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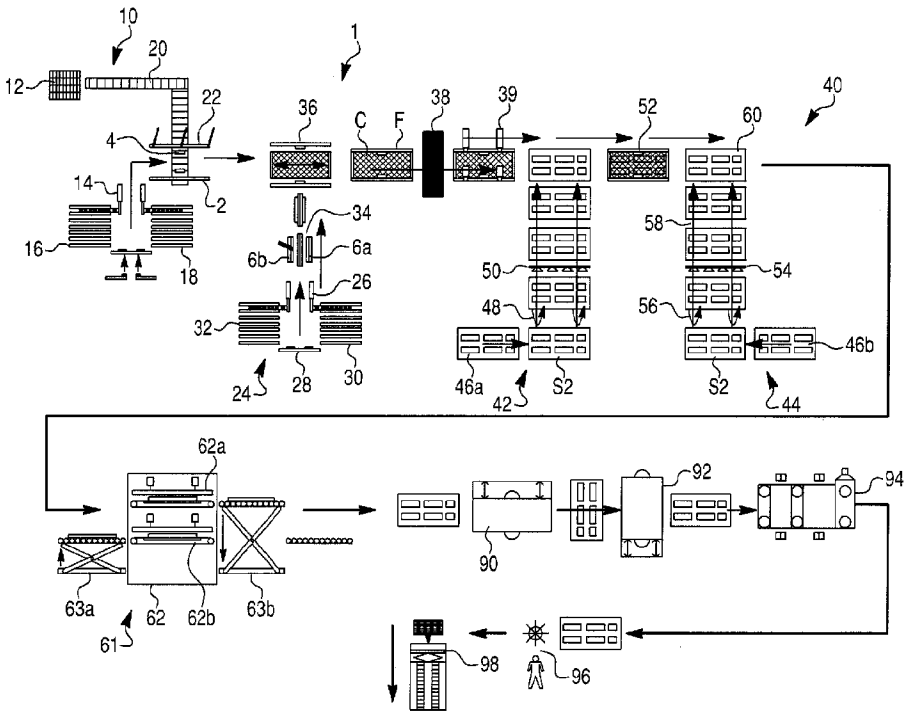
(54) Title: AUTOMATED DOOR ASSEMBLY, PRESS, AND ADHESIVE THEREFOR



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Provided is a system and method of making a door having first and second door skins (S1, S2) and an internal frame (F). The top and bottom surfaces of the frame are coated with an adhesive and the frame (F) is placed on a first door skin (S1). The second door skin (S2) is then placed on the opposite surface of the frame (F). The assembled components are then pressed to bond the first and second door skins (SI, S2) to the frame (F).

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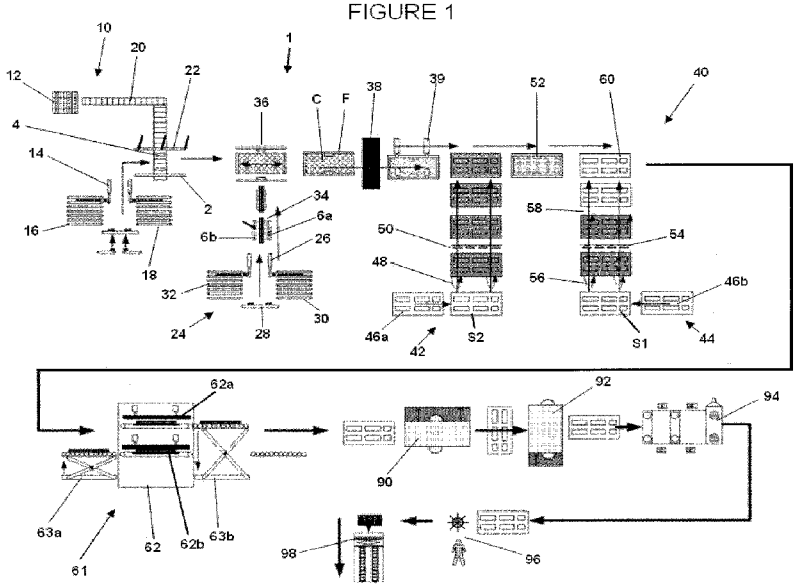
FIGURE 1



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AUTOMATED DOOR ASSEMBLY, PRESS, AND ADHESIVE THEREFOR

[0001]

FIELD

[0002] This disclosure is directed to an automated system and method for manufacturing a door having first and second door facings and an internal door frame.

BACKGROUND

[0003] Doors are typically made from two molded or flush door skins attached to opposite sides a central door frame. The door facings are often molded from a wood fiber and resin compound, although fiberglass resin formed polymer door facings are known. The door frame typically includes stiles and rails made of wood located around the perimeter of the door. The interior of the door may optionally include a core.

[0004] Manual assembly of doors is relatively labor intensive, expensive, and subject to quality variations. During manual assembly, a door facing is placed on a production table with its intended exterior surface face down. Adhesive is then applied to the stiles and rails of a frame. The adhesively coated frame parts are then placed on the door facing on the table. Adhesive applied to a second side of the stiles and rails faces upwardly and a second door facing is placed with its exterior surface face upon the second side of the frame. The resulting assembled door is stacked at a holding station so that additional doors may be assembled. The assembled doors should be handled carefully, given that the components of the door can easily shift during transportation.

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[0005] Each successive door assembly is stacked on top of the previous door assembly until a predetermined quantity of door assemblies has been stacked. The stack of door assemblies is then transported to and loaded in a press. The press applies pressure to the entire stack for a period of time sufficient to allow the adhesive to bond the door facings to the frame. Conventional adhesives, such as polyvinyl acetate, may take approximately thirty minutes or more in-press before the door reaches "green" strength. The door achieves green strength when the adhesive has reached sufficient bonding strength to hold the door components together for further handling.

[0006] Once an acceptable green strength is achieved, the doors may be removed from the press and moved to an in-process inventory until the adhesive reaches maximum cure strength. Depending on the adhesive used, the doors may need to remain in inventory for a relatively long period of time, for example two hours or more, or even as long as twenty-four hours, before the adhesive reaches maximum bonding strength.

[0007] After reaching maximum cure strength the doors are then moved to a final processing station. Final processing includes edge trimming the doors to customer specification and optional coating and/or painting of door skins and exposed edges of the stiles and rails around each door perimeter. Using this process, manufacturing time for a door may be twenty-four hours or more, from the time production is initiated to the resulting finished door is complete.

SUMMARY

[0008] In accordance with an embodiment, a door-making system includes at least one coating station, at least one assembly station, and at least one pressing station. The coating station applies adhesive to at least one of a door frame, a first door skin, and a second door skin. The assembly station joins the first and second door skins to opposite surfaces of the frame. The pressing station includes a first press and a second press for alternately receiving the assembled doors.

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[0009] In accordance with a further embodiment, a door pressing station includes at least one press having an upper die and a lower die. The upper die has an upper convex surface and the lower die has a lower convex surface. The upper and lower convex surfaces face one another to define a mold cavity.

[0010] In accordance with a further embodiment, a method of making a door includes adhesively bonding a first door skin and a second door skin to opposite sides of a frame to assembly doors as part of a production process. The assembled doors are alternately received in a first press and a second press.

[0011] In accordance with another embodiment, a method of pressing an assembled door includes loading an assembled door into a press having an upper die with an upper convex portion and a lower die with a lower convex portion. The upper and lower convex surfaces face one another to press the door assembly.

[0012] In one embodiment, there is provided a door-making system comprising at least one coating station for applying adhesive to at least one of a door frame having stiles and rails forming a perimeter of the door frame, a first door skin and a second door skin. The system further includes at least one assembly station for joining the first and second door skins to opposite first and second surfaces of the door frame, respectively, to form assembled doors. The system further includes a pressing station for alternatingly pressing at least two of the assembled doors, the pressing station comprising a first press and a second press vertically stacked one on top of another for alternately receiving at least two of the assembled doors, each press comprises an upper die and a lower die. The system further includes at least one material handling device for transporting the assembled doors between the stations. The pressing station is adapted to perform a pressing operation on at least a first of the assembled doors in the first press while loading or discharging at least a second of the assembled doors into or out of the second press. The first and second presses include a pressing surface shaped to compress central portions of the first and second door skins to a greater extent than peripheral portions disposed about the perimeter of the first and second door skins, so that

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surfaces of the central portions and the peripheral portions of the first and second door skins are coplanar with each other, and the peripheral portions are in contact with the stiles and rails of the door frame upon completion of the pressing operation. The at least one coating station comprises a first coating station for applying adhesive to the frame, a second coating station for applying adhesive to the first door skin, and a third adhesive station for applying adhesive to the second door skin and the first and second door skins comprise at least one panel and the second and third coating stations apply a bead of adhesive to the panels of the first and second door skins respectively.

[0011b] In another embodiment, there is provided a door-making system comprising at least one coating station for applying adhesive to at least one of a door frame having opposite first and second surfaces, a first door skin, or a second door skin, and at least one assembly station for joining the first and second door skins to the opposite first and second surfaces of the door frame, respectively, to form assembled doors. The system further includes a pressing station for pressing the assembled door, the pressing station comprising a first press and a second presses for alternately receiving assembled doors, and at least one material handling device for transporting the assembled doors between the stations. The first and second presses each comprises an upper die having an upper convex surface and a lower die having a lower convex surface, wherein the upper and lower convex surfaces are removably connected to the upper and lower dies, respectively.

[0011c] In another embodiment, there is provided a door-making system, comprising at least one coating station for applying adhesive to at least one of a door frame having opposite first and second surfaces, a first door skin, or a second door skin and at least one assembly station for joining the first and second door skins to the opposite first and second surfaces of the door frame, respectively, to form assembled doors. The system further includes a pressing station for pressing the assembled door, the pressing station comprising a first press and a second presses for alternately receiving assembled doors. The system further includes at least one material handling device for transporting the assembled doors between the stations. The first and second presses each comprises an upper die having an upper convex surface and a lower die

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having a lower convex surface, wherein the upper and lower convex surfaces are constructed and arranged for imparting a concave shape to at least central regions of the first and second door skins of the door assembly during pressing.

[0011d] In another embodiment there is provided a door-making system comprising at least one coating station for applying adhesive to at least one of a door frame having opposite first and second surfaces, a first door skin, or a second door skin. The system further includes at least one assembly station for joining the first and second door skins to the opposite first and second surfaces of the door frame, respectively, to form assembled doors. The system further includes a pressing station for pressing the assembled door, the pressing station comprising a first press and a second presses for alternately receiving assembled doors. The system further includes at least one material handling device for transporting the assembled doors between the stations. The first and second presses each comprises an upper die having an upper convex surface and a lower die having a lower convex surface and the upper and lower convex surfaces have a radius of curvature of about **0.1** mm to about **2.0** mm.

[0011e] In another embodiment there is provided a door making system comprising at least one coating station for applying adhesive to at least one of a door frame having opposite first and second surfaces, a first door skin, or a second door skin, and at least one assembly station for joining the first and second door skins to the opposite first and second surfaces of the door frame, respectively, to form assembled doors. The system further includes a pressing station for pressing the assembled door, the pressing station comprising a first press and a second presses for alternately receiving assembled doors. The system further includes at least one material handling device for transporting the assembled doors between the stations. The first and second presses each comprises an upper die having an upper convex surface and a lower die having a lower convex surface and the upper and lower convex surfaces have a radius of curvature of about **0.2** mm to about **0.5** mm

[0011f] In another embodiment there is provided a door-making system comprising at least one spray coating station for spraying adhesive to a door frame having stiles and rails forming

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a perimeter of the door frame, a first door skin, or a second door skin, and at least one assembly station for joining the first and second door skins to opposite first and second surfaces of the door frame, respectively, to form assembled doors. The system further includes a pressing station for alternatingly pressing at least two of the assembled doors, the pressing station comprising at least a first press and a second press vertically stacked one on top of another for receiving at least two of the assembled doors, wherein the pressing station is adapted to perform a pressing operation on at least a first of the assembled doors in the first press while loading or discharging at least a second of the assembled doors into or out of the second press, and wherein the first and second presses include a pressing surface shaped to compress central portions of the first and second door skins to a greater extent than peripheral portions disposed about the perimeter of the first and second door skins, so that surfaces of the central portions and the peripheral portions of the first and second door skins are coplanar with each other, and the peripheral portions are in contact with the stiles and rails of the door frame upon completion of the pressing operation. The system further includes at least one material handling device for transporting the assembled doors between the stations.

