

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
29 November 2007 (29.11.2007)

PCT

(10) International Publication Number
WO 2007/135544 A2

(51) International Patent Classification:
H04N 1/60 (2006.01)

(21) International Application Number:
PCT/IB2007/001315

(22) International Filing Date: 22 May 2007 (22.05.2007)

(25) Filing Language: Italian

(26) Publication Language: English

(30) Priority Data:
PI2006A000057 22 May 2006 (22.05.2006) IT

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(81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,
AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH,

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

(84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL,
PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM,
GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:

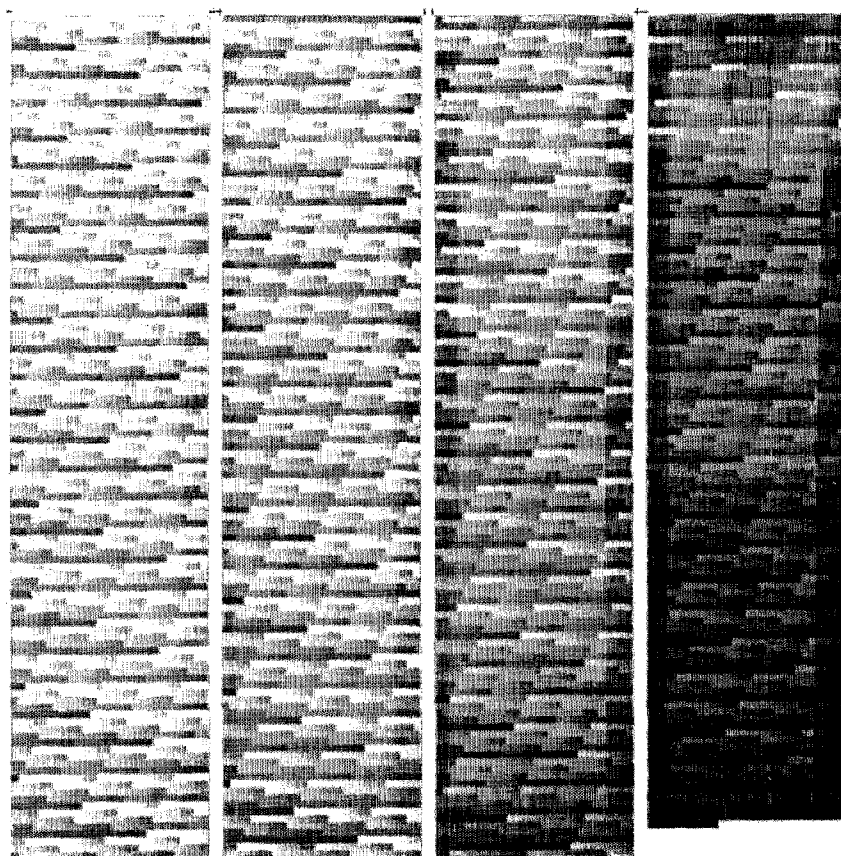
— of inventorship (Rule 4.17(iv))

Published:

— without international search report and to be republished
upon receipt of that report

[Continued on next page]

(54) Title: METHOD FOR COLOUR MANAGEMENT IN A PRINTING SYSTEM, BY USING THE COLOURS ACTUALLY
PRINTED BY THE PRINTER



(57) Abstract: A method for colour management for managing colour in a printing process comprises the following steps:
— defining at least a receipt comprising at least a preferred percentage of inks, — printing by means of a printing device a real colour obtained by means of said at least a recipe; — implementing the real measure of said at least a real colour printed by said printing device; — associating with said recipe the real measure of said real colour; — replacing each ideal colour of an ideal image to be printed with the corresponding real colour.

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Method for colour management in a printing system, by using the colours actually printed by the printer

The invention relates to the technical field of colour management systems that enable images to be printed on items of any type. In particular, the invention relates to the technical field relating to obtaining methods and systems that enable the colours of the prints to be selected and set in such a manner as to obtain a print the result of which is known *a priori*.

The invention thus relates to the technical field of any printing system.

In the present invention reference is generally made to the printing systems, they being understood to comprise any printing system, whether relating to professional, office or industrial printing. Particularly, the system has considerable advantages for industrial printing systems in the ceramics and textiles field and in any other manufacturing field that uses silkscreen printing or the like.

The object of the present invention is a method for managing printing.

Methods and systems of the aforesaid type are known and widely used.

Although the known methods and systems perform in a satisfactory manner the function assigned to them, they have some drawbacks.

In particular, the known art relating to colour management systems that enable images to be printed on items of any type and/or the colours of prints to be selected and set in such a way as to obtain a print the result of which is known *a priori* has some drawbacks.

Before the digital era, quality printing operators used proprietary or closed colour management systems, where all the devices had been integrated or calibrated with known values to work together and exclusively, i.e. each part of the system was integrated with the other parts and only with

them. Those treating the colour, or the user of said device, were highly specialised professional technicians who were able to operate these closed systems, constructing a large variety of adaptations to the colour of an image, the image having been acquired by a scanner, and were able to predict with reasonable accuracy what would be the final result of the print on the basis of their manipulations. This prior-art solution nevertheless had the drawback that the real correspondence of the desired colour to the colour effectively printed by the printing system is strictly linked to the personal skills of the technician and is therefore difficult to repeat and also aleatory. It is furthermore necessary to train highly specialised personnel to obtain quality results in which the desired colour actually corresponds to the printed colour, with costs and time that are often great. A further drawback relates to the fact that often many test prints were necessary to calibrate the system correctly, with increased printing costs and time.

