushed pavement material



is conveyed from the cutter drum **118** to the evacuation conveyor **120**, for instance when the crushed pavement material is conveyed by the intermediate conveyor **126**. In this embodiment, the crushed pavement material is therefore substantially coated with binder material when it is transferred from the crusher vehicle **102** to the material feeder **106**. In an alternative embodiment, the crusher vehicle **102** does not comprise a binder reservoir. In this case, the binder material may be provided from an external source, such as another vehicle located near the crusher vehicle **102**, or the crushed pavement material may be transferred uncoated, i.e. without being coated with binder material, into the material feeder **106**.

[0055] Now referring to FIGS. **1** and **2**, the paver vehicle **104** comprises a frame **130** mounted on continuous tracks **131**. The paver vehicle **104** has a front end **132** located substantially adjacent the material feeder **106** and a rear end **134**. The paver vehicle **104** further comprises an inlet hopper **136** to receive crushed pavement material from the material feeder **106**, and material processing means, shown generally at **138**, in communication with the inlet hopper **136** for processing the crushed pavement material using processes known to the skilled addressee and applying the processed crushed pavement material on the road **150** to form a new paved surface.

[0056] In the illustrated embodiment, the inlet hopper **136** is located at the front end **132** of the paver vehicle **104**, near the material feeder **106**, to facilitate the transfer of crushed pavement material from the material feeder **106** to the paver vehicle **104**.

[0057] In one embodiment, the binder material is not provided in the crusher vehicle **102**, but is instead provided by the material processing means **138** of the paver vehicle **104**. In this embodiment, the crushed pavement material is therefore evacuated uncoated from the crusher vehicle **102** and is temporarily stored uncoated in the material feeder **106**, before being transferred towards the paver vehicle **104** to be received still uncoated in the inlet hopper **136**. The crushed pavement material then enters the material processing means **138** to be coated with binder material and processed for application on the road **150**.

[0058] In the illustrated embodiment, the paver vehicle **104** comprises a standard paver vehicle, such as a Vision 5200-2 manufactured by Joseph Voegel AG (Ludwigshafen, Germany). Alternatively, the paver vehicle **104** may instead comprise any paver vehicle known to the skilled addressee and deemed appropriate for use in the present system. In yet another embodiment, the paver vehicle **104** instead comprises a custom paver vehicle built for use in the present system.

[0059] Now turning to FIGS. **1** and **2**, the material feeder **106** comprises a container **140** which is generally elongated in the direction **F** of forward travel of the material feeder **106**. The container **140** comprises an open top container end **200** and a closed bottom container end **202** for receiving and temporarily storing the crushed pavement material. More specifically, the container **140** comprises a front container end **204** which is adapted to be located near the second conveyor end **124** of the evacuation conveyor **130** and a rear container end **206** which may be placed in communication with the paver vehicle **104**, and more specifically with the inlet hopper **136** of the paver vehicle **104**, during a paving operation. The material feeder **106** further comprises a second conveyor, or feeding conveyor **208**, which extends generally longitudinally relative to the container **140** at or near the closed bottom container end **202** for moving a desired amount of crushed

pavement material rearwardly, from the front container end **204** to the rear container end **206**, towards the paver vehicle **104** during a paving operation.

[0060] In the illustrated embodiment, the feeding conveyor **208** extends generally horizontally, as shown in FIG. **2**. Alternatively, the feeding conveyor **208** may instead be angled relative to the closed bottom container end **202**.

[0061] Still in the illustrated embodiment, the feeding conveyor **208** comprises a belt conveyor. Alternatively, the feeding conveyor **208** may instead comprise any other type of conveyor deemed to be suitable by the skilled addressee.

[0062] Still in the illustrated embodiment, the material feeder **106** comprises an existing vehicle known in the art as a live bottom truck **210**, which has been modified to be used specifically in the system **100**. A live bottom truck is usually used to facilitate dumping of the content of its container rearwardly using a conveyor located at the bottom of the container. The conveyor is usually activated to move the content of the container rearwardly until the container is substantially empty, and the conveyor is then deactivated. Live bottom trucks are therefore not usually operated continuously over a relatively long period of time.

