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VARDESEN**; Pl. Catalunya, 1 2nd floor, E-08002 Barcelona (ES).(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,

BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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(54) Title: SELECTING COLORANT AMOUNT FOR PRINTING

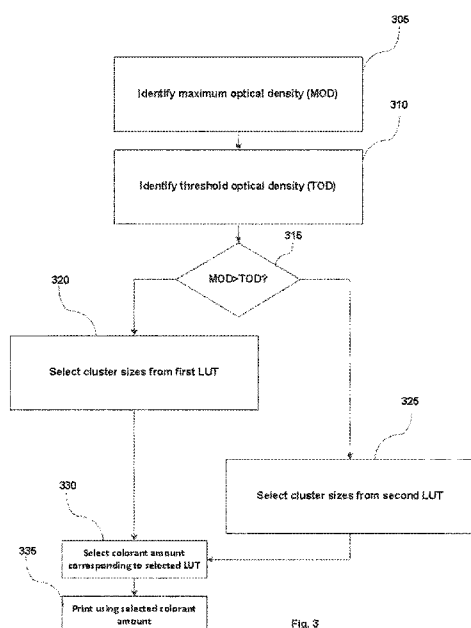


Fig. 3

(57) Abstract: A method for selecting a colorant amount for printing is described in which a maximum optical density of an image is identified. The maximum optical density is compared with a threshold optical density, and when the threshold is exceeded, dot cluster sizes from a first lookup table are selected, otherwise, dot cluster sizes from a second lookup table are selected. A colorant thickness corresponding to the selected dot cluster sizes is selected for printing the image.

Selecting colorant amount for printing

BACKGROUND

5 [001] Colorants that generally adhere to the surface of substrates, e.g. paper or plastic, with little or no penetration into the substrates are used in various printing processes and presses. Each area on the final output, i.e. the printed substrate, may include clusters of colorant dots that cover a percentage of the area. The rest of the area may remain clear, i.e. it may not be covered by
10 colorant. The number of dots per cluster attributes to the resolution of the printed image. The optical density of the image may be controlled by controlling the percentage the dots occupy on the specific area. A 100% occupation implies a cluster where the dots occupy the space of the entire area, i.e. there remains no clear area. For the same colorant, a lower
15 percentage occupation results in lower optical density compared to a higher percentage occupation that results in higher optical density.

BRIEF DESCRIPTION

20 [002] Some non-limiting examples will be described in the following with reference to the appended drawings, in which:

[003] Fig. 1 shows an area with different cluster sizes and colorant thicknesses for the same optical density;

25

[004] Fig. 2 illustrates a flow diagram of a method for printing an image on a print medium according to an example;

[005] Fig. 3 illustrates a flow diagram of a method for selecting a colorant
30 amount for printing according to an example;

[006] Fig. 4 illustrates a block diagram of a printing press according to an example.

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DETAILED DESCRIPTION

[007] When a printing press is calibrated, the cluster's thickness, i.e. the height the colorant may reach on the substrate, is determined based on the maximum theoretical optical density achieved with 100% occupation. Thereafter, a desired optical density of each area (up to the maximum optical density) may be achieved by selecting a percentage occupation (between 0% and 100%) that corresponds to the desired optical density. However, the thickness of the colorant remains the same for all clusters and for the entire image. Even for areas with low optical density (i.e. light color areas on the image), the printed cluster shall have the same colorant thickness but low percentage occupation. However, in the majority of images, the maximum desired optical density of any area of the image does not approach the maximum theoretical optical density. That means that occupation percentages close to the 100% occupation are rarely encountered.

[008] It is possible to achieve the same optical density with two (or more) distinct percentage occupations and respective distinct colorant thicknesses. Fig. 1a and 1b shows a side view and top view, respectively, of an area where the same optical density is achieved with different cluster sizes and colorant thicknesses. Area S is shown printed with two percentage occupations that both may achieve the same optical density. The thickness of the cluster T2 with the higher percentage occupation is lower compared to the thickness of the cluster T1. When a lower thickness is used, the colorant saving may be defined by the equation:

[009] $C_S = 1 - (OD_R / OD_O) * C_A$

[010] C_S is the total colorant saving, OD_R is the Optical Density of the area with 100% occupation using the lower thickness, OD_O is the Optical Density of the area using 100% occupation with the higher thickness, and C_A is the amount of colorant used due to the cluster size increase. C_A corresponds to the colorant included in the grayed area of Fig. 1b. It is noted that it may not be possible to apply the lower thickness colorant if the optical density in the image to be printed exceeds the OD_R .

