

US008991462B2

(12) **United States Patent**
Tyler

(10) **Patent No.:** **US 8,991,462 B2**
(45) **Date of Patent:** ***Mar. 31, 2015**

(54) **AUTOMATED DOOR ASSEMBLY SYSTEM AND METHOD**

USPC 156/556, 557, 558, 559, 563, 297, 300,
156/292; 52/455, 456, 784.1, 784.15,
52/784.16; 198/403; 414/758, 760, 761,
414/768

(75) Inventor: **Kenneth Charles Tyler**, Collins, MS
(US)

See application file for complete search history.

(73) Assignee: **Masonite Corporation**, Tampa, FL (US)

(56) **References Cited**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 50 days.

This patent is subject to a terminal disclaimer.

U.S. PATENT DOCUMENTS

1,870,517 A 8/1932 Lacey
2,565,779 A * 8/1951 Muddiman 198/404
2,735,461 A 2/1956 Pater
2,889,586 A 6/1959 Akerberg

(Continued)

(21) Appl. No.: **13/407,281**

FOREIGN PATENT DOCUMENTS

(22) Filed: **Feb. 28, 2012**

CN 201061892 Y 5/2008
DE 2733765 A1 2/1979

(65) **Prior Publication Data**

US 2012/0152430 A1 Jun. 21, 2012

(Continued)

OTHER PUBLICATIONS

Machine translation of European of European Patent Application Publication No. EP-2025481A2, published Feb. 2009, 6 pages.

(Continued)

Related U.S. Application Data

(60) Continuation of application No. 12/910,975, filed on Oct. 25, 2010, now Pat. No. 8,123,895, which is a division of application No. 10/941,016, filed on Sep. 15, 2004, now Pat. No. 7,819,163.

Primary Examiner — John Goff

(74) *Attorney, Agent, or Firm* — Berenato & White, LLC

(60) Provisional application No. 60/502,982, filed on Sep. 16, 2003.

(57) **ABSTRACT**

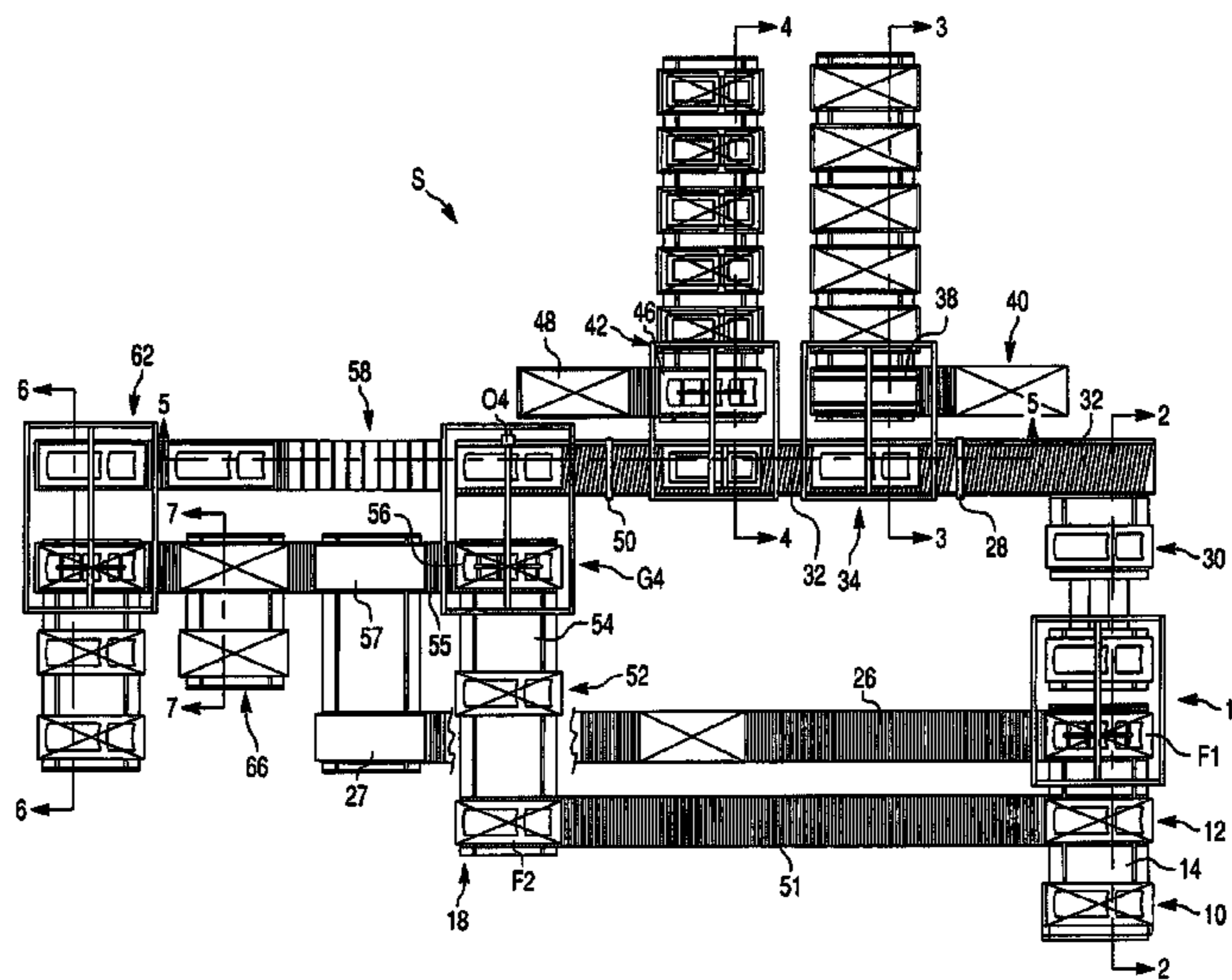
The present invention is directed to a method of making a door having first and second door facings and an internal doorframe. An interior side of a first facing is coated with quick acting adhesive. A frame is placed on the coated interior side about the periphery of the first facing. The frame is then coated with quick acting adhesive. An interior side of a second facing is placed on the coated frame. The facings and frame assembly are then compressed to form a door. The present invention also provides for an automated system of making the door.

