

PRODUCT PACKAGING SYSTEM AND METHOD

Field of the Invention

The present disclosure relates to a product packaging system, and more particularly, to a dunnage pad transfer mechanism for use with a dunnage conversion machine in a packaging system.

Background

When shipping a product from one location to another, the product is generally shipped in a container with a protective packaging material. The container may be a cardboard box. The protective packaging material may a plastic air bag, a paper pad, a foam pad, or other resilient material.

A dunnage conversion machine, or converter, may be used to convert a stock material, such as paper sheets, plastic sheets, or foam, into cushioning dunnage products, or dunnage pads. Converters typically discharge dunnage products in a predetermined discharge direction through an exit to a transitional zone, such as a holding area or a staging area, from which the dunnage products may later be removed for insertion into a container for packaging purposes.

Summary

The present disclosure relates to a system and method for supplying and distributing dunnage products to multiple packing stations. The system is characterized by a supply of dunnage products, a distribution assembly, and multiple packing stations, combined to provide a packaging system and method that afford advantages over existing packaging arrangements. In particular, an exemplary packaging system includes a supply of dunnage products, a plurality of packing stations, and a distribution assembly that selectively distributes the dunnage products from the supply to selected ones of the packing stations to keep the packing stations automatically supplied with dunnage products. The distribution assembly includes one or more dunnage carriers that transport the dunnage product from the supply to

the selected packing station, and control surfaces with cam paths that cooperate with cam followers on the dunnage carriers to control the opening and closing of the dunnage carriers to retrieve and deposit the dunnage product without requiring power to be provided to the dunnage carrier. The motion of the dunnage carrier as the cam
5 followers engage the cam paths causes the dunnage carrier to open or close against a biasing force, thereby simplifying the distribution assembly.

Paraphrasing the claims, an exemplary packaging system comprises a supply of at least one dunnage product, a plurality of packing stations, and a distribution assembly that selectively distributes the dunnage product from the supply to a
10 selected one of the packing stations. The distribution assembly includes a closed distribution path, at least one dunnage carrier configured to transport the dunnage product along the distribution path, a plurality of control surfaces, and a dunnage deflector at each of the supply and each packing station. Each of the control surfaces has multiple cam paths, and one of the control surfaces is positioned adjacent each
15 packing station. The dunnage carrier includes at least one cam follower configured to engage a selected one of the cam paths. And the dunnage deflector at each of the packing stations is selectively operable to engage the dunnage product in the dunnage carrier to direct the cam follower of the dunnage carrier onto the selected cam path to deliver the dunnage product to the selected one of the packing stations.
20 A control surface also is positioned adjacent the supply.

In one or more embodiments, the system further includes a controller that selectively controls the dunnage deflectors at each packing station to distribute the dunnage product to the selected one of the packing stations.

In one or more embodiments, the distribution assembly includes a conveyor
25 that defines the distribution path and is capable of transporting the at least one dunnage carrier along the distribution path.

In one or more embodiments, the distribution path is elevated above the packing stations.

In one or more embodiments, the dunnage deflector at each of the packing
30 stations is selectively movable between an extended position to engage the dunnage

product in the dunnage carrier and a retracted position removed from the extended position.

In one or more embodiments, the supply of dunnage includes a converter that converts a sheet stock material into a dunnage product that has a lower density than the sheet stock material.

In one or more embodiments, the converter is a cushioning conversion machine capable of converting kraft paper into a cushioning dunnage product.

In one or more embodiments, the converter is mounted on a stand at an elevated position.

In one or more embodiments, at least one of the packing stations includes a receptacle for receiving and storing dunnage products therein until needed.

In one or more embodiments, each packing station includes a receptacle for receiving and storing dunnage products therein until needed.

In one or more embodiments, the receptacle has an opening in a side near a bottom surface of the receptacle to facilitate removing dunnage products in the order in which they are supplied to the receptacle.

An exemplary packaging method, comprising the following steps: (a) supplying a dunnage product from a supply; (b) transporting the dunnage product from the supply via a distribution assembly along a distribution path with a plurality of packing stations arranged along the distribution path; and (c) controlling elements of the distribution assembly to deliver the dunnage product to a selected one of the plurality of packing stations.

In one or more embodiments, the transporting step includes transporting the dunnage products in a clamping device mounted to a conveyor.

In one or more embodiments, the transporting step includes automatically opening a clamping device having a pair of jaws to receive a dunnage product therebetween as the conveyor moves the clamping device past an exit of the supply, and automatically closing the clamping device to capture the dunnage product between the pair of jaws as the conveyor moves the clamping device past the supply.

In one or more embodiments, the delivering step includes automatically opening the clamping device as the conveyor moves the clamping device past the selected packing station.

5 In one or more embodiments, the controlling step includes controlling a dunnage deflector adjacent each of the plurality of packing stations to move between an extended position and a retracted position to control the orientation of the dunnage product as the dunnage product is transported past each packing station.

10 In one or more embodiments, the controlling step includes controlling a dunnage deflector adjacent each of the plurality of packing stations to move between an extended position and a retracted position to control the orientation of the dunnage product and the clamping device as the dunnage product is transported past each packing station, wherein the clamping device includes a cam follower that interacts with a cam path on a cam surface at each packing station that controls whether the clamping device moves to an open position.