[011] Fig. 2 illustrates a flow diagram of a method for printing on a print medium according to an example. In block 205 a maximum optical density of the image may be identified. If the maximum optical density of the image

approaches the maximum theoretical optical density achievable by the printing press, i.e. if an area of the image requires a percentage occupation close to 100%, then no action may be taken and printing may resume with default values. When this is not the case, a minimum compliant area size may be identified in block 210. The minimum compliant area size may be the smaller size where all areas of the image having a size equal to that size may have an average optical density up to the identified maximum optical density of the image. That is, no average optical density of any area having a size equal to that size may exceed the identified maximum optical density. To identify the minimum compliant area size, a number of area sizes may be selected. Using smaller area sizes may pose a higher risk of detecting an average optical density of a selected area that exceeds the identified maximum optical density of the image. However, smaller area sizes may allow a lower colorant thickness and thus a higher colorant saving. As the selected area size increases, the possibility of detecting an average optical density of an area that is higher than the identified maximum density of the image may decrease, but this may also be the case for the colorant saving as they may allow a higher, comparatively, colorant thickness to that of the smaller area sizes.

[012] For example, in an image, the maximum identified optical density may be found to have a value of 1.25 for a specific color. It may then be found that various area sizes may be allowable. For example, an area size of 8x8 mm may allow a first colorant thickness with colorant cluster size having a percentage occupation of 80% to achieve the 1.25 value; an area size of 4x4 mm may allow a second colorant thickness, lower than the first colorant thickness, with colorant cluster size having a percentage occupation of 90% to achieve the 1.25 value; and an area size of 2x2 mm may allow a third colorant thickness, lower than the second colorant thickness, with colorant cluster size having a percentage occupation of 95% that may achieve the 1.25 value. The 2x2 mm area size may thus be identified as the minimum compliant area size.

[013] In another example, where the maximum optical density of the image may be found to exceed the 1.25 value but not the 1.35 value, the 2x2 mm area size may not be a compliant area size. Therefore, in that case the area size of 8x8 mm may allow a first colorant thickness with colorant cluster size having a percentage occupation of 90% to achieve the 1.35 value and the area size of 4x4 mm may allow a second colorant thickness, lower than the

first colorant thickness, with colorant cluster size having a percentage occupation of 98% to achieve the 1.35 value. As a consequence, the 4x4 mm area size may be identified as the minimum compliant area size that may provide the minimum colorant thickness and, thus, the maximum colorant saving.

[014] In one example, the identification of the minimum compliant area size may be implemented by blurring the image. Various blurring masks of different size may be used to identify the minimum compliant area size. That is, starting from a smaller blurring mask and increasing the size of the blurring mask until no pixel of the blurred image may have an optical density higher than the maximum optical density of the image. However, any other technique may be used to identify the minimum compliant area size.

[015] The average optical density and the maximum optical density may belong to an average optical density range and a maximum optical density range, respectively. The minimum compliant area size may correspond to the largest area where a trained human eye may not distinct between two optical densities with values within the average optical density value range.

[016] When the minimum compliant area size is identified, then, in block 215, a colorant thickness corresponding to the identified minimum compliant area size may be selected. The colorant thickness may be lower than the default thickness. In block 220, the optical density of each area of the image having the identified minimum compliant area size may then be identified. For each area of the image having the minimum compliant area size and for the selected colorant thickness a colorant cluster size may then be identified in block 225. There are two options: either the colorant cluster size may be selected corresponding to the new selected colorant thickness, thereby having a percentage occupation higher than the default one would be if the default colorant thickness were used; or the colorant cluster size may be identified in the default colorant thickness and a correspondence table may give the actual percentage occupation for the lower thickness.

[017] This may depend on the implementation of the method. In example implementations the analysis of the image may be implemented externally to the printing press, at an image processing station, and the printing press may

simply receive instructions including the selected colorant thickness and the corresponding colorant cluster sizes for each area of the image. In other example implementations the printing press may calculate the colorant thickness and corresponding colorant cluster sizes based on the maximum optical density of the image. Finally, in block 230, the image may be printed using the identified cluster sizes.

[018] The image may be separated in various channel images, one for each basic color. In some implementations, such as in some HP Indigo Digital Presses, the basic colors may be up to seven. However, any number of channels may be used, one corresponding to each color, according to the specifications of the printing press. The process may then be repeated for each of the basic colors and each of the channel images. When an image is received, either at the printing press or at the image processing station, it may be separated in the channel images. Then each channel image may be blurred (or smoothed) with a specific window. The average optical density for each area may then be defined and the maximum compliant area size may be identified for each channel.

