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PRINTING SYSTEM

(57) A printing system comprising:

- a print station (16) disposed at a sheet transport path (18) diverging to at least two output paths (44);

- a sheet feeder (10) arranged to feed a stream of media sheets (60) into the transport path (18) so as to be fed sequentially to the print station (16);

- a duplex loop arranged to redirect sheets, onto which a first image has been printed on a first side, into the sheet transport path upstream of the print station;

- a sheet ejector (64) disposed upstream of the print station and downstream of a junction of the duplex loop with the transport path for ejecting unsuitable sheets (60) from the transport path (18) to a discharge path (66); and

- a controller (20) arranged to receive print instructions concerning printing multiple copies of at least one multi-page document (D1) and to schedule a print order of images to be consecutively printed on the sheets (60) such that the printed copies are fed to their respective output path in a predetermined page order, characterized in that:

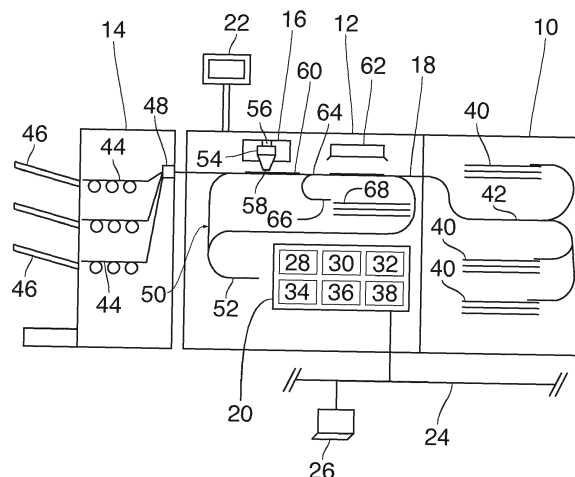
the controller (20) is further arranged to:

- reserve at least two output paths (44) for receiving sheets (60) of the same document;

- as long as no sheet has been rejected, direct the sheets to only one of the reserved output paths (44); and,

- if a sheet returning from the duplex loop (50) is ejected by the sheet ejector (64), re-scheduling the print order and directing subsequent printed sheets to at least two of the reserved output paths (44) in a sequence preserving the page order in each of these output paths.

Fig. 1



Description

[0001] The invention relates to a printing system comprising:

- a print station disposed at a sheet transport path diverging to at least two output paths;
- a sheet feeder arranged to feed a stream of media sheets into the transport path so as to be fed sequentially to the print station;
- a duplex loop arranged to redirect sheets, onto which a first image has been printed on a first side, into the sheet transport path upstream of the print station;
- a sheet ejector disposed upstream of the print station and downstream of a junction of the duplex loop with the transport path for ejecting unsuitable sheets from the transport path to a discharge path; and
- a controller arranged to receive print instructions concerning printing multiple copies of a multi-page document and to schedule a print order of images to be consecutively printed on the sheets such that the printed copies are fed to their respective output path in a predetermined page order.

[0002] A printing system of this type has been proposed in European Patent Application No. 17 173 404.9 as well as in WO 2016177676 A1.

[0003] In such a printing system, the sheet ejector forms part of a system for monitoring the quality of the sheets that are fed to the print station. For example, when the print engine is an ink jet printer for printing high quality images, the nozzles of the print head will be arranged at a very small spacing above the top surface of the sheets that are conveyed on the transport path. Consequently, the top surfaces of the sheets must be perfectly flat in order to prevent the sheets from colliding with the print head. It may therefore be recommendable to scan the surfaces of the sheets in the transport path upstream of the print station with a sensor, e.g., a 3D laser scanner, and when the sensor detects any wrinkles or other surface irregularities of a sheet, this sheet will be skipped in the print sequence, by diverting the sheet into the discharge path before it reaches the print station.

[0004] However, ejecting sheets disrupts the sequence of the stream of sheets. Rejected sheets require reprinting and insertion into the position of the ejected sheets. This generally requires discharging additional sheets upstream of the rejected sheet, as else the page order in the output stack would be incorrect. One example is when a sheet on a duplex pass is rejected, thereby requiring said one-side printed sheet and all one-side printed sheets trailing behind said sheet to be discharged. In consequence, the productivity of the printing system is compromised and the amount of waste of material (media sheets and ink) is increased. One solution to that problem has been proposed in the prior application.

[0005] It is an object of the invention to provide an al-

ternative printing system which permits a high productivity and a reduction of waste.

[0006] In order to achieve this object, the system according to the invention is characterized in that the controller is further arranged to:

- reserve at least two output paths for receiving sheets of the same document;
- direct the sheets initially to only one of the reserved output paths; and,
- if a sheet returning from the duplex loop is ejected by the sheet ejector, re-scheduling the print order and directing subsequent printed sheets to at least two of the reserved output paths in a sequence preserving the page order in each of these output paths;

(a) identifying a sheet number M_x of a sheet immediately following the ejected sheet;

(b) identifying, for each reserved output path (44), a sheet number M_i of a sheet that has last been fed into that output path, i being an index that indicates the output path; and

(c) selecting the output path for which $(M_i + 1 - M_x)$ modulo s is smallest, and feeding the subsequent printed sheets to that output path;

wherein s is the number of sheets of the document (D_1), the sheet numbers M_x , M_i run from 1 to s and count the sheets of the document, and $M_i = 0$ stands for an empty output path.