15 In one or more embodiments, the supplying step includes converting a sheet stock material into the dunnage product, which has a lower density than the sheet stock material.

In one or more embodiments, the converting step includes converting kraft paper into a cushioning dunnage product.

20 In one or more embodiments, the delivering step includes depositing the dunnage products into a receptacle at the selected packing station.

Brief Description of the Drawings

FIG. 1 is a front perspective view of an exemplary packaging system.

25 FIG. 2 is an enlarged view of a portion of the system of FIG. 1.

FIG. 3 is a cross-sectional view of an exemplary dunnage conversion machine of the system of FIG. 1.

FIG. 4 shows a rear perspective view of a dunnage carrier used in the system shown in FIG. 1.

FIG. 5 is a perspective view of a portion of a dunnage carrier of the system shown in FIG. 4 in an operable configuration.

FIG. 6 is a perspective view of the portion of the dunnage carrier of FIG. 4 in a disconnected configuration.

5 FIG. 7 is a rear perspective view of a portion of the system shown in FIG. 1.

FIG. 8 is a right side perspective view of the portion of the system shown in FIG. 7.

FIG. 9 is a front perspective view of the portion of the system shown in FIG. 7.

10 FIG. 10 is a left perspective view of the dunnage conversion machine shown in FIG. 1.

FIG. 11 is a right side perspective view of the system as shown in FIG. 8 with an empty dunnage carrier approaching a guide surface.

FIG. 12 is a left side perspective view of the system as shown in FIG. 11 with the dunnage carrier engaging the guide surface.

15 FIG. 13 is a left side perspective view of the system as shown in FIG. 12 with the dunnage carrier engaging the guide surface further downstream from the position of the guide surface in FIG. 12.

FIG. 14 is a rear perspective view of the system as shown in FIG. 13.

20 FIG. 15 is a right side perspective view of the system as shown in FIG. 10 with the dunnage carrier opened to capture a dunnage product.

FIG. 16 is a left side perspective view of the system as shown in FIG. 10 with the dunnage carrier closed after passing the guide surface without a dunnage product.

FIG. 17 is a left perspective view of the system as shown in FIG. 10.

25 FIG. 18 is a left side perspective view of the system as shown in FIG. 10 with a dunnage carrier closing to capture a dunnage product.

FIG. 19 is a left side perspective view of the system as shown in FIG. 18 with the dunnage carrier transporting the dunnage product away from the dunnage conversion machine.

FIG. 20 is a left side perspective view of the dunnage carrier transporting the dunnage product to a packing station.

FIG. 21 is a right side perspective view of the system as shown in FIG. 11 with a dunnage carrier approaching a guide surface while transporting a dunnage product.

5 FIG. 22 is a right side perspective view of the system as shown in FIG. 15 with a dunnage carrier approaching an exit of the dunnage conversion machine while transporting a dunnage product.

FIG. 23 is a right side perspective view of the system as shown in FIG. 16 with a dunnage carrier bypassing an exit of the dunnage conversion machine while
10 transporting a dunnage product.

FIG. 24 is a right side perspective view of the dunnage carrier transporting the dunnage product to the packing station.

FIG. 25 is an overhead perspective view of a packing station portion of the system of FIG. 1.

15 FIG. 26 is a front perspective view of a guide surface at the packing station shown in FIG. 25.

FIG. 27 is a front perspective view of the guide surface at the packing station shown in FIG. 26 with an empty dunnage carrier.

FIG. 28 is a front perspective view of the guide surface at the packing station
20 shown in FIG. 26 with a dunnage carrier transporting a dunnage product to the packing station.

FIG. 29 is a front perspective view of the guide surface at the packing station shown in FIG. 26 with the dunnage carrier delivering the dunnage product.

FIG. 30 is an alternative front perspective view of the guide surface at the
25 packing station shown in FIG. 29 with the dunnage carrier delivering the dunnage product.

FIG. 31 is an enlarged view of the dunnage carrier as shown in FIG. 30.

FIG. 32 is a front perspective view of an empty dunnage carrier in a closed configuration after passing the guide surface shown in FIG. 27.

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Detailed Description

The present invention generally provides a packaging system and method for supplying dunnage products to a plurality of packing stations. Referring to the drawings in detail, and initially to FIGS. 1 and 2, an exemplary packaging system 100 includes a supply 102 of dunnage products 104, a plurality of packing stations 106, and a distribution assembly 110 that selectively distributes the dunnage products 104 from the supply 102 to selected ones of the packing stations 106. The distribution assembly 110 includes one or more dunnage carriers 112 (FIG. 4) configured to travel along and to transport dunnage products 104 along a closed distribution path. The supply 102 of dunnage products 104 and the packing stations 106 are arranged along the distribution path.

The distribution assembly 110 also includes a plurality of control surfaces 114 at the supply 102 and at each of the packing stations 106 that cooperate with the dunnage carriers 112 to control retrieving and depositing the dunnage products 104 as the dunnage carriers 112 move along the distribution path. The system 100 also may include a controller 120 that selectively directs the distribution assembly 110 to deliver dunnage products 104 to the packing stations 106, or to direct the supply 102 to provide dunnage products 104 for transport, or a combination thereof.