(51) **Int. Cl.**
B29C 65/00 (2006.01)
B62D 65/06 (2006.01)

(52) **U.S. Cl.**
CPC **B62D 65/06** (2013.01)
USPC **156/556; 156/563; 414/758**

(58) **Field of Classification Search**
CPC B27D 1/00; B27D 1/04; E06B 3/72;
B65G 47/52

20 Claims, 5 Drawing Sheets



(56)

References Cited

U.S. PATENT DOCUMENTS

2,993,244 A 7/1961 James
 3,132,981 A 5/1964 Stack
 3,225,505 A 12/1965 Lytz
 3,367,823 A 2/1968 Clausen et al.
 3,616,090 A 10/1971 Larson
 3,671,615 A 6/1972 Price
 3,765,993 A 10/1973 Raffensparger et al.
 3,824,058 A 7/1974 Axer et al.
 3,963,552 A * 6/1976 Troutner et al. 156/299
 4,039,369 A * 8/1977 Versteeg 156/551
 4,342,615 A * 8/1982 Koch, II 156/563
 4,517,148 A 5/1985 Churchland
 4,643,787 A 2/1987 Goodman
 4,842,669 A 6/1989 Considine
 5,020,966 A 6/1991 Kiker
 5,142,835 A 9/1992 Mrocca
 5,155,959 A 10/1992 Richards et al.
 5,167,105 A 12/1992 Isban et al.
 5,177,868 A 1/1993 Kyle et al.
 5,415,943 A * 5/1995 Groger et al. 428/537.1
 5,560,168 A 10/1996 Gagne et al.
 5,588,996 A * 12/1996 Costello 118/668
 5,665,197 A 9/1997 Fujii et al.
 5,752,594 A * 5/1998 Fournier 198/803.9
 5,776,292 A * 7/1998 Fujii et al. 156/299
 5,875,609 A 3/1999 Quinif
 5,992,127 A 11/1999 Quinif
 6,067,699 A 5/2000 Jackson
 6,085,813 A 7/2000 Elliott et al.
 6,125,901 A * 10/2000 Englisch et al. 156/362
 6,132,836 A 10/2000 Quinif
 6,170,224 B1 1/2001 Boyse et al.
 6,389,769 B1 5/2002 McKinney et al.

6,811,647 B1 * 11/2004 Graf et al. 156/264
 7,314,534 B2 1/2008 Hardwick
 7,501,037 B2 3/2009 Stroup et al.
 7,819,163 B2 * 10/2010 Tyler 156/563
 8,171,700 B2 5/2012 Barnes
 2001/0030103 A1 * 10/2001 Runonen 198/403
 2002/0100996 A1 8/2002 Moyes et al.
 2003/0173734 A1 * 9/2003 Wong et al. 271/198
 2004/0096535 A1 5/2004 Hudecek et al.
 2005/0102940 A1 5/2005 Tyler
 2009/0071609 A1 3/2009 Stroup et al.
 2009/0211688 A1 8/2009 Pertilla et al.
 2012/0027999 A1 2/2012 Liang et al.

FOREIGN PATENT DOCUMENTS

DE 19916041 A1 * 10/2000
 DE 10224793 C1 7/2003
 EP 0860253 A2 8/1998
 EP 1260329 A2 11/2002
 EP 2025481 A2 2/2009
 EP 2258916 A1 12/2010
 EP 2415571 A2 2/2012
 GB 2293853 A 4/1996
 JP 59118618 A 7/1984
 JP 2001032436 A 2/2001
 JP 2005104052 4/2005
 WO 2005087464 A1 9/2005

OTHER PUBLICATIONS

Dexheimer et al, "Hot-Melt Adhesives", Adhesives in Manufacturing, p. 325, 1983.
 International Search Report, International Application No. PCT/7S2014/030297, mailed Jun. 12, 2014.