Currently, digital printing requires the integration of hardware and software that are constantly updated. The need arises therefrom for open colour management, i.e. it is necessary to be able to have non-closed printing systems, in which the various parts of the system can interface operationally with one another, the various parts of the system being designed and constructed to interface with a great number, for example, of different peripherals, in such a way as to have maximum integration between operating systems, graphic and peripheral applications, leading the major companies to discuss new management of the standardised colour. Substantially, the management of open colour, in the digital field, provides the use of a computer or at least a CPU on which there are loaded one or more different display, printer management, graphic processing etc programmes, said CPU or computer being suitable for being operationally connected to any type of printing device, and the various programmes loaded onto the CPU or onto the computer being

subject to working alternatively or in combination with one another or one using the results of the other: for example, the graphic processing programme enables the graphic processing of the design or image or the like and the printing programme manages communication with the printer and paging of the drawing made or modified by the graphic processing programme.

A currently felt need is to reproduce the colour images on different peripherals in a constant and repeatable manner.

A colour management system (so-called CMS, Colour Management System) is a collection of software instruments, or computer programmes, designed for correctly managing the various capacities to reproduce the colour of the scanners, monitors, traditional printers, machines for typographical printing and printers for colour tests, to ensure a coherent colour for the entire printing production process. Ideally, this means that the colours displayed on the monitor will precisely represent the colours of the final product. This also means that the various applications for graphics, monitors and the operating systems will display the colours, integrating them together, in the most constant and homogenous way possible.

The task of the colour management systems, the so-called CMS (Colour Management System), is to compensate for the differences existing between devices belonging to the same category or to different categories. Substantially, all the CMS resort to a reference colour space that is wider than that of the individual devices used in the processing. A CMS has the task of reproducing the colours of a device, like a monitor, having a wide range of colours (the so-called gamut), with a device with a smaller range of colours, like a printing system.

In fact, according to the prior art the CIEXYZ colorimetric space is defined that is suitable for this purpose, but more and more often it is preferred to use the colorimetric space defined by CIE in 1976 and also called CIELAB. This space has the advantage of having a visually more uniform distribution

of colours than the CIEXYZ space, so it is possible to quantify numerically the difference existing between two different colours in a more significant manner. The CIEXYZ colorimetric space works with three coordinates, X, Y, Z, whilst the colorimetric space CIELAB works with the three coordinates L, a, b, also called L, a* and b*, components that can be calculated from the CIEXYZ components with a simple mathematical formula.

By using this CIELAB space, a "universal" description of the colour is then obtained that can then be used to calculate the colour components to be used with any other device. The proper conversion operation is managed by the Colour Management Module (CMM), a fundamental element of any CMS, using the aforesaid "colour profiles" a collection of data that describes the capacity that a certain device has to reproduce colours.

The creation of a colour profile entails the use of suitable instruments, that are often rather costly, that are not always available to the final user. In some cases, when high reproduction fidelity is not required, the profiles can be used that are made available by the manufacturer of the device or by the producers of the colour management software. Above all, for the latter it was, however, practically impossible to manage to provide the colour profiles for all existing devices or even only for most of the colour profiles; further, the first CMS used proprietary formats for the profiles that made them usable only with that specific colour management system.

A solution proposed by the prior art, in particular by the ICC (International Colour Consortium), was to define a common format for the colour profiles, or more simply profiles, that enables the use thereof with different colour management systems.

A CMS (colour management system) thus helps reduce or eliminate the problems of colour correspondence and helps maintain these features unaltered over time. The task of CMS

colour management systems is to compensate for the differences existing between devices belonging to the same category or to different categories. Substantially, all the CMS resort to a reference colour space that is wider than the space of the single devices used in the processing. A colour management system or CMS is a "translator" of colour space of origin of the image (such as, for example, a scanner, monitor, digital camera) in the colour space of the destination unit, which may be another monitor or a printing unit or the like. The CMS is simply a motor that interprets the profile of a peripheral and "adapts" it or rather converts it, through appropriate operations, to another one. In order to perform the conversion, the CMS needs information both from the colour space of origin and from the destination colour space. A colour conversion always occurs with the help of two profiles. For example, the RGB values read by a scanner are converted in the CIELAB colour space using the profile of the scanner, and from here in the RGB space of the monitor used for displaying in the CMYK space of the printer that will be used to produce the copies on paper, exploiting for these conversions the profiles of the monitor and printer.

For example, the profile of a monitor is a table that, for each numeric triad RGB, provides the absolute coordinates (for example Lab) of the colour produced by this triad whilst the profile of a printer is a table that, for each combination of inks CMYK provides the absolute coordinates (for example Lab) of the colour produced by this combination. The colour management systems can be further used to convert colours on the basis of the characteristics of a printing unit that is different from the one on which printing is taking place. This process of simulating another printing unit is commonly used for the colour test of jobs that will be printed with an offset typographical machine.

As in the case of the monitor, it is not possible to construct all the lines of the table because they are too

numerous, so only some are constructed using a software called a profiler and a measuring instrument (colorimeter or spectrophotometer). The procedure is as follows: the software prints a so-called "target", i.e. a series of small coloured squares (patches) the so-called recipe of which is known, CMYK (or RGB depending on the type of printer) i.e. the composition is known or the percentage of the inks necessary for producing the colour is known. These patches are measured with the measuring instrument and the result is used by the profiler for producing the profile.

In practice, according to the prior-art system, a software is used for printing the target and an instrument is used for measuring it. The instrument is connected to the computer and supplies the data to the profiling software that processes the data to produce the profile.

The process for making a profile of a printing system according to the prior art thus consists of the following steps:

- producing a TARGET (i.e. a set of coloured patches) on the item that is selected by means of the specific printing system;
- measuring the printed target by means of the measuring instrument;
- using the profiling software to produce, through numerical techniques of interpolation of the measured values, the ICC profile, containing a three-dimensional table (called CLUT) of correspondence between CIE Lab values and the percentages of the inks necessary for producing the equivalent colour (i.e. the so-called recipe).

A drawback is that the ICC profile, being the result of an "interpolation", may not be correct. In fact, an interpolation often generates ICC profiles that seem to be correct but in fact produce completely incorrect printing profiles.