[0011g] In another embodiment, there is provided a door pressing station comprising at least first and second door presses vertically stacked relative to one another, the first and second door presses each comprising an upper die having an upper surface and a lower die having a lower surface, the upper and lower surfaces substantially spanning a width of the upper and lower dies, respectively, and facing one another to define a mold cavity in which a door assembly is received for pressing, each door assembly comprising a door frame having stiles and rails forming a perimeter of the door frame, and a pair of door skins disposed on opposite sides of the door frame. The system further includes a loading table upstream of the first and second presses, the loading table adapted to load assembled doors into the first and second presses. The system further includes a discharging table downstream of the first and second presses, the discharging table adapted to unload the assembled doors from the first and second presses after each door has been pressed. The upper and lower surfaces of the dies of the first and second presses are shaped to compress central portions of the pair of door skins to a greater extent than peripheral portions disposed about the perimeter of the pair of door skins, so that surfaces of the central portions and the peripheral portions of the pair of door skins are

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coplanar with each other, and the peripheral portions are in contact with the stiles and rails of the door frame upon discharge.

[0011h] In another embodiment, there is provided a door pressing station comprising at least first and second door presses vertically stacked relative to one another, the first and second door presses each comprising an upper die having an upper compressible surface and a lower die having a lower compressible surface, the upper and lower compressible surfaces defining pressing regions of varying shape facing one another to define a mold cavity in which a door assembly is received for pressing. The system further comprises a loading table upstream of the first and second presses, the loading table adapted to load assembled doors to the first and second presses. The system further comprises a discharging table downstream of the first and second presses, the discharging table adapted to unload the assembled doors from the first and second presses. The upper compressible surface of the upper die comprises an upper convex surface, the lower compressible surface of the lower die comprises a lower convex surface, and the upper and lower convex surfaces are configured to compress central portions of the assembled doors to a greater extent than peripheral portions disposed about the perimeter of the assembled doors, so that surfaces of the central portions and the peripheral portions of the assembled doors are coplanar with each other, and the peripheral portions are in contact with stiles and rails forming a perimeter of a door upon discharge.

[0011i] In another embodiment there is provided a door pressing station comprising at least first and second door presses vertically stacked relative to one another, the first and second door presses each comprising an upper die having a first pressing surface and a lower die having a second pressing surface, the first and second pressing surfaces having central regions that are closer to each other than peripheral regions to define a mold cavity in which a door assembly is received for pressing, wherein a compressible member is disposed along the upper and lower dies within the mold cavity. The system further comprises a loading table upstream of the first and second presses, the loading table adapted to load assembled doors to the first and second presses. The system further comprises a discharging table downstream of the first and second presses, the discharging table adapted to unload the assembled doors from the first

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and second presses, wherein the first and second pressing surfaces are shaped to compress central portions of the assembled doors to a greater extent than peripheral portions disposed about the perimeter of the assembled doors, so that surfaces of the central portions and the peripheral portions of the assembled doors are coplanar with each other, and the peripheral portions are in contact with stiles and rails forming a perimeter of a door upon discharge.

[0011j] In another embodiment, there is provided a door-making system comprising a pressing station comprising at least a first press and a second press vertically stacked one on top of another. The first and second presses are each configured to receive, press, and discharge at least one preassembled door having a door frame containing stiles and rails forming a perimeter of the door frame, at least two door skins, and adhesive. The first and second presses are further configured to press in alternating manner with respect to one another. Each of the first and second presses include dies shaped to compress central portions of the at least two door skins to a greater extent than peripheral portions disposed about the perimeter of the at least two door skins, so that surfaces of the central portions and the peripheral portions of the at least two door skins are coplanar with each other, and the peripheral portions are in contact with the stiles and rails of the door frame upon discharge.

[0013] Other embodiments, including apparatus, systems, methods, and the like which constitute part of the teachings herein, will become more apparent upon reading the following detailed description of the exemplary embodiments and viewing the drawings. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and therefore not restrictive.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Figure **1** is a schematic view of an exemplary automated door production line.

[0015] Figure **2** is a sectional, plan view of a defective door.

[0016] Figure **3**A is a plan view of an exemplary door facing having adhesive applied thereto.

[0017] Figure **3**B is a plan view of another exemplary door facing having adhesive applied thereto. .

[0018] Figure **4** is a plan, schematic view of an exemplary double press.

[0019] Figures **5**A-**4**C are sectional, schematic views of an exemplary pressing process for a door assembly.

[0020] Figure **6** is a sectional, schematic view of an exemplary press and door assembly.

[0021] Figure **7**A is a plan view of an exemplary post-press door assembly.

[0022] Figure **7**B is a sectional, plan view of the door assembly of Figure **7**A taken along line **7**B-**7**B.

[0023] Figure **7**C is a sectional, plan view of the door assembly of Figure **7**A taken along line **7**C-**7**C.

[0024] Figure **8** is a sectional, schematic view of a door assembly in an exemplary door press utilizing spacers.

[0025] Figure **9** is a sectional, schematic view of a door assembly in an exemplary door press utilizing attached plates.

[0026] Figure **10** is a sectional, schematic view of a door assembly in an exemplary door press utilizing membranes.

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[0027] Figure **11** is a sectional, schematic view of a door assembly in an exemplary door press utilizing expandable membranes.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENT(S) AND EXEMPLARY METHOD(S)

[0028] Reference will now be made in detail to exemplary embodiments and methods as illustrated in the accompanying drawings, in which like reference characters designate like or corresponding parts throughout the drawings. It should be noted, however, that the teachings herein in their broader aspects are not limited to the specific details, representative devices and methods, and illustrative examples shown and described in connection with the exemplary embodiments and methods.

[0029] Figure **1** depicts an automated door production line **1**. In an exemplary embodiment, the door production line **1** is a synchronous system designed to operate at a specific rate of movement, for example, one door produced per unit of time. In order to avoid bottlenecks, each step in the process, including transportation, occurs at the specific rate of movement. Therefore, it is important to provide suitable press time and proper adhesive application to sufficiently bond the components of the door together. Improper bonding can lead to quality issues.

[0030] Figure **2** shows a door D**1** having such quality issues. Improper bonding time can cause the separation or delamination of the door skins S**1**, S**2** from the core element C. Delamination is especially persistent in door skins S**1**, S**2** having a number of molded panels. For example, molded six panel door skins S**1**, S**2** bonded to a core C with a hot melt adhesive using conventional processes may experience delamination across the width of the door D**1**. The delamination between skins S**1**, S**2** and the core C is an indication of internal polyurethane (PUR) adhesive bond failure which may be caused by tension stresses or spring-back of the bowed skins and compressed core areas in the ovolos, or molded panel design areas, of the

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molded skins S1, S2. In these cases, the initial green or set strength of various PUR formulations along with typical PUR roll coating and door pressing approaches may not overcome the stresses leading to delamination. Pre-cured back surfaces of the door skins S1, S2 may also prevent effective PUR wetting when the adhesive is applied only to the frame. To overcome these deficiencies various improvements in the process have been made.

[0031] Figure **1** shows the production line **1** having an exemplary series of stations for assembling a door. Various material handling and movement devices and methods may be used to transport components of the door assembly and are simply designated by the arrows in the individual stations and between stations. Material handling and movement devices may include, for example, conveyors, gantry, manipulators, grippers, automated guided vehicles, and automated storage/retrieval systems. The components and stations of the production line may be operated by an operator's control, automatically utilizing various sensors including optical, magnetic, and radio sensors, or any combinations of manual and automatic operation. Though specific examples of material handling and movement may be provided in the exemplary description of certain stations, these may be modified as would be understood by one of ordinary skill in the art upon viewing this disclosure.

[0032] As shown in Figure **1**, a stile assembly station **10** includes a lock block indexing device **12** and a stile indexing device **14**. In an exemplary embodiment the stile indexing device **14** removes stiles **2** from a first stile conveyor **16** and a second stile conveyor **18**. A single stile conveyor, a set of first and second stile conveyors **16**, **18**, or more than two stile conveyors may be utilized depending on the throughput rate. More stile conveyors or sets of stile conveyors allow an increase in the throughput rate of the production line **1**. When a pair of stiles **2** have been removed from the top-level conveyor of the first and second sets of stile conveyors **16**, **18**, a new pair of stiles **2** is delivered to the top-level conveyor to replace them. Because conveying the stiles **2** to the appropriate position to be picked up by the stile indexing device **14** may take longer than the movement rate of the system, the stile indexing device **14** alternatively may take the next pair of stiles **2** from the next level of conveyors.

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[0033] As the stiles **2** are being retrieved by the stile indexing device **14**, lock blocks **4** are removed by the lock block indexing device **12** and moved along a conveyor **20** or other suitable material transportation device. The lock blocks **4** may be removed by the lock block indexing device **12** in a manner similar to the stiles **2**, or the lock blocks **4** may be removed from a pallet containing multiple lock blocks **4**. Both the stiles **2** and the lock blocks **4** are moved to a lock block attachment station **22**. At the lock block attachment station **22**, the lock blocks **4** are connected to the stiles **2**. The lock blocks **4** may be attached to the stiles **2** via adhesive, for example a hot melt adhesive, a mechanical fastener, or a combination thereof. While Figure **1** depicts a lock block **4** being attached to each stile **2**, optionally only a single lock block **4** may be attached. The movement and handling of all the components in stations **10** and **22** may be handled manually or automatically by robotic systems such as pick and place robotic arms, robotic indexers, and the like.

[0034] Rail assembly station **24** includes a rail indexing device **26** which selects a pair of rails **6**a, **6**b from a rail conveyor system **28**. In an exemplary embodiment the rail conveyor system **28** includes a top rail conveyor **30** and a bottom rail conveyor **32**, though a single rail conveyor, or more than two rail conveyors may alternatively be used as discussed above in connection with the first and second stile conveyors **16**, **18**. As shown in Figure **1**, a single top rail **6**a may be selected from the top rail conveyor **30** and a single bottom rail **6**b is selected from the bottom rail conveyor **32**. In various exemplary embodiments, a door having more than one top rail **6**a, such as a double top rail (not shown), more than one bottom rail **6**b, such as a double bottom rail (not shown), or both a double bottom rail and double top rail, and/or one or more intermediate rails (not shown) may be desired. Therefore, the rail indexing device **26** may be capable of variably selecting a single rail **6**a, **6**b or multiple rails from the top rail conveyors **30**, the bottom rail conveyors **32**, and optionally intermediate rail conveyors (not shown). If more than a single top and/or bottom rail **6**a, **6**b is selected, the two rails **6**a, **6**b are attached, for example, by fasteners or an adhesive such as a hot melt adhesive to form the double rail.

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[0035] After being selected, the rails **6**a, **6**b are moved to a core attachment station **34**. At the core attachment station **34**, a core C is connected to the top rail **6**a and the bottom rail **6**b, for example, by a hot melt adhesive. The core C may be brought to the core attachment station **34** by a conveyor or indexing device (not shown) similar to those shown and described with respect to the lock blocks **4**, stiles **2**, or rails **6**a, **6**b. The core C may be an expandable core or a solid core, such as, fiberboard, or any suitable substance depending on the door. In an exemplary embodiment, the core C is an expandable corrugated cardboard core or honeycomb paper core. The production line **1** may be set up and utilized so that the core C is variable and optional so that different cores C may be selectively attached to the rails or omitted from the assembled frame. Optionally the core may be formed in situ.