* cited by examiner

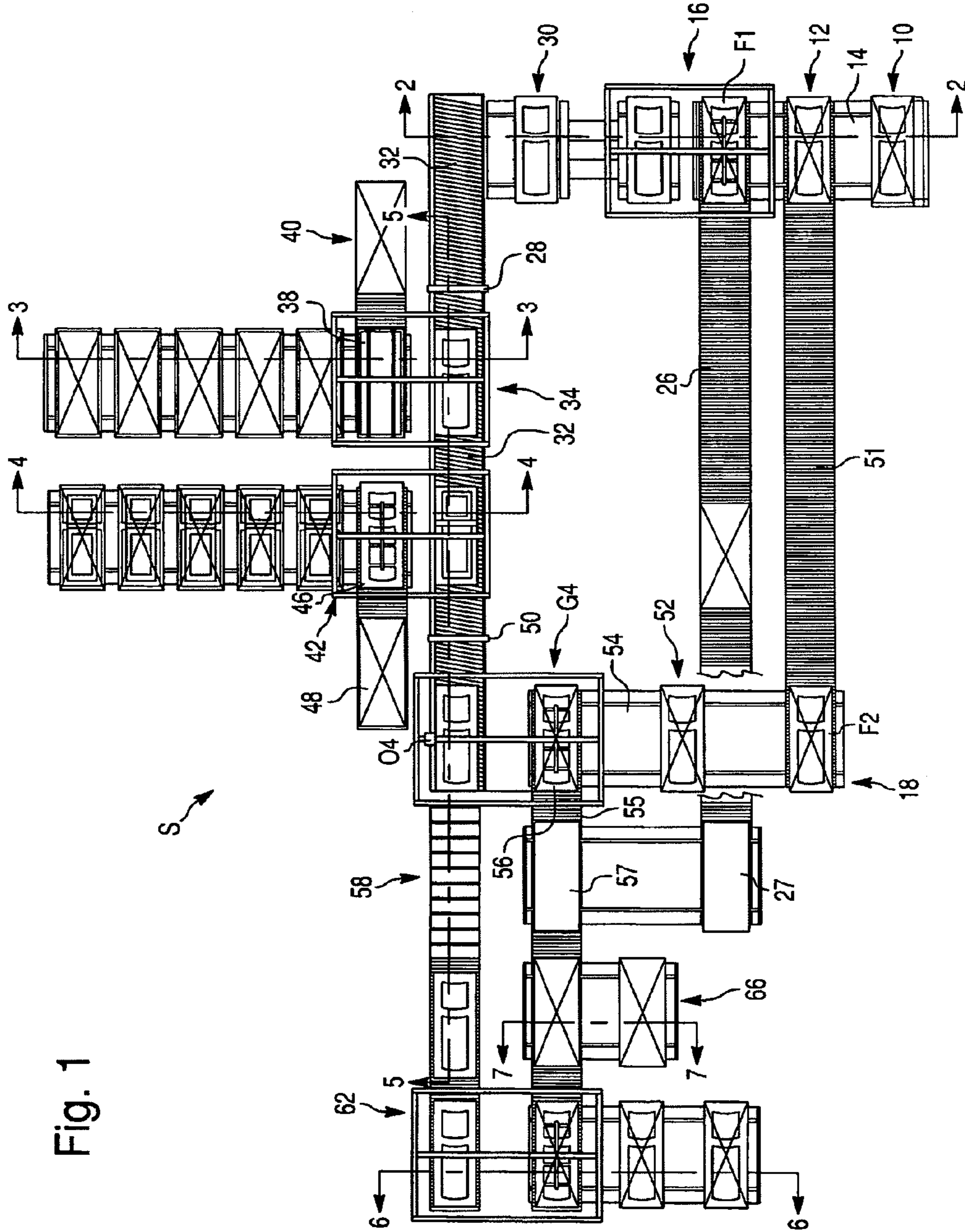


Fig. 1

Fig. 4

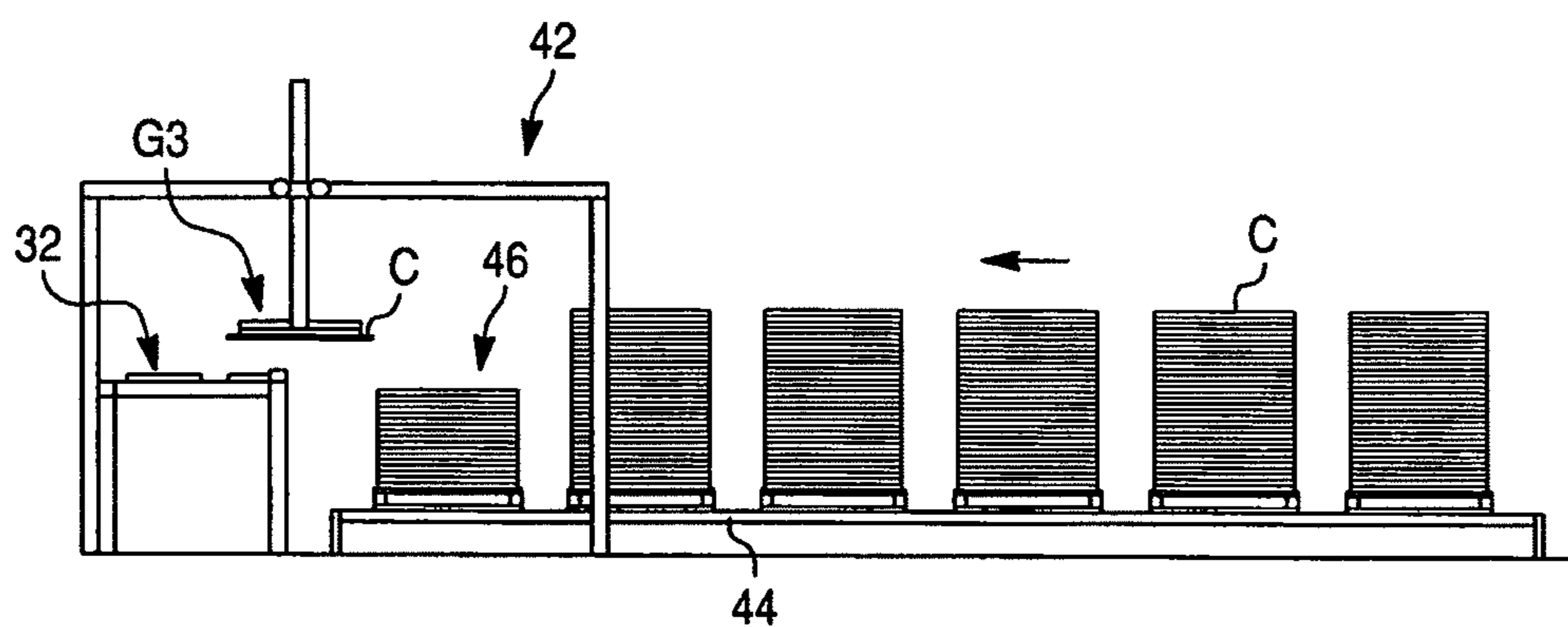


Fig. 6

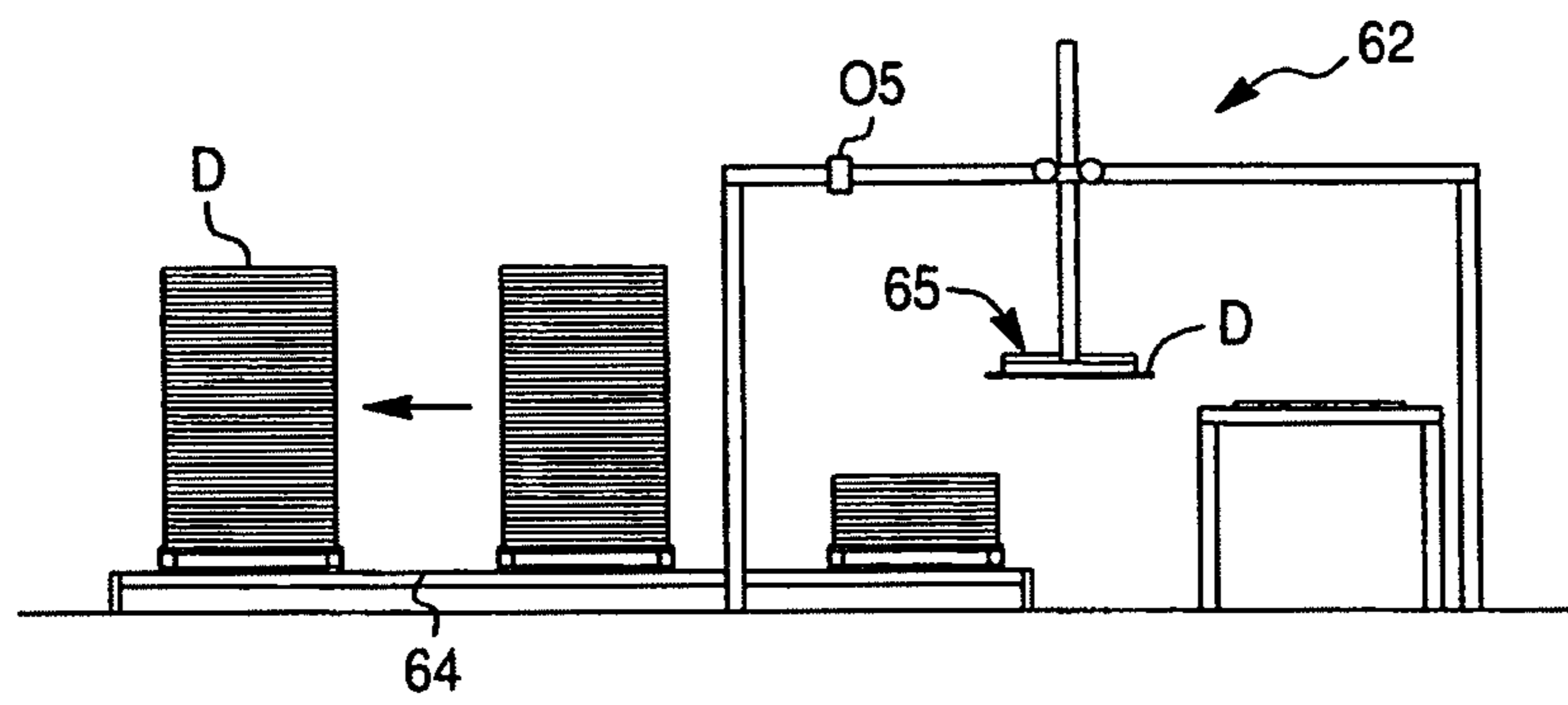
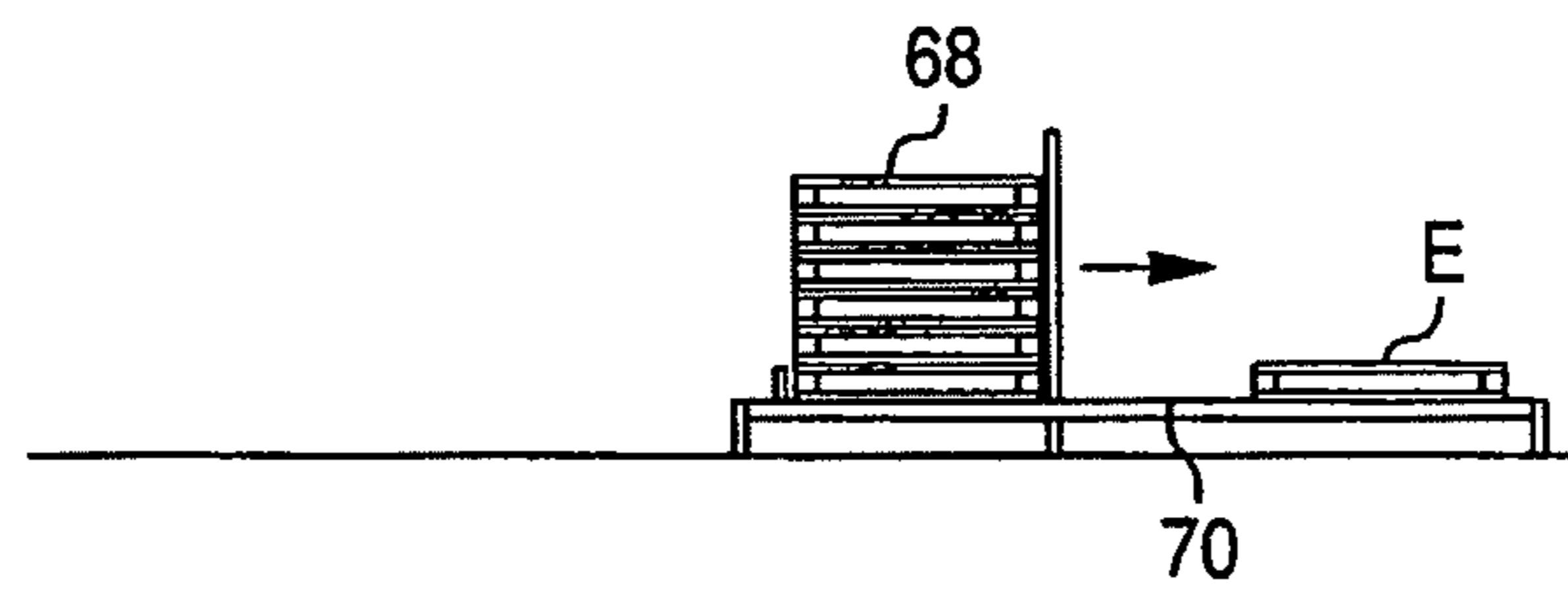


Fig. 7



1

AUTOMATED DOOR ASSEMBLY SYSTEM AND METHOD

CROSS-REFERENCE TO RELATED APPLICATION AND CLAIM TO PRIORITY

This application is a continuation of application Ser. No. 12/910,975, filed on Oct. 25, 2010, now U.S. Pat. No. 8,123,895, which is a divisional of application Ser. No. 10/941,016, filed on Sep. 15, 2004, now U.S. Pat. No. 7,819,163, which claims priority to provisional application No. 60/502,982, filed Sep. 16, 2003, the disclosures of which is incorporated herein by reference and priority to which is claimed.

FIELD OF THE INVENTION

The present invention is directed to a method of making a door having first and second door facings and an internal doorframe. An interior side of the first facing is coated with quick acting adhesive. The frame is placed on the coated interior side about the periphery of the first facing. The frame is then coated with quick acting adhesive. An interior side of the second facing is placed on the coated frame. The facing and frame assembly are then compressed to form a door. The present invention also provides for an automated system of making the door.

BACKGROUND OF THE INVENTION

Molded doors are assembled using two door facings, often molded from a wood fiber/resin compound. The door facings form the outer surfaces of the door. Such doors often include an internal frame that provides structural support. The frame typically includes stiles and rails located around the perimeter of the door. The door may also include a core material, such as expandable cardboard material, particleboard, medium density fiberboard, or other some other one-piece core component.

