1 OCT 2004

SUBSTRATE FEEDING DEVICE AND METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a substrate feeding device and method. More particularly, the present invention relates to a substrate feeding device and method adapted for feeding a substrate to a laminator, and capable of easy control for adjustment even with a simple structure.

2. Description Related to the Prior Art

A color filter is used in a liquid crystal display panel (LCD) and plasma display panel (PDP), and has a structure including a transparent glass substrate, patterns of color pixels of red (R), green (G) and blue (B) colors, and a black matrix of a black color (BK). The liquid crystal display panel (LCD) and plasma display panel (PDP) in a large size are used remarkably. Although the glass substrate has such a considerably small thickness as 1-10 mm, a width or length of the glass substrate is likely to be 1 meter or more.

To produce the color filter, a film transfer method is well-known. In the film transfer method, laminated material is prepared, and includes a photosensitive layer or transfer film. A laminator is supplied with the laminated material, transfers the transfer film to a surface of the glass substrate transparent, to effect lamination. Then an exposure device applies light to the transfer film through a mask having a regular pattern, so as to expose the transfer film. The glass substrate after being exposed is processed in a developer machine, to form a predetermined pattern of pixels and a black matrix. The glass substrate is supplied to the laminator at a regular interval in a horizontal

orientation, to laminate the transfer film to the transfer surface or an underside of the glass substrate except for marginal regions outside the transfer region.

Examples of devices for feeding the glass substrate to the laminator include a device of JP-A 5-008833, in which a pair of walking beams are moved up and down, and back and forth in the feeding direction, to feed the glass substrate. Also, a device disclosed in JP-A 2000-264418 includes plural pallets having movable mechanisms, for transferring the glass substrate from one pallet to another for feeding. Furthermore, a device in JP-A 2000-277587 includes a robot hand for holding and feeding the glass substrate.

However, those known types of substrate feeding device have a problem in that a structure or control for mechanical intermittent feeding is extremely complex in feeding the glass substrate at a regular interval. Furthermore, no known techniques are capable of treating substrates of plural types with high efficiency or simplicity in a single substrate feeding device.

SUMMARY OF THE INVENTION

In view of the foregoing problems, an object of the present invention is to provide a substrate feeding device and method of which efficiency in feeding plural successive substrates can be set high even in a simple structure.

Another object of the present invention is to provide a substrate feeding device and method adapted for feeding a substrate to a laminator, and capable of easy control for adjustment even with a simple structure.

In order to achieve the above and other objects and advantages of this invention, a substrate feeding method for

feeding a first substrate and a second substrate succeeding to the first substrate is provided. A substrate distance defined between the first and second substrates is adjusted by selectively feeding the first and second substrates, to set the substrate distance at a predetermined first distance. After the substrate distance has reached the first distance, the substrate distance is shortened by controlling the first and second substrates in feeding sequences different from one another, to set the substrate distance at a second distance shorter than the first distance. After the substrate distance is set at the second distance, the first and second substrates are fed at a predetermined ejecting speed, to keep the substrate distance at the second distance.

According to another aspect of the invention, a substrate feeding device includes an ejecting feeder for feeding a first substrate at a predetermined ejecting speed. At least one stocking feeder feeds a second substrate succeeding to the first substrate toward the ejecting feeder. A distance determiner checks a substrate distance defined between the first and second substrates by comparison with a predetermined first distance. A control unit adjusts the substrate distance by selectively driving the ejecting feeder and the stocking feeder, to set the substrate distance at the first distance according to a distance determining signal from the distance determiner, and after the substrate distance has reached the first distance, the control unit shortening the substrate distance by controlling the ejecting feeder and the stocking feeder in feeding sequences different from one another, to set the substrate distance at a second distance shorter than the first distance, then the control unit driving the ejecting feeder and the stocking feeder at

the predetermined ejecting speed, to keep the substrate distance at the second distance.

Furthermore, a receiving feeder is supplied with the second substrate, for feeding the second substrate toward the stocking feeder. The ejecting feeder feeds the first substrate to a lamination roll.

The control unit, in the feeding sequences different from one another, drives the ejecting feeder at the predetermined ejecting speed, and also drives the stocking feeder at a high speed higher than the predetermined feeding speed, and starts measuring elapsed time in response to the distance determining signal, and when the elapsed time comes up to a first predetermined time, determines that the substrate distance has become the second distance.

The lamination roll is further supplied with laminated material, the laminated material includes a support, and a transfer film overlaid on the support. The lamination roll laminates the transfer film to the first substrate by attachment with heat and pressure.

The distance determiner includes a first stop sensor, positioned downstream from the ejecting feeder, for detecting a reach of a front edge of the first substrate. A second stop sensor is positioned downstream from the stocking feeder, for detecting a reach of a front edge of the second substrate. A pursuit starting sensor is positioned downstream from the second stop sensor at the first distance, for detecting passage of a rear edge of the first substrate. The control unit, in response to detection signals from the first and second stop sensors, stops respectively the ejecting feeder and the stocking feeder, so as to set the substrate distance at a distance L0 that is shorter than the

first distance, and then prolongs the substrate distance by driving the ejecting feeder in keeping the stocking feeder stopped, and while the substrate distance is prolonged, determines that the substrate distance has reached the first distance in response to a detection signal from the pursuit starting sensor.

Furthermore, a first position sensor is disposed upstream from the ejecting feeder, for detecting the first substrate fed by the ejecting feeder. A second position sensor is disposed upstream from the first position sensor at the second distance, for detecting the second substrate fed by the stocking feeder. If the second substrate reaches the second position sensor before the first substrate moves past the first position sensor, then the control unit determines that the substrate distance is shorter than the second distance, and prolongs the substrate distance by driving the ejecting feeder in keeping the stocking feeder stopped.

The control unit, when the substrate distance is shorter than the second distance, drives the ejecting feeder so as to prolong the substrate distance over the second distance, and after the distance determiner outputs the distance determining signal upon coming of the substrate distance to the first distance, shortens the substrate distance by driving the stocking feeder at the high speed, to set the substrate distance at the second distance.

Furthermore, a third position sensor is disposed upstream from the lamination roll, for detecting the first substrate fed by the lamination roll. A fourth position sensor is disposed upstream from the third position sensor at the second distance, for detecting the second substrate fed by the ejecting feeder. The control unit, if the second

1 OCT 2004

substrate has reached the fourth position sensor before the first substrate moves past the third position sensor, determines that the substrate distance is shorter than the second distance, and prolongs the substrate distance by driving the lamination roll in keeping the ejecting feeder stopped.