The supply 102 of dunnage products 104 in the illustrated embodiment includes a dunnage converter 122, such as a converter of a type typically referred to as a cushioning conversion machine. Cushioning conversion machines heretofore have been used to convert sheet stock material, such as paper, in sheet form, into cushioning dunnage products, or pads, that have a lower density than the starting sheet stock material. An exemplary stock material is kraft paper. The resulting pads typically are relatively lightweight and are relatively less dense than the stock material from which they are made.

A cross-section of an exemplary dunnage converter 122 is shown in FIG. 3, and includes a forming assembly 124 through which sheet stock material is advanced by a feed assembly 126. An exemplary sheet stock material is kraft paper, which may be fan-folded and provided to the dunnage converter in a rectangular stack. Drawing

the sheet stock material through the forming assembly 124 causes the sheet stock material to crumple and the lateral edges to turn inwardly to form a strip of cushioning 128 having a lower density than the sheet stock material. The feed assembly 126 typically also connects or otherwise acts on overlapped layers of crumpled stock material to secure the overlapped layers of crumpled stock material together to maintain the shape of the strip of cushioning 126. A severing assembly 130 downstream of the forming assembly 124 and the feeding assembly 126 severs dunnage products 104 of desired lengths from the strip of cushioning 128.

The illustrated dunnage converter 122 produces dunnage products 104 having a length dimension, a width dimension, and a thickness dimension, and the length dimension is much greater than either the width dimension or the thickness dimension. The converter discharges the dunnage product 104 lengthwise, generally in a first direction parallel to the length dimension, through an exit 132 of the dunnage converter 122 in a generally horizontal discharge direction, where a shelf 134 presents and supports the dunnage product 124 for retrieval by one of the dunnage carriers 112 of the distribution assembly 110. The dunnage converter 122 is mounted on a frame or stand 136 so that the dunnage products 104 are discharged at a convenient height for retrieval by the distribution assembly 110 from the supply 102.

The supply 102 of dunnage products 104 is not limited to the use of paper dunnage or to the type of cushioning pads described above. In alternative embodiments, different types of dunnage converters can be employed to produce other types of dunnage, including void fill, cushioning, or blocking-and-bracing dunnage, respectively made from one or more of air bags, foam-filled blocks or bags, paper strips, foam peanuts, etc. The supply 102 of dunnage products 104 also does not have to include a dunnage converter. For example, one or more dunnage converters may be remotely located to produce dunnage products 104 that are subsequently transported to the supply 102. In such a case, the supply 102 would include a dunnage product storage element and a dispenser for dispensing dunnage products 104 through the exit for retrieval by the distribution assembly 110.

Returning to FIG. 2, each packing station 106 includes a receptacle 140 for receiving the cushioning pad or other dunnage product 104 from the distribution assembly 110 for subsequent use by a packer. Each packing station 106 typically additionally or alternatively will include a packing surface (not shown) for supporting a container into which dunnage products 104 would be placed by a packer, or into which dunnage products would be dispensed directly, without the need for a packer. An exemplary packing surface could be provided by a table or a conveyor belt. The receptacle 140 generally would be located at an elevated position above the packing surface, and the distribution assembly 110 is located above the receptacle 140.

The illustrated receptacle 140 has one or more openings 142 toward a bottom of one side that makes it easier for a packer to retrieve dunnage products 104 from the receptacle 140. The receptacle 140 can be considered to be part of either the distribution assembly 110 or the packing station 106.

The distribution assembly 110 distributes the dunnage products 104 supplied by the supply 102 to the packing stations 106. To accomplish its purpose, the distribution assembly 110 may include a conveyor 146 that defines the distribution path of the dunnage products 104 and transports the dunnage products 104 along the distribution path. The conveyor 146 transports the one or more dunnage carriers 112 in a direction of conveyance, generally referred to as a downstream direction. An upstream direction is opposite the downstream direction. In the illustrated embodiment, the conveyor 146 is an overhead conveyor and the downstream direction is clockwise around the distribution path, when viewed from above.

The one or more dunnage carriers 112 are configured to travel along the distribution path defined by the conveyor 146, and are configured to retrieve a dunnage product 104 from the exit 132 of the supply 102, and transport and then release the dunnage product 104 at a selected one of the plurality of packing stations 106. In an exemplary embodiment shown in FIGS. 4-6, each dunnage carrier 112 is connected to a segment of the conveyor 146 through a bracket 150 mounted to the conveyor 146 and one or more magnetic elements 152 coupled to the dunnage carrier 112 to facilitate ready removal for adjustment, repair, or replacement of the

dunnage carrier 112 to or from the conveyor 146. The illustrated embodiment employs two magnetic elements 152 arranged at right angles to each other. Magnets may be employed that either are secured to the conveyor, or to the bracket 150, or a combination thereof. In the illustrated embodiment, a flexible strap 153 also helps to
5 secure the dunnage carrier 112 to the conveyor 146 as a backup to the magnetic elements 152. Other fastening methods may be employed to secure the dunnage carrier 112 to the bracket 150 or the conveyor 146.

