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Gottschalk

(54) **EDGE GRINDING APPARATUS**

(76) Inventor: **Charles Gottschalk**, Whitehouse, OH (US)

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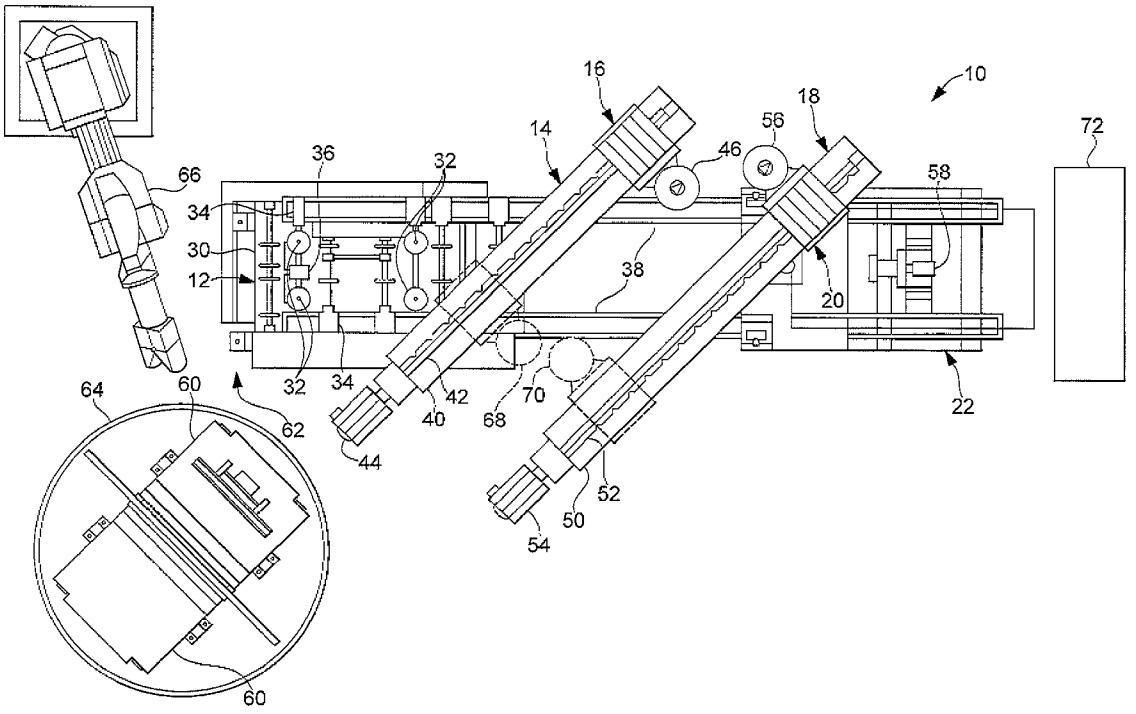
(57) **ABSTRACT**

An edge grinding apparatus for sheets of glass includes a conveyance device coupled to a support structure, wherein the conveyance device includes a conveying position and a grinding position, a carriage support disposed adjacent the conveyor, and a grinding carriage slidingly coupled to the carriage support, the grinding carriage including at least one movable grinding head, wherein a glass sheet is carried by the conveyance device from the conveying position to the grinding position, the glass sheet secured to one of the conveyance device and a fixed table while in the grinding position, at least one edge of the glass sheet ground by the at least one moveable grinding head while in the grinding position.



