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[Continued on next page]

(54) **Title:** PRINTING SYSTEM AND METHOD

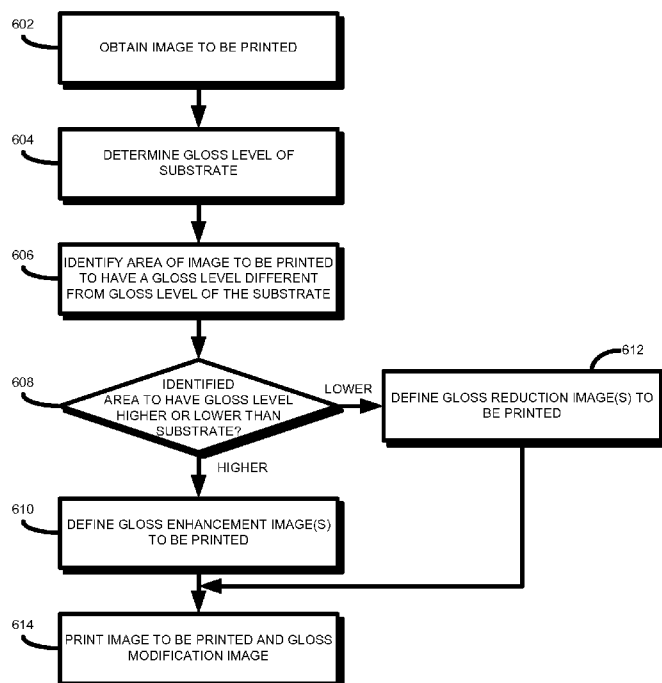


FIGURE 6

(57) **Abstract:** According to one example, there is provided a method of printing. The method comprises generating a gloss modification image based on a substrate gloss level and a desired gloss level for a portion of the image, and printing the image and the gloss modification image on the substrate.



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PRINTING SYSTEM AND METHOD

BACKGROUND

Modern digital printing systems are capable of producing high quality printed
5 images on a wide-range of substrates. However, in addition to the quality of
the printed image, the level of glossiness (hereinafter referred to as gloss
level) of the printed image is important from an aesthetic aspect.

The gloss level of a printed image is largely determined by the surface
10 properties of the substrate on which an image is printed and the properties of
the ink used. Substrates usually have a substantially uniform gloss level
across their surface. Varnish may also be applied to change the gloss level of
a printed image or a portion thereof.

BRIEF DESCRIPTION

Examples, or embodiments, of the invention will now be described, by way of
non-limiting example only, with reference to the accompanying drawings, in
which:

Figure 1 is a simplified illustration of a printing system according to one
20 example;

Figure 2 is a simplified illustration of a liquid electro-photographic printing
system according to one example;

Figure 3a illustrates a magnified cross section view of a portion of a substrate;

Figure 3b illustrates a magnified cross section view of a portion of a substrate;

25 Figure 4 is a simplified block diagram of a printer controller according to one
example;

Figure 5 illustrates an image to be printed according to one example;

Figure 6 is a flow diagram outlining a method of operating a printing system
according to one example;

30 Figure 7 illustrates a magnified cross section view of a portion of a substrate
of which the gloss level of a portion of a printed image has been increased
according to one example;

Figure 8 illustrates a gloss reduction pattern according to one example;

Figure 9 illustrates a magnified cross section view of a portion of a substrate of which the gloss level of a portion of a printed image has been reduced according to one example;

Figure 10 shows a graph illustrating the relationship between the gloss level of a printed image portion and the number of gloss enhancement and reduction
5 images used according to one example; and

Figure 11 is a flow diagram outlining a method of operating a printing system according to one example.

10 **DETAILED DESCRIPTION**

As already mentioned, the gloss level of a printed image is determined largely by the surface properties of the substrate on which an image is printed and the properties of the ink used. For water-based inkjet printing and liquid
15 electro-photographic (LEP) printing systems images printed on glossy substrates will have a glossy appearance, and images printed on matte substrates will have a matte appearance. Images printed using xerography techniques, however, substantially modify the substrate surface properties making the gloss level of such images less dependent on the type of substrate.

20

Figure 12 shows a series of photographs that demonstrate the effect of printing an image on a paper substrate using both an LEP printing system and a xerographic printing system.

25 Figure 12a shows a microscopic level image of a typical plain office paper substrate.

Figure 12b shows a microscopic level image of an LEP image printed on such a substrate. As can be seen, the surface characteristics of the printed image
30 do not dramatically modification the surface properties of the substrate.

Figure 12c shows a microscopic level image of a xerographic printed image printed on the same type of substrate. As can be seen the xerographic image dramatically modifies the surface properties of the substrate.

An image, or a portion thereof, printed on a matte substrate may have its gloss level modified by applying a varnish layer. However, such printing systems require the use of additional printheads or varnish applicators to
5 apply a solid layer of varnish.

The gloss level of a varnished area is largely determined by the characteristics of the varnish and the surface characteristics of the substrate. Accordingly, such systems are not able to produce varying gloss levels within
10 a single printed image. Furthermore, such systems do not allow for a gloss level of portion of a printed image to be specified, and do not allow a desired variable gloss level to be achieved.