Manual assembly of molded doors is relatively labor intensive, expensive, and subject to quality variations. A door facing is manually placed on a production table with its intended, exteriorly disposed surface face down. The parts of a frame, comprising individual stiles and rails, are then passed through a roll coater by hand. The roll coater applies conventional glue to opposing sides of the frame parts. The coated frame parts are then placed on top of the door facing that is on the table. A second door facing is then placed on the frame parts. The resulting assembly is then indexed downwardly so that another door may be assembled. The assembly must be carefully moved, given the components can easily shift at this point.

Manual assembly of the next molded door is repeated as described above, with each successive assembly being stacked on top of the previous assembly until a predetermined quantity of door assemblies has been stacked on the table. The table of door assemblies is then transported to a press, and the stack is placed in the press. The press applies pressure to the entire stack for a period of time sufficient to allow the glue to sufficiently bond the door assemblies. Conventional glues may take about one hour or more in-press before the door reaches "green" strength. A door achieves green strength when the glue has reached sufficient bonding strength to hold the door components together for further handling. Once green strength is achieved, the doors may be removed from the press and moved to an in-process inventory until the glue reaches maximum cure strength. Depending on the glue used, the doors may need to remain in inventory for a relatively long

2

period of time, for example four hours or more, or even twenty-four hours or more, before the glue reaches maximum bonding strength. After maximum bonding strength is achieved, the doors are moved to a final processing station. Final processing includes edge trimming the doors to customer specification and coating and/or painting the door skins and exposed edges of the stiles and rails around each door perimeter. Therefore, manufacturing time for a door using conventional methods may be twenty-four hours or more, from the time production is initiated to the resulting finished door.