The drawback is represented by the fact that any printing

system produces imprecise results, i.e. the result that is obtained is not uniform and there is no consistency with what is shown on the video and what is actually printed, because the printing process is affected, for example, by the variations of the pigments, the items, the environmental factors such as temperature and humidity and every other factor that varies over time. As a result, the colour displayed on the video then will not be what is actually printed and also the colour produced, once printed, may have alterations compared with the initial colour.

A solution proposed by the prior art in particular is the known ICC system that consists of creating a three-dimensional table called "CLUT" that contains a series of formulations of the percentages of the inks necessary for producing the specific colour (known henceforth in the description also as "recipes") that do not all actually correspond to the desired colour. In fact, the so-called CLUT is made by printing a series of colours and combining the corresponding "recipe" therewith. Of necessity, it is not possible to think of generating a recipe in this way for each possible colour, but the recipe of the missing colours, i.e. those that are not measured directly, is provided by interpolation by means of a series of algorithms that assess, using pairs of "recipe"-measure near values, what the recipe may be.

In the moment in which the operator wishes to print a set colour, the ICC profile indicates the recipe corresponding thereto, even if the recipe is generated by interpolation and in this case is a merely theoretical recipe and it is not possible to know whether the printing result will be actually what is known. Often, for different reasons, the actually printed colour differs, sometimes in a substantial manner, from the colour that indicates the recipe associated therewith. The known art teaches that for a colour that it is desired to print the system provides, owing to the ICC profiles, the recipe corresponding thereto, but once the

print is set using that recipe it is by no means certain that the printed colour is the one initially set. In fact, most times the result is very different from the initial result. Different profiling systems exist that also produce substantial differences in the printing results but the management of the colours is one of the open problems of the printing systems and none of the known systems resolves the serious technical problem of being able to know, before printing, what the real result of printing will be and therefore of being able to know in advance what the final result will be.

The printing result has until today been a print that, although it is improved, still has differences compared with the desired print.

Thus with the traditional systems, including the most advanced ones, it is not possible to have the certainty that the print corresponds to the image designed and/or displayed on the video.

The drawbacks of the prior art are evident. Printing is often very costly, especially in industrial processes, but it is completely uneconomic that proofs have to be printed to see the concrete result. To this there is added the enormous waste of time and the fact that, using approximation it is often necessary to make several prints with a consequent multiplication of the costs. The only effective system for being able to see what the printing result is, until today consists of printing an image. Once the image is printed it is compared with the result that it was desired to obtain and the settings of the colours are changed in such a way as to be able to approach the desired result as much as possible. This of course leads to an expenditure of material, time and a notable cost.

Substantially, the main problem of the prior art is thus linked to the fact of having printing systems in which the result is not foreseeable that will be obtained once the print is obtained. This problem is made even worse by the

fact that often for technical and commercial necessities it is necessary to make different graphic processing programmes and different computers or CPUs dialogue with different printers, obviously whilst also taking account of the difference of the items on which they will be printed.

The present invention resolves the aforesaid technical problems by means of a method for managing colour in a printing process that comprises the following steps:

- a) providing a recipe, or a preferred percentage of inks;
- b) printing by means of a printing device a real colour obtained using said recipe;
- c) obtaining, through a measuring instrument, the real measure of said at least a real colour printed by said printing device;
- d) associating with said recipes the real measure of said real colour;
- e) setting up an ideal image comprising at least an ideal colour generated by at least a recipe;
- f) replacing each ideal colour of said image with the corresponding real colour, for example identifying the correspondence between the real colour and the ideal colour.

The replacement of the ideal colour with the real colour, i.e. the "transformation" of the image from ideal to real may occur automatically, according to what has been defined above or the operator may be asked to confirm, or the operator may have an ideal image devoid of colours and may add the colours, i.e. he may colour it, choosing only between the real colours that are available.

In this way in the drawing, or image or the like each ideal colour is replaced, or is chosen initially by the operator, with the corresponding real colour, i.e. with the colour that will actually be printed by the printing device.

In practice the method according to the present invention provides that the ideal colour is the colour that the graphic processing programme, or the like, has in memory as a colour

that should be printed following a precise recipe, i.e. a percentage mixture of the inks. Nevertheless, due to the drawbacks disclosed above, the so-called ideal colour hardly ever reflects the corresponding so-called real colour, i.e. the colour that the printing device actually produces.

Through the above method the colour that is printed by the printing device following the associated recipe, is measured, and the result of the measurement is used to replace ideal colour with the real colour, which will then be printed following the recipe.

By repeating the above process it is possible to generate a palette of real colours, which comprises only the colours actually printed by the printing device.

The method is applied to the specific total printing system (i.e. printing system, item and inks) that it is intended to use and in order for it to give the desired results must be repeated whenever any printing system component is changed, including any adjustment that may modify printing conditions. The method that is the object of the present invention thus overcomes the previously described drawbacks inasmuch as the image display system that will be printed uses a series of colours, the information of which is contained in the palette describer, which comprises only the colours that the specific printing system has actually printed and which have been measured after printing.

The solution in subject provides using only the colours printed by the printer and then measured, i.e. only those for which there is certain proof that the printer is able to print and not others.

No profiling or interpolation of colours is thus used to generate colours of the printing system, but only those colours are used that the printer has actually produced, i.e. the real colours the result of which it is possible to know *a priori* without the need to make further print trials.

According to an advantageous feature of the present invention, whilst in the currently used ICC profiles the

print of the colour that it is wished to obtain occurs by calculating through interpolation of the "recipe" by which the colour should be produced, in the invention in question it occurs by using the recipe of the real colour that is actually printed that is most similar to the ideal colour.