There is, however, significant value, both aesthetically and commercially, in
15 being able to select, prior to printing an image, a desired gloss level for a portion of the image, and producing a printed image at least a portion of which has the desired gloss level.

Examples described herein provide a printing system and a method of
20 operating a printing system that enables a printed image to be produced such that a portion of a printed image has a desired gloss level. Furthermore, the desired gloss level may be higher or lower than the gloss level of the substrate on which the image is printed and may also be higher or lower than other portions of the printed image.

25 Referring now to Figure 1, there is shown a simplified illustration of a printing system 100 according to one example. The printing system 100 comprises a print engine 102 for printing on a substrate, such as a substrate 104. The substrate 104 is advanced through a print zone 105 of the print engine 102 by
30 a substrate advance mechanism 108.

The operation of the printing system 100 is generally controlled by a printer controller 110.

In one example the print engine 102 is a liquid electro-photographic (LEP) print engine, an example of which is shown in greater detail in Figure 2.

5 In this example the print engine 102 comprises a rotatable photoconductor drum 202 on which an electrical charge is developed by a charging module 204, as the drum 202 rotates. A light imaging module 206 selectively shines light, such as laser light, on different portions of the drum 202 to selectively dissipate electrical charges in accordance with an image, or an image
10 separation, to be printed. In this way a latent image is produced on the photoconductor drum 202 comprising charged and non-charged regions. The latent image is developed by a binary image developer (BID) 208 which provides liquid ink, such as Hewlett-Packard's ElectroInk, in proximity to the surface of the drum 202 such that ink from the BID 208 is electrostatically
15 transferred to the surface of the drum 202 in accordance with the latent image produced thereon.

The ink developed on the drum 202 is electrostatically transferred to a heated intermediate transfer member (ITM) 210. In one example the ITM 210 may be
20 heated to around 100 degrees Celsius. Carrier liquid of the transferred image is evaporated leaving an image film having a high percentage of ink solids on the ITM 210. The image film is then transferred to a substrate 214 positioned on an impression roller 212 through the application of pressure between the impression roller 212 and the ITM 210.

25 Typically an LEP image printed in this way has a thickness in the order of about 2 to 10 microns.

In full colour printing, multiple images are each developed using a different
30 colour ink (such as a cyan ink, a yellow ink, a magenta ink, and black ink), and may be generated and transferred separately to a substrate to produce a full colour image. In other examples multiple colour image separations may be

generated on the ITM 210 and transferred in a single transfer step to a substrate 214.

5 The thinness of an LEP image film created on the ITM 210 is such that when the image film is transferred to a substrate the image film substantially follows the surface profile of the substrate. In this way, the gloss level of the printed image substantially matches the gloss level of the substrate, as is illustrated in Figure 3.

10 Figure 3a illustrates a magnified cross section view of a portion of a substrate 302. The upper surface of the substrate 302 has a high degree of surface smoothness which gives the substrate 302 a glossy appearance. A layer of LEP image film 304 printed on the upper surface of the substrate 302 closely follows the surface profile of the substrate, and hence the printed image 304
15 also exhibits glossy finish.

Figure 3b illustrates a magnified cross section view of a substrate 306. The upper surface of the substrate 306 has a degree of unevenness or roughness which gives the substrate 302 a matte appearance. A layer of LEP image film
20 308 printed on the upper surface of the substrate 306 closely follows the surface profile of the substrate, and hence the printed image 308 exhibits a matte finish.

As previously described, the printing system 100 is generally controlled by a
25 printer controller 110 which is shown in more detail in Figure 4. The controller 110 comprises a processor 402 such as a microprocessor, a microcontroller, a computer processor, or the like. The processor 402 is in communication with a memory 406 via a communication bus 404. The memory 406 stores computer understandable instructions 408 that, when executed by the
30 processor 402 cause the controller 110 to operate the printing system 100 in accordance with the methods described below and as illustrated in Figure 6 and 10.

An example of operating a printing system to generate a printed image having a portion that has desired gloss level that is different from the gloss level of the substrate on which the image is printed is described below with additional reference to Figure 5.

5

At block 602 (Figure 6) the controller 110 obtains an image to be printed. The image to be printed is defined in a suitable digital form, for example in a print job file. The print job file may be suitably generated by a raster image processor (RIP), a graphic design computer application, a computer printer driver, or other appropriate means.

10

As shown in Figure 5, first image layer 502 is defined that describes an image to be printed 504. The image 504 includes a portion that is to be printed such it has a desired gloss level when printed.

15

The portion of the image that is to be printed to have a desired gloss level is defined in a second image layer 506, which defines a portion 508 to have a desired gloss level. In one example the portion 508 may correspond to the whole of the image to be printed 504. In one example the desired gloss level of the portion 508 is defined in gloss units.

20

It should be noted that the defined gloss level of the portion 508 is an absolute gloss level, and is not dependent on the gloss level of the substrate on which the image is to be printed.

25

At block 604 the controller 110 determines the gloss level of a substrate on which the obtained image is to be printed. In one example the gloss level of the substrate is obtained from a user through a user interface (not shown) provided on the printing system 100. In another example the gloss level of the substrate is determined from a glossmeter (not shown) which is appropriately positioned in the substrate path of the printing system. In another example the gloss level of the substrate is determined by reading, using a suitable imaging

30

device, a computer readable code, such as a barcode, printed on the substrate.