[0007] As long as no sheets need to be ejected, all printed sheets are fed to a single output path so that they will be output and optionally stacked in a desired page order. If a sheet is rejected, it may be necessary to discard also some of the subsequent sheets that are in the duplex loop and belong to the same copy of the document. However, as soon as a print cycle for a next copy of the document begins, another output path, which has been reserved for that purpose, will be used for opening a new stack of printed copies. This permits to save at least some of the copies in the duplex loop that would otherwise have to be discarded, and yet the page order will be preserved in both stacks that are formed in the two output paths. In general, the stack in the first output path will then contain an incomplete copy of the document. However, this copy may be completed at a later stage in the print process.

[0008] More specific optional features of the invention are indicated in the dependent claims.

[0009] Optionally, the controller may switch back to the first output path as soon as a next sheet which has the required image content is returned from the duplex loop. Then the last copy in the first stack will be completed and completion of the last copy in the second stack will be postponed. Then, in case that another sheet needs to be rejected, the controller may select the one of the two or more incomplete stacks for which the number of sheets to be discarded will be smallest.

[0010] In certain situations, the number of sheets to be

wasted may be reduced further by re-scheduling sheets that had originally been assigned to a later copy of the document to a copy that was left incomplete due to a defective sheet.

[0011] If the printing system has more than two output paths, each output path containing a stacker for stacking the printed sheet, it may be useful to initialize the stacks in the different output paths such that the sheet numbers of the top sheets in each stack are evenly distributed over the total number of sheets of the document. This will minimize the number of sheets that need to be discarded before a next sheet returning from the duplex loop fits on one of the several stacks.

[0012] The invention further relates to a method of scheduling a print job for a printing system in accordance with the principles described above, and a software product implementing the invention.

[0013] Embodiment examples of the invention will now be described in conjunction with the drawings, wherein:

- Fig. 1 is a schematic view of a printing system according to the invention;
- Fig. 2 is a diagram illustrating an example of scheduling images that belong to a plurality of documents to be printed;
- Fig. 3 is a more detailed diagram illustrating an example of scheduling images of a single document to be printed;
- Fig. 4 is a diagram analogous to Fig. 3, illustrating consequences of a defective media sheet in a conventional scheduling process;
- Fig. 5 is a diagram analogous to Fig. 3 showing how the images are rescheduled in accordance with an embodiment of the invention;
- Figs. 6 and 7 are schematic illustrations of conditions of two output bins in the printing system shown in Fig. 1;
- Fig. 8 is a diagram showing a re-scheduling process as an alternative to what has been shown in Fig. 5;
- Fig. 9 is a diagram of a later stage of the scheduling process for the document considered in Fig. 3;
- Fig. 10 is a diagram analogous to Fig. 9 showing a re-scheduling process according to the invention in case of a defective sheet in the schedule according to Fig. 9; and

Fig. 11

diagrammatically shows an example of initialized fill states of four output bins in a printing system according to the invention.

[0014] As is shown in Fig. 1, a printing system that is described here as a representative example comprises a sheet feeder 10, a main body 12, and a sheet receiver 14. The main body 12 comprises a print station 16 disposed at a sheet transport path 18, an electronic controller 20 and a user interface 22.

[0015] The controller 20 may be formed by a computer, a server or a workstation and is connected to all the functional components of the printing system for controlling the printing system and is further connected to the user interface 22 and to a network 24 via which the controller may communicate with a remote workstation 26 of a user or operator. In an alternative embodiment, the controller 22 may also be installed outside of the main body 12 for controlling the various system components via the network 24.

[0016] The hardware and/or the software of the controller 20 includes among others a print job receiving section 28, a scheduler 30, a feed control section 32, a print control section 34, an output control section 36, and a sheet manager 38. The print job receiving section 28 is arranged to receive, e.g., via the network 24, print jobs each of which includes image data for one or more pages to be printed as well as various job settings. Optionally, the image data may also be received from a local scanner whereas the job settings are input at the user interface 22. The job settings include among others instructions that specify for each image to be printed the properties or type of a recording medium on which the image shall be printed.

[0017] The sheet feeder 10 includes a plurality of holders 40 each of which accommodates a supply, e.g. a stack of media sheets of a certain media type. The media types in the different holders 40 may differ in sheet thickness, sheet material, surface properties of the sheets and the like. The sheet feeder 10 further includes a feed mechanism 42 arranged to separate individual sheets from a selected one of the holders 40 and to supply them one by one into the sheet transport path 18 under the control of the feed control section 32.

[0018] When the job receiving section 28 has received a print job, the scheduler 30 determines a sequence in which the images of this print job shall be printed. For the purposes of this description, the term "image" shall designate a page size image that is to be printed onto one side of a recording sheet. The scheduler 30 further has access to a data base that stores the media types and properties of the sheets accommodated in the various holders 40. Based on the job settings that concern the media properties, the scheduler 30 selects the holders 40 from which the sheets with the desired properties are to be taken and determines a sequence in which the sheets of the different media types are to be fed into the

sheet transport path 18 such that the sequence of sheets matches the sequence of images to be printed.

