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Cutting Control System For Horizontal Casting System

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CUTTING CONTROL SYSTEM FOR HORIZONTAL CASTING SYSTEM

Metal products may be produced by both vertical casting procedures as well as horizontal casting procedures. During a typical horizontal casting procedure, a first belt (or other conveying means) draws the metal product out of a mold, and continues to draw the metal product until the metal product reaches a second belt (or other conveying means) that is downstream from the first belt, and the second belt also begins to pull on the metal product. A saw is positioned between the first belt and the second belt, and the saw cuts the metal product so that it is no longer continuous. A potential problem with such a configuration is that, if the metal product is not in a correct position on the conveying means and/or relative to the saw, the cut may be hazardous to operators, may damage the metal product, and/or may jeopardize safety of the workplace. For example, if the metal product is not far enough downstream on the conveying means and the cut is made, a piece of the metal product may be expelled from the conveying means at a dangerous velocity. Likewise, if the metal product is at an incorrect position, the cut may damage the metal product and require scrapping of the damaged portion.

In view of these limitations, a cutting control system is provided with a metal casting system that controls the cutting operation performed by a cutting device such that the cutting operation is performed based on a detected characteristic of the metal product. Such a detected characteristic may be indicative that the metal product is at a proper position relative to the cutting device.

The cutting control system includes at least one clamp, at least one sensor, and a controller. Along the processing path, the at least one clamp and the at least one sensor may be upstream from the cutting device or downstream from the cutting device. Optionally, more than one clamp and more than one sensor may be provided along the processing path. In such examples, all of the clamps may be on a same side of the cutting device (e.g., upstream from the cutting device), or at least one of the clamps may be downstream from the cutting device and another one of the clamps may be upstream from the cutting device. Likewise, in these examples, all of the sensors may be on a same side of the cutting device, or at least one of the sensors may be downstream from the cutting device and another one of the sensors may be upstream from the cutting device.

The at least one clamp may be controlled to selectively clamp the metal product, either automatically (i.e., by the controller) or manually as desired. The at least one sensor detects at least one characteristic of the metal product at a location along the processing path relative to the clamp and/or the cutting device. The location at which the at least one sensor detects the at least one characteristic is along the processing path such that the at least one clamp is between the location and the cutting device. The at least one characteristic may include, but is not limited to, a distance between the sensor and the processing path at the location, marks or other indicators on the metal product, ends of the metal product, a presence or absence of the metal product in the processing path at the location, or other suitable characteristics as desired. As such, the at least one sensor may be various suitable devices or components for detecting the at least one characteristic.

The controller may be various suitable computing devices, controlling devices, or other suitable devices or combinations of devices for controlling the cutting device. The controller may control the cutting device to perform a cutting operation based on the detection by the at least one sensor of the at least one characteristic. As an example, the at least one sensor may transmit a signal to the controller indicating that the metal product is detected at the clamp and/or the metal product is safe to cut, and the controller may control the cutting device to perform the cutting operation based on the detected presence of the metal product at the clamp and/or safety confirmation. Conversely, if the at least one sensor does not detect the at least one characteristic, the controller may not cause the cutting device to perform the cutting operation. The control of the cutting device by the controller based on the detected characteristic may ensure that the metal product is at a location in relation to the cutting device prior to making the cut to improve safety and/or quality of the cut in the metal product.

In some cases, the metal casting system includes more than one processing path such that more than one metal product may be processed if desired. In these cases, the cutting control system may include at least one clamp and at least one sensor for each processing path. As an example, the metal casting system may include a first processing path and a second processing path. In this example, the first processing path may include a first clamp and a first sensor and the second processing path may include a second clamp and a second sensor. Alternatively, in this example, the first processing path may include the first clamp, the second processing path

may include the second clamp, and a single sensor is configured to detect the at least one characteristic at a location on each of the first processing path and the second processing path.

The below figure illustrates an example of a metal casting system 100 with a cutting control system 102. In this figure, the metal casting system 100 is a horizontal continuous casting system with a casting mold 104, a conveyor system 106, and a cutting device 112. During a casting process, a metal product is ejected from the casting mold 104 and conveyed by the conveyor system 106 along a processing path 105 at least partially defined by the conveyor system 106 in a processing direction (indicated by arrow 103).