Each dunnage carrier 112 includes a mechanism for retrieving a dunnage product, such as the illustrated clamping device 154. The clamping device 154, also
10 could be referred to as a gripper, and is similar to a pair of tongs. The clamping device 154 thus includes a pair of arms, at least one of which rotates about a pivot axis 156. When mounted to the conveyor 146, the pivot axis 156 is generally oriented parallel to the conveyor's direction of movement, the downstream direction. The arms of the clamping device 154 include a pair of control portions 160, like the reins or
15 handle portions of tongs, that extend from one side of the pivot axis 156, and a pair of jaws 162 that extend from an opposite side of the pivot axis 156. The control portions 160 are used to control the clamping device 154, and specifically the actions of the jaws 162. The pivot axis 156 allows the clamping device 154 to move between a closed position with distal ends of the jaws 162 in proximity to each other so as to
20 hold the dunnage product 104 therebetween, and an open position with distal ends of the jaws 162 spaced further apart, so as to deliver the dunnage product 104 to one of the packing stations 106 or to be ready to receive the dunnage product 104 at the exit 132 of the supply 102.

The illustrating clamping device 154 thus uses a pinching movement to
25 engage and hold a dunnage product 104 between the distal ends of the jaws 162. The jaws 162 alternatively could be referred to as arms, hands, or fingers, with distal ends that move toward and away from one another to grasp, hold, and release a dunnage product 104 therebetween. The distal ends of the jaws 162 may be provided with engagement surfaces to facilitate gripping the dunnage product 104,
30 such as selected surface textures or materials, elements that perforate the dunnage

product 104, or openings coupled to a vacuum source to hold the dunnage product 104 with suction, or other features that facilitate gripping the dunnage product 104.

In the illustrated clamping device 154, the distal ends of the jaws 162 are connected together by a flexible element 164 extending between the distal ends of the jaws 162 that bends about a central portion 166 when the jaws 162 are in the closed position. The jaws 162 and the flexible element 164 thus form a mouth into which the dunnage product 104 can be received and held for transport. The flexible element 164 straightens as the jaws 162 move to the open position, the central portion 164 thereby facilitates ejecting the dunnage pad 104 from the clamping device 154 as the flexible element 164 straightens between the jaws 162.

The illustrated clamping device 154 is biased to the closed position by a biasing element 170, such as one or more springs or other resilient materials or structure. This allows the clamping device 154 to hold the dunnage product 104 during transport without any active energy requirements. Energy is only needed to move the jaws 162 to the open position, acting against the biasing element 170, and as discussed below this energy can be provided by the movement of the conveyor 146. Alternative biasing elements 170 may be employed to bias the clamping device 154 to either the open position or the closed position.

Alternative types of clamping device may be used in place of the illustrated clamping device 154 in the dunnage carrier 112. And the dunnage carrier 112 may include alternative ways to receive a dunnage product 104 at the exit 132 of the supply 102, hold the dunnage product 104 for transport, and release or dispense the dunnage product 104 at the packing station 106. Smaller, flowable dunnage products, for example, may be supplied in a carrier that the clamping device 154 would transport on the conveyor 146 along with the dunnage products.

Turning to FIGS. 7-23, the conveyor 146 not only transports the dunnage carrier 112 along the distribution path, but also provides the power to open the clamping device 154 against the action of the biasing element 170. In other words, movement of the dunnage carrier 112 is used to open the clamping device 154 to

retrieve the dunnage product 104 from the exit 132 of the supply 102 and to open the clamping device 154 to deposit the dunnage product 104 at a selected packing station 106. To effect opening the clamping device 154, the distribution assembly 110 uses the control surfaces 114, which are positioned adjacent the conveyor 146 at
5 each of the packing stations 106 and adjacent the exit 132 of the supply 102. The control portions 160 of the clamping device 154 are configured to engage the control surfaces 114 and move along the control surfaces 114 as the conveyor 146 advances the dunnage carrier 112. To that end, the distal ends of the control portions 160 may be fitted with bearings or a rotating bushing, including a bushing made of a
10 low-friction material. Interaction between the control portions 160 and the control surfaces 114 cooperates to control the clamping device 154 and its movement between the open position (FIG. 15) and the closed position (FIG. 12). The control surfaces 114 define paths that function as cams (also referred to as cam paths), and the control portions 160 function as cam followers to effect the desired pivoting
15 movement of the jaws 162. By using control surfaces 114, active powered mechanisms are not needed on each dunnage carrier 112 to open and close the clamping device 154 as it moves between the open position and the closed position.

Each of the control surfaces 114 provide multiple paths for the control portions 160 of the clamping device 154, depending on whether the clamping device 154
20 needs to be in the open position or the closed position. These paths may be defined by grooves, recessed portions, or protruding portions that receive or otherwise engage distal ends of the control portions 160 of the clamping device 154 as the conveyor 146 moves the dunnage carrier 112 past the control surfaces 114. These paths also can be referred to as cam paths or cam trajectories. In the illustrated
25 embodiment, each control surface 114 includes three paths, that approach one another and diverge to separate or bring together the distal ends of the control portions 160 and thus move the jaws 162 between the closed and open positions.

To control which paths on the control surface 114 the control portions 160 take, a bypass arm 176 is mounted adjacent the conveyor 146 ahead of each control
30 surface 114. The bypass arm 176 is positioned to engage a dunnage product 104

held in the jaws 162 as the dunnage carrier 112 moves past. The bypass arm 176 influences the orientation of the clamping device 154 through engagement with the dunnage product 104. The bypass arm 176 alternatively may be referred to as a dunnage influencer or a dunnage deflector. The bypass arm 176 is mounted ahead
5 of the control surface 114, upstream of the control surface 114, such that the dunnage carrier 112 passes the bypass arm 176 before the control surface 114.