According to an advantageous embodiment, the method that is the object of the present invention is implemented by the following steps:

1. a computer program or software produces the appropriate information in the form of one or more files, so that an image is printed containing a certain number of coloured areas, defined hereinafter as "palette". Said file/s contain/s in particular the recipes of the colours. This software stores the information for the physical creation of the palette in the form that is usually used by a printing process, i.e. as a density combination of the dyes (inks) used by the printer, the so-called "recipe" that defines how each colour contained in the palette has been produced;
2. using the recipe of each colour in the file, i.e. the density combination of the dyes (inks), the printer produces a series of coloured areas, called patches, that constitute the palette, the real colorimetric values of which are unknown *a priori*;
3. the coloured areas of the palette, once printed, are measured with a measuring means or instrument for measuring the colour, preferably the measuring means can be a spectrophotometer, but nevertheless a scanner and/or RGB camera and/or similar colour measuring instruments can also be used;
4. each measure of the corresponding coloured area of the palette is then associated with the recipe on the basis of which it has been printed, substantially combining the real measure of the real colour with the recipe that has produced it, thus generating a file that will henceforth be called "palette describer", which consists of a file

that contains all the information about the real colours, i.e. produced by the printing process, i.e. both the recipe, already known before the palette printing process, and the measure of the real colour, known on the other hand after printing.

When it is desired to print any image, an application programme generates a new approximate image or "proof", corresponding in form to the original image, but generated using the "palette describer" to replace the colorimetric value of each point of the original image with the colorimetric value contained in the "palette describer" that is most similar to it and thus providing a "proof" image i.e. an image corresponding to the real print.

Substantially, the method according to the present invention provides for a computer program replacing the ideal colours of an image with the real colours that will be obtained by printing the image by means of the printing device, by means of the method disclosed above. An ideal colour is replaced by the real colour in a preferred manner through the identification of the similarity of two colours. The assessment of the similarity of two colours is a function defined by recognised standards such as, for example, Delta E of CIE.

The approximate image or "proof" can then be printed, having the certainty that the colours contained therein will be reproduced in an exact manner by the printer, because each colour of the approximate image was obtained by the palette describer, made following measurement of the palette.

In practice, the original image is modified by using only the colours that the printing process is able to produce, implementing the approximation on the basis of the real colours produced by the printing process.

The system that is the object of the present invention enables the colour to be printed to be chosen from a list of real colours that the printer has actually printed and which were measured and placed on the list by coupling them with

the recipe thereof.

After the recipe of the colour has been obtained in this way, there is the certainty that the printer will reproduce that colour.

In this way it is possible to easily overcome the drawbacks of the prior art due to the fact that, according to current ICC technology, interpolation is used for creating non-measured colours.

It is also possible to measure objectively the result obtained to assess if the approximate image is satisfactory from the point of view of the appearance, inasmuch as the differences compared to the original are considered or are not considered to be acceptable.

As the palette describer contains a pair of "recipe-measure" values, a proof image can be produced, whilst with the ICC profile the recipe is interpolated, as it is not possible to know which colour will then actually be produced.

This is obtained by the application of mathematical functions to the approximate image and to the original one, which assess the chromatic differences in numerical terms of perceptive difference.

It is thus possible to obtain a general assessment of similarity that objectively measures the acceptability or not of the transformation carried out for the printing thereof.

By also using the recipe that is associated with each patch of the palette it is possible to produce the information required by the printing process to reproduce the approximate image. For example, in the case of a silkscreen printing process, the application software, using for each point of the approximate image the associated recipe, will produce the information necessary for preparing the silkscreens necessary for printing. In the profiling system according to the prior art ICC, given a colour to be printed, the system provides the recipe that enables that colour to be used. This occurs because in the ICC profile there is a measuring step of measuring the colours printed by the printer, as in our

system, but once a certain number of colours have been measured, a 3D structure (CLUT) is created that contains both the recipes of the printed colours and those of colours that are not printed but obtained using mathematical interpolation algorithms. The created structure thus contains only in part real data whilst many of them are only hypothetical.

As a result, a current CMS according to the prior art enables the recipe for the print of a certain colour to be obtained from the ICC profile, but does not offer any guarantee that the colour that is printed will always be the desired one. Further, it is not possible to know beforehand what difference there may be between the desired colour and the printed colour or to view what the colour is.

The system that is the object of the present invention, on the other hand, enables the colour to be printed to be chosen from a list of real colours that the printer has actually printed and which have been measured and placed on the list, combining them with the recipe thereof.

After the colour has been chosen in this way, there is thus the certainty that the printer will reproduce that colour according to the recipe associated therewith.

Further, according to the system that is the object of the present invention it is possible to measure objectively the result obtained to assess whether the approximate image is satisfactory from the point of view of the appearance, i.e. whether the differences from the original are considered to be acceptable or not. This is obtained through the application of mathematical functions to the approximate image and the original one, which evaluate the chromatic and perceptive differences in numeric terms.

It is thus possible to obtain a global similarity assessment that objectively measures the acceptability or unacceptability of the transformation performed for printing. Reduced to the essential structure and with reference to the figures of the attached drawings, a method for managing colour in a printing system, according to the present

invention, provides that the selection of a colour to be printed that is nearer the one desired by the user, is conducted using as a parameter of choice the colours actually printed by the printer and measured, i.e. the user chooses the ideal colours or those that he would ideally like to see represented after the printing process, and the method and the system of implementation of the method according to the present invention provide the user with the result in terms of real colours or as the image, or drawing or wording or the like will actually be after the printing process, and without printing the image or drawing or wording or the like, but by printing and measuring a sheet of testpieces or patches, which testpieces are measured according to the method disclosed above and the obtained measurement is used to generate a real image, or an image similar to the ideal image, but displayed, for example on the video only through the use of real colours, or actually printable colours, by which the ideal colours are replaced.

The system provides that, given a colour to be printed, the colour that is closest to it can be chosen, according to a perceptive measure, using a file, that is called palette describer, which contains the information only on the colours actually printed by the printer and measured. Said information consists of each recipe combined with the measurement of the actually printed colour corresponding thereto.

The basic innovation of the present invention consists of the fact that the colour management system is based on the colours actually printed by the printer, which constitute the selection parameter for the final user. The operator or user, when he designs the image to be printed, can choose the colours from within a list of colours consisting only of the colours actually printed by the printer and measured. Thus the approximate image or real image, which reproduces the image to be printed or ideal image, is identical to the image that will then be printed, consisting of the real colours

resulting from the printing process.

