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# (54) Automatic printing parameters adjustment and control method

(57) The present invention relates to an automatic method of setting and controlling print parameters which allows selecting, from a database, initial settings that are close to the final settings for a printer, said settings being dependent on the print speed and being obtained by an expert system by means of analyzing the characteristics of the digital file containing information about the job to be printed, and carrying out test prints at a variable speed, for automatically detecting print errors depending on the print speed, and the settings necessary for each speed, generating final settings dependent on the print speed that allow printing at any speed without having to carry out new print tests. The method also allows determining a maximum print speed at which printing can be carried out without errors.

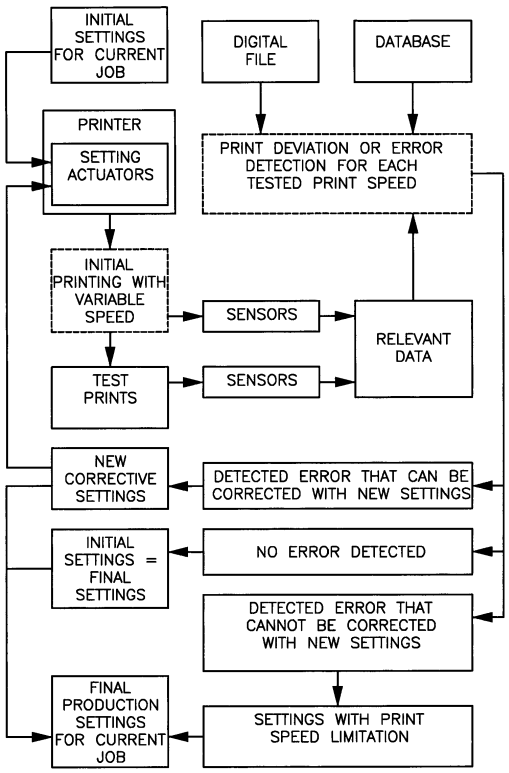


*Fig.2*

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## Description

### Technical Field

**[0001]** The present invention relates to an automatic method of setting and controlling print parameters for printers that are provided with multiple printing groups, which allows carrying out a first printing with initial settings very close to the optimal settings, in addition to allowing constant supervision of the printing quality for a range of print speeds, and the determination of the maximum print speed, all this controlled by an expert system.

### State of the Art

**[0002]** The use of an expert system for comparing captured images of a printed product with a digital file with information about the job to be printed (hereinafter, digital file) for determining the corrections in the settings of the printer that are necessary to eliminate print errors or deviations is known in the state of the art. An example of this method is patent application ES2395182.

**[0003]** Document US7059245B2 also discloses a system capable of implementing initial inking settings close to the optimal settings based on analyzing the digital file and correcting said settings depending on an analysis of the actual results of print tests, and furthermore includes the possibility of storing the settings considered as optimal after this iterative job to be used as initial settings for future print jobs. This document only contemplates the setting for inking and not other parameters, and it does not contemplate carrying out that analysis or setting for a range of print speeds.

**[0004]** Document JP2001328235 describes a method which is very similar to the preceding method, but without the initial digital file analysis and it has the same limitations.

**[0005]** Document JPH01306246 discloses said initial digital file analysis and the implementation of initial settings, without specifying them, in the printer. In this prior art document, the final settings obtained are stored for improving the initial settings of future jobs.

**[0006]** Another related document is the prior art document US2011222123 which describes a method according to which a digital document is analyzed for extracting some of its characteristics, templates having characteristics that are identical or similar to those extracted are then searched for in a database, and the settings saved as optimal settings are used for the selected template as the initial settings for printing the digital file, therefore only a few final settings are necessary for obtaining a quality print.

**[0007]** These prior art documents do not contemplate the possibility of carrying out the setting in real time with a variable print speed, or the possibility of the expert system being capable of determining a maximum speed at which printing can be carried out without impairing the print quality.