[0063] In one embodiment, the live bottom truck **210** comprises an ABS RC-series™ or BC-series™ live bottom trailer manufactured by ABS Remorques Inc. (Asbestos, Canada). Alternatively, the live bottom truck **210** may instead comprise any live bottom truck known to the skilled addressee and deemed appropriate for use in the present system. In yet another embodiment, the material feeder **106** instead comprises a custom material feeder built for use in the present system.

[0064] In the illustrated embodiment, the live bottom truck **210** comprises a trailer **212** mounted on wheels **214** for receiving the container **140** and a mover vehicle **216** mounted on powered wheels **217** and coupled to the trailer **212** for displacing the live bottom truck **210**. The live bottom truck **210** may further comprise a brake system, such as a hydraulic brake system, not shown but widely known in the art, operatively connected to the wheels **214**.

[0065] A live bottom truck of the prior art typically further comprises a cab mounted on the mover vehicle near the front end of the container for housing an operator of the live bottom truck. However, in the present embodiment, the cab of the live bottom truck **210** has been removed and replaced with a controller **218** secured to the live bottom truck **210** on the mover vehicle **216**, forwardly of the container **140**. The controller **218** is used to control various elements of the material feeder **106**. This configuration advantageously prevents the cab from possibly interfering with the evacuation conveyor **120** and thereby preventing the evacuation conveyor **120** from extending over the container **140** of the material feeder **106**, as will become apparent below.

[0066] Furthermore, if the cab were not removed, it would be located below the evacuation conveyor **120**. The operator of the material feeder **106** would therefore have to be located inside the cab during the paving operation. Since crushed pavement material is conveyed on the evacuation conveyor **120** and may fall off from the evacuation conveyor **120**, the present configuration provides a relatively high level of safety for the operator by obviating the need for the operator of the material feeder **106** to stand or sit below the evacuation conveyor **120**.

[0067] In one embodiment, the controller **218** comprises an engine **300** operatively coupled to the powered wheels **217** of

the mover vehicle **216**. This configuration advantageously provides sufficient power to displace the live bottom truck **210** containing crushed pavement material, which may significantly increase the weight of the live bottom truck **210** as one skilled in the art will appreciate. This configuration also enables the material feeder **106** to be moved independently. This advantageously obviates the need to use another vehicle to tow or push the material feeder **106** to the desired site or into a storage area, for instance.

[0068] Alternatively, the material feeder **106** may not comprise an engine and may instead be pushed by the paver vehicle **104**.

[0069] The controller **218** may further be operatively connected to a steering system, not shown, of the live bottom truck **210** to enable the operator to steer the live bottom truck **210** using the controller **218**. This advantageously enables the system **100** to be used for paving curved portions of the road **150**. It will be appreciated that the steering system may be operatively connected to the wheels **214** of the trailer **212** or to the powered wheels **217** of the mover vehicle **216**.

[0070] In one embodiment, the steering system comprises an existing steering system of the live bottom truck **210**, but alternatively, the steering system may comprise any other steering system known to the skilled addressee operatively connected to the wheels.

[0071] In one embodiment, the controller **218** further comprises a hydraulic drive system containing hydraulic fluid, which may be operatively coupled to the hydraulic brake system of the live bottom truck **210** to power and control the hydraulic brake system. The hydraulic drive system may further be operatively coupled to the feeding conveyor **208** to enable the feeding conveyor **208** to be actuated by the hydraulic drive system.

[0072] To enable a desired amount of crushed pavement material to be transferred to the paver vehicle **104**, a conveying speed of the feeding conveyor **208** may be adjusted. More specifically, the feeding conveyor **208** may be operatively connected to a conveyor speed controller, not shown, for controlling the conveying speed of the feeding conveyor **208**.

[0073] The skilled addressee will understand that when the system **100** is used continuously over a certain distance, for instance to repave a certain portion of the road **150**, and during a certain time, the desired amount of crushed pavement material may instead be expressed as a debit of crushed material.

[0074] In one embodiment, the conveyor speed controller comprises a flow valve which is operatively coupled to the hydraulic drive system. By manually adjusting the flow of hydraulic fluid in the hydraulic drive system using the conveyor speed controller, the operator may adjust the speed of the feeding conveyor **208**, as a person skilled in the art will appreciate.

[0075] Alternatively, the conveyor speed controller may instead comprise electronic control means which are operated by the operator to adjust the speed of the feeding conveyor **208**.