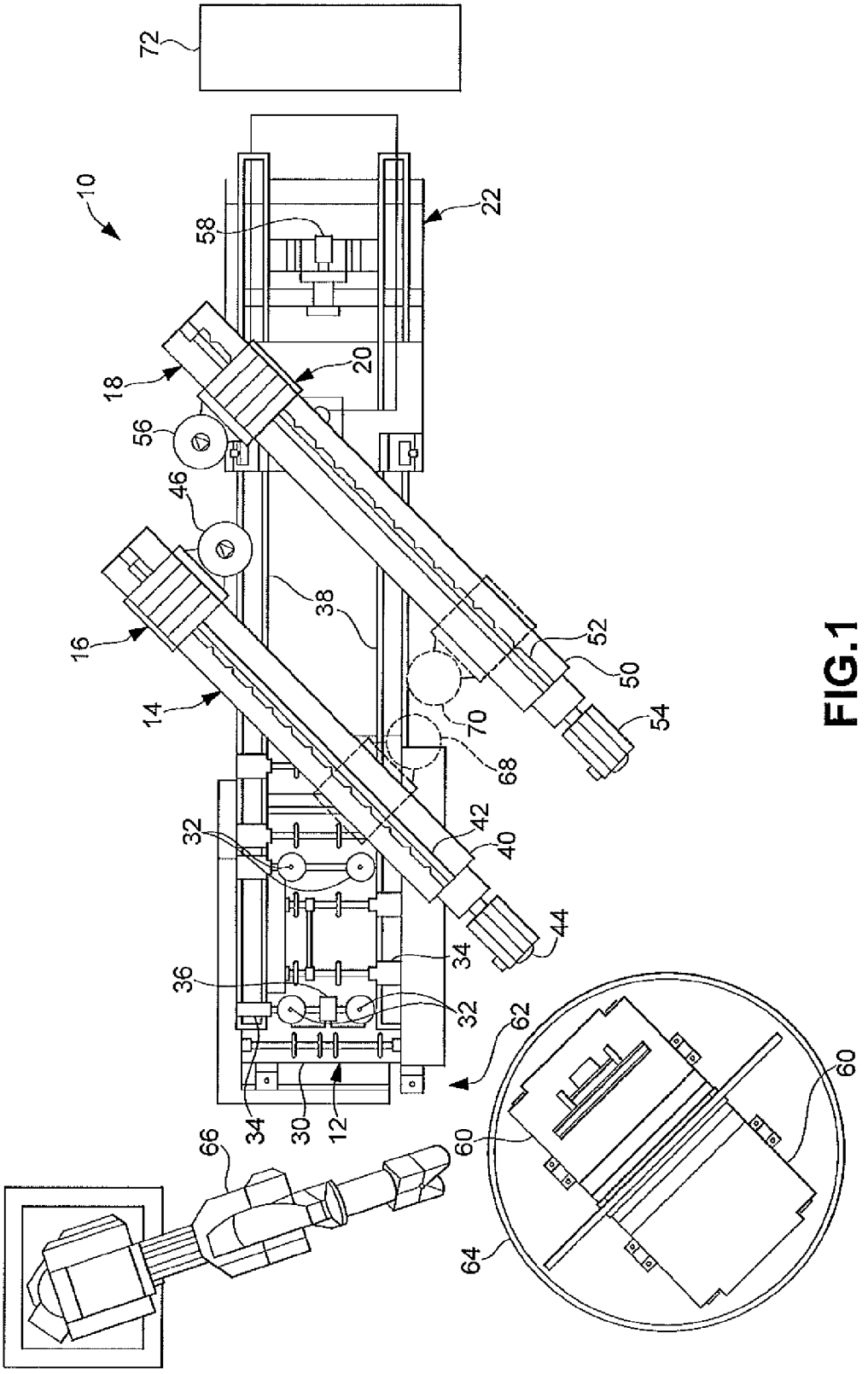

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FIG.1

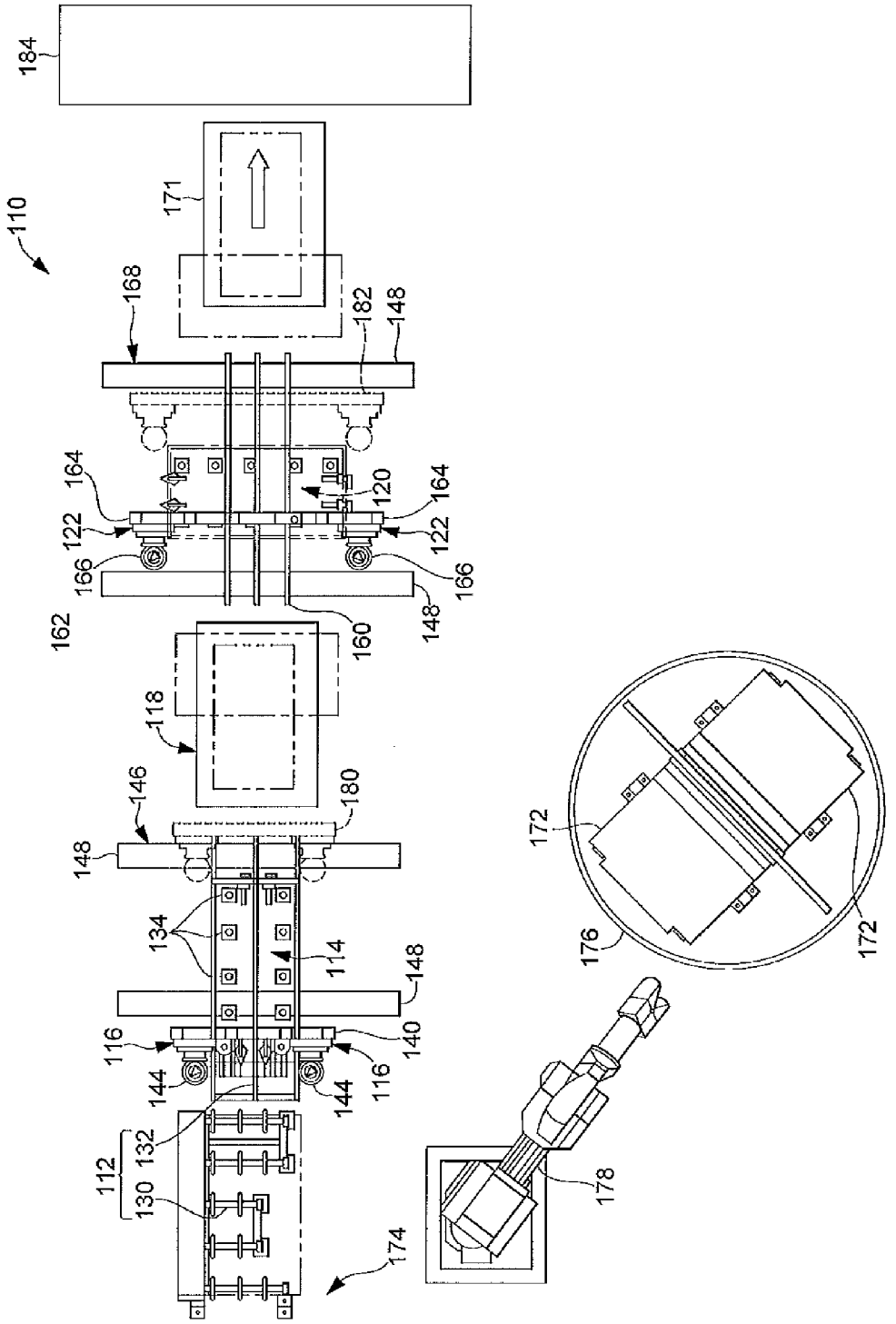
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FIG.2

EDGE GRINDING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This patent application claims the benefit of U.S. Provisional Patent Application Ser. No. 61/288,924 filed on Dec. 22, 2009, hereby incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The invention relates to grinding equipment, and more specifically to an edge grinding apparatus for sheets of glass.