**[0008]** On the other hand, document US2011315036 describes a method for keeping the tension of a print substrate on which printing is carried out constant, which substrate in the case of this prior art document is a flexible web material. The print speed is changed and the tension of the print substrate is analyzed in the first step of testing; based on the data obtained an optimal operating speed is calculated. This case contemplates the possibility of carrying out a step of testing during which an optimal print speed for maintaining the tension of the print substrate is empirically determined, but it does not contemplate the possibility of carrying out settings in other print parameters, or of determining the optimal speed based on the print quality, or based on the corrections that can be obtained by setting those other print parameters. This prior art document therefore determines an optimal print speed for maintaining the tension of the print substrate, but not an optimal speed that is related to or allows maintaining the print quality, such that it solves a different problem based on different data.

**[0009]** The foregoing and other drawbacks are solved in the invention described below.

### Brief Description of the Invention

**[0010]** The present invention provides an automatic method of setting and controlling printers provided with multiple printing groups, such as flexographic, offset or rotogravure printers, for example. Said method starts from at least one digital file which contains at least the information about the job to be printed and which can optionally further contain non-printable information, such as, for example, information about the colors to be used, to the mixtures of colors necessary for obtaining the colors to be used, or to the print substrate on which printing must be carried out. Said print substrate will preferably, though in a non-excluding manner, be a flexible web material.

**[0011]** An expert system determines initial print settings that will be used for configuring some of the print parameters in an initial printing by means of operating setting actuators controlled by said expert system, said setting actuators being integrated in the printer and controlling some of its print parameters. Said initial settings are determined based on the information contained in said at least one digital file and/or on the information contained in a database. Said expert system could also be a fuzzy logic or heuristic system.

**[0012]** The expert system can analyze the digital file for extracting some of its characteristics which can influence the settings necessary for printing, such as, for example, the proportion of surface printed with each color, the percentage of coverage, the colors used as a base, the color hues required, the print substrate base required, the print sleeves required or the order thereof, the print motif or design, the print pressures required, the desired ink viscosity, the color density required, etc. After that analysis, the expert system searches in the database for

stored previous jobs which had similar or identical characteristics. Based on that search the expert system can use the final settings obtained in similar previous jobs as the initial settings of the present job after applying the present method of setting and controlling, thus achieving an initial printing that requires few additional settings or none at all.

**[0013]** If the expert system finds an identical previous job or a job with differences that are below certain pre-established values, it can determine that a step of initial printing is unnecessary and can directly implement the settings of the previous job as the final settings of the current job to start production, otherwise, it will use said settings of the previous job as the initial settings of the current job and the initial printing will start after the implementation thereof.

**[0014]** Said settings determined by the expert system are dependent on the print speed, the setting values will vary depending on the print speed variable. Therefore, it may be, for example, a range of initial settings, or a formula having the print speed as a variable, a curve, or a table. By way of example, said settings can affect any one or several of the following parameters: the ink color, the pressure of the print rollers, the print sleeves used or the order thereof, the inking of each color, the drying of the ink or the tension of the print substrate on which printing is carried out, the print motif.

**[0015]** The initial settings are implemented for an initial print speed, and an initial printing of the content of the at least one digital file or of a part thereof on the print substrate is carried out. The initial printing is carried out at different speeds with the initial settings adapted to the print speed used at all times as a result of the automatic operation of the setting actuators controlled by the expert system.

**[0016]** At least one sensor acquires relevant information about the print job carried out for each print speed and transmits said relevant information to the expert system which compares it with the at least one digital file, with parts thereof, and/or with the database. Based on this comparison, the expert system detects print deviations and/or errors, or the absence thereof, for example, those relating to the register, color, color saturation, size of print dots (a phenomenon known as dot gain), the lack or surplus of ink, the mixture of colors due to inadequate drying, print deformation due to an incorrect tension of the print substrate, excessive or inadequate pressure of the print rollers, erroneous ink viscosity, wrong color density, etc.

**[0017]** Once the print deviations or errors are detected, the expert system automatically calculates new print settings correcting said deviations or errors for those speeds at which said errors or deviations occurred.