The lamination roll contacts at least one transfer region of the first substrate for lamination, the transfer region is formed in a middle of a substrate lower surface. Each of the receiving feeder, the stocking feeder and the ejecting feeder includes a feeder mechanism for supporting a lower surface of a pair of lateral edge portions of the first or second substrate, and for feeding the first or second substrate, the lateral edge portions being so disposed as to dispose the transfer region therebetween.

The at least one transfer region includes plural transfer regions arranged in a train transversely to feeding of the first and second substrates. The feeder mechanism includes first and second side feeder rollers for supporting the lateral edge portions of the first or second substrate. At least one middle feeder roller supports an intermediate portion defined in the first or second substrate between the plural transfer regions.

The feeder mechanism includes plural rotatable feeder rollers.

The plural feeder rollers include first and second groups of feeder rollers. Each of the feeder rollers in the first group includes a roller body, and a flange portion, formed to project from a periphery of the roller body, for contacting and regulating a lateral edge of the first or second substrate.

The feeder mechanism further comprises plural nip rollers, disposed higher than the feeder rollers in a rotatable manner, for nipping the first or second substrate in cooperation with the feeder rollers. A roller shifter shifts the nip rollers between a nip position and a retracted position for setting the first or second substrate free.

Furthermore, a nip sensor is disposed near to the roller shifter, for detecting a front edge of the first or second substrate. The control unit controls the roller shifter, sets the nip roller in the nip position while the nip sensor outputs a detection signal, and sets the nip roller in the retracted position while the nip sensor outputs a non-detections signal.

The ejecting feeder includes plural guide rollers, rotatable about a rotational axis that is substantially vertical to a surface of the first substrate, for regulating a lateral edge of the first substrate. A horizontal shifter mechanism supports the guide rollers in a shiftable manner, and causes the guide rollers to set the first substrate in a predetermined feeding path while the nip rollers are in the retracted position.

Furthermore, a supply mechanism supplies the receiving feeder with the second substrate. A stock sensor checks whether the second substrate is disposed at the receiving feeder. While the stock sensor outputs a detection signal, the control unit inhibits the supply mechanism from supplying the receiving feeder with the second substrate.

Furthermore, an auxiliary stock sensor checks whether the first substrate is disposed at the ejecting feeder. When the auxiliary stock sensor outputs a detection signal, the control unit allows the ejecting feeder to feed the first

1 OCT 2004

substrate to the lamination roll.

Furthermore, an auxiliary stock sensor checks whether the second substrate is disposed at the stocking feeder.

Furthermore, first, second and third heaters preheat the first or second substrate disposed at respectively the ejecting feeder, the stocking feeder and the receiving feeder to a target temperature adapted for operation of the lamination roll, the first, second and third heaters operating for application of heat at first, second and third temperatures, the first temperature being higher than the target temperature, the third temperature being lower than the target temperature, and second temperature being higher than the first temperature.

Each of the first, second and third heaters includes plural heater elements controllable for a temperature separately.

Furthermore, a horizontal movable device supports the feeder roller in a shiftable manner transversely to feeding of the first and second substrates.

Furthermore, a flotation blower blows gas to a lower surface of the first or second substrate fed by the feeder mechanism, for preventing a substrate middle portion from flexing under gravity.

The laminated material further includes a cover film overlaid on the transfer film in a peelable manner. The cover film is peeled from the transfer film in a position upstream from the lamination roll, and removed from the laminated material.

In another preferred embodiment, furthermore, a stopper mechanism is shifted by a control of the control unit, and contacts and stops the second substrate after the substrate

distance has become the second distance, to prolong the substrate distance. The control unit, when the stopper mechanism contacts the second substrate, starts measuring an elapsed time, and when the elapsed time comes up to a second predetermined time, determines that the substrate distance has come up to a third distance adapted for lamination.

The stopper mechanism is disposed downstream from the ejecting feeder, and movable between an inserted position and a retracted position, and when in the inserted position, protrudes into a feeding path of the first and second substrates, and when in the retracted position, is away from the feeding path. The control unit sets the stopper mechanism in the inserted position upon movement of the first substrate past the stopper mechanism and for a reference time equal to or longer than the second predetermined time, stops the second substrate, and after lapse of the reference time, sets the stopper mechanism in the retracted position, allows feeding the second substrate, so as to set the substrate distance at the third distance.

Consequently, it is possible in a substrate feeding device and method to raise efficiency in feeding plural successive substrates set high even in a simple structure. Furthermore, it is possible to feed a substrate to a laminator in an easy control for adjustment even with a simple structure.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects and advantages of the present invention will become more apparent from the following detailed description when read in connection with the accompanying drawings, in which:

Fig. 1 is an explanatory view in side elevation, illustrating a laminator for transferring a transfer film to a glass substrate;

Fig. 2 is a plan illustrating the glass substrate with a transfer region;

Fig. 3 is a perspective illustrating a portion of a substrate feeding device;

Fig. 4 is an explanatory view in plan, illustrating the substrate feeding device;

Fig. 5 is a perspective illustrating a portion of another preferred substrate feeding device without flanged feeder rollers;

Fig. 6 is a perspective illustrating a portion of still another preferred substrate feeding device having a stopper mechanism;

Fig. 7 is an explanatory view in plan, illustrating an additional preferred embodiment in which a plurality of transfer regions are determined for laminating the transfer film.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S) OF THE PRESENT INVENTION

In Fig. 1, a laminator 10 is depicted, with which a substrate feeding device is used. The laminator 10 is constituted by a preheater component 11, an attacher 12, a laminated material supplier 13, a cooler 14, a peeler 15, a substrate ejector 16, and a control unit 17 of Fig. 3. A transfer film or photosensitive layer is transferred to a transparent glass substrate 18 in a transfer region TA as illustrated in Fig. 2.

The glass substrate 18 is supplied by a supply robot

hand 19 to the preheater component 11. Suction pads are provided in a body of the supply robot hand 19. A back surface of the glass substrate 18 is sucked by the suction pads and held for movement. The supply robot hand 19 keeps the glass substrate 18 oriented to direct a transfer receiving surface in a downward direction, and supplies the glass substrate 18 to the preheater component 11.