[019] Fig. 3 illustrates a flow diagram of a method of selecting a colorant amount for printing in a printing press. In block 305 a maximum optical density of an image may be identified. That means that an area with the maximum optical density may be detected. In block 310 a threshold optical density is identified. The threshold optical density may be equal to OD_R , i.e. the optical density of the area with 100% occupation using the lower thickness clusters. In block 315 it may be checked if the identified maximum optical density exceeds the threshold optical density. It is noted that in some implementations the thickness of the colorant may be set for the whole image after the minimum compliant area size is determined. In other implementations, the maximum optical density may be identified in contiguous areas of the image (e.g. lines) and the thickness may be modifiable per contiguous area of the image. Now, in block 320, cluster sizes from a first lookup table (LUT) may be selected when the identified maximum optical density exceeds the threshold optical density. In block 325, cluster sizes from a second lookup table may be selected when the identified maximum optical density does not exceed the threshold optical density. The first lookup table may include percentage occupations and respective colorant thickness for optical densities up to the

OD_O value, that is, optical density of the area with 100% occupation with the higher thickness. The second lookup table may include percentage occupations and respective colorant thickness for ODs up to the OD_R value, that is, optical density of the area with 100% occupation with the lower thickness. A first colorant amount may be associated with a first cluster size set and a second colorant amount may be associated with a second cluster size set. The size of clusters in the second cluster set may be higher than the size of clusters in the first cluster set for the same optical density. Accordingly, the second colorant amount may be lower than the first colorant amount. In some implementations, the printing press may include more than two lookup tables and select between them. In yet other implementations the OD_R value may be defined as a function of the maximum identified optical density and the lookup table may be calculated on the fly for the received image or image channel. In block 330 the colorant amount, i.e. the thickness of the colorant when printed on the substrate, that corresponds to the selected cluster sizes may be selected. In block 330, the printing press may then print based on the selected cluster sizes and corresponding selected colorant amount.

[020] Fig. 4 is a block diagram of a printing press according to an example. Printing press 400 may comprise a controller 405 and an image forming unit 410. The controller 405 may receive an image from an input interface of the printing press, process the image to identify a maximum optical density of an area of the image and select between a standard colorant amount and at least one reduced colorant amount. The standard colorant amount may correspond to a predetermined cluster size table 417 and the at least one reduced colorant amount may correspond to at least one increased cluster size table 419, respectively. The printing press may further comprise a memory 415 to store the predetermined cluster size table 417 and the corresponding standard colorant amount, and at least one increased cluster size table 419 and the corresponding at least one reduced colorant amount. The image forming unit 410 may receive the selected colorant amount and cluster size table and print the image on a print medium 415 based on the received selected colorant amount and respective cluster size table. Alternatively or additionally the printing press may further comprise a processing module to calculate the increased cluster table and the corresponding reduced colorant amount based on the stored predetermined cluster size table, the corresponding standard colorant amount and the maximum identified optical density of the image to be

printed.

[021] The printing press may be any type of press where colorants are not dissolved in the print medium during or after printing. For example, the printing press may be an electrophotography press, e.g. a liquid electrophotography press, or an offset press. The printing press may comprise colorant applicators 425 comprising colorant, an imaging member 420 having a surface to form a latent image of the received image thereon, and a transfer member 430. The colorant applicators 425 may receive the selected colorant amount and apply the corresponding colorant volume on the imaging member 420 to generate a colorant image on the imaging member 420. The intermediate transfer member 430 may receive the colorant image from the imaging member 420 and transfer the colorant image to the print medium 450. The print medium may be pressed against the intermediate transfer member 430 by an impression member 440.

[022] In electrophotography presses, the imaging member 420 may be a photoconductive member and the colorant applicators 425 may be binary ink developers (BIDs). The intermediate transfer member 430 may be an image transfer blanket. The impression member 430 may be an impression cylinder.

[023] In offset presses, the imaging member 420 may be an offset plate of a plate cylinder and the colorant applicators 425 may be ink rollers. The intermediate transfer member 430 may be a blanket of an offset cylinder. The impression member 440 may also be an impression cylinder.

[024] It is noted that images printed according to examples disclosed herein may be indistinguishable to images printed using the default colorant amounts. In order to identify that an image has been printed according to examples herein, a comparison between two similar images may be employed where one image includes an area with an optical density approaching the OD_0 and another image that doesn't include such an area. If the printing press has been printed according to examples herein, then the image with the OD_0 will be printed using the higher colorant thickness while the other image will be printed using the lower colorant thickness. Subsequent thickness measurements may, therefore, not be consistent something that would indicate usage of examples as disclosed herein.

