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(54) **Device for printing, corresponding method and printed product**

(57) This device (2) for printing on a smooth surface (16) of a flexible substrate (14) comprises a printing section (4) having at least a first inkjet printing unit (20) and a second inkjet printing unit (22). The device comprises a supporting conveyor means (40) adapted for conveying

the substrate substantially without mechanical tension from the first inkjet printing unit to the second printing unit, the inkjet printing unit being arranged so as to print with a single-pass onto the surface while the substrate is on the supporting conveyor means.

Application to printing of flexible printed products.

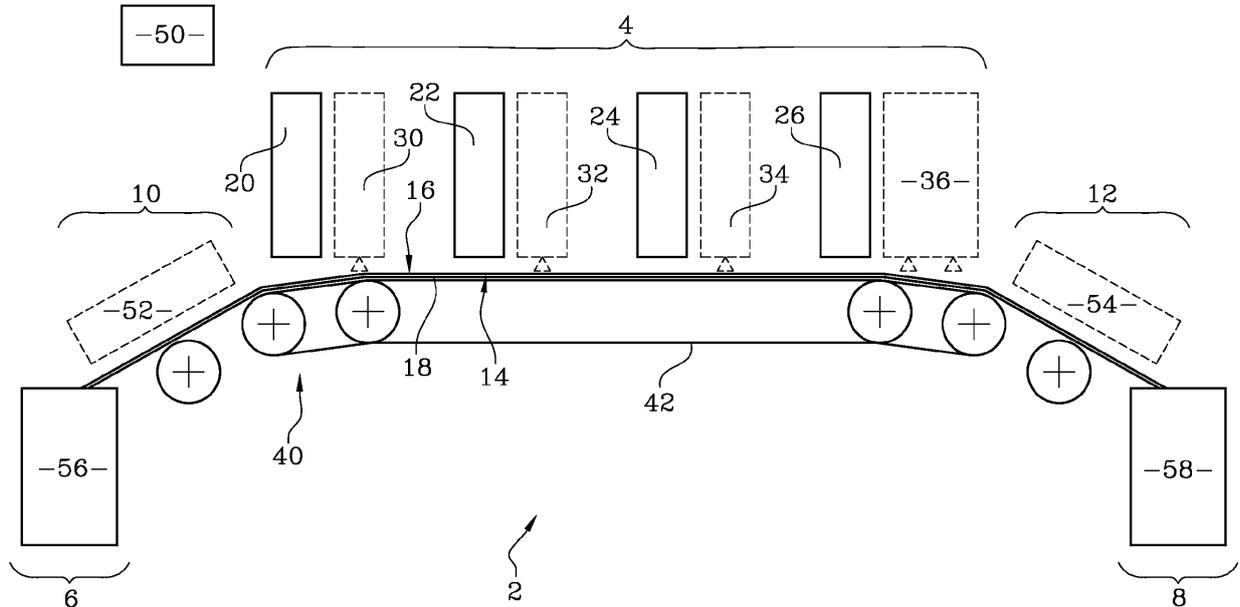


FIG.1

Description

[0001] The invention relates to a device according to the preamble of claim 1.

[0002] Such a device is known from WO 2010/084386. The known device is adapted to print on a rigid, porous substrate such as a fibre board.

[0003] The known device is not adapted for printing on the smooth surface of a flexible substrate, such as a PVC foil or other plastic foils.

[0004] EP 1 577 101 discloses a device for printing on fabrics, cloth, hides or the like and is only adapted to print on porous or absorbent material.

[0005] The present application seeks to overcome the drawbacks of the prior art and to propose a device which is capable of printing with inkjet printing units on a smooth, preferably non-absorbing, surface of a flexible substrate.

[0006] Further problems inherent to the above prior art are:

[0007] During digital printing 4 or more colours are applied one after the other. First Cyan (C), then Magenta (M), then Yellow (Y) and finally Black (K) as example.

[0008] This works for absorbing substrates or UV inks. Absorbing substrates are able to transfer the liquid phase (water/solvent) into the layer away from the surface. By doing so, the pigment and resin stays attached on the surface. If the liquid is not dried or transported away quick enough, i.e. before the next ink droplet, e.g. Magenta, hits the surface, it could happen that the colours blend or bleed into each other, leading to non-sharp images. UV inks can be cured direct after applying them with UV LED so the merging of drops is not happening. For smooth and non-absorbent surfaces, the liquid parts of the ink can not be carried away quickly to the interior of the substrate.