The preheater component 11 is constituted by a substrate feeding device 20, an upper heater group 21 and a lower heater group 22, and includes a train of four feeders that are a receiving feeder 25, first and second stocking feeders 26 and 27 and an ejecting feeder 28. The receiving feeder 25 receives the glass substrate 18 from the supply robot hand 19, and feeds the glass substrate 18 in a feeding direction. The glass substrate 18 is then fed by the first and second stocking feeders 26 and 27, and reaches the ejecting feeder 28. The glass substrate 18 stands by in the ejecting feeder 28, and is sent to a lamination roll set in the attacher 12 in response to a command signal from the attacher 12.

The upper and lower heater groups 21 and 22 are opposed to one another so that a path of the glass substrate 18 is located between those. The upper and lower heater groups 21 and 22 heat the glass substrate 18 being fed up to a predetermined temperature. Examples of the upper and lower heater groups 21 and 22 are far infrared ray heaters, Nichrome wire heaters, hot air heaters and the like.

In the receiving feeder 25, heating temperature in the upper and lower heater groups 21 and 22 is set at a low level to suppress thermal deformation. In the first and second stocking feeders 26 and 27, heating temperature in the upper and lower heater groups 21 and 22 is set at a considerably

higher level in order to heat the glass substrate 18 sufficiently in a short time. In the ejecting feeder 28, heating temperature in the upper and lower heater groups 21 and 22 is set at a relatively higher level to prevent drop in the temperature of the glass substrate 18 even in standing by for a laminating operation. For example, a target temperature at which the glass substrate 18 should be heated finally is 110 degrees centigrade. Heaters 21a and 22a at the receiving feeder 25 are set at 100 degrees centigrade. Heaters 21b and 22b at the second stocking feeder 26 and heaters 21c and 22c at the first stocking feeder 27 are set at 180 degrees centigrade. Heaters 21d and 22d at the ejecting feeder 28 are set at 120 degrees centigrade. Thus, the glass substrate 18 is heated sufficiently even in a short time and without thermal deformation. The temperature does not drop even in a standby state. Note that the temperatures at which the upper and lower heater groups 21 and 22 are set are not limited to those levels, but can be predetermined according to a substrate size or the required target temperature. Each of the upper and lower heater groups 21 and 22 is constituted by a great number of surface heating elements in a small size arranged in a matrix form. Each of the surface heating elements is controlled individually by a controller (not shown). The temperature of each of the surface heating elements can be controlled separately for the purpose of regularizing the temperature distribution of the glass substrate 18. For example, portions along two lateral edges can be heated at higher temperature than other portions in view of dissipation of heat along the lateral edges. Furthermore, minimum stop time is predetermined for the feeder train 25-28, so the temperature of the glass substrate

18 can be raised unfailingly to the predetermined temperatures.

In the substrate feeding device 20 as depicted in Fig. 3, each of the receiving feeder 25, the first and second stocking feeders 26 and 27 and the ejecting feeder 28 includes a flotation blower 30 or flotation table, feeder rollers 31, guide rollers 33, nip rollers 34, a stock sensor group 35, a position/stop sensor group 36, a nip sensor group 37, a pursuit starting sensor 38 and a position sensor group 39. The feeder rollers 31, flanged feeder rollers 32, the guide rollers 33 and the nip rollers 34 constitute a feeder mechanism. The feeder rollers 31 and the flanged feeder rollers 32 support lateral edge portions of the glass substrate 18 to feed the glass substrate 18. The flotation blower 30 is opposed to a lower surface of the glass substrate 18. Numerous air blowing holes 30a are formed in the flotation blower 30. Clean air is blown by the air blowing holes 30a to the glass substrate 18, to float the middle portion of the glass substrate 18 against the gravity applied considerably to the middle portion. In other words, the flotation blower 30 prevents the middle portion of the glass substrate 18 from flexing downwards under the gravity.

Note that the ejecting feeder 28 does not include the flanged feeder rollers 32. In Fig. 3, the flanged feeder rollers 32 are depicted in a mixed manner with the ejecting feeder 28 only for the purpose of easy understanding.

There are formed slots 30b in lateral portions of the flotation blower 30 for receiving the feeder rollers 31 and the flanged feeder rollers 32 in a rotatable manner. Also, the feeder rollers 31 and the flanged feeder rollers 32 are

movable in a direction crosswise to feeding of the glass substrate 18 for being set in a direction transverse to the feeding. A stepping motor 40 causes the feeder rollers 31 and the flanged feeder rollers 32 to rotate. A motor driver 41 is connected with the stepping motor 40, and caused by the control unit 17 to control the stepping motor 40 according to detection signals from the sensor groups 35-39. As the feeder rollers 31 and the flanged feeder rollers 32 are movable in the longitudinal direction of the slots 30b, plural types of the glass substrate 18 can be fed by the feeding device no matter how much differences the types have in the size.

The feeder rollers 31 and the flanged feeder rollers 32 contact the lower surface of the portions along the lateral edges of the glass substrate 18, and rotate to feed the glass substrate 18. A surface of the glass substrate 18 is oriented downwards. The feeder rollers 31 and the flanged feeder rollers 32 contact the lateral edge portions outside the transfer region TA. Thus, the feeder rollers 31 and the flanged feeder rollers 32 do not damage the transfer region TA, or do not cause dust to stick the transfer region TA. A flange 32a of the flanged feeder rollers 32 guides the glass substrate 18. In other words, the flange 32a regulates a position of the glass substrate 18 in a direction crosswise to the feeding.

A horizontal shifter mechanism 42 is associated with the guide rollers 33. The control unit 17 causes the horizontal shifter mechanism 42 to set the guide rollers 33 in one of first and second positions. The guide rollers 33, when in the first position, contact lateral faces of the glass substrate 18, and when in the second position, are away from

the glass substrate 18. The guide rollers 33 in the first position correct the position and inclination of the glass substrate 18 in the transverse direction crosswise to the feeding, to raise precision in straight movement of the glass substrate 18. In order to prevent breakage of the glass substrate 18, the control unit 17 keeps the nip rollers 34 set in the free position before setting the guide rollers 33 in the first position, and keeps the guide rollers 33 set in the second position before setting the nip rollers 34 in the nip position.

