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A METHOD OF PRINTING

This invention relates to a method of providing visible marks such as patterns, words, logos or indicia onto an edge of a stack of sheets or leaves, particularly when the sheets or leaves are assembled together in the form of books, or pamphlets.

US Patent 1.866.968 discloses printing a mark on the face of each page to be assembled into a book, such that when the assembled pages are cut to size the assembled pages produce a character at the cut edges after cutting. However, the patent does not disclose a method of providing patterns or indicia on the edges of assembled leaves or sheets of paper.

A method of providing indicia on the edges of a plurality of assembled sheets is disclosed in US Patent 4.823.150. In the method disclosed therein the sheets of material (paper) are assembled into books and the indicia printed by means of an ink-jet printer which places printed marks on the assembled cut edges by dividing said edges into a grid, and selecting the locations on the edges for printing the indicia and then identifying the locations according to the grid, and subsequently programming the printing means to print the marks in accordance with the locations identified by the grid.

Such a method has the disadvantage that the indicia on the edges are printed in a separate operation after the books have been assembled.

Yet another method of providing marks of the edge of a pamphlet is shown in US Patent 4.427.290 which is utilised in photocopiers which are specifically modified for the process.

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In the present invention the indicium or indicia on the edges are formed during the printing operation for each respective sheet or leaf in the book. This has the advantage that the system is flexible, cheap, and can be utilised on standard printing equipment when controlled by a microprocessor.

According to the invention, there is provided a method of providing at least one indicium on the edges of a plurality of stacked leaves assembled one on top of the other to form a book or pamphlet, each respective leaf having at least one pigmented mark at at least one predetermined location on at least one face of the leaf at its edge margin adjacent said edge, the assemblage of the marks on the individual faces of the leaves forming said indicium on the edge wherein the indicium or indicia are broken down into elements and each element is assigned Cartesian co-ordinates according to the X and Y co-ordinate system with Y ordinates being related to the pagination of a respective leaf in the stacked leaves, and X co-ordinates for said respective leaf corresponding to individual mark elements on the face of a leaf and required along said Y ordinate for forming the indicium(a).

Preferably each leaf is a paper leaf, and each leaf is marked on its face edge margin prior to cutting the leaf to size, the cut passing through said marks on each leaf.

The X and Y co-ordinates are derived by computer-controlled means, said control means also controlling the print means for marking the edge margins of the leaves.

The invention also provides a method of printing indicia on the edge of an assembly of sheets which takes into account the variations in the manufacturing process when printing and assembling the sheets to form a book or pamphlet.

Other advantages of the system are that it is easily controlled by any common 386 or 486 microprocessor and it can be used with cheap plain paper.

The invention further provides for books having edges with at least one indicium thereon being formed according to the above methods.

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Yet another aspect of the invention provides for an apparatus for placing at least one indicium on the edges of a stack of leaves forming a book or pamphlet, said apparatus including programmable control means which can decompose said indicium into X and Y co-ordinates with the Y ordinates being related to the pagination of a particular leaf in the stack, and the X ordinates corresponding to the individual mark element or elements on the face of a leaf that are required along that Y ordinate.

The invention will be described by way of example and with reference to the accompanying drawings in which:

Fig. 1 shows a book comprising an assembly of leaves or sheets having indicia on an edge thereof:

Fig. 2 illustrates the forming of indicia into X and Y co-ordinates:

Fig. 3 shows how X co-ordinates are derived for a particular Y ordinate corresponding to a particular leaf in the assembly:

Fig. 4 shows the edge margin of the leaf in Fig. 3 with marks formed thereon according to first embodiment of the invention;

Fig. 5 and Fig. 6 show how the marks of figure 4 may be located at the edge;

Fig. 7 illustrates a mark with colour fading at the edges according to a second embodiment of the invention:

Fig. 8 illustrates the indicia when the marks according to the first embodiment on the different pages are misaligned:

Fig. 9 illustrates the indicia when the marks are of the type shown in the second embodiment shown in Fig. 7, with some misalignment:

Fig. 10 illustrates indicia of the type shown in Fig. 9 on one face of one leaf according to the second embodiment of the invention:

Fig. 11 is an edge view of a leaf, according to a third embodiment of the invention:

Fig. 12 is an edge view of a leaf, according to a fourth embodiment of the invention:

Fig. 13 is an edge view of a leaf printed on one face according to the second embodiment of the invention: and

Fig. 14a shows typical indicia which can be provided on the edges of a stack of sheets and Figs 14 b-d show the same indicia which are altered by altering the shading in the outer elements making up the edges of the indicia.

