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(54) **INDUSTRIAL INKJET PRINTING METHOD**

(57) A method of inkjet printing for enhancing the production speed comprising the steps wherein the thickness of a substrate (940, S) is determined to adapt the height position of a stack (199, ST1) at the input (200, I) of an inkjet printing device (P), wherein the stack (199, ST1) is carried on a pallet (P) connected to a fork of a powered pallet jack (100, PJ1) and the stack (199, ST1) is aligned and wherein an upright-side of the stack (199, ST1) is aligned with said input (200, I).

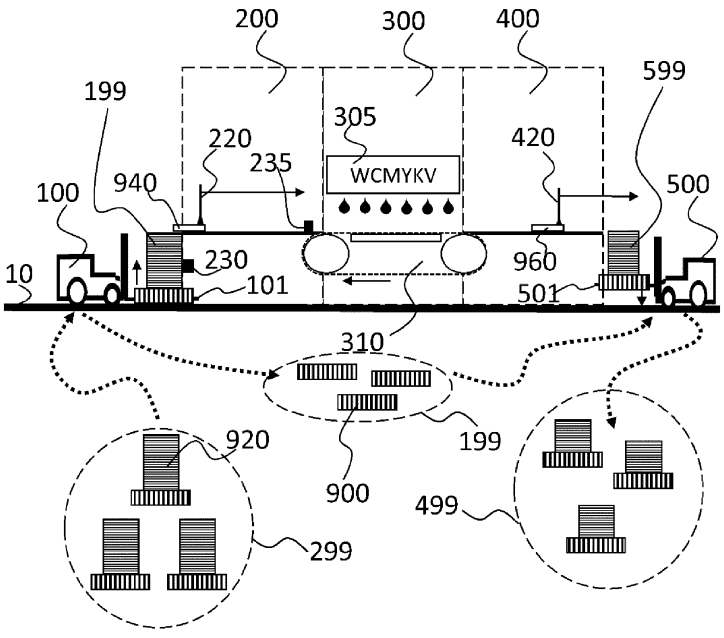

Fig. 2

EP 4 197 802 A1

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Description

Technical Field

[0001] The invention is related to an industrial inkjet printing method with an automatic board feeder.

Background Art

[0002] To automate an inkjet printing method an automatic board feeder is added to the inkjet printing devices. Said feeder take from a pallet of substrates a substrate one by one to the input (side) of an inkjet printing device. By clamping means or suction cups on said feeder a substrate on top of the stack are taken and transported to said input of the inkjet printing device. For large or heavy substrates are such automatic board feeders at inkjet printing devices an advantage for the production speed, especially when said inkjet printing devices are wide-format inkjet printing devices wherein an image is printed by more than one pass of an inkjet-head-module when droplets are jetted on the applied substrate. An example of such automatic board feeder at an inkjet printing device is the MediaMaster™ from manufacturer EFI™. The feeder is for example put in front of VUTEK™ GS3200 which is such a wide-format inkjet printing device.

[0003] Nowadays the printing speed of such inkjet printing devices is increasing for example by adding more inkjet-heads in the device; using higher resolution of the inkjet-heads or optimal calibrating so less passes are needed for printing an image with a high print quality. The Jeti Tauro™ H3300 UHS LED can print up to 600 m2/ h wherein the predecessor was only able to print up to 300 m2/h. The printing speed was doubled in less than 5 years.

[0004] Therefor there is need for more automation in the inkjet printing method which can follow the contemporary and future printing speed with great accuracy so the production speed and working conditions can be improved.

Summary of invention

[0005] In order to overcome the problems described above, preferred embodiments of the present invention have been realised with an inkjet printing method as defined by claim 1.

[0006] By determining the thickness of a single substrate on a stack which shall be docked at the input (side) of an inkjet printing device and lifted according said thickness, the time to accurately grab the substrate at the top of the stack shall be taken less time so substrates can be applied faster in the inkjet printing device.

[0007] Further objects of the invention will become apparent from the description hereinafter.

Brief description of drawings

[0008]

Fig.1 is a flowchart of a preferred embodiment with sequential steps.
Fig. 2 is an illustration of a preferred embodiment of a digital printing device with an automatic board feeder.

Description of embodiments

[0009] An embodiment of the invention is inkjet printing comprising the steps:

- determining (1001, DETERM) the thickness of a single substrate of a stack (199, ST1);
- adapting (1002, ADAPT) a print gap height of an inkjet-head-module (305) of an inkjet printing device (P) according the thickness;
- carrying (1003, $CARRY_{PL1}$) the stack (199, ST1) on a pallet (PL1) with a fork (101, F1) of a powered pallet jack (100, PJ1);
- moving (1004, $MOVE_{PJ1}$) the pallet jack (100, PJ1) on a floor (10) to an input (200, I) of the inkjet printing device (P);
- aligning (1005, ALIGN) an upright-side of the stack (199, ST1) with the input (200, I) by controlling the pallet jack (100, PJ1);
- lifting up (1006, $LIFT_{F1}$) the fork (101, F1) with a distance substantially equal to the thickness;
- transporting (1007, $TRANS_S$) a substrate (940, S) at a top of the stack (199, ST1) on the input (200, I) in a direction (D) and aligning minimum one side of the substrate (940, S) on the input (200, I) to be substantially parallel to the direction or substantially perpendicular to the direction (D);
- printing (1008, PRINT) on the applied substrate by the inkjet-head-module (305);
- repeating (1009, REPEAT) the previous three steps ($LIFT_{F1}$, $TRANS_s$, PRINT) for printing on a following substrate of the stack (199, ST1). Preferably the previous steps are sequential steps of the embodiment. By said steps the automation in the inkjet printing method is enhanced which can follow the contemporary and future printing speed with great accuracy so the production speed and working conditions can be improved.