The nip rollers 34 are formed from Teflon. A roller shifter 43 is associated with the nip rollers 34. The control unit 17 causes the roller shifter 43 to set the nip rollers 34 in a selected one of first and second positions. The nip rollers 34, when set in the first position, squeeze the glass substrate 18 between those and the feeder rollers 31, and when set in the second position, come away from the glass substrate 18. The lateral edge portions of the glass substrate 18 are squeezed between the nip rollers 34 and the feeder rollers 31, to prevent slips of the glass substrate 18 being fed. In order to prevent breakage of the glass substrate 18, the nip rollers 34 are slowly moved shortly before contacting the glass substrate 18 for the purpose of setting the nip rollers 34 in the first position. When the glass substrate 18 becomes squeezed by lamination rolls, the nip rollers 34 becomes set in the second position. Note that, instead of using Teflon, the nip rollers 34 may be formed from other suitable materials, such as fluororubber, silicone rubber, and other rubbers and elastomers.

A central slot 30c is formed in the center of the flotation blower 30. The sensor groups 35-39 are disposed in

the central slot 30c, and are a heat-resistant reflection type and also optical fibre type. The sensor groups 35-39 are arranged in the feeding direction of the glass substrate 18, and connected with the control unit 17, and send a detection signal to the control unit 17 upon detecting the glass substrate 18. The control unit 17 controls feeding by recognizing the position of the glass substrate 18 according to detection signals from the sensor groups 35-39.

In Fig. 4, positions of elements in the feeder train 25-28 are illustrated, including the feeder rollers 31, the flanged feeder rollers 32, the guide rollers 33, the nip rollers 34, the stock sensor group 35, the position/stop sensor group 36, the nip sensor group 37, the pursuit starting sensor 38 and the position sensor group 39. The stock sensor group 35 includes auxiliary stock sensors 35a and 35b and stock sensors 35c and 35d for detecting existence and lack of the glass substrate 18 in the feeder train 25-28. When the auxiliary stock sensor 35a of the ejecting feeder 28 is turned on, the transfer film or photosensitive layer becomes ready for being transferred in the attacher 12. Upon generation of a transport starting signal from the attacher 12, the glass substrate 18 is fed at the ejecting speed V1 that is determined according to a speed of advance to a set of lamination rolls to be described later. When either one of the stock sensors 35c and 35d is turned on in the receiving feeder 25, the supply robot hand 19 does not supply the receiving feeder 25 with the glass substrate 18. So the glass substrate 18 can be prevented from overlapping on another substrate. When both of the stock sensors 35c and 35d are turned off, a succeeding glass substrate 18 is supplied by the supply robot hand 19.

There are a stop sensor 36a, position/stop sensors 36b and 36c and a stop sensor 36d disposed in downstream positions of the receiving feeder 25, the first and second stocking feeders 26 and 27 and the ejecting feeder 28. The position/stop sensor 36b is included in a distance determiner. In the ejecting feeder 28, the stop sensor 36a, when reached by a front edge of the glass substrate 18, is turned on and generates a signal adapted for stopping the glass substrate 18. In the first and second stocking feeders 26 and 27 and the ejecting feeder 28, each of the position/stop sensors 36b and 36c, and the stop sensor 36d, when reached by the front edge of the glass substrate 18, is turned on and generates a signal adapted for stopping the glass substrate 18 in case a preceding glass substrate exists in a succeeding one of the feeders.

Nip sensors 37a-37h are disposed near to the nip rollers 34. If a front edge of the glass substrate 18 reaches any of the nip rollers 34, a corresponding one of the nip sensors 37a-37h is set in the nip position. When a rear edge of the glass substrate 18 moves past the nip rollers 34, a corresponding one of the nip rollers 34 is set in the retracted position.

The pursuit starting sensor 38 is disposed at a distance L1 from the position/stop sensor 36b of the first stocking feeder 27. The pursuit starting sensor 38 is included in the distance determiner. When a preceding glass substrate 18a is fed to the attacher 12 from the ejecting feeder 28, a rear edge of the preceding glass substrate 18a moves past the pursuit starting sensor 38 to turn off the pursuit starting sensor 38. In response to this, a succeeding glass substrate 18b in each of the receiving feeder 25 and the first and

1 OCT 2004

second stocking feeders 26 and 27 starts being fed in a pursuing manner at a higher feeding speed V2 than the ejecting speed V1.

The feeding in the pursuing manner is effected in a pursuing time T. Values of the higher feeding speed or pursuing speed V2 and the pursuing time T are conditioned according to a selected one of the substrate sizes, so as to supply the preceding and succeeding glass substrates 18a and 18b to the attacher 12 at an interval that is equal to a distance L2. See Fig. 3. When the pursuing time T passes, the substrate distance or interval between the preceding glass substrate 18a fed by the ejecting feeder 28 and the succeeding glass substrate 18b fed by the first stocking feeder 27 comes down to the distance L2. After the pursuing time T elapses, the feeding is changed over to feed the succeeding glass substrate 18b at the ejecting speed V1 toward the attacher 12 with the distance L2 from the preceding glass substrate 18a kept.

Thus, the substrate distance or interval between the successive glass substrates 18 is adjusted at the distance L2 in the ejecting feeder 28 disposed short of the attacher 12. The preceding and succeeding glass substrates 18a and 18b can be supplied with high precision successively to the attacher 12. Even if irregularity occurs in the feeding in the position upstream from the ejecting feeder 28, there is no problem because the substrate distance between the preceding and succeeding glass substrates 18a and 18b can be regulated before the attacher 12. As the glass substrate 18 stops at the feeder train 25-28 in each predetermined position, the glass substrate 18 can be fed to the attacher 12 with precision irrespective of the substrate size or irregularity

in the supply of the glass substrate 18 to the receiving feeder 25. Note that the higher feeding speed V2 can be set high to shorten a distance of pursuing movement. The whole size of the feeding device can be reduced.