[0019] When the print process has been started, the feed control section 32 controls the feed mechanism 42 to supply the sheets in the sequence as scheduled into the sheet transport path 18, and the print control section 34 controls the print station 16 so as to print a corresponding image on the top side of each sheet.

[0020] In the example shown, the output section 14 has a plurality of output paths 44 including bins in which the sheets may be stacked after they have left the print station 16. When a stack, which may for example comprise a set of sheets forming one or more complete copies of a multi-page document, has been completed, the stack will be forwarded to an associated output tray 46. In an alternative embodiment the completed stacks may also be forwarded to a finisher (not shown) for performing finishing operations such as stapling, punching and the like.

[0021] The output section 14 further includes a switch 48 which is controlled by the output control section 36 for directing each sheet to a designated one of the output paths 44.

[0022] In the example shown, the main body 12 of the printing section also includes a duplex loop 50 which branches off from the sheet transport path 18 downstream of the print station 16, reverses the orientation of the sheets in a sheet reversing mechanism 52 and then returns the sheets upside down to the entry side of the sheet transport path 18.

[0023] It shall further be assumed in this example that the print station 16 includes as print engine an ink jet print head 54 that is disposed above the sheet transport path 18 and is adjustable in height by means of a height adjustment mechanism 56. Dependent upon the thickness and other properties of the sheets, the height of the print head 54 is adjusted such that a nozzle face 58 at the bottom side of the print head forms only a very narrow gap with a top surface of a sheet 60 that is being conveyed past the print head. In this way, it will be assured that, for each individual sheet, the ink jet print process will be performed with an optimal nozzle-to-sheet distance.

[0024] As the gap between the nozzle face 58 and the sheet 60 may be very small, any wrinkles or a surface waviness or other surface irregularities of the sheet 60 may result in a poor image quality or even in a collision of the sheet with the print head. For this reason, a sensor 62 for monitoring the quality of the sheets is disposed at the sheet transport path 18 upstream of the print station 16. The sensor 62 may for example be a 3D laser scanner that scans the entire surface of the sheet in order to capture a surface relief. The relief data are transmitted to the sheet manager 38 in the controller 20, where they are processed further to decide whether the quality of the sheet is acceptable or not. The sensor 62 may also detect other quality criteria relating to, for example, alignment errors or skew errors of the sheets.

[0025] When a sheet is found to be unacceptable, the sheet manager 38 controls a sheet ejector 64 in the sheet

transport path 18 in order to excise this sheet from the scheduled sequence and to divert it into a discharge path 66 via which the sheet is discharged into a discharge bin 68. In this way, the defective sheet will be skipped in the print process. However, the image that was designated for being printed onto the discarded sheet must nevertheless be printed. Normally, this situation would lead to an abortion of the print process, with the result that the entire print process, including the scheduling process, has to be started anew, and all the sheets that had been present already in the sheet transport path 18 and in the duplex loop 50 would have to be discarded.

[0026] It should be observed in this context that Fig. 1 is only a schematic sketch and that, in practice, the number of sheets that can be accommodated in the sheet transport path 18 and in the duplex loop 50 may be considerably large. For example, the duplex loop 50 may be arranged to accommodate as many as 32 sheets.

[0027] The controller 20 and, in particular, the scheduler 30 is configured to re-schedule the images to be printed whenever a sheet has been found unacceptable and has been ejected by the sheet ejector 64. The purpose of re-scheduling is to minimize the number of sheets being wasted without disrupting the page order in the stacks in the output paths 44.

[0028] Fig. 2 is an example of scheduling a print process for printing multiple copies of each of two multi-page documents D1 and D2. In the example shown, the document D1 comprises 5 sheets designated by sheet numbers M_i with $i = 1, \dots, 5$ (only M_1 being visible in Fig. 2), corresponding to 10 pages in duplex printing. According to the job specifications, three copies $C_1 - C_3$ of the document D1 shall be printed. Each sheet bears a label B1 indicating the output path 44 (bin) to which the sheets are to be directed.

[0029] The document D2 comprises 6 duplex sheets in this example. Several copies C_1, C_2 , etc. of this document are to be printed, and each sheet bears a label B2, indicating that the sheets are to be stacked in the bin of an output path 44 different from the one where the copies of the document D1 will be stacked, so that the copies of the two documents are kept separate from one another.

[0030] It would be possible to use a schedule in which the copies of document D1 are printed interleaved with copies of the document D2, and the documents would still be separated because the copies are sent to different bins. In this example, however, the multiple copies of the documents D1 and D2 are printed one after the other, so that, while the document D1 is being printed, the bin labelled as B2 will remain empty.

[0031] Fig. 3 is a more detailed diagram of a schedule for printing on the media sheets of the document D1 shown in Fig. 2. The sequence of sheets that have been shown in Fig. 3 indicate the sequence in which the sheets are fed past the print station 16 for receiving an image on the back side after they have passed through the duplex loop 50. A section O contains sheets that have been

finished already and are conveyed into the output path designated as B1. A sequence DL represents sheets that are in the duplex loop 50 which, in this example, has a capacity of 9 sheets. A section I represents sheets that have not yet entered into the duplex loop. It will be observed that the image content of the sheets is variable only for the sheets in the section I, whereas, for the sheets in the duplex loop, the image content and the related sheet number can no longer be changed because an image has already been printed on the first side of the sheet.

