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(54) **Title**: METHOD FOR CALIBRATING A PRINTING MACHINE

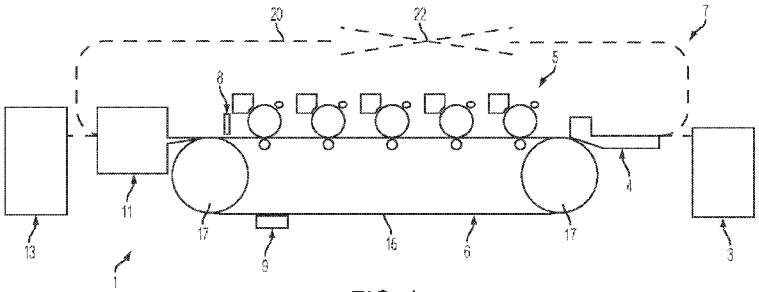

FIG. 1

(57) **Abstract**: This application relates to a method for calibrating a printing machine, in particular a digital multi-color printing machine adapted for duplex printing comprising a plurality of printing units. The method comprises the steps of transporting a first group of sheets of an at least semi-transparent type through the printing machine in such a manner that the sheets are moved at least once through the plurality of printing units, transporting a second group of sheets of an at least semi-transparent type through the printing machine in such a manner that the sheets are moved at least twice through the plurality of printing units, with the sheets being turned over between the passages, printing at least one register mark on one of the sheets of the first group of sheets during the first passage through the printing units, measuring the respective register mark at a register sensor located -in the transport direction of the sheets - downstream of the plurality of printing units, printing at least one register mark on one of the sheets of the second group of sheets during the second passage through the printing units, with no register marks being printed during the first passage, measuring the respective register mark at the register sensor located - in the transport direction of the sheets - downstream of the plurality of printing units, and detecting calibration parameters with the use of the thusly obtained measured results provided by the register sensor.

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METHOD FOR CALIBRATING A PRINTING MACHINE

TECHNICAL FIELD OF THE INVENTION

The present invention relates to a method for calibrating a printing machine, in particular a digital multi-color printing machine comprising a plurality of printing units.

BACKGROUND ART

In the field of printing machines, the application of a printing image in correct positional arrangement on a printing substrate is of considerable importance regarding the printing quality. Any misaligned printing of one or more colors on the printing substrate is readily perceived by the human eye and felt to be distracting.

Therefore, it is generally known that printing machines are regularly calibrated. In particular, it may be necessary to perform a calibration for each printing substrate that is being used. This means, when different printing substrates are used, a calibration must be performed for each individual printing substrate.

For such a calibration, as a rule, a plurality of register marks are printed on a transport belt of the printing machine and on the respective sheets of the printing substrate during a calibration process. If the printing machine comprises a duplex device, register marks are printed on the front side (recto printing) as well as on the reverse side (verso printing) of the respective sheets and are subsequently measured by means of a register sensor.

If the printing substrate is partially transparent, the calibration cannot be performed in its usual way because the register marks printed on the front side may show through, thus impairing a measuring of the register marks on the reverse side of the sheet by means of the register sensor.

To solve this problem, application DE 10 2004 007 367 that goes back to the applicant has suggested a method wherein, while the front and reverse sides are being printed, the sheet is offset transverse to its

transport direction through the printing machine in order to print the respective register marks offset with respect to each other on the front and reverse sides of a sheet. This can prevent the measurement of the marks by means of the register sensor from being disrupted; however, in part, this method is highly complex in view of the required offset of the sheet, and an appropriate device allowing sufficient transverse offset of the sheets must be provided.

SUMMARY OF THE INVENTION

Considering this prior art, it is the object of the present invention to provide a simplified method for calibrating a printing machine, in particular a digital multi-color printing machine comprising a plurality of printing units, said printing machine not requiring a transverse offset of the sheets to be printed.