[0076] In yet another embodiment, the conveyor speed controller may instead comprise automated control means to automatically control the speed of the feeding conveyor **208** according to the amount of crushed pavement material desired for the paving operation. For instance, the automated control means may be configured to adjust the speed of the feeding conveyor **208** according to the speed of forward travel of the paver vehicle **104**. Alternatively, the automated control

means may be configured according to a preprogrammed sequence which corresponds to a desired configuration of a portion of the road **150** to be paved. For instance, the speed of the feeding conveyor **208** may be increased when the paver vehicle **104** is paving a predetermined portion of the road **150** in order to deliver a greater amount of crushed pavement material to the paver vehicle **104**. This would enable the paver vehicle **104** to form a thicker paved surface on this predetermined portion of the road **150**. Similarly, the speed of the feeding conveyor **208** may be decreased when the paver vehicle **104** is paving the predetermined portion of the road **150** in order to deliver a lesser amount of crushed pavement material to the paver vehicle **104**. This would enable the paver vehicle **104** to form a thinner paved surface on this predetermined portion of the road **150**.

[0077] It will also be appreciated that the thickness of the road surface may be controlled by varying the forward travel speed of the paver vehicle **104**. For instance, in one embodiment, the forward travel speed of the paver vehicle **104** and of the material feeder **106** may be adjusted within a range extending between about 4 m/min. to about 7 m/min. It will be appreciated that a lower forward travel speed will generally create a thicker road surface, while a greater forward travel speed will generally create a thinner road surface.

[0078] Furthermore, the controller **218** is sized and shaped to fit under the evacuation conveyor **120** while remaining spaced from the evacuation conveyor **120**, i.e. without interfering with the evacuation conveyor **120**. In the embodiment shown in FIGS. 1 and 2, the elements of the controller **218** are selected and positioned on the live bottom truck **210** such that the controller **218** is low enough to fit under the evacuation conveyor **120** without interference with the evacuation conveyor **120**, while still enabling the second conveyor end **124** of the evacuation conveyor **120** to be positioned above the front container end **204**.

[0079] In the present embodiment, a guard plate **220** further extends above the controller **218**. The guard plate **220** may be used to prevent damage to the controller **218** which may be caused by crushed pavement material falling from the evacuation conveyor **120**. In one embodiment, the guard plate **220** has a surface area which is sufficient to cover the controller **218** when the guard plate **220** is installed over the controller **218**.

[0080] Furthermore, in the illustrated embodiment, the guard plate **220** is angled relative to the road **150** at the same angle  $\theta_1$  as the evacuation conveyor **120** to be able to fit under the evacuation conveyor **120** even when the material feeder **106** is substantially close to the crusher vehicle **102**.

[0081] Alternatively, the controller **218** may be positioned elsewhere on the material feeder **106**.

[0082] In the illustrated embodiment, the controller **218** is further configured to be readily accessible to an operator standing next to the material feeder **106**. More specifically, the controller **218** comprises a control panel **302** which faces laterally relative to the live bottom truck **210**. This configuration enables the operator to control the material feeder **106** while standing beside the controller **218** and walking alongside the live bottom truck **210** as the material feeder **106** travels forward.

[0083] Alternatively, the controller **218** may instead be configured to be readily accessible to an operator of the paver vehicle **104**, which is located rearwardly of the material feeder. In this configuration, the operator of the paver vehicle **104**, who is located on the paver vehicle **104**, may thereby

visually assess the level of crushed pavement material in the inlet hopper 136 and adjust the speed of the feeding conveyor 208 to prevent the inlet hopper 136 from becoming empty or from overflowing.

[0084] In yet another embodiment, the controller 218 may instead be configured such that some elements of the controller 218 are accessible by a first operator standing beside the live bottom truck 210 while other elements of the controller 218 are accessible by a second operator located on the paver vehicle 104 and operating the paver vehicle 104.

[0085] In the illustrated embodiment, a rear end 222 of the feeding conveyor 208 is located above and overlaps the inlet hopper 136 of the paver vehicle 102, such that the crushed pavement material may fall into the inlet hopper 136 by gravity.

[0086] In one embodiment, the paver vehicle 104 may further be secured to the material feeder 106 to ensure that the rear end 222 of the feeding conveyor 208 is always located above the inlet hopper 136 of the paver vehicle 104 during a paving operation, as both the paver vehicle 104 and the material feeder 106 are travelling forward. In this configuration, the paver vehicle 104 and the material feeder 106 would travel at the same forward travel speed during the paving operation.