[0032] In the example shown in Fig. 3, the section O comprises the first three media sheets M1 - M3 of a first copy C1 of the document. The next two sheets returning from the duplex loop are the sheets M4 and M5 of the first copy C1, and they are followed by 5 sheets of the next copy C2, whereas the last two sheets in the duplex loop correspond already to the third copy C3 of the document. The sheet at the rightmost end in the section I in Fig. 3 is the first sheet M1 of the fourth copy C4.

[0033] Fig. 4 illustrates a situation where the sheets have been scheduled as in Fig. 3, but the fourth sheet M4 of the first copy C1 is found to be defective and is ejected by the sheet ejector 64, so that sheet M4 will not reach the output stack. The next sheet M5 cannot be fed to the output stack, neither, because then the page order in the output stack would be disrupted and the pages of sheet M4 would be missing. The same holds true for all subsequent sheets in the duplex loop so that, in general, it would be necessary to discard all the sheets in the duplex loop, which means that, in this example, as many as 9 media sheets would be wasted before printing of the last two sheets of the first copy C1 would be resumed with the first sheets in the section I.

[0034] Fig. 5 illustrates the same situation as Fig. 4, but shows the result of a scheduling process according to the invention. Again, sheet M4 of the first copy C1 is defective and must be ejected, and the last sheet M5 of the first copy C1 has to be discarded as well. However, the next sheet in the duplex loop, i.e. the first sheet M1 of the second copy C2 is not discarded, but instead a new stack of printed copies is opened in the empty bin B2. Thus, the print process can be continued and all subsequent sheets in the duplex loop can be utilized so that the number of wasted sheets is reduced to two. In this case, a message on the user interface 22 will alert the user or operator that the copies of the document D1 will be output on two of the output trays 46.

[0035] In the example shown in Fig. 5, the stacking of printed sheets M4 and M5 on the first stack in the bin B1 is resumed as soon as the last sheet (M2 of copy C3) in the duplex loop has been printed. Thus, the second bin B2 will contain the complete second copy C2 and an incomplete copy C3 comprising only the sheets M1 and M2. This copy will then be completed by the end of the print process, at the latest.

[0036] As an alternative, it would also be possible to continue with stacking sheets in the bin B2 and to leave

the copy C1 in the bin B1 incomplete. Then, this copy would be completed by the end of the print process for document D1.

[0037] Fig. 6 shows the condition of the bins B1 and B2 at the time when the duplex loop section DL in Fig. 5 has been emptied. Then the first bin B1 contains the first three sheets M1 - M3 of the first copy C1, and the bin B2 contains the second copy C2 and the first two sheets M1, M2 of the third copy C3. At this instant, the output control section 36 will switch back to the first bin B1, so that the first copy C1 will be completed and stacking in bin B1 will continue with a fourth copy C4.

[0038] Fig. 7 illustrates the state at the time when the rightmost sheet (M2 of C4) in Fig. 5 has been finished. The next sheet, a sheet with number M3, would be sent to bin B1 in order to continue with the copy C4. However, this sheet might as well be sent to bin B2 in order to continue with copy C3.

[0039] At the time when the sheet M4 of copy C1 is ejected in Fig. 5, the image contents of all the sheets in the section I may still be changed (except in case of a conflict concerning the required media type), so that it is possible to modify the schedule by freely switching between stacking in bin B1 or bin B2. Frequently, the likelihood that a sheet becomes defective and has to be ejected depends upon the image content of the image printed on the first side of the sheet. For example, if the image covers a large solid area so that a larger amount of ink is applied to the sheet, this may cause the sheet to become so wavy that it has to be discarded. Consequently, when a sheet M4 has been ejected, it is likely that, in a later copy, it will again be the sheet M4 that is found to be defective and has to be discarded. It will therefore be a good strategy to continue with stacking in bin B2 until the "critical" sheet M4 (of copy C3 in this example) has been finished and forms the topmost sheet on the stack in bin B2. Then, if another sheet M4 has to be ejected, the next sheet following in the duplex loop will be M5 and will fit into the page order of the stack in bin B2, so that printing can readily be continued with stacking sheets in bin B2 and the only sheet that has to be wasted is the defective sheet M4. Then, the same strategy may be applied for bin B1, i.e. the stack in that bin would be filled up until the topmost sheet is M4.

[0040] Fig. 8 illustrates a strategy which may be applied as an alternative to Fig. 4 in a case where no empty bin is available for opening a second stack. Such a situation may occur for example if the operator has not yet removed printed copies from the output trays, so that all bins other than B1 are still occupied.

[0041] As is shown in Fig. 8, it is not mandatory to discard all the sheets in the duplex loop section DL. Instead, when sheet M4 of copy C1 is defective, it is sufficient to discard only the sheets up to and including the sheet M3 of the next copy C2. The next sheet is a sheet M4 which was originally assigned to the second copy C2 (see Fig. 3), but may be re-assigned to the first copy C1, so that stacking in bin B1 may be resumed with that sheet. This

strategy of "intelligent rejection" in case of a defective sheet may be combined with the strategy of switching between different bins in order to minimize the amount of waste.