[0010] The operator of the inkjet printing device (P) may selecting the paper type on a console whereby the thickness of a single substrate is known because it is stored in memory and accessible by the console. Said thickness is in the embodiment used for a) determining and adapting the print gap height which is the shortest distance between the nozzle plate of an inkjet-head in the inkjet-head-module (305) and the printing side (300) of the inkjet printing device; and b) for lifting up the stack

(199, ST1) with a distance equal or substantially equal to the thickness. The thickness of a substrate is mostly determined by a micrometre or thickness gauge but from the weight per m^2 and dimensions of the substrate it may also be determined. The thickness of a substrate may be determined by reading content from an identification code on the stack or the pallet which carries the stack.

[0011] The pallet (P1) with the stack (199, ST1) is docked at the input (side) of the inkjet printing device (P). The transport of the pallet (PL1) is hereby done by a powered pallet jack over a floor (10) of the production site. An example of a powered pallet jack is a Raymond™ 8210 which is powered with a lithium-ion battery, thus an electric pallet jack. Said pallet jack is thus driven, preferably rolled to said input (200, I) over the floor (10). Such pallet jack has typically one or more forks (101, F1) which carries the pallet (PL1) preferably a EUR-pallet as specified by the European Pallet Association (EPAL). Using always EUR-pallet makes that the automation of the embodiment can be more improved because said EUR-pallets defines fixed dimensions e.g. distances between forks.

[0012] It is important that the substrates are accurately docked, also called inserted, in the inkjet printing device (P) e.g. in a borderless inkjet printing method to avoid ink spoiling in the printing side (300). In the embodiment comprises therefor an aligning-step to align an upright-side of the stack (199, ST1) with the input (200, I) by controlling the pallet jack (100, PJ1) for example at an alignment means (230) at the input (200, I). To assure the accuracy also minimum one side of the substrate (940, S), after transported on the input (200, I) in a direction (D), shall be aligned to be substantially parallel to the direction (D) or substantially perpendicular to the direction (D) for example aligning against an other alignment means (235) at the input (200, I).

[0013] Preferably are the application-step ($APPL_p$) and lifting-down-step ($LIFT_{F2}$) of the other fork (501, F2) are performed during the repeating-step (1009, REPEAT) to speed up even more the production instead of before the repeating-step (1009, REPEAT).

Inkjet printing device (P)

[0014] The one or more inkjet inks are jetted by one or more inkjet-heads ejecting small droplets in a controlled manner through nozzles onto the substrate moving relative to the inkjet-head(s). The inkjet-head(s) are part of one or more inkjet-head-modules.

[0015] A preferred inkjet-head for the inkjet printing device is a piezoelectric head. Piezoelectric inkjet printing is based on the movement of a piezoelectric ceramic transducer when a voltage is applied thereto. The application of a voltage changes the shape of the piezoelectric ceramic transducer in the inkjet-head creating a void, which is then filled with inkjet ink or liquid. When the voltage is again removed, the ceramic expands to its original shape, ejecting a drop of ink from the inkjet-head.

[0016] A preferred piezoelectric inkjet-head is a so-called through-flow piezoelectric drop-on-demand inkjet-head. By using through-flow inkjet-heads, the reliability is enhanced and thus a more efficient and economical method of manufacturing high quality printed substrates is obtained. However, the inkjet printing method according to the present invention is not restricted to piezoelectric inkjet printing. Other inkjet-heads can be used and include various types, such as a continuous type inkjet-head.

[0017] The inkjet-head normally scans back and forth in a transversal direction across the moving substrate (940, S), known as a multi-pass printing mode. Sometimes the inkjet-head does not print on the way back. Bidirectional printing is preferred for obtaining a high areal throughput.

[0018] Another preferred printing method is by a "single pass printing process", which can be performed by using page wide inkjet-heads or multiple staggered inkjet-heads that cover the entire width of the substrate (940, S). In a single pass printing process, the inkjet-heads usually remain stationary and the substrate is transported under the inkjet-heads. In a preferred embodiment is thus a single pass inkjet printing method used for printing the substrate (940, S).

[0019] An advantage of using a multi-pass printing mode is that the liquid UV curable inkjet ink is cured in a consecutive passes, rather than in a single pass that would require a curing device with a high UV output. The inkjet-head lifetime is also larger for multi pass printing. While in single pass printing one side shooter is sufficient to replace the whole inkjet-head, in multi pass printing side (300) shooters and even failings can be tolerated. Also the cost of a multi-pass printer is usually much lower, especially for large format substrates.

Curing / drying device

[0020] If aqueous or solvent based pigmented inkjet inks are used, then some curing device for evaporation of water and organic solvents is required. Suitable curing means include a heat radiation means like a hot air dryer, an oven, or an infrared light source, such as an infrared laser, one or more infrared laser diodes or infrared LEDs.

[0021] An effective infrared radiation source for aqueous inkjet inks has an emission maximum between 0.8 and 2.5 μm, preferably between 0.8 and 1.5 μm. Such an infrared radiation source is sometimes called a NIR dryer.