[0009] Furthermore, if the water based ink is dried between the colour application steps, unsupported polymeric material, like a calendered PVC sheet without glass veil is changing its mechanical properties like the tensile strength. This leads to problems in the alignment, thus leading to poor printing quality (out of register).

[0010] According to the invention, to solve this problem the drying between the colours is done on a transfer belt or other supporting conveying means, so with tensionless transport, that is leading to improved printing quality.

[0011] The final problem to be mentioned is the drying in short distances between the colours. A transport belt is expensive, so it should be limited in its length, as well the control of a straight drive of the belt is getting more and more complicated by its length. The drying length can be shortened by higher impinging air velocities of an air drying unit. This can only be done with a rigid transport for the substrate (sheet or web). Again the conveyor belt is supporting this function. Without the belt, thin substrates like blown polymer films or thin calendered sheets could not withstand higher impinging velocities.

[0012] The invention's object is therefore most gener-

ally a device according to claim 1.

[0013] According to particular embodiments, the device can have one or more of the features stated in the dependent claims 2 to 9.

[0014] The invention's object is also a method as indicated in claims 10 to 12 as well as a printed product as indicated in claim 13.

[0015] Further features and advantages of the invention will become apparent from the description of a preferred embodiment of the device, method and printed product according to the invention, illustrated by way of a non-limiting example in the accompanied drawing, wherein the only figure is a schematic view of a device according to the invention.

[0016] With reference to the figure, the device for printing according to the invention is generally designated by the reference number 2. The device 2 comprises a printing section 4, a substrate infeed section 6, a substrate storing section 8, a preheating section 10 and a post-cooling section 12.

[0017] The terms "upstream", "downstream" and "in-between" are used with reference to a conveying direction defined by a conveyor means 40 (see below).

[0018] The infeed section 6 is arranged upstream of printing section 4 and the storing section 8 is arranged downstream of printing section 4. The preheating section 10 is arranged in-between infeed section 6 and printing section 4 and the post-cooling section 12 is arranged downstream printing section 4 and upstream storing section 8.

[0019] The preheating section 10 and the post-cooling section 12 are optional.

[0020] The device for printing 2 comprises also a substrate 14.

[0021] The substrate 14 is flexible and has a smooth surface 16.

[0022] The term "smooth" means in the scope of the present invention that the surface 16 has a roughness of not more than 0,5 mm or not more than 0,25 mm and preferably not more than 0,2mm.

[0023] Also, the surface 16 is non-absorbent. The surface 16 is therefore, at least substantially, closed and without open pores.

[0024] The term "flexible" means that the substrate 14 deforms itself substantially under its own weight. It deforms itself under its own weight, when unsupported between two inkjet printing units, at least in the order of the printing resolution of the inkjet printing units (see below).

[0025] Preferably, the term "flexible" is defined as falling under the method described as an example in ISO DIS 10581: 2011 or in ISO 24344.

[0026] In this method, the flexibility is defined by the capacity of the substrate (floor) being rolled around a 20 mm mandrel without cracking of the substrate being observed.

[0027] The substrate 14 has for example a thickness that is not more than 5 mm. The substrate 14 is preferably a plastic foil in particular made of PVC, vinyl, polyethyl-

ene, polypropylene or polyamide.

[0028] In the present case the substrate 14 is a web 18, but the substrate 14 can also be individual sheets.

[0029] The printing section 4 comprises a first inkjet printing unit 20, a second inkjet printing unit 22 and further inkjet printing units, such as third 24 and fourth 26 inkjet printing units. Each inkjet printing unit 20, 22, 24, 26 is adapted to print one colour onto the surface 16. For example the first printing unit 20 prints Cyan, second printing unit 22 prints Magenta, third printing unit 24 prints Yellow and fourth printing unit 26 prints Black. The number of printing units can vary, but in the present invention, at least two inkjet printing units are present.

[0030] The printing units 20, 22, 24, 26 are digital inkjet printing units. They extend across the whole width of the substrate 14 when printing so as to be able to print in a single pass.

[0031] The printing units 20, 22, 24, 26 are adapted to print either with water-based ink or with solvent-based ink. The printing units 20, 22, 24, 26 comprise preferably each an ink tank comprising the water-based ink or the solvent-based ink having the respective colour.