In the illustrated embodiment, the control surface 114 is mounted to an inside side of the conveyor 146 and the bypass arm 176 is mounted on an outside side of the conveyor 146. The inside side of the conveyor 146 is inside the closed
10 distribution path defined by the conveyor 146, and the outside side of the conveyor 146 is the opposite, on the outside of the closed distribution path defined by the conveyor 146. The bypass arm 176 interacts with the dunnage product 102 held by the clamping device 154 to rotate the clamping device 154 about the pivot axis 156, and thus direct the control portions 160 of the clamping device 154 to engage the
15 control surface 114 in such a way the control portions 160 and the control surface 114 move the clamping device 154 to the desired position.

If the dunnage carrier 110 is holding a dunnage product 104 as the dunnage carrier 110 approaches the supply 102, the clamping device 154 should remain in the closed position. The clamping device 154 does not need to open (move to the open
20 position) to release the dunnage product 104 at the supply 102. And the clamping device 154 does not need to move to the open position to receive a dunnage product 104 from the supply 102. Accordingly, the bypass arm 176 directs the dunnage carrier 112 to move past the supply 102 while retaining the dunnage product 104 and keeping the clamping device 154 in the closed position (see FIGS. 21-23). As the
25 dunnage carrier 112 travels past the bypass arm 176, the bypass arm 176 engages the dunnage product 104. This causes the clamping device 154 to rotate about the pivot axis 156 to a rotated orientation, and directs both of the control portions 160 into a common bypass path on the control surface 114. In the illustrated embodiment, the bypass path is the uppermost path. The bypass path allows the clamping device

154 to remain in the closed position as the dunnage carrier 112 passes the exit 132 of the supply 102.

This rotated orientation of the clamping device 154 positions the control portions 160 vertically above the jaws 162 so that the dunnage product 102 held in the jaws 162 passes below the shelf 134 at the exit 132 of the supply 102. As the control portions 160 exit the control surface 114, the control surface 114 can guide or allow the control portions 160 to rotate the clamping device 154 out of the rotated orientation to place the control portions 160 in an approximately horizontal, non-rotated, default or transport orientation as the dunnage carrier 110 transports the dunnage product 102 onward to a selected one of the packing stations 106.

If the dunnage carrier 110 is empty as it approaches the supply 102, without a dunnage product 104, the clamping device 154 needs to be in the open position to retrieve the dunnage product 104 from the supply 102. The dunnage carrier 112 travels past the bypass arm 176 without the bypass arm 176 rotating the clamping device 154 to the rotated orientation. The bypass arm 176 is positioned to engage the dunnage product 104 held in the jaws 162 of the clamping device 154, or an upper jaw 162 of the clamping device 154 if elevated by the presence of a dunnage product 104 between the upper and lower jaws 162. Thus, the absence of a dunnage product 104 means that the dunnage carrier 112 is unaffected by the bypass arm 176.

The illustrated clamping device 154 includes two control portions 160, a first control portion or first cam follower 190 and a second control portion or second cam follower 192. When the system 100 wants to open the jaws 162 (move the jaws 162 of the clamping device 154 to the open position), as the control portions 160 engage the control surface 114, the control surface 114 splits and guides the control portions 190 and 192 into different paths. The first control portion 190, the lower control portion, generally travels a path that is parallel to the direction of travel, the downstream direction. This path is substantially horizontal in the illustrated embodiment. The second control portion 192, the upper control portion, the distal end of which is spaced from the distal end of the first control portion 190, engages the

control surface 114 in such a way that the second control portion 192 follows another path. This path typically lies between the horizontal path and the uppermost path, the bypass path, and therefore can be referred to as a middle path. The paths of the first and second control portions 190 and 192 vertically diverge, causing at least one of
5 the jaws 162 of the clamping device 154 to rotate about the pivot axis 156 to move the clamping device 154 to the open position.

In the open position, the clamping device 154 is ready to receive a dunnage product 104 from the exit 132 of the supply 102. As the dunnage carrier 110 passes the exit 132 of the supply 102, the control surface 114 brings the paths of the control
10 portions 190 and 192 back together, allowing the flexible element 164 to move the jaws 162 back together, capturing the dunnage product 104 (if present) on the shelf 134 at the exit 132 of the supply 102. In the illustrated embodiment, the middle path ends suddenly, allowing the biasing element 170 to quickly return the jaws 162 of the clamping device 154 to the closed position and capturing the dunnage product 104 in
15 the mouth of the clamping device 154 between the jaws 162.

In the illustrated embodiment, the control surface 114 at the supply 102 is located on a bend in the conveyor 146 and follows a curved path of the conveyor 146. In other words, the control surface 114 parallels the distribution path defined by the conveyor 146. If the conveyor 146 was straight adjacent the supply 102, the
20 control surface 114 also would be straight. In the illustrated configuration, the vertical displacement of the paths defined by the control surface 114 is used to move the clamping device 154 from the closed position to the open position. The curvature of the control surface 114 as it follows the path of the conveyor 154 does not impact whether the clamping device 154 is in the open position or the closed position. The
25 control surface also curves relative to the pivot axis 156 so that the control portions 160 can engage the various paths of the control surface without binding. The distance of the control surface 114 from the pivot axis 156 generally is based on the length of the control portions 160 from the pivot axis 156. Different lengths of the first control portion 190 and the second control portion 192 also can be used with features

of the control surface 114 to funnel or otherwise guide the desired one of the first control portion 190 and the second control portion 192 to the desired path.