[0022] If UV curable pigmented inkjet inks are used, then curing is usually performed by ultraviolet radiation alone. If so-called hybrid UV curable pigmented inkjet inks containing also water or organic solvents are used, then the curing device preferably further also includes curing means used for aqueous or solvent based pigmented inkjet inks.

[0023] In inkjet printing, the curing device may be arranged in combination with the inkjet-head of the inkjet

printer, travelling therewith so that the inkjet ink is exposed to curing radiation very shortly after been jetted.

[0024] Any ultraviolet light source, as long as part of the emitted light can be absorbed by the photo-initiator or photo-initiator system, may be employed as a radiation source, such as a high or low pressure mercury lamp, a cold cathode tube, a black light, an ultraviolet LED, an ultraviolet laser, and a flash light. Of these, the preferred source is one exhibiting a relatively long wavelength UV-contribution having a dominant wavelength of 300-400 nm. Specifically, a UV-A light source is preferred due to the reduced light scattering therewith resulting in more efficient interior curing.

[0025] UV radiation is generally classed as UV-A, UV-B, and UV-C as follows:
UV-A: 400 nm to 320 nm; UV-B: 320 nm to 290 nm; UV-C: 290 nm to 100 nm.

[0026] Furthermore, it is possible to cure the image using, consecutively or simultaneously, two light sources of differing wavelength or illuminance. For example, the first UV-source can be selected to be rich in UV-C, in particular in the range of 260 nm-200 nm. The second UV-source can then be rich in UV-A, e.g. a gallium-doped lamp, or a different lamp high in both UV-A and UV-B. The use of two UV-sources has been found to have advantages such as a fast curing speed and a high curing degree.

[0027] In a particularly preferred embodiment, the UV curing is performed using UV LEDs having an emission wavelength higher than 360 nm.

[0028] For facilitating curing, the inkjet printer may include one or more oxygen depletion units. The oxygen depletion units place a blanket of nitrogen or other relatively inert gas (e.g. CO_2), with adjustable position and adjustable inert gas concentration, in order to reduce the oxygen concentration in the curing environment. Residual oxygen levels are usually maintained as low as 200 ppm, but are generally in the range of 200 ppm to 1200 ppm.

[0029] In a preferred embodiment an image is printed on the substrate by jetting droplets where after the droplets are dried or cured, and optionally the printed image is varnished with inkjet technology.

Input (200, I)

[0030] The input (side) (200, I) of an inkjet printing device (P) is where a substrate for printing is inserted in / applied on the inkjet printing device (P).

[0031] The method according to any of the claims from 1 to 11 wherein the transporting-step (1007, $TRANS_S$) comprises one or more of the following steps:

- sheet-separating the substrate (940, S) from the stack (199, ST1);
- climatizing the stack (199, ST1) or the substrate (940, S) at the top by humidifying and/or drying;
- flattening the substrate (940, S) at the top;
- cutting the substrate (940, S) in more than one piece.

[0032] The sheet-separating may comprising one or more of the following steps

- airblowing towards the stack (199, ST1) for forming an air cushion between the substrate at the top and the following substrates; or
- decharging static charges on the stack (199, ST1) or the substrate at the top;

[0033] The transporting is preferably performed by a picking system (220) which comprises clamping means or suction cups to pick the substrate on top of the stack and transport it to the input. The picking system (220) preferably comprises a row or array of suction cups with auto on/off valves. Optionally the suction cups are quick release suction cups and optionally the picking system (220) comprises suction cup (level) compensators. The picking system (220) may comprise means to adapt the positions of the suction cups in said row or said array for aligning them according the dimensions of the substrate (940, S). If the dimensions are known said means may automatically change said positions of the suction cups.

[0034] Preferably at the input (200, I) more than one powered pallet jack may be docking. Hereby the input (200, I) or picking system (220) is able to control multiple substrates for printing simultaneously.

[0035] Preferably the input (200, I) comprises one or more movable stack guides for supporting and aligning one or more upright-sides and/or one or more upright-corners of the stack (199, ST1). Preferably said movable stack guides are moved by a powered means according the dimensions of the substrate (940, S).

Output (400, O)

[0036] The inkjet printing device (P) has also an output (side) (400, O) where the printed substrate (960) is removed from the inkjet printing device (P).

[0037] In a preferred embodiment there is not only at the input (200, I) of the inkjet printing device (P) is a powered pallet jack docked. Said embodiment comprises additionally:

- applying ($APPL_p$) the printed substrate (960) on top of an other stack (599, ST2) on an other pallet (PL2) at an output (400, O) of the inkjet printing device (P);
- lifting down ($LIFT_{F2}$) a fork (501, F2) of an other powered pallet jack (500, PJ2) with an other distance substantially equal to the thickness and wherein said fork (501, F2) carries the other pallet (PL2).

[0038] After printing the substrate is removed from the output (400, O) towards an other stack (599, ST2). The specific lifting down makes that the other stack becomes an orderly pile of printed substrates which may be easily stored in a magazine or easily handled in a post printing

process such as cutting or folding.

[0039] The application-step is preferably a transporting-step and more preferably performed by a picking system (420) which comprises clamping means or suction cups to pick the substrate from the output and transport it to the top of the other stack. The picking system (420) preferably comprises a row or array of suction cups with auto on/off valves. Optionally the suction cups are quick release suction cups and optionally the picking system (420) comprises suction cup (level) compensators. The picking system (420) may comprise means to adapt the positions of the suction cups in said row or said array for aligning them according the dimensions of the substrate (940, S). If the dimensions are known said means may automatically change said positions of the suction cups.

