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(54) **A device for large format printing comprising a single central conditioning unit for controlling and monitoring the condition of the developer**

(57) A large format , single pass printer, having a printing width (PW) for printing a toner image on a substrate, the substrate having a width (WS) and a length (LS), wherein, a number n, equal to or larger than 2, of printing engines each with a printing width PWE_i , smaller than said printing width PW is provided, said number n being chosen such that

$$\sum_{i=1}^{i=n} PWE_i \geq PW,$$

characterised in that

- i) a single central conditioning unit for controlling and monitoring the condition of the developer is provided, and
- ii) said central unit is further equipped for circulating said developer to all of said n printing engines and back to said central unit.

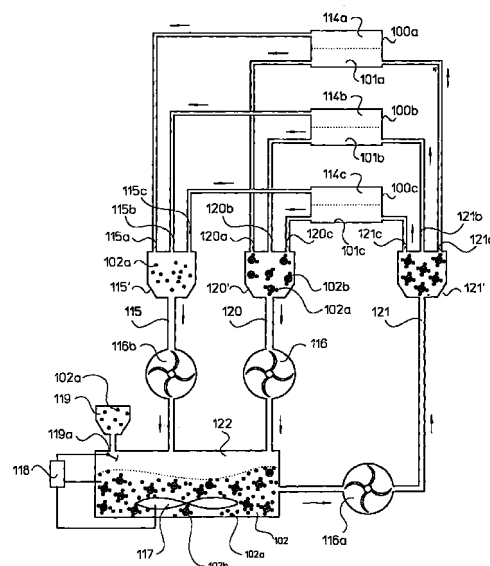


Fig 2

Description

FIELD OF THE INVENTION

[0001] This invention relates to a printing apparatus for large format printing. It relates especially to a large format printer comprising electrostatographic printing devices.

BACKGROUND OF THE INVENTION

[0002] In large format printing, e.g. poster printing, billboard printing, sign printing, the weatherability of the print is very important. In that area silk-screen printing is still a dominant printing method. This method has however many drawbacks : first of all it is rather time consuming since for every colour a dedicated screen has to be made and printed, the method is basically analogue and not well compatible with digital input files.

[0003] More and more images to be printed are available in digital form, so that also in the printing of large formats, digital addressable printing techniques become indispensable.

[0004] A well known digital addressable printing technique that is useful for large format printing is ink-jet printing, both with water based inks and with solvent based inks. An example of an ink-jet printer for large format printing can be found in, e.g. **US-A-5 488 397**, wherein a printer is disclosed having two or more parallel ink-cartridges shuttling over the width of the substrate to be printed while the substrate moves in a direction basically perpendicular to the direction of movement of the shuttling ink-cartridges.

[0005] In **WO-A-96/01489** an ink-jet printer for large format printing is disclosed wherein a single ink-cartridge shuttles over the substrate to be printed.

[0006] In **US-A-4 864 328** an in-jet printer is disclosed, wherein only one printing engine (ink-jet head) having a multiple array of nozzles is moved as a shuttle over the paper.

[0007] In **EP-A-526 205** again an ink-jet printer is disclosed, wherein only one printing engine (ink-jet head) having a multiple array of nozzles is moved as a shuttle over the paper.

[0008] A commercial ink-jet printer IDANIT 162Ad (trade name) available from Idanit Technologies, Israel, uses multiple ink-jet printheads mounted in a staggered position over the width of the substrate to be printed. In this device the printing substrate has to pass several times under the array of staggered ink-jet printheads while between each pass the printheads are slightly moved with respect to the drum in a direction parallel to the width of the substrate. This multi-pass printing enhances the resolution that can be printed, while in the printhead itself the nozzle can be positioned fairly far apart. The same concept (but with much less printheads) has also be commercially implemented in printers such as the Lasermaster DesignWinder, Iris Realist,

Stork Textile Proofer, Polaroid DryJet, ... and is e.g. further described in **WO-A-96/34762**.

[0009] Although ink-jet printing provides the possibility for printing large formats in short time, the resulting printing quality is not always up to the demands, the stability of the image in, e.g. billboards where the image has to be weatherproof leaves still room for improvement.

[0010] In **US-A-5 138 366** a thermal printer using at least two thermal printing heads is described for printing on large substrates. The maximum format for a commercially available large format printer using thermal technology, however, is 36 inch, as provided by the Matan Sprinter, Israel.

[0011] In **US-A-5 237 347** an electrophotographic printer is disclosed wherein a single photoconductor is exposed to the light of several exposure units, so a large latent image can be written on the photoconductor and after development be transferred to a final substrate. The printer having the largest printing width for printing full colour images based on electrophotographic techniques, is e.g. the Xeikon DCP50, having a printing width of 50 cm. In electrostatic technology full colour printing machines having a printing with of 54 inch are available, said devices being fed with liquid electrophotographic developer.

[0012] In **WO-A-96/18506** a shuttling printer using more than one Direct Electrostatic Printing (DEP) engine is disclosed wherein these engines are placed one after the other for printing multi-colour swaths.

[0013] In DEP (Direct Electrostatic Printing) toner particles are deposited directly in an image-wise way on a receiving substrate, the latter not bearing any image-wise latent electrostatic image.

[0014] This makes the method different from classical electrography, in which a latent electrostatic image on a charge retentive surface is developed by a suitable material to make the latent image visible, or from electrophotography in which an additional step and additional member is introduced to create the latent electrostatic image (photoconductor and charging/exposure cycle).

[0015] A DEP device is disclosed in e.g. **US-A-3 689 935**. This document discloses an electrostatic line printer having a multi-layered particle modulator or printhead structure comprising :

- a layer of insulating material, called isolation layer ;
- a shield electrode consisting of a continuous layer of conductive material on one side of the isolation layer ;
- a plurality of control electrodes formed by a segmented layer of conductive material on the other side of the isolation layer ; and
- at least one row of apertures.

[0016] Each control electrode is formed around one aperture and is isolated from each other control elec-

trode.

[0017] Selected electric potentials are applied to each of the control electrodes while a fixed potential is applied to the shield electrode. An overall applied propulsion field between a toner delivery means and a support for a toner receiving substrate projects charged toner particles through a row of apertures of the printhead structure. The intensity of the particle stream is modulated according to the pattern of potentials applied to the control electrodes. The modulated stream of charged particles impinges upon a receiving substrate, interposed in the modulated particle stream. The receiving substrate is transported in a direction perpendicular to the printhead structure, to provide a line-by-line scan printing. The shield electrode may face the toner delivery means and the control electrodes may face the receiving substrate. A DC-field is applied between the printhead structure and a single back electrode on the receiving substrate. This propulsion field is responsible for the attraction of toner to the receiving substrate that is placed between the printhead structure and the back electrode.

[0018] In EP-A-849 087 a single pass large format printer is disclosed, having at least two printing engines (DEP engines or electrophotographic engines) which are staggered with respect to the printing direction so that a large format image can be printed which is larger in size than the printing width of one of said printing engines.

[0019] In EP-A-849-645 a large format printer is disclosed having a page wide DEP-printhead structure combined with multiple smaller sized toner applicator modules, and in EP-A-849 640 a large format printer is disclosed having a page wide photoconductor combined with multiple smaller sized toner delivery means.

[0020] In the art of printing large formats, however, slight density fluctuations between neighbouring image swaths easily lead to overall image deterioration. This phenomenon can be seen in shuttle printers in which neighbouring printing swaths do, although they receive the same image input, not always print at the same density. When this phenomenon appears, banding is seen in the final image. Also in page wide printers, the print-out from neighbouring printing units does not always have exactly the same density although all printing units are activated by the same digital image input. This leads again to the problem of uneven density and banding in the final image.

[0021] Thus there is still a need for further improved large format printing devices making it possible to print at elevated speed with no or very low banding.

OBJECTS AND SUMMARY OF THE INVENTION

[0022] It is an object of the invention to provide a printer for high speed printing of large format images with good image quality.

[0023] It is a further object of the present invention to

provide a printer, printing large format images with a high printing speed, using dry printing methods and toner particles.

[0024] It is still a further object of the present invention to provide a printer, printing large format images with a high printing speed, without banding or problems of density variations.

[0025] It is a further object of the present invention to provide a printer for printing large format images at high printing speed with good long term stability and reliability.

[0026] Further objects and advantages of the invention will become clear from the description hereinafter.

[0027] The objects of the invention are realised by providing a single pass printer, having a printing width (PW) for printing a toner image on a substrate, the substrate having a width (WS) and a length (LS), wherein, a number n, equal to or larger than 2, of printing engines each with a container for developer, said container having an active portion and with a printing width PWE_i , in a direction of a longitudinal axis, smaller than said printing width PW is provided, said number n being chosen such that

$$\sum_{i=1}^{i=n} PWE_i \geq PW,$$

characterised in that

i) a single central conditioning unit for controlling and monitoring the condition of the developer is provided, and

ii) said central conditioning unit is equipped with means for circulating said developer to all of said n printing engines and back to said central unit.

[0028] Preferably said printing width is at least 40 cm, and said longitudinal axes are essentially parallel.

Preferably said printing engines are electro(stato)graphic engines, especially Direct Electrostatic Printing (DEP) engines, or electrophotographic engines.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

Figure 1 is a schematic illustration of a large format single pass printer with at least 2 printing engines and with a central conditioning unit according to the present invention.

Figure 2 shows schematically an other embodiment of a large format single pass printer with at least 2 printing engines and with a central conditioning unit according to the present invention.