Referring now to FIGS. 21-32, the conveyor 146 and the dunnage carrier 112 transport the dunnage product 104 to the selected one of the packing stations 106.

5 Operating similarly to the control surface 114 at the supply 102, at the control surfaces 114 adjacent each packing station 106, the first and second control portions 190 and 192 can be directed onto vertically divergent paths to open the jaws 162. But at the selected packing station 106 the clamping device 154 moves to the open position to release the dunnage product 104 and deliver the dunnage product 104 to
10 the packing station 106. In the illustrated embodiment, when the clamping device 154 moves to the open position, separating the jaws 162, the dunnage product 104 drops down into the receptacle 140. In other words, gravity delivers the dunnage product 104 from the dunnage carrier 112 to the packing station 106.

The control surfaces 114 at each packing station 106 are configured slightly
15 differently from the control surface 114 at the supply 102, however, given their different functions. Opening the clamping mechanism 154 while in its generally horizontal transport orientation works well for receiving and capturing the dunnage product 104 at the exit 132 of the supply 102, and probably also would allow the dunnage product 104 to fall out of the clamping mechanism 154 into the receptacle
20 140 at the packing station 106. But by rotating the clamping mechanism 154 to open the jaws 162 while facing downward, delivery of the dunnage product 104 to the packing station 106 is more certain. In other words, the system 100 can use the bypass arms 176 and the control surfaces 114 to control the rotational orientation of the clamping device 154 in addition to controlling whether the clamping device 154 is
25 in the open position or the closed position.

At each packing station 106, the bypass arm 176 typically is controlled by the controller 120, which controls an actuator to move the bypass arm 176 between an extended delivery position and a retracted bypass position. In contrast to the control surface 114 at the supply 102, if the dunnage product 104 is not to be delivered to
30 the packing station 106 the bypass arm 176 is retracted so that it will not engage the

dunnage product 104. In that case, the control portions 160 both pass the control surface 114 along a common bypass path and the clamping device 154 remains in the closed position without changing its orientation. The bypass path in the control surface 114 at the packing stations 106 is horizontal, parallel to the distribution path and the conveyor 146.

If the dunnage product 104 is to be delivered to the packing station 106, however, the controller 120 moves the bypass arm 114 to the extended delivery position. This can be accomplished by an actuator¹⁹⁶, such as a solenoid or pneumatic or electric motor or other motive device. If the clamping device 154 is holding a dunnage product 104, the dunnage product 104 will engage the bypass arm 176 and cause the clamping device 154 to rotate about the pivot axis 156 to the rotated orientation. In the rotated orientation, the control portions 160, specifically the first control portion 190 and the second control portion 192, of the clamping device 154 engage respective diverging paths on the control surface 114 at the packing station 106. The control surfaces 114 at the packing stations 106 typically only have two paths. The bypass path described above, and a control path that diverges from the bypass path. A funnel or other guide feature guides the second control portion 192 to a path that vertically diverges from the bypass path that the first control portion 190 engages. As the first and second control portions 190 and 192 follow respective paths and vertically separate, the jaws 162 of the clamping device 154 move to the open position to release the dunnage product 104. In the rotated orientation, the open mouth of the jaws 162 of the clamping device 154 faces downward, below horizontal, and gravity pulls the dunnage product 104 out of the clamping device 154 to fall into the receptacle 140, delivering the dunnage product to the packing station 106.

If either the bypass arm 176 is in the extended delivery position but the clamping device 154 is not holding a dunnage product 104, or the bypass arm 176 is in the retracted bypass position, the dunnage carrier 112 passes the bypass arm 176 without a change in orientation and both control portions 190 and 192 traverse the bypass path. Thus, the controller 120 can control the bypass arms 176 at each

packing station 106 to bypass one or more packing stations 106 and deliver the dunnage product 104 at a subsequent packing station 106. In contrast, since the dunnage carrier 112 only bypasses the supply 102 when the dunnage carrier 112 is transporting a dunnage product 104, the bypass arm 176 adjacent the control surface 5 114 by the supply 102 may be left in an extended position.

Each packing station 106 also may include a sensor 200 to detect how full the adjacent receptacle 140 is. The sensor 200 outputs a signal to the controller 120. Based on the signal from the sensor 200, the controller 120 can control the bypass arm 114 associated with that packing station 106 to move to the extended position 10 and thereby "request" delivery of the next dunnage product 104 transported by the dunnage carrier 112 to the packing station 106. To ensure that packing stations 106 on the distribution path further from the supply 102 of dunnage products 104 are not starved of dunnage products 104, the controller 120 may control the bypass arms 176 at each packing station 106 to ensure equitable distribution of the dunnage 15 products 104 to the packing stations 106. Thus, alternative control methods also are contemplated, and the controller 120 may control respective bypass arms 176 to allow the dunnage carrier 112 to bypass one or more packing stations 106 without delivering the dunnage product 102, such as to deliver dunnage products 106 to the packing station 106 that has the fewest dunnage products 106 in its receptacle 140 20 or to the packing station 106 that is consuming dunnage products 104 the quickest. The signal from the sensor 200 may indicate that the receptacle 140 at a particular one of the packing stations 106 is less than full or empty and in need of dunnage products 104. The signal from the sensor 200 may alternatively indicate the degree of fullness of the receptacle 140 or only whether the receptacle 140 is full enough to 25 enable detection of dunnage products 104 in the receptacle 140.