[0036] The attached lock block **4** and stile **2** assembly and the attached rail **6**a, **6**b and optional core C are then transferred to the frame assembly station **36**. Robotic handling devices such as a clamp and gantry system may be used to deliver the frame components to the frame assembly station **36**. When an expandable core C is used, the rails **6**a, **6**b may be drawn apart to expand the core C. The rails **6**a, **6**b and stiles **2** are then attached together to form an assembled frame F. The rails **6**a, **6**b and stiles **2** may be attached with mechanical fasteners, an adhesive, for example, a hot melt adhesive, or any combination of fasteners and adhesive. In various exemplary embodiments, different combinations of the lock blocks **4**, stiles **2**, rails **6**a, **6**b, and core C may be preassembled before reaching the production line. It should be noted that the term frame F used throughout the rest of this description includes the assembled stiles **2**, rails **6**a, **6**b, optional lock block(s) **4**, and optional core C.

[0037] When the frame F is assembled, either through the assembly system and process described above, preassembly, or a combination thereof, the frame F is moved to a frame adhesive station **38**. In an exemplary embodiment, the frame adhesive station **38** is capable of applying an adhesive to both sides of the frame F. Adhesive application may be accomplished by passing the frame F through a double roll coater of the frame adhesive station **38**. In an exemplary embodiment, the roll coater applies adhesive to the frame F in an amount between about **6** and about **35** g/sft (grams per square foot) as measured on a surface of the

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stiles **2** or rails **6**a, **6**b. In various exemplary embodiments, the amount of adhesive is between about **15** and about **26** g/sft. This amount of adhesive may help prevent quality issues, such as pillowing discussed above. After the adhesive is applied, the frame F is transferred to a door skin assembly station **40**. Robotic handling devices such as a clamp and gantry system **39** may be used to deliver the frame from the frame adhesive station **38** to the door skin assembly station **40**.

[0038] The door skin assembly station **40** includes a first skin feeder **42** and a second skin feeder **44**. The first skin feeder **42** may include a door skin pallet **46**a or multiple pallets of door skins. Similarly, the second skin feeder **44** may include a door skin pallet **6**b or multiple pallets of door skins S**1**, S**2**. In an exemplary embodiment, the first skin feeder **42** provides a bottom door skin S**2** and the second skin feeder **44** provides a top door skin S**1**. The top and bottom door skins S**1**, S**2** may be identical or different depending on the production requirements. The top and bottom door skins S**1**, S**2** may be any variety of door skins including wood composite door skins, solid wood door skins, polymer door skins, sheet molding compound door skins, molded door skins, and flush door skins. Though two skin feeders **42**, **44** are shown, a single skin feeder may be utilized which provides both the top and bottom door skins S**1**, S**2**.

[0039] Door skins S**1**, S**2** may be unloaded from the pallets **46**a, **46**b and placed on a conveyor (not shown) either manually or through a robotic handling device such as a vacuum gantry. If the door skins S**1**, S**2** are removed from the pallets **46**a, **46**b manually, the operator moving the door skins S**1**, S**2** may perform a visual quality inspection. If a door skin S**1**, S**2** is found to be unsatisfactory, the operator may place it on a disposal conveyor. If the door skin S**1**, S**2** is found to be acceptable, the operator may place it on a production conveyor. Alternatively, the door skin S**1**, S**2** may be removed from the pallets **46**a, **46**b with an automated device and a camera or set of cameras may be set up so that a remote operator can perform visual inspection. The operator is then able to determine if the door skins S**1**, S**2** are acceptable and signal the robotic handling system to place the door skins S**1**, S**2** on either the production conveyor or the disposal conveyor. In various exemplary embodiments, the inspection may

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be performed automatically by tactile inspection devices, such as touch probes, or non-tactile inspection devices, such as laser or optical sensors. For example, a camera may optically capture the image of a door skin S1, S2. The image may then be processed and measured by a microprocessor. If the door skin S1, S2 is acceptable, the microprocessor can signal the robotic handling device to place the door skin S1, S2 on the production conveyor. If the door skin S1, S2 is not accepted, the microprocessor signals the robotic handling device to place the door skin S1, S2 on the disposal conveyor.

[0040] The first and second pallets **46**a, **46**b may have door skins S1, S2 facing the same direction. For example, the door skins S1, S2 in pallets **46**a, **46**b may have an intended exterior surface (depicted in white) facing up. Depending on the parameters of the production line **1**, the door skins S1, S2 from one or both pallets **46**a, **46**b may need to be flipped so that their intended interiorly disposed surface (shaded) is facing down. In the exemplary embodiment shown in Figure **1**, after a door skin S2 is removed from the first skin feeder **42**, it is transferred to a first flipping station **48**. The first flipping station may utilize any automated flipping apparatus, for example a star conveyor. Optionally, before the bottom door skin S2 is connected to the frame, a first adhesive applicator **50** applies a layer of adhesive to the interior surface of the door skin S2. The first adhesive applicator **50** may be a first spray coater with one or more spray heads.

[0041] In various exemplary embodiments, the first adhesive applicator **50** is capable of applying adhesive to the door skin S2 in beads or lines. As best shown in Figures **3**A and **3**B, the device may be a nozzle or jet capable of applying under pressure a liquid form of an adhesive, for example a hot melt adhesive such as PUR or ethylene vinyl acetate (EVA), to a door skin S2. The adhesive may be applied in individual lines, such as the wavy lines A1 as shown in Figure **3**A. The adhesive lines A1 are vertically orientated and placed just outside of and down the middle of the panels P. The type of adhesive application shown in Figure **3**A is one way to prevent delamination of the door skin S2 from the core C.

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[0042] In the exemplary embodiment shown in Figure **3**B, a bead of adhesive is applied to each panel P. Applying the adhesive to the door skin S**2** in this way creates a spot-weld-type gluing effect when the door skin S**2** is pressed to the core C, further bonding the door skin S**2** and the core C reducing the chance of delamination. Various other glue patterns, such as a web pattern or a checkered pattern, or combinations of glue patterns may be utilized depending on the configuration and design of the door skins S**1**, S**2**. In various exemplary embodiments, the first adhesive applicator **50** is capable of applying different adhesives in a variety of patterns and locations so that different door types may be made on a single production line **1**.

[0043] After the optional adhesive application, the bottom door skin S**2** is moved to the first door assembly station **52**. The bottom door skin S**2** may be moved by a robotic handling device such as a vacuum gantry, conveyor, or combination thereof. The adhesively coated frame F is transported to the first door assembly station **52** and placed onto the bottom door skin S**2**. Various stops, limits, tactile sensors, and non-tactile sensors may be used to align and position the bottom door skin S**2** and the frame F.

[0044] Similar to the bottom door skin S**2**, the top door skin S**1** is transferred from the second skin feeder **44**. The top door skin S**1** may have an optional adhesive coating applied by a second adhesive applicator **54**. The second adhesive applicator **54** may include all the features and capabilities discussed above with respect to the first adhesive applicator **50**. Accordingly, the second adhesive applicator **54** may be identical to or different from the first adhesive applicator **50**.

[0045] As discussed above, the second pallet of skins **46**b has the exterior surface of the top door skins S**1** facing up. Therefore, to apply adhesive to the interior surface, the top door skin S**1** is flipped at a second flipping station **56**. Because the top door skin S**1** is placed onto the top surface of the frame F, it must be flipped again at a third flipping station **58** after the adhesive is applied. Various exemplary embodiments may omit application of adhesive to the top door skin S**1** and therefore the second and third flipping stations **56**, **58** may be bypassed or omitted. Additionally, the second adhesive applicator **54** may be capable of applying

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adhesive from underneath the top door skin **S1** so that the second and third flipping stations **56**, **58** may be omitted. Alternatively, the door skins **S1**, **S2** in pallets **46**a, **46**b may be provided interior-side up so as to avoid the use of the flipping stations **48**, **56**.

[0046] After the optional adhesive application, the top door skin **S1** is moved to a second door assembly station **60**. At the second door assembly station **60** the top door skin **S1** is placed onto the frame F opposite the bottom door skin **S2** so that the interior surface of the top door skin **S1** faces down towards the frame F. Various stops, limits, tactile sensors, and non-tactile sensors may be used to align and position the door skin **S1** and the frame F.

[0047] In various exemplary embodiments, the door skin assembly station **40** includes a device or devices for applying a liquid, for example water, to the inner surface of the door skins **S1**, **S2** before they are attached to the frame. A spray head or other suitable device can apply water, for example in a misting spray, to the inner surface of the door skins **S1**, **S2**. The liquid may be applied by the first and second adhesive applicators **50**, **54** in connection with an adhesive or variably without an adhesive. Alternatively, the liquid may be applied prior to, or subsequent the optional adhesive application. The application of water helps prevent warping and may improve skin wetting and increase the bond quality between resin that may be present in the door skins **S1**, **S2** and the frame and the core C. The amount of water applied is enough to dampen the inner surface of the door skins **S1**, **S2**, though more water may be applied so that the moisture permeates at least partially into the door skins **S1**, **S2**. Other surface treatments may also be applied to the surface in addition to water or alternatively to water in order to increase bond quality.

[0048] After the top door skin **S1** is connected to the frame F, the assembled door is transferred to a pressing station **61** where the door is pressed to more fixedly bond the door skins **S1**, **S2** to the frame F and core C. As discussed above, because the production line **1** is automated, each step is performed at the set rate of movement to avoid bottlenecks. For example, the amount of time for the lock block attachment station **22** to attach the lock blocks **4** to the stiles **2** is equal to rate of movement, the time for the frame F to be transferred to the first door

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assembly station **52** equals the rate of movement, and the time in between completed doors coming off the production line **1** is equal to the rate of movement. In various exemplary embodiments, the rate of movement of the presently described system is about **7** seconds to about **15** seconds, for example about every **8** seconds, though the time may vary depending on several factors such as the adhesive selected, as would be understood by one of ordinary skill in the art upon viewing this disclosure. The rate of movement may not be long enough, however, for sufficient bond strength to form between the door skins S**1**, S**2** and the frame F and core C.

[0049] To allow for a pressing time that exceeds the rate of movement, a double press **62** is used. The double press includes an upper press **62**a and a lower press **62**b. As shown in Figure **1**, a first assembled door is transferred onto a loading table **63**a. The loading table **63**a may be a two-position table and may include a conveyor device, such as powered rollers, to move the assembled doors on and off the loading table **63**a. The loading table **63**a places an assembled door into one of the top and bottom presses **62**a, **62**b, for example the bottom press **62**b. After the production line **1** moves again, a second assembled door is loaded onto the loading table **63**a and the loading table **63**a is raised to place the second assembled door into the upper press **62**a. After the production line **1** moves again, the first assembled door is removed from the lower press **62**b and transferred to a discharging table **63**b. The discharging table **63**b may be a two-position table and may include a conveyor device, such as powered rollers, to move the assembled doors on to and off of the discharging table **63**b. As the first door is transferred from the lower press **62**b, the loading table **63**a places a third assembled door in the lower press **62**b to replace the first assembled door. Using the double press **62**, the pressing of assembled doors is alternated between the upper and lower presses **62**a, **62**b. An assembled door can therefore undergo a pressing operation, which may include the opening and closing the dies of the upper and lower presses **62**a, **62**b, for approximately twice as long as the rate of movement. The extra press time allows a greater bond to be created between the door skins S**1**, S**2**, and the frame F and the core C.

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[0050] In various exemplary embodiments, the press imparts approximately **100** psi to the door skins S**1**, S**2** adjacent the stile and rail sections. The pressure along the remaining areas of the door skins S**1**, S**2** covering the core C varies.

[0051] The double press **64** may also be capable of rapid closure. For example, an upper die **70** and a lower die **74** in each of the upper and lower presses **62**a, **62**b of the double press **62** may be capable of transitioning from an open position to contacting the door skins S**1**, S**2** and reaching a final pressure in less than **10** seconds. In various exemplary embodiments, the double press **62** is capable of reaching final pressure in approximately one second or less. A fast closing double press **62** allows for a faster acting adhesive to be used and therefore quicker set and cure times.