BACKGROUND OF THE INVENTION

[0003] Glass produced using a float process is cut into sheets and subjected to secondary operations before being incorporated into a product or a building. Typically, the peripheral edges of the glass sheets are ground for a variety of reasons such as appearance, ease of handling, safety, ability to perform secondary operations, and to militate against damage that may occur to the edges. Glass sheets are typically rectangular in shape and therefore, require grinding on the four sides of the glass sheet. Equipment used to grind the edges is typically automated to reduce processing time and for consistency.

[0004] Single sided edge grinding devices known in the art may be used to grind a single edge of the glass sheet at one time by one or more grinding wheels. The glass sheet is passed adjacent a grinding wheel or series of grinding wheels having a fixed position. The wheels or wheels are effective to remove a desired amount of material from a first edge of the glass sheet. The glass sheet is then rotated on a transfer unit and a remainder of the edges are ground by the same grinding device or by another similar grinding device. While effective, the single sided edge grinding device requires at least four grinding operations to be performed on the glass sheet, which may amount to considerable processing time.

[0005] To increase productivity, multiple single sided edge grinding devices may be arranged in series to ensure a continuous supply of parts. Four single sided edge grinding devices and three transfer units placed between the grinding devices are required to minimize a processing time of the glass sheet. A large amount of manufacturing floorspace is needed to accommodate an apparatus comprising multiple single sided edge grinding devices and multiple transfer units. The large amount of manufacturing floorspace needed to accommodate multiple single sided edge grinding devices reduces the advantages afforded by increased productivity.

[0006] It would be desirable to have an edge grinding apparatus for sheets of glass that minimizes processing time, the amount of necessary equipment, and the footprint of the edge grinding apparatus.

SUMMARY OF THE INVENTION

[0007] Presently provided by the invention, an edge grinding apparatus for sheets of glass that minimizes processing time, the amount of necessary equipment, and the footprint of the edge grinding apparatus has surprisingly been discovered.

[0008] In one embodiment, an edge grinding apparatus comprises a conveyance device coupled to a support structure, wherein the conveyance device includes a conveying position and a grinding position, a carriage support disposed adjacent the conveyor, and a grinding carriage slidingly coupled to the carriage support, the grinding carriage including at least one movable grinding head, wherein a glass sheet is carried by the conveyance device from the conveying position to the grinding position, the glass sheet secured to one of the conveyance device and a fixed table while in the grinding position, at least one edge of the glass sheet ground by the at least one moveable grinding head while in the grinding position.

[0009] In another embodiment, an edge grinding apparatus for sheets of glass comprises a platen slidingly coupled to a guide rail, a first grinding bridge adjacent the guide rail, a first grinding head slidingly coupled to the first grinding bridge, a second grinding bridge adjacent the guide rail, and a second grinding head slidingly coupled to the second grinding bridge, wherein the first grinding head and the second grinding head cooperate to grind a plurality of edges of a glass sheet coupled to the platen.

[0010] In yet another embodiment, an edge grinding apparatus for sheets of glass comprises a fixed table, a conveyor movably coupled to a support structure adjacent the fixed table, the conveyor having a conveying position and a grinding position, a carriage support adjacent the conveyor, and a grinding carriage slidingly coupled to the carriage support, the grinding carriage including a pair of movable grinding heads, wherein a glass sheet is carried by the conveyor and deposited on the fixed table when the conveyor is moved into the grinding position, and wherein the glass sheet is selectively secured to the fixed table and a plurality of edges of the glass sheet are ground when the grinding carriage head traverses at least a portion of the carriage support.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The above, as well as other advantages of the invention, will become readily apparent to those skilled in the art from the following detailed description of an embodiment of the invention when considered in the light of the accompanying figures, in which:

[0012] FIG. **1** is a top plan view of an edge grinding apparatus according to the present invention; and

[0013] FIG. **2** is a top plan view of an edge grinding apparatus according to another embodiment of the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

[0014] The following detailed description and appended drawings describe and illustrate various exemplary embodiments of the invention. The description and drawings serve to enable one skilled in the art to make and use the invention, and are not intended to limit the scope of the invention in any manner.

[0015] FIG. **1** shows an edge grinding apparatus **10** according to an embodiment of the present invention. The edge grinding apparatus **10** includes a vacuum platen **12**, a first angled bridge **14**, a first movable grinding head **16** (i.e. first grinding carriage), a second angled bridge **18**, a second movable grinding head **20** (i.e. second grinding carriage), and a conveyance device **22**. As illustrated, the edge grinding apparatus **10** is at least a portion of a manufacturing line.

[0016] The vacuum platen **12** includes a carriage **30**, a plurality of vacuum points **32**, a slide mount **34**, and an actuator **36**. The carriage **30** is a rigid, rectangular frame

typically formed from aluminum. Alternately, the carriage **30** may be any shape and formed from any conventional material. A first side of the carriage **30** defines a carriage plane. A second side of the carriage **30** defines a mounting plane.