**[0018]** By way of non-limiting example, these new settings relate to correcting the pressure of the print rollers, the inking of each color, the ink color, the color saturation in the ink, the drying of the ink, the tension of the print substrate, the dot gain correction, the ink viscosity, the color density and/or the register of one color with respect to others.

**[0019]** These new settings can be subjected to a new print test, restarting the method in an iterative manner until achieving optimal printing, or they can be used directly as the final settings for a job. If deviations or errors were not detected during the tests with the initial settings, said initial settings will be used as the final settings.

**[0020]** Both the relevant data gathered during the initial printing or printings and the new calculated settings are stored in the database, linking them with the initial settings used and with the characteristics of the digital file used, such that a previous job which had similar characteristics can be located in the database for subsequent jobs, and both the initial settings that did not result in errors and the settings that resulted in errors, as well as the final settings that correct said errors, can be allowed.

**[0021]** The expert system therefore gradually broadens its knowledge based on the experience stored in the database, and therefore it gradually improves the initial settings such that few or no initial printings are necessary if one and the same job already printed previously or a very similar job is repeated. The data gathered by a specific printer can be stored locally or can be shared by a plurality of printers, and the database can be physically located in a printer or implemented in a remote server which can be centralized in a single physical server or be distributed and shared by means of a digital cloud.

**[0022]** The setting actuators carrying out the print settings are controlled by the expert system, and their range of action is limited by a maximum limit and a minimum limit established by a physical or mechanical limitation, and once one of these limits is reached further settings beyond such limit cannot be carried out.

**[0023]** The expert system uses the information extracted from the digital file, the database, and the information provided by the at least one sensor during the initial printing or printings for determining a maximum print speed at which the printer can print the actual digital file without there being print deviations or errors that cannot be corrected with the additional settings of one of the parameters that can be influenced by the expert system.

**[0024]** In other words, the print speed cannot be increased if said increase in speed leads to a print deviation or error that requires an additional setting of a setting actuator that has already reached its upper and lower limit.

**[0025]** For example, if the size of the print dot is reduced below the desired size upon increasing the speed and the inking has to be increased or the pressure of the rollers has to be increased to compensate for said reduction in the size of print dots, and said two settings have already reached their limit, the print speed cannot be increased any further.

**[0026]** As can be seen in the preceding example, one and the same error can sometimes be corrected by carrying out two different settings or with a joint setting of both. The expert system can assess the different options

and chose the most suitable option at all times, in this example, increasing inking will increase ink consumption and will require an increase in drying, whereas an increase in the pressure of the roller will not have these consequences, so this option will be chosen as it is more economical.

**[0027]** After the initial printing or printings, the expert system determines the final production settings for a range of speeds and a maximum speed that could be used as the production speed, and stores this information in the database.

**[0028]** As a result of this method, said optimal production speed can be optimized, reaching greater speeds than with conventional setting systems and maintaining the quality, thus achieving better equipment use and subsequent cost reduction. Furthermore, it enables changing the production speed without having to carry out initial setting printings again since the setting values for different speeds are already available, and said settings can be automatically implemented in real time without stopping production.

**[0029]** The present method is preferably applied to a flexographic printer, an offset printer or a rotogravure printer, having a central drum with a number of printing groups that have said print rollers.

**[0030]** Other features of the invention will be described in the following detailed description of an embodiment.

Brief Description of the Drawings

**[0031]** The foregoing and other advantages and features will be better understood from the following detailed description of an embodiment in reference to the attached drawings which must be interpreted in an illustrative and non-limiting manner, in which:

Figure 1 shows a diagram of the processes forming the first step of the method in which the expert system analyzes the digital file for extracting some of its characteristics and comparing them with the information contained in the database in search of a previous job having similar characteristics for obtaining the final optimal settings thereof; boxes with a dotted line represent processes or actions, and boxes with a continuous line represent devices or information packets; and

Figure 2 shows a diagram of the processes forming the following steps of the proposed method in which the initial settings are implemented in the printer by the setting actuators after which initial printings are performed with variable speeds, and where sensors analyze both the process and the result to detect deviations or errors to enable obtaining final production settings; boxes with a dotted line represent processes or actions and boxes with a continuous line represent devices or information packets.