In accordance with the invention, this object is achieved by a method in accordance with Claim 1. In particular, such a method comprises the following: the transport of a first group of sheets of an at least semi-transparent type through the printing machine in such a manner that the sheets are moved at least once through the plurality of printing units; the transport of a second group of sheets of an at least semi-transparent type through the printing machine in such a manner that the sheets are moved at least twice through the plurality of printing units, with the sheets being turned over between the passages; the printing of at least one register mark on one of the sheets of the first group of sheets during the first passage through the printing units; the measurement of the respective register mark at a register sensor located – in the transport direction of the sheets – downstream of the plurality of printing units; the printing of at least one register mark on one of the sheets of the second group of sheets during the second passage through the printing units, with no register marks being printed during the first passage; the measurement of the respective register mark at the register sensor located – in the transport direction of the sheets – downstream of the plurality of printing units; and the detection of the calibration parameters with the use of the thus

obtained measured results of the register sensor. Such a method does not require a transverse offset of the sheets and is also suitable for a calibration of the printing machine for at least semi-transparent sheets. Of course, the sheets may also be fully transparent.

In a preferred embodiment of the invention, the sheets of the first group, after the first passage through the plurality of printing units, are fed to a stacker of the printing machine, without another passage through the printing units. As a result of this, the calibration period is reduced because the sheets do not first move along a duplex path. In this embodiment, after the first passage through the plurality of printing units, the sheets of the first group are preferably moved through a fusing unit.

Preferably, after the first passage through the printing units, the sheets of the second group are moved through a fusing unit in order to be put into the same state that they would have if the front side had also been printed. To this end, the fusing unit is preferably operated in a fusing mode while the second group of sheets is being moved through said unit.

For a good calibration, preferably a plurality of register marks is printed on the transport belt before the respective groups of sheets and subsequently measured by the register sensor, with the measured results thus obtained being input in the detection of the calibration parameters. In a similar manner, preferably a plurality of register marks is printed on a transport belt of the printing machine after the respective groups of sheets and subsequently measured by the register sensor, with the measured results thus obtained being again input in the detection of the calibration parameters. In one embodiment of the invention, at least one register mark is printed between each of the sheets of the respective groups on a transport belt of the printing machine and subsequently measured by the register sensor, with the measured results thus obtained also being input in the detection of the calibration parameters.

BRIEF DESCRIPTION OF THE DRAWINGS

Hereinafter, the invention will be explained in greater detail with reference to a preferred exemplary embodiment of the invention and with reference to the drawings which show in

Fig. 1 a schematic representation of a multi-color printing machine;

Fig. 2 a schematic plan view of a transport belt of the multi-color printing machine;

Fig. 3 a schematic representation of a register mark;

Fig. 4 a flow chart that shows an exemplary process during a calibration of the multi-color printing machine.

DETAILED DESCRIPTION OF THE INVENTION

Positional and directional indications used in the description hereinafter relate to the representation in the drawings and are not intended to restrict the application in any way.

Fig. 1 shows a schematic representation of a multi-color printing machine 1 comprising a feeder 3, a positioning unit 4, a plurality of printing units 5, a first transport unit 6, a second transport unit 7, a register sensor 8, a cleaning unit 9, a fusing unit 11 and a stacker 13.

The most diverse embodiments of such multi-color printing machines have been known, and Fig. 1 represents only a highly schematic example of such a machine.

The feeder 3 is disposed to receive a stack of sheets and to feed the individual sheets to the positioning unit 4 that will align a sheet in regard of its position in order to then move it on to the first transport unit 6. In a known manner, this alignment may comprise an in-track alignment (in the direction of movement of the sheet), a cross-track alignment (transverse to the direction of movement of the sheet) as well as a skew alignment (diagonal to the direction of movement of the sheet). The printing units 5 are of a type that is suitable to print the respective color separation images on the sheets located on the first transport unit 6. In the shown multi-color printing machine 1, five

printing units 5 are shown, said printing units being operated, for example, with the colors Black, Cyan, Magenta, Yellow and a custom ink such as, for example, Clear DryInk. As is obvious to the person skilled in the art, it is also possible, of course, to use other colors, and the sequence of the colors in the printing units may be different from the aforementioned sequence. The printing units 5 are shown as electrophotographic printing units, however, they may also be printing units based on ink-jet technology or any other printing technology. The printing units 5 are located above the first transport unit 6.