[025] A similar comparison may be made at a press level by measuring the amount of colorant consumed. That is, by comparing the colorant consumed for the one image and for the other. A lower colorant consumption that may not be attributed merely to the area with an optical density approaching the OD₀ may be an indication of usage of examples disclosed herein for printing images.

CLAIMS

1. A method for printing an image on a print medium, comprising:
 - identifying a maximum optical density of the image;
 - 5 identifying a minimum compliant area size, wherein all areas of the image having a size equal to the identified minimum compliant area size have an average optical density up to the identified maximum optical density;
 - selecting a colorant thickness corresponding to the identified minimum compliant area size;
 - 10 identifying the optical density of each area of the image having the identified minimum compliant area size;
 - identifying a colorant cluster size for each area of the image having the minimum compliant area size and for the selected colorant thickness;
 - printing the image on the print medium using the identified cluster
 - 15 sizes.
2. The method according to claim 1, wherein identifying the minimum compliant area size comprises blurring the image using blurring masks of different sizes.
3. The method according to claim 2, wherein identifying the minimum area
- 20 size comprises:
 - selecting a candidate area size;
 - comparing the average optical density of each area of the image having a size equal to the candidate area size;
 - increasing the size of the candidate area size until the optical density of
 - 25 all areas having a size equal to the candidate area size falls below the maximum optical density.

4. The method according to claim 1, wherein the average optical density and the maximum optical density is an average optical density range and a maximum optical density range, respectively
- 5 5. The method according to claim 4, wherein the minimum compliant area size is identified so that any two optical density values within the average optical density range are not detectable as distinct values by a human eye.
6. A method for selecting a colorant amount for printing, comprising:
- identifying a maximum optical density of an image;
- 10 comparing the identified maximum optical density with a threshold optical density;
- selecting cluster sizes from a first lookup table when the identified maximum optical density exceeds the threshold optical density;
- selecting cluster sizes from a second lookup table when the identified
- 15 maximum optical density does not exceed the threshold optical density;
- selecting the colorant amount that corresponds to the selected cluster sizes;
- printing the image using the selected colorant amount
7. The method according to claim 6, wherein the first lookup table is
- 20 associated with a first colorant amount and the second lookup table is associated with a second colorant amount.
8. The method according to claim 7, wherein the first colorant amount is associated with a first cluster size set and the second colorant amount is associated with a second cluster size set.
- 25 9. The method according to claim 8, wherein the size of clusters in the second cluster set is higher than the size of clusters in the first cluster set for

the same optical density and the second colorant amount is lower than the first colorant amount, respectively.

10. A printing press, comprising:

5 a controller, to receive an image, identify a maximum optical density of the image and select between a standard colorant amount and at least one reduced colorant amount, wherein the standard colorant amount corresponds to a predetermined colorant cluster size table and the at least one reduced colorant amount corresponds to at least one increased cluster size table, respectively;

10 an image forming unit, to receive the selected colorant amount and respective cluster size table and print the image on a print medium based on the received colorant amount and respective cluster size table.

11. A printing press according to claim 10, further comprising a memory to store:

15 the predetermined colorant cluster table and the respective standard colorant amount, and

the at least one increased cluster tables and the respective reduced colorant amounts.

12. A printing press according to claim 10, further comprising

20 a memory to store the predetermined colorant cluster table and the respective standard colorant amount, and a

processing module to calculate the at least one colorant cluster table and the corresponding reduced colorant amounts based on the stored predetermined colorant cluster table, the corresponding standard colorant amount and the identified maximum optical density of the image.

25 13. A printing press according to claim 10, wherein the image forming unit further comprises:

colorant applicators comprising colorant, an imaging member having a surface to form a latent image of the received image thereon, and a transfer member,