Detailed Description of an Embodiment

**[0032]** According to a preferred embodiment described in Figure 1, the proposed method has a first step in which a pre-printing digital file is supplied to the expert system which analyzes same to extract relevant information relating to the characteristics of said digital file; some of this information can be non-printable information stored together with the printing patterns within the digital file. This analysis allows obtaining information about the proportion of surface printed with each color, the percentage of coverage of the support, the colors used as a base, the color hues required, the size of the print dot required, the print substrate base required, the print sleeves required, the print motifs or designs, the pressure of the print rollers required, the ink viscosity required, the desired color density, etc.

**[0033]** After that analysis, the expert system searches in a database for a previous job that had characteristics that are identical or similar to the characteristics extracted from the digital file of the current job. According to the present embodiment, said database is located in a remote server which is remotely accessed. Said remote server is centralized in a single centralized physical server, but in another embodiment, it is a server distributed in the digital cloud keeping the data distributed among a plurality of non-centralized physical servers. Said remote server contains data provided by a plurality of printers.

**[0034]** Once a similar previous job is located, print settings stored together with said similar previous job which were accepted at that time as optimal settings are accessed. Said settings relate to printer parameters that can be automatically controlled by the expert system by means of setting actuators, and they relate to the pressure of the print rollers, the inking of each color, the ink color, the color saturation in the ink, the drying of the ink, the tension of the print substrate and the register of one color with respect to others.

**[0035]** As shown in Figure 2, the expert system then implements the settings provided by the database in the printer by means of said setting actuators, using them as the initial print settings for the current print job.

**[0036]** A certain number of initial printings are carried out on a print substrate using a variable print speed, starting in this embodiment with a lower speed and gradually increasing it to a greater speed.

**[0037]** A first assembly of sensors monitors different relevant printer parameters and environmental parameters, and a second group of sensors monitors the print substrate once it has been printed, obtaining relevant information about the job carried out; said sensors of the second group of sensors are preferably optical sensors, and the relevant data obtained are images of the print substrate. All the relevant data obtained with these sensors are analyzed in real time by the expert system which compares such data with information from the digital file and with information from the database, for detecting possible print errors or chromatic deviations at all or at

one of the print speeds. The possible errors that are analyzed by the expert system are errors in register, color, saturation, the size of print dots (also called dot gain), the lack or surplus of ink, mixture of colors due to inadequate drying, print deformation due to an incorrect tension of the print substrate, incorrect pressure of the print rollers, incorrect ink viscosity, or erroneous color saturation.

**[0038]** Once said errors or deviations are detected, the new corrective print settings which allow eliminating the detected deviations or errors and can be implemented by the setting actuators are then calculated by means of information contained in a database and/or by means of algorithms. These new settings relate to correcting the pressure of the print rollers, the inking of each color, the ink color, the color saturation in the ink, the drying of the ink, the tension of the print substrate, correcting the dot gain, the ink viscosity, the color density and/or the register of one color with respect to others.

**[0039]** For example, if a color has excessive saturation with a certain print speed a solvent can be added to the ink of that color; if the print dot is too small the pressure of the rollers can be increased; or if there is an error in register one print roller can be moved with respect to the others.

**[0040]** These new settings are implemented and a new printing can be carried out to check the results or to use said new settings as the final production settings. Furthermore, one can choose to prevent printing at the speed at which said deviation or error occurs and to limit the range of print speeds.

**[0041]** This printing operation, monitoring with sensors relevant information about the printing for analyzing and calculating corrections, can be repeated in an iterative manner until achieving an error-free and flawless printing.

**[0042]** This method provides variable optimal settings that are dependent on the print speed, and also the typical errors detected at each speed, all related to the specific characteristics of a pre-printing digital file. All this generated information is stored in the database for optimizing subsequent printings, which provides training for the expert system that reduces the need for initial printings.