Figure 3 shows schematically a large format single

pass printer that can be equipped with a central conditioning unit according to the present invention. Figure 4 shows schematically an other implementation of a large format single pass printer that can be equipped with a central conditioning unit according to the present invention.

Figure 5 shows schematically a large format single pass printer with at least 2 printing engines and with a central conditioning unit according to the present invention, wherein the printing engines are engines for Direct Electrostatic Printing.

Figure 6 shows schematically a large format single pass four colour printer using at least two electrophotographic printing engines equipped with central conditioning units according to this invention.

Figure 7 shows schematically a large format single pass printer with a shuttle using at least two electrophotographic printing engines to be equipped with central conditioning units according to this invention.

DETAILED DESCRIPTION OF THE INVENTION

Definitions

[0030] In this document "central conditioning unit" is used to describe a unit wherein the condition of the developer is monitored, controlled and wherein the condition of the developer (especially with respect to the concentration and the charge of the toner) is kept constant during printing.

[0031] The wording "active portion of container for developer" is used to indicate the portion of the container wherein either the sleeve of the magnetic brush, in a printing engine working with a developer containing magnetic particles, or the surface dispensing roller, in a printing engine working with a non-magnetic mono component developer, are loaded with charged toner particles via direct contact between the toning material and the sleeve or the dispensing roller. In the case of a container for developer with a magnetic brush assembly said active portion is e.g. the portion in the magnetic brush assembly in which developer is jumped to the sleeve of the magnetic brush by, e.g. a rotating transport screw. Additional transport screws or paddles delivering developer to said active portion, but not delivering said developer material directly to said sleeve is the "non-active portion of the container".

[0032] In this document the wording "toner transferring element or elements" is used to designate those parts of a printing engine used to provide a toner image either on an intermediate image bearing member or on a final substrate to be printed. In a DEP printing engine, the "toner transferring element" or "element for applying toner particles" is or are the row(s) of printing apertures in the printhead structure. In an electrophotographic printing engine, the "toner transferring element" or "element for applying toner particles" is or are the latent

image bearing member(s).

[0033] In this document the wording "staggered printing engines" is used to indicate a number of printing engines (at least two), each of the printing engines comprising a toner transferring element, that are positioned in the printer so that at the longitudinal axis of the toner transferring means, comprised in at least two of the number of printing engines do not coincide.

[0034] The wording "substrate" or "image receiving element" can in this document mean a final image receiving element whereon the toner image is printed, as well as an "intermediate image receiving member" used to accept a toner image and to transfer that image to a final image receiving member.

[0035] The width of the image receiving substrate (WS) is the dimension of that substrate that is essentially perpendicular to the direction of movement of the substrate in the printer.

[0036] The length of the image receiving substrate (WL) is the dimension of that substrate that is essentially parallel to the direction of movement of the substrate in the printer.

[0037] It was found and described in **EP-A-849 087**, that by using at least two and preferably at least three printing engines, with a printing width PWE smaller than the total printing width PW of the printer, spread over the width of the substrate to be printed and arranged so that the longitudinal axis of the toner transferring elements of at least two of the printing engines do not coincide, a fast high resolution printer for large (large means herein having a surface of at least 0.25 m² and an image width of at least 30 cm) formats could be built. A printer according to this invention can be constructed in such a way that any printing width, from 10 cm up to more than, e.g., 5 meter, can be realised. Preferably a printer according to this invention is manufactured such as to have a printing width (PW) of at least 40 cm, preferably of at least 60 cm and more preferably of at least 120 cm.

[0038] A printer according to this invention is a "single pass" printer, i.e. the substrate passes the printing engines only once. For example, a printer, wherein several printing engines are rigidly mounted over the total width of the substrate to be printed, so that the longitudinal axis of the toner transferring elements of at least two of the printing engines do not coincide, and that is equipped with means for moving said substrate with respect to said printing engines in a single direction, is a single pass printer according to the present invention. In a single pass printer all the image information being adapted to be printed with printing engines with width WPE, (i.e. a printing line) is printed in its totality on an area of the substrate being present near the printing engines and the substrate is moved further on, an a further line is printed, and so on.

When the toner concentration in the developer is not constant over the printing time, the amount of charged toner particles that can be brought to the substrate by the printing engine is also fluctuating in the time, which

leads to reduced image quality. It is known in the art to control and monitor the condition of the developer - i.e. ratio of amount of toner particles to the amount of carrier particles, charge of the toner particles, etc. - and to automatically adapt the developer condition to the image density so that the engine prints, when driven by the same image data, the same optical density level. Means for doing so are disclosed in, e.g., EP-A-785 484, US-A-5 559 579, EP-A-687 962, US-A-5 420 617, US-A-5 231 452, etc..

[0039] In the case of a printer wherein n printing engines, each having a printing width WPE smaller than the printing width PW, are spread over the total printing width so that the total printing width can be printed in a single pass, it must not only be assured that the amount and the charge of the toner particles do remain constant over the printing time within each of the printing engines, but also that at any moment of the printing in each of the printing engines the same amount of toner particles is brought to the toner transferring means and that the (average) charge of the toner particle is also the same. It seems straightforward to implement, in such a printer the teachings concerning the monitoring of the condition of the developer to the developer used in each individual printing engine separately and have all printing engine giving the same image density when driven by the same image data.

[0040] During experimentation, it was however found that, in a printer as described immediately above, when the condition of the developer was monitored for each of the printing engines separately, the printing quality in terms of banding deteriorated with the printing time, due to the fact that the change in developer condition with the time was, in spite of the monitoring in each printing engine separately, still not the same for all the printing engines.

[0041] Further experimentation revealed that when the condition of the developer was controlled in a central conditioning unit, and when all printing engines received developer from this central conditioning unit, the image quality reached in a printer wherein n printing engines, each having a printing width WPE smaller than the printing width PW, are spread over the total printing width so that the total printing width can be printed in a single pass, did not or almost invisibly change with the printing time.

[0042] Thus the use of a central conditioning unit, as in the present invention, did not only simplify the large format single pass printer and make it less expensive and less bulky (without such a central unit every printing engine needs to have its own developer control and monitoring unit) but did also lead to better image quality that remained unaltered over a longer period of printing.

[0043] It was found that for keeping - in a printer as described above - the developer in perfect condition with the aid of a central conditioning unit it was necessary that the developer circulated quite rapidly from the central conditioning unit to the printing engines and

back. Preferably the circulating speed is chosen such that at any moment during printing at most 25 % by volume of the developer is present in the active portion of the container for developer in the printing engines while at least 75 % are continuously being circulated through the central conditioning unit for keeping its condition constant.

[0044] For keeping the condition of the developer constant, the central conditioning unit can be connected not only to a circuit for circulating developer to all printing engines but also to a reservoir of fresh toner particles. The connection with said reservoir is equipped with a valve that selectively can be opened and closed depending on the condition of the developer in the central conditioning unit.

[0045] Moreover to reduce waste, the toner particles that are not used in the transfer to the substrate, can be recovered and also connected in the central conditioning unit so that these non-used toner particles are recycled instead of simply dumped.

[0046] In figure 1 a schematic view of a central conditioning unit useful in this invention is shown coupled to three printing engines (100a, 100b and 100c). Each of printing engines comprises a container (101a, 101b and 101c) for developer from where the toner particles are brought to the toner transfer means (not shown). In the heart of the central unit a container (122) is present wherein the developer (102) containing toner particles (102a) and carrier particles (102b) can be mixed by one or more mixing means (107). The mixing provides a tribo-electric charge on the toner particles. The container is coupled to inlets (120a, 120b, 120c) over a collection vessel (120') for the developer circulating between the containers for developer of each of the printing engines and the container (122). Means for moving (116) the developer towards the container are also provided. The means for moving the developer (116, 116a) or the non-used toner particles (116b) can be any means known in the art, e.g. paddles moved by a motor, pumps, Archimedian screws, etc. The container contains further an outlet (121) coupled to each of the printing engines, this outlet is also provided with means (116a) for moving the conditioned developer towards the various printing engines using a distribution box (121') through ducts (121a, 121b and 121c). The container (122) is further coupled to a vessel (119) containing fresh toner particles, said vessel being coupled to said container over valve (119a) that can selectively be opened and closed. The container (122) is coupled to means for monitoring the condition of the developer i.e. to means for measuring the ratio of toner to carrier particles (118) and/or the charge of the toner particles. The means for measuring the ratio of toner to carrier particles (118) and/or the charge of the toner particles are coupled to the valve (119a) for selectively opening and closing said valve depending on the measured result of the developer condition and the intended one. Optionally said means for measuring the ratio of toner to

carrier particles (118) and/or the charge of the toner particles can be coupled to the mixing means (117) so that also the mixing can be used to control the charge of the toner particles to a predetermined constant value. The means for moving (116, 116b) the non-used toner particles and the developer from the printing engines towards the container and the means (116a) for moving the conditioned developer from the central conditioning unit towards the various printing engines are equipped for giving such a circulating speed to the developer that at any moment during printing at most 25 % by volume of the developer is present in the active portion of the container for developer in (101a, 101b and 101c) the printing engines while at least 75 % are continuously being circulated through the central conditioning unit for keeping its condition constant. The ducts connecting the central conditioning unit with the various printing engines can be made from rigid material as well as of flexible material. It is preferred to use ducts in flexible polymeric material.

[0047] In figure 2, a schematic view of a central conditioning unit useful in this invention is shown coupled to three printing engines (100a, 100b and 100c) as in figure 1. In this figure the printing engines are further equipped with means (114a, 114b and 114c) for collecting non used toner particles, by doing so the amount of waste during printing is minimised. The central conditioning unit is coupled to said means for collecting the non-used toner particles using a collection vessel (115') through ducts (115a, 115b and 115c). Means (116b) are provided to bring the non-used toner particles from the printing engines to the container (122) in the central conditioning unit, wherein the non-used toner particles are mixed with the circulating developer and used again.