[0042] Fig. 9 shows a continuation of the schedule shown in Fig. 5. It shall be assumed that the print process has continued with stacking copies C4 (Fig. 5), C5 and C6 in bin B1, so that the bin B2 is still in the state shown in Fig. 7, containing a complete copy C2 and the first two sheets of copy C3. The schedule shown in Fig. 9 includes the last two sheets M4 and M5 of copy C6 and the first sheet M1 of copy C7 in the section O, the remaining sheets of C7 and another copy C8 in the duplex loop, and yet another copy C9 in the input section I. Now, as shown in Fig. 10, it shall be assumed that sheet M2 of copy C7 is found to be defective and is ejected. Then, the scheduling algorithm will check whether the number of wasted sheets can be reduced by switching to the other bin B2. Fortunately, the next sheet M3 following the defective sheet M2 fits in the page order of the stack in bin B2, so that printing can be continued with stacking sheets in bin B2 without having to discard any further sheets. In other scenarios, it may still be necessary to discard some sheets in the duplex loop, but the number of discarded sheets can in many cases be reduced significantly by intelligently switching between the bins B1 and B2.

[0043] As a general rule, if the document has s sheets, M_x is the sheet number of the sheet immediately following the ejected sheet, and M_i is the sheet number of the top-most sheet of the stack in the i -th bin, the task is to identify the bin for which $(M_i + 1 - M_x)$ modulo s is smallest. In the example shown in Fig. 10, M_x is $M_3 = 3$, M_i for the first bin B1 is $M_1 = 1$ (first sheet of copy C7), and M_i for the second bin B2 is $M_2 = 2$ (Fig. 7). Thus, for the first bin B1, $(M_i + 1 - M_x)$ modulo s is $1 + 1 - 3$ modulo $5 = 4$, and for the second bin, $(M_i + 1 - M_x)$ modulo s is $2 + 1 - 3$ modulo $5 = 0$. So, the best strategy is to continue with stacking in bin B2.

[0044] If the printing system has three or more output paths 44, as shown in Fig. 1, it is useful to initialize the bins in the output paths in a particular way in order to reduce the likelihood that a large number of sheets has to be wasted.

[0045] As an example, Fig. 11 shows four bins B1 -B4 that are available in the printing system for collecting copies of one and the same document. It is assumed here that the document has 20 pages, so that each copy of the document consists of 10 duplex sheets. The bin B1 is scheduled for receiving the printed copies as long as no sheet has to be ejected. It is observed however that the assignment of the bin numbers B1 - B4 to the different output paths of the printing system is arbitrary.

[0046] The second bin B2 is left empty. The third bin B3 is filled with the first three sheets of one copy of the document, and the fourth bin B4 is filled with the first six sheets of another copy of the document. As soon as the bins B3 and B4 have been initialized in this way, printing is continued with stacking sheets in bin B1.

[0047] Then, if a sheet M1, M2 or M3 is found to be defective and must be ejected, the next sheet that can be utilized will be sheet M4, and this sheet and the following sheets will be directed to bin B3, so that the number of sheets to be discarded will not be larger than two (plus the defective sheet). On the other hand, if a defect is found for a sheet M4, M5 or M6, the subsequent sheets will be directed to bin B4, and again the number of sheets that must be discarded will be limited to two. Finally, if a defect is found for one of the sheets M7 to M10, the next sheet M1 will be stacked in bin B2 and the number of sheets to be discarded will not be larger than 3. In any case, the bin B2, B3 or B4 that has been selected for stacking the sheets after the ejection event will be filled until it contains a number of sheets equal to 0 modulo 10, 3 modulo 10 and 6 modulo 10, respectively, so that, if another defect occurs, the situation can be handled in the same way as described above.

[0048] In general, if N bins are available in the printing system and the document to be printed has s sheets, the initial fill states $n(i)$ of the bins B_i ($i = 2, 3, \dots, N$) will be given by the following formula:

$$n(i) = (i-1) [s/N],$$

wherein $[]$ are the Gaussian brackets, i.e. $[s/N]$ is the largest integer that is smaller than s/N . Here the index $i = 1$ indicates the bin B1 that is used regularly, in absence of an ejection event.

[0049] The above formula assures that the fill states of the bins are evenly distributed over the range of sheet numbers M1, M2, ..., Ms of the document, so that the number of sheets that need to be discarded until the next sheet fits into the page order in one of the bins will never be larger than s/N .