**[0043]** The setting actuators have an operating range comprised between a minimum setting and a maximum setting due to physical or mechanical limitations. The expert system corrects the deviations or errors by carrying out the settings with said setting actuators within said operating range, but if a setting outside of this operating range of one of the setting actuators is required in order to make a correction for a certain speed, it would not be possible to carry out same. In such case the expert system would determine the speeds at which error-free printing could be not be carried out, and would therefore determine a maximum speed at which error-free printing can be carried out. That information is also stored in the database.

**[0044]** Some of the errors or deviations can be corrected by means of setting different setting actuators. In this case, the expert system determines the possible or the most desirable settings.

**[0045]** As a result of this method, the expert system generates specific final settings for each speed of the tested range of speeds. This allows changing the print speed once the production phase is started without changing the print quality as a result, since the settings necessary for keeping the quality constant with variable print speeds can be implemented.

## Claims

**1.** An automatic method of setting and controlling print parameters for printers which includes:

- automatically determining, by means of an expert system, optimal initial print settings based on the information contained in a database;
- implementing said initial settings in the flexographic printer by means of setting actuators controlled by the expert system;
- carrying out an initial printing, on a print substrate, of the information contained in the at least one digital file, or in a part thereof, with said initial settings implemented;
- acquiring relevant data from the result of said printing or from parts thereof by means of at least one sensor;
- analyzing, by means of the expert system, the acquired relevant data based on the information contained in the said at least one digital file, with parts thereof and/or with data contained in said database;
- detecting print errors and/or deviations by means of said analysis;
- the expert system calculating based on said analysis and detection new print settings necessary for correcting the detected errors and/or deviations;
- implementing said new settings in the printer by means of the setting actuators;
- storing the information obtained in said database for improving the initial settings of subsequent printings;

**characterized in that**

- said information for the initial settings is selected in said database from a comparison with data extracted from a digital file or from a part thereof
- the print settings determined by the expert system are dependent on the print speed;
- said print settings would vary adapting to said print speed, which is modified during one or more initial printings under the control of the expert system for a range of print speeds;
- the detection of the print errors and/or deviations is carried out by the expert system for each

speed of said range of print speeds used; and
• the optimal settings for each speed obtained during the initial printings are stored in the database, linking said optimal settings with each print speed and with the characteristics of the pre-printing digital file used.

**2.** The method according to claim 1, **characterized in that** the step of acquiring data includes acquiring relevant data about the printer's job during printing and/or environmental data.

**3.** The method according to claim 1 or 2, **characterized in that** the expert system determines a maximum print speed beyond which the settings of the setting actuators do not allow correcting the print errors or defects detected by the expert system.

**4.** The method according to any one of the preceding claims, **characterized in that** the optimal initial print settings are obtained by searching among previous jobs existing in the database having characteristics similar to the current job contained in the digital file.

**5.** The method according to claim 4, **characterized in that** the characteristics that are analyzed in said digital file for determining the similarity between a current job and a previous job is at least one of the following:

- the proportion of surface printed with each color;
- the percentage of coverage;
- the colors used as a base;
- the color hues required;
- the print substrate required;
- the print sleeves required;
- the size of the print dot required;
- print motif (design);
- pressures;
- viscosities;
- color density.

**6.** The method according to any one of the preceding claims, **characterized in that** the print deviations and/or errors examined by the expert system comprise at least one of the following aspects:

- register;
- color;
- saturation;
- the size of print dots or dot gain;
- pressures;
- viscosities;
- color density;
- lack or surplus of ink;
- mixture of colors due to inadequate drying;
- print deformation due to incorrect tension of the print substrate.

**7.** The method according to any one of the preceding claims, **characterized in that** the settings carried out in the printer by the expert system by means of controlling setting means is carried out on at least one of the following parameters:

- the pressure of the print rollers;
- the inking of each color;
- the ink color
- the color saturation in the ink
- the drying of the ink;
- the tension of the print substrate;
- the register;
- dot gain;
- viscosities;
- color density.

**8.** The method according to any one of the preceding claims, **characterized in that** said at least one sensor is an optical sensor and/or a spectrometer.

**9.** The method according to any one of the preceding claims, **characterized in that** said capturing of relevant data from the result of the printing includes capturing data about solvent retention by means of a gas analyzer.