The substrate distance between the preceding and succeeding glass substrates 18a and 18b is checked by means of six position sensors 39a, 39b, 39c, 39d, 39e and 39f and the position/stop sensors 36b and 36c. Among those sensors, the position sensor 39b is combined with the position sensors 39a, the position sensor 39d with the position sensor 39c, the position sensor 39e with the position/stop sensor 36b, and the position sensor 39f with the position/stop sensor 36c. In any of the combinations, an interval is predetermined as the distance L2. If an output from an upstream sensor included in the combination comes to a detection level at the same time as or before coming of an output from a downstream sensor included in the combination to a non-detection level, then it is detected that the substrate distance between the preceding and succeeding glass substrates 18a and 18b is equal to or shorter than the distance L2. Then the succeeding glass substrate 18b is stopped being fed for the pursuit. The preceding glass substrate 18a is fed to increase the substrate distance, until the substrate distance between the preceding and succeeding glass substrates 18a and 18b comes up to the distance L2 again. Then the succeeding glass substrate 18b restarts being fed. The feeding speed of the succeeding glass substrate 18b is V1 that is according to the insertion speed toward the lamination roll set.

In Fig. 1, the attacher 12 includes a lamination roll set 50 and backup rollers 51. The lamination roll set 50

includes lamination rolls 50a and 50b arranged in a vertical direction. Heaters are incorporated in the lamination rolls 50a and 50b. Laminated material 52 is superposed over the glass substrate 18. The glass substrate 18 and the laminated material 52 are squeezed and fed by the lamination roll set 50, so as to attach the laminated material 52 to the glass substrate 18 with heat and pressure. The backup rollers 51 are rotated by contact with the lamination rolls 50a and 50b, and prevent flexure of the lamination rolls 50a and 50b for regularizing pressure in attachment. Also, a flotation blower 53 or table is disposed between the substrate feeding device 20 and the attacher 12 and has a construction substantially the same as the flotation blower 30. Thus the glass substrate 18 is kept horizontal, and prevented from interfering with the lamination roll 50a, as the center of the glass substrate 18 is prevented from flexing downwards in the course of inserting the glass substrate 18 into the lamination roll set 50.

The laminated material supplier 13 includes a support shaft 54a, a half cutter 55, a cover film peeler 56 and a back tension roller 57. The laminated material 52 is wound as a laminated material roll 54, and includes a support 52b, transfer film 52a or photosensitive layer overlaid thereon, and a peelable cover film 52c overlaid thereon as an uppermost layer. The laminated material supplier 13 peels the cover film 52c from the laminated material roll 54, and supplies the lamination roll set 50 with the support 52b with a transfer film 52a or photosensitive layer oriented upwards.

The laminated material 52 includes a transfer film 52a or photosensitive layer overlaid on the support 52b together

with an auxiliary layer, intermediate layer and the like. The cover film 52c is overlaid on the transfer film 52a. A back surface of the support 52b is coated with an antistatic agent.

The half cutter 55 cuts the laminated material 52 halfway in each position according to the length of the glass substrate 18. The halfway cutting cuts the cover film 52c and the transfer film 52a, but keeps the support 52b uncut.

The cover film peeler 56 peels the cover film 52c from the laminated material 52 at portions cut intermediately for attachment to the glass substrate 18. The cover film peeler 56 includes an adhesive tape roll 56a, a press roller 56b, and a tape winder 56d. Pressure-sensitive adhesive tape 56c is unwound from the adhesive tape roll 56a, and is stuck to the cover film 52c by the press roller 56b. The pressure-sensitive adhesive tape 56c captures the cover film 52c, and is wound and withdrawn by the tape winder 56d. Portions of the cover film 52c at borderlines between the preceding and succeeding glass substrates 18a and 18b remain on the transfer film 52a in the laminated material 52 without being peeled.

The attacher 12 sends a transport starting signal to the substrate feeding device 20 in response to passage of the half cut line at a predetermined position. The half cut line is positioned suitably for the glass substrate 18, while the transfer film 52a of the laminated material 52 is attached to the glass substrate 18. Also, the support 52b is fed downwards from the lamination roll set 50 with movement of the glass substrate 18.

The cooler 14 is constituted by a cooling air blowing board 60 and feeder rollers 61. In the cooling air blowing

board 60, cooling air having high cleanness is passed through the HEPA (high efficiency particulate air) filter, and is blown to the glass substrate 18. The glass substrate 18, while fed by the feeder rollers 61, is cooled down to the room temperature that is 30 degrees or lower.

The peeler 15 is constituted by a peeler roller 62 and a support winder 63, and peels the support 52b from the glass substrate 18. A winder shaft 63a winds the support 52b in a roll form. A winding motor (not shown) rotates the winder shaft 63a. The winding motor is controlled for the torque, and causes the support 52b to have constant tension in positions downstream from the lamination roll set 50, to prevent the support 52b from being loose.

A flotation blower 65 or flotation table is included in the substrate ejector 16 disposed downstream from the peeler 15. The flotation blower 65 has the same construction as the flotation blower 30 at the preheater component 11. An upper surface of the glass substrate 18 removed from the peeler 15 is sucked by a robot hand (not shown), and is ejected.

The operation of the above embodiment is described now. The supply robot hand 19 supplies the receiving feeder 25 with the preceding glass substrate 18a, which is fed by the first and second stocking feeders 26 and 27 and the ejecting feeder 28, and heated by the upper and lower heater groups 21 and 22 at a predetermined temperature. When a front edge of the preceding glass substrate 18a reaches the stop sensor 36a in the ejecting feeder 28, the preceding glass substrate 18a is stopped. Then second, third and fourth glass substrates are supplied and fed, and stopped in the feeders 25-27 in positions of the position/stop sensors 36b and 36c and the stop sensor 36d.

1 OCT 2004

In the attacher 12, the lamination roll set 50 rotates to feed the laminated material 52. When a half cut line of the laminated material 52 comes to a predetermined position, a transport starting signal is sent to the substrate feeding device 20. In response to the transport starting signal, the ejecting feeder 28 in the substrate feeding device 20 feeds the preceding glass substrate 18a at the ejecting speed V1 of a level adapted to insertion into the lamination roll set 50. When the rear edge of the succeeding glass substrate 18b passes the pursuit starting sensor 38, the succeeding glass substrate 18b starts pursuit at the higher feeding speed V2 than the speed V1. Upon the lapse of the time T, the succeeding glass substrate 18b starts being fed at the ejecting speed V1. The succeeding glass substrate 18b is distant by the substrate distance L2 from the preceding glass substrate 18a preceding thereto.

Similarly, the third and fourth glass substrates 18b advance at the higher feeding speed V2 that is higher than the ejecting speed V1 of the preceding glass substrate 18a directed to the lamination roll set 50. The substrate distance between the preceding and succeeding glass substrates 18a and 18b is decreased and becomes L2, before the preceding glass substrate 18a is inserted into the lamination roll set 50. The glass substrate 18 stopped in the receiving feeder 25 is then fed. When both of the stock sensors 35c and 35d are turned off, the supply robot hand 19 supplies the receiving feeder 25 with another glass substrate, which is fed similarly.