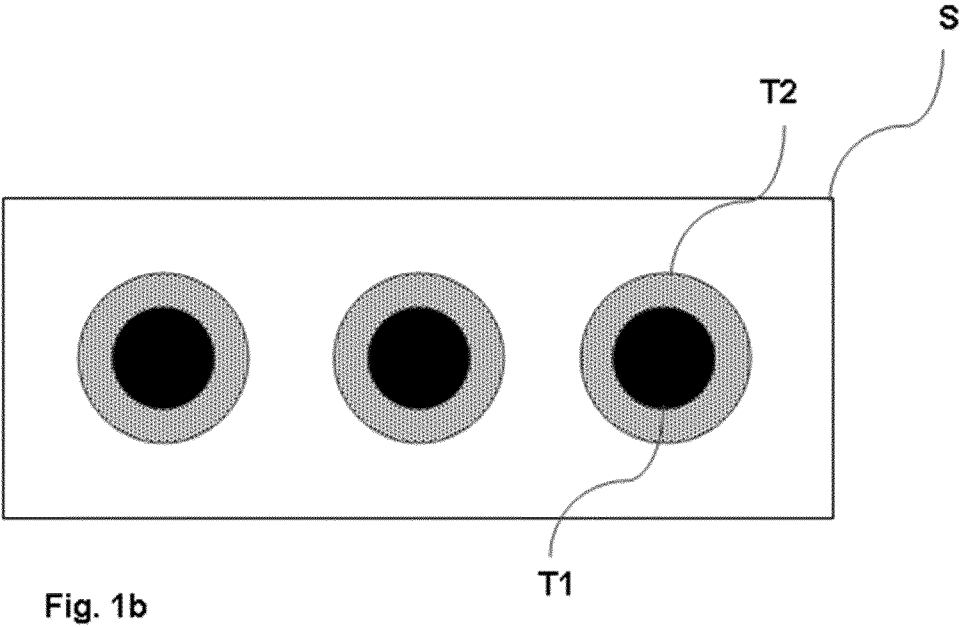
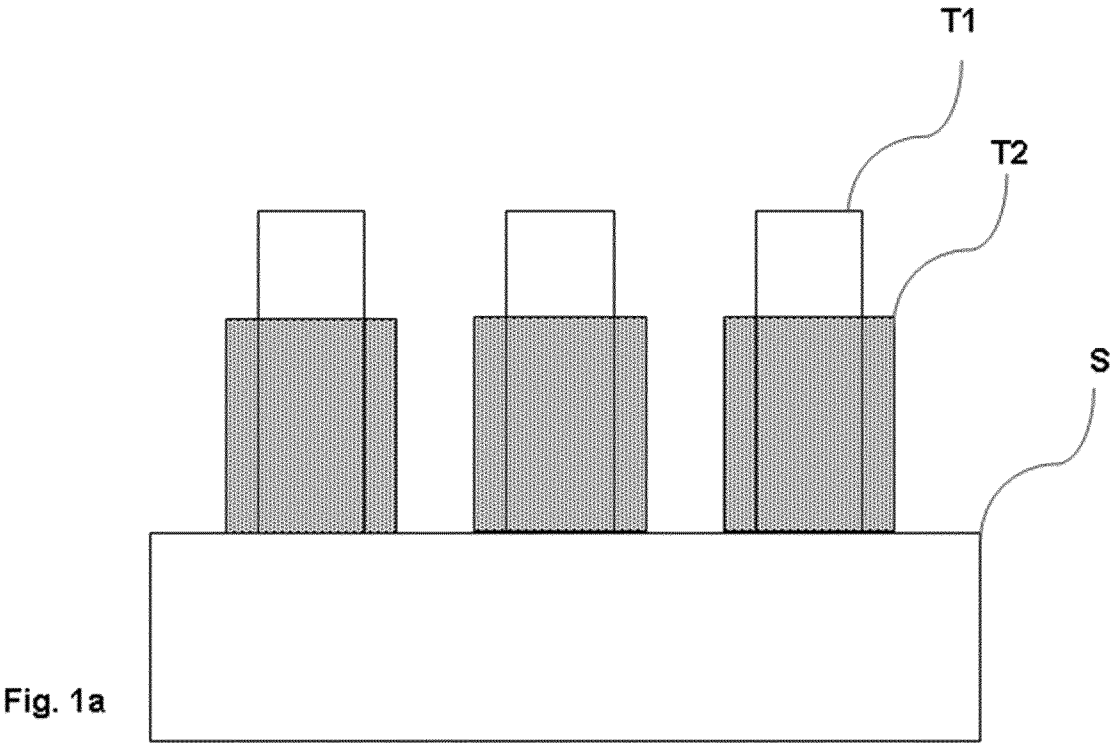
wherein,

- 5 the colorant applicators are to receive the selected colorant amount and apply the corresponding colorant volume on the imaging member to generate a colorant image on the imaging member,

the intermediate transfer member is to receive the colorant image from the imaging member and transfer the colorant image to the print medium.

- 10 14. A printing press according to claim 13, wherein the printing press is an electrophotography press.