[0040] The application-step ($APPL_p$) in said preferred embodiment comprises one or more of the following steps:

- airblowing towards the other stack (599, ST2) for forming an air cushion between the printed substrate (960) and the top of the other stack (599, ST2);
- aligning or guiding one or more upright-sides of the other stack (599, ST2);
- climatizing the other stack (599, ST2) or the printed substrate (960) by humidifying and/or drying;
- flattening the printed substrate;
- cutting the printed substrate (960) in more than one piece;
- folding the printed substrate. Said additional steps makes further handling of the other stack (599, ST2) or printed substrates of the other stack (599, ST2) easier and thus a faster production can be achieved.

[0041] Preferably are said application-step ($APPL_p$) and said lifting-down-step ($LIFT_{F2}$) of the other fork (501, F2) performed during or before the repeating-step (1009, REPEAT).

[0042] Preferably at the output (400, O) more than one powered pallet jack may be docking. Hereby the output (200, I) or picking system (420) is able to control multiple printed substrates simultaneously.

[0043] Preferably the output (400, O) comprises one or more movable stack guides for supporting and aligning one or more upright-sides and/or one or more upright-corners of the stack (199, ST1). Preferably said movable stack guides are moved by a powered means according the dimensions of the substrate (940, S).

[0044] Between the Input (200, I) and Output (200, I) there is a printing side (300) where the substrate (P) receives droplets forming an image from an inkjet-head-module (305).

Inkjet ink

[0045] The inkjet inks that are printed as droplets on the substrate (940, S) preferably contain a colorant. The colorant may be a dye, but is preferably a pigment. A colour pigment is less susceptible to light fading.

[0046] The pigmented inkjet inks may be selected from aqueous pigmented inkjet inks, solvent based pigmented inkjet inks and radiation curable pigmented inkjet inks. However, the one or more pigmented inkjet inks are preferably radiation curable inkjet inks, most preferably UV curable inkjet inks.

[0047] The pigmented inkjet inks preferably contain organic colour pigments as they allow for obtaining a high colour gamut on the substrate (940, S). Carbon black and titanium dioxide are inorganic pigments, which can be advantageously used in the present invention for composing black respectively white pigmented inkjet inks.

[0048] An organic colour pigment may be chosen from those disclosed by HERBST, Willy, et al. Industrial Organic Pigments, Production, Properties, Applications. 3rd edition. Wiley - VCH , 2004. ISBN 3527305769. Suitable colour pigments are disclosed in paragraphs [0128] to [0138] of WO 2008/074548 (AGFA GRAPHICS).

[0049] In a preferred embodiment, the pigmented inkjet inks form a CMYK(W) or CRYK(W) inkjet ink set.

[0050] Pigment particles in inkjet inks should be sufficiently small to permit free flow of the ink through the inkjet-printing device, especially at the ejecting nozzles. It is also desirable to use small particles for maximum colour strength and to slow down sedimentation.

[0051] The numeric average pigment particle size of an organic colour pigment and an inorganic black pigment is preferably between 0.050 and 1 μm, more preferably between 0.070 and 0.300 μm and most preferably between 0.080 and 0.200 μm. The determination of the numeric average particle diameter is best performed by photon correlation spectroscopy at a wavelength of 633 nm with a 4mW HeNe laser on a diluted sample of the pigmented inkjet ink. A suitable particle size analyzer used was a Malvern™ nano-S available from Goffin-Meyvis. A sample can, for example, be prepared by addition of one drop of ink to a cuvette containing 1.5 mL ethyl acetate and mixed until a homogenous sample was obtained. The measured particle size is the average value of 3 consecutive measurements consisting of 6 runs of 20 seconds.

[0052] A white pigment preferably has a numeric average pigment particle size larger than 180 nm in order to have a strong opacifying capability. Suitable white pigments are given by Table 2 in [0116] of WO 2008/074548 (AGFA GRAPHICS) . The white pigment is preferably a pigment with a refractive index greater than 1.60. The white pigments may be employed singly or in combination. Preferably titanium dioxide is used as pigment with a refractive index greater than 1.60. Suitable titanium dioxide pigments are those disclosed in [0117] and in [0118] of WO 2008/074548 (AGFA GRAPHICS).

[0053] When using UV curable pigmented inkjet inks, polymerizable compounds and at least one photoinitiator is present in the inkjet ink.

[0054] Any polymerizable compound commonly known in the art may be employed. The polymerizable

compound may be any monomer or oligomer found in the Polymer Handbook Vol 1 + 2, 4th edition, edited by J. BRANDRUP et al., Wiley-Interscience, 1999 . An oligomer in the present invention is understood to contain 2 to 8 repeating monomeric units. Preferred monomers and oligomers are those listed in [0106] to [0115] in EP 1911814 A (AGFA) .

[0055] Preferably a monomer or oligomer capable of free radical polymerization is used as polymerizable compound. A combination of monomers, oligomers and/or prepolymers may also be used. The monomers, oligomers and/or prepolymers may possess different degrees of functionality, and a mixture including combinations of mono-, di-, tri-and higher functionality monomers, oligomers and/or prepolymers may be used. However preferably an amount of at least 60 to 100 wt% of monofunctional polymerizable compounds is used in the UV curable pigmented inkjet ink with the wt% based on the total weight of the inkjet ink. The viscosity of the radiation curable inkjet inks can be adjusted by varying the amount of specific monomers and oligomers.