[0032] The printing section 4 comprises at least one dryer unit 30 arranged downstream the first printing unit 20 and upstream the second printing unit 22. In the present case, the device 2 comprises one dryer unit 30, 32, 34, 36 associated to each printing unit 20, 22, 24, 26 and arranged downstream of the printing unit to which it is associated. Each dryer unit 30, 32, 34, 36 is adapted to dry the ink printed by the associated printing unit 20, 22, 24, 26 onto the surface 16.

[0033] Each dryer unit 30, 32, 34, 36 is for example a hot air dryer unit or an infrared dryer unit. The dryer unit the furthest downstream in the printing section 4, in the present case dryer unit 36, has a drying capacity bigger than the drying capacity of the remaining dryer units 30, 32, 34.

[0034] The device for printing 2 comprises furthermore conveyor means 40 adapted for conveying the substrate 14 substantially without mechanical tension from the first inkjet printing unit 20 to the second inkjet printing unit 24 and in particular from the first inkjet printing unit 20 to the inkjet printing unit furthest downstream, in the present case printing unit 26.

[0035] The inkjet printing units 20, 22, 24, 26 are each arranged so as to print with a single pass onto the surface 16 while the substrate 14 is on the supporting conveyor means 40. In the present case, the conveyor means 40 comprise a transport belt 42. The conveyor means 40 is adapted to convey the substrate 14, while it is printed on, so that the substrate 14 is exclusively applied to the conveyor means 40 by gravity. In other words, when the substrate 14 is conveyed from the first inkjet printing unit 20 to the subsequent inkjet printing units 22, 24 or 26, no pressure is applied onto the substrate 14, except where applicable the pressure applied by the printing operation itself from each inkjet unit or from the dryer units. To this end, the conveyor means are arranged substantially or

exactly horizontally from the first inkjet printing unit to the inkjet printing unit furthest downstream.

[0036] Alternatively, the device for printing 2 can comprise a tackifier or adhesive by which the substrate 14 adheres to the conveyor means 40.

[0037] The device for printing 2 comprises furthermore control means 50 controlling the print units 20, 22, 24, 26, the dryer units 30, 32, 34, 36, the conveyor means 40, the infeed section 6, the storing section 8, the pre-heating section 10 and the post-cooling section 12.

[0038] The pre-heating section 10 is adapted to heat the smooth surface 16 of the substrate 14 prior to printing by the first printing unit 20. To this end, the pre-heating section 10 comprises a pre-heating unit 52, which is for example a hot air heater or an infrared heater.

[0039] The post-cooling section 12 is adapted to cool the substrate 14 downstream of the dryer unit furthest downstream, incidentally dryer unit 36. To this end, the post-cooling section 12 comprises a cooling unit 54 for example a cool air blower.

[0040] The substrate infeed section 6 comprises substrate feed means 56, for example a reel unwinder which unwinds the web of substrate 14. Alternatively, in case the substrate 14 are sheets, the substrate feed means 56 are a sheet feeder.

[0041] The storing section 8 comprises substrate receiving means 58. In the present case, the substrate receiving means 58 are a reel take-up. In case the substrate 14 are sheets, the substrate receiving means 58 comprise a sheet stacker.

[0042] During operation, the control means 50 control the conveyor means 40 and the substrate feed means 56 as well the substrate receiving means 58 so that the feed speed of the substrate feed means, the receiving speed of the substrate receiving means and the conveying speed of the conveyor means 40 are identical and so that no mechanical tension is applied to the substrate 14 due to a possible difference in speed of the feed means 56, receiving means 58 and conveyor means 40.

[0043] The method of printing on a substrate is executed in the following manner.

[0044] The substrate 14 is unwound from the substrate infeed section 6, passes the pre-heating section 10, in which it is pre-heated, and enters the printing section 4. Upon entering the printing section, the substrate 14 is applied onto the conveyor means 40. When being conveyed by the conveyor means 40, the substrate 14 is applied all the time onto the conveyor means 40 exclusively by gravity and is exclusively transported all the time by these conveyor means. In other terms, the substrate 14 is not pushed by the infeed section 6 nor drawn by storing section 8.

[0045] Also, the surface 16 is not in contact with any other feed members during its passage in printing section 4.

[0046] Then the first printing unit 20 prints a first ink onto the surface 16 in a single pass. Subsequently dryer unit 30 dries the surface 16 and the ink which has been

printed by printing unit 20.