The method according to the present invention, especially if implemented by CPU, or computers or the like, provides the following steps in order to generate a file, the so-called palette describer:

- setting up at least a recipe and/or composition, that substantially consists of percentages of dyes and/or inks;
- printing at least a real colour using said recipe;
- measuring and/or acquiring at least a colorimetric value or real measure of the real colour resulting from printing the corresponding recipe;
- associating with the at least a recipe the real measure of the corresponding real colour.

The method provides for initially a series of recipes being printed the real result of which is not known. The print produces a series of patches, or coloured areas with real colours, i.e. with actually printed colours, each of which areas, corresponding to a given recipe, will then be measured, said real measure then being combined with the corresponding recipe.

The data of the real measure and of the recipe are then gathered in a file, called a "palette describer", that constitutes the selection parameter usable for forming an approximate image (or "proof") i.e. of a real image, in which real image the ideal colours are substituted by the real colours.

Advantageously, the list of the real colours that are reproducible by the printer (so-called palette describer) consists of a file containing the information on said colours (i.e. the "recipe" of each colour combined with the measurement of the printed colour) that enables the printing process to produce the colours of the palette.

The system thus not only enables the real colour to be seen on the video that the printer can reproduce but above all enables the differences to be measured that there are between said colour and the colour that it was desired to obtain,

i.e. the ideal colour. It is in fact certainly not certain that between the two colours there is a coincidence, as often occurs with prior-art procedures.

In the ICC system said coincidence is hypothetical, inasmuch as the system provides the nearest recipe without ensuring that this recipe gives exactly the hoped-for result. In the system that is the object of the invention, on the other hand, the colour is immediately proposed that is the nearest one about which the information is known that enables it to be assessed how far it approaches or differs from the colour that it was desired to obtain.

Advantageously, said information on the colour enables the existing differences to be measured between the desired colour and the colour that is exactly reproducible by the printer.

Advantageously, said information on the colour is used to create an image, called "proof", which is viewable on a monitor and consists of the real colours, i.e. colours actually printed by the printer, and only of those.

The creation of this "proof" image that corresponds exactly to the image that can be printed enables the "*a priori*" result to be assessed and measurements to be conducted that can enable the differences to be calculated and/or highlighted, not only between the single colours but also between the wanted image, i.e. the ideal image, and the printable image, i.e. the real image.

This enables the user to verify diverse choices before actually proceeding with printing, possibly changing some colours and replacing them with others or choosing the printing configuration that provides the best result, or the closest result to the ideal result.

The invention enables the operator to use a programme containing all the information on the colours actually printed by the printer in such a way as to be able to replace each ideal colour of the original ideal image with the real colours and generate the final image, i.e. the real image

corresponding to the image that will actually be printed.

In the method in question the first step is identical to the one used to produce an ICC profile: a target is printed, obtained by combining the percentages of the inks in an algebraic manner in such a way as to produce a wide number of combinations of inks and therefore to obtain a large number of different colours. If, for example, the printing system has 4 inks and 6 printing densities (0, 20, 40, 60, 80 and 100 %), a target would consist of 1,296 coloured patches. It is clear that the more numerous and the better distributed the colours of the target are inside the gamut of the printer, the better the profiling result will be because the printer gamut will be better sampled.

According to an advantageous embodiment of the present invention the target that is thus produced is measured by a spectrophotometer and the measurements that are thus produced are evaluated to decide if they can be used to create the palette describer or to produce a better target, i.e. a target that produces colours that are more evenly distributed over the gamut of the printer, evaluated in the CIE Lab colour space. For this purpose special software is used that calculates which colours are required to reach the desired degree of uniformity and which for each of the new colours obtains a new recipe by interpolating between known recipe-measuring pair values.

The software obtains, from the values measured in the colour space CIE Lab, the gamut of the printer and subdivides it according to a 3D grid with a set pitch. From the Lab value of each point (intersection) of the grid the percentage of the inks is calculated that are necessary for producing the equivalent colour, using the information on "near" colours. In fact, for each measured colour there exists the "recipe", i.e. the percentages of the inks used. It is therefore an interpolation procedure in the CIE Lab three-dimensional space that produces a new target the colours of which should be evenly distributed inside the gamut of the printer,

according to the selected grid.

The old and new recipes together enable a new target, called Level 1, to be produced. By printing this new target and measuring the resulting colours, it will be subsequently evaluated whether the desired uniformity has been reached or whether a further approximation phase is required. In order to assess how much the real measured values are uniformly distributed in the CIELab space, different mathematical methods exist, such as, for example, measuring the local density and the calculation of the standard deviation from the average one.

The level 1 target is printed and measured with a spectrophotometer. If the measured values do not meet the criteria of being "uniformly distributed" they can nevertheless be used again to generate a new target (called Level 2) the colours of which are more evenly distributed in the CIE Lab colour space. In practice, this procedure tends to produce a target the colours of which produce colours that are so distributed in the colour space of the printer as to accurately describe the behaviour. Briefly, in the ICC profile the table contains "invented" numeric values by means of the interpolation of the measured values, whilst the method in question produces a table containing only measured and therefore true values.

According to this advantageous embodiment it is thus possible to produce a target consisting of colours distributed in the most uniform manner possible inside the gamut obtainable with the inks of the printing system in question. By printing this new target and measuring the resulting colours thereof, it is estimated whether the desired uniformity has been reached and a further approximation step is required. An important difference between the present invention and the known art is that the method proposed by the present invention tests the hypotheses conducted by printing and measuring the hypothesised colours according to what has been disclosed above.

Advantageously, the information contained in the palette describer can be used in two ways:

- by a program made in such a way as to modify the original image, by substituting each colour with the most similar one obtained from the describer. In this way, an approximate image is produced that shows how the image will actually be printed;
- by a CMS that uses the describer in the same way as it would use the CLUT contained in the ICC profile, i.e. by calculating the recipe that should produce the required colour by means of interpolation between "near" values of colour-measure/recipe pairs.