[0056] The UV curable inkjet ink contains one or more photoinitiators, preferably one or more free radical photoinitiators. A free radical photoinitiator is a chemical compound that initiates polymerization of monomers and oligomers when exposed to actinic radiation by the formation of a free radical.

[0057] Suitable photo-initiators are disclosed in CRIVELLO, J.V., et al. VOLUME III: Photoinitiators for Free Radical Cationic . 2nd edition. Edited by BRADLEY, G.. London,UK: John Wiley and Sons Ltd, 1998. p.287-294.

[0058] The inkjet inks are most preferably UV LED curable pigmented inkjet inks. Such inkjet inks allow for reliable and cost-effective inkjet printing.

[0059] In a particularly preferred embodiment, the one or more photoinitiators include an acylphosphine oxide photoinitiator and a thioxanthone photoinitiator. Such a combination allows for fast UV curing with UV LEDS emitting above 370 nm. UV LEDs are more economical in operating the inkjet printing than mercury lamps.

[0060] In order to increase the photosensitivity further, the UV curable inkjet ink may additionally contain co-initiators. Suitable examples of co-initiators can be categorized in three groups: (1) tertiary aliphatic amines, such as methyldiethanolamine and N-methylmorpholine; (2) aromatic amines such as 2-(dimethylamino)ethylbenzoate; and (3) (meth)acrylated amines such as dialkylamino alkyl(meth)acrylates and N-morpholinoalkyl-(meth)acrylates. The preferred co-initiators are aminobenzoates.

[0061] A preferred amount of photoinitiator and co-initiator is 0.1 to 30 wt%, and most preferably 5 to 10 wt% of the total weight of the UV curable inkjet ink.

[0062] The one or more pigmented inkjet inks may contain further additives such as surfactants, polymerization inhibitors and dispersants for the colour pigments.

[0063] The preparation of pigmented UV curable inkjet inks is well-known to the skilled person. Preferred methods of preparation are disclosed in paragraphs [0076] to [0085] of WO 2011/069943 (AGFA).

Powered Pallet jack (100, 500)

[0064] Powered pallet jacks also known as electric pallet trucks are motorized to allow lifting and moving of heavier and stacked pallets. Some contain a platform for the user to stand while moving pallets. The powered pallet jack is generally moved by a throttle on the handle to move forward or in reverse and steered by swinging the handle in the intended direction.

[0065] Said pallet jacks comprises one or more forks were on a load is carried such as a pallet with a stack of substrates.

[0066] Preferably moving such pallet jack comprises

- the guiding of the pallet jack by one or more sensed guiding lines on the floor (10); or
- the guiding of the pallet jack by one or more floor (10) rails on the floor (10); or
- the guiding of the pallet jack by a memory-stored path of floor (10)-coordinates e.g. GPS coordinates.

[0067] Preferably the lifting-up of the fork (101, F1) is controlled wireless via an operator system of the inkjet printing device (P).

[0068] And a preferred embodiment comprises after docking , more preferably after the alignment-step (1005, ALIGN), the sequential steps:

a) measuring a height of the stack (199, ST1); and
b) lifting the fork (101, F1) up or down depending on the measured height to a new height wherein the top of the stack (199, ST1) is parallel to the input (200, I).

[0069] The measuring of said height may be performed by one or more sensors at the input (200, I) or on the pallet jack (100, PJ1). To get said top parallel to the input the distance for transporting (1007, TRANSs) the substrate (940, S) towards the input (200, I) becomes smaller thus shorter production times can be achieved.

[0070] Said sensors may also be used to determine the number of substrates on the stack. Said number may be visualized on the console of the inkjet printing device (P).

[0071] The aligning-step (1005, ALIGN) may be performed by projection of parallel lines on the floor (10) with a laser light unit at the input (200, I) and checking if the stack is within said parallel lines when the pallet is docked. The distance between the parallel lines may be adapted if the dimensions of the stack are known e.g. by reading an identification code on the pallet or the stack.

Substrate (940, S)

[0072] Any type of substrate may be used if it is pos-

sible to stack such as paper or board to form a stack (= a stack of substrates) which is A stack is an orderly pile of substrates. Preferably a stack contains a plurality of equal dimensioned substrates of the same substrate-type.

[0073] The substrate may be selected from the group consisting of folding carton, acrylic plates, honeycomb board, corrugated board, foam, medium density fibre-board, solid board, rigid paper board, fluted core board, plastics, foam board, corrugated plastic, leather panels, carpet, vinyl, veneer, wood.

[0074] The substrate preferably comprises an inkjet acceptance layer.

Identification code

[0075] In a preferred embodiment the stack or the pallet which carries the stack contains one or more identification codes that are used to receive content about the substrate of a stack. An upright side of the stack preferably comprises said identification code for example on a label glued on said upright side. If the identification code is read for example the thickness of a single substrate can be received but also other content can be received:

> dimensions of the substrate (width, depth, height), substrate-type, color of the substrate, humidity of the substrate, the position in the warehouse or
> an assignment of the stack for a specific customer. The content may be used to control the inkjet printing device and/or the powered pallet jacks (PJ1, PJ2).