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With reference to Fig. 1. there is illustrated a bound book with indicia (10) on the fore edges (11) of the assembled pages of the bound sheets or leaves forming the book. In this case. for the purpose of illustration only. the indicia (10) spell out the word "WORD". but could be any pattern. logo or trade mark as is desired.

With reference to Fig. 2. the indicia are initially decomposed into cartesian co-ordinates according to an XY co-ordinate system. This can be achieved using a computer program. The image or indicium is converted into data form by scanning. or keyboard input. or by any suitable method. Indicia images are converted into individual information elements according to the best method. Preferably the images are treated by the computer program so that images are sorted into a 'bitmap' type file. Other suitable methods may also be used. but preferably the information files formed using other techniques are transformed into the 'bitmap' form.

The filed images are fed into the program and are inserted into a matrix breaking down the image into two dimensions. The image elements are thus divided into their horizontal and vertical ordinates.

If the indicia are printed on the fore edge (11) of the book. then the Y ordinates may be made to correspond to the pagination of the book or assembled leaves.

If it is required to print on one side of the leaf or page of a book then the smallest Y element corresponds with the thickness of the page. and if it is required to print on both sides of the leaf. the smallest Y element corresponds with 1/2 thickness of each leaf. Thus the Y ordinates can be made to correspond perfectly with the pagination of the book.

With respect to Fig. 3. taking a particular Y ordinate corresponding with leaf P. then the X co-ordinates for the particular Y ordinate build up a data line so that all elements (21-28) of the indicia are included in the line X-X'.

The division of the image in the 'X' dimension can be defined so that the smallest element of the image is given an arbitrary constant value. this may be typically 0.05 mm. The "pixel" obtained is calibrated so its dimensions are proportional to the physical dimensions of the elements to

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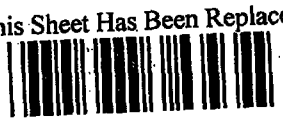

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be printed. This information may be transferred to an imaginary line as shown in Fig. 4 and thickened to a width B to make the elements visible.

These elements (21-28) are then used to print marks on the edge margin of at least one face of a respective leaf on page P (see Fig. 5) in the course of the printing process. i.e. while the respective leaf is being printed such that the width B of the elements straddles the cut line or trim line (t-t') of the leaf. The cutting or trimming takes place after the book has been assembled. and passes through the X-X' element marks on each leaf. The leaf P after trimming is shown in Fig. 6.

Alternatively. the X-X' element marks (21-28) for leaf P may be printed on the edge of the leaf so that the element marks (21-28) intersect with the face edge of each leaf.

This operation is repeated for every leaf in the book so that. on assembly of the book. the marks on each edge form the indicia (10) on the fore edge (11) of the book.

The same technique can be additionally or alternatively applied to the top edge and bottom edge of the book and hence the book can be provided with indicia on its three (unbound) edges in the course of the normal printing operation.

A controller such as a microprocessor uses the computer program for decomposing the indicia into their X-X' elements with respect to the pagination of the assembly. and for determining the order of the elements for each leaf and the distribution relative to the edge margin of each leaf.

The program calculates the precise position of every point. taking into account various parameters. such as the variations in the lengths and widths of the leaves and the thickness of the leaves. to give a precise distribution of the elements of the indicia along the cutting axis t-t'.

The elements composing the indicia are then printed to form marks on a print face of each leaf along its respective edge margins. The print operation may be controlled by said controller using the X-Y co-ordinates derived above. When the assembled pages are bound. the marks on the faces of each leaf form indicia on the fore edge of the book.

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According to the requirements of the user the component program may process the pixels in order to obtain their assigned shadings to ameliorate alignment faults due to production tolerances.

According to a second embodiment of the invention. the elements (21-28) composing the indicia are preferably printed so that the marks have a high pigment density at their centres and fade towards at least some of their edges. as shown in Fig. 7. The rate of pigment fade can be chosen to suit manufacturing tolerances in the overall process. These tolerances may build up in the actual printing process. the properties of the paper. the assembly process and trimming process. The tighter the tolerances. the less the required fall-off in pigmentation.

In the case of a book as shown in Fig. 1. if there are large variations in alignments of the marks on the edges of the leaves. the indicia become fuzzy. as shown in Fig. 8.