Various attempts have been made to automate production of interior molded doors. However, the production equipment necessary is often very expensive, and the methods used overly complex. Production capability from a single manufacturing facility is often limited. In addition, the glues used typically require curing presses, which are relatively expensive. Furthermore, such glues require a relatively long period of time before green strength is achieved, as well as a relatively long period of time before maximum cure strength is achieved, which is impractical in an automated production system.

As such, conventional systems and methods for automated door assembly have not proven to be cost efficient. Therefore, there is a need for an automated door assembly system and method that is cost efficient, and that achieves final product quality that is desirable to consumers.

SUMMARY OF THE INVENTION

The present invention is directed to a method of making a door. An interior side of a first facing is coated with quick acting adhesive. A doorframe is placed on the coated interior side about the periphery of the first facing. The frame is then coated with quick acting adhesive. An interior side of a second facing is placed on the coated frame. The facings and frame are compressed, thereby forming a door.

The present invention is also directed to a system for making a door. The system includes first and second stations, each for receiving a plurality of door facings. A conveyor operably associated with the first station receives and transports in a first direction an exterior surface of a door facing. A third station operably associated with the conveyor applies quick acting adhesive on an interior surface of the door facing. A fourth station operably associated with the conveyor positions a doorframe onto the adhesive covered interior surface of the door facing. A fifth station operably associated with the conveyor applies quick acting adhesive on the doorframe. A transfer mechanism operably associated with the second station positions an interior surface of a facing from the second station onto the adhesive covered doorframe. A compression station operably associated with the conveyor compresses the facings and the doorframe, thereby forming a door.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is a schematic diagram of a system for making a door according to a preferred facility layout of the present invention;

FIG. 2 is a side elevational view of a portion of the facility layout of FIG. 1 taken along line 2-2 and viewed in the direction of the arrows;

FIG. 3 is a side elevational view of a portion of the facility layout of FIG. 1 taken along line 3-3 and viewed in the direction of the arrows;

3

FIG. 4 is a side elevational view of a portion of the facility layout of FIG. 1 taken along line 4-4 and viewed in the direction of the arrows;

FIG. 5 is a side elevational view of a portion of the facility layout of FIG. 1 taken along line 5-5 and viewed in the direction of the arrows;

FIG. 6 is a side elevational view of a portion of the facility layout of FIG. 1 taken along line 6-6 and viewed in the direction of the arrows; and

FIG. 7 is a side elevational view of a portion of the facility layout of FIG. 1 taken along line 7-7 and viewed in the direction of the arrows.

DETAILED DESCRIPTION OF THE INVENTION

A preferred facility layout of a system S for making doors according to the present invention is best shown in FIG. 1. System S includes a loading station 10 for receiving door facings. Pallet loads of door facings may be transported to loading station 10 by fork truck. For example, each pallet load may include 200 door facings. From loading station 10, pallets may be transported to a distribution station 12 via a loading conveyor 14.

From distribution station 12, pallets are transported to either a first station 16 for processing a first door facing F1 of a door being manufactured, or a second station 18 for processing a second door facing F2 on the opposing side of the door. Preferably, the first three pallets of door facings received at distribution station 12 are directed to first station 16. The next three pallets of door facings received at distribution station 12 are directed to second station 18. Door facings F1, F2 may be made from a wood fiber composite, hardboard, steel, polymer and like materials used to manufacture door skins. Preferably, door facings F1, F2 are contoured, although flush doors may be manufactured through use of system S.

As best shown in FIG. 2, pallets of door facings F1 may be transported from distribution station 12 to a receiving port 20 of first station 16 via a first station conveyor 22. From receiving port 20, each door facing F1 is transported to a feed port 24 of first station 16. Preferably, a gantry device G1 using a suction or vacuum mechanism lifts one facing F1 from the pallet at receiving port 20, transports facing F1 to feed port 24, and places facing F1 thereon. Gantry device G may move along rails R for transporting facing F1.

An optical sensor O1 is preferably associated with receiving port 20 for sensing when a pallet received therein is empty. When the sensor senses an empty pallet, the empty pallet is moved onto a first station pallet conveyor 26, as best shown in FIG. 1. Empty pallets may be pushed onto pallet conveyor 26 using an actuator. The empty pallets are transported to a pallet storage port 27. Another full pallet is then forwarded into position from distribution station 12 to receiving port 20 via first station conveyor 22.

Data from optical sensor O1 in receiving port 20 is preferably communicated to distribution station 12. Once an empty pallet is discharged from receiving port 20, and moved out of first station 16 via pallet conveyor 26, distribution center 12 automatically forwards the next pallet into position in first station 16. Alternatively, the timing and rate of door skin depletion at first and second stations 16, 18 may be controlled by a programmable logic controller ("PLC"). Distribution station 12 may coordinate distribution of pallets according to a determined rate of depletion of pallets at first and second stations 16, 18.

Although FIG. 2 depicts one stack of pallets in loading station 10, one stack of pallets in distribution station 12, and one stack of pallets in receiving port 20, system S may accom-

4

modate additional stacks of pallets. For example, loading conveyor 14 and/or first station conveyor 22 may be extended in length to accommodate more than one stack of pallets. As such, FIG. 2 is provided for purposes of explanation only, and the invention is not so limited. The precise configuration of system S may also depend on the specific requirements of a manufacturing facility and/or available space. However, first and second stations 16, 18 preferably can hold a combined minimum of at least six pallets.

From feed port 24, door facing F1 is transported to a third station 28, where door facing F1 is coated with a quick acting adhesive, as best shown in FIG. 1. Preferably, feed port 24 is operably associated with a star conveyor 30, which places facings F1 onto a production conveyor 32 leading to third station 28. Star conveyor 30 includes openings 31 defined by cooperating supports, or wickets 30A, for receiving and holding door facings F1 from feed port 24, as best shown in FIG. 2. Wickets 30A extend outwardly from a central member 30B like spokes on a wheel. Each wicket 30A includes a planar member 30C extending outwardly from central member 30B. A leg 30D extends substantially perpendicular to the planar member 30C at the outermost end of each wicket relative to central member 30B. Legs 30D extend outwardly from planar member 30C in the direction of rotation of star conveyor 30, as shown by arrow R in FIG. 2.