At block 606 the controller 110 determines, from the image layer 506, the
5 desired gloss level of the portion 508 of the image to be printed 504.

At block 608 the controller 110 determines whether the desired gloss level of the portion 508 is higher or lower than the determined gloss level of the substrate.

10

If the controller 110 determines that the desired gloss level of the portion 508 is higher than the determined gloss level of the substrate, the controller 110 generates (610) one or multiple gloss enhancement images to be printed corresponding to the portion 508. Details of the gloss enhancement image(s)
15 are given further below.

20

If the controller 110 determines that the desired gloss level of the portion 508 is lower than the determined gloss level of the substrate, the controller 110 generates (612) one or multiple gloss reduction images to be printed corresponding to the portion 508. Details of the gloss reduction image(s) are
given further below.

25

At block 614 the controller 110 controls the printing system 100 to print the obtained image to be printed and to print the generated gloss enhancement or gloss reduction image or images. In this way, the area of the printed image defined to have a desired gloss level exhibits the, or substantially the, desired gloss level.

30

In one example the gloss enhancement and reduction images are images to be printed on top of (i.e. are printed after) the portion 508. In another example the gloss enhancement and reduction images are printed beneath (i.e. are printed before) the portion 508.

If the gloss level of the portion 508 is determined to be higher than the gloss level of the substrate the controller 110 generates one or multiple gloss enhancement images to be printed. In one example each gloss enhancement image is a copy of the portion of the image to be printed 504 that corresponds to the portion 508. In other words, the portion of the image to be printed 504 that is to have a higher gloss level than the substrate will be overprinted, with the same image content, one or multiple times.

In another example each gloss enhancement image may be defined to be printed in a transparent ink or varnish. In one example each gloss enhancement image is a solid fill image.

The effect of printing one or multiple additional image layers is illustrated in Figure 7. Figure 7 illustrates a magnified cross section view of a substrate 702 the upper surface of which has a degree of unevenness or roughness which gives the substrate 702 a surface having a low gloss level. In the portion 508 multiple gloss enhancement images (706a to 706n) have been overprinted on the printed image 704. As shown, each successive gloss enhancement image 704 that is printed reduces the surface roughness, and hence increases the gloss level of the portion 508 to the, or to substantially the, desired gloss level defined for the portion 508.

The relationship between the gloss level of a printed image and the number of gloss enhancement images printed can be determined through testing, for example taking into account factors including: ink characteristics; initial substrate gloss level; substrate type; and so on. Figure 10 shows a graph illustrating (line 1002) the relationship between the number of gloss enhancement images printed and the gloss level of the image portion 508, for a given ink and a given substrate. In one example the number of gloss enhancement images may be in the range of about 1 to 50, depending on the desired gloss level to be achieved. In other examples, however, a greater number of gloss enhancement images may be useful.

As can be seen, as additional gloss enhancement images are printed, the gloss level of the gloss enhanced region increases. In the example shown, at a certain point the rate of improvement in gloss level reduces as the number of additional gloss enhancement layers are printed.

5

This data may be stored, for example, in a lookup table in a memory or other storage media, and used by the controller 110 to determine the number of gloss enhancement images to be printed given the desired gloss level of the image portion 508 and the gloss level of the substrate on which the image is to be printed.

10

If the gloss level of the portion 508 is determined to be lower than the gloss level of the substrate the controller 110 generates one or multiple gloss reduction images to be printed. In one example each gloss reduction image is a modified copy of the portion of the image to be printed 504 that corresponds to the portion 508. In other words, the portion of the image to be printed 504 that is to have a lower gloss level than the substrate will be overprinted with the modified image content one or multiple times.

15

In one example the modified image content is obtained by masking the area to be overprinted with a gloss reduction mask or pattern, as described below. In another example each gloss reduction image may be based on the gloss reduction mask.

20

An example gloss reduction pattern or mask 802 is illustrated in Figure 8. The gloss reduction pattern 802 comprises a pattern of printing fluid marks, or dots, to be printed 804. The pattern of marks is arranged such that when printed the gloss level of the printed gloss reduction image is lower than the gloss level of the image on which the gloss reduction image is printed.

25

30

In this example the dots to be printed 804 are arranged in a regular pattern, and each dot to be printed 804 is surrounded by an area not to be printed 806. The density of the pattern of dots to be printed may be varied, but in some

examples be in the range of about 30 to 80% density (where 100% density is a solid fill area). In other examples other gloss reduction patterns may be used, such as patterns having a non-regular arrangement of dots to be printed 804. In other examples patterns other than round dots may be used, for example rectangular or oval dots.

The effect of printing a gloss reduction pattern 802 on a glossy substrate is illustrated in Figure 9. The gloss reduction pattern increases the surface roughness which reduces specular reflection of light, and hence reduces the gloss level of the area printed with the gloss reduction pattern 802.

Overprinting a gloss reduction pattern 802 multiple times further increases surface roughness and further reduces the gloss level of the area printed.

The relationship between the gloss level of a printed image and the number of gloss reduction images printed can be determined through testing, for example taking factors including: ink characteristics; initial substrate gloss level; substrate type; and so on. Figure 10 shows a graph illustrating (line 1004) the relationship between the number of gloss reduction images printed and the gloss level of the gloss reduced portion, for a given ink and a given substrate.