**10.** The method according to any one of the preceding claims, **characterized in that** the database is a remote database and stores data from a plurality of printers.

**11.** The method according to claim 10, **characterized in that** said remote database is implemented in a remote server, which is centralized in one and the same physical server, or distributed between a plurality of physical servers forming a digital cloud.

**12.** The method according to any one of the preceding claims, **characterized in that** the printer is a printer selected from a flexographic printer, an offset printer or a rotogravure printer.

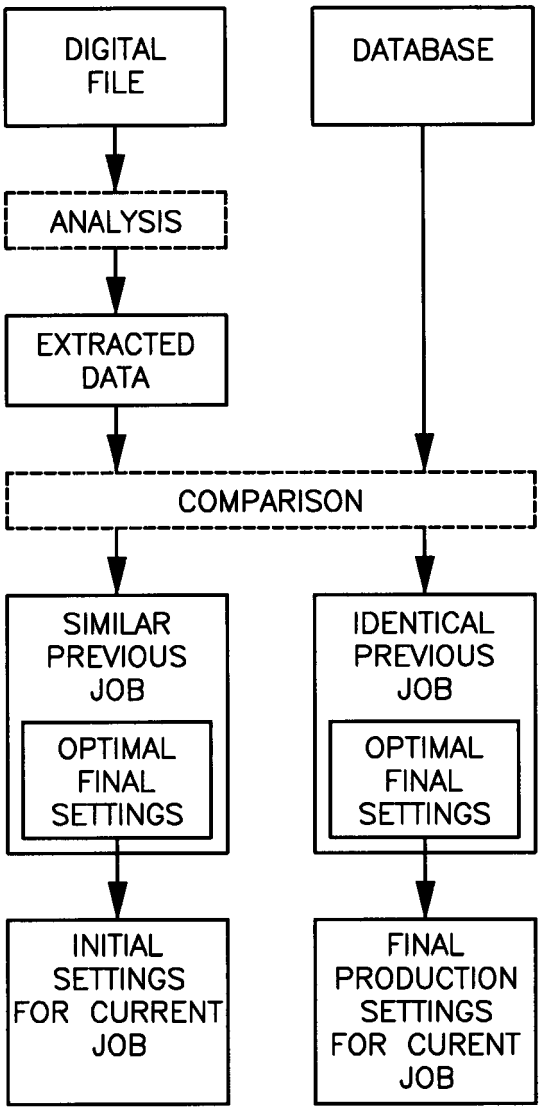
DIGITAL FILE
DATABASE
ANALYSIS
EXTRACTED DATA
COMPARISON
SIMILAR PREVIOUS JOB
OPTIMAL FINAL SETTINGS
IDENTICAL PREVIOUS JOB
OPTIMAL FINAL SETTINGS
INITIAL SETTINGS FOR CURRENT JOB
FINAL PRODUCTION SETTINGS FOR CURENT JOB