The lamination roll set 50 attaches the transfer film 52a of the laminated material 52 to the glass substrate 18 with heat and pressure after positioning of the half cut line

to the glass substrate 18. The glass substrate 18 is cooled down to the room temperature by the cooler 14. The support 52b is peeled by the peeler 15 from the glass substrate 18. Thus, the transfer film 52a is transferred to the transfer region TA on a lower surface of the glass substrate 18. The glass substrate 18 is fed to the substrate ejector 16, and ejected by the robot hand sucking the upper surface.

In the above embodiment, each of all the feeder rollers 31 is driven by a stepping motor for rotation. Alternatively, one motor may be used in each one block for drive the feeder rollers 31 with a transmission belt. Furthermore, rotatable free rollers without a power source may be combined suitably. Also, tendency drive rollers, torque motor driven rollers and the like may be used. It is preferable to dispose the feeder rollers 31 at a relatively short distance or the purpose of stably feeding plural types of the glass substrate 18. Furthermore, it is possible not to use the nip rollers 34 if sufficient friction exists between the feeder rollers 31 and the glass substrate 18 to avoid slip of the glass substrate 18 being fed. The control of the feeding device is facilitated. Occurrence of dust can be reduced. In the above embodiment, the flanged feeder rollers 32 is used in the receiving feeder 25, the first and second stocking feeders 26 and 27. Furthermore, it is possible not use the flanged feeder rollers 32 in any of those feeders. See Fig. 5. Any of the feeders include feeder rollers 71 and guide rollers 72. The feeder rollers 71 regulate the position of the glass substrate 18 in the direction transverse to the feeding. The guide rollers 72 regulate the glass substrate 18 in the transverse direction.

In the above embodiment, the interval between the glass substrates is regulated at the substrate distance L2 in the ejecting feeder 28. Furthermore, another preferred embodiment includes a stopper mechanism 85 as illustrated in Fig. 6. The stopper mechanism 85 is disposed at a front end of the ejecting feeder 28, and shiftable between first and second positions, and when in the first position, contacts the front edge of the glass substrate 18 to inhibit the glass substrate 18 from moving further, and when in the second position, allows the glass substrate 18 to move further. Movement of the stopper mechanism 85 regulates the feeding of the preceding and succeeding glass substrates 18a and 18b at the substrate distance L2 before the supply to the attacher 12. Note that the control for feeding in the pursuing manner is predetermined to regulate the substrate distance at a distance L3 that is shorter than the distance L2.

In the above embodiments, the lateral edge portions of the glass substrate 18 are supported by the feeder rollers 31 and the flanged feeder rollers 32. However, it is possible according to an embodiment of Fig. 7 that each of support shafts 90 has two side feeder rollers and a middle feeder roller 91. Unlike the above embodiments, a train of plural transfer regions TA are arranged with a small interval in a single piece of the glass substrate 18. Note that the support shafts 90 and the feeder rollers 91 have such shiftable structures that the pitch and number of the feeder rollers 91 may be adjusted suitably for each one of plural substrate sizes. Also, the substrate to be fed may be formed from metal, resin or any other material instead of glass.

Note that, even while the receiving, stocking and ejecting feeders 25-28 are controlled for feeding according

07 OCT 2004

to the above embodiment, the lamination roll set 50 continues rotating invariably without stopping. If the glass substrate 18a or 18b at the ejecting feeder 28 has not yet been squeezed by the lamination roll set 50, the glass substrate 18a or 18b can be fed at a different speed or can be stopped by controlling the ejecting feeder 28. However, if the glass substrate 18a or 18b extends both on the ejecting feeder 28 and on the lamination roll set 50, the ejecting feeder 28 feeds the glass substrate 18a or 18b always at the predetermined ejecting speed V1.

In the above embodiment, the position/stop sensor 36b operates in two manners, in other words, detects a front edge of the succeeding glass substrate 18b in order to stop the succeeding glass substrate 18b, and also detects a rear edge of the preceding glass substrate 18a for the purpose of checking the substrate distance. However, it is possible to use two sensors specialized for respectively the two purposes without unifying the use. Also, the position/stop sensor 36c may be replaced with two sensors for the same reason.

In the above embodiment, the position sensors 39a and 39b and/or the position sensors 39c and 39d check whether the substrate distance is shorter than the distance L2 for the purpose of avoiding rear-end collision of the preceding glass substrate 18a. If the substrate distance is shorter than the distance L2, the lamination roll set 50 is driven for rotation to feed the preceding glass substrate 18a. The ejecting feeder 28 is turned off to stop the succeeding glass substrate 18b, so as to elongate the substrate distance. Accordingly, some of the feeder rollers 31 included in the ejecting feeder 28 and disposed on a downstream side remain stopped in a slipping state in contact with the preceding

glass substrate 18a being fed.

However, the feeder rollers 31 included in the ejecting feeder 28 may be grouped into plural roller groups, which may be driven independently by use of a clutch, plural motors or the like. This makes it possible to stop the succeeding glass substrate 18b in contact with the upstream group of rollers after checking the substrate distance at the position sensors 39a and 39b, or at the position sensors 39c and 39d, and to feed the preceding glass substrate 18a by means of the downstream group of rollers.

Note that only a single sensor may be used for operation of both the stop sensor 36a and the auxiliary stock sensor 35a. Also, it is possible not to dispose the auxiliary stock sensor 35b, but to assign operation of the auxiliary stock sensor 35b to one of the other sensors in the embodiment. Furthermore, only a single sensor may be used for operation of both the stop sensor 36d and the stock sensor 35c.

Note that the above-described sequence of the pursuit at the time that the substrate distance is shorter than L2 may be eliminated. To be precise, the ejecting feeder 28 is driven with the first stocking feeder 27 kept stopped. When the substrate distance comes up to L2, then the ejecting feeder 28 and the first stocking feeder 27 can be driven at the ejecting speed V1.