Advantageously, the above method provides for the greatest possible number of colours being acquired inasmuch as the more colours are acquired the better the needs of the customer can be met.

This does not, however, prevent the acquired colours also being able to be reduced according to concrete printing needs.

The system provides for the existence of a file that contains the information required for the printer to print the colours. Said file is updated with the RGB and/or CIE Lab and/or spectral values to create the so-called palette describer (Fig. 1).

Advantageously, the file with the information on the colours generated at the start of the process, taking account of the dyes (T) at the disposal of the printer and of the possible densities (D), enables a palette to be printed having a known number of colours and the greatest possible.

The printed palette (Fig.2) consists of a series of coloured zones (so-called tesseras or patches or areas), for example produced with the T dyes and the D densities.

The dimensions of the patches have to be compatible with the features of the instrument used to measure the colorimetric value thereof. They may also be very small (for example 1x1 mm) in such a way as to concentrate on a small surface the

greatest possible number of colours, thus making the acquisition of colours faster and minimising scanning time.

In this case an RGB scanner or a spectrometric scanner will be used that, owing to the particular acquisition features, enables even small areas to be acquired with the greatest precision and in a shorter time.

The result of the acquisition is a file that contains the colorimetric measurement of each real colour produced combined with the respective recipe.

This result is added to the initial one of the colour recipe so that at the end of the process a file is obtained (so-called palette describer) that contains, for each colour, both the measurement and composition or recipe thereof, which data can be used for various purposes, but which essentially enables the result to be known already during the step of preparing the printing data and therefore before printing.

It is clear that such a system makes it superfluous to make test prints to then adjust the recipes in such a way that the print is as similar as possible to what is desired, inasmuch as owing to the present invention the procedure is completely reversed.

Advantageously, the palette describer so implemented can be used by a programme that enables the draughtsman to use the palette to make test images.

The programme is made in such a way as to modify the original or ideal image, replacing each colour with the most similar one obtained by the palette describer. In this way an approximate or real image is obtained that shows how the image will actually be printed.

Advantageously, the system of the present invention is applicable to each printing process.

Advantageously, it is further possible to measure the differences between the original image and the approximate image that represents what will actually be printed.

Further features are the subject of the appended claims.

The advantages and features of the present invention will be

better understood by those skilled in the art from the above description and with the help of the drawings that are attached by way of non-limiting example, in which:

Figure 1 shows an example of the contents of the file, also called "palette describer", of the colours, reduced in size for simplicity of representation and which in the bottom right-hand corner has some measurements of the coloured areas of the palette measured after printing. The palette describer contains both the recipes of the colours known *a priori*, and the spectrum or CIELab measurement of the colours made after the print of the palette of colours;

Figure 2 shows by way of example the printing of a "palette", i.e. of the series of printable colours. The black and white print nevertheless makes it difficult to understand the various colour variations.

CLAIMS

1. Method for managing colour in a printing process comprising the following steps:
 - a) defining at least a receipt comprising at least a preferred percentage of inks;
 - b) printing by means of a printing device a real colour obtained by means of said at least a recipe;
 - c) obtaining the real measure of said at least a real colour printed by said printing device;
 - d) associating with said recipe the real measure of said real colour;
 - e) replacing each ideal colour of an ideal image to be printed with the corresponding real colour.
2. Method according to claim 1, and further comprising generating a so-called describer of a palette of real colours and corresponding recipes and measures, generated according to the steps of methods a) to d) of claim 1.
3. Method according to any one of claims 1 to 2 characterised in that said palette comprises a certain number of coloured areas.
4. Method according to any one of claims 1 to 3 characterised in that said palette is generated by a computer or software program loaded or running on at least a CPU or computer or electronic processor.
5. Method according to any one of claims 1 to 4 characterised in that said software or program stores the combination of densities of the pigments (inks) used by the printer, i.e. said recipe that defines how each colour contained in the palette has been produced.
6. Method according to any one of claims 1 to 5 characterised in that said print of said real colours of said palette is produced using the recipe of each colour in the file, i.e. the combination of density of the dyes, i.e. the printer produce a series of coloured areas, called patches, that constitute the palette, the real colorimetric values of which are unknown.

7. Method according to any one of claims 1 to 6 characterised in that the printed coloured areas of the palette called patches, are measured with a measuring means or instrument for measuring the colour, preferably a spectrophotometer and/or a scanner RGB and/or RGB camera and/or spectrometric scanner and/or similar colour measuring instruments.
8. Method according to any one of claims 1 to 7 characterised in that said measure of the corresponding coloured area of the palette is associated with the recipe on the basis of which it was printed by substantially associating the real measure of the real colour to the recipe that generated it.
9. Method according to any one of claims 1 to 8 characterised in that said software or programme generates a file called a "palette describer", said palette describer consisting of a file that contains information on the real colours associated with the corresponding recipes.
10. Method according to any one of claims 1 to 9 characterised in that the choice of colour of the ideal image, or image to be printed is made using as a selection parameter only the colours actually printed and measured by the printer, i.e. only the real colours.
11. Method according to any one of claims 1 to 10 characterised in that, to generate a "file", said palette describer, comprises the following steps:
 - setting up at least a recipe and/or composition, that substantially consists of percentages of dyes and/or inks;
 - printing at least a real colour using said recipe;
 - measuring and/or acquiring at least a colorimetric value or real measure of the real colour resulting from printing the corresponding recipe;
 - associating with the at least a recipe the real measure of the corresponding real colour.