[0052] In various exemplary embodiments, one of the upper and lower dies **70**, **74** or both dies **70**, **74** may be moved towards and away from the assembled door to close the press. As best shown in Figure **4**, actuators **64**, such as hydraulic or pneumatic cylinders may be connected to the upper die **70**. Figure **4** depicts the upper press **62**a in an open position and the lower press **62**b in a closed position. Each upper and lower press **62**a, **62**b may also include a conveyor **65**, for example a belt conveyor or powered rollers, to assists in loading and discharging the assembled door from the respective press **62**a, **62**b. In an exemplary embodiment, at least part of the conveyor **65** is arranged to position the bottom door skin S**2** above a stationary lower die **74**. As best shown in Figure **4**, the lower die **74** may be located between the top part of the conveyor **65** and the bottom, or return, part of the conveyor **65**. During the pressing operation, the upper die **70** closes, pressing the door assembly against the conveyor **65** and the lower die **74**. The conveyor **65** should be made from a flexible material that is durable enough to withstand the pressure applied by the dies **70**, **74**. In various exemplary embodiments, the conveyor **65** may include a first side and a second side with an open center section (not shown). The first and second side may include belts or rollers and be positioned along the edges of the door to contact the door skins S**1**, S**2** adjacent the frame F. The first and second side conveyors and open center section allow the lower die **74** to contact the central region of the bottom door skin S**2** directly. Various other devices and methods for

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positioning the assembled doors D2 into the upper and lower presses **62**a, **62**b, for example a push rod, may also be used. The press **62** may also include various stops, limits, tactile sensors, and non-tactile sensors may be used to align and position the door to square the frame F before pressing.

[0053] Although the exemplary embodiments discussed above are with respect to a double press **62**, it should be understood that the pressing apparatus may alternatively have three, four, five, or more presses. As the number of presses increases, the pressing time per press can likewise increase without slowing the overall movement time. Moreover, the presses **62**a, **62**b may be placed side-by-side on the same level or otherwise oriented as opposed to the stacked relationship shown in Figure **1**. Various material handling devices, such as a switching conveyor, may provide the assembled doors to the presses **65**a, **65**b in an alternating fashion.

[0054] As shown in Figures **5**A-**5**C, in various exemplary embodiments both the upper and lower presses **62**a, **62**b of the double press **62** include an upper die **70** having a convex portion **72**a and a lower die **74** having a convex portion **72**b. The convex portions **72**a, **72**b over compress at least the central portions of the top and bottom door skins S**1**, S**2** so that at least part of the interior surface of the door skins S**1**, S**2** is coplanar with or below the respective surface of the frame F to which the skin is attached. The over compression helps increase the bond between the door skins S**1**, S**2** and the core C. In various exemplary embodiments, the radius of curvature of the convex portions **72**a, **72**b is between about **0**.**1** mm and about **2** mm. In certain embodiments the radius of curvature of the convex portions **72**a, **72**b is between about **0**.**2** mm and approximately **0**.**5** mm. The radius of curvature of the convex portions **72**a, **72**b may vary however, depending on design and production characteristics such as the design of the door, the size of the door, the press time, and the amount of pressure applied.

[0055] Figures **5**A-**5**C depict an exemplary embodiment where the convex portions **72**a, **72**b begin approximately at the outer edges of the upper and lower dies **70**, **74**. In an exemplary embodiment shown in Figure **6**, a flat section **75**a, **75**b extends around the outer edge of the dies **70**, **74**, and the convex portions **72**a, **72**b begin in a more centrally located region. The

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flat sections **75**a, **75**b may have approximately the width of typical stiles on the longitudinal sides and the width of typical rails on the lateral sides. The flat section **75**a, **75**b may also be slightly larger than a standard frame F size to accommodate different width doors, as the size of the convex sections **72**a, **72**b may be varied and still obtain desirable results. For example, relatively small central convex sections **72**a, **72**b compared to the length and width of a standard door may be provided in the upper and lower dies **70**, **74** which could still effectively reverse the natural bowing of the door skins S**1**, S**2** and therefore help prevent pillowing and delamination.

[0056] As best shown in Figure **5**A, when the door is placed into the press a strong adhesive connection may be present between the perimeters of the door skins S**1**, S**2** and the stiles **2** and rails **6**, but internal stresses in the door skins S**1**, S**2** may lead to pillowing and separation from the core C. The pillowing effect can cause separation between the door skins S**1**, S**2** and the core C of as much as **1** inch or greater and can reach about **2** inches at the very center of the door skins S**1**, S**2**. As shown in Figure **5**B, when the press is closed, the convex portions **72**a, **72**b over compress the central portion of the door skins S**1**, S**2** respectively. The over compression not only helps to bond the door skins S**1**, S**2** to the core C, but also redirects the natural bowing of the door skins S**1**, S**2**. Because the door skins S**1**, S**2** are fixed at the frame F, the internal forces have a tendency to push away from the frame F, forcing the door skins S**1**, S**2** away from the core C. Once the bowing is reversed, any internal stresses remaining in the door skins S**1**, S**2** are redirected inwards, pushing the center of the door skins S**1**, S**2** towards the core C as opposed to away from it. As shown in Figure **5**C, when the press **64** is opened, the pillowing is eliminated and the door skins S**1**, S**2** may return to an approximately flat shape. The resultant door has increased bond strength compared to typical doors with less chance of pillowing or delamination.

[0057] In various exemplary embodiments, the door skins S**1**, S**2** may have a slight concave cross-sectional shape after pressing is complete. Figure 7A shows a pressed door D**2** and Figures 7B and 7C depict cross-sectional views of Figure 7A showing the concave shape imparted to the door D**2**. It should be noted that the concave sectional profile shown in Figures

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7B and 7C may not be to scale. The concave shape retained in the door skins S1, S2 after pressing is completed is due to the fact that the door skins S1, S2 may undergo plastic deformation resulting from the over compression and therefore will not return to a planar surface after the pressing operation. The concave shape, however, may be less than noticeable by the unaided human eye and therefore undetectable to consumers. For example, the resulting shape of the door skins S1, S2 may have a maximum concave depth that is less than the maximum convex height of the upper and lower dies **70**, **74**. In various exemplary embodiments, the maximum depth of the concave section, when present, is about **0.05** mm to about **0.5** mm.

[0058] Figures **5**A-**5**C depict an exemplary embodiment where the convex portions **72**a, **72**b are formed integrally with the upper and lower dies **70**, **74**. In various other exemplary embodiments an upper spacer **76**a and a lower spacer **76**b are inserted between the upper and lower dies **70**, **74** and the door skins S1, S2 respectively as shown in Figure **8**. The spacers **76**a, **76**b may be made from a rigid material, for example a metallic material, or they may be made from a resilient material such as a silicone, polymer, elastomer, wood, or cardboard. The spacers **76**a, **76**b may have a convex shape similar to the dies **70**, **74** shown in Figures **5**A-**5**C, or they may simply provide a raised area to over compress the door skins S1, S2. The use of spacers **76**a, **76**b allows different sizes, shapes, and amounts of contour to be interchanged for different door sizes and designs. A human operator or robotic handling device may place the spacers **76**a, **76**b between the door skins S1, S2 and the upper and lower dies **70**, **74** as the assembled door is loaded into the double press **64**. The spacers **76**a, **76**b may also be placed either above or below the top belt of the conveyor **65** when used in conjunction with the exemplary embodiment depicted in Figure **4**. The handling device may determine the type of spacers **76**a, **76**b appropriate for the door based on information received from an operator, a central computing system, through image recognition, or various other techniques associated with variable batch production.

[0059] In various other exemplary embodiments, the convex or raised portion is achieved through an upper plate **78**a and a lower plate **78**b that are attached to the upper and lower dies

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70, **74** as shown in Figure **9**. The upper and lower plates **78**a, **78**b may be made from various materials including elastomeric, metallic, ceramic, cellulosic, or composite materials. Multiple upper and lower plates **78**a, **78**b may be used, each having a different size, shape, and/or radius of curvature. The different upper and lower plates **78**a, **78**b may be used in association with different door sizes and designs. The upper and lower plates **78**a, **78**b may be removably connected to the upper and lower dies **70**, **74**. For example, the plates**78**a, **78**b may be attached to the upper and lower dies **70**, **74** through removable mechanical fasteners such as bolts or latches, or through a magnetic connection. Different upper and lower plates **78**a, **78**b may be interchanged manually or automatically as discussed above in relation to the upper and lower spacers **76**a, **76**b.

[0060] In various exemplary embodiments, the over compression of the door skins S**1**, S**2** is achieved through an upper membrane **80**a and a lower membrane **80**b fastened to the upper and lower dies **70**, **74** as shown in Figure **10**. The membranes **80**a, **80**b may have a thickness of about **0.1** mm to about **2.0** mm. The membrane may be made from a material that allows differential compression, such as a material comprising silicone or rubber. When pressed onto the door skins S**1**, S**2**, the compression of the upper and lower membranes **80**a, **80**b is greatest at the areas adjacent the rails and stiles **82** and decreases towards the center of the door **84**. Therefore, the upper and lower membranes **80**a, **80**b are thicker at the center of the door skins S**1**, S**2** and cause over compression. The variable compression allows a single set of upper and lower membranes **80**a, **80**b to press different door sizes and designs. Accordingly, the upper and lower membranes **80**a, **80**b may be permanently attached to the upper and lower dies **70**, **74** or they may be semi-permanently attached where a secure constant connection is desired but replacement upper and lower membranes may be provided. In various embodiments, however, the upper and lower membranes **80**a, **80**b may be removably secured to the upper and lower dies **70**, **74** so that membranes **80**a, **80**b of different sizes, shapes, materials, or any combination thereof may be easily interchanged.

[0061] In various exemplary embodiments, the convex or raised portion is achieved through an upper expandable membrane **86**a and a lower expandable membrane **86**b attached to the

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upper and lower dies **70**, **74** as shown in Figure **11**. The expandable membranes **86**a, **86**b are made of an expandable or otherwise flexible material. Gas, such as compressed air, is supplied to upper and lower chambers **88**a, **88**b formed between the upper and lower dies **70**, **74** and the upper and lower expandable membranes **86**a, **86**b respectively. The added pressure from the gas is transferred to the door skins S**1**, S**2** and causes over compression during pressing. Though only a single chamber **88**a, **88**b is shown in Figure **11** associated with each die **70**, **74**, there may be more than one chamber and the chambers may be selectively supplied with gas to provide different amounts of compression to different door sections or to different door sizes and designs.

[0062] As best shown in Figure **1**, after the pressing station **62**, the assembled door D**2** is taken off the main production line **1**. The door D**2** then may pass through a number of optional finishing operations as needed. For example, the door may be passed through a stile trimming station **90** and a rail trimming station**92** to remove excess material. If the blades of the trimming stations **90**, **92** are parallel the door may need to be rotated between the stile trimming station **90** and the rail trimming station **92**. After the edges have been trimmed, the door may be placed through an edge coating station **94**. Here the edges of the door, such as the exposed rails **6**a, **6**b and stiles **2** are coated or painted. Other painting or coating may be accomplished at this station or separately.

[0063] When the door D**2** is completed, it passes to an inspector **96** who checks the door for quality issues. In various exemplary embodiments the quality inspection may be performed automatically as discussed above with respect to the door skin assembly station **40**. Any unacceptable door is either discarded or reworked, and all doors passing inspection are sent to palletizer **98** for stacking.

[0064] A number of commonly used and commercially available adhesives have been discussed above such as PUR and EVA hot melt adhesives. However, aspects of the teachings herein are also directed to the novel use of adhesive compositions. In an exemplary embodiment, a PUR adhesive comprising polyurethane and isocyanurate is used in the above-

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disclosed system. In a separate embodiment, an adhesive comprising polyurethane and cyanoacrylate is used in the above-identified system. These chemicals increase the initial green or set strength of the adhesives, securing the bond between the door skin and the frame, eliminating delamination caused by the stresses of bowed or warped skins.