[0087] A person skilled in the art will appreciate that other means for transferring the crushed pavement material from the feeding conveyor 208 to the inlet hopper 136 of the paver vehicle 104 may alternatively be used.

[0088] The paver vehicle 104 may further be removably secured to the material feeder 106 such that the paver vehicle 104 may be detached from the material feeder 106 when the system 100 is not performing a paving operation. This would advantageously facilitate displacing the paver vehicle 104 and the material feeder 106 from one site to another and storing the paver vehicle 104 and the material feeder 106 between paving operations.

[0089] In one embodiment, the material feeder 106 is not secured to the crusher vehicle 102. Instead, the material feeder 106 is spaced from the crusher vehicle by a given distance. This given distance may be adjustable during a paving operation to enable the material feeder 106 and the crusher vehicle 102 to travel forward at different forward travel speeds. For instance, on a portion of the road 150, it may be desirable to remove a relatively thin pavement surface and repave this portion of the road 150 with a relatively thick pavement surface. In this case, the crusher vehicle 102 may travel at a faster forward travel speed than the paver vehicle 104 and the material feeder 106.

[0090] As a skilled person will appreciate from FIGS. 1 and 2, the given distance between the crusher vehicle 102 and the material feeder 106 may be adjusted such that the second conveyor end 124 of the evacuation conveyor 120 is located within a certain horizontal range R over the container 140. This certain horizontal range R extends rearwardly from the front container end 204 towards the rear container end 206. The certain horizontal range R is delimited by a rear limit position 224 and a front limit position 226. The rear limit position 224 is defined by the location of the second end 214 of the evacuation conveyor 120 when the crusher vehicle 102 is substantially adjacent the material feeder 106 or even contacts the material feeder 106. The front limit position 226 is defined by the location of the second end 214 of the evacuation conveyor 120 when the second end 214 of the evacuation conveyor 120 is substantially vertically aligned with the front container end 204. In this embodiment, the second end 214 of

the evacuation conveyor 120 remains aligned vertically with the open top container end 200 to enable the crushed pavement material to be transferred by gravity from the evacuation conveyor 120 into the container 140.

[0091] A person skilled in the art will appreciate that the crushed pavement material may be evacuated rearwardly by the evacuation conveyor 120 with a certain horizontal rearward speed if the speed of the evacuation conveyor 120 is relatively high. This may cause the crushed pavement material to be transferred from the second end 214 of the evacuation conveyor 120 into the container 140 along an arcuate trajectory, as shown in FIG. 2. Accordingly, in one embodiment, the second end 214 of the evacuation conveyor 120 may be located slightly frontwardly of the front container end 204 and still enable the crushed pavement material to be transferred by gravity into the open top container end 200.

[0092] In an alternative embodiment, the horizontal location of the second end 214 of the evacuation conveyor 120 may not be confined within the certain range R described above. For instance, the evacuation conveyor 120 may be extendable such that the second end 214 of the evacuation conveyor 120 is located rearwardly beyond the rear limit position 224. Alternatively, the crushed pavement material may be transferred from the evacuation conveyor 120 into the container 140 using any other means deemed suitable by the skilled addressee, in which case the second end 214 of the evacuation conveyor 120 need not be necessarily vertically aligned with the open top container end 200.

[0093] Now referring to FIGS. 2 and 4, the feeding conveyor 208 extends generally longitudinally relative to the container 140 and comprises a plurality of axles 402 which are rotatably mounted to the container 140, near the closed bottom container end 202, and which extend transversely relative to the container 140. Each axle 402 has a first axle end 404, a second axle end, not shown, and a pair of sprockets 406, each sprocket being secured to one of the first and second axle ends 404. The sprockets 408 engage spaced-apart left chain 400 and right chain, not shown, and drive the left and right chains 400 at substantially the same speed.

[0094] A plurality of transverse members 408 further extend between the chains 400 and are spaced from each other to form a support structure for receiving a belt 410. In this configuration, little or no tension is applied on the belt 410 itself during operation, because the tension is instead applied on the chains 400. This advantageously prevents the belt 410 from being damaged or even breaking under tension, especially when enough crushed pavement material is deposited on the belt 410 to substantially impede movement of the feeding conveyor 208. This is also very advantageous when the belt 410 is used in a substantially continuous manner over a certain time, which may impose to the belt 410 more fatigue than it was designed for.