However. the degree of fuzziness can be controlled by using marks with deliberate degrees of pigmentation fade to mask the production variations. This will be discussed in detail below. By using elements of the type shown in Fig. 7 for every group of elements assigned to particular X-X' lines on the particular faces of leaves (see Fig. 10) it is possible to produce a desired and controlled fuzziness. as shown in Fig. 9.

Another means of masking the variations in leaf or sheet alignment is illustrated by the third embodiment of the invention shown in Fig. 11. The marks corresponding to particular elements of the indicia are put in different widths (see Fig. 11) on the front face (f) and back face (f') of each leaf.

According to a fourth embodiment of the invention. as shown in Fig. 12. the marks are offset along the X-X' axis on the front face (f) and back face (f') of each leaf.

The density of pigmentation in the marks varies for a given point on the edge of the sheet when observed through the edges of the assembled sheets as a result of the amount of ink (i) on the sheet edges.

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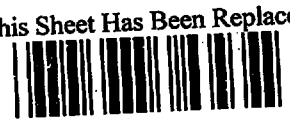

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The consecutive elements composing the indicia and having different widths or being offset can be printed on the front and back face of each sheet (f, f') as shown in the third and fourth embodiments illustrated in Figs. 11 and 12 or on one face only of consecutive sheets. Further, it is possible to apply the marks to all sheets or only some sheets.

Throughout this specification, the word 'printing' is meant to cover all techniques of providing a visible mark onto a support and the word 'ink' is meant to cover all pigmented marks making up the visible mark.

By printing on both faces of the leaves of the book or pamphlet it is possible, through the use of different density shading and/or different colours, to print on the odd-numbered pages different messages or logos to those on the even-numbered pages and to give an impression which interacts with the reader who manipulates the pages. For example, a first message such as the name or logo of a firm could be printed on the fore edge of the odd-numbered pages and a second message, such as a telephone number, could be printed on the fore edge of the even-numbered pages. When the fore edge of the book or pamphlet is flexed in the right direction, the first message becomes visible in a denser form than the second message since a larger part of the edge portion of the odd-numbered pages becomes visible. Conversely, when the fore edge of the book or pamphlet is flexed in the left direction, the second message becomes visible in a denser form than the first message.

By making a first message in heavier print or in a different colour than the second message, it is possible to provide two superposed messages, the first message dominating the second message.

According to the wishes of the user the program processes the pixels in order to obtain the necessary shadings to ameliorate the faults in adjustment as discussed earlier.

The preferred method for achieving these shadings is by algorithmic calculations. The fringe pixels, i.e. the pixels forming the fringes (edge portions) of the element to be processed are corrected on the one hand according to variable parameters, and on the other hand according to calculation. Each fringe pixel is corrected by applying to it a grading (shading) in relation to its neighbouring pixels. Hence, each fringe pixel is corrected by horizontal scanning, then vertical scanning, and lastly by

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scanning across each of its diagonals. that is four scans in order to determine the level of shading desired. In general this process is done at a speed determined by the capacity of the processor and takes only fractions of a second.

For example for a black motif on a white background as shown in Fig. 14a. the user can select a grading to make the edge pixels of a lighter shade towards the interior as shown in Fig. 14b (in-shading). Alternatively the user can make the edge pixels of a darker shade fading outwardly to add shaded matter as shown in Fig. 14c (out-shading). or better still shade the edges in both directions. see Fig. 14d.

In other words. the in-shading of the edge pixels can be used to reduce the visible surface (or a proportion thereof) and the out-shading of the edge pixels can be used to increase the visible surface. and in combination give an accurate reproduction of the original.

As previously described. the matrix of each motif or indicium is divided into horizontal strata such that each stratum (line X. Fig. 4) for a particular page contains a sequence of data to be sent.

The user of the program may also define the width of the indicium that theoretically appears on the page and the width of the indicium that is removed with the trimmings (see Fig.6). The width for each stratum is then defined so as to obtain a sequence or bundle of elements of width B (see Fig. 5). In this manner. as previously described. during the final stages of binding. the book trim line will pass through the ink zone and not to one side.

For any element. each sequence or bundle of data is sent to its proper place for each page including any text. with the exception that any data sequence relating to the edge motif is positioned in the margin of the page. This allows for high accuracy as the elements of the motif are positioned and printed with the text. All imposition corrections to the print can be applied automatically without error.