The first transport unit 6 essentially comprises a transparent transport belt 15 that is guided so as to circulate around appropriate guide and/or drive rollers 17 in order to provide a closed path of movement. In particular the first transport unit 6 is intended to transport one of the sheets coming from the positioning unit 4 past the printing units 5 in the direction of the fusing unit 11 in order to allow a printing of the sheet by the printing units 5. The direct transport path of a sheet from the feeder 3 via the positioning unit 4 and the first transport unit 6 through the printing units 5 to the fusing unit 11 and the stacker 13 is referred to as a simplex path.

The second transport unit 6 forms a so-called duplex path that is represented by the dashed line 20. The crossed dashed lines 22 represent a sheet-turning unit inside the duplex path. The duplex path is provided in the known manner so as to receive a sheet at an end of the fusing unit 11 downstream in the direction of transport of a sheet and so as to return said sheet to the positioning unit 4 in order to return said sheet for a second printing. In order to permit a printing of the reverse side of the sheet, the turning unit is provided in the duplex path. The duplex path and the turning unit provided therein may have any suitable design that is not illustrated in detail here. However, the turning unit is preferably a unit wherein the lead edge of the sheet is maintained while the sheet is being turned. Although the duplex path is shown such that it extends around the printing units 5 at the top, it is also possible, of course, for said path to extend at the bottom around the transport unit 6.

The register sensor 8 is an optical sensor that is directed at the transport belt 15 downstream of the printing units, viewed in the direction of rotation of the transport belt 15. Below the transport belt 15 is a reflector or white background (not illustrated) that is located opposite the register sensor 8. The most diverse optical sensors may be used as the register sensor 8. For example, said sensor is a sensor that generates voltage signals corresponding to light-dark or dark-light transitions, said voltage signals being comparable with a prespecified threshold value and evaluated.

Viewed in the direction of circulation of the transport belt, the cleaning unit 9 is located downstream of the register sensor 8 and comprises means that are suitable for cleaning the transport belt 15, such means being, for example, rotating brushes or stationary strippers.

Viewed in the direction of circulation of the transport belt 15, the fusing unit 11 is located downstream of the printing units 5 at an end of the first transport unit 6, said end being remote from the positioning unit 4, and is suitable for receiving printed sheets from the transport belt 15. Suitable means for fusing, for example, a toner applied by the electrophotographic printing units, are provided in the fusing unit. The stacker 13 is provided adjacent to the fusing unit 11 and is disposed to receive printed sheets.

During the operation of the multi-color printing machine 1, it is possible to print register marks on the transport belt and, optionally, on the sheets present thereon, for various purposes such as, for example, calibration purposes or for the adjustment of the peripheral register for a print job. These register marks are then moved past the register sensor 8 and detected in the known manner.

Fig. 2 is a schematic plan view of the transport belt 15, wherein, in order to simplify the illustration, no printing units are shown above the transport belt. The plan view shows only the register sensor 8 next to the transport belt 15 as a part of the multi-color printing machine. The arrow A indicates the advance direction of the transport belt from right to left.

In accordance with the representation of Fig. 2, three sheets 25 forming a group can be seen on the transport belt as well as a plurality of

virtual register frames 27. During a calibration process of the multi-color printing machine, said process being explained hereinafter, register marks are printed in these virtual register frames. In practice, the number of sheets forming a group will, as a rule, deviate from the three shown sheets, and the exact number of sheets of such a group, as a rule, depends on the dimensions of the printing machine, as well as on the dimensions of the sheets themselves.