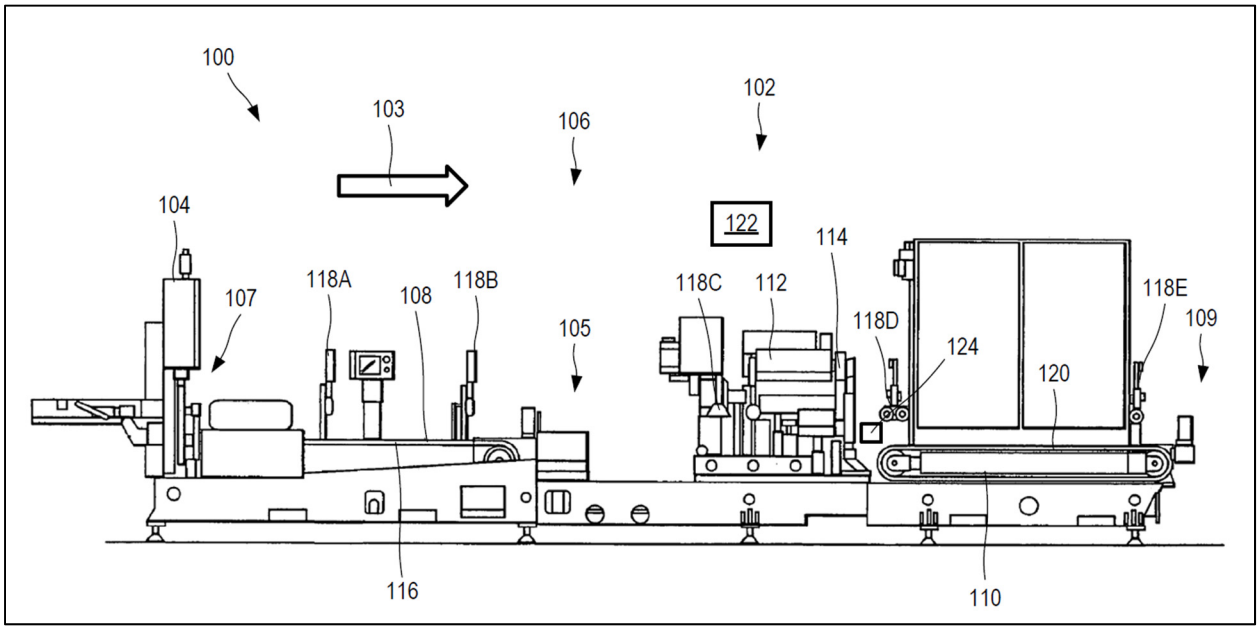

Fig. 1 – Horizontal Casting System with Cutting Control System

In the above figure, the conveyor system 106 includes a first conveyor 108 and a second conveyor 110. The first conveyor 108 defines an upstream end 107 of the conveyor system 106 and is downstream from the casting mold 104 and adjacent to an outlet of the casting mold 104. The second conveyor 110 defines a downstream end 109 of the conveyor system 106 and is downstream from the first conveyor 108. The first conveyor 108 and the second conveyor 110 may include various conveying mechanisms, and in the figure illustrated, they include endless belts 116, 120. The cutting device 112 is between the first conveyor 108 and the second conveyor 110 and may be any suitable device or mechanism for selectively cutting the metal

product to form cut sections of the metal product. In the example illustrated, the cutting device includes a saw 114.

During the continuous casting process, a continuous metal product may exit the casting mold 104 and be supported on the first conveyor 108. The cutting device 112 selectively cuts the metal product into desired sections and such that the metal product is no longer continuous. The second conveyor 110 may support the cut sections of the metal product after the cutting operation and may at least partially support the metal product prior to the cutting operation. After the cutting operation, the second conveyor 110 conveys the cut metal product towards the downstream end 109 such that the metal product may be further processed as desired.