[0095] Alternatively, instead of a belt conveyor, the feeding conveyor 208 may comprise any other type of conveyors deemed suitable by the skilled addressee.

[0096] With reference to FIGS. 1 to 4, a method for performing cold in-place recycling of pavement will now be described, in accordance with one embodiment.

[0097] The paver vehicle 104, the material feeder 106 and the crusher vehicle 102 are first provided and positioned on the road 150 to be repaved. The material feeder 106 is positioned rearwardly of the crusher vehicle 102 and the paver vehicle 104 is positioned rearwardly of the material feeder 106, as described above. More specifically, the front con-

tainer end **204** is located below the second conveyor end **124** of the evacuation conveyor **130**, and the rear container end **206** is located near the paver vehicle **104** such that it is in communication with the paver vehicle **104**.

[0098] The evacuation conveyor **120** is further angled at the angle  $\theta_1$  and the crusher vehicle **102** is spaced from the material feeder **106** by a given distance such that the second end **214** of the evacuation conveyor **120** is positioned above the open top container end **200** of the material feeder **106**.

[0099] The cutter drum **118** of the crusher vehicle **102** is then powered to crush pavement on the road **150**. The crushed pavement material is transferred from the road **150** to the evacuation conveyor **120** via the intermediate conveyor **126**, and is continuously moved or evacuated rearwardly by the evacuation conveyor **120**.

[0100] In one embodiment, the crushed pavement material is mixed with a binder material before being evacuated rearwardly, as explained above.

[0101] The crushed pavement material then falls by gravity from the second end **214** of the evacuation conveyor **120** into the container **140** and onto the feeding conveyor **208**.

[0102] Once in the container **140**, the crushed pavement material may accumulate depending on the conveying speed of the feeding conveyor **208**, as one skilled in the art will appreciate. The crushed pavement material in the container **140** therefore acts as a buffer, as explained above.

[0103] The crushed pavement material is continuously moved rearwardly by the feeding conveyor **208** to the paver vehicle **104**.

[0104] In one embodiment, the debit of crushed pavement material may be adjusted according to the forward travel speed of the paver vehicle **104**. More specifically, the debit of crushed pavement material may be adjusted by adjusting the conveying speed of the feeding conveyor **208** according to the desired debit of crushed pavement material to be transferred to the paver vehicle **104**, as explained above.

[0105] The crushed pavement material is then continuously conveyed or moved rearwardly at the desired debit and falls into the inlet hopper **136** of the paver vehicle **104**. The crushed pavement material may then be processed by the material processing means and applied on the road **150** to thereby repave the road **150**.

[0106] A person skilled in the art will appreciate that the system **100** described above may alternatively be configured according to one of various other configurations. For instance, instead of using an existing live bottom truck, the material feeder **106** may instead be entirely manufactured from scratch.

[0107] In an alternative embodiment, the material feeder **106** does not comprise a live bottom truck, or any other vehicle. Instead, the container **140** is directly secured to the front end of the paver vehicle **104**. In this embodiment, the engine of the paver vehicle **104** may be selected according to the extra weight of the container **140** and of the crushed pavement material which may be received in the container **140**.

[0108] Although the above description relates to a specific preferred embodiment as presently contemplated by the inventor, it will be understood that the invention in its broad aspect includes mechanical and functional equivalents of the elements described herein.

1. A material management system for continuous cold in-place recycling of pavement, the system comprising:

- a crusher vehicle for crushing pavement material on a paved ground surface, the crusher vehicle comprising a first conveyor extending rearwardly from the crusher vehicle for continuously evacuating crushed pavement material rearwardly from the crusher vehicle;
- a paver vehicle located rearwardly of the crusher vehicle for repaving the ground surface using the crushed pavement material; and
- a material feeder located between the crusher vehicle and the paver vehicle for supplying the paver vehicle with the crushed pavement material from the crusher vehicle, the material feeder comprising:
  - a container for receiving and temporarily storing the crushed pavement material, the container having an open top container end and a closed bottom container end, the container further having a front container end located near the first conveyor and a rear container end in communication with the paver vehicle; and
  - a second conveyor extending between the front container end and the rear container end for continuously moving crushed pavement material rearwardly from the front end towards the rear end in order to enable the paver vehicle to repave the ground surface the crushed pavement material.