As is obvious from the plan view of Fig. 2, a plurality of virtual register frames is positioned before and after the sheets 25 of the group, viewed in advance direction of the transport belt 15, one virtual register frame 27 being positioned between each of the sheets 25 of the group, and two of the virtual register frames being positioned on each of the sheets 25. In practice, the number of virtual register frames in the respective positions before, after, between and on the sheets of the group may deviate from the shown number, whereby it may also be possible that no virtual register frames at all are provided in some of these positions. The sheets, the virtual register frames and also the register sensor 8 are centered relative to a longitudinal axis B of the transport belt 15.

Fig. 3 shows an example of a register mark 30 consisting of register lines 33 through 38 that are printed within a virtual register frame 27. In the shown example, the register mark 20 consists of two register lines 33, 34 having the color Black, one register line 35 having the color Cyan, one register line 36 having the color Magenta, one register line 37 having the color Yellow, as well as one register line 38 having a custom color. The respective register lines 33 through 38 are successively printed by the respective printing units 5. It is then possible for the register sensor 8 to detect and evaluate the register mark shown in Fig. 3 downstream of the last printing unit 5.

Fig. 4 shows a flow diagram of an example of a process for calibrating the multi-color printing machine for at least semi-transparent sheets that are to be printed. First, the printing machine is initialized in block

100, this comprising the input that the subsequent calibration routine is provided for at least semi-transparent sheets.

Thereafter, the process control moves on to block 102 where the register marks are printed on the sheets of a first group. In particular, a first group of sheets from the feeder 3 is decollated and guided toward the stacker 13 via the positioning device 4, the first transport unit 6 and the fusing unit 11. In so doing, the respective printing units 5 print a first group of register marks on the respective sheets. This additionally allows print register marks to be printed on the transport belt as indicated in Fig. 2.

In block 104, the register marks thus printed are subsequently detected by the register sensor 8.

Thereafter, the process control moves on to block 106 where register marks are printed in a specific manner on the sheets of a second group. In so doing, in particular a second group of sheets is transported out of the feeder 3 in order to be guided – via the positioning unit 4, the transport unit 6, the fusing unit 11, the second transport unit 7 – back to the positioning unit 4, the first transport unit 6, the fusing unit 11 and finally to the stacker 13. In so doing, the sheets are passed twice through the printing units, said sheets being turned by an appropriate turning unit in the second transport unit 7 before the second passage. In accordance with block 108, the sheets are not printed by the printing units 5 during the first passage; however, during the second passage register marks are printed on the sheets. During the second passage, register marks may again be printed on the transport belt 15, i.e., in the same manner as illustrated by Fig. 2.

In block 108, the register marks thus printed are then detected and measured by the register sensor 8.

Subsequently, the process control moves on to block 110 where the calibration process is completed.

Preferably, the fusing unit 11 is operated in normal mode during the entire calibration process, so that the respective sheets are exposed to the fusing process by the fusing unit. Even though the sheets of the second group are not printed during the first passage through the printing units 5, the

fusing unit 11 may change the properties of the individual sheet so that said sheets display the same properties during the second passage that they would have had if they had been printed during the first passage.

The invention has been explained in detail with reference to a preferred embodiment in accordance with the invention, without being restricted to the specifically illustrated embodiment.

In particular, the design of the printing machine 1 may differ from the depicted design. Also, it is not absolutely necessary that register marks be printed in corresponding virtual register frames 27 during the calibration process, as is shown by Fig. 2. Rather, the number of register marks may be different from the number of virtual register frames shown in Fig. 2. Of course, it is also possible to interchange the sequence of the groups of sheets or to guide them in an interleaved manner through the printing machine.

For example, the sheets of the second group may first be guided through the printing units and in the duplex path. While they are in the duplex path, the sheets of the first group are guided through the printing units and printed as previously described. Directly following this, the sheets of the second group coming out of the duplex path are printed by the printing units during said sheets' second passage.