The controller 120 (shown schematically in FIG. 1) selectively directs elements of the distribution assembly 110 to distribute dunnage products 104 to respective packing stations 106. The controller 120 can then control the supply 102 to supply dunnage products 104 to the distribution assembly 110, and control the distribution 30 assembly 110 to provide dunnage products 104 to each packing station 106. The

supply 102 also can operate independently of the controller 120, providing dunnage products 104 to always provide a dunnage product 104 at the exit 132 as soon as the previously-supplied dunnage product 104 is removed. Although the controller 120 generally operates without interaction from the packer, input and output devices, such as a keyboard and a display, for example, can be provided to give the packer access to information from and provide a way to input information to the controller 120. As another example, in place of a sensor that tells the controller when one of the receptacles 140 needs additional dunnage products 104, the packer could use a foot pedal or other type of switch to signal the controller 120 that the packing station 106 needs more dunnage products 104, and the controller 120 then can control the needed delivery. The controller 120 thus facilitates automating much of the packaging system 100.

The controller 120 is an electronic device or system that manages and controls the operation of other devices in the packaging system 100, such as the conveyor 146, the bypass arms 176, and the supply 102. The controller 120 may include components such as a microprocessor, a memory, one or more input/output interfaces, and circuits and software. A computer, having a central processing unit, memory, and specialized software, may function as the controller 120 in controlling the operative elements of the packaging system 100.

In summary, the supply 102 provides a first dunnage product 104 at the exit 132. For example, a dunnage converter can convert a stock material into the dunnage product that is supported at the exit 132 on the shelf 134. The conveyor 146 moves an empty dunnage carrier 112 along the distribution path to the supply 102. As the dunnage carrier 112 approaches the supply 102, the control portions 160 of the clamping device 154 engage the control surface 114 adjacent the supply 102 and the first control portion 190 and the second control portion 192 are spread apart as they travel separate paths defined by the control surface 114, moving the clamping device 154 to the open position. As the dunnage carrier 112 moves along the control surface 114 and passes the exit 132 of the supply 102, the paths of the control surface allow the control portions 190 and 192 to come back together, allowing the

clamping device 154 to return to the closed position, capturing the dunnage product 104 on the shelf 134 at the exit 132 of the supply 132 and carrying the dunnage product 104 away from the exit 132 along the distribution path. The controller 120 controls the bypass arms 176 to deliver the dunnage product to a selected one of the packing stations 106. At packing stations 106 to be bypassed, the bypass arm 176 is retracted, and the conveyor 146 moves the dunnage carrier 112 through the packing station 106 without any change in orientation.

When the dunnage carrier 112 reaches the selected packing station 106, the extended bypass arm 176 engages the dunnage product 104 and rotates the clamping device 154 about the pivot axis 156, rotating the jaws 162 and the dunnage product 104 downward. The control portions 160 of the clamping device 154 engage the control surface 114 adjacent the selected packing station 106, and the first control portion 190 and the second control portion 192 are guided onto diverging paths. The diverging paths open the jaws 162, moving the clamping device 154 to the open position and allowing the dunnage product 104 to fall out of the clamping device 104 and delivering the dunnage product 104 to the packing station 106. The dunnage product 104 will fall into the receptacle 140, and when the packer is ready the packer will withdraw the dunnage product 104 through the opening 142 in the receptacle for use in packing one or more objects in a container for shipment. The conveyor 146 continues to move the dunnage carrier 112 along the distribution path and back to the supply 102 to retrieve another dunnage product 104, continuing the process.

As understood from the foregoing, an exemplary method of supplying dunnage products from a supply to a plurality of packing stations includes the steps of (i) delivering a dunnage product from an exit of the supply; (ii) moving a dunnage carrier along a distribution path that passes the exit of the supply and the plurality of packing stations; (iii) controlling the dunnage carrier to move between an open position and a closed position through interaction between the dunnage carrier and control surfaces mounted adjacent the supply and each of the plurality of packing stations along the distribution path; and (iv) selectively controlling a path defined by the control surface

taken by a control arm associated with the dunnage carrier to cause the dunnage carrier to move to the open position or the closed position at each of the supply and the plurality of packing stations.

To summarize, an exemplary packaging system 100 and method supplies
5 dunnage products 104 to a distribution assembly 110 for distribution from a supply 102 to a selected one of a plurality of packing stations 106. The distribution assembly 110 includes a closed distribution path, at least one dunnage carrier 112 configured to transport the dunnage product 104 along the distribution path, a plurality of control surfaces 114, and a dunnage deflector or bypass arm 176 at each packing station
10 106. Each of the control surfaces 114 has multiple cam paths. The dunnage carrier 112 includes at least one cam follower or control portion 160 configured to engage a selected one of the cam paths on the control surface 114. And the dunnage deflector 176 is selectively operable to engage the dunnage product 104 in the dunnage carrier 112 to direct the cam follower 160 onto the selected cam path to deliver the
15 dunnage product 104 to the selected one of the packing stations 106.