Claims

1. A printing system comprising:

- a print station (16) disposed at a sheet transport path (18) diverging to at least two output paths (44);
- a sheet feeder (10) arranged to feed a stream of media sheets (60) into the transport path (18) so as to be fed sequentially to the print station (16);
- a duplex loop arranged to redirect sheets, onto which a first image has been printed on a first side, into the sheet transport path upstream of the print station;
- a sheet ejector (64) disposed upstream of the print station and downstream of a junction of the duplex loop with the transport path for ejecting unsuitable sheets (60) from the transport path

(18) to a discharge path (66); and

- a controller (20) arranged to receive print instructions concerning printing multiple copies of at least one multi-page document (D1) and to schedule a print order of images to be consecutively printed on the sheets (60) such that the printed copies are fed to their respective output path in a predetermined page order,
- reserve at least two output paths (44) for receiving sheets (60) of the same document (D1);
- as long as no sheet has been rejected, direct the sheets to only one of the reserved output paths (44); and,
- if a sheet returning from the duplex loop (50) is ejected by the sheet ejector (64), re-scheduling the print order and directing subsequent printed sheets to at least two of the reserved output paths (44) in a sequence preserving the page order in each of these output paths,

characterized in that:

the controller is further arranged to perform the following steps whenever a sheet (60) has been ejected:

- (a) identifying a sheet number M_x of a sheet immediately following the ejected sheet;
- (b) identifying, for each reserved output path (44), a sheet number M_i of a sheet that has last been fed into that output path, i being an index that indicates the output path; and
- (c) selecting the output path for which $(M_i + 1 - M_x)$ modulo s is smallest, and feeding the subsequent printed sheets to that output path;

wherein s is the number of sheets of the document (D1), the sheet numbers M_x , M_i run from 1 to s and count the sheets of the document, and $M_i = 0$ stands for an empty output path.

2. The printing system according to claim 1, wherein the controller (20) is arranged to re-schedule the print order for images to be printed on sheets that have not yet reached the duplex loop (50).
3. The printing system according to any of the previous claims, wherein the controller (20) is arranged to switch back to feeding the printed sheets to the former output path (44) when the output path selected in step (c) has reached a predetermined fill state.
4. The printing system according to claim 3, wherein the predetermined fill state depends upon a sheet number of a sheet that has been ejected.

5. The printing system according to claim 3, wherein the predetermined fill state is selected for each output path (44) such that the fill states, modulo s , of the output paths are evenly distributed over the range from 1 to s .

6. The printing system according to claim 5, comprising a step of initializing the fill states of the output paths such that the fill states of the output paths are evenly distributed over the range from 1 to s .

7. A method of scheduling a print process on a printing system comprising:

- a print station (16) disposed at a sheet transport path (18) diverging to at least two output paths (44);

- a sheet feeder (10) arranged to feed a stream of media sheets (60) into the transport path (18) so as to be fed sequentially to the print station (16);

- a duplex loop arranged to redirect sheets, onto which a first image has been printed on a first side, into the sheet transport path upstream of the print station;

- a sheet ejector (64) disposed upstream of the print station and downstream of a junction of the duplex loop with the transport path for ejecting unsuitable sheets (60) from the transport path (18) to a discharge path (66); and

- a controller (20) arranged to receive print instructions concerning printing multiple copies of at least one multi-page document and to schedule a print order of images to be consecutively printed on the sheets (60) such that the printed copies are fed to their respective output path in a predetermined page order, the method being **characterized by** the steps of:

- reserving at least two output paths (44) for receiving sheets (60) of the same document (D1);
- as long as no sheet has been rejected, directing the sheets to only one of the reserved output paths (44); and,

- if a sheet returning from the duplex loop (50) is ejected by the sheet ejector (64), re-scheduling the print order and directing subsequent printed sheets to at least two of the reserved output paths (44) in a sequence preserving the page order in each of these output paths, **characterized by:**

- (a) identifying a sheet number M_x of a sheet immediately following the ejected sheet;

- (b) identifying, for each reserved output path (44), a sheet number M_i of a sheet that has last been fed into that output path, i being an index that indicates the output path; and

(c) selecting the output path for which $(M_i + 1 - M_x)$ modulo s is smallest, and feeding the subsequent printed sheets to that output path;

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wherein s is the number of sheets of the document (D1), the sheet numbers M_x , M_i run from 1 to s and count the sheets of the document, and $M_i = 0$ stands for an empty output path.

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8. A software product comprising program code on a machine-readable non-transitory medium, the program code, when loaded into a controller (20) of a printing system according to claim 1, causes the controller to perform the method according to claim 7.