CLAIMS

1. Method for calibrating a printing machine, in particular a digital multi-color printing machine comprising a plurality of printing units, said method comprising the following the steps:
   - transporting a first group of sheets of an at least semi-transparent type through the printing machine in such a manner that the sheets are moved at least once through the plurality of printing units;
   - transporting a second group of sheets of an at least semi-transparent type through the printing machine in such a manner that the sheets are moved at least twice through the plurality of printing units, with the sheets being turned over between the passages;
   - printing at least one register mark on one of the sheets of the first group of sheets during the first passage through the printing units;
   - measuring the respective register mark at a register sensor located – in the transport direction of the sheets – downstream of the plurality of printing units;
   - printing at least one register mark on one of the sheets of the second group of sheets during the second passage through the printing units, with no register marks being printed during the first passage;
   - measuring the respective register mark at the register sensor located – in the transport direction of the sheets – downstream of the plurality of printing units; and
   - detecting calibration parameters with the use of the thus obtained measured results provided by the register sensor.

2. Method as in Claim 1, wherein the sheets of the first group, after the first passage through the plurality of printing units, are fed to a stacker

of the printing machine, without another passage through the printing units.

3. Method as in Claim 1 or 2, wherein, after the first passage through the plurality of printing units, the sheets of the first group are moved through a fusing unit.

4. Method as in one of the previous claims, wherein, after the first passage, the sheets of the second group are moved through a fusing unit.

5. Method as in Claim 4, wherein the fusing unit is operated in a fusing mode while the second group of sheets is being moved through said unit.

6. Method as in one of the previous Claims, wherein, before the respective groups of sheets, respectively a plurality of register marks is printed on a transport belt of the printing machine, said register marks being subsequently measured by the register sensor, and the measured results thus obtained being input in the detection of the calibration parameters.

7. Method as in one of the previous Claims, wherein, after the respective groups of sheets, respectively a plurality of register marks is printed on a transport belt of the printing machine, said register marks being subsequently measured by the register sensor, and the measured results thus obtained being input in the detection of the calibration parameters.

8. Method as in one of the previous Claims, wherein, between each of the sheets of the respective groups, at least one register mark is printed on a transport belt of the printing machine, said register mark being subsequently measured by the register sensor and the measured results

thus obtained being input in the detection of the calibration parameters.