[0017] The plurality of vacuum points **32** is disposed on the carriage **30** adjacent the carriage plane. Alternately, the plurality of vacuum points **32** may be disposed on at least one mounting spar that spans an interior of the carriage **30**. Each of the vacuum points **32** includes a sealing cup and is in fluid communication with a vacuum pump (not shown).

[0018] The slide mount **34** is disposed on the carriage adjacent the mounting plane. Alternately, the slide mount **34** may be disposed on at least one mounting spar that spans an interior of the carriage **30**. At least three slide mounts **34** are typically disposed on the carriage **30** to maintain a substantially planar relationship therebetween. Each of the slide mounts **34** engages a guide rail **38**. As shown, two parallel guide rails **38** substantially equal to a length of the edge grinding apparatus **10** engage the slide mounts **34**, permitting the carriage **30** to traverse the rails **38** in a linear motion. The guide rails **38** have a loading end and an unloading end and are mounted to a first fixed support structure (not shown). The first fixed support structure is a metal frame affixed to a floor, but any similarly rigid structure may be used.

[0019] The actuator **36** is a servo motor having a drive screw affixed to at least one of the guide rails **38** that applies a force upon a threaded portion of the slide mount **34**, causing the carriage **30** to traverse the rails **38**. Alternately, the actuator **36** may be any other device such as a fluid piston; a rack and motor operated pinion; or a track actuator that imparts a force between a fixed object and at least one of the slide mount **34** and the carriage **30** to traverse the carriage **30** on the guide rails **38**.

[0020] The first angled bridge **14** includes a first main body **40** (i.e. a first carriage support) having a first grinding head guide **42** and a first grinding head actuator **44**. The first main body **40** is a three sided frame having a transverse top rail coupled to two fixed vertical supports, but any shape may be used. The first main body **40** is obliquely disposed across the guide rails **38**. The first grinding head guide **42** is formed in the transverse top rail, and the first grinding head actuator **44** is disposed at an end of the transverse top rail. In certain embodiments, the first movable grinding head **16** is slidingly coupled to the first main body **40**. As a non-limiting example, the first grinding head actuator **44** is a servo motor having a drive screw rotatingly coupled to the transverse top rail that applies a force upon a threaded portion of the first movable grinding head **16**, causing the first movable grinding head **16** to traverse the first grinding head guide **42**. Alternately, the first grinding head actuator **44** may be any other device such as a fluid piston; a rack and motor operated pinion; or a track actuator that imparts a force between the first main body **40** and the first movable grinding head **16** to traverse the first movable grinding head **16** on the first grinding head guide **42**.

[0021] The first movable grinding head **16** includes a first grinding wheel **46** rotatingly coupled to a motor disposed in the first movable grinding head **16**. The first grinding wheel **46** is typically a diamond grinding wheel as is known in the art, but other types of grinding wheels may be used. An axis of the first grinding wheel **46** is substantially perpendicular to the carriage plane. A position of the first grinding wheel **46** may be adjusted along the axis of the first grinding wheel **46** to align a peripheral edge of the first grinding wheel **46** with a peripheral edge of a glass sheet secured to the vacuum points **32** of the carriage **30**.

[0022] The second angled bridge **18** includes a second main body **50** (i.e. a second carriage support) having a second grinding head guide **52** and a second grinding head actuator **54**. The second main body **50** is a three sided frame having a transverse top rail coupled to two fixed vertical supports, but any shape may be used. The second main body **50** is obliquely disposed across the guide rails **38**. The second grinding head guide **52** is formed in the transverse top rail, and the second grinding head actuator **54** is disposed at an end of the transverse top rail. In certain embodiments, the second movable grinding head **20** is slidingly coupled to the second main body **50**. As a non-limiting example, The second grinding head actuator **54** is a servo motor having a drive screw rotatingly coupled to the transverse top rail that applies a force upon a threaded portion of the second movable grinding head **20**, causing the second movable grinding head **20** to traverse the second grinding head guide **52**. Alternately, the second grinding head actuator **54** may be any other device such as a fluid piston, a rack and motor operated pinion, or a track actuator that imparts a force between the second main body **50** and the second movable grinding head **20** to traverse the second movable grinding head **20** on the second grinding head guide **52**.

[0023] The second movable grinding head **20** includes a second grinding wheel **56** rotatingly coupled to a motor disposed in the second movable grinding head **20**. The second grinding wheel **56** is typically a diamond grinding wheel as is known in the art, but other types of grinding wheels may be used. An axis of the second grinding wheel **56** is perpendicular to the carriage plane. A position of the second grinding wheel **46** may be adjusted along the axis of the second grinding wheel **56** to align a peripheral edge of the second grinding wheel **56** with a peripheral edge of the glass sheet secured to the vacuum points **32** of the carriage **30**.

[0024] The conveyance device **22** is coupled to the first fixed support structure and includes two motor operated conveyor belts movably mounted adjacent the unloading end of the guide rails **38**. The two conveyor belts are spaced apart and are substantially aligned with the guide rails **38**. A conveyance device actuator **58** rotates the conveyance device **22**, causing a transfer surface of the conveyor belts to enter the carriage plane adjacent the carriage **30**. Alternately, a series of rollers, a shuttle carrier, or the like may be used as the conveyance device **22**.

