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