[0065] The foregoing detailed description of the certain exemplary embodiments has been provided for the purpose of explaining the principles of the teachings herein and their practical application, thereby enabling others skilled in the art to understand the teachings herein for various embodiments and with various modifications as are suited to the particular use contemplated. This description is not necessarily intended to be exhaustive or to limit the teachings herein to the precise embodiments disclosed. Additional embodiments are possible and are intended to be encompassed within this specification and the scope of the teachings herein.

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EMBODIMENTS IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A door-making system, comprising:

at least one coating station for applying adhesive to at least one of a door frame having stiles and rails forming a perimeter of the door frame, a first door skin and a second door skin;

at least one assembly station for joining the first and second door skins to opposite first and second surfaces of the door frame, respectively, to form assembled doors;

a pressing station for alternatingly pressing at least two of the assembled doors, the pressing station comprising a first press and a second press vertically stacked one on top of another for alternately receiving at least two of the assembled doors, each press comprises an upper die and a lower die; and

at least one material handling device for transporting the assembled doors between the stations,

wherein the pressing station is adapted to perform a pressing operation on at least a first of the assembled doors in the first press while loading or discharging at least a second of the assembled doors into or out of the second press,

wherein the first and second presses include a pressing surface shaped to compress central portions of the first and second door skins to a greater extent than peripheral portions disposed about the perimeter of the first and second door skins, so that surfaces of the central portions and the peripheral portions of the first and second door skins are coplanar with each other, and the peripheral portions are in contact with the stiles and rails of the door frame upon completion of the pressing operation,

wherein the at least one coating station comprises a first coating station for applying adhesive to the frame, a second coating station for applying adhesive to the first door skin, and a third adhesive station for applying adhesive to the second door skin, and

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wherein the first and second door skins comprise at least one panel and the second and third coating stations apply a bead of adhesive to the panels of the first and second door skins respectively.

2. The door-making system of claim I, wherein the door-making system is a synchronous system having a rate of movement and the pressing station performs a pressing operation on the assembled doors for a period of time that is twice the rate of movement.

3. The door-making system of any of claim **1** or **2**, wherein the at least one assembly station comprises a first assembly station for joining the first door skin to the first surface of the door frame and a second assembly station for joining the second door skin to the second surface of the door frame.

4. The door-making system of any of claims **1** to **3**, wherein the upper die has an upper convex surface and the lower die has a lower convex surface.

5. The door-making system of claim **4**, wherein the upper and lower convex surfaces are integrally formed with the upper and lower dies, respectively.

6. A door-making system, comprising:

at least one coating station for applying adhesive to at least one of a door frame having opposite first and second surfaces, a first door skin, or a second door skin;

at least one assembly station for joining the first and second door skins to the opposite first and second surfaces of the door frame, respectively, to form assembled doors;

a pressing station for pressing the assembled door, the pressing station comprising a first press and a second presses for alternately receiving assembled doors;

at least one material handling device for transporting the assembled doors between the stations; and

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wherein the first and second presses each comprises an upper die having an upper convex surface and a lower die having a lower convex surface,

wherein the upper and lower convex surfaces are removably connected to the upper and lower dies, respectively.

7. The door-making system of claim **6**, wherein the upper and lower convex surfaces are magnetically connected to the upper and lower dies, respectively.

8. A door made with the door-making system of any one of claims **1** to **7**.

9. A door-making system, comprising:

at least one coating station for applying adhesive to at least one of a door frame having opposite first and second surfaces, a first door skin, or a second door skin;

at least one assembly station for joining the first and second door skins to the opposite first and second surfaces of the door frame, respectively, to form assembled doors;

a pressing station for pressing the assembled door, the pressing station comprising a first press and a second presses for alternately receiving assembled doors;

at least one material handling device for transporting the assembled doors between the stations; and

wherein the first and second presses each comprises an upper die having an upper convex surface and a lower die having a lower convex surface,

wherein the upper and lower convex surfaces are constructed and arranged for imparting a concave shape to at least central regions of the first and second door skins of the door assembly during pressing.

10. A door made with the door-making system of claim **9**.

11. A door-making system, comprising:

at least one coating station for applying adhesive to at least one of a door frame having opposite first and second surfaces, a first door skin, or a second door skin;

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at least one assembly station for joining the first and second door skins to the opposite first and second surfaces of the door frame, respectively, to form assembled doors;

a pressing station for pressing the assembled door, the pressing station comprising a first press and a second presses for alternately receiving assembled doors;

at least one material handling device for transporting the assembled doors between the stations; and

wherein the first and second presses each comprises an upper die having an upper convex surface and a lower die having a lower convex surface,

wherein the upper and lower convex surfaces have a radius of curvature of about **0.1** mm to about **2.0** mm.

12. A door made with the door-making system of claim **11**.

13. A door making system, comprising:

at least one coating station for applying adhesive to at least one of a door frame having opposite first and second surfaces, a first door skin, or a second door skin;

at least one assembly station for joining the first and second door skins to the opposite first and second surfaces of the door frame, respectively, to form assembled doors;

a pressing station for pressing the assembled door, the pressing station comprising a first press and a second presses for alternately receiving assembled doors;

at least one material handling device for transporting the assembled doors between the stations; and

wherein the first and second presses each comprises an upper die having an upper convex surface and a lower die having a lower convex surface,

wherein the upper and lower convex surfaces have a radius of curvature of about **0.2** mm to about **0.5** mm.

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14. The door-making system of claim **1**, wherein the first and second presses each comprises an upper die having an upper membrane attached thereto and a lower die having a lower membrane attached thereto, the upper and lower membranes for over compressing the central area of the first and second door skins.

15. The door-making system of claim **1**, wherein the pressing station further comprises an upper insert and a lower insert for placing between the upper and lower dies of the upper press and the first and second door skins, the upper and lower inserts for imparting a concave shape to at least the central regions of the first and second door skins during pressing.

16. A door made with the door-making system of any of claims **13** to **15**.

17. A door-making system, comprising:

at least one spray coating station for spraying adhesive to a door frame having stiles and rails forming a perimeter of the door frame, a first door skin, or a second door skin;

at least one assembly station for joining the first and second door skins to opposite first and second surfaces of the door frame, respectively, to form assembled doors;

a pressing station for alternatingly pressing at least two of the assembled doors, the pressing station comprising at least a first press and a second press vertically stacked one on top of another for receiving at least two of said assembled doors, wherein said pressing station is adapted to perform a pressing operation on at least a first of said assembled doors in the first press while loading or discharging at least a second of said assembled doors into or out of the second press, and wherein the first and second presses include a pressing surface shaped to compress central portions of the first and second door skins to a greater extent than peripheral portions disposed about the perimeter of the first and second door skins, so that surfaces of the central portions and the peripheral portions of the first and second door skins are coplanar with each other, and the peripheral portions are in contact with the stiles and rails of the door frame upon completion of the pressing operation; and

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at least one material handling device for transporting the assembled doors between the stations.

18. The door-making system of claim **17**, wherein the at least one coating station comprises a first coating station for applying adhesive to the frame, a second coating station for applying adhesive to the first door skin, and a third adhesive station for applying adhesive to the second door skin.

19. The door-making system of claim **18**, wherein the first and second door skins comprise at least one panel and the second and third coating stations apply a bead of adhesive to the panels of the first and second door skins respectively.

20. The door-making system of claim **17**, wherein the door-making system is a synchronous system having a rate of movement and the pressing station performs a pressing operation on the at least two assembled doors for a period of time that is greater than the time to assemble a single door.

21. The door-making system of claim **17**, wherein the at least one assembly station comprises a first assembly station for joining the first door skin to the first surface of the door frame and a second assembly station for joining the second door skin to the second surface of the door frame.

22. The door-making system of claim **17**, wherein the first and second presses each comprises an upper die having an upper convex surface and a lower die having a lower convex surface.

23. The door-making system of claim **22**, wherein the upper and lower convex surfaces are integrally formed with the upper and lower dies, respectively.

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24. The door-making system of claim **22**, wherein the upper and lower convex surfaces are removably connected to the upper and lower dies, respectively.

25. The door-making system of claim **22**, wherein the upper and lower convex surfaces are constructed and arranged for imparting a concave shape to at least central regions of the first and second door skins of the door assembly during pressing.

26. The door-making system of claim **17**, wherein the first and second presses each comprises an upper die having an upper membrane attached thereto and a lower die having a lower membrane attached thereto, the upper and lower membranes configured for compressing the central area of the first and second door skins to a greater extent than the peripheral portions of the first and second door skins.

27. The door-making system of claim **17**, further comprising a loading table upstream of said pressing station, said loading table adapted to load the assembled doors to both said first and second presses.

28. The door-making system of claim **27**, wherein said loading table moves between first and second positions corresponding to a location of said first and second presses.

29. The door-making system of claim **17**, further comprising a discharging table downstream of said pressing station, said discharging table adapted to unload the assembled doors from both said first and second presses.

30. The door-making system of claim **29**, wherein said discharging table moves between first and second positions corresponding to a location of said first and second presses.

31. A door pressing station, comprising:

at least first and second door presses vertically stacked relative to one another, the first and second door presses each comprising an upper die having an upper surface

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and a lower die having a lower surface, the upper and lower surfaces substantially spanning a width of said upper and lower dies, respectively, and facing one another to define a mold cavity in which a door assembly is received for pressing, each door assembly comprising a door frame having stiles and rails forming a perimeter of the door frame, and a pair of door skins disposed on opposite sides of the door frame;

a loading table upstream of said first and second presses, said loading table adapted to load assembled doors into said first and second presses; and

a discharging table downstream of said first and second presses, said discharging table adapted to unload said assembled doors from said first and second presses after each door has been pressed,

wherein the upper and lower surfaces of the dies of the first and second presses are shaped to compress central portions of the pair of door skins to a greater extent than peripheral portions disposed about the perimeter of the pair of door skins, so that surfaces of the central portions and the peripheral portions of the pair of door skins are coplanar with each other, and the peripheral portions are in contact with the stiles and rails of the door frame upon discharge.

32. The door pressing station of claim **31**, wherein the upper and lower surfaces are convex.

33. The door pressing station of claim **32**, wherein the upper and lower convex surfaces are removably connected to the upper and lower dies, respectively, or integrally formed with the upper and lower dies, respectively.

34. The door pressing station of claim **32**, wherein said upper and lower convex surfaces are continuously curving surfaces having a general parabolic shape with a vertex substantially at a center of said upper and lower dies, respectively.

35. The door pressing station of claim **32**, wherein said upper and lower dies are formed with a flat section circumscribing said convex surfaces.

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36. The door pressing station of claim **35**, wherein said flat section has a width commensurate with a width of a stile of a door.

37. A door pressing station, comprising:

at least first and second door presses vertically stacked relative to one another, the first and second door presses each comprising an upper die having an upper compressible surface and a lower die having a lower compressible surface, the upper and lower compressible surfaces defining pressing regions of varying shape facing one another to define a mold cavity in which a door assembly is received for pressing;

a loading table upstream of said first and second presses, said loading table adapted to load assembled doors to said first and second presses; and

a discharging table downstream of said first and second presses, said discharging table adapted to unload said assembled doors from said first and second presses,

wherein the upper compressible surface of the upper die comprises an upper convex surface, the lower compressible surface of the lower die comprises a lower convex surface, and wherein the upper and lower convex surfaces are configured to compress central portions of the assembled doors to a greater extent than peripheral portions disposed about the perimeter of the assembled doors, so that surfaces of the central portions and the peripheral portions of the assembled doors are coplanar with each other, and the peripheral portions are in contact with stiles and rails forming a perimeter of a door upon discharge.

38. The door pressing station of claim **37**, wherein the upper and lower convex surfaces are integrally formed with the upper and lower dies, respectively.