[0025] In use, the edge grinding apparatus **10** facilitates efficient edge grinding of the glass sheet in a compact footprint. Several pieces of the glass sheet are stored in a glass rack **60** at an apparatus first end **62**. A rack turntable **64** that rotates about a central axis allows two glass racks **60** facing opposite directions to be placed on the rack turntable **64** simultaneously. A loading device **66** is an arm-style industrial robot having an attachment affixed thereto. The attachment is a plurality of vacuum powered suction cups. The loading device **66** and the attachment move into a loading position and lift the glass sheet from the glass rack **60**. The loading device **66** and the attachment including the glass sheet move into an unloading position. The unloading position aligns the glass sheet with the vacuum platen **12** and the vacuum points **32** while the glass sheet is substantially parallel to the carriage plane. The attachment releases the plurality of vacuum powered suction cups, depositing the glass sheet on the vacuum points **32**. A plurality of fixed or movable sheet guides may be

used to align the glass sheet on the vacuum platen **12**. The vacuum pump is activated, securing the glass sheet to the vacuum points **32** of the vacuum platen **12**.

[0026] The actuator **36**, the first movable grinding head **16**, and the second movable grinding head **20** are activated after the glass sheet is secured to the vacuum platen **12**. The actuator **36** causes the vacuum platen **12** to move along the guide rails **38** at a desired rate. The first grinding head actuator **44** causes the first movable grinding head **16** to move along the first main body **40** to a first grinding position **68**. The motor disposed in the first movable grinding head **16** causes the first grinding wheel **46** to spin at a desired rate. The second grinding head actuator **54** causes the second movable grinding head **20** to move along the second main body **50** to a second grinding position **70**. The motor disposed in the second movable grinding head **20** causes the second grinding wheel **56** to spin at a desired rate.

[0027] The glass sheet secured to the vacuum platen **12** includes a first lateral edge, a second lateral edge, a leading edge, and a trailing edge. The first lateral edge and the second lateral edge are positioned substantially parallel to the guide rails **38**. The leading edge and the trailing edge are positioned substantially perpendicular to the guide rails **38**.

[0028] The first grinding wheel **46** in the first grinding position **68** comes into contact with the first lateral edge of the glass sheet as the glass sheet passes under the first angled bridge **14**. As the vacuum platen **12** continues to move along the guide rails **38**, the first movable grinding head **16** remains stationary, grinding the first lateral edge of the glass sheet. After grinding of the first lateral edge is completed, the first grinding head actuator **44** moves the first movable grinding head **16** along the first grinding head guide **42**, grinding the trialing edge of the glass sheet. The first grinding head actuator **44** may move the first movable grinding head **16** in a manner that forms a chamfered corner or a rounded corner between the leading edge and the first lateral edge, the first lateral edge and the trailing edge, and the trailing edge and the second lateral edge of the glass sheet.

[0029] The second grinding wheel **56** grinds the leading edge and the second lateral edge of the glass sheet. The second grinding wheel **56** in the second grinding position **70** comes into contact with the leading edge of the glass sheet as the glass sheet approaches the second angled bridge **18**. The second grinding head actuator **54** moves the second movable grinding head **20** along the second grinding head guide **52**, grinding the leading edge of the glass sheet. After the leading edge is ground, the second grinding head actuator **54** stops moving the second movable grinding head **20**, grinding the second lateral edge of the glass sheet as the vacuum platen **12** continues to move along the guide rails **38**. The second grinding head actuator **54** may move the second movable grinding head **20** in a manner that forms a chamfered corner or a rounded corner between the first lateral edge and the leading edge, the leading edge and the second lateral edge, and the second lateral edge and the trailing edge of the glass sheet.

[0030] After the leading edge, the first lateral edge, the second lateral edge, and the trailing edge of the glass sheet are ground, the vacuum platen **12** continues to a distal end of the guide rails **38** and stops. The conveyance device actuator **58** is engaged, lifting the conveyance device **22** at least partially into the carriage plane. Simultaneously, the vacuum pump is deactivated. The conveyance device **22** is engaged, removing the glass sheet from the vacuum platen **12**. After removal of the glass sheet, the vacuum platen **12** is returned to the system first end **62**, the first movable grinding head **16** is returned to the first grinding position **68**, and the second movable grinding head **20** is returned to the second grinding position **70**. The conveyance device **22** transports the glass sheet to a packing station **72** where the glass sheet is packed for shipping. Alternately, the packing station **72** may be any type of secondary operation. Upon return of the vacuum platen **12**, a second glass sheet is placed on the vacuum platen **12** and the edge grinding process is repeated.

[0031] FIG. **2** shows a second embodiment of an edge grinding apparatus **110** according to an embodiment of the present invention. The edge grinding apparatus **110** includes a conveyor **112**, a first fixed vacuum table **114**, a first pair of movable grinding heads **116**, a part rotation table **118**, a second fixed vacuum table **120**, and a second pair of movable grinding heads **122**. As illustrated, the edge grinding apparatus **110** is at least a portion of a manufacturing line.

[0032] The conveyor **112** includes a roller portion **130** and a first belt portion **132**. The roller portion **130** is a motor operated series of rollers aligned with the first belt portion **132** and is coupled to a second fixed support structure (not shown). The first belt portion **132** includes three motor operated conveyor belts and is movably coupled to the second fixed support structure. A belt portion actuator coupled to the first belt portion **132** and the second fixed support structure moves the first belt portion **132** from a grinding position to a conveying position and from the conveying position to the grinding position. The glass sheet disposed on the first belt portion **132** when the first belt portion **132** moved from a conveying position to a grinding position is disposed on the first fixed vacuum table **114**.