15. A printing press according to claim 13, wherein the printing press is an offset press.



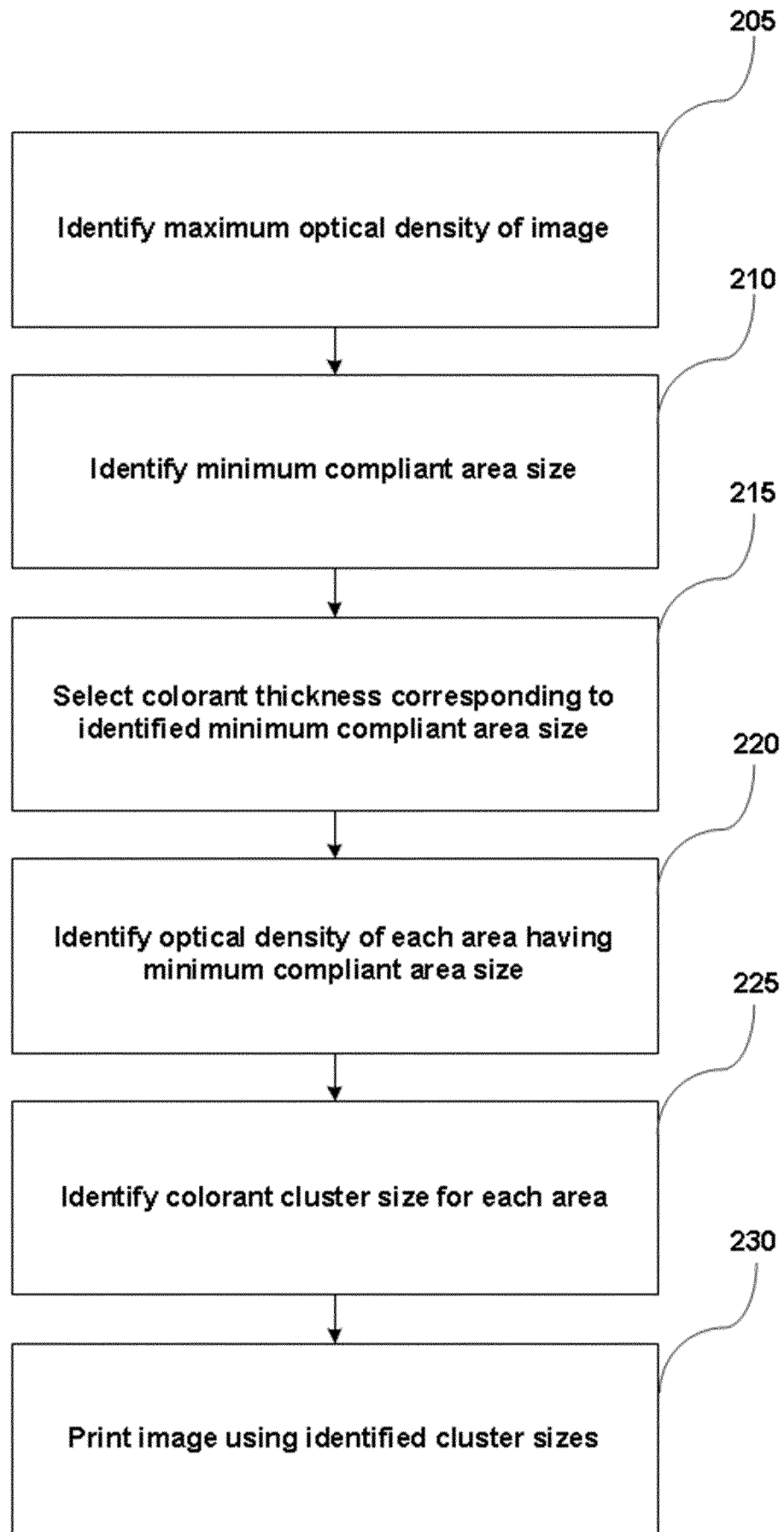


Fig. 2

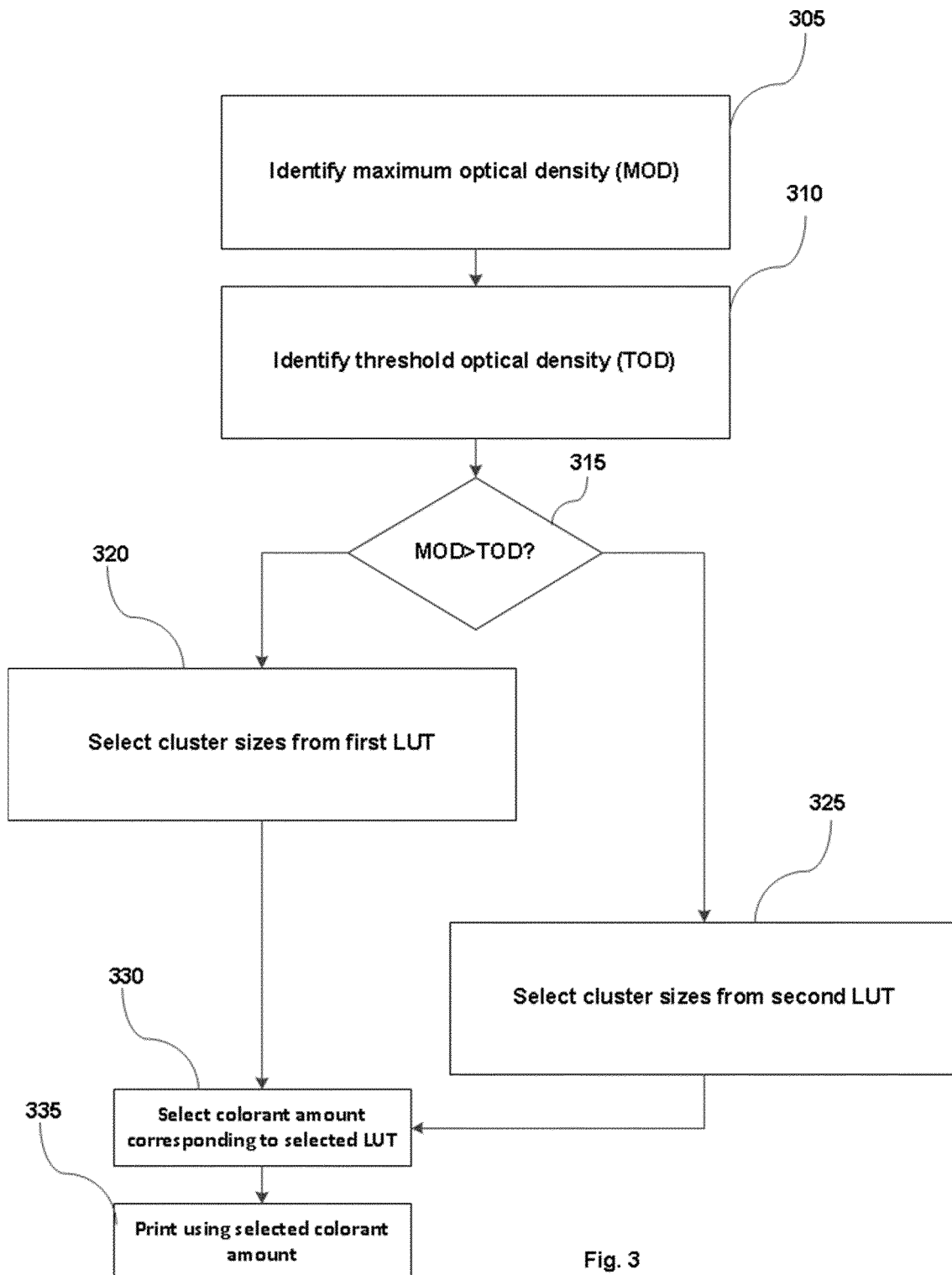


Fig. 3

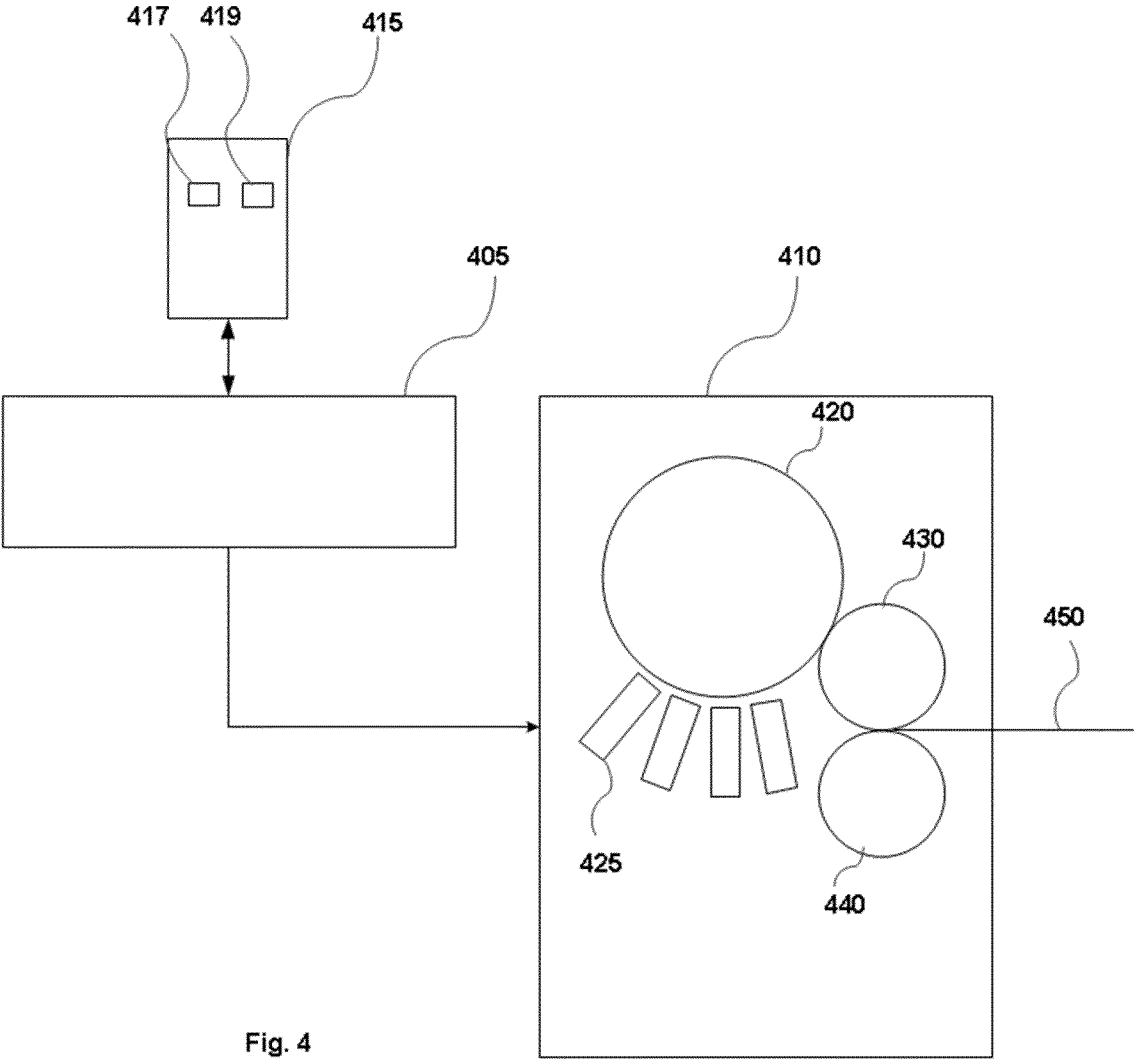


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2015/057888

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 1-5
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/057888

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04N1/40
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

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	US 2011/194162 A1 (NAKASO SUGURU [JP] ET AL) 11 August 2011 (2011-08-11) paragraph [0043] - paragraph [0066]; figures 6-8	6-15
A	----- US 4 708 459 A (COWAN CARL E [US] ET AL) 24 November 1987 (1987-11-24) column 15, line 20 - column 16, line 50; figures 1-6 -----	6-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

14 December 2015

Date of mailing of the international search report

07/01/2016

Name and mailing address of the ISA/