39. The door pressing station of claim **37**, wherein the upper and lower convex surfaces are removably connected to the upper and lower dies, respectively.

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40. The door pressing station of claim **37**, wherein said upper and lower convex surfaces *are* continuously curving surfaces having a general parabolic shape with a vertex substantially at a center of said upper and lower dies, respectively.

41. The door pressing station of **37**, wherein said upper and lower dies are formed with a flat section circumscribing said convex surfaces.

42. The door pressing station of claim **41**, wherein said flat section has a width commensurate with a width of a stile of a door.

43. A door pressing station, comprising:

at least first and second door presses vertically stacked relative to one another, the first and second door presses each comprising an upper die having a first pressing surface and a lower die having a second pressing surface, the first and second pressing surfaces have central regions that are closer to each other than peripheral regions to define a mold cavity in which a door assembly is received for pressing, wherein a compressible member is disposed along said upper and lower dies within said mold cavity;

a loading table upstream of said first and second presses, said loading table adapted to load assembled doors to said first and second presses; and

a discharging table downstream of said first and second presses, said discharging table adapted to unload said assembled doors from said first and second presses,

wherein the first and second pressing surfaces are shaped to compress central portions of the assembled doors to a greater extent than peripheral portions disposed about the perimeter of the assembled doors, so that surfaces of the central portions and the peripheral portions of the assembled doors are coplanar with each other, and the peripheral portions are in contact with stiles and rails forming a perimeter of a door upon discharge.

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44. The door pressing station of claim **43**, wherein the first and second pressing surfaces are mounted to the upper and lower dies, respectively.

45. The door pressing station of claim **43**, wherein the first and second pressing surfaces are removably connected to the upper and lower dies, respectively.

46. A door-making system, comprising:

a pressing station comprising at least a first press and a second press vertically stacked one on top of another, the first and second presses each configured to receive, press, and discharge at least one preassembled door having a door frame containing stiles and rails forming a perimeter of the door frame, at least two door skins, and adhesive, the first and second presses further being configured to press in alternating manner with respect to one another, wherein each of the first and second presses include dies shaped to compress central portions of the at least two door skins to a greater extent than peripheral portions disposed about the perimeter of the at least two door skins, so that surfaces of the central portions and the peripheral portions of the at least two door skins are coplanar with each other, and the peripheral portions are in contact with the stiles and rails of the door frame upon discharge.

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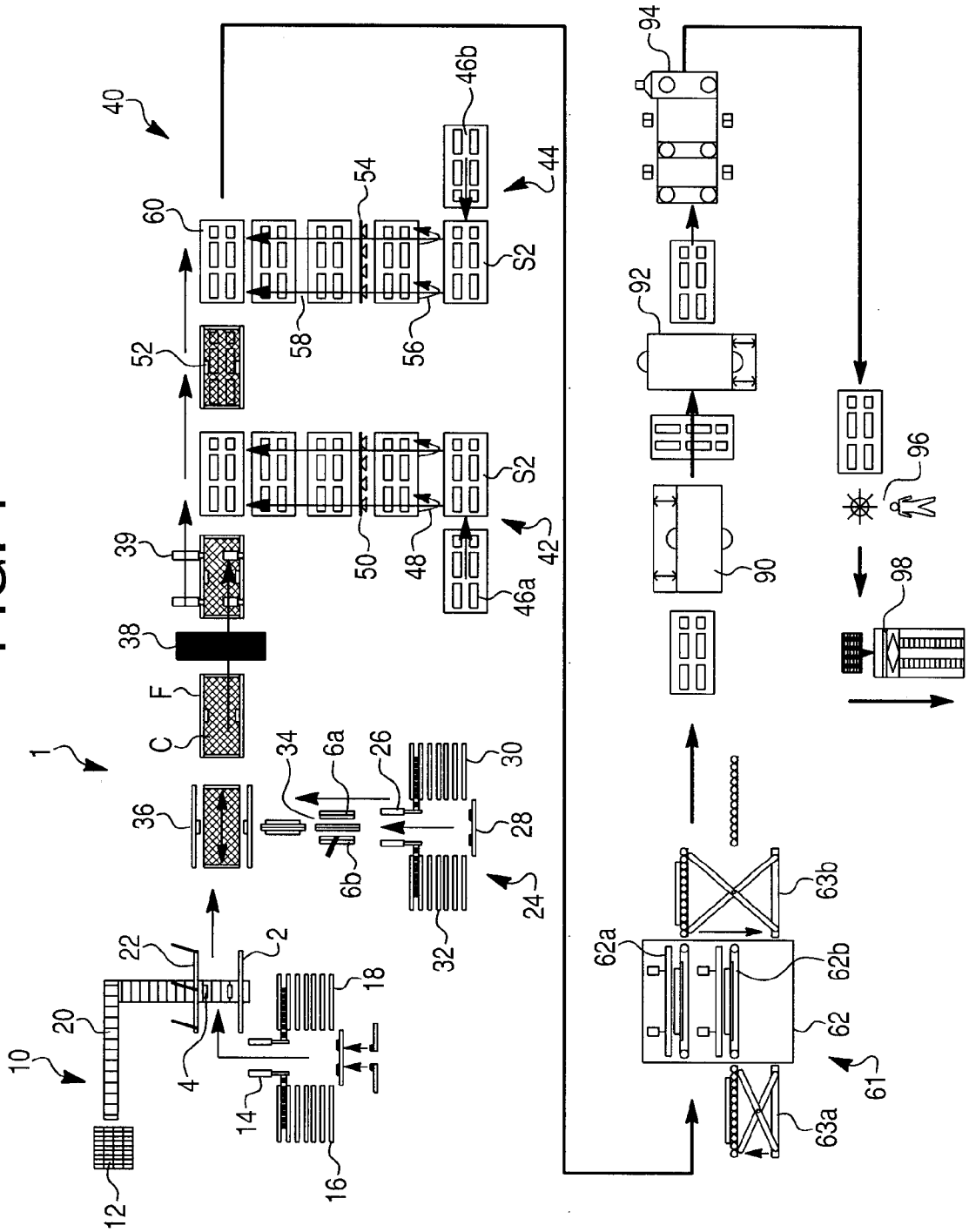
FIG. 1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30
36
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6b
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FIG. 2