Although the invention has been shown and described with respect to a certain embodiment, equivalent alterations and modifications will occur to others skilled in the art upon the reading and understanding of this specification and the annexed drawings. In particular regard to the various functions performed by the
20 above described integers (components, assemblies, devices, compositions, etc.), the terms (including a reference to a "means") used to describe such integers are intended to correspond, unless otherwise indicated, to any integer which performs the specified function of the described integer (i.e., that is functionally equivalent), even though not structurally equivalent to the disclosed structure which performs the
25 function in the herein illustrated exemplary embodiment of the invention.

Claims

1. A packaging system, comprising:
a supply of at least one dunnage product;
a plurality of packing stations; and
5 a distribution assembly that selectively distributes the dunnage product from the supply to a selected one of the packing stations;
wherein the distribution assembly includes a closed distribution path, at least one dunnage carrier configured to transport the dunnage product along the distribution path, a plurality of control surfaces, and a dunnage deflector at each of
10 the supply and each packing station;
wherein each of the control surfaces has multiple cam paths, and one of the control surfaces is positioned adjacent the supply and adjacent each packing station;
wherein the dunnage carrier includes at least one cam follower configured to engage a selected one of the cam paths;
15 wherein the dunnage deflector at each of the packing stations is selectively operable to engage the dunnage product in the dunnage carrier to direct the cam follower of the dunnage carrier onto the selected cam path to deliver the dunnage product to the selected one of the packing stations.
- 20 2. The system claimed in claim 1, further comprising a controller that selectively controls the dunnage deflectors at each packing station to distribute the dunnage product to the selected one of the packing stations.
- 25 3. The system claimed in claim 1 or any preceding claim, wherein the distribution assembly includes a conveyor that defines the distribution path and is capable of transporting the at least one dunnage carrier along the distribution path.
4. The system claimed in claim 1 or any preceding claim, wherein the distribution path is elevated above the packing stations.

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5. The system claimed in claim 1 or any preceding claim, wherein the dunnage deflector at each of the packing stations is selectively movable between an extended position to engage the dunnage product in the dunnage carrier and a retracted position removed from the extended position.

6. The system claimed in claim 1 or any preceding claim, wherein the supply of dunnage includes a converter that converts a sheet stock material into a dunnage product that has a lower density than the sheet stock material.

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7. The system claimed in claim 6, wherein the converter is a cushioning conversion machine capable of converting kraft paper into a cushioning dunnage product.

8. The system claimed in claim 6, wherein the converter is mounted on a stand at an elevated position.

9. The system claimed in claim 1 or any preceding claim, wherein at least one of the packing stations includes a receptacle for receiving and storing dunnage products therein until needed.

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10. The system claimed in claim 1 or any preceding claim, wherein each packing station includes a receptacle for receiving and storing dunnage products therein until needed.

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11. The system claimed in claim 10, wherein the receptacle has an opening in a side near a bottom surface of the receptacle to facilitate removing dunnage products in the order in which they are supplied to the receptacle.

12. A packaging method, comprising the following steps:
supplying a dunnage product from a supply;
transporting the dunnage product from the supply via a distribution assembly
along a distribution path with a plurality of packing stations arranged along the
5 distribution path;
controlling elements of the distribution assembly to deliver the dunnage
product to a selected one of the plurality of packing stations.

13. The packaging method claimed in claim 12, wherein the transporting
10 step includes transporting the dunnage products in a clamping device mounted to a
conveyor.

14. The packaging method claimed in claim 12 or any of claims 12 to 13,
wherein the transporting step includes automatically opening a clamping device
15 having a pair of jaws to receive a dunnage product therebetween as the conveyor
moves the clamping device past an exit of the supply, and automatically closing the
clamping device to capture the dunnage product between the pair of jaws as the
conveyor moves the clamping device past the supply.

20 15. The packaging method claimed in claim 12 or any of claims 12 to 14,
wherein the delivering step includes automatically opening the clamping device as
the conveyor moves the clamping device past the selected packing station.

16. The packaging method claimed in claim 13 or any of claims 13 to 15,
25 wherein the controlling step includes controlling a dunnage deflector adjacent each of
the plurality of packing stations to move between an extended position and a
retracted position to control the orientation of the dunnage product as the dunnage
product is transported past each packing station.

17. The packaging method claimed in claim 13 or any of claims 13 to 16, wherein the controlling step includes controlling a dunnage deflector adjacent each of the plurality of packing stations to move between an extended position and a retracted position to control the orientation of the dunnage product and the clamping
5 device as the dunnage product is transported past each packing station, wherein the clamping device includes a cam follower that interacts with a cam path on a cam surface at each packing station that controls whether the clamping device moves to an open position.

10 18. The packaging method claimed in claim 12 or any of claims 12 to 17, wherein the supplying step includes converting a sheet stock material into the dunnage product, which has a lower density than the sheet stock material.

19. The packaging method claimed in claim 18, wherein the converting step
15 includes converting kraft paper into a cushioning dunnage product.

20. The packaging method claimed in claim 12 or any of claims 12 to 19, wherein the delivering step includes depositing the dunnage products into a receptacle at the selected packing station.

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