[0033] The first fixed vacuum table **114** includes a plurality of first vacuum points **134** coupled to the second fixed support structure. The first vacuum points **134** are disposed in a common plane to support the glass sheet when the first belt portion **132** moves from a conveying position to a grinding position. Each of the vacuum points **134** includes a sealing cup and is in fluid communication with a vacuum pump (not shown).

[0034] The first pair of movable grinding heads **116** is movably coupled to a first grinding carriage **140**. Servo motors, each having a drive screw rotatingly coupled to the first grinding carriage **140**, are first head actuators. The drive screw applies a force upon a threaded portion of each of the first pair of movable grinding heads **116**, allowing a distance between the first pair of movable grinding heads **116** to be adjusted. The first pair of movable grinding heads **116** includes a first pair of grinding wheels **144** rotatingly coupled to a pair of motors in the first pair of movable grinding heads **116**. The first pair of grinding wheels **144** are typically diamond grinding wheels as is known in the art, but other types of grinding wheels may be used. A pair of axes of the first pair of grinding wheels **144** is substantially perpendicular to the common plane formed by the first plurality of vacuum points **134**. A position of the first pair of grinding wheels **144** may be adjusted along the pair of axes to align a peripheral edge of the first pair of grinding wheels **144** with a peripheral edge of the glass sheet secured to the first plurality of vacuum points **134** of the first fixed vacuum table **114**.

[0035] The first grinding carriage **140** is slidably coupled to a first carriage support **146**. The first carriage support **146** includes two three sided frames **148**, each having a transverse top rail coupled to two fixed vertical supports, joined by a carriage guide (not shown). The carriage guide is perpendicular to each of the top rails. The first carriage support **146** is

disposed across the first belt portion **132** and the first fixed vacuum table **114**, the carriage guide disposed parallel to the first belt portion **132** of the conveyor **112**.

[0036] A first carriage actuator (not shown) is a servo motor having a drive screw rotatingly coupled to the carriage guide that applies a force upon a threaded portion of the first grinding carriage **140**, causing the first grinding carriage **140** to traverse the carriage guide. Alternately, the first carriage actuator may be any other device such as a fluid piston, a rack and motor operated pinion, or a track actuator that imparts a force between the carriage guide and the first grinding carriage **140** to traverse the first grinding carriage **140** on the carriage guide.

[0037] The part rotation table **118** is disposed at an end of the conveyor, between the first belt portion **132** and a second belt portion **160**. The part rotation table **118** includes a second roller portion (not shown) and a rotating unit (not shown). The second roller portion is a motor operated series of rollers aligned with the first belt portion **132** and is coupled to the second fixed support structure. The rotating unit is positioned above the second roller portion and is motor and actuator operated. The second roller portion and the rotating unit cooperate to rotate the glass sheet 90 degrees around an axis normal to a side of the glass sheet.

[0038] The second belt portion **160** includes three motor operated conveyor belts and is movably coupled to the second fixed support structure. A belt portion actuator coupled to the second belt portion **160** and the second fixed support structure moves the second belt portion **160** from a grinding position to a conveying position and from the conveying position to the grinding position. The glass sheet disposed on the second belt portion **160** when the second belt portion **160** moved from a conveying position to a grinding position is disposed on the second fixed vacuum table **120**.

[0039] The second fixed vacuum table **120** includes a second plurality of vacuum points **162** coupled to the second fixed support structure. The second plurality of vacuum points **162** is disposed in a common plane to support the glass sheet when the second belt portion **160** moves from a conveying position to a grinding position. Each of the vacuum points **162** includes a sealing cup and is in fluid communication with a vacuum pump (not shown).

[0040] The second pair of movable grinding heads **122** is movably coupled to a second grinding carriage **164**. Servo motors, each having a drive screw rotatingly coupled to the second grinding carriage **162**, are second head actuators. The drive screw applies a force upon a threaded portion of each of the second pair of movable grinding heads **122**, allowing a distance between the second pair of movable grinding heads **122** to be adjusted. The second pair of movable grinding heads **122** includes a second pair of grinding wheels **166** rotatingly coupled to a pair of motors in the second pair of movable grinding heads **122**. The second pair of grinding wheels **166** are typically diamond grinding wheels as is known in the art, but other types of grinding wheels may be used. A pair of axes of the second pair of grinding wheels **166** is substantially perpendicular to the common plane formed by the second plurality of vacuum points **162**. A position of the second pair of grinding wheels **166** may be adjusted along the pair of axes to align a peripheral edge of the second pair of grinding wheels **166** with a peripheral edge of the glass sheet secured to the second plurality of vacuum points **162** of the second fixed vacuum table **120**.

[0041] The second grinding carriage **164** is slidably coupled to a second carriage support **168**. The second carriage support **168** includes two three sided frames **148**, each having a transverse top rail coupled to two fixed vertical supports, joined by a carriage guide (not shown). The carriage guide is perpendicular to each of the top rails. The second carriage support **168** is disposed across the second belt portion **160** and the second fixed vacuum table **120**, the carriage guide disposed parallel to the second belt portion **160**.

[0042] A second carriage actuator (not shown) is a servo motor having a drive screw rotatingly coupled to the carriage guide that applies a force upon a threaded portion of the second grinding carriage **164**, causing the second grinding carriage **164** to traverse the carriage guide. Alternately, the second carriage actuator may be any other device such as a fluid piston, a rack and motor operated pinion, or a track actuator that imparts a force between the carriage guide and the second grinding carriage **164** to traverse the second grinding carriage **164** on the carriage guide.