In the above embodiment, the succeeding glass substrate 18b, if the substrate distance is shorter than L2, is kept stopped while the preceding glass substrate 18a is fed, so as to increase the substrate distance. However, the substrate distance may be increased in other manners. For example, the control unit 17 may drive the first stocking feeder 27 at a lower speed than the speed of the ejecting feeder 28. The

succeeding glass substrate 18b can be fed at the lower speed so as to separate the succeeding glass substrate 18b gradually from the preceding glass substrate 18a.

Although the present invention has been fully described by way of the preferred embodiments thereof with reference to the accompanying drawings, various changes and modifications will be apparent to those having skill in this field. Therefore, unless otherwise these changes and modifications depart from the scope of the present invention, they should be construed as included therein.

What is claimed is:

1. A substrate feeding device comprising:

an ejecting feeder for feeding a first substrate at a predetermined ejecting speed;

at least one stocking feeder for feeding a second substrate succeeding to said first substrate toward said ejecting feeder;

a distance determiner for checking a substrate distance defined between said first and second substrates by comparison with a predetermined first distance; and

a control unit for adjusting said substrate distance by selectively driving said ejecting feeder and said stocking feeder, to set said substrate distance at said first distance according to a distance determining signal from said distance determiner, and after said substrate distance has reached said first distance, said control unit shortening said substrate distance by controlling said ejecting feeder and said stocking feeder in feeding sequences different from one another, to set said substrate distance at a second distance shorter than said first distance, then said control unit driving said ejecting feeder and said stocking feeder at said predetermined ejecting speed, to keep said substrate distance at said second distance,

wherein said control unit, in said feeding sequences different from one another, drives said ejecting feeder at said predetermined ejecting speed, and also drives said stocking feeder at a high speed higher than said predetermined ejecting speed, and starts measuring elapsed time in response to said distance determining signal, and when said elapsed time comes up to a first predetermined time, determines that said substrate distance has become said second distance.

2. A substrate feeding device as defined in claim 1, further comprising a receiving feeder, supplied with said second substrate, for feeding said

second substrate toward said stocking feeder;

wherein said ejecting feeder feeds said first substrate to a lamination roll.

3. A substrate feeding device as defined in claim 1, wherein said control unit stores information of said high speed and said first predetermined time that are predetermined according to a size of said first and second substrates.

4. A substrate feeding device as defined in claim 1, wherein said lamination roll is further supplied with laminated material, said laminated material includes a support, and a transfer film overlaid on said support;

said lamination roll laminates said transfer film to said first substrate by attachment with heat and pressure.

5. A substrate feeding device as defined in claim 4, wherein said distance determiner includes:

a first stop sensor, positioned downstream from said ejecting feeder, for detecting a reach of a front edge of said first substrate;

a second stop sensor, positioned downstream from said stocking feeder, for detecting a reach of a front edge of said second substrate;

a pursuit starting sensor, positioned downstream from said second stop sensor at said first distance, for detecting passage of a rear edge of said first substrate;

said control unit, in response to detection signals from said first and second stop sensors, stops respectively said ejecting feeder and said stocking feeder, so as to set said substrate distance at a distance L0 that is shorter than said first distance, and then prolongs said substrate distance by driving said ejecting feeder in keeping said stocking feeder stopped, and while said substrate distance is prolonged, determines that said substrate

distance has reached said first distance in response to a detection signal from said pursuit starting sensor.

6. A substrate feeding device as defined in claim 5, further comprising:

a first position sensor, disposed upstream from said ejecting feeder, for detecting said first substrate fed by said ejecting feeder; and

a second position sensor, disposed upstream from said first position sensor at said second distance, for detecting said second substrate fed by said stocking feeder;

if said second substrate reaches said second position sensor before said first substrate moves past said first position sensor, then said control unit determines that said substrate distance is shorter than said second distance, and prolongs said substrate distance by driving said ejecting feeder in keeping said stocking feeder stopped or driven more slowly than said ejecting feeder.

7. A substrate feeding device as defined in claim 6, wherein said control unit, after said distance determiner outputs said distance determining signal upon coming of said substrate distance to said first distance, shortens said substrate distance by driving said stocking feeder at said high speed, to set said substrate distance at said second distance.

8. A substrate feeding device as defined in claim 7, further comprising:

a third position sensor, disposed upstream from said lamination roll, for detecting said first substrate fed by said lamination roll;

a fourth position sensor, disposed upstream from said third position sensor at said second distance, for detecting said second substrate fed by said ejecting feeder;

said control unit, if said second substrate has reached said fourth position sensor before said first substrate moves past said third position

sensor, determines that said substrate distance is shorter than said second distance, and prolongs said substrate distance by keeping said ejecting feeder stopped or driven more slowly than said lamination roll.

9. A substrate feeding device as defined in claim 7, wherein said lamination roll contacts at least one transfer region of said first substrate for lamination, said transfer region is formed in a middle of a substrate lower surface;

each of said receiving feeder, said stocking feeder and said ejecting feeder includes a feeder mechanism for supporting a lower surface of a pair of lateral edge portions of said first or second substrate, and for feeding said first or second substrate, said lateral edge portions being so disposed as to dispose said transfer region therebetween.

10. A substrate feeding device as defined in claim 9, wherein said at least one transfer region includes plural transfer regions arranged in a train transversely to feeding of said first and second substrates;

said feeder mechanism includes:

first and second side feeder rollers for supporting said lateral edge portions of said first or second substrate;

at least one middle feeder roller for supporting an intermediate portion defined in said first or second substrate between said plural transfer regions.

11. A substrate feeding device as defined in claim 9, wherein said feeder mechanism includes plural rotatable feeder rollers.

12. A substrate feeding device as defined in claim 11, wherein said plural feeder rollers include first and second groups of feeder rollers;

each of said feeder rollers in said first group includes:

a roller body; and

a flange portion, formed to project from a periphery of said roller body, for contacting and regulating a lateral edge of said first or second substrate.

13. A substrate feeding device as defined in claim 11, wherein said feeder mechanism further comprises:

plural nip rollers, disposed higher than said feeder rollers in a rotatable manner, for nipping said first or second substrate in cooperation with said feeder rollers;

a roller shifter for shifting said nip rollers between a nip position and a retracted position for setting said first or second substrate free.

14. A substrate feeding device as defined in claim 13, further comprising a nip sensor, disposed near to said roller shifter, for detecting a front edge of said first or second substrate;

wherein said control unit controls said roller shifter, sets said nip roller in said nip position while said nip sensor outputs a detection signal, and sets said nip roller in said retracted position while said nip sensor outputs a non-detections signal.