As can be seen, as additional gloss reduction images are printed, the gloss level of the gloss enhanced region increases. In the example shown, at a certain point the rate of decrease in gloss level reduces as the number of additional gloss reduction layers are printed.

This data may be stored, for example, in a lookup table in a memory or other storage media, and used by the controller 110 to determine the number of gloss reduction images to be printed given the desired gloss level of the image portion 508 and the gloss level of the substrate on which the image is to be printed.

The gloss enhancement and gloss reduction images are referred to herein as gloss modification images.

In a further example, further improvements in the level of gloss enhancement can be achieved by increasing the length of time between an image and associated gloss enhancement image or image being printed and the ink becoming set. For example, in an LEP printing system the ink setting time may be increased by keeping the ink above a predetermined temperature after transfer of the printed image from the ITM 210 (Figure 2) to the substrate 214 has occurred. In a printing system using UV curable inks, the ink setting time may be increased by delaying complete curing of a portion of the image corresponding to a gloss enhancement image. In both cases, increasing the ink setting time allows the ink to more fully settle, and have less surface roughness, before becoming set.

Advantageously, in an LEP printing system such as the HP Indigo range of digital presses, the ink setting time may be increased by operating the printing system in accordance with the additional method steps outlined in the flow diagram of Figure 11, and without requiring any hardware modifications.

At block 1102 the controller 110 determines, in addition to the gloss enhancement image(s) to be printed, an increase in the ink setting time after the image to be printed and one or multiple gloss enhancement images have been printed. In a HP Indigo type digital press, an increase in the ink setting time may be achieved by making use of so-called null disengage cycles. A null disengage cycle is where the impression roller 212 is mechanically disengaged, or distanced, from ITM (210) such that as the impression roller 212 rotates no contact is made between substrate 214 held on the impression roller 212 and the ITM 210. During a null disengage cycle, no image is developed on the photoconductor drum 202, and hence no image is transferred to the ITM 210. However, the ITM 210 is maintained hot, and the distance between the ITM 210 and the impression roller 212 is small enough

that ink previously transferred on to a substrate held on the impression roller remains heated by the ITM 210.

5 By performing one or multiple null disengage cycles in this way allows the ink setting time of the ink printed on the substrate 212 to be increased, hence further increasing the overall gloss level of the printed image.

10 As before, testing will indicate the relationship between the number of null disengage cycles used and the level of gloss enhancement for particular ink and substrate combinations. An example of the increase in gloss level based on a number of null disengage cycles is shown as line 1006 in Figure 10. Again, this data may be stored in a suitable memory or lookup table, thus allowing the controller 110 to determine a number of gloss enhancement
15 images to be printed and a number of zero or more null disengage cycles to be used in combination to generate a printed image with a portion thereof having a desired gloss level.

At block 1104, the controller 110 controls the printer to perform the determined number of null disengage cycles.

20 In printing systems that use UV curable ink the controller 110 may controller a UV curing module to use a combination of gloss enhancement images and the delaying of the curing of the whole or a portion of a printed image to produce a printed image having the desired gloss level.

25 Although the examples above have been described primarily with reference to LEP printing systems, it will be appreciated that the techniques described herein may be applied to other printing system that generate a printed image that forms a distinct ink layer on top of a substrate surface. Examples of such
30 printing technology include liquid electro-photographic (LEP) printing technology, and inkjet ultra-violet (UV) curable printing technology. Other printing technology, such as aqueous inkjet printing technology, in which ink is absorbed into a porous substrate surface and hence does not form a distinct

ink layer on top of a substrate, are not considered suitable types of print engine.

It will be appreciated that examples and embodiments of the present invention
5 can be realized in the form of hardware, software or a combination of
hardware and software. As described above, any such software may be
stored in the form of volatile or non-volatile storage such as, for example, a
storage device like a ROM, whether erasable or rewritable or not, or in the
form of memory such as, for example, RAM, memory chips, device or
10 integrated circuits or on an optically or magnetically readable medium such
as, for example, a CD, DVD, magnetic disk or magnetic tape. It will be
appreciated that the storage devices and storage media are examples of
machine-readable storage that are suitable for storing a program or programs
that, when executed, implement examples of the present invention. Examples
15 of the present invention may be conveyed electronically via any medium such
as a communication signal carried over a wired or wireless connection and
examples suitably encompass the same.

All of the features disclosed in this specification (including any accompanying
20 claims, abstract and drawings), and/or all of the steps of any method or
process so disclosed, may be combined in any combination, except
combinations where at least some of such features and/or steps are mutually
exclusive.

25 Each feature disclosed in this specification (including any accompanying
claims, abstract and drawings), may be replaced by alternative features
serving the same, equivalent or similar purpose, unless expressly stated
otherwise. Thus, unless expressly stated otherwise, each feature disclosed is
one example only of a generic series of equivalent or similar features.

30

CLAIMS

1. A method of printing comprising:

generating a gloss modification image based on a substrate gloss level and a
5 desired gloss level for a portion of the image; and
printing the image and the gloss modification image on the substrate.