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Authorized officer

Seytter, Fritz

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2015/057888

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011194162 A1	11-08-2011	JP 5392126 B2	22-01-2014
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		US 4708459 A	24-11-1987
		WO 8705719 A1	24-09-1987

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 1-5

In the description (par. 11-18) and in claim 1, the combination of features "identifying a maximum optical density of the image" and "identifying a minimum compliant area size" having "an average optical density up to the identified maximum density" does not make sense, as, obviously, any area of any size in an image will have an average optical density "up to" the identified maximum optical density. Or, in the words of the description, the condition "no average optical density of any area having a size equal to that size may exceed the identified maximum optical density of the image" (p. 3, l. 8-9) is true for any area, as an average obtained from values whose upper limit is the "maximum optical density" can not exceed this value. The claim therefore does not seem to be limiting the "minimum compliant area size" to any meaningful value. It is therefore unclear what the technical effect of the feature should be. Further, there is no disclosure in the application documents meaningfully motivating the apparent relationship between area size and colorant thickness disclosed in the detailed example in par. 12-18. It is open to pure speculation why a larger area size "allows" higher colorant thickness than a smaller area size (par. 12). For example, it could be speculated that the relationship is due to properties of a particular imaging method, however, while no detail is provided regarding these issues, the application lacks disclosure of information relevant to be able to understand the invention claimed in claims 1-5. For these reasons, meaningful search is not possible.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guidelines C-IV, 7.2), should the problems which led to the Article 17(2) declaration be overcome.