[0043] A utility device **171** is disposed adjacent the second pair of movable grinding wheels **122** and is coupled to the second fixed support structure. In FIG. **2**, the utility device **171** is generically represented as a part rotation table, but any other device such as a part washer, a drilling station, and a checking fixture may be used.

[0044] In use, the edge grinding apparatus **110** facilitates efficient edge grinding of the glass sheet in a compact footprint. Several pieces of the glass sheet are stored in a second glass rack **172** at a second apparatus first end **174**. A second rack turntable **176** that rotates about a central axis allows two second glass racks **172** facing opposite directions to be placed on the second rack turntable **176** simultaneously. A second loading device **178** is an arm-style industrial robot having an attachment affixed thereto. The attachment is a plurality of vacuum powered suction cups. The second loading device **178** and the attachment move into a loading position and lift the glass sheet from the second glass rack **172**. The second loading device **178** and the attachment including the glass sheet move into an unloading position. The unloading position aligns the glass sheet with the roller portion **130**, substantially parallel to the series of rollers. The attachment releases the plurality of vacuum powered suction cups, depositing the glass sheet on the roller portion **130**. A plurality of fixed or movable sheet guides may be used to accurately align the glass sheet on the roller portion **130**. The roller portion **130** and the first belt portion **132** are activated, transporting the glass sheet to the first belt portion **132**.

[0045] The glass sheet continues on the first belt portion **132** until the glass sheet is aligned with the first fixed vacuum table **114**. An optical sensor or other type of sensor is used to locate the position of the glass sheet on the first belt portion **132** to ensure alignment of the glass sheet with the first fixed vacuum table **114**. The belt portion actuator is activated, moving the first belt portion **132** from the conveying position into a grinding portion, depositing the glass sheet on the first fixed vacuum table **114**. The vacuum pump in communication with the first fixed vacuum table **114** is activated, securing the glass sheet. The motors disposed in the first pair of movable grinding heads **116** are activated to cause the first pair of grinding wheels **144** to spin at a desired rate. The first carriage actuator causes the first grinding carriage **140** including the first pair of movable grinding heads **116** to move along the carriage guide from a primary grinding position **180**. The first pair of grinding wheels **144** grinds the peripheral edges of the

glass sheet as the first grinding carriage **140** traverses the carriage guide. Upon the first grinding carriage **140** traversing a length of the carriage guide, the first pair of grinding wheels **144** has traversed past the peripheral edges of the glass sheet. The vacuum pump is deactivated and the belt portion actuator is activated, moving the first belt portion **132** from the grinding position into a conveying position, lifting the glass sheet from the first fixed vacuum table **114**. The first belt portion **132** and the second roller portion are activated, transporting the glass sheet from the first belt portion **132** onto the second roller portion of the part rotation table **118**.

[0046] The glass sheet traverses across the second roller portion until the glass sheet is in a rotation position. An optical sensor or other type of sensor is used to locate the position of the glass sheet on the second roller portion to ensure alignment of the glass sheet with the rotating unit. Once the glass sheet is positioned, the rotating unit is lowered until the rotating unit contacts the glass sheet. A plurality of vacuum powered suction cups couple the glass sheet to the rotating unit. The rotating unit is raised from the second roller portion and rotated 90 degrees around the axis normal to the side of the glass sheet. After rotation is completed, the rotating unit is lowered until the glass sheet contacts the second roller portion. The plurality of vacuum powered suction cups is released, separating the glass sheet from the rotating unit. The rotating unit is then raised from the glass sheet and the second roller portion. The second roller portion and the second belt portion **160** are then activated and the glass sheet traverses from the part rotation table **118** onto the second belt portion **160**.

[0047] The glass sheet continues on the second belt portion **160** until the glass sheet is aligned with the second fixed vacuum table **120**. An optical sensor or other type of sensor is used to locate the position of the glass sheet on the second belt portion **160** to ensure alignment of the glass sheet with the second fixed vacuum table **120**. The belt portion actuator is activated, moving the second belt portion **160** from the conveying position into a grinding portion, depositing the glass sheet on the second fixed vacuum table **120**. The vacuum pump in communication with the second fixed vacuum table **120** is activated, securing the glass sheet. The motors disposed in the second pair of movable grinding heads **122** are activated to cause the second pair of grinding wheels **166** to spin at a desired rate. The second carriage actuator causes the second grinding carriage **164** including the second pair of movable grinding heads **122** to move along the carriage guide from a secondary grinding position **182**. The second pair of grinding wheels **166** grinds the peripheral edges of the glass sheet as the second grinding carriage **164** traverses the carriage guide. Upon the second grinding carriage **164** traversing the length of the carriage guide, the first pair of grinding wheels **166** has traversed past the peripheral edges of the glass sheet. The vacuum pump is deactivated and the belt portion actuator is activated, moving the second belt portion **160** from the grinding position into a conveying position, lifting the glass sheet from the second fixed vacuum table **120**. The second belt portion **160** is activated, transporting the glass sheet from the second belt portion **160** onto the utility device **171**.

[0048] As shown, the utility device **171** rotates the glass sheet 90 degrees about an axis normal to a side of the glass sheet similar to the rotating unit. Rotation of the glass sheet into a packing position facilitates handling and storage of the glass sheet. A conveyance portion of the utility device **171** transports the glass sheet to a packing station **184** where the glass sheet is packed for shipping. Alternately, the packing station **184** may be any type of secondary operation. Upon return of the first pair of movable grinding heads **116** to the primary grinding position **180** and return of the second pair of movable grinding heads **122** to the secondary grinding position **182**, a second glass sheet is placed on the roller portion **130** and the edge grinding process is repeated.