[0048] This is a preferred embodiment of this invention.

[0049] The distribution box (121') can be omitted and the separate ducts (121a, 121b and 121c) can originate directly from the container (122) of the central unit for controlling and monitoring the developer. Also the collection vessels (115' and 120') can be omitted and the inlets (115a, 115b, 115c, 120a, 120b and 120c) can be connected directly to the container (122) of the central unit for controlling and monitoring the developer. It is also possible to omit collection vessel 115' and guiding the non-used toner particles directly into the ducts for circulating the developer. By doing so the total printer is simplified as the means for moving the non-used toner particles to the central conditioning unit can also be omitted.

[0050] A printer wherein n printing engines, each having a printing width WPE smaller than the printing width PW, are spread over the total printing width so that the total printing width can be printed in a single pass can be constructed as shown in the schematic perspective view in figure 3. Three printing engines 100a, b and c), each with a printing width WPEa, WPEb and WPEc and

a respective longitudinal axis in the direction of said printing width are positioned in a staggered configuration under an image receiving substrate (109), having a width (WS) and a length (LS) and travelling in the direction of arrow A. (in fig 2. the substrate is shown as transparent for the sake of clarity). The respective widths of the printing engines, the number, n, of printing engines and an optional overlap of some or all of the printing engines, is chosen in such a way that the desired printing width (PW), preferably larger than 40 cm, is reached, therefore said number n is chosen such that

$$\sum_{i=1}^{i=n} PWE_i \geq PW.$$

[0051] It is preferred that the respective longitudinal axis of the respective printing engines are essentially parallel to each other and to the width of the substrate. In figure 3, the three staggered printing engines are considered as a set of printing engines. Such a set of printing engines can be used to print a single colour and when this is in fact done, then a colour printer according to this invention comprises, multiple sets of staggered printing engines, e.g., one set for each colour to be printed. For example, a printer according to the first specific embodiment of this invention, wherein each set of staggered printing engines prints only one colour, will for printing four colours, e.g., yellow, magenta, cyan and black (YMCK), comprise four sets of staggered printing engines. In such a printer each of said four sets of printing engines is preferably coupled to a central unit for controlling and monitoring the developer according to this invention.

[0052] In figure 4 a schematic perspective view of a further large format single pass printer that beneficially can be equipped with a central conditioning unit according to this invention is shown.

[0053] Five printing engines (100a, b, c, d, and e), each with a printing width WPEa, WPEb, WPEc, WPEd and WPEe and respective longitudinal axis in the direction of said widths are rigidly arranged so that the respective longitudinal axis are essentially parallel to each other and that the centre points of the respective printing widths are on one line. This line is preferably essentially parallel to the width (WS) of the substrate to be printed. The respective longitudinal axis form an angle α ($0^\circ < \alpha < 90^\circ$) with the line through the centre point. Preferably the respective widths of the printing engines are equal and the number of printing engines installed for realising a printer with printing width (PW) is determined as a function of the width of the printing engine and angle α according to the formula : $n > PW / ((\cos \alpha) \cdot WPE)$. When it is desired to achieve a large printing width (PW) with only a limited number of printing engines the angle α can be calculated from the formula above.

[0054] E.g. for a printer with printing width 80 cm, 3

printing engine each with width 30 cm, the angle α is minimally 27°.

[0055] In figure 4, the five printing engines are considered as a set of printing engines. Such a set of printing engines can be used to print a single colour and when this is in fact done, then a colour printer according to this invention comprises, multiple sets of printing engines, e.g., one set for each colour to be printed, arranged as shown in figure 4. For example, a printer according to the second specific embodiment of this invention, wherein each set of printing engines print only one colour, will for printing four colours, e.g., yellow, magenta, cyan and black (YMCK), comprise four sets of printing engines. These sets can then be located one after another and the substrates moves past said four sets, but since each set prints the totality of a line at once in one colour, the printer is still a single pass printer. In such a printer each of said four sets of printing engines is preferably coupled to a central unit for controlling and monitoring the developer according to this invention.

[0056] The printing engines, used in this invention, are preferably electro(stato)graphic printing engines and especially electrophotographic and direct electrostatic printing (DEP) engines. Preferably the printing engines are direct electrostatic printing engines. Typical DEP devices useful for implementing the present invention have been disclosed in, e.g. EP-A 675 417, EP-A 708 386, EP-A 710 897, EP-A 710 898, EP-A 731 394, EP-A 736 822, US-A-5 539 438, US-A-5 202 704, US-A-5 283 594, US-A-5 036 341, US-A-5 374 949, US-A-4 814 796, US-A-5 204 696, US-A-5 327 169, etc.

[0057] In a very preferred embodiment of the invention, a large format printer using at least two printing engines coupled to a central conditioning unit has DEP engines as described in European Application 98202607.2 filed on August 3, 1998.

[0058] A schematic, non-limitative, example of a large format printer incorporating a central conditioning unit according to this invention and having at least 2 DEP engines (engines for Direct Electrostatic Printing) each with printing width WPE smaller than the printing width of the printer is shown in figure 5. The printer comprises means for moving a substrate (109) to be printed in the direction of arrow A at linear speed LSS, and means for fixing (110) the toner image to the substrate. Two identical DEP engines (100a and 100b) are shown, coupled to a single central conditioning unit. Each of the DEP engines has a back electrode (105) located on the same first side of the substrate to be printed, the back electrodes are kept at a DC-voltage (V4). This voltage is preferably the same in all DEP engines present in the printer. On the second side of the substrate, in each DEP engine a population of charged toner particles, is generated in a magnetic brush assembly (104), with a non-magnetic sleeve (104b) and a magnetic core (104a). By means of a DC-field (V5) and/or an AC-field (AC1), charged toner particles are jumped from said sleeve (104b) of the magnetic brush (104), rotating in

the direction of arrow C with a linear surface speed, LSM to the surface (103a) of a Charged Toner Conveyer (CTC) (103), that has a radius R and that rotates in the direction of arrow B at a linear surface speed. The surface of the CTC is kept at a DC voltage (V1) and/or an AC voltage (AC2). The DC voltage (V1) on the surface of the CTC is different from the DC voltage (V4) on the back electrode. Thus a propulsion field is created between the surface of the CTC and the back electrode wherein a flow (111) of charged toner particles from the CTC to the back electrode is created. A printhead structure (106) comprising printing apertures (107) and a common shield electrode (106b) is placed in that flow. The surface of the CTC is moved near the printing apertures (107) to bring said charged toner particles in the development zone (113). This development zone is the space between the surface of the CTC and printhead structure wherein the propulsion field creates said flow (111) of toner particles towards an image receiving member (109) to be printed. Around each printer aperture a control electrode is present, applying an image-wise varying DC voltage (V3) to control electrodes (106a) around the printing apertures, the strength of the propulsion field can be changed so as to let said charged toner particles image-wise pass the printing apertures. The remaining charged toner particles are further displaced downstream of the printing zone to a cleaning station (114, 115) in which the non-used toner particles are completely removed from the surface of said CTC to have a bare surface again. Then the CTC moves further on towards the magnetic brush, located upstream of the development zone where again a fresh population of charged toner particles, wherein no wrong sign toner particles are present, is provided on the surface of the CTC. During printing developer is circulated from the container (122) of the central conditioning unit to the containers for developer (101) of each of the printing engines by means (116, 116a, 116b) for moving the developer through outlet (121) and distribution box (121') and from said containers for developer (101) back to the container (122) in the central conditioning unit through outlets (120) in the containers (101) and collecting box (120'). The means for moving the developer are equipped so as to have at any moment during printing at most 25 % by volume of the developer is present in the active portion of the containers (101a, and 101b) of the printing engines while at least 75 % are continuously circulated through the central conditioning unit for keeping its condition constant. The container (122) is further coupled to a vessel (119) containing fresh toner particles, said vessel being coupled to said container over valve (119a) that can selectively be opened and closed. The container (122) is coupled to means for monitoring the condition of the developer i.e. to means for measuring the ratio of toner to carrier particles (118) and/or the charge of the toner particles. The means for measuring the ratio of toner to carrier particles (118) and/or the charge of the toner particles are coupled to the valve

(119a) for selectively opening and closing said valve depending on the measured result and the intended one. Optionally said means for measuring the ratio of toner to carrier particles (118) and/or the charge of the toner particles can be coupled to the mixing means (117) so that also the mixing can be used to control the charge of the toner particles to a predetermined constant value.

[0059] The non-used toner particles that have been removed by collecting means (114, 115) from the CTC in every printing unit are recycled to the single central conditioning unit by means (116b) for moving the non-used toner over a collecting box (115')

[0060] The location and/or form of the shield electrode (106b) and the control electrode (106a) can, in other embodiments of a device for a DEP method using toner particles according to the present invention, be different from the location shown in fig. 5.

[0061] Although in fig. 5 an embodiment of a device for a DEP method using two electrodes (106a and 106b) on printhead 106 is shown, it is possible to implement a DEP method, using toner particles according to the present invention using devices with different constructions of the printhead (106). It is, e.g. possible to implement a DEP method with a device having a printhead comprising only one electrode structure as well as with a device having a printhead comprising more than two electrode structures. The apertures in these printhead structures can have a constant diameter, or can have a broader entrance or exit diameter.