2. The method of claim 1, further comprising, where the desired gloss level is
higher than the substrate gloss level, generating and printing a gloss
10 enhancement image.

3. The method of claim 1, further comprising, where the desired gloss level is
less than the substrate gloss level, generating and printing a gloss reduction
15 image.

4. The method of claim 1, wherein the number of gloss modification images to
generate and to print is determined, based on the gloss level of the substrate
and the desired gloss level, from data pre-stored in a memory

20 5. The method of claim 1, wherein the step of printing prints the gloss
modification image one of: on top of the printed image; and beneath the
printed image.

6. The method of claim 2, wherein the step of generating a gloss
25 enhancement image generates an image to be printed having one of: the
same image content as the area defined to have a desired gloss level; a
transparent ink; and a varnish.

7. The method of claim 3, wherein the step of generating a gloss reduction
30 image generates a pattern of dots arranged such that when printed the gloss
level of the printed gloss reduction image is lower than the gloss level of the
image on which the gloss reduction image is printed.

8. The method of claim 1, wherein the step of printing is performed using one of: a liquid electro-photographic (LEP) printer; and an ink jet printer using ultra-violet curable ink.

5 9. The method of claim 2, wherein the step of printing is performed using a liquid electro-photographic (LEP) printing system, and wherein the ink setting time of a printed gloss enhancement image is increase by using null disengage cycles of an impression roller on which the substrate is maintained.

10 10. A printing system comprising:
a controller to:

obtain an image to be printed;

obtain data defining an area of the image and a desired gloss level of the area when printed;

15 obtain the gloss level of a substrate on which the image is to be printed;

generate, based on the gloss level of the substrate and the desired gloss level of the area, one or multiple gloss modification images; and

20 control the printing system to print the image and gloss modification images such that the area of the image when printed has substantially the desired gloss level.

11. The printing system of claim 10, wherein the controller is to:

25 generate a gloss enhancement image when it determines that the desired gloss level is higher than the substrate gloss level and to generate a gloss reduction image when it determines that the desired gloss level is lower than the substrate gloss level;

determine, using the desired gloss level and the substrate gloss level, a quantity of gloss modification images to print using data stored in a memory;

30 and

control the printing system to print the determined quantity of gloss modification layers such that the area of the image when printed has substantially the desired gloss level.

12. The printing system of claim 10, wherein the printing system is a liquid electro-photographic printing system, and wherein each gloss modification image is printed as a film of LEP ink.

5

13. The printing system of claim 1, wherein the controller is further to generate a gloss reduction image defining a pre-determined pattern of ink marks to be printed, the pattern defined to reduce the gloss level of an image on which they are printed.

10

14. The printing system of claim 12, wherein the controller is further to increase the ink setting time of printed gloss enhancement images by using one or multiple null disengage cycles.

15 15. A printed article comprising an image printed on a substrate, a portion of the printed image having a gloss level different from the gloss level of the substrate; wherein the portion of the printed image comprises one or multiple printed gloss modification images arranged to modify the gloss level of the portion.

20

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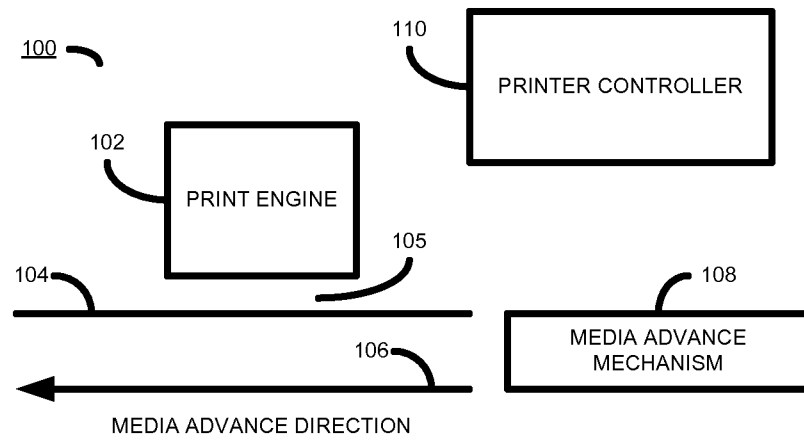