[0076] An identification code may include alphanumerical data, such as a name and/or numbers, but preferably it is a machine readable identification code. The identification code is preferably machine readable as this generally speeds up the manufacturing process and/or the logistic process as it allows for faster identification without errors. There is no restriction on the type of machine-readable identification code. It may be a simple bar code, but it may also be a so-called 2D code. Preferred 2D codes include a barcode, a QR code, a datamatrix code, a cool-data-matrix code, an aztec code, an upcode, a trillcode, a quickmark code, a shot code, a mcode, a beetagg and the like.

[0077] One or more identification codes may be after reading also be inkjet printed together next to the image on the substrate for additional control of the printing process.

[0078] The identification code is preferably read when the powered pallet jack (100, PJ1) is docked. An identification code reader, such as a smartphone with an QR-code app, is hereby constructed at the input (200, I) of the inkjet printing device. The received content of the identification code is preferably used to control the powered pallet jack for better alignment of the pallet or stack. Said received content may contain for this the dimensions of the pallet or the stack. The received content of the identification code is preferably used to control the inkjet printing device. Said received content may contain for this the thickness of a single substrate to adapt the print gap height or a customer information to adapt the print queue list with only print jobs of said customer or prevent print jobs which are not for said customer.

[0079] The received content of the identification code is may contain the substrate-type of the substrates on the stack. Said content may be used to control the inkjet printing device such as adapting the print mode, adapting the print speed, adapting the curing / drying parameters.

[0080] The received content may also be used for warehouse stock controlling.

[0081] If the received content of the identification code contains the dimensions of a single substrate on the stack, then said content may be used to adapt the alignment of the clamping means or suction cups of a picking system (220, 420) at the input (200, I) and/or output (400, O).

Image

[0082] There is no real limitation on the type of image inkjet printed on the substrate (940, S). The image may consist of a single colour or it may include multiple colours such as black, white, cyan, magenta, yellow, red, orange, violet, blue, green and brown.

[0083] The image may be purely decorative, but it may also contain alphanumerical data or other type of information, such as a logo or a pictogram.

Example

[0084] Figure 2 illustrates a preferred embodiment of the invention: a system that is capable to doing the steps: determining (1001, DETERM) the thickness of a single substrate of a stack (199, ST1); adapting (1002, ADAPT) a print gap height of an inkjet-head-module (305) of an inkjet printing device (P) according the thickness; carrying (1003, $CARRY_{PL1}$) the stack (199, ST1) on a pallet (PL1) with a fork (101, F1) of a powered pallet jack (100, PJ1); moving (1004, $MOVE_{PJ1}$) the pallet jack (100, PJ1) on a floor (10) to an input (200, I) of the inkjet printing device (P); aligning (1005, ALIGN) an upright-side of the stack (199, ST1) with the input (200, I) by controlling the pallet jack (100, PJ1); lifting up (1006, $LIFT_{F1}$) the fork (101, F1) with a distance substantially equal to the thickness; transporting (1007, $TRANS_s$) a substrate (940, S) at a top of the stack (199, ST1) on the input (200, I) in a direction (D) and aligning minimum one side of the substrate (940, S) on the input (200, I) to be substantially parallel to the direction or substantially perpendicular to the direction (D); printing (1008, PRINT) on the applied substrate by the inkjet-head-module (305); repeating (1009, REPEAT) the previous three steps ($LIFT_{F1}$, $TRANS_s$, PRINT) for printing on a following substrate of the stack (199, ST1) by the inkjet printing device (P).

[0085] The powered pallet jack (100, PJ1) rolls the

docket pallet (101) with the stack (199, ST1) from a storage location (299) having a plurality of pallets carrying a stack (920) with unprinted substrates. Said pallet jack (100, PJ1) is guided over the floor (10). The stack (199, ST1) carried on a fork (101) of the pallet jack (100, PJ1) is aligned against an alignment means (230) at the input (I, 200). After printing the empty pallet (PL1) is stored by guiding the pallet jack (100, PJ1) over the floor (10) to another storage location (199) having empty pallets (900).

[0086] After the docking a substrate (940, S) is taken from the top of the stack (199, ST1) with a picking system (220) and transported against an other alignment means (235) at the input (I, 200) as illustrated by an arrow.

[0087] At the printing side (300) an image is printed on a substrate by an inkjet-head-module (305) which is capable of printing white (W), cyan (C), magenta (M), yellow (Y), black (K) and varnish (V). The substrate is transported on a vacuum belt system (310). The arrow near the vacuum belt illustrates the direction of conveying.

[0088] At the output (400, O) a printed substrate is taken with another picking system for transporting to the other stack (599) which is carried on another pallet (PL2) from the other location (199). The pallet (PL2) itself is carried on a fork (501) of another powered pallet jack (500) which is docked at the output (500, O).

[0089] After printing the stack with printed substrates is stored at a third location (499) by guiding the pallet (PL2) over the floor (10).