[0062] The back electrode (105) of this DEP device can also be made to co-operate with the printhead structure, said back electrode being constructed from different styli or wires that are galvanically isolated and connected to a voltage source as disclosed in e.g. US-A-4,568,955 and US-A-4,733,256. The back electrode, co-operating with the printhead structure, can also comprise one or more flexible PCB's (Printed Circuit Board).

[0063] Between said printhead structure (106) and the charged toner conveyer (103) as well as between the control electrode around the apertures (107) and the back electrode (105) behind the toner receiving member (109) as well as on the single electrode surface or between the plural electrode surfaces of said printhead structure (106) different electrical fields are applied. In the specific embodiment of a device, useful for a DEP method, using a printing device with a geometry according to the present invention, shown in fig 5. voltage V1 is applied to the sleeve of the charged toner conveyer 103, voltage V2 to the shield electrode 106b, voltages V3₀ up to V3_n for the control electrode (106a). The value of V3 is selected, according to the modulation of the image forming signals, between the values V3₀ and V3_n, on a time basis or grey-level basis. Voltage V4 is applied to the back electrode behind the toner receiving member. In other embodiments of the present invention multiple voltages V2₀ to V2_n and/or V4₀ to V4_n can be used. Voltage V5 is applied to the surface of the sleeve of the

magnetic brush.

[0064] In a DEP device according to the present invention an additional AC-source can beneficially be connected to the sleeve of said magnetic brush.

[0065] The magnetic brush 104 preferentially used in a DEP device according to the present invention is of the type with stationary core and rotating sleeve.

[0066] In a DEP device, according to a preferred embodiment of the present invention, any type of known carrier particles and toner particles can successfully be used. It is however preferred to use "soft" magnetic carrier particles. "Soft" magnetic carrier particles useful in a DEP device according to a preferred embodiment of the present invention are soft ferrite carrier particles. Such soft ferrite particles exhibit only a small amount of remanent behaviour, characterised in coercivity values ranging from about 4 kA/m up to 20 kA/m (50 up to 250 Oe). Further very useful soft magnetic carrier particles, for use in a DEP device according to a preferred embodiment of the present invention, are composite carrier particles, comprising a resin binder and a mixture of two magnetites having a different particle size as described in EP-B 289 663. The particle size of both magnetites will vary between 0.05 and 3 µm. The carrier particles have preferably an average volume diameter (d_{v50}) between 10 and 300 µm, preferably between 20 and 100 µm. More detailed descriptions of carrier particles, as mentioned above, can be found in EP-A-675 417.

[0067] It is preferred to use in a DEP device according to the present invention, toner particles with an absolute average charge over mass ratio ($|q/m|$) corresponding to $5 \mu\text{C/g} \leq |q/m| \leq 15 \mu\text{C/g}$, preferably to $8 \mu\text{C/g} \leq |q/m| \leq 11 \mu\text{C/g}$. The charge to mass ratio of the toner particles is measured by mixing the toner particles with carrier particles, and after 15 min of charging the q/m-ratio is measured with a device such as the Toshiba TB-200 blow-off tester. In this disclosure the charge to mass ratio is taken as the absolute value, as a DEP device according to this invention can function either with negatively charged toner particles or with positively charged toner particles depending on the polarity of the potential difference between V1 and V4. Preferably the toner particles used in a device according to the present invention have an average volume diameter (d_{v50}) between 1 and 20 µm, more preferably between 3 and 15 µm. More detailed descriptions of toner particles, as mentioned above, can be found in EP A 675 417 that is incorporated herein by reference.

[0068] It is preferred in large format printers using at least two printing engines coupled to a central conditioning unit according to this invention, not-only to prevent changes in toner concentration in the different printing units, but also to use toner particles with a narrow charge distribution, i.e. the charge of the toner particles shows a distribution wherein the coefficient of variability (v), i.e. the ratio of the standard deviation to the average value, is equal to or lower than 0.4 preferably lower than 0.3. The charge distribution of the toner

particles is measured by an apparatus sold by Dr. R. Epping PES-Laboratorium D-8056 Neufahrn, Germany under the name "q-meter. In, e.g., US-A-5 569 567, US-A-5 622 803 and US-A-5 532 097 it is disclosed how to prepare both negatively and positively chargeable toner particles with narrow charge distribution. It is a preferred embodiment of the invention to use toner particles prepared according to the method described in these disclosures.

[0069] A DEP device making use of the above mentioned marking toner particles can be addressed in a way that enables it to give black and white. It can thus be operated in a "binary way", useful for black and white text and graphics and useful for classical bi-level half-toning to render continuous tone images.

[0070] A large format printer according to this invention using DEP devices is especially suited for rendering an image with a plurality of grey levels. Grey level printing can be controlled by either an amplitude modulation of the voltage V3 applied on the control electrode, 106a or by a time modulation of V3. By changing the duty cycle of the time modulation at a specific frequency, it is possible to print accurately fine differences in grey levels. It is also possible to control the grey level printing by a combination of an amplitude modulation and a time modulation of the voltage V3, applied on the control electrode.

[0071] The combination of a high spatial resolution and of the multiple grey level capabilities typical for DEP, opens the way for multilevel half-toning techniques, such as e.g. described in EP-A-634 862 with title "Screening method for a rendering device having restricted density resolution". This enables the DEP device, according to the present invention, to render high quality images.

[0072] The embodiment of a large format printer with a central development unit according to this invention as schematically shown in figure 5, i.e. wherein the printing proceeds with DEP engines and with a two-component developer comprising magnetic carrier particles and non-magnetic toner particles and wherein the non-used toner particles are recycled in the printing process is the most preferred embodiment of the invention. In an other preferred embodiment of the present invention the outlet of developer in the individual printing engines (120a, 120b, 120c) is used as transportation help in the recovery system for non-used toner, thus the ducts (115a, 115b, 115c) for non-used toner are led in the outlet of developer in the individual printing engines (120a, 120b, 120c) so that said recovered toner particles can be transported to said central conditioning station with the aid of said developer material that also has to be transported to said central conditioning unit. It is equally well suitable to lead the outlets of developer in the individual printing engines (120a, 120b, 120c) directly to the collecting means (114, 115) of the different printing units and transporting said combined used developer and recuperated toner to said central conditioning unit.

[0073] Nevertheless large format printers with a central conditioning unit according to this invention wherein the non-used toner particles are not recycled and only the developer is circulated from the central conditioning unit to the printing engines and back are within the scope of the present invention.

[0074] Also large format printers with a central conditioning unit according to this invention (in which toner particles are conditioned and/or pre-charged) using DEP engines printing with non-magnetic mono-component developer are within the scope of the present invention.

[0075] As said above, large format printers using at least two printing engines coupled to a central conditioning unit according to this invention, can be implemented with classical electrophotographic printing engines. Examples of such printers are described in figures 4 and 5 of EP-A-849 087 that is incorporated herein by reference. In figure 6 a large format single pass four colour printer using at least two electrophotographic printing engines equipped with central conditioning units according to this invention is shown. The printer comprises means (108) to move the substrate (109) in web form, withdrawn from a roll (109') in the direction of arrow A and means (110) to fix the toner image to the substrate. The printer is shown with only two printing stations (engines) (100a and b), each having an intermediate toner receiving member (206a and b), rotating in the direction of the arrow. The stations (100a and b) comprise further, arranged around each of the intermediate members (206a and b), electrophotographic engines (Y, M, C, K), for each colour, that image-wise deliver toner particles to the intermediate member. Each of the electrophotographic engines comprises a photoconductive drum (201), rotating in the direction of the arrow. The photoconductive drum contacts the intermediate member (206) or is arranged very close to it. Around each photoconductive drum are arranged in the direction of rotation : a cleaning unit (202), a charging unit (203), an exposure unit (204) and a toner delivering unit (205). The toner delivering unit (205) of each of the electrophotographic engines the in printing engines (100a and 100b) containing developer of the same colour are connected to a central conditioning unit according to this invention. In the figure only the connections of the engine printing the yellow colour (Y) are shown. During printing developer is circulated from the container (122) of the central conditioning unit to the toner delivering unit (205) of each of the printing engines printing the yellow image (Y) by means (116, 116a, 116b) for moving the developer through outlet (121) and distribution box (121') and from said toner delivering unit (205) back to the container (122) in the central conditioning unit through outlets (120) in the toner delivering unit (205) and collecting box (120'). The means for moving the developer are equipped so as to have at any moment during printing at most 25 % by volume of the developer is present in the active portion of

the toner delivering unit (205) of the printing engines while at least 75 % are continuously circulated through the central conditioning unit for keeping its condition constant. The container (122) is further coupled to a vessel (119) containing fresh toner particles, said vessel being coupled to said container over valve (119a) that can selectively be opened and closed. The container (122) is coupled to means for monitoring the condition of the developer i.e. to means for measuring the ratio of toner to carrier particles (118) and/or the charge of the toner particles. The means for measuring the ratio of toner to carrier particles (118) and/or the charge of the toner particles are coupled to the valve (119a) for selectively opening and closing said valve depending on the measured result and the intended one. Optionally said means for measuring the ratio of toner to carrier particles (118) and/or the charge of the toner particles can be coupled to the mixing means (117) so that also the mixing can be used to control the charge of the toner particles to a predetermined constant value.

[0076] The non-used toner particles that have been removed in the cleaning unit (202) are recycled to the single central conditioning unit by means (116b) for moving the non-used toner over a collecting box (115'). Transfer means (not shown), e.g. a transfer corona, can be incorporated in the printing engines to assist both the transfer of the toner particles from the latent image bearing member to the intermediate member and from the intermediate member to the substrate to be printed. Only the coupling of the electrophotographic printing engines for printing the yellow image to the central conditioning unit are shown in the figure. The three other central conditioning units are very schematically shown and are marked M, K, C to indicate that these are coupled to the printing engines printing the magenta, cyan and black image respectively.