2. The system as claimed in claim 1, wherein the crusher vehicle extends between a front end and a rear end; further wherein the first conveyor comprises a first conveyor end connected to the rear end of the crusher vehicle and a second conveyor end located rearwardly and upwardly relative to the first conveyor end.

3. The system as claimed in claim 2, wherein the second conveyor end is located above the open top container end, near the front container end to enable crushed pavement material to fall from the first conveyor into the container through the open top container end.

4. The system as claimed in claim 3, wherein the second conveyor end is located rearwardly of the front container end when the front container end is near the crusher vehicle.

5. The system as claimed in claim 1, wherein the material feeder comprises a live bottom truck including a trailer mounted on wheels for receiving the container and a mover vehicle mounted on powered wheels and coupled to the trailer for displacing the live bottom truck.

6. The system as claimed in claim 5, wherein the live bottom truck comprises a controller secured to the mover vehicle forwardly of the container, the controller being operatively connected to the second conveyor to enable adjusting a conveying speed of the second conveyor.

7. The system as claimed in claim 6, wherein the controller is sized and shaped to fit under the first conveyor while remaining spaced from the first conveyor.

8. The system as claimed in claim 7, wherein the first conveyor extends upwardly and rearwardly from the crusher vehicle, the first conveyor thereby defining a first conveyor angle relative to the paved ground surface.

9. The system as claimed in claim 8, wherein the material feeder further comprises a guard plate extending above the controller, the guard plate being angled relative to the paved ground surface at the same angle as the first conveyor angle.

10. The system as claimed in claim 6, wherein the controller is operatively connected to the powered wheels of the mover vehicle.

11. The system as claimed in claim 6, wherein the live bottom truck further comprises a steering system operatively

connected to at least one of the wheels of the trailer and the powered wheels of the mover vehicle, the controller being operatively connected to the steering system to enable an operator to steer the live bottom truck using the controller.

**12.** The system as claimed in claim 1, wherein the second conveyor comprises:

- a plurality of axles rotatably mounted to the container, near the closed bottom container end, the plurality of axles extending transversely relative to the container, each axle having a first axle end, a second axle end and a pair of sprockets, each sprocket being secured to one of the first and second axle ends;

- spaced-apart left and right chains, each chain engaging the sprocket secured at a corresponding one of the first and second axle ends of each one of the plurality of axles;

- a plurality of transverse members extending between the left and right chains, the plurality of transverse members being spaced from each other to form a support structure; and

- a belt received on the support structure.

**13.** A method for performing cold in-place recycling of pavement comprising:

- providing a crusher vehicle comprising a first conveyor extending rearwardly from the crusher vehicle;

- providing a material feeder comprising:

- a container having an open top container end and a closed bottom container end, the container further having a front container end and a rear container end; and

- a second conveyor extending between the front container end and the rear container end;

- locating the front container end near the first conveyor;

- locating a paver vehicle near the rear container end such that the rear container end is in communication with the paver vehicle;

- crushing pavement material on a ground surface using the crusher vehicle;

- continuously moving crushed pavement material from the crusher vehicle into the container using the first conveyor;

- continuously moving crushed pavement material from the container to the paver vehicle using the second conveyor;

- repaving the ground surface with the paver vehicle using the crushed pavement material supplied to the paver vehicle.

**14.** The method as claimed in claim 13, further comprising: adjusting a debit of crushed pavement material supplied to the paver vehicle according to a forward travel speed of the paver vehicle.

**15.** The method as claimed in claim 14, wherein adjusting the debit of crushed material comprises adjusting a conveying speed of the second conveyor.

**16.** The method as claimed in claim 13, further comprising: after crushing pavement material on the ground surface, mixing the crushed pavement material with a binder material.

**17.** A method for manufacturing the material feeder of the material management system claimed in claim 1, the method comprising:

- providing a live bottom truck comprising a container and a cab located forwardly of the container;

- removing the cab from the live bottom truck;

- securing a controller to the live bottom truck forwardly of the container to thereby form the material feeder, the controller being sized and shaped to fit under the first conveyor when the front container end is near the crusher vehicle;

- operatively connecting the controller to the second conveyor to enable controlling a conveying speed of the second conveyor.

**18.** The method as claimed in claim 17, further comprising operatively connecting the controller to powered wheels of the live bottom truck.

\* \* \* \* \*