When it is required to print on more than one outer edge of the book. care must be taken that the data composing the indicia are sequenced in the right order. For example. if a book is to be provided with messages on its

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three unbound edges, and if these messages are to be readable when the book is placed in horizontal position on its back cover, the data composing the indicia on the bottom edge of the odd-numbered pages and the data composing the indicia on the top edge of the even-numbered pages must be sequenced in the reading direction, i.e. from left to right. However, the data composing the indicia on the top edge of the odd-numbered pages and the data composing the indicia on the bottom edge of the even-numbered pages must be sequenced in the direction opposite to the reading direction, i.e. from right to left.

The computer program operates simultaneously in all three matrices (top, bottom and fore edge) and for each page or stratum gives three streams of data which relate to the exact positions of the elements of the motifs along each edge of the page, the sequential order of each stream of data being determined as explained above.

In the program each colour is produced independently by layers or similar techniques as is required.

Each bundle of data for each stratum may be sent as needed by colour, by page, particularly or all at once towards different points such as screens, discs, printers, modems, or to a software editor or simply be integrated with other data and final transfer to a printer.

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CLAIMS

1. A method of providing at least one indicium on the edges of a plurality of stacked leaves assembled one on top of the other to form a book or pamphlet, each respective leaf having at least one pigmented mark at at least one predetermined location on at least one face of the leaf at its edge margin adjacent said edge, the assemblage of the marks on the individual faces of the leaves forming said indicium on the edge, characterised in that said indicium or indicia are broken down into elements and each element is assigned cartesian co-ordinates according to the X and Y co-ordinate system with Y ordinates being related to the pagination of a respective leaf in the stacked leaves, and X co-ordinates for said respective leaf corresponding to individual mark elements on the face of a leaf and required along said Y ordinate for forming the indicium(a).

2. A method as claimed in claim 1, wherein said X and Y co-ordinates are derived by computer-controlled means, said control means also controlling print means for marking the edge margins of the leaves.

3. A method as claimed in claim 1 or claim 2, wherein each leaf is marked on its face edge margin prior to cutting the leaf to size, said cut passing through said marks on each leaf.

4. A method as claimed in any one of claims 1 to 3, wherein each mark on each leaf is formed with a pigmented central area, fading towards at least one edge thereof.

5. A method as claimed in any one of claims 1 to 4, in which the assembled marks on each leaf have a minimum width at the edge and a predetermined location such that, when the leaves are assembled as desired, the aligned marks form said indicium, and misalignment in said marks are compensated for by adjacent marks having different widths, even when their nominal widths are the same.

6. A method as claimed in any one of claims 1 to 5, in which said assembled marks on each page have a nominal width at the edge and a predetermined location, such that, when the leaves are assembled as desired, the aligned marks form said indicium and the marks on alternate leaves are off-set from those on adjacent leaves.



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7. A method as claimed in any one of claims 1 to 6. wherein said leaves are formed from a cellulose-based material. preferably paper.

8. A method as claimed in any one of claims 1 to 7. wherein each leaf is marked on only one face adjacent said edge.

9. A method as claimed in any one of claims 1 to 8. wherein a plurality of indicia are formed on the edges of the sheets.

10. A method as claimed in any one of claims 1 to 9. wherein the Y ordinate element corresponds to the thickness of each leaf for printing on one face of each leaf of the stack. or 1/2 thickness of each leaf when printing on both faces of the leaves in the stack.

11. A method as claimed in any one of claims 1 to 10 wherein the X ordinate elements are 0.05 mm.

12. A method as claimed in any one of claims 1 to 7. or 9 to 11. when dependent upon claim 7. wherein each leaf is marked on both faces adjacent said edge. the marks on one face differing in density of shading. or colour or form from the marks on the other face so that when flexing the leaves in opposite directions different indicia are seen. the indicia combining on the edge of the book or pamphlet.

13. A method of placing at least one indicium on the edges of a stack of leaves which is substantially as described herein.

14. A book or pamphlet of stacked sheets having at least one indicium on the unbound edges thereof. said indicium being made by a method as claimed in any one of Claims 1 to 13.

15. Apparatus for placing at least one indicium on the edges of a stack of leaves forming a book or pamphlet. said apparatus including programmable control means which can decompose said indicium into X and Y co-ordinates with the Y ordinates corresponding to the pagination of a particular leaf in the stack. and the X co-ordinates corresponding to the individual mark element required along that Y ordinate.

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16. Apparatus as claimed in Claim 15, wherein said control means also control a print means which prints the elements on the face side of each leaf in an edge margin thereof.

17. Apparatus for placing an indicium on the edge of a stack of leaves and which is substantially as described herein.

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