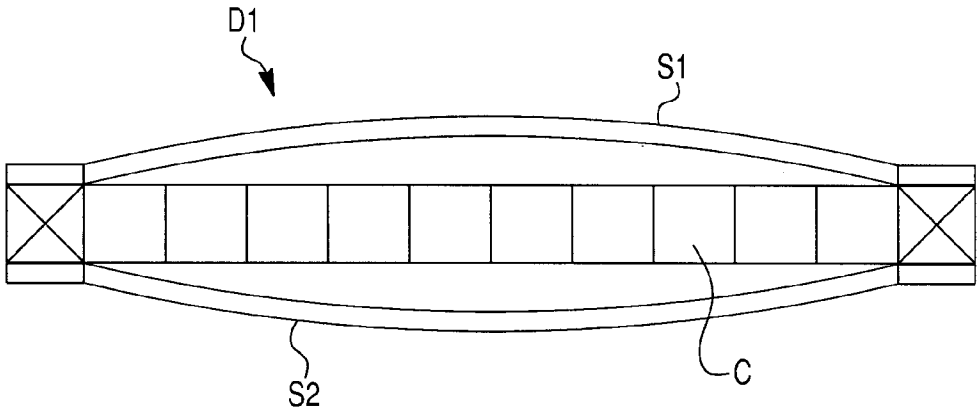

FIG. 3A

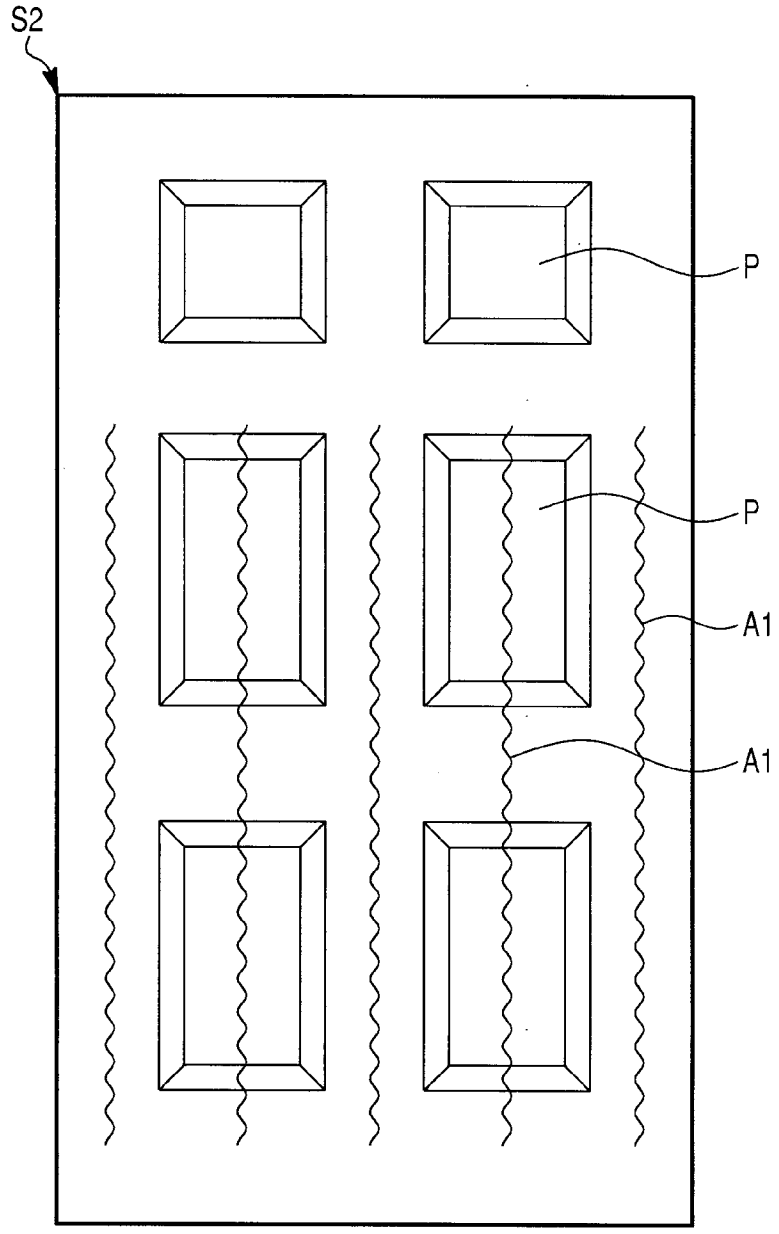

FIG. 3B

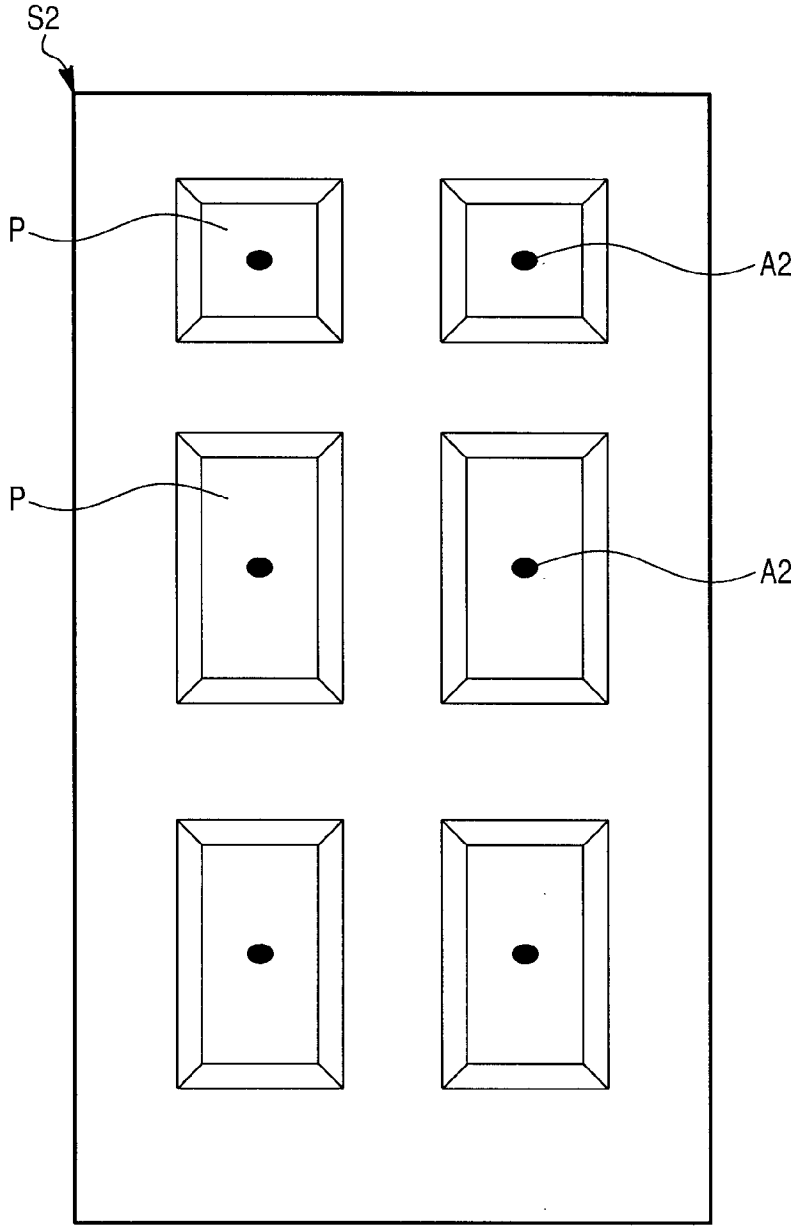

FIG. 4

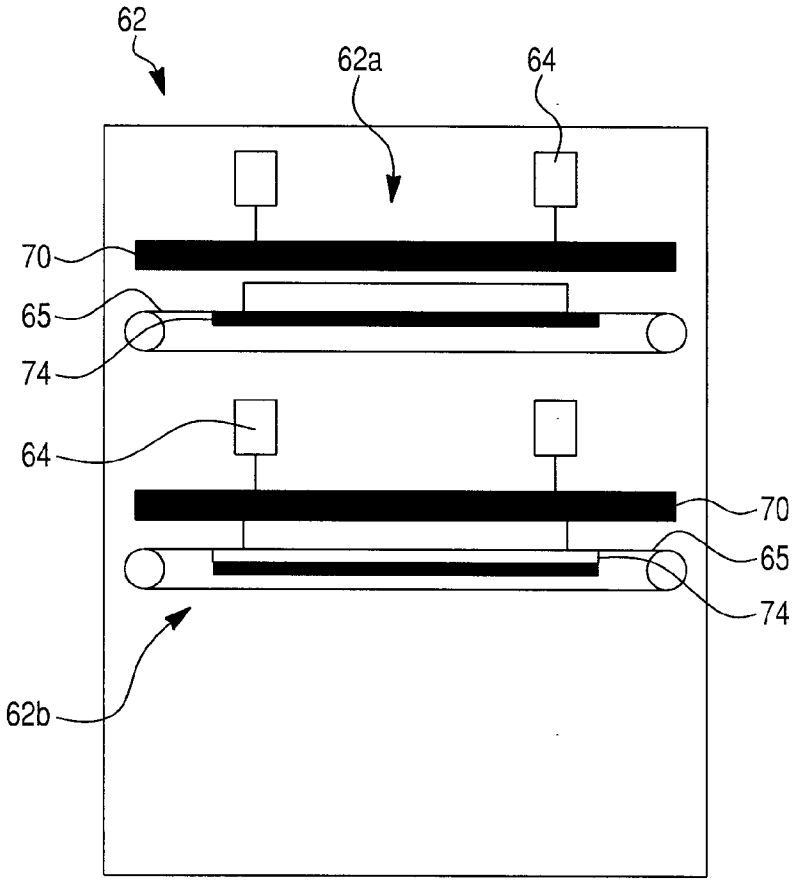

FIG. 5A

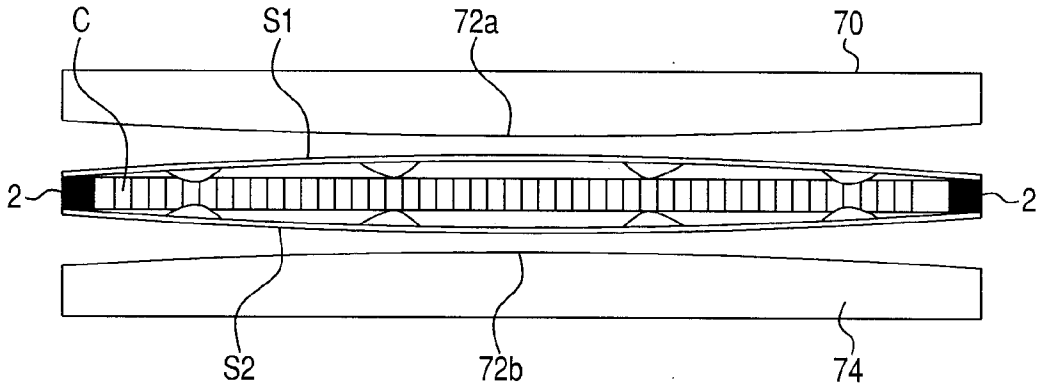

FIG. 5B

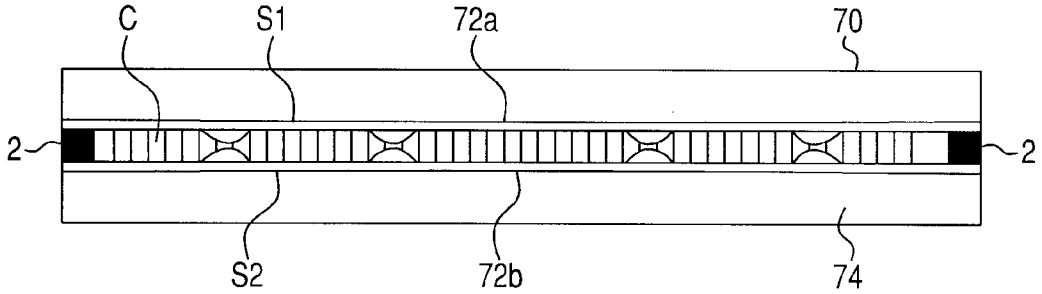

FIG. 5C

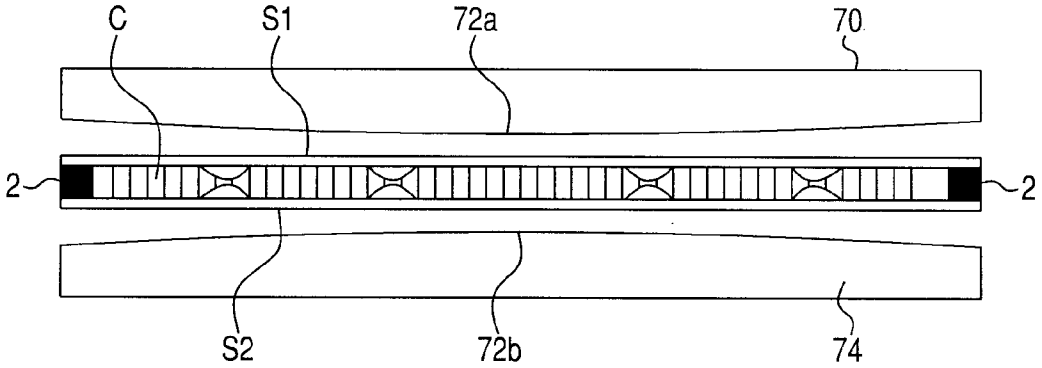

FIG. 6

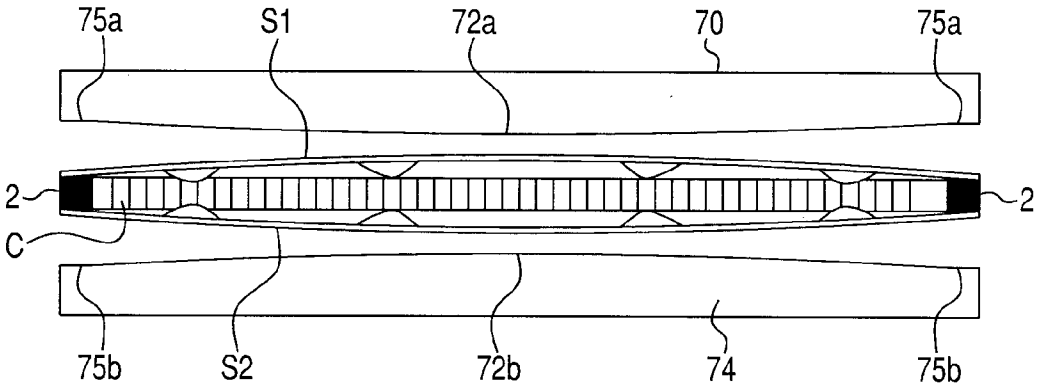

FIG. 7A

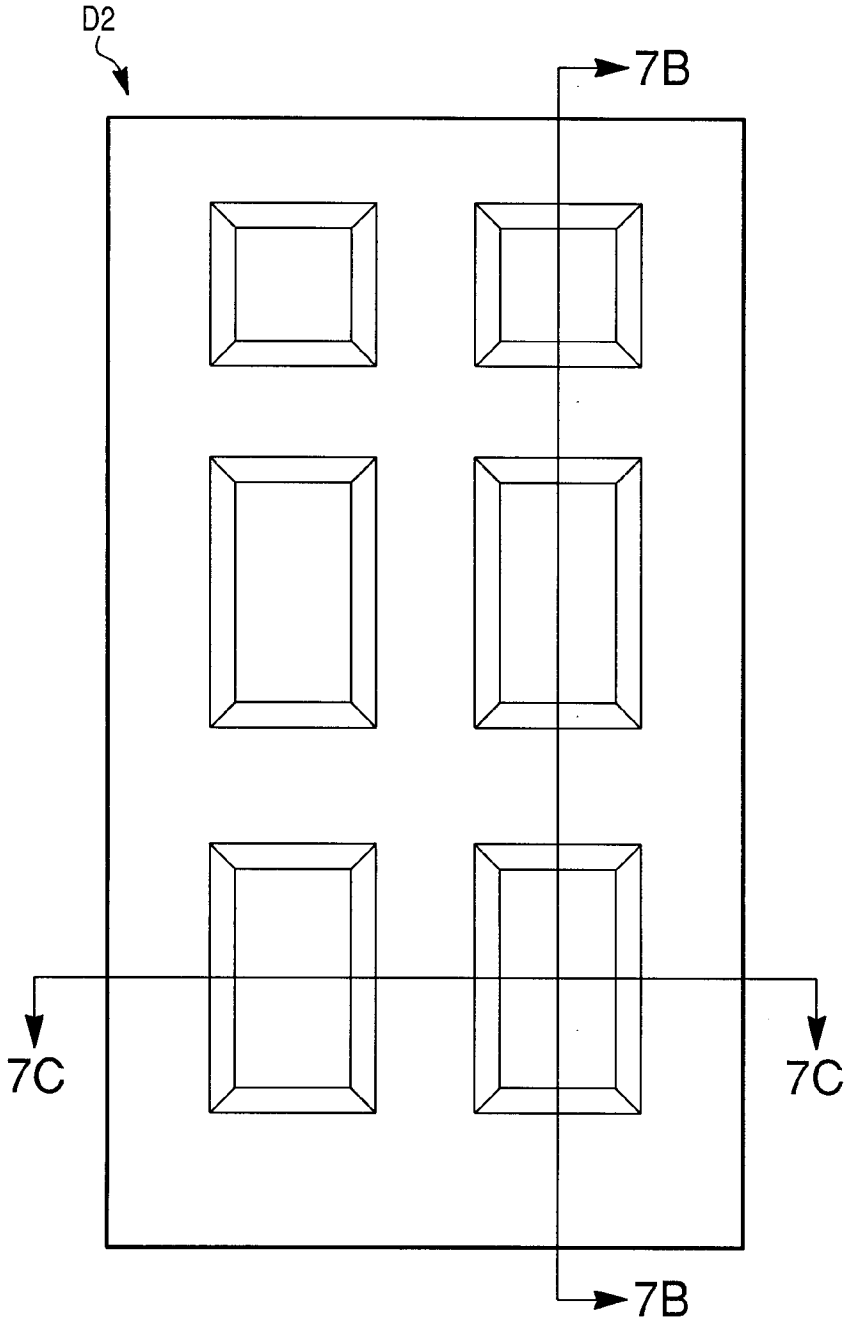

FIG. 7B