15. A substrate feeding device as defined in claim 13, wherein said ejecting feeder includes:

plural guide rollers, rotatable about a rotational axis that is substantially vertical to a surface of said first substrate, for regulating a lateral edge of said first substrate; and

a horizontal shifter mechanism for supporting said guide rollers in a shiftable manner, and for causing said guide rollers to set said first substrate in a predetermined feeding path while said nip rollers are in said retracted position.

16. A substrate feeding device as defined in claim 15, further comprising:

a supply mechanism for supplying said receiving feeder with said second substrate;

a stock sensor for checking whether said second substrate is disposed at said receiving feeder;

wherein while said stock sensor outputs a detection signal, said control unit inhibits said supply mechanism from supplying said receiving feeder with said second substrate.

17. A substrate feeding device as defined in claim 16, further comprising an auxiliary stock sensor for checking whether said first substrate is disposed at said ejecting feeder;

wherein when said auxiliary stock sensor outputs a detection signal, said control unit allows said ejecting feeder to feed said first substrate to said lamination roll.

18. A substrate feeding device as defined in claim 16, further comprising an auxiliary stock sensor for checking whether said second substrate is disposed at said stocking feeder.

19. A substrate feeding device as defined in claim 16, further comprising first, second and third heaters for preheating said first or second substrate disposed at respectively said receiving feeder, said stocking feeder and said ejecting feeder to a target temperature adapted for operation of said lamination roll, said first, second and third heaters operating for application of heat at first, second and third temperatures, said first temperature being lower than said target temperature, said third temperature being higher than said target temperature, and second temperature being higher than said third temperature.

20. A substrate feeding device as defined in claim 19, wherein each of said first, second and third heaters includes plural heater elements controllable for a temperature separately.

21. A substrate feeding device as defined in claim 16, further comprising a horizontal movable device for supporting said feeder roller in a shiftable manner transversely to feeding of said first and second substrates.

22. A substrate feeding device as defined in claim 21, further comprising a flotation blower for blowing gas to a lower surface of said first or second substrate fed by said feeder mechanism, for preventing a substrate middle portion from flexing under gravity.

23. A substrate feeding device as defined in claim 1, wherein said laminated material further includes a cover film overlaid on said transfer film in a peelable manner;

said cover film is peeled from said transfer film in a position upstream from said lamination roll, and removed from said laminated material.

24. A substrate feeding device as defined in claim 1, further comprising a stopper mechanism for being shifted by a control of said control unit, and for contacting and stopping said second substrate after said substrate distance has become said second distance, to prolong said substrate distance; wherein said control unit, when said stopper mechanism contacts said second substrate, starts measuring an elapsed time, and when said elapsed time comes up to a second predetermined time, determines that said substrate distance has come up to a third distance adapted for lamination.

25. A substrate feeding device as defined in claim 24, wherein said stopper mechanism is disposed downstream from said ejecting feeder, and

movable between an inserted position and a retracted position, and when in said inserted position, protrudes into a feeding path of said first and second substrates, and when in said retracted position, is away from said feeding path;

said control unit sets said stopper mechanism in said inserted position upon movement of said first substrate past said stopper mechanism and for a reference time equal to or longer than said second predetermined time, for stopping said second substrate, and after lapse of said reference time, sets said stopper mechanism in said retracted position, for allowing feeding said second substrate, so as to set said substrate distance at said third distance.

26. A substrate feeding method for feeding a first substrate and a second substrate succeeding to said first substrate, comprising steps of:

adjusting a substrate distance defined between said first and second substrates by selectively feeding said first and second substrates, to set said substrate distance at a predetermined first distance;

after said substrate distance has reached said first distance, shortening said substrate distance by controlling said first and second substrates in feeding sequences different from one another, to set said substrate distance at a second distance shorter than said first distance; and

after said substrate distance is set at said second distance, feeding said first and second substrates at a predetermined ejecting speed, to keep said substrate distance at said second distance,

wherein in said feeding sequences different from one another, said first substrate is fed at said predetermined ejecting speed, and also said second substrate is fed at a high speed higher than said predetermined feeding speed; said distance shortening step further includes:

starting measuring elapsed time in response to a reach of said substrate distance to said first distance;

when said elapsed time comes up to a first predetermined time, determining that said substrate distance has become said second distance.

27. A substrate feeding method as defined in claim 26, wherein said first and second substrates are fed to a lamination roll at said predetermined ejecting speed.

28. A substrate feeding method as defined in claim 27, wherein said lamination roll is further supplied with laminated material, said laminated material includes a support, and a transfer film overlaid on said support;

said lamination roll laminates said transfer film to said first substrate by attachment with heat and pressure.

29. A substrate feeding method as defined in claim 28, wherein said distance adjusting step includes:

detecting a reach of a front edge of said first substrate in a first stop detecting station; detecting a reach of a front edge of said second substrate in a second stop detecting station positioned upstream from said first stop detecting station;

in response to detections at said first and second stop detecting stations, stopping respectively said first and second substrates, so as to set said substrate distance at a distance L0 that is shorter than said first distance;

prolonging said substrate distance by feeding said first substrate in keeping said second substrate stopped; and

detecting passage of a rear edge of said first substrate in a pursuit starting detecting station positioned downstream from said second stop detecting station at said first distance, so as to determine that said substrate distance has reached said first distance while said substrate distance is prolonged.

1 OCT 2004

ABSTRACT OF THE DISCLOSURE

SUBSTRATE FEEDING DEVICE AND METHOD

A substrate feeding device includes an ejecting feeder for feeding a first glass substrate at an ejecting speed V1. At least one stocking feeder feeds a second glass substrate succeeding to the first glass substrate toward the ejecting feeder. A set of three sensors checks a substrate distance defined between the first and second glass substrates by comparison with a predetermined distance L1. A control unit adjusts the substrate distance by selectively driving the ejecting feeder and stocking feeder, to set the substrate distance at the distance L1 according to a distance determining signal from the set of the three sensors. After the substrate distance has reached the distance L1, the control unit shortens the substrate distance by controlling the ejecting feeder and stocking feeder in feeding sequences different from one another, to set the substrate distance at a distance L2 shorter than the distance L1. Then the control unit drives the ejecting feeder and stocking feeder at the ejecting speed V1, to keep the substrate distance at the distance L2.

FIG. 4