[0047] Subsequently the substrate 14 passes to the second printing unit 22 in which a second ink is printed onto the surface 16 in a single pass. As the first ink has been dried, the second ink is printed on the surface 16 without risk of mixing with the first ink. Also, as the conveyor means 40 displace the substrate 14 without mechanical tension, the substrate 14 is in perfect register with the ink applied by printing units 20, 22.

[0048] The substrate 14 passes then the second dryer unit 32, third printing unit 24, third dryer unit 34, fourth printing unit 26 and finally fourth dryer unit 36.

[0049] The third and fourth ink applied by third and fourth printing units 24, 26 is also dry and in register owing to the conveyor means 40 and dryer units 34, 36.

[0050] The substrate 14 is then passed by the conveyor means 40 to the cooling unit 54, where the substrate is cooled down.

[0051] Finally, storing section 8 receives the substrate 14 and takes up the web for example onto a reel. Alternatively, the web can be cut into sheets in the storing section and stacked.

[0052] The finished product is a printed product having a substrate 14 and a pattern of ink printed on the surface 16.

[0053] Before storing in the storing section 8, a finishing layer can be applied onto the surface 16.

[0054] Further features and advantages of the invention are:

[0055] The substrate is an extruded or blown polymer film. The substrate is made from PET.

[0056] The printing units 20, 22, 24, 26 are digital printing units. The printing units are fixed.

[0057] The substrate 14 is applied onto the conveyor means 40 and the conveyor means 40 conveys the substrate in the printing section 4 so as to keep the substrate aligned in register with respect to each printing unit and each dryer unit.

[0058] The pre-heating enhances the printing quality in the first printing unit 22.

[0059] The inks can be dried or fixed by the dryer units by means of impingement or IR drying, or another drying method. The heat and energy introduced in the intermediate drying steps executed by the dryer units leads to a better fixation and quality when applying the subsequent colour inks. After the last drying step the material could be cooled down and wind up or processed further.

[0060] Also, thanks to the dryers, the length of the conveyor means can be kept short.

[0061] Finally, each time the expression "adapted to" is used with respect to an operation in the present patent application, it is understood that the corresponding operation is also disclosed.

Claims

1. Device (2) for printing on a surface (16) of a substrate

(14),

the device (2) comprising a printing section (4) having at least a first inkjet printing unit (20) and a second inkjet printing unit (22), the device being **characterized in that**

the device comprises a supporting conveyor means (40) adapted for conveying the substrate substantially without mechanical tension from the first inkjet printing unit to the second inkjet printing unit, the inkjet printing units being arranged so as to print with a single-pass onto the surface while the substrate is on the supporting conveyor means, the surface (16) being a smooth surface and the substrate (14) being a flexible substrate.

2. Device according to claim 1, wherein the device comprises at least a dryer unit (30) arranged downstream the first inkjet printing unit (20) and upstream the second inkjet printing unit (22) and the dryer unit is adapted to dry the ink printed by the first inkjet printing unit.

3. Device according to claim 2 wherein the dryer unit is a hot-air or an IR dryer unit.

4. Device according to any one of claims 1 to 3, wherein the device comprises a pre-heating section (10) and/or a post-cooling section (12).

5. Device according to any one of claims 1 to 4, wherein the supporting conveyor means (40) include a conveyor belt (42).

6. Device according to any one of claims 1 to 5, wherein the supporting conveyor means (40) is adapted to convey the substrate (14) while it is exclusively applied by gravity to the supporting conveyor means.

7. Device according to any one of claims 1 to 6, wherein each of the inkjet printing units (20, 22, 24, 26) is adapted to print with water-based ink or with solvent-based ink, preferably the inkjet printing units comprise a tank containing water-based ink or a solvent-based ink.

8. Device according to any one of claims 1 to 7, wherein the device comprises a substrate infeed section (6), in particular either a reel unwinder or a sheet feeder, and a substrate storing section (8), in particular a reel take-up or a sheet stacker.

9. Device according to any one of claims 1 to 8, wherein the device comprises a substrate (14), in particular a plastic foil, preferably made of PVC, vinyl, polyethylene, polypropylene or PET.

10. Method of printing on a smooth surface of a substrate, by using a device according to any one of the

preceding claims.