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Fig. 1

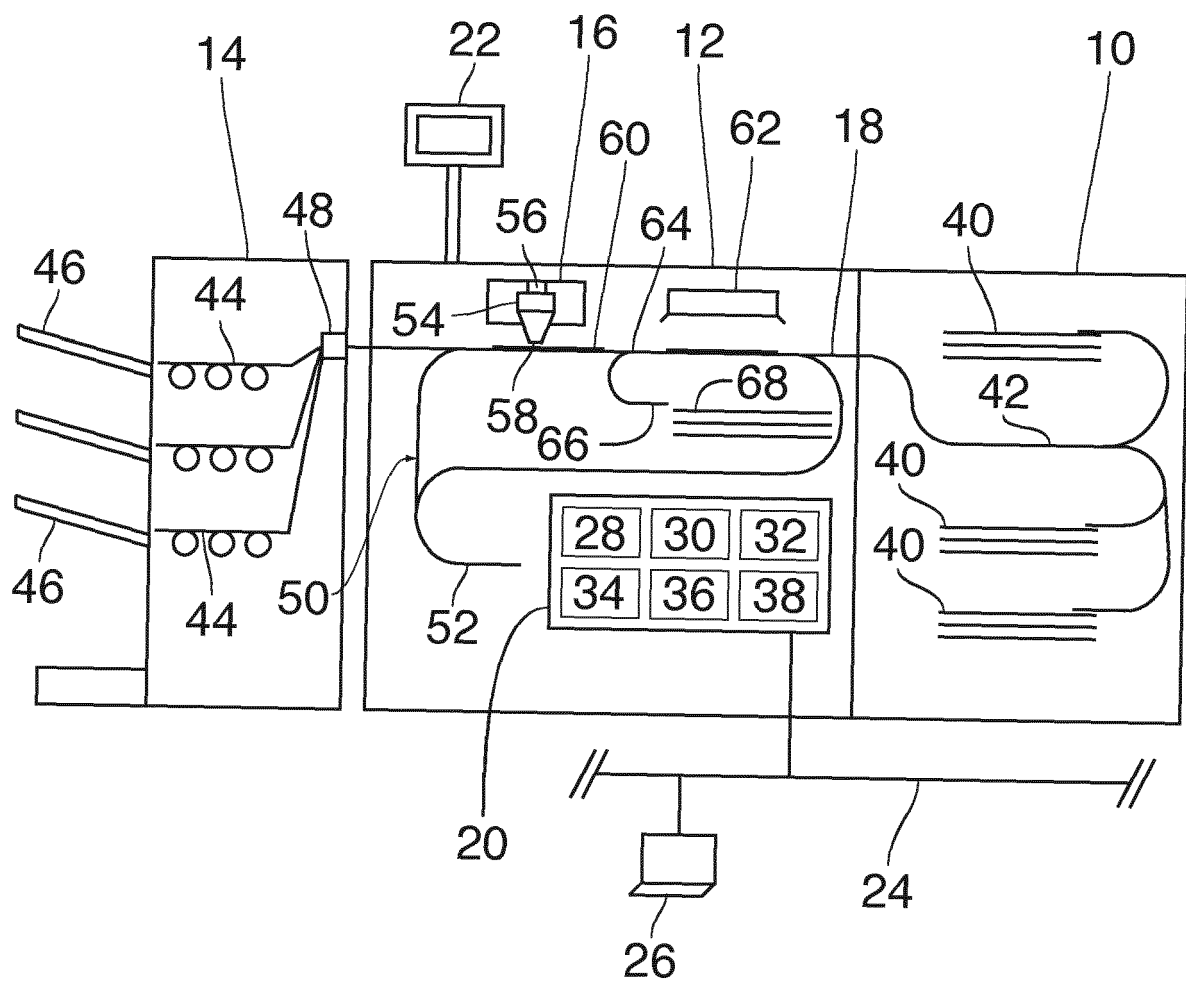


Fig. 2

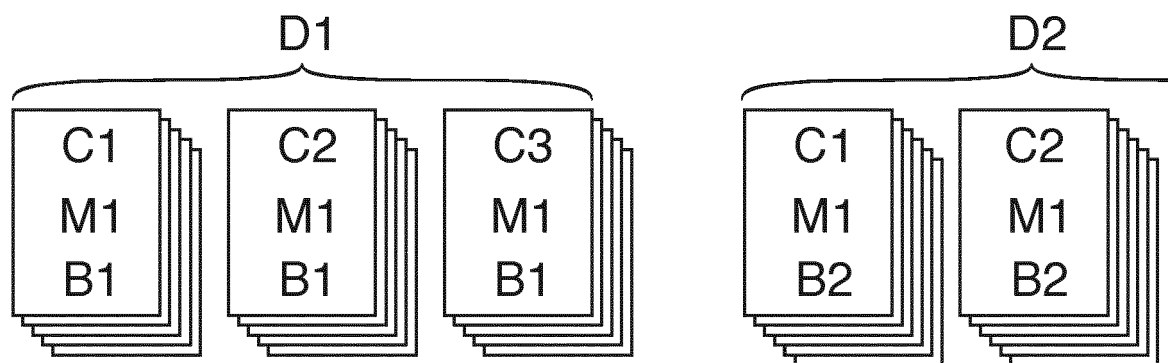


Fig. 3

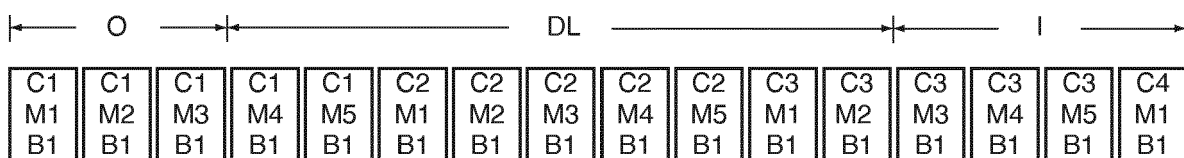


Fig. 4

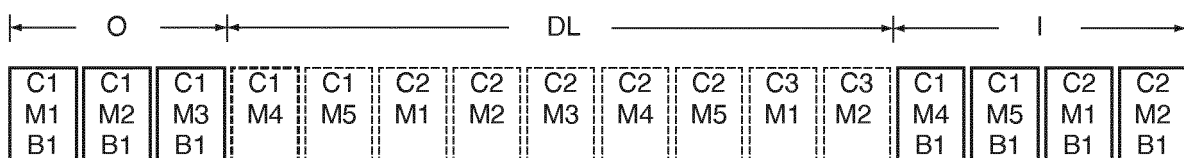


Fig. 5

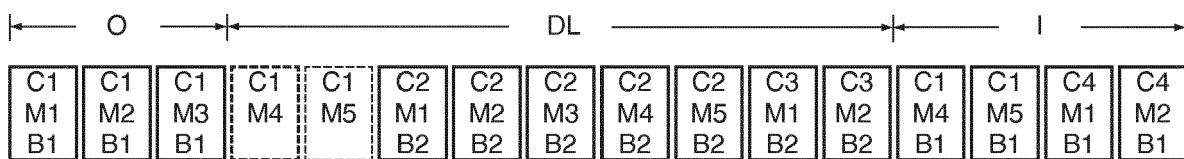


Fig. 6

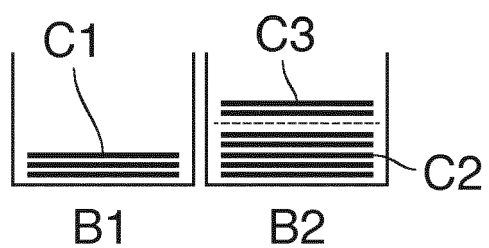


Fig. 7

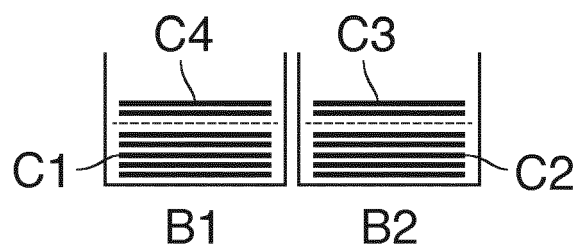


Fig. 8

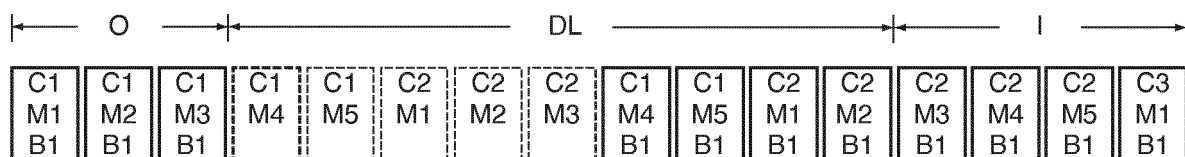


Fig. 9

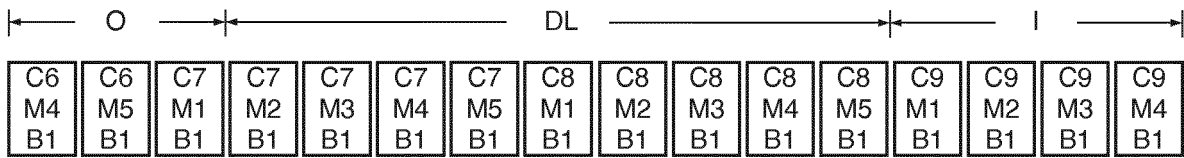


Fig. 10

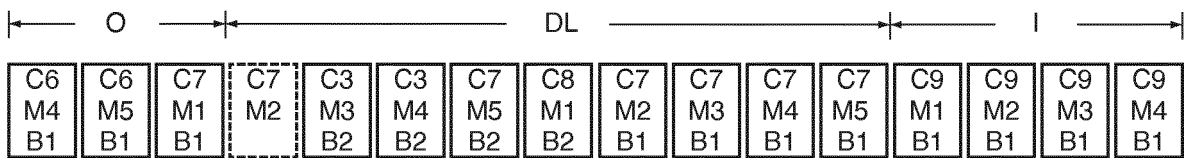
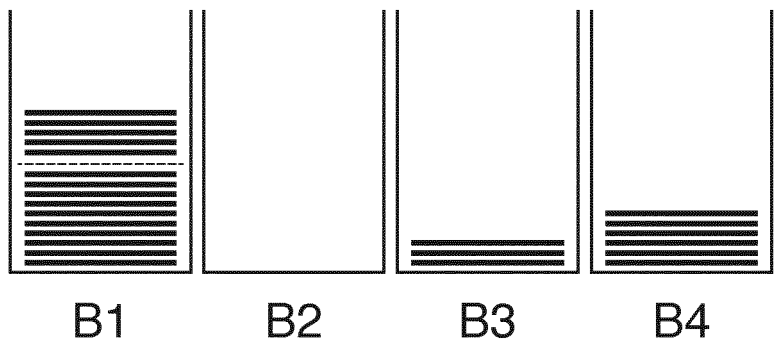


Fig. 11





EUROPEAN SEARCH REPORT

Application Number
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A	WO 2016/177676 A1 (OCE-TECHNOLOGIES B V [NL]) 10 November 2016 (2016-11-10) * page 1, line 5 - page 3, line 17; page 5, line 21 - page 8, line 22; page 13, line 18 - page 14, line 1; claims 1-10; figures 1-8 *	1-8	INV. B41J13/00 B41J3/60
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			TECHNICAL FIELDS SEARCHED (IPC)
			B41J G03G
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 2 April 2019	Examiner Gaubinger, Bernhard
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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02-04-2019

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