[0077] It is e.g. possible to take an electrophotographic printing engine as the Xeikon DCP/50D for which the multiple development stations are made more compact and less expensive and for which both magnetic brush assemblies with the same colour developer (e.g. front side of page and back side of page) are fed from a single central conditioning unit where a monitoring and regulation of the toner concentration takes place. Also an implementation in which no dual sided printing takes place but in which multiple magnetic brush assemblies are staggered with respect to each other in order to obtain a much larger printing width (e.g. 3 units staggered in order to obtain an electrophotographic full colour printing press with printing width of 1.5 m in which all 3 units - or 6 units for a recto-verso version - are fed from a single container for developer in which toner concentration is monitored and adapted) falls within the scope of the present invention.

[0078] In a moving shuttle-type printer wherein the shuttle has a wide printing width and carries at least two printing engines so that a large format image is written in separate image bands (swaths), can be implemented

with a central conditioning unit according to this invention when the printing engines on the shuttle printing the same colour are coupled to a central conditioning unit. Such a printer has been disclosed in EP-A-849 087. An implementation according to the present invention has the additional benefit that said moving shuttle system does not need multiple heavy developer supplies, so that its movement can be made less complicated and less expensive thanks to said central conditioning unit that can be placed on the moving parts of the shuttle printer, but preferably it is NOT placed upon said moving parts of said shuttle type printer. The shuttle is travelling over the image receiving member (substrate) in a first direction, preferably a direction that is essentially parallel to the width of the substrate to be printed. After having printed a single band over the width of the substrate, the substrate is moved in a direction different from said first direction, over a length corresponding to the width of the printhead structure and toner delivering means. The shuttle can have a printing width of at least 30 cm, preferably the shuttle has a printing width of at least 40 cm, more preferably 60 cm, and for printing very large substrate in a short printing time, even at least 120 cm. This is different from the shuttling printers known in the art while by a shuttle of this invention broader bands can be printed. This means that even with a fairly low shuttling speed of the printer a large format print can be made in a short time. Such a shuttling printer can very beneficially be used for printing images of very large dimension (e.g. > 5 meter width) with a very high printing speed (e.g. > 500 m²/hour).

[0079] A shuttle according to the present invention can, e.g., comprises three printing engines with a width of, e.g., 0.3 m, that are staggered and mounted in a shuttle in such a way that the three engines shuttle together without changing their relative positions to each other. Such a printer makes it possible, when the shuttling proceeds with the longest dimension of the shuttling printers (i.e. in this example 0.9 m width) perpendicular to the width of the large substrate, to print in one shuttle movement a band that is 0.9 m wide. It is clear that such a shuttle can be constructed with less or more printing engines, with wider or smaller engines, etc., without going beyond the scope of this invention.

[0080] In figure 7, a schematic view of a printer with shuttling printing engines is shown as a projection of the shuttle in the plane of the substrate (109) to be printed.

[0081] The shuttle (112), comprising 3 printing engines (100a, b and c), the respective engines having a width WPEa, b and c, moves over the width (WS) of the substrate to be printed in the direction of arrow B, and after having printed a single band over the width of the substrate, the substrate is moved in the direction of arrow A over a length corresponding to the working width (i.e. the width of the band (swath width of the shuttle, SWS) that can be printed) of the shuttle (112). The shuttle returns in a direction opposite to arrow B and prints the next swath.

EXAMPLES

[0082] Throughout the printing examples, the same developer, comprising toner and carrier particles was used.

The carrier particles

[0083] A macroscopic "soft" ferrite carrier consisting of a MgZn-ferrite with average particle size 50 μm , a magnetisation at saturation of 36 $\mu\text{Tm}^3/\text{kg}$ (29 emu/g) was provided with a 1 μm thick acrylic coating. The material showed virtually no remanence.

The toner particles

[0084] The toner used for the experiment had the following composition : 97 parts of a co-polyester resin of fumaric acid and bispropoxylated bisphenol A, having an acid value of 18 and volume resistivity of 5.1×10^{16} ohm.cm was melt-blended for 30 minutes at 110° C in a laboratory kneader with 3 parts of Cu-phthalocyanine pigment (Colour Index PB 15:3). A resistivity decreasing substance - having the following formula : $(\text{CH}_3)_3\text{N}^+\text{C}_{16}\text{H}_{33} \text{Br}^-$ was added in a quantity of 0.5 % with respect to the binder, as described in WO-A-94/027192.

[0085] After cooling, the solidified mass was pulverised and milled using an ALPINE Fließbettgegenstrahlmühle type 100AFG (trade name) and further classified using an ALPINE multiplex zig-zag classifier type 100MZR (trade name). The average particle size was measured by Coulter Counter model Multisizer (trade name), was found to be 6.3 μm by number and 8.2 μm by volume. In order to improve the flowability of the toner mass, the toner particles were mixed with 0.5 % of hydrophobic colloidal silica particles (BET-value 130 m^2/g).

The developer

[0086] An electrostatographic developer was prepared by mixing said mixture of toner particles and colloidal silica in a 9 % ratio (wt/wt) with carrier particles. The triboelectric charging of the toner-carrier mixture was performed by mixing said mixture in a standard tumbling set-up for 10 min. The developer mixture was run in the magnetic brush for 5 minutes, after which the toner was sampled and the tribo-electric properties were measured using the Toshiba TB-200 blow-off device, resulting in a q/m-ratio of -14 $\mu\text{C}/\text{g}$.

The printhead structure (106)

[0087] A printhead structure (106) was made from a polyimide film of 50 μm thickness, double sided coated with a 5 μm thick copper film. The printhead structure (106) had two rows of printing apertures. On the back

side of the printhead structure, facing the image receiving member, a rectangular shaped control electrode (106a) was arranged around each aperture. Each of said control electrodes was connected over 2 M Ω resistors to a HV 507 (trade name) high voltage switching IC, commercially available through Supertex, USA, that was powered from a high voltage power amplifier. The printing apertures were rectangular shaped with dimensions of 360 by 120 μm . The dimension of the central part of the rectangular shaped copper control electrodes was 500 by 260 μm . The apertures were spaced so to obtain a resolution of 33 dots/cm (85 dpi). On the front side of the printhead structure, facing the charged toner conveyer roller, a common shield electrode (106b) was arranged around the aperture zone leaving a free polyimide zone of 1620 μm . Said printhead structure was fabricated in the following way. First of all the control and shield electrode pattern was etched by conventional copper etching techniques. The apertures were made by a step and repeat focused excimer laser making use of the control electrode patterns as focusing aid. After excimer burning the printhead structure was cleaned by a short isotropic plasma etching cleaning. Finally a thin coating of PLASTIK70, commercially available from Kontakt Chemie, was applied over the control electrode side of said printhead structure.

Container for developer

[0088] A large container for developer was used equipped with mixing means so that 20 kg of developer was constantly shaken. A smaller amount of developer was pumped by transport screws to the individual magnetic brush assemblies. No toner monitoring device was present in said container for developer. Regulation of said toner concentration was done by calculating the amount of toner printed from the image signals and adding an amount of 102 % of said calculated removed toner concentration. (It was found that about 2% of said calculated toner amount "disappeared" in the printing process).

The charged toner conveyer (CTC)

[0089] The CTC was a cylinder with a sleeve made of aluminium, coated with TEFLON (trade name of Du Pont, Wilmington, USA) with a surface roughness of 2.2 μm (Ra-value) and a diameter of 30 mm. The charged toner conveyer (103) was connected to an AC power supply (AC1) with a square wave oscillating field between 1750 V peak to peak at a frequency of 3.0 kHz with +50 V DC-offset. Said CTC was equipped with a stainless steel scraper blade removing all remaining toner particles from said CTC-surface and collecting said removed toner particles by means of a developer transport to a single container for developer.

Magnetic brush assembly (MB)

[0090] Charged toner particles were propelled to this conveyer from a stationary core (104a)/rotating sleeve (104b) type magnetic brush (104) comprising two mixing rods and one metering roller. One rod was used to transport the developer through the unit, the other one to mix toner with developer.

[0091] The magnetic brush 104 was constituted of the so called magnetic roller, which in this case contained inside the roller assembly a stationary magnetic core (104a), having three magnetic poles with an open position (no magnetic poles present) to enable used developer to fall off from the magnetic roller (open position was one quarter of the perimeter and located at the position opposite to said CTC (103). The magnetic brush was so constructed that during operation fresh developer was pumped into its developer container at such a large flux that a large amount of developer was also falling out of the magnetic brush again. Said amount of "exhausted" developer falling out of said magnetic brush assembly was pumped over the scraper blade means in said charged toner conveyer to said container for developer in which 20 kg of developer was present. The sleeve (104b) of said magnetic brush had a diameter of 20 mm and was made of stainless steel roughened with a fine grain to assist in transport ($R_a=3 \mu\text{m}$) and showed an external magnetic field strength in the zone between said magnetic brush and said CTC of 0.045 T, measured at the outer surface of the sleeve of the magnetic brush. The magnetic brush was connected to a DC power supply with a -50 V DC-offset.

[0092] A scraper blade was used to force developer to leave the magnetic roller. On the other side a doctoring blade was used to meter a small amount of developer onto the surface of said magnetic brush. The sleeve was rotating at a linear surface speed (LSM) four times higher than the linear surface speed (LSC) of said CTC roller, and in a direction opposite to the rotation direction of said CTC-roller.