The cutting control system 102 includes a controller 122, clamps 118A-E, and at least one sensor 124. The clamps 118A-E may be various suitable devices to selectively engage and hold the metal product at various locations along the processing path 105, such as roller clamps, static clamps, or other suitable devices or components as desired. In the above figure, the sensor 124 is downstream from the cutting device 112 and upstream from the clamp 118D; however, the particular positioning of the sensor 124 relative to the cutting device 112 and/or the clamp 118D (or the other clamps) should not be considered limiting. The sensor 124 may be vertically offset above the processing path 105, although in other cases, the sensor 124 need not be vertically offset from the processing path 105. For example, the sensor 124 may be horizontally offset from the processing path 105 without being vertically offset from the processing path 105.

The sensor 124 detects at least one characteristic of the metal product in a location that enables the sensor 124 to confirm that the metal product is at a particular clamp. In the above figure, the location at which the sensor 124 is configured to detect the at least one characteristic is along the processing path 105 such that the clamp 118D is between the location and the cutting device 112. The at least one characteristic detected by the sensor 124 may include, but is not limited to, a distance between the sensor and the processing path at the location, marks or other indicators on the metal product, ends of the metal product, a presence or absence of the metal product in the processing path at the location, or other suitable characteristics as desired. The sensor 124 may be various suitable devices or components for detecting the at least one characteristic, including contact sensors or non-contact sensors.

During the casting process, the controller 122 may receive a signal from the sensor 124 that includes data information about the at least one characteristic. In some cases, the sensor 124 may continuously transmit the signal to the controller 122, although in other examples, the sensor 124 may transmit the signal based on a detected change in the at least one characteristic. The controller 122 may analyze the data from the sensor 124 and compare the detected characteristic to a predetermined characteristic. In various aspects, the predetermined characteristic may be indicative that the metal product is at a proper location for cutting with the cutting device 112.

Based the detected characteristic matching the predetermined characteristic, the controller 122 may control the cutting device 112 to perform the cutting operation. In other examples, based on the detected characteristic not being the same as the predetermined characteristic, the controller 122 may not cause the cutting device 112 to perform the cutting operation. In such cases, the controller 122 may optionally output a notification to the operator, via a user interface, notifying the operator that the detected characteristic is not the same as the predetermined characteristic and/or that the metal product is not in the proper location for performing the cutting operation and that it is not safe or desirable to cut the metal product. Optionally, the notification may include an option for the operator to override the notification, and in an example in which the sensor 124 may be malfunctioning, the operator may override the alert and manually perform the cutting operation.

The below figure is a top-view of a metal casting system 200 that is substantially similar to the metal casting system 100 except that the metal casting system 200 includes two processing paths 105A-B, each of which may process a metal product (not illustrated). In this figure, the processing path 105A is offset from the processing path 105B in a lateral direction, and the metal casting system 200 includes two casting molds 104A-B, two first conveyors 108A-B, two second conveyors 110A-B, and two cutting devices 112A-B.