Feed port 24 is preferably a conveyor that moves facings F1 into openings 31 of star conveyor 30. Feed port 24 transports one facing F1 into an opening 31. Facing F1 is thereby pushed into opening 31 until the forwardly moving edge of facing F1 contacts central member 30B. Once a facing F1 has indexed into opening 31, star conveyor 30 rotates several degrees, thereby rotating facing F1. The next adjacent opening 31 is thereby ready to receive the next facing F1 from feed port 24.

Legs 30D on wickets 30A keep facings F1 from sliding off of planar members 30C. However, facings F1 are not clamped into star conveyor 30. Therefore, as star conveyor 30 rotates, each facing eventually falls forward in direction R onto the forwardly disposed, adjacent planar member 30C of wicket 30A due to gravity. Typically, each facing F1 will fall forward after having been rotated 90° or more by star conveyor 30. Star conveyor 30 continues to rotate each facing F1 about 180°. Each facing F1 then slides off the wicket 30A onto production conveyor 32 when wicket 30A is downwardly sloped relative to central member 30B. Tangential forces created during rotation of facing F1 also cause facing F1 to slide onto production conveyor 32.

Preferably, a door facing F1 is indexed from feed port 24 into an opening 31 every 10 to 12 seconds. More preferably, star conveyor 30 includes twenty openings 31 and holds 10 facings F1, with wickets 30A rotating 18° every three seconds. The conveyor of feed port 24 and production conveyor 32 are positioned so that ten openings are above the conveyors and ten openings are below the conveyors. After ten openings (or 1/2 of the openings) have received door facings F1, a door facing F1 is released onto production conveyor 32 with each successive rotation of star conveyor 30. This, in turn, moves one of the empty openings into position adjacent feed port 24, and another facing F1 indexes into a corresponding opening 31.

Door facings F1 are thereby "flipped" onto production conveyor 32 from feed port 24. Typically, door facings are stacked on a pallet with the intended interior surface of each door facing stacked on top of the intended exterior surface of the next facing in the stack. However, door facing F1 is placed onto production conveyor 32 so that the intended interior surface of each facing F1 is "face up", with the intended exterior surface of facing F1 placed against production con-

5

veyor **32**. In this way, the intended interior surface of door facing **F1** is exposed for coating at third station **28**.

Preferably, the quick acting adhesive applied at third station **28** is a hot melt, polyurethane reactive (PUR) adhesive. However, other quick acting adhesives known in the art may also be used. The adhesive may be heated for application, and sprayed onto the interior surface of each facing **F1** by spray headers. The spray headers may include multiple spray nozzles, which apply an even coat of adhesive on the entire surface. Alternatively, the spray headers may be adjusted for selectively coating portions of the interior surface. The width and thickness of the adhesive applied may also be adjusted depending on the desired amount of adhesive and/or the width of the door being assembled. Depending on the specific formulation of the adhesive, it has an "open time" in which components can be moved around prior to the glue achieving hardening strength. These open times can vary from less than a minute to several hours. However, the quick-acting adhesive has sufficient tackiness so that the components do not shift as the components proceed in the manufacturing process.

After the adhesive has been applied to the interior surface of door facing **F1**, door facing **F1** is transported via production conveyor **32** from third station **28** to a fourth station **34**, as best shown in FIGS. **1** and **3**. At fourth station **34**, stiles and rails are positioned onto the adhesive covered interior surface of door facing **F1**. Preferably, the stiles and rails are pre-assembled as a perimeter frame **P**. Fourth station **34** includes a fourth station conveyor **36** and a lifting gantry **G2**. Pallets of frames **P** move along conveyor **36** into a receiving port **38** of fourth station **34**, wherein each frame **P** is lifted and placed onto a corresponding facing **F1** by gantry **G2**. Preferably, lifting gantry **G2** includes clamp-type "fingers" for lifting and moving each frame **P** into position. The pallets of frames **P** may be supplied to fourth station **34** by fork truck.

Fourth station **34** preferably includes optical sensors **O2** for ensuring proper positioning and alignment of each perimeter frame **P** onto the adhesive covered interior surface of door facing **F1**. The optical sensors indicate when each door facing **F1** is moving into fourth station **34** via production conveyor **32**. Alternatively, fourth station **34** may include a mechanical limit switch for ensuring proper positioning of frame **P** on facing **F1**. At that time, mechanical stops elevate into position to stop movement of facing **F1**, and hold facing **F1** in the proper position for securing the frame thereto. After frame **P** has been positioned onto facing **F1**, the mechanical stops lower and allow facing **F1** to proceed along production conveyor **32**.

As best shown in FIG. **1**, after all of the frames **P** from a pallet have been used, the empty pallet is moved from receiving port **38** to a fourth station empty pallet stacker **40**. An optical sensor **O3** senses when the pallet in receiving port **38** is empty. The empty pallet is then removed from receiving port **38** via automatic forks similar to those used on fork trucks. The forks engage the pallet and a lifting device elevates the pallet a sufficient distance to allow clearance for the next empty pallet to be placed in the same position, for example the forks may lift the empty pallet several inches. When the next pallet is sensed to be in position by an optical sensor, the lifting device lowers the first pallet on top of the second pallet. The forks retract, and the lifting device is lowered to the original position, whereby the forks can now index into the second pallet. The stack of two pallets is then lifted to provide clearance for the arrival of the next pallet. This process is repeated until a full stack of empty pallets is achieved, for example 20 pallets. The stack of empty pallets may then be removed by fork truck.

6

If a solid core door is desired, system **S** may include a fifth station **42** where a core component **C** is positioned onto the adhesive covered interior surface of door facing **F1**, as best shown in FIGS. **1** and **4**. It should be understood, however, that fifth station **42** is optional, and system **S** may be configured for manufacturing coreless doors. Similar to fourth station **34**, fifth station **42** includes a conveyor **44**, which transports pallets of core components **C** to a receiving port **46**. Each component **C** is then lifted and placed onto the adhesive covered interior surface of facing **F1** via a gantry device **G3**. Gantry device **G3** may be similar to gantry device **G1** from first station **16**, which has a suction mechanism for lifting and transporting each core **C** into position. Alternatively, gantry device **G3** may have clamp-type fingers, similar to gantry device **G2** from fourth station **34**. Pallets of core components **C** may be supplied to fifth station **42** by fork truck. The core components may be made from cardboard, medium density fiberboard, and the like. The fiberboard may be either routed or molded to fit the contours of facings **F1**, **F2**. A preferred core component **C** is made from an expanded, honeycomb-type cardboard, given such material is relatively inexpensive.