The reference surface of said CTC was placed at a distance between 650 μm from the reference surface of said magnetic brush.

The printing engine

[0093] A printhead structure, mounted in a PVC-frame, was bent with frictional contact over the surface of the roller of the charged toner conveyer roller. A 50 μm (this is distance d) thick polyurethane coating was used as self-regulating spacer means (110). The printhead structure in combination with the charged toner conveyer, the magnetic brush, the scraper-blade with toner recovery, the developer supply to said magnetic brush and the developer "recuperation" in said magnetic brush, was combined in a single frame, called "printing unit". Three of said printing units were staggered on 2 lines, without overlap so as to obtain a printing width of

46 cm (using printhead structures having a printing width of 154 mm).

[0094] A single back electrode was present behind the paper whereon the printing proceeded, the distance between the back electrode (105) and the back side of the printhead structure (d_B) was set to 1000 μm and the paper travelled a linear speed (LSM) of 200 cm/min. The back electrode was connected to a high voltage power supply, applying a voltage V_4 of + 1000 V to the back electrode.

[0095] The shield electrodes 106b were grounded : $V_2 = 0 \text{ V}$. To the individual control electrodes an (image-wise) voltage V_3 between 0 V and +280 V was applied.

Measurement of printing quality

[0096] A printout made on paper with a DEP device and developer described above, was judged for homogeneity of the image density and possible banding after a long printing run.

[0097] Image banding could not be observed with this printing device. As a comparative example a printout was made with the same configuration but now the toner concentration was regulated for each magnetic brush assembly separately. After many meters of printing the "structure" of the 3 printing units, building the total printout, became clearly visible in the printing result.

[0098] It must be clear for those skilled in the art that many other implementations of cleaning, recovery and mixing systems can be provided without departing from the spirit of the present invention.

Claims

1. A large format , single pass printer, having a printing width (PW) for printing a toner image on a substrate, the substrate having a width (WS) and a length (LS), wherein, a number n, equal to or larger than 2, of printing engines each with a container for developer, said container having an active portion and with a printing width PWE_i , in a direction of a longitudinal axis, smaller than said printing width PW is provided, said number n being chosen such that

$$\sum_{i=1}^{i=n} PWE_i \geq PW,$$

characterised in that

- i) a single central conditioning unit for controlling and monitoring the condition of the developer is provided, and
- ii) said central conditioning unit is equipped with means for circulating said developer to all of

said n printing engines and back to said central unit.

2. A large format printer according to claim 1, wherein said printing engines further comprise means for collecting non-used toner particles and said central condition unit is equipped to receive said non-used toner particles and with means for mixing said non-used toner particles with said circulating developer. 5
3. A large format printer according to claim 1 or 2, wherein at least two of said longitudinal axis do not coincide. 10
4. A large format printer according to any of claims 1 to 3, wherein said means for circulating said developer from said central conditioning unit to all of said n printing engines and back to said central unit are equipped as to have at any moment during printing at most 25 % by volume of the developer present in the active portion of the containers of the printing engines while at least 75 % are continuously circulated through said central conditioning unit. 15 20
5. A large format printer according to any of claims 1 to 4, wherein said printing engines are devices for direct electrostatic printing. 25
6. A large format printer according to claim 5, wherein said devices for direct electrostatic printing use two-component developer containing magnetic carrier particles and non-magnetic toner particles. 30
7. A large format printer according to claim 5, wherein said devices for direct electrostatic printing use non-magnetic mono-component developer. 35
8. A large format printer according to any of claims 1 to 4, wherein said printing engines are electrophotographic units. 40
9. A large format printer, with printing width (PW), for printing a toner image on a substrate, having a width (WS) and a length (LS), comprising : 45
 - i) means for moving said substrate a first direction,
 - ii) means for moving a shuttle having a swath width, SWS, in a second direction, different from said first direction, said shuttle carrying a number n, equal to or larger than 2, of printing engines, each with a printing width PWE_i , in a direction of a longitudinal axis, smaller than said swath width, SWS, said number n being chosen such that 50 55

$$\sum_{i=1}^{i=n} PWE_i \geq PW,$$

characterised in that
a single central conditioning unit for controlling and monitoring the condition of the developer is provided, and said central conditioning unit is further equipped with means for circulating said developer to all of said n printing engines and back to said central unit.