[0049] In addition to grinding the edges of the glass sheet, the edge grinding apparatus **10**, **110** may also be used to grind the corners of the glass sheet into a chamfer or an arcuate shape by the first movable grinding head **16**, the second movable grinding head **20**, the first pair of movable grinding heads **116**, and the second pair of movable grinding heads **122**. The chamfer or the arcuate shape is formed between the successive edges of the glass sheet when excess glass is ground from the glass sheet by at least one of the grinding heads **16**, **20**, **116**, **122**. A profile of the chamfer or the arcuate shape is able to be programmed by an operator of the edge grinding apparatus **10**, **110** into a controller of the heads **16**, **20**, **116**, **122** prior to the start of a grinding operation.

[0050] From the foregoing description, one ordinarily skilled in the art can easily ascertain the essential characteristics of this invention and, without departing from the spirit and scope thereof, can make various changes and modifications to the invention to adapt it to various usages and conditions.

What is claimed is:

1. An edge grinding apparatus for sheets of glass comprising:

a conveyance device coupled to a support structure, wherein the conveyance device includes a conveying position and a grinding position;

a carriage support disposed adjacent the conveyor; and

a grinding carriage slidingly coupled to the carriage support, the grinding carriage including at least one movable grinding head, wherein a glass sheet is carried by the conveyance device from the conveying position to the grinding position, the glass sheet secured to one of the conveyance device and a fixed table while in the grinding position, at least one edge of the glass sheet ground by the at least one moveable grinding head while in the grinding position.

2. The edge grinding apparatus according to claim **1**, wherein the conveyance device includes a vacuum point to secure the glass sheet thereto.

3. The edge grinding apparatus according to claim **1**, wherein the at least one edge of the glass sheet is ground by moving the grinding carriage along at least a portion of the carriage support such that the at least one moveable grinding head grinds the at least one edge of the glass sheet.

4. The edge grinding apparatus according to claim **1**, wherein the at least one edge of the glass sheet is ground by moving the glass sheet past at least a portion of the carriage support such that the at least one moveable grinding head grinds the at least one edge of the glass sheet.

5. The edge grinding apparatus according to claim **1**, wherein the carriage support is disposed at least one of transversely and obliquely across the conveyor.

6. The edge grinding apparatus according to claim **1**, wherein the glass sheet has four edges, the four edges ground during one pass of the glass sheet past the carriage support.

7. The edge grinding apparatus according to claim **1**, wherein a flat chamfer is ground between the edges of the glass sheet.

8. The edge grinding apparatus according to claim **7**, wherein a profile of the chamfer is able to be programmed by an operator of the edge grinding apparatus.

9. The edge grinding apparatus according to claim **1**, wherein an arcuate shape is ground between the edges of the glass sheet.

10. The edge grinding apparatus according to claim **9**, wherein a profile of the arcuate shape is able to be programmed by an operator of the edge grinding apparatus.

11. An edge grinding apparatus for sheets of glass comprising:

a platen slidingly coupled to a guide rail;

a first grinding bridge adjacent the guide rail;

a first grinding head slidingly coupled to the first grinding bridge;

a second grinding bridge adjacent the guide rail; and

a second grinding head slidingly coupled to the second grinding bridge, wherein the first grinding head and the second grinding head cooperate to grind a plurality of edges of a glass sheet coupled to the platen.

12. The edge grinding apparatus according to claim **11**, wherein the platen includes at least one vacuum point for securing the glass sheet to the platen.

13. The edge grinding apparatus according to claim **11**, wherein at least one of the first grinding bridge and the second grinding bridge is disposed at least one of transversely and obliquely across the guide rail.

14. The edge grinding apparatus according to claim **11**, wherein at least one edge of the glass sheet is ground by moving the first grinding head along at least a portion of the first grinding bridge.

15. The edge grinding apparatus according to claim **11**, wherein at least one edge of the glass sheet is ground by moving the second grinding head along at least a portion of the second grinding bridge.

16. The edge grinding apparatus according to claim **11**, wherein at least one edge of the glass sheet is ground by moving the platen along the guide rail such that the glass sheet traverses at least one of the first grinding bridge and the second grinding bridge.

17. The edge grinding apparatus according to claim **11**, wherein the glass sheet has four edges, the four edges ground during one pass of the glass sheet past each of the first grinding bridge and the second grinding bridge.

18. An edge grinding apparatus for sheets of glass comprising:

a fixed table;

a conveyor movably coupled to a support structure adjacent the fixed table, the conveyor having a conveying position and a grinding position;

a carriage support adjacent the conveyor; and

a grinding carriage slidingly coupled to the carriage support, the grinding carriage including a pair of movable grinding heads, wherein a glass sheet is carried by the conveyor and deposited on the fixed table when the conveyor is moved into the grinding position, and wherein the glass sheet is selectively secured to the fixed table and a plurality of edges of the glass sheet are ground when the grinding carriage head traverses at least a portion of the carriage support.

19. The edge grinding apparatus according to claim **18**, wherein the fixed table includes at least one vacuum point for securing the glass sheet to the fixed table.

20. The edge grinding apparatus according to claim **18**, further comprising a part rotation table disposed adjacent the conveyor to rotate the glass sheet around an axis normal to a side of the glass sheet.

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