12. Method according to any one of claims 1 to 11 characterised in that said information contained in said palette describer is the information in percentages of dyes (T) and of densities (D) that are possibly printable by the printer, with which there are associated the RGB and/or CIE Lab and/or spectral values relating to the real colours actually printed with said information.
13. Method according to any one of claims 1 to 12 characterised in that said information on the colour contained in the so-called palette describer is used for creating a real image, said "proof", displayable on a monitor and constituted by the real colours actually printed by the printer and measured.
14. Method according to any one of claims 1 to 13 characterised in that said real image or "proof" has only the real colours, actually printed by the printing device.
15. Method according to any one of claims 1 to 14 characterised in that said real image or "proof" is measurable and comparable with the ideal image.
16. Method according to any one of claims 1 to 15 characterised in that the comparison between said real image or "proof" and said ideal image provides the difference between said two images and/or between the single points of said two ideal and real images.
17. Method according to any one of claims 1 to 16 characterised in that said substitution of the ideal colour of said ideal image with the corresponding real colour is made on the basis of a resemblance criterion of two colours, said resemblance being a function defined by known and recognised standards such as, for example, a Delta E of the CIE.
18. Method according to any one of claims 1 to 17 characterised in that said method is implemented and made by means of a computer program that performs the following steps:

- initially an application software produces the appropriate information in the form of one or more files so that an image is printed containing a certain number of coloured areas (defined below as "palette"). Said file/s contain/s in particular the recipes of the colours. This software stores the information for the physical creation of the palette in the form that is usually used by a printing process, i.e. as a combination of densities of the dyes (inks) used by the printer (the so-called "recipe" that defines how each colour of the palette is composed).
 - Using the recipes in the file (i.e. the combination of densities of the dyes) the printer produces a series of coloured areas, called patches, (so-called palettes) the colorimetric values of which are a priori unknown.
 - The coloured areas of the palette, once printed, are measured with a suitable instrument for measuring the colour.
 - measuring each coloured area of the palette is then associated with the recipe on the basis of which it has been printed, generating a file called a "palette describer", which consists of a file that contains both the recipe of the colour that has actually been printed that was already known before the palette printing process, and the value of the measure, performed after printing.
19. Method according to any one of claims 1 to 18 characterised in that said method comprises a program that, given an image to be printed or ideal image, produces a new image, called approximate or real or "proof", using the "palette describer" and replacing the colorimetric value of each point of the original image with the colorimetric value contained in the "palette describer" that is most similar thereto and thus providing a real image or "proof" corresponding to the actual print.

20. Method according to any one of claims 1 to 19 characterised in that said method further provides the following steps:
- generating a so-called target i.e. a palette of printable colours
 - said target or palette is measured with a suitable instrument
 - said measures of said targets are assessed in terms of uniform distribution in the CIELab space and alternatively: or are used to create the said palette describer, or are reused to produce a new target, having colours that are more evenly distributed in the gamut of the printer, preferably assessed in the CIELab colour space.
21. Method according to claim 20 characterised in that said new target is generated in order to obtain the desired degree of uniformity and in that for each of the new colours the method obtains a new recipe by using known colours of recipe-measure pairs, i.e. generates new colours calculated from measurement data of real colour associated with the corresponding recipe.
22. Method according to one or more of claims 20 or 21 characterised in that said method provides the following steps:
- obtaining, from the values measured in the CIE Lab colour space, the gamut of the printer
 - subdividing said space according to a 3D grid having a defined step
 - calculating the percentage of the inks that are necessary for producing the colour that is equivalent to the Lab value of each point (intersection) of the grid using the information of real "near" colours.
23. Method according to any one of claims 20 to 22 characterised in that said method provides the following steps:
- printing the new target obtained with said recipes

- measuring the colours of the new target with a suitable instrument
 - evaluating, with any suitable algorithm, whether the desired uniformity has been reached or whether a further approximation step is required.
24. Method according to any one of claims 20 to 23 characterised in that said method provides the following step: repeating one or more steps of claims 20 to 23.
25. Method according to one or more of preceding claims characterised in that one or more steps relating thereto are implementable by a computer program.
26. Computer program, comprising information codes, processed for performing all the method steps according to one or more preceding claims when said program is run by a computer.
27. Computer program, comprising information codes, processed for performing all the steps of the method according to one or more of the preceding claims, which computer program is incorporated into a support that is readable by a computer and/or loaded into the memory of a computer or CPU or the like.
28. System for managing the colour in a printing process comprising:
- at least a display device for displaying at least an ideal image comprising at least an ideal colour, such as, for example, a video or monitor or the like
 - at least a printing device, like a printer, a silkscreen printing machine, or the like
 - at least a detecting device for detecting at least a colour parameter, such as, for example, a spectrophotometer and/or a RGB scanner and/or RGB camera and/or spectrometric scanner and/or similar colour measuring instruments
- characterised in that it comprises the following method steps:
- providing a so-called recipe consisting of at least a

preferred colour mixing percentage

- printing by means of said printing device at least a testpiece or real colour of said at least a real colour corresponding to said recipe
- detecting by means of said measuring device the at least a parameter of said at least a real colour
- associating said parameter or measure of said real colour with the corresponding recipe
- displaying, by the display device, the real colour corresponding to the parameter of the corresponding recipe
- replacing every ideal colour of the ideal image with a corresponding or similar real colour, thereby generating a real image.

29. System according to claim 28 characterised in that it comprises one or more method steps according to one or more of claims 1 to 27.

30. Method according to any one of claims 1 to 27 characterised in that said method is applied to the specific printing system that it is intended to use and has to be repeated each time that any component of the printing system is changed and/or any adjustment that could modify printing conditions.

31. System according to claims 28 and/or 29 characterised in that the system is applied to the specific printing system that it is intended to use and has to be repeated each time that any component of the printing system and/or any adjustment that could modify printing conditions is changed.

32. Method according to claim 1, wherein the real colour that replaces the ideal colour of the ideal image to be printed is chosen on the basis of a perceptive resemblance criterion between said real colour and said ideal colour.

33. Method according to claim 32, wherein said perceptive resemblance criterion is the criterion of the Delta E of

CIE.