Claims

1. A method of inkjet printing comprising the steps:

- determining (1001, DETERM) the thickness of a single substrate of a stack (199, ST1);
- adapting (1002, ADAPT) a print gap height of an inkjet-head-module (305) of an inkjet printing device (P) according the thickness;
- carrying (1003, $CARRY_{PL1}$) the stack (199, ST1) on a pallet (PL1) with a fork (101, F1) of a powered pallet jack (100, PJ1);
- moving (1004, $MOVE_{PJ1}$) the pallet jack (100, PJ1) on a floor (10) to an input (200, I) of the inkjet printing device (P);
- aligning (1005, ALIGN) an upright-side of the stack (199, ST1) with the input (200, I) by controlling the pallet jack (100, PJ1);
- lifting up (1006, $LIFT_{F1}$) the fork (101, F1) with a distance substantially equal to the thickness;
- transporting (1007, $TRANS_S$) a substrate (940, S) at a top of the stack (199, ST1) on the input (200, I) in a direction (D) and aligning minimum one side of the substrate (940, S) on the input (200, I) to be substantially parallel to the direction or substantially perpendicular to the direction (D);
- printing (1008, PRINT) on the applied substrate by the inkjet-head-module (305);
- repeating (1009, REPEAT) the previous three steps ($LIFT_{F1}$, $TRANS_s$, PRINT) for printing on a following substrate of the stack (199, ST1).

2. The method according to claim 1 comprising the additional steps

- applying ($APPL_p$) the printed substrate (960) on top of an other stack (599, ST2) on an other pallet (PL2) at an output (400, O) of the inkjet printing device (P);
- lifting down ($LIFT_{F2}$) a fork (501, F2) of an other powered pallet jack (500, PJ2) with an other distance substantially equal to the thickness and wherein said fork (501, F2) carries the other pallet (PL2).

3. The method according claim 2 wherein the application-step ($APPL_p$ comprises one or more of the following steps:

- airblowing towards the other stack (599, ST2) for forming an air cushion between the printed substrate (960) and the top of the other stack (599, ST2);
- aligning or guiding one or more upright-sides of the other stack (599, ST2);
- climatizing the other stack (599, ST2) or the printed substrate (960) by humidifying and/or drying;
- flattening the printed substrate;
- cutting the printed substrate (960) in more than one piece;
- folding the printed substrate.

4. The method according to claim 2 or claim 3 wherein the application-step ($APPL_p$) and lifting-down-step ($LIFT_{F2}$) of the other fork (501, F2) are performed during the repeating-step (1009, REPEAT).

5. The method according to claim 2 or claim 3 wherein the application-step ($APPL_p$) and lifting-down-step ($LIFT_{F2}$) of the other fork (501, F2) are performed before the repeating-step (1009, REPEAT).

6. The method according to any of the claims from 1 to 5 wherein the moving-step (1004, $MOVE_{PJ1}$) comprises the guiding of the pallet jack (100, PJ1) by one or more sensed guiding lines on the floor (10).

7. The method according to any of the claims from 1 to 5 wherein the moving-step (1004, $MOVE_{PJ1}$) comprises the guiding of the pallet jack (100, PJ1) by one or more floor (10) rails on the floor (10).

8. The method according to any of the claims from 1 to

5 wherein the moving-step (1004, $MOVE_{PJ1}$) comprises the guiding of the pallet jack (100, PJ1) by a memory-stored path of floor (10)-coordinates.

9. The method according to any of the claims from 1 to 8 wherein the lifting-up-step (1006, $LIFT_{F1}$) of the fork (101, F1) is controlled wireless via an operator system of the inkjet printing device (P).

10. The method according to any of the claims from 1 to 9 wherein the input (200, I) comprises one or more movable stack guides for supporting and aligning one or more upright-sides and/or one or more upright-corners of the stack (199, ST1).

11. The method according to any of the claims from 1 to 10 comprising the sequential steps after the alignment-step (1005, ALIGN):

a) measuring a height of the stack (199, ST1); and
b) lifting the fork (101, F1) up or down depending on the measured height to a new height wherein the top of the stack (199, ST1) is parallel to the input (200, I).

12. The method according to any of the claims from 1 to 11 wherein the transporting-step (1007, $TRANS_S$) comprises one or more of the following steps:

- sheet-separating the substrate (940, S) from the stack (199, ST1);
- climatizing the stack (199, ST1) or the substrate (940, S) at the top by humidifying and/or drying;
- flattening the substrate (940, S) at the top;
- cutting the substrate (940, S) in more than one piece.

13. The method according to any of the claims from 1 to 12 wherein the stack (199, ST1) or the pallet (P1) comprises an identification code which comprises content for controlling the powered pallet jack (100, PJ1) and/or inkjet printing device (P) when said identification code is read.

14. The method according to any of the claims from 1 to 13 for printing an image on the substrate by jetting droplets where after the droplets are dried or cured.