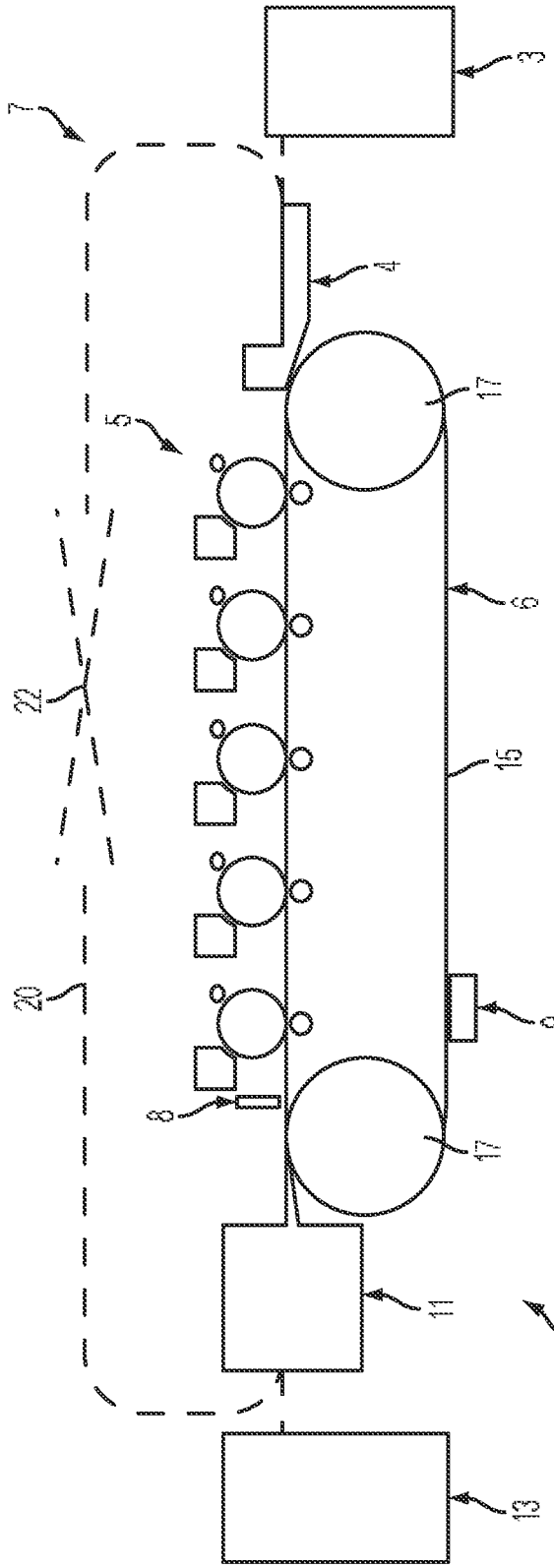

FIG. 1

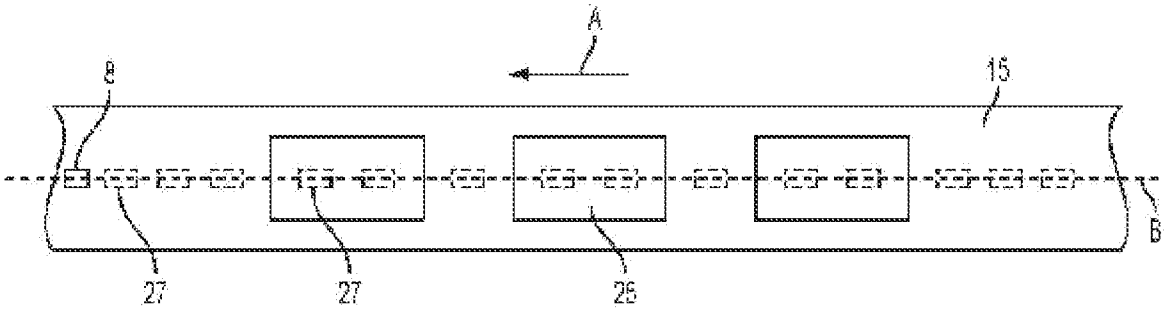

FIG. 2

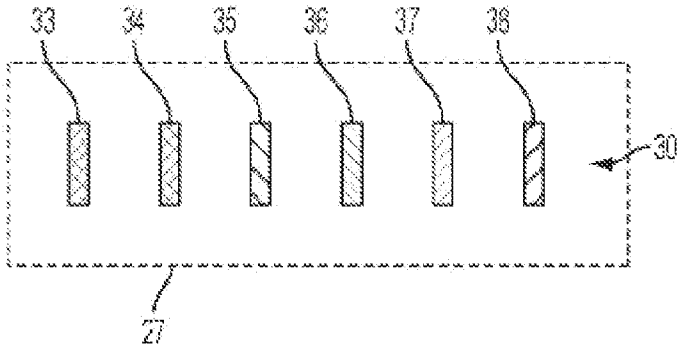

FIG. 3

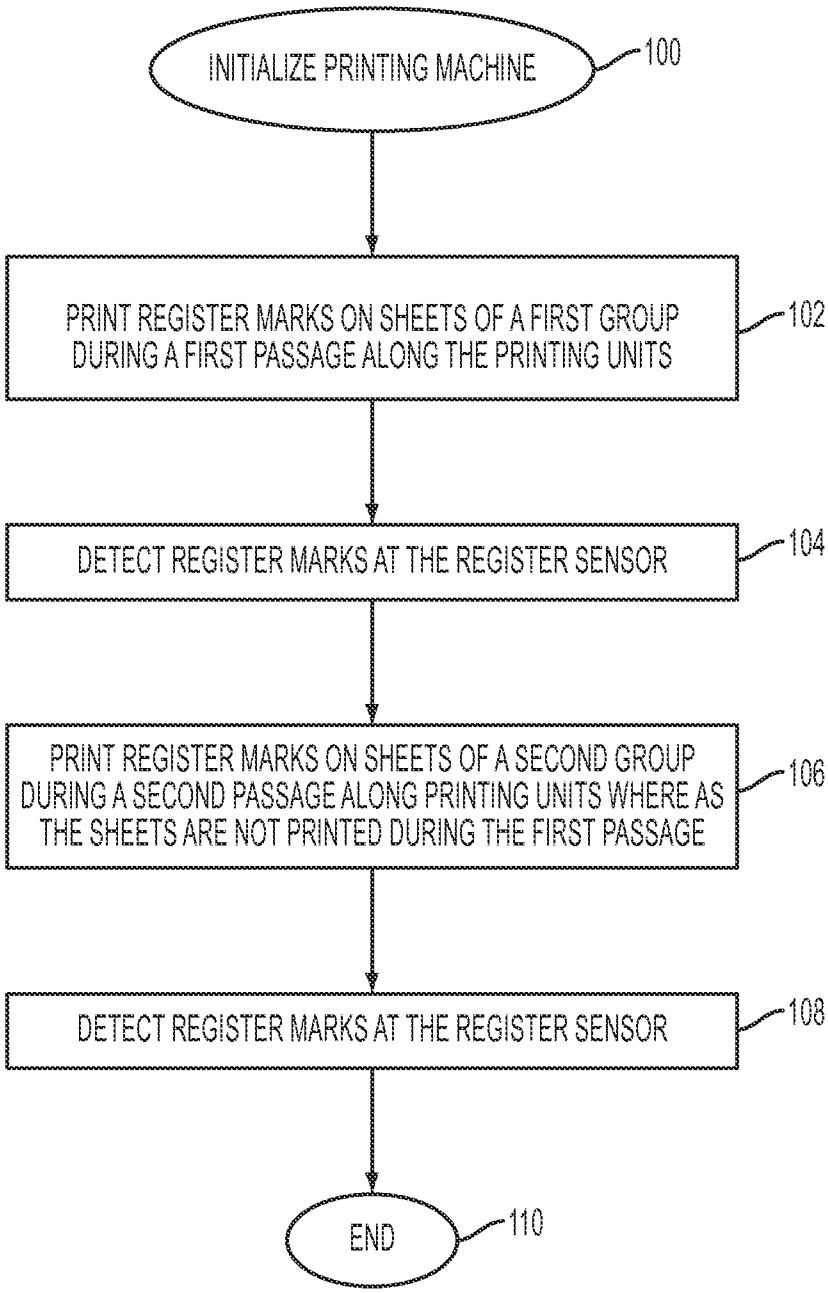
INITIALIZE PRINTING MACHINE
100
PRINT REGISTER MARKS ON SHEETS OF A FIRST GROUP DURING A FIRST PASSAGE ALONG THE PRINTING UNITS
102
DETECT REGISTER MARKS AT THE REGISTER SENSOR
104
PRINT REGISTER MARKS ON SHEETS OF A SECOND GROUP DURING A SECOND PASSAGE ALONG PRINTING UNITS WHERE AS THE SHEETS ARE NOT PRINTED DURING THE FIRST PASSAGE
106
DETECT REGISTER MARKS AT THE REGISTER SENSOR
108
END
110

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2009/055493

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04N1/50 B41F33/00

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)
B41F G01G

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 practical, 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.
A	WO 2005/077658 A (EASTMAN KODAK CO [US]; BONESS JAN DIRK [DE]) 25 August 2005 (2005-08-25) cited in the application the whole document	1
A	AU 2005 202 009 A1 (CANON KK) 5 January 2006 (2006-01-05) page 6, line 5 - page 8, line 17; figure 1	1
A	EP 1 292 115 A (XEROX CORP [US]) 12 March 2003 (2003-03-12) paragraphs [0031] - [0036]; figure 3	1
A	US 2008/050132 A1 (BONESS JAN D [DE] ET AL) 28 February 2008 (2008-02-28) paragraphs [0024] - [0026]	1

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
31 July 2009	12/08/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Hardell, Alexander

INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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