- 11. Method according to claim 10, wherein the substrate is a web or a sheet. 5
- 12. Method according to any one of claims 10 or 11, using a device according to at least claim 8, wherein the supporting conveyor means are operated at a speed identical to the speed of the substrate infeed section and the substrate storing section (8). 10
- 13. Printed product comprising a substrate (14), a smooth surface (16) and a pattern printed on the smooth surface, the pattern being obtained by the method according to one of claims 10 to 12. 15

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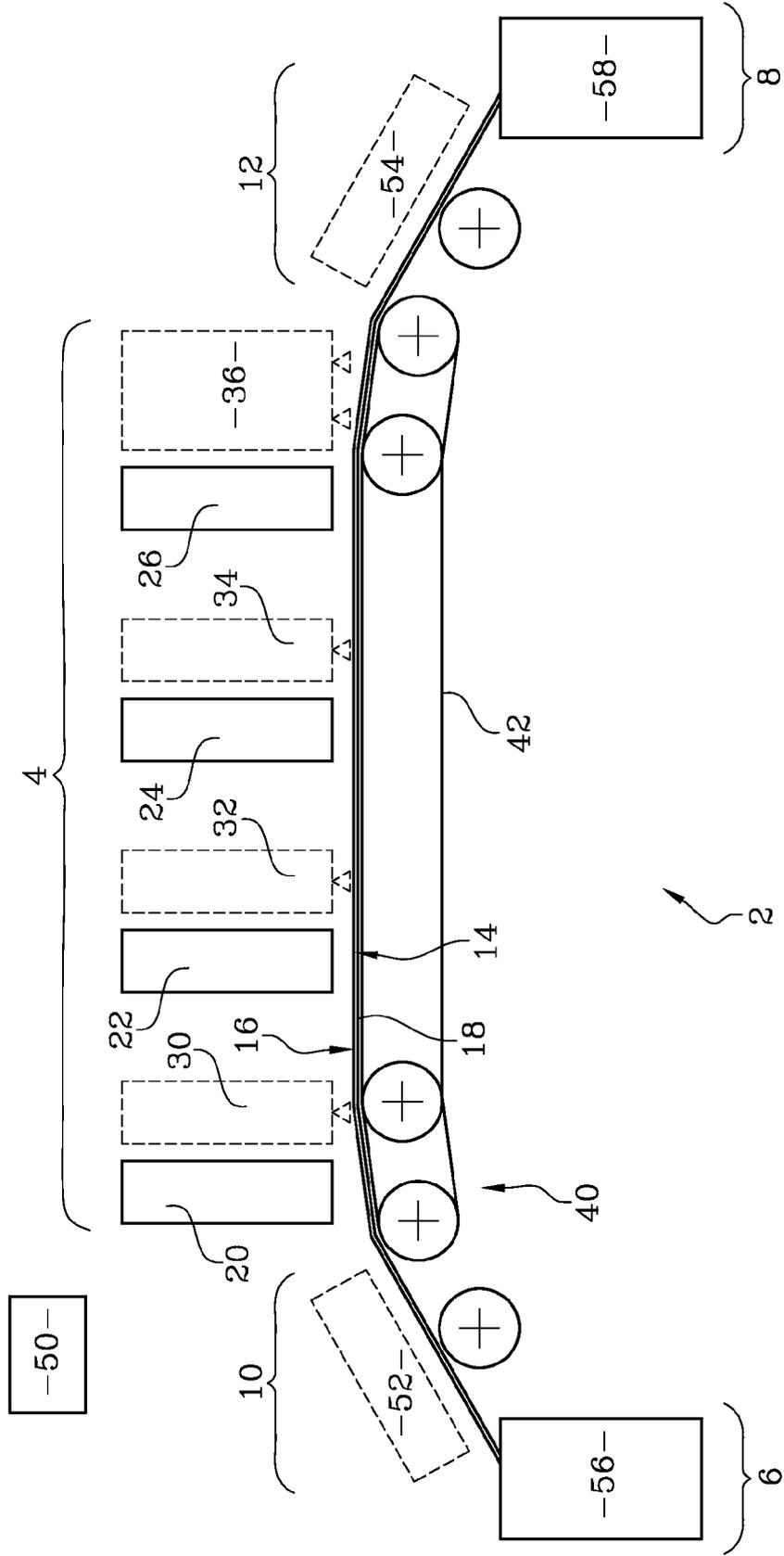


FIG.1



EUROPEAN SEARCH REPORT

Application Number
EP 12 17 2582

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Place of search The Hague		Date of completion of the search 17 July 2013	Examiner Curt, Denis
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ANNEX TO THE EUROPEAN SEARCH REPORT
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