10. A large format printer according to claim 9, wherein at least two of said longitudinal axis do not coincide.

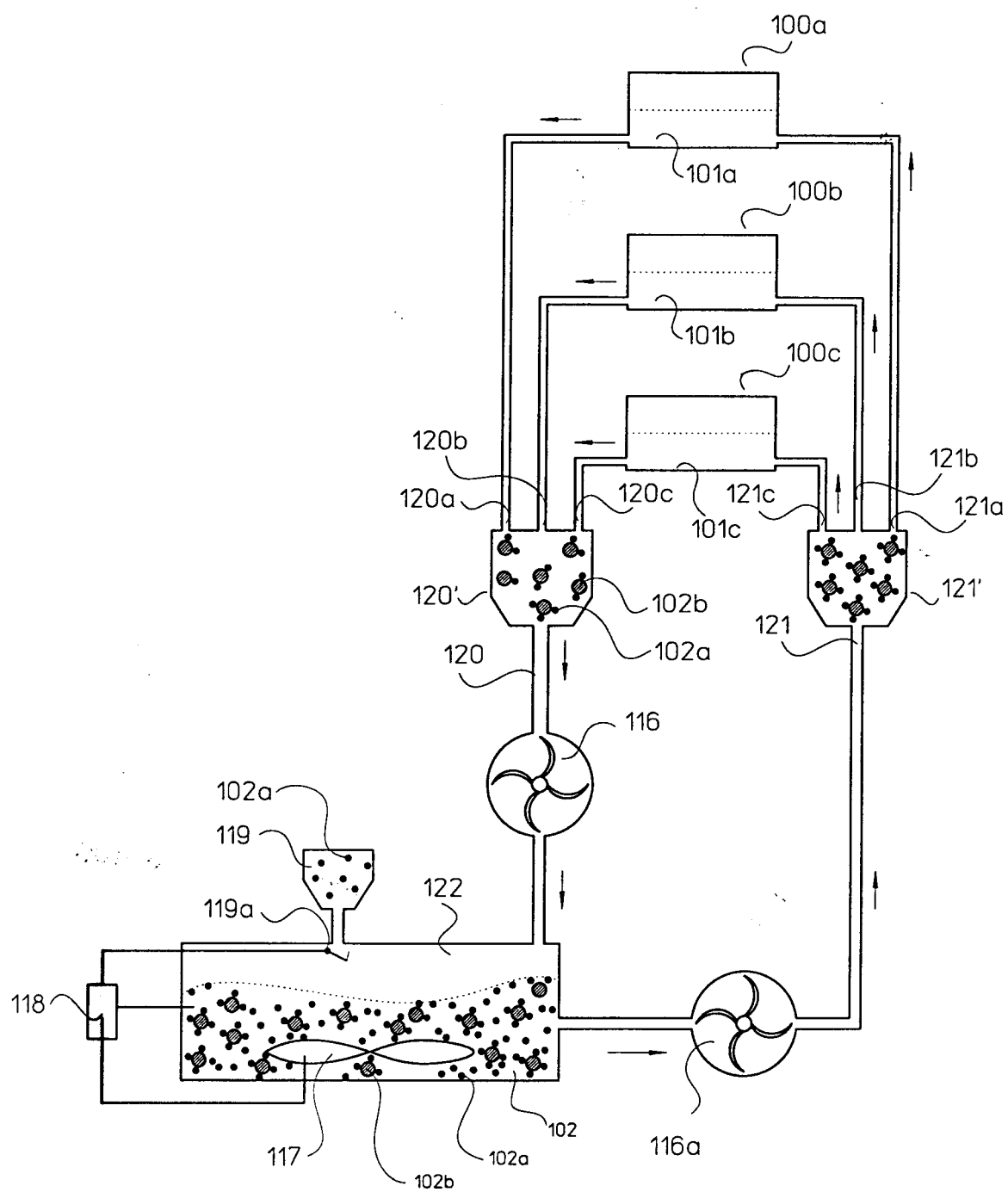


Fig. 1

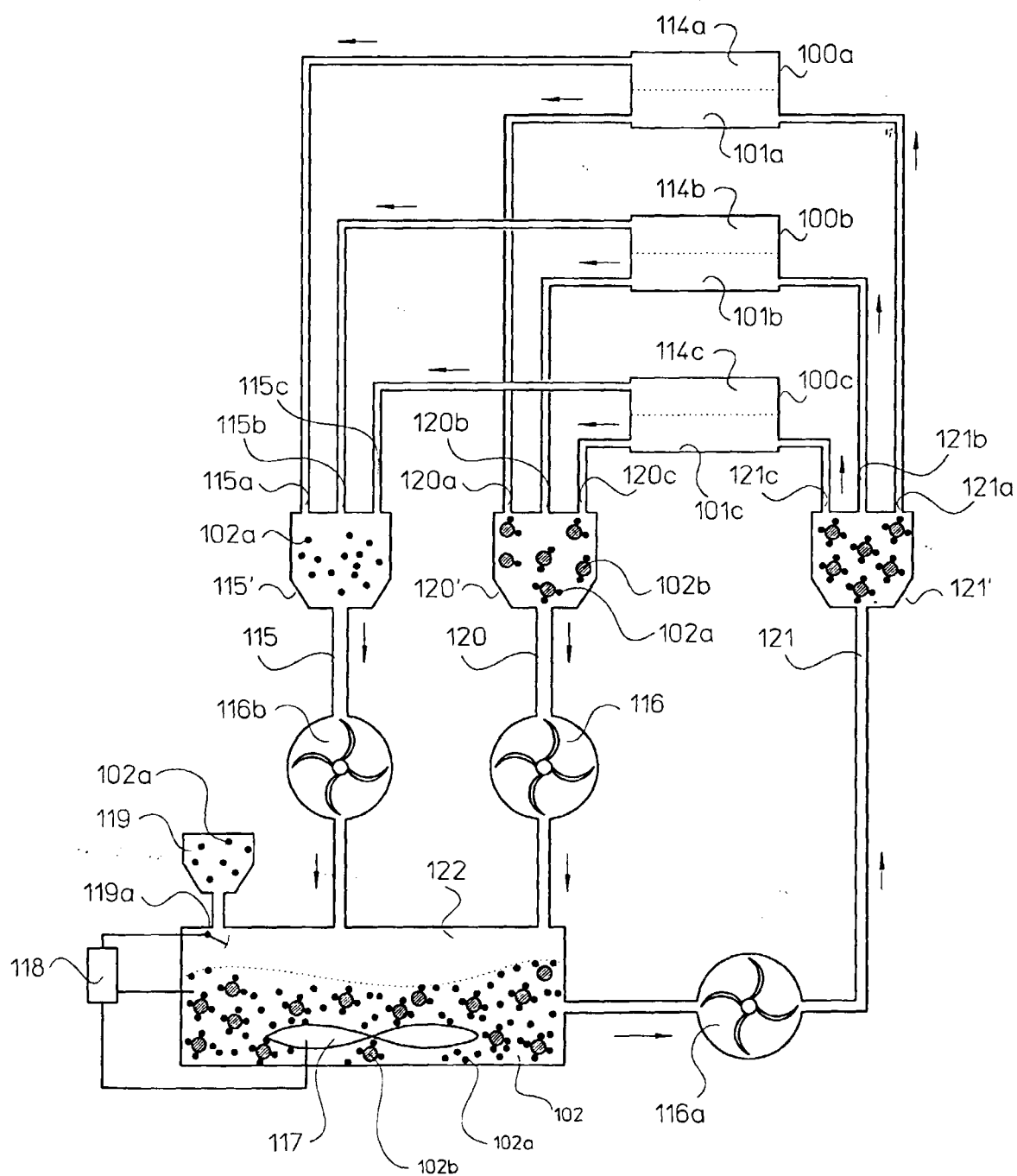


Fig. 2

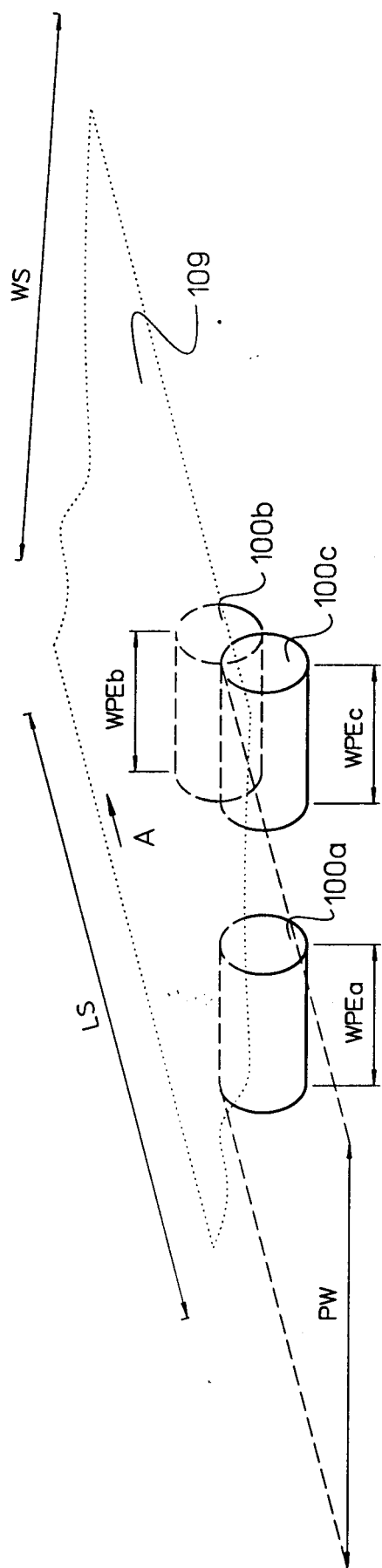


Fig. 3

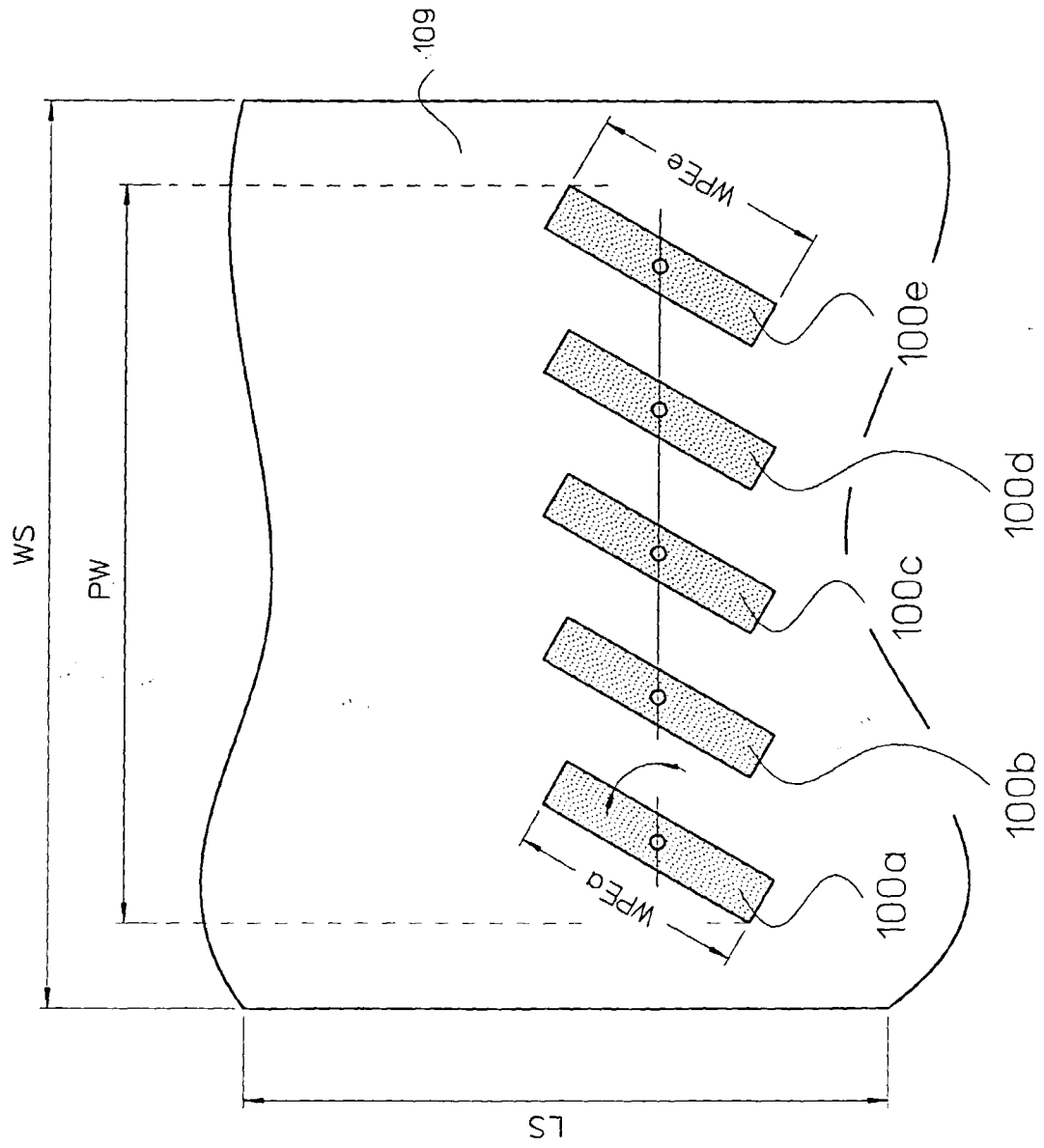
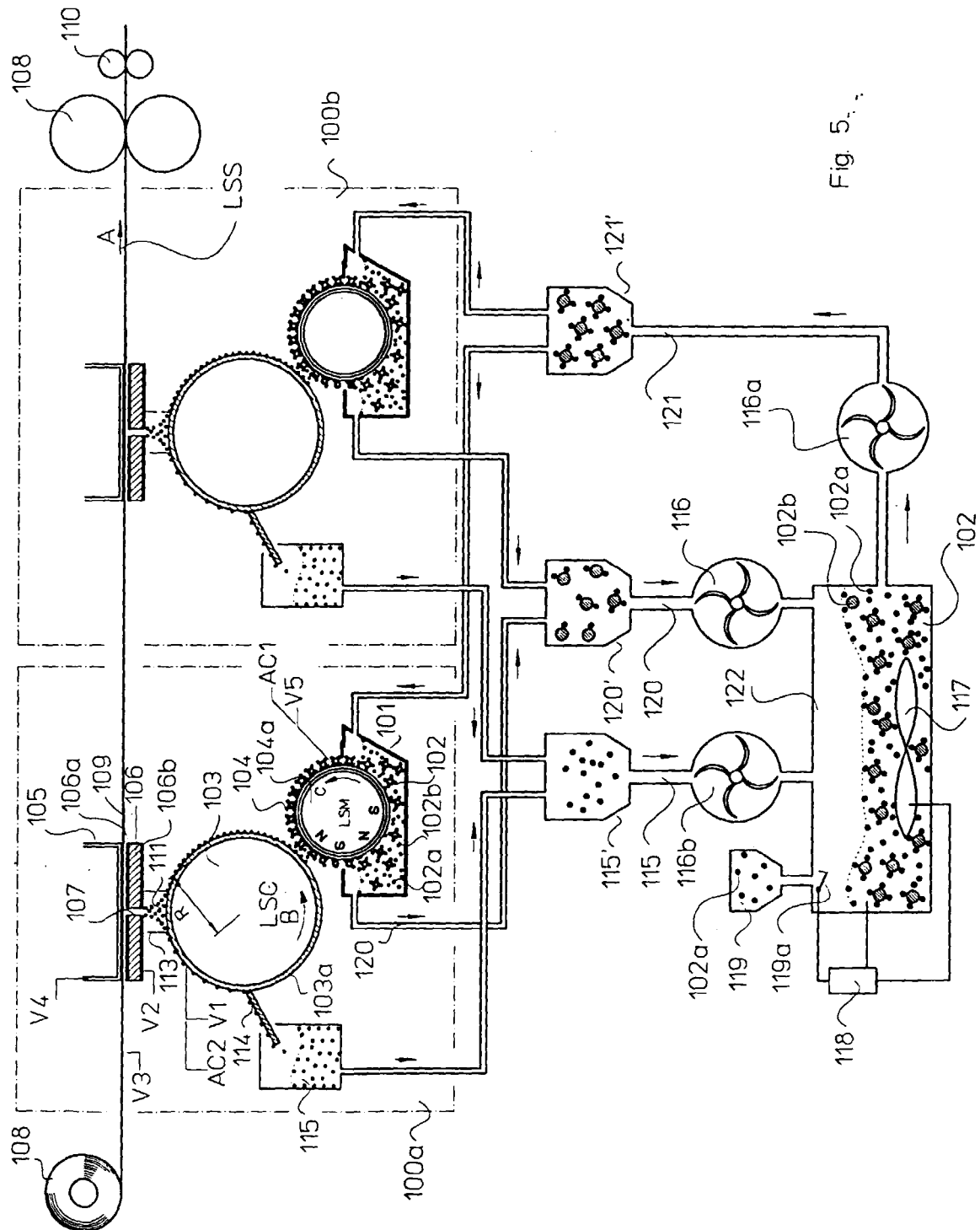