34. Method according to claim 1 or 31 or 32, wherein there is provided printing a plurality of real colours, each real colour of said plurality of real colours being obtained from a corresponding recipe.
35. Method according to claim 34, wherein said plurality of real colours defines a palette comprising a plurality of coloured areas.
36. Method according to claim 34, wherein said palette is generated by a program loadable on computer means.
37. Method according to any one of claims 34 to 36, and further comprising evaluating whether the real colours of said plurality of real colours are distributed evenly in the gamut of the printing device.
38. Method according to claim 37, wherein the gamut of said printing device is assessed, with reference to the uniform distribution of said real colours, in the CIELab colour space.
39. Method according to claim 37 or 38, wherein, if the real colours of said plurality of real colours are not distributed evenly in the gamut of the printing device, there is provided generating a plurality of new recipes calculated so as to obtain a plurality of new real colours that are more evenly distributed in the gamut of said printing device.
40. Method according to claim 39, wherein said new real colours correspond to respective new recipes determined by interpolating known recipe-measure pairs values.
41. Method according to claim 1, or according to any one of claims 32 to 40, wherein from said ideal image to be printed, after said substituting, an actually printable real image is obtained that is at least partially defined by said real colour or by the real colours of said plurality.
42. Method according to claim 41, wherein said real image is entirely formed by said real colour or by the real

colours of said plurality.

43. Method according to claim 41 or 42, and further comprising displaying said real image on a monitor.
44. Method according to any one of claims 41 to 43, and further comprising determining the perceptive difference between said real image and said ideal image.
45. Method according to claim 44, wherein said perceptive difference is assessed between the single points of said real image and said ideal image.
46. Method according to claim 1, or according to any one of claims 32 to 45, and further comprising storing in a file the, or each recipe and the or each measure associated with the corresponding recipe.
47. Method according to claim 46, and further comprising processing said file to identify the real colour to be replaced with an ideal colour of said ideal image to be printed.
48. Method according to claim 1, or according to any one of claims 32 to 47, wherein the, or each, recipe contains information on the density of each ink that is usable in said printing process.
49. Method according to claim 1, or according to any one of claims 32 to 48, wherein said measure is selected from a group comprising: RGB value, CIE Lab value, spectral measurement of the real printed colour using the corresponding recipe.
50. Method according to any preceding claim, applied to a printing process on ceramic objects.

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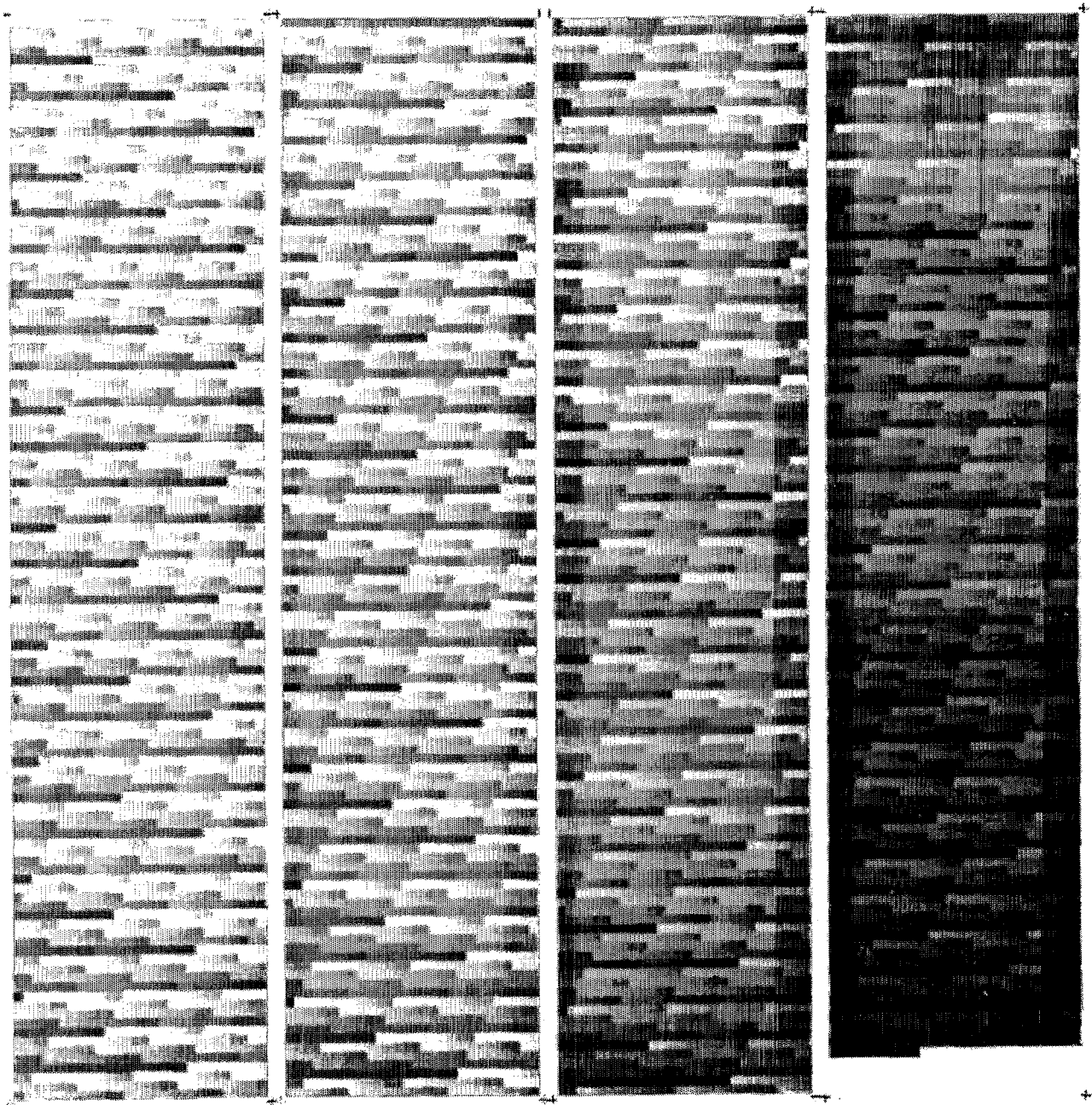


Fig. 2