FIGURE 1

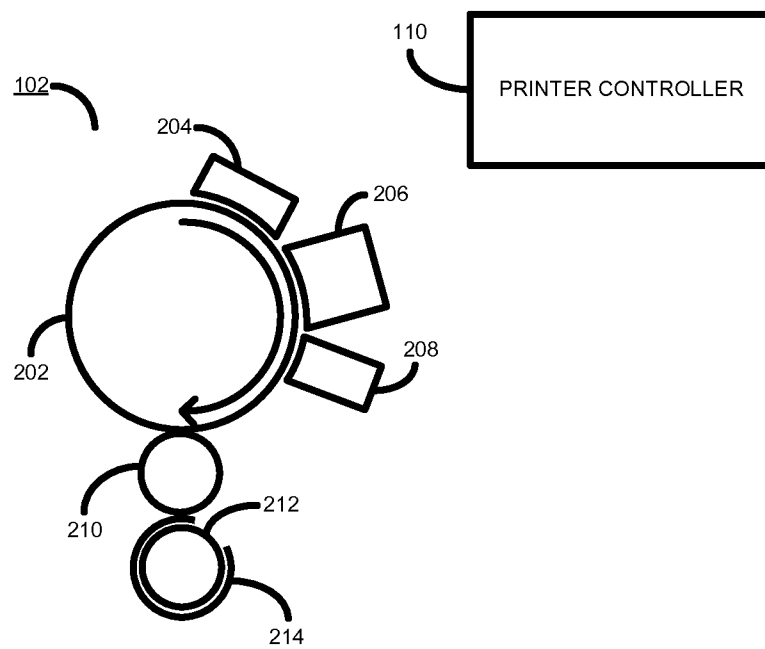


FIGURE 2

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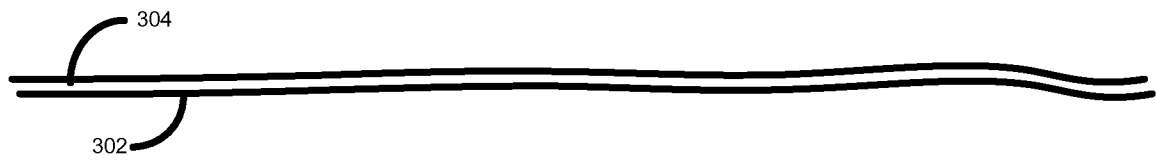