Fig. 4



உதிர்தல்

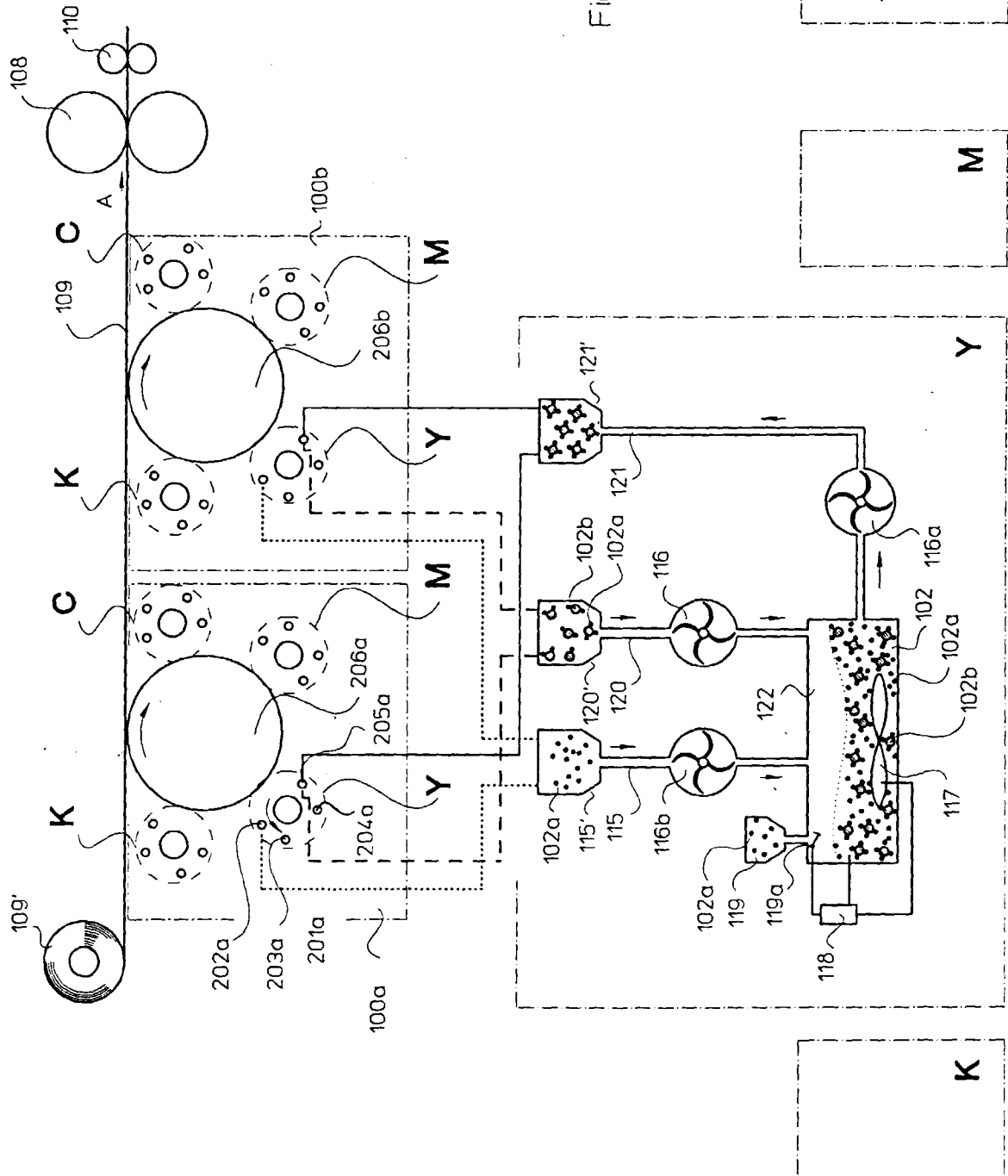


Fig. 6

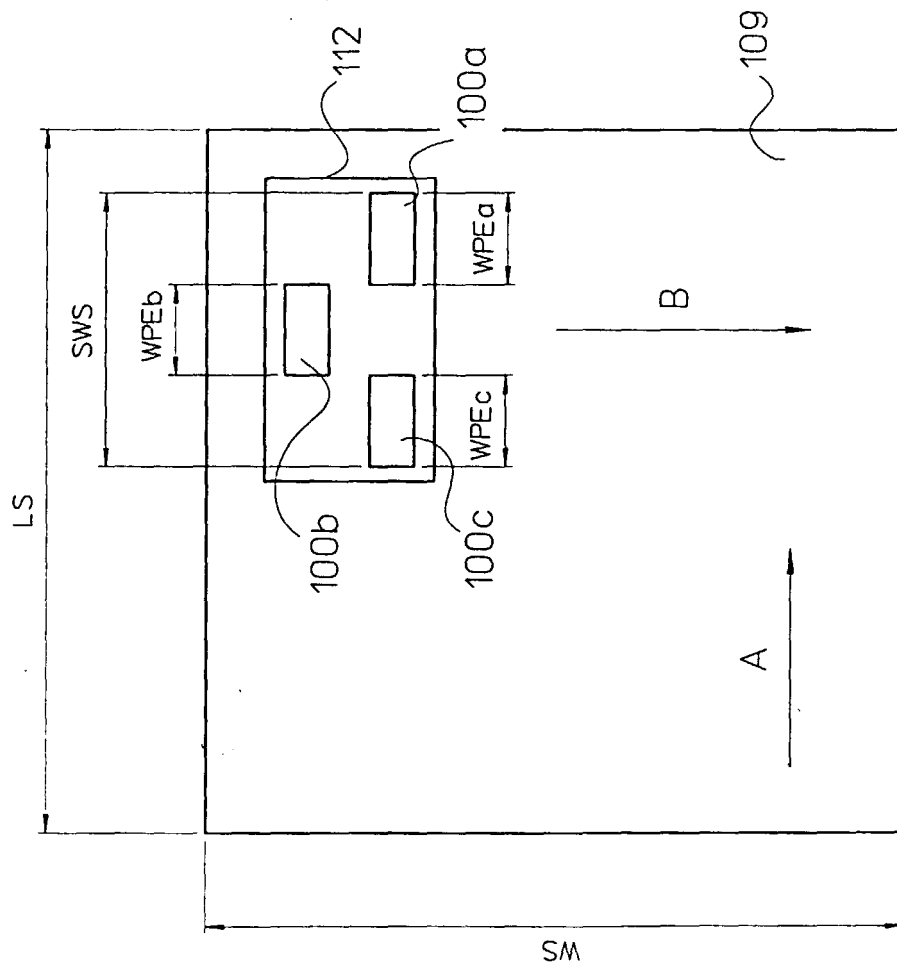


Fig. 7



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 20 3008

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
D,A	EP 0 849 645 A (AGFA GEVAERT NV) 24 June 1998 * the whole document *	1,3,5-7, 9,10	G03G15/08 G03G15/34
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A	US 5 797 074 A (MURAMATSU SATOSHI ET AL) 18 August 1998 * the whole document *	1,2,6-9	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			G03G B41J
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 8 February 1999	Examiner Lipp, G
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 98 20 3008

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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08-02-1999

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