15. The method according to claim 14 whereby the printed image is varnished with inkjet technology.

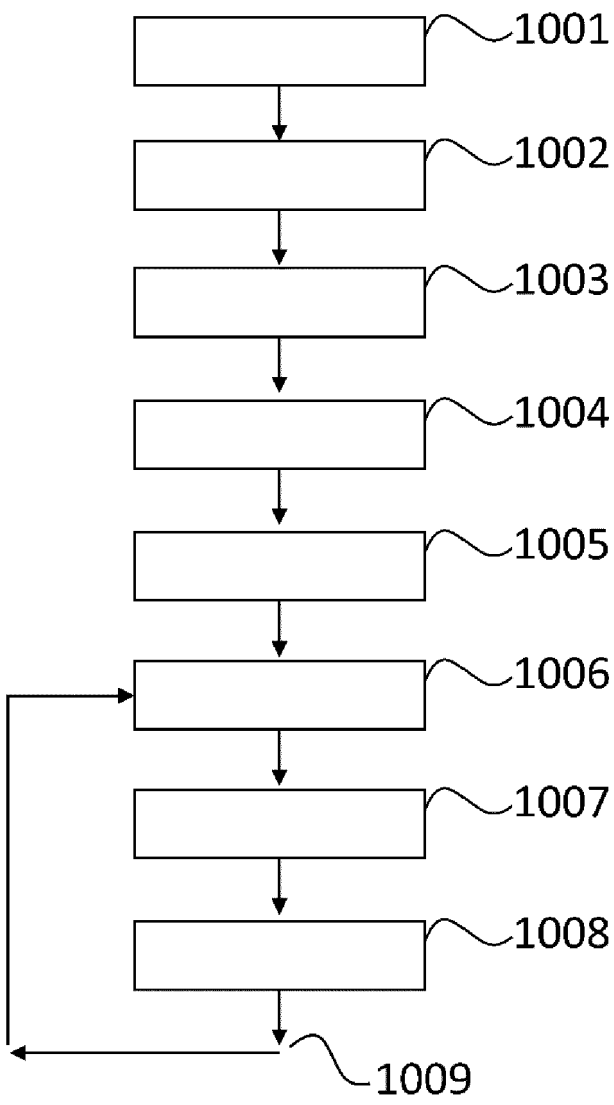

Fig. 1

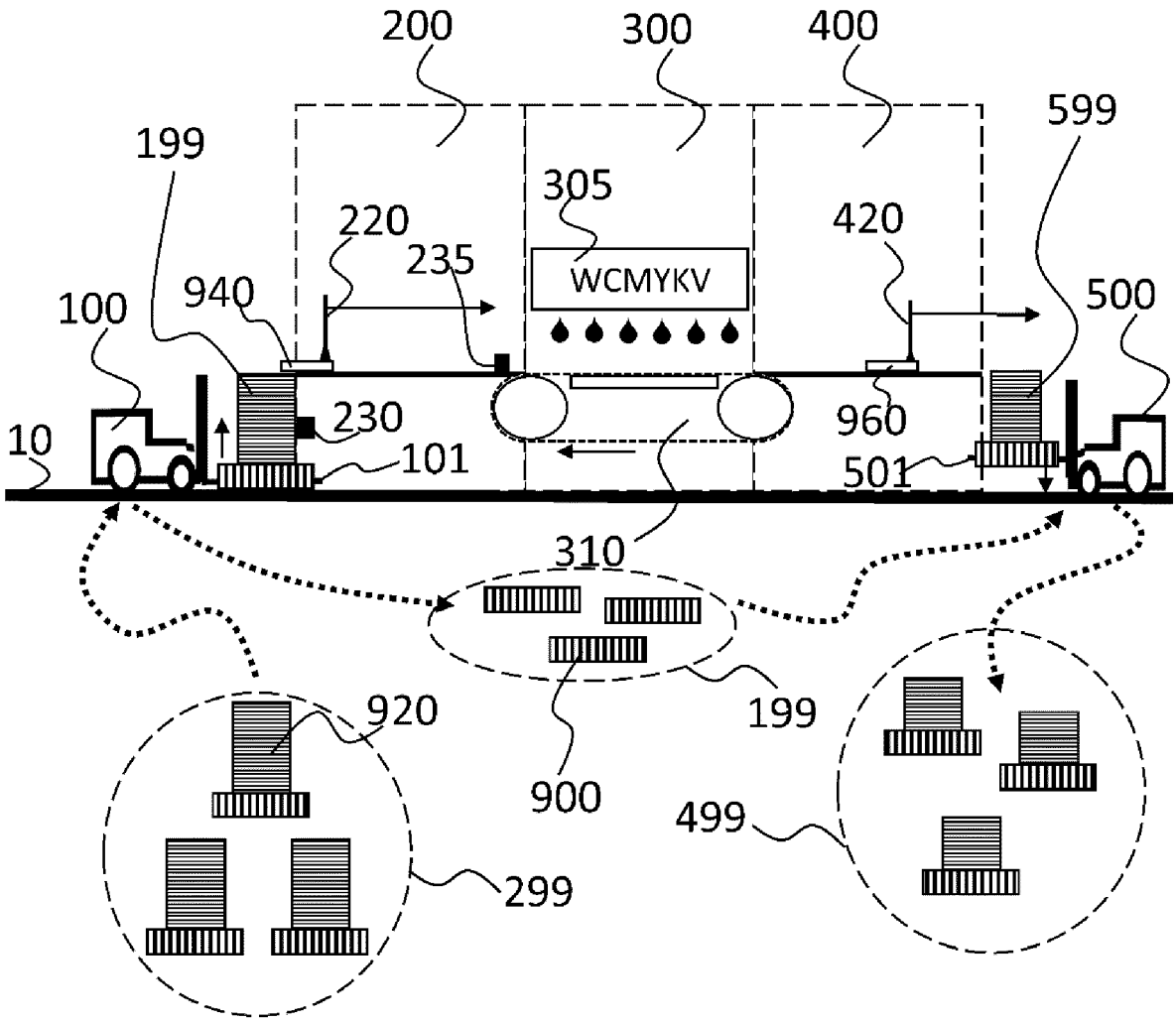
200
300
400
599
199
305
220
235
420
WCMYKV
940
100
500
230
960
10
101
501
310
199
920
900
499
299

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 21 21 5958

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