FIGURE 3a

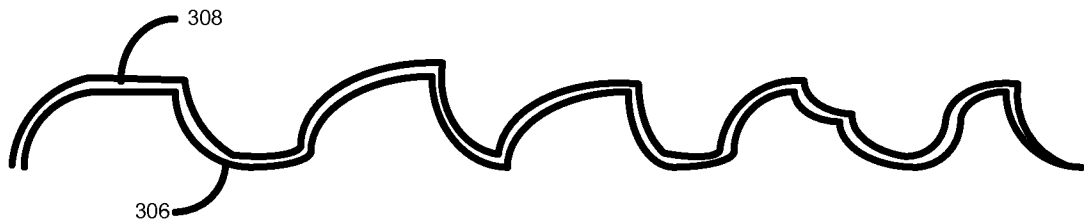


FIGURE 3b

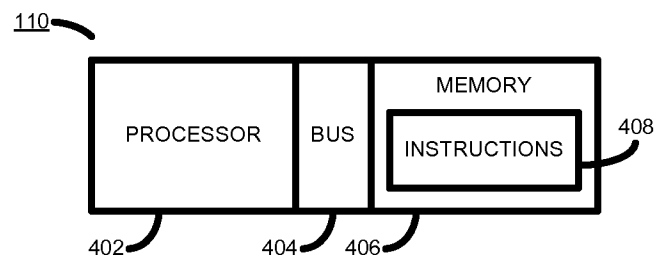


FIGURE 4

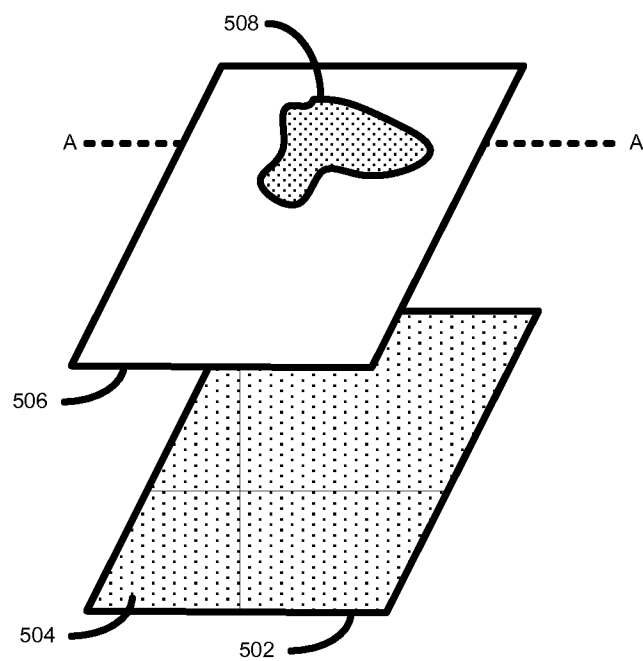


FIGURE 5

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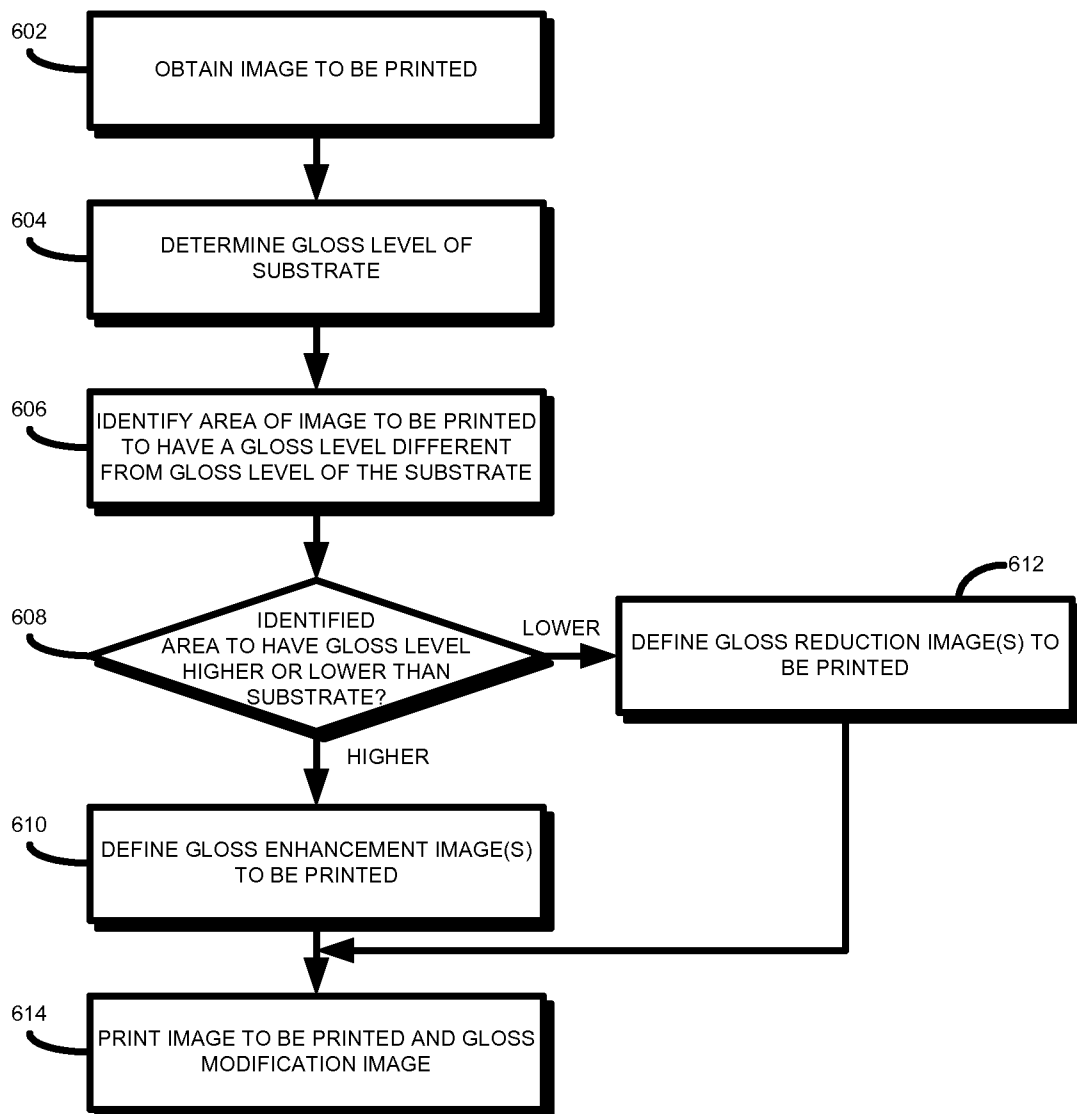


FIGURE 6

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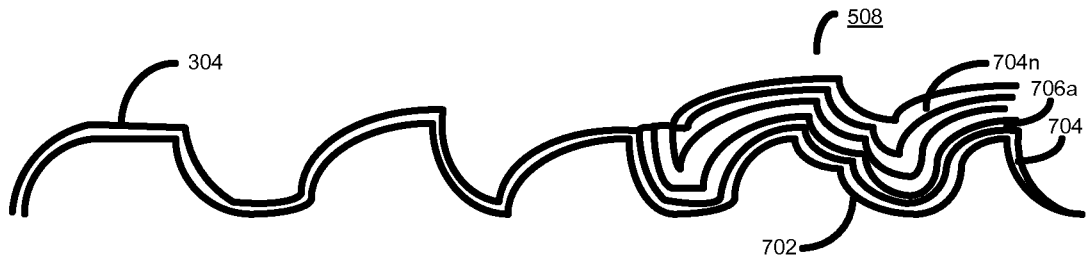