*Fig. 1*

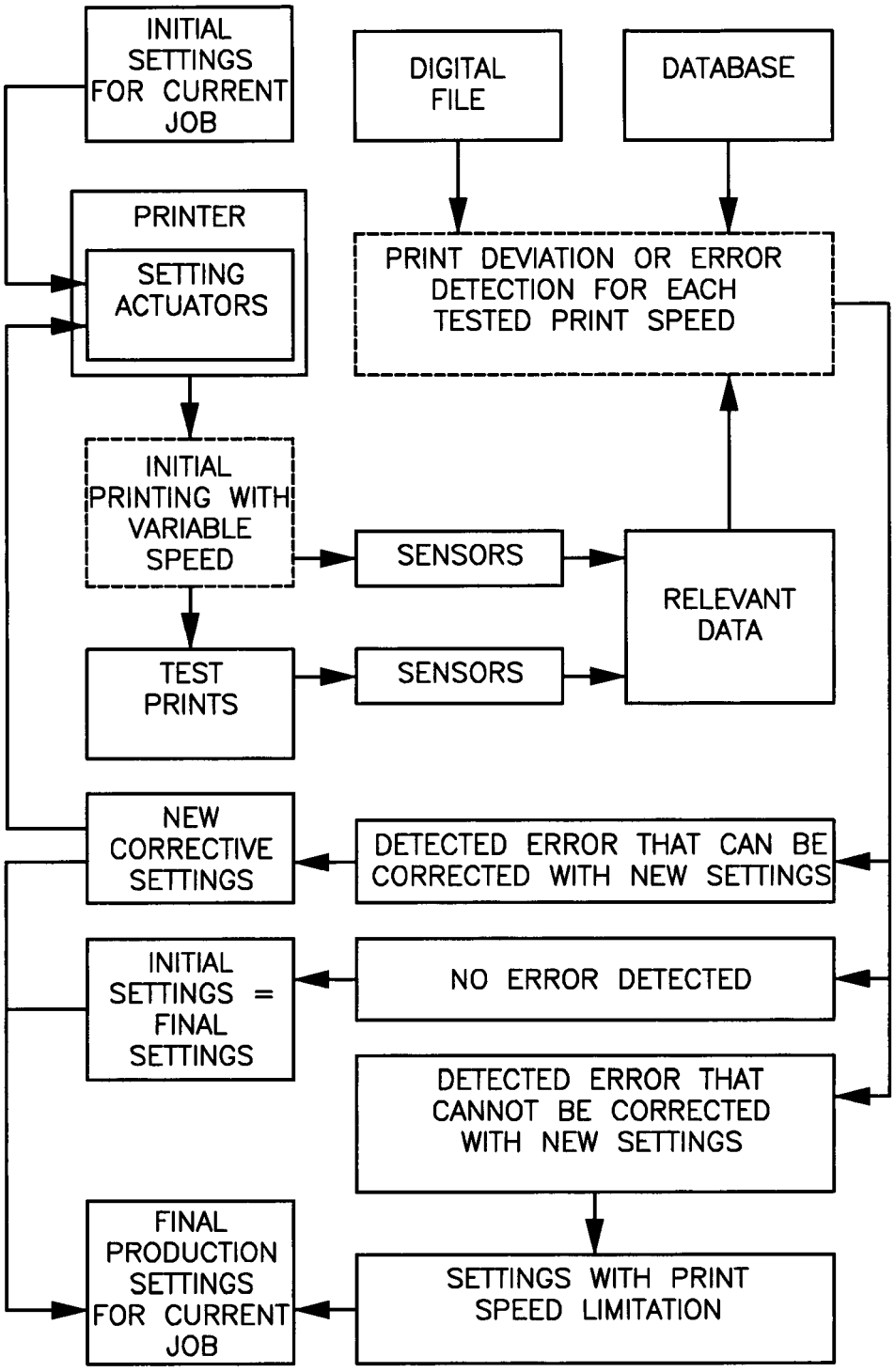
INITIAL SETTINGS FOR CURRENT JOB
DIGITAL FILE
DATABASE
PRINTER
SETTING ACTUATORS
PRINT DEVIATION OR ERROR DETECTION FOR EACH TESTED PRINT SPEED
INITIAL PRINTING WITH VARIABLE SPEED
SENSORS
RELEVANT DATA
TEST PRINTS
SENSORS
NEW CORRECTIVE SETTINGS
DETECTED ERROR THAT CAN BE CORRECTED WITH NEW SETTINGS
INITIAL SETTINGS = FINAL SETTINGS
NO ERROR DETECTED
DETECTED ERROR THAT CANNOT BE CORRECTED WITH NEW SETTINGS
FINAL PRODUCTION SETTINGS FOR CURRENT JOB
SETTINGS WITH PRINT SPEED LIMITATION

*Fig.2*

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# EUROPEAN SEARCH REPORT

Application Number
EP 13 38 0059

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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 16 June 2014 | Hajji, Mohamed-Karim |

CATEGORY OF CITED DOCUMENTS

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## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 38 0059

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16-06-2014

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## REFERENCES CITED IN THE DESCRIPTION

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