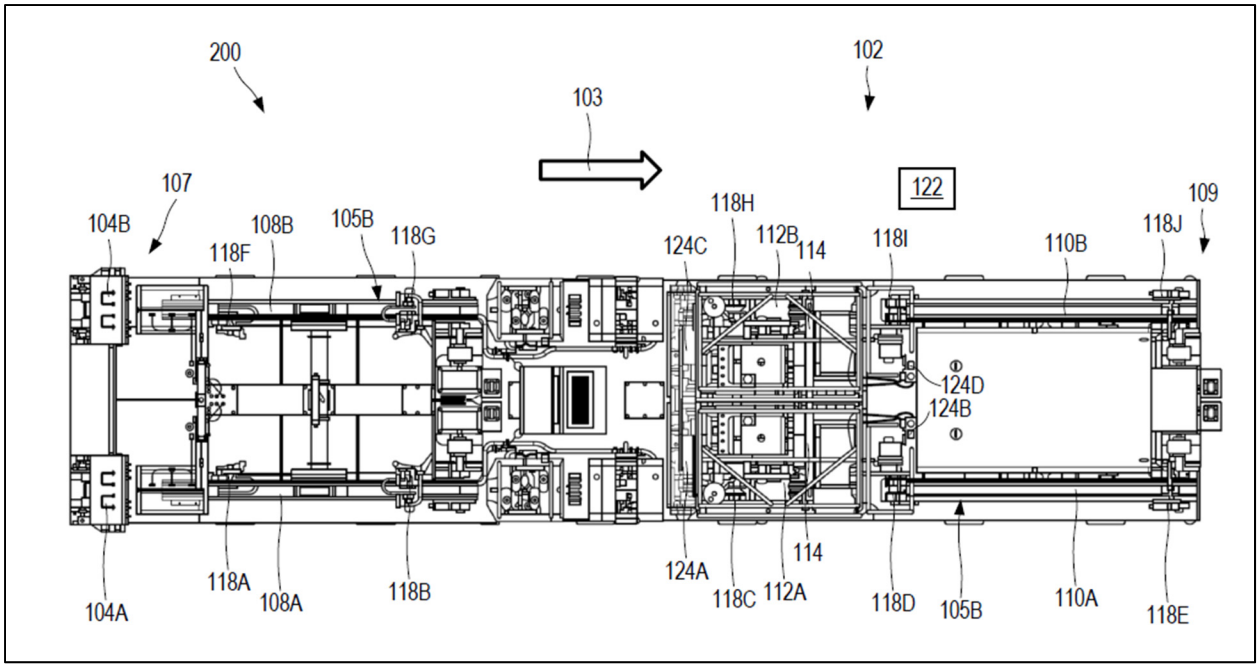

Fig. 2 – Horizontal Casting System with Cutting Control System

Similar to the metal casting system 100, the metal casting system 200 includes the cutting control system 102. In Fig. 2, the cutting control system 102 includes a first set of clamps 118A-E for the first processing path 105A and a second set of clamps 118F-J for the second processing path 105B. The cutting control system 102 also includes four sensors 124A-D: the sensors 124A-B are provided for the first processing path 105A, and the sensors 124C-D are provided for the processing path 105B. Moreover, as illustrated, the sensors 124A and 124C are provided upstream from the respective cutting devices 112A-B, and the sensors 124B and 124D are provided downstream from the respective cutting devices 112A-B. The sensor 124A may detect the at least one characteristic at a location on the processing path 105A such that the clamp 118C is between the location and the cutting device 112A, and the sensor 124B may detect the at least one characteristic at a location on the processing path 105A such that the clamp 118D is between the cutting device 112A and the location. Similarly, the sensor 124C may detect the at least one characteristic at a location on the processing path 105B such that the clamp 118H is between the location and the cutting device 112B, and the sensor 124D may detect the at least one characteristic at a location on the processing path 105B such that the clamp 118I is between the cutting device 112B and the location.

In another configuration, the sensors 124C-D may be omitted, and the sensors 124A-B may be configured to detect the at least one characteristic at locations on each of the processing paths 105A-B. For example, the sensor 124A may detect (i) the at least one characteristic at a location on the processing path 105A such that the clamp 118C is between the location and the cutting device 112A and (ii) the at least one characteristic at a location on the processing path 105B such that the clamp 118H is between the location and the cutting device 112B. Various other configurations and arrangements of clamps 118 and/or sensors 124 may be utilized as desired.

A method for controlling a cutting operation during a metal casting process with the cutting control system 102 includes receiving, by the controller 122, a signal from the sensor 124 with data about at least one detected characteristic of the metal product. The method may include comparing, by the controller 122, the detected characteristic with a predetermined characteristic, which may be indicative of a proper positioning of the metal product relative to the cutting device 112 and/or a clamp (e.g., the clamp 118D). The predetermined characteristic may include, but is not limited to, a presence of the metal product, a presence of a mark or indicator, an end of the metal product, a reduced distance between the location and the sensor 124 (e.g., because the thickness of the metal product changes the detected distance), or other suitable characteristic as desired. Based on the detected characteristic matching the predetermined characteristic (or falling within a predetermined threshold of the predetermined characteristic), the controller 122 outputs a command causing the cutting device 112 to perform the cutting operation and cut the metal product. Optionally, a notification or alert may transmitted to a user interface that is communicatively coupled to the controller 122. The notification or alert may be presented to the operator via the user interface, and the operator may be allowed to choose to cut the metal product or perform other operations as desired.