FIGURE 7

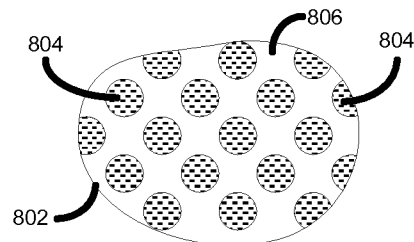


FIGURE 8



FIGURE 9

5/6

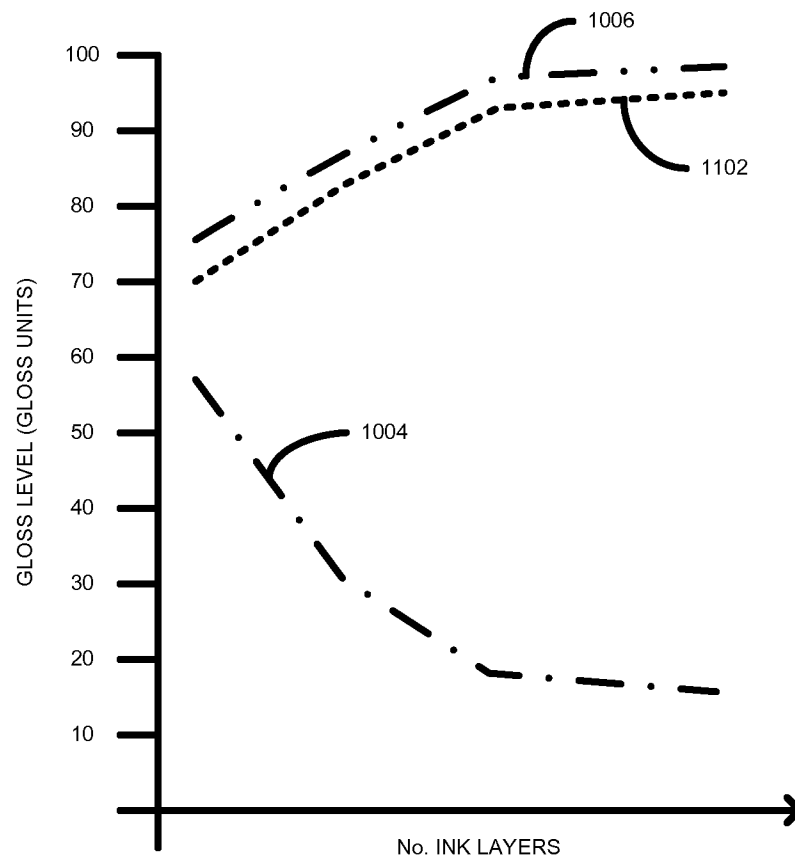


FIGURE 10

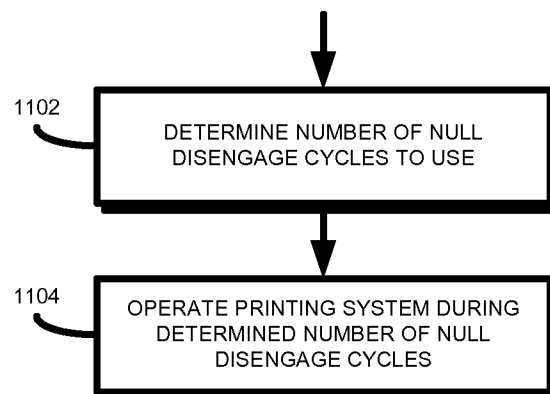


FIGURE 11

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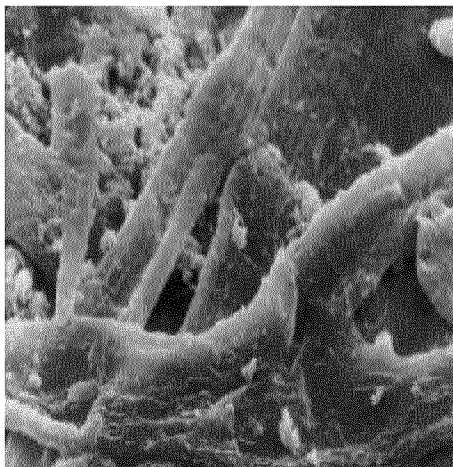


FIGURE 12a

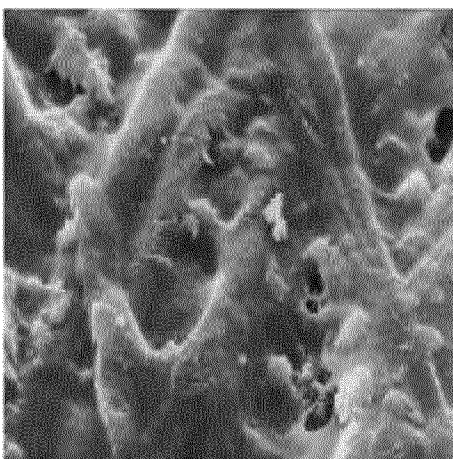


FIGURE 12b

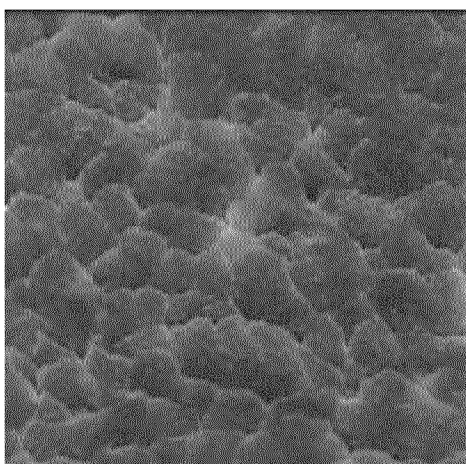


FIGURE 12c

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2012/076638

A. CLASSIFICATION OF SUBJECT MATTER
 INV. H04N1/54 B41J2/00
 ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 H04N B41J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2012/026394 A1 (CANON KK [JP]; NISHIKAWA HIROMITSU [JP]) 1 March 2012 (2012-03-01)	1-5,7, 10,11, 13,15
Y	abstract; figure all paragraphs [0002], [0009], [0010], [0014], [0072], [0073]	6,8,9, 12,14
Y	----- US 2012/223982 A1 (KONDO TAKAMITSU [JP] ET AL) 6 September 2012 (2012-09-06) abstract; figure all paragraphs [0005], [0039] - [0049], [0069] - [0080]	6,8,9, 12,14
A	----- US 2012/050365 A1 (KONNO YUJI [JP] ET AL) 1 March 2012 (2012-03-01) the whole document -----	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

24 June 2013

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2012/076638

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