As best shown in FIG. **1**, after all of the core components **C** from a pallet have been used, the empty pallet is moved from receiving port **46** to a fifth station empty pallet stacker **48**, which is similar to empty pallet stacker **40** from fourth station **34**.

After core component **C** is placed onto adhesive covered interior surface of facing **F1**, door facing **F1** is then transported to a sixth station **50** via production conveyor **32**, as best shown in FIG. **1**. The upwardly facing surfaces of perimeter frame **P** and core **C**, relative to production conveyor **32**, are coated or sprayed with quick acting adhesive at sixth station **50**. Preferably, a hot melt (PUR) adhesive is used, as described above. The hot melt adhesive applied at sixth station **50** is preferably, but need not be, the same quick acting adhesive applied at third station **28**. The adhesive is preferably applied using spray headers, but may also be applied by roll coating or other such application methods. Portions of the perimeter frame **P** and/or core **C** may be selectively coated by adjusting the spray headers or other coating device used for applying the adhesive. For example, if a core component is not used in the manufacturing process, third and sixth stations **28**, **50** may be adjusted to selective coat or spray around the perimeter of the interior surface of door facing **F1** and the perimeter frame **P**, respectively.

After hot melt (PUR) adhesive has been applied at sixth station **50**, second door facing **F2** may be placed onto the adhesive covered frame **P** and core **C**. Second door facings **F2** are transported from distribution station **12** to second station **18** via a second station conveyor **51**. A transfer mechanism **52** is provided, which transports and positions each facing **F2** from second station **18** onto the adhesive covered frame **P** and core component **C**. Transfer mechanism **52** preferably includes a transfer conveyor **54** for transporting pallets of facings **F2** from second station **18** to a gantry device. As described above, pallets of facings **F2** are forwarded via conveyor **54** to a transfer receiving port **56**. Each facing **F2** is then lifted and placed onto adhesive covered surface of frame **P** via gantry **G4**. Gantry **G4** may be similar to the gantry used at first station **16**, and includes vacuum cups that suction to each door facing **F2** when moving each door facing **F2** into position. Preferably, optical sensors **O4** are provided for ensuring proper positioning and alignment of the intended interior surface of facing **F2** onto adhesive covered frame **P**, as described above for fourth station **34**.

Once all of the second door facings **F2** are used from a pallet in transfer receiving port **56**, empty pallets are removed

via a transfer conveyor **55**, and may be stored in an empty pallet storage port **57**, similar to empty pallet port **27**. The two empty pallet ports may be operatively connected via a conveyor, so that empty pallets may be easily removed from one empty pallet port **27** by fork truck.

After door facings **F1**, **F2**, and frame **P** and core **C** have been assembled, the resulting assembly is transported via production conveyor **32** to a compression station **58**, as best shown in FIGS. **1** and **5**. Facings **F1**, **F2**, frame **P** and core **C** are compressed to form a door **D**. Compression station **58** preferably includes a series of pinch rollers **60** for compressing facings **F1**, **F2** and the frame. Pinch rollers **60** provide sufficient compression for curing hot melt (PUR) adhesive, and are relatively inexpensive compared to presses required for "cold" adhesive curing. Pinch rollers **60** force door facings **F1**, **F2** against the interior components (i.e. frame **P** and core **C**). Upon exiting pinch rollers **60**, the quick acting adhesive securing the components of door **D** has already achieved green strength. Preferably, production conveyor **32** moves door **D** through compression station **58** at a rate of about 175 feet per minute. Thus, door **D** undergoes compression by pinch rollers **60** for only a few seconds, preferably twelve seconds or less. By contrast, conventional presses typically require a compression period of forty-five minutes or more before green strength is reached.

Exiting pinch rollers **60**, each door **D** is successively stacked on a pallet at a stacking station **62**, as best shown in FIGS. **1** and **6**. Doors **D** are stacked on a pallet until a predetermined number of doors has accumulated thereon, for example forty doors per pallet. Each door is removed from production conveyor **32** and stacked onto a pallet via a gantry **G5**, which is similar to the other gantries described above. Stacking station **62** may include an optical sensor **O5** for indicating when a pallet is full. A full pallet of finished doors is then transported via a stacking conveyor **64** to an in-process storage area for stack down time. Preferably, a stack down time of at least about thirty minutes is allowed so that sufficient adhesive strength is achieved before final processing of the doors **D**. Preferably, the quick acting adhesive reaches about 75% final cure strength, more preferably about 95% cure strength, during a stack down time of one hour or less. By contrast, conventional systems typically require a stack down time of between at least 4-24 hours or more before final processing may be initiated. Final processing may include edge trimming to customer specifications and/or coating the exposed edges of the frame with a protective coating or paint.

Empty pallets are supplied to stacking station **62** via a pallet station **66**, as best shown in FIGS. **1** and **7**. A stack of empty pallets is received at a pallet receiving port **68**, unstacked via automatic forks as described above, and forwarded via a pallet station conveyor **70**. Single empty pallets **E** are thereby staged to accept finished doors.

The process time, from application of adhesive at third station **28** to the compressed door **D**, is approximately one minute. Door **D** may then be finally processed after about one hour of stack down time, more preferably after about thirty minutes of stack down time. Preferably, no step in the production process (aside from stack down time) takes longer than twelve seconds. As such five doors per minute, or **300** doors per hour, can be produced by system **S**. More than **2000** doors per eight-hour shift may easily be produced with relatively low labor costs. For example, operation of system **S** may be achieved with two fork truck operators and one roving operator. Thus, substantial savings in labor cost are realized. In addition, the hot melt (PUR) technology and pinch rollers **60** provide additional savings because conventional presses, required for conventional cold adhesive formulations, are

relatively expensive. For example, an automated production line making 300 doors per hour using cold adhesive technology would require at least six conventional presses to achieve comparable assembly rates.

5 Preferably, system **S** can hold at least about one hour's worth of components (door facings **F1**, **F2**, frames **P** and core components **C**). For example, each pallet load of door facings received at first and second stations **16**, **18** may comprise 200 facings.

10 The present invention is also directed to a method of making a door using system **S** described above. A first door facing **F1** and a second door facing **F2** are provided. An interior side of the first facing **F1** is then coated with quick acting adhesive. Preferably, a hot melt (PUR) adhesive is sprayed on the interior side of first facing **F1**. Portions of the interior side of the first facing **F1** may also be selectively coated with the adhesive. A frame is placed on the coated interior side about the periphery of the first door facing **F1**. A core component may also be placed on the coated interior side of the first door facing **F1**. The frame (and core) is coated with quick acting adhesive, preferably the same type of hot melt (PUR) adhesive used during the first application. An interior side of the second door facing **F2** is placed onto the adhesive coated frame. The assembly is then compressed to form a door.