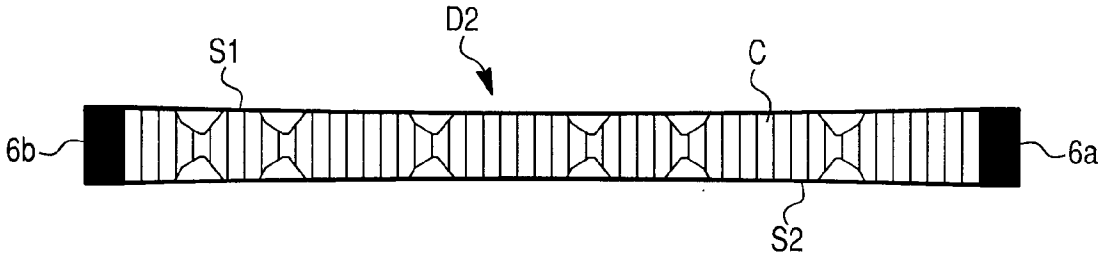

FIG. 7C

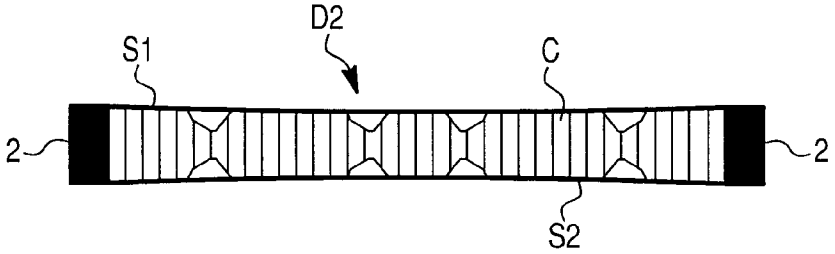

FIG. 8

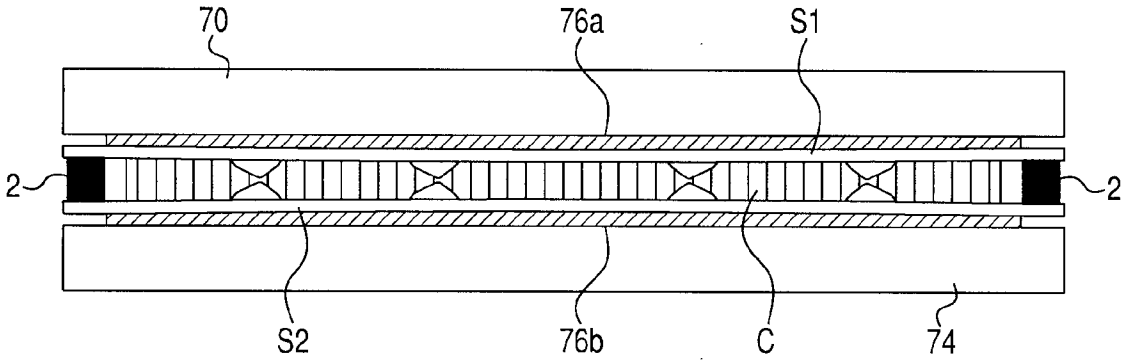

FIG. 9

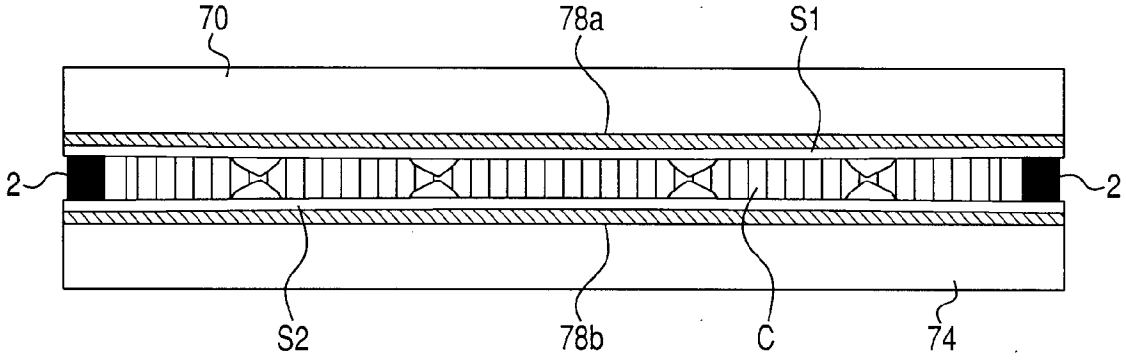

FIG. 10

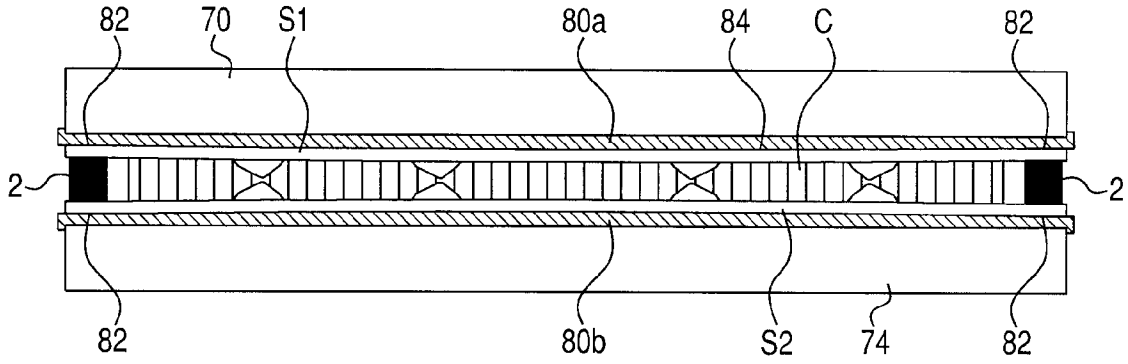
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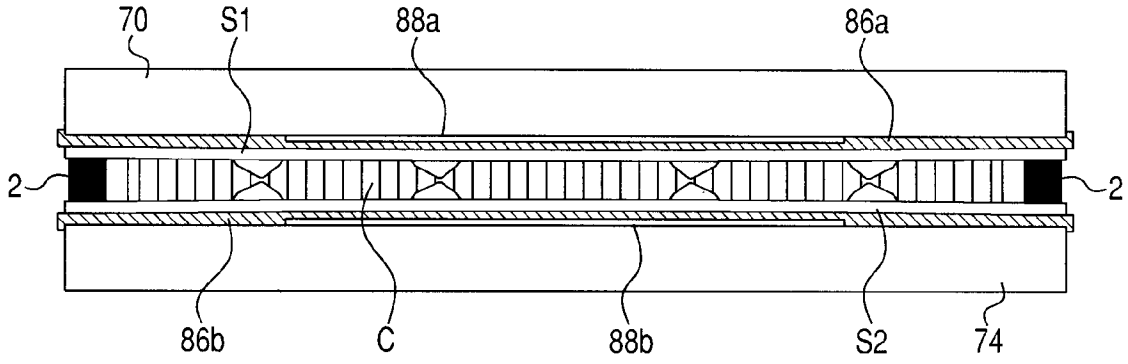
FIG. 11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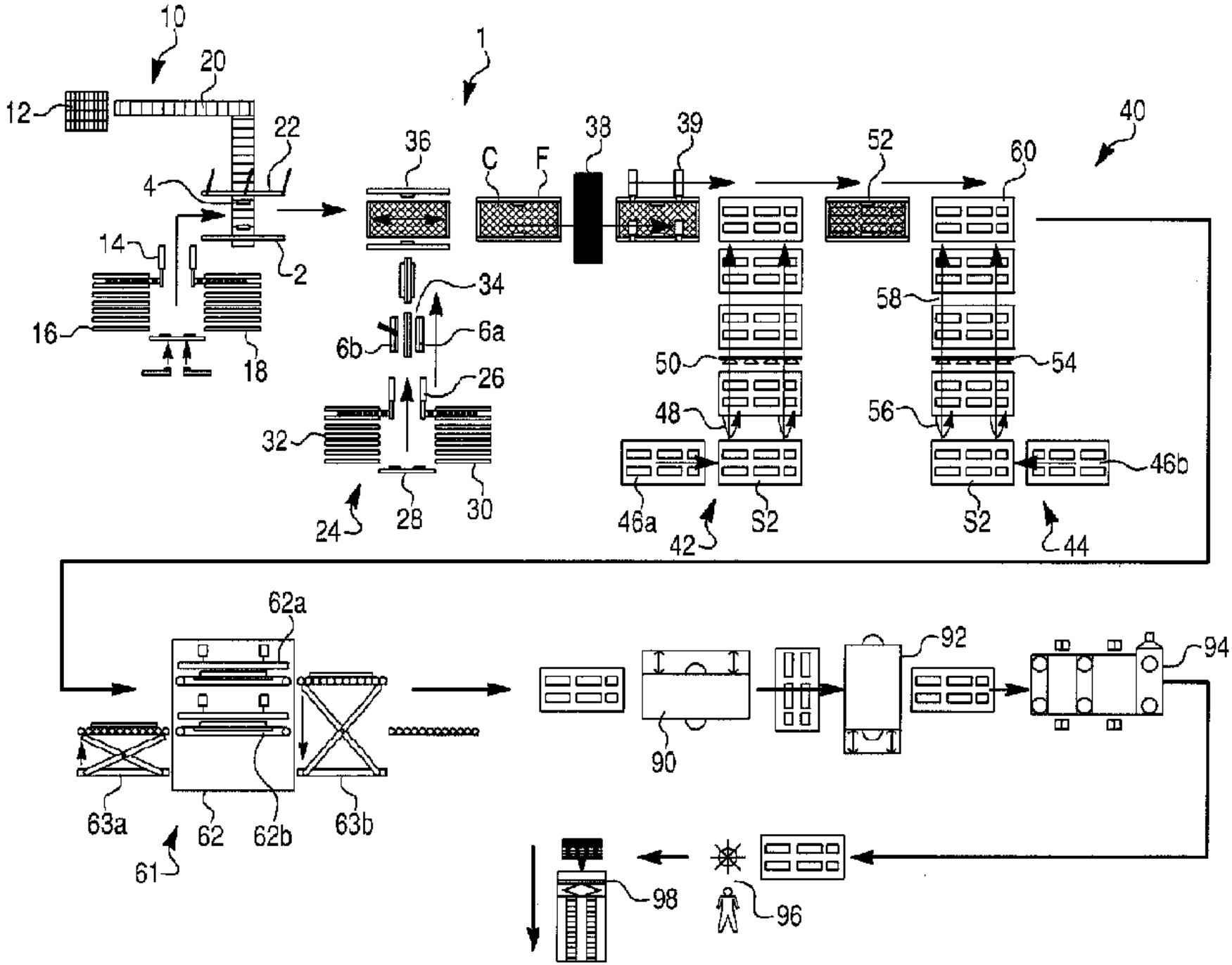
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