25 It will be apparent to one of ordinary skill in the art that various modifications and variations can be made in construction or configuration of the present invention without departing from the scope or spirit of the present invention. Thus, it is intended that the present invention include all such modifications and variations, provided they come within the scope of the following claims and their equivalents.

I claim as follows:

1. A door making system, comprising:

- a first station configured to receive a first plurality of stacked door facings having respective first exterior surfaces disposed face up and respective first interior surfaces disposed face down and stacked on corresponding first exterior surfaces of adjacent door facings of the first plurality of stacked door facings;
- 35 a second station configured to receive a second plurality of stacked door facings having respective second exterior surfaces disposed face up and respective second interior surfaces disposed face down and stacked on corresponding second exterior surfaces of adjacent door facings of the second plurality of stacked door facings;
- 40 a door facing inverter configured to receive a first door facing unstacked from the first plurality of stacked door facings and conveyed from the first station with the first exterior surface disposed face up and the first interior surface disposed face down, and to flip the first door facing to dispose the first exterior surface face down and the first interior surface face up;
- 45 a third station configured to receive the flipped first door facing and to coat adhesive on at least a portion of the face-up first interior surface of the first door facing;
- 50 a fourth station configured to position stiles and rails of a doorframe onto the adhesive-coated face-up first interior surface;
- 55 a fifth station configured to receive the first door facing with the doorframe thereon and to position a core component in contact with the adhesive-coated face-up first interior surface so that the doorframe is located around the core component;
- 60 a sixth station configured to receive the first door facing with the doorframe and the core component thereon and to coat adhesive on at least a portion of upwardly facing surfaces of the doorframe and the core component;
- 65

a transfer mechanism configured to receive a second door facing unstacked from the second plurality of stacked door facings and conveyed from the second station with the second exterior surface disposed face up and the second interior surface disposed face down, and to position the face-down second interior surface into contact with the adhesive-coated upwardly facing surfaces of the doorframe and the core component to form a door assembly; and

a compression station configured to compress the door assembly.

2. The door making system of claim **1**, further comprising:
a distribution center for receiving the first plurality of stacked door facings and the second plurality of stacked door facings;
a first station production conveyor for transporting the first plurality of stacked door facings to the first station; and
a second station production conveyor for transporting the second plurality of stacked door facings to the second station.

3. The door making system of claim **1**, further comprising a gantry configured to lift the first door facing from the first plurality of stacked door facings and to transport the first door facing to a production conveyor for conveyance to the door facing inverter.

4. The door making system of claim **1**, wherein the door facing inverter comprises a star conveyor, the star conveyor comprising a central member, a plurality of wickets radially extending from a central member at regular angular intervals and rotatable with the central member.

5. The door making system of claim **4**, wherein the wickets of the star conveyor are configured to support the first door facing solely by force of gravity without clamps.

6. The door making system of claim **1**, wherein the third station comprises spray headers configured to coat the adhesive on at least a portion of the face-up first interior surface.

7. The door making system of claim **1**, wherein the fourth station is configured to position the doorframe, with the stiles and rails in a preassembled state, onto the adhesive-coated face-up first interior surface.

8. The door making system of claim **7**, wherein the fourth station further comprises a gantry for moving the doorframe from a pallet of a plurality of doorframes onto the adhesive-coated face-up first interior surface.

9. The door making system of claim **1**, wherein the compression station comprises pinch rollers configured to compress the door assembly.

10. The door making system of claim **1**, further comprising:
a stacking station comprising a gantry configured to stack the compressed door assembly on a pallet of stacked compressed door assemblies.

11. A door making system, comprising:
a first station configured to receive a first plurality of stacked door facings having respective first exterior surfaces disposed face up and respective first interior surfaces disposed face down and stacked on corresponding first exterior surfaces of adjacent door facings of the first plurality of stacked door facings;
a second station configured to receive a second plurality of stacked door facings having respective second exterior surfaces disposed face up and respective second interior surfaces disposed face down and stacked on corresponding second exterior surfaces of adjacent door facings of the second plurality of stacked door facings;
a door facing inverter configured to receive a first door facing unstacked from the first plurality of stacked door

facings and conveyed from the first station with the first exterior surface disposed face up and the first interior surface disposed face down, and to flip the first door facing to dispose the first exterior surface face down and the first interior surface face up;

a third station configured to receive the flipped first door facing and to coat adhesive on at least a portion of the face-up first interior surface of the first door facing;

a fourth station configured to position stiles and rails of a doorframe onto the adhesive-coated face-up first interior surface;

a fifth station configured to receive the first door facing with the doorframe thereon and to coat adhesive on at least a portion of an upwardly facing surface of the doorframe;

a transfer mechanism configured to receive a second door facing unstacked from the second plurality of stacked door facings and conveyed from the second station with the second exterior surface disposed face up and the second interior surface disposed face down, and to position the face-down second interior surface into contact with the adhesive-coated upwardly facing surface of the doorframe to form a coreless door assembly; and

a compression station configured to compress the coreless door assembly.

12. The door making system of claim **11**, further comprising:
a distribution center for receiving the first plurality of stacked door facings and the second plurality of stacked door facings;
a first station production conveyor for transporting the first plurality of stacked door facings to the first station; and
a second station production conveyor for transporting the second plurality of stacked door facings to the second station.

13. The door making system of claim **11**, further comprising a gantry configured to lift the first door facing from the first plurality of stacked door facings and to transport the first door facing to a production conveyor for conveyance to the door facing inverter.

14. The door making system of claim **11**, wherein the door facing inverter comprises a star conveyor, the star conveyor comprising a central member, a plurality of wickets radially extending from a central member at regular angular intervals and rotatable with the central member.

15. The door making system of claim **14**, wherein the wickets of the star conveyor are configured to support the first door facing solely by force of gravity without clamps.

16. The door making system of claim **11**, wherein the third station comprises spray headers configured to coat the adhesive on at least a portion of the face-up first interior surface.

17. The door making system of claim **11**, wherein the fourth station is configured to position the doorframe, with the stiles and rails in a preassembled state, onto the adhesive-coated face-up first interior surface.

18. The door making system of claim **17**, wherein the fourth station further comprises a gantry for moving the doorframe from a pallet of a plurality of doorframes onto the adhesive-coated face-up first interior surface.

19. The door making system of claim **11**, wherein the compression station comprises pinch rollers configured to compress the coreless door assembly.

11

12

20. The door making system of claim **11**, further comprising:

a stacking station comprising a gantry configured to stack the compressed coreless door assembly on a pallet of stacked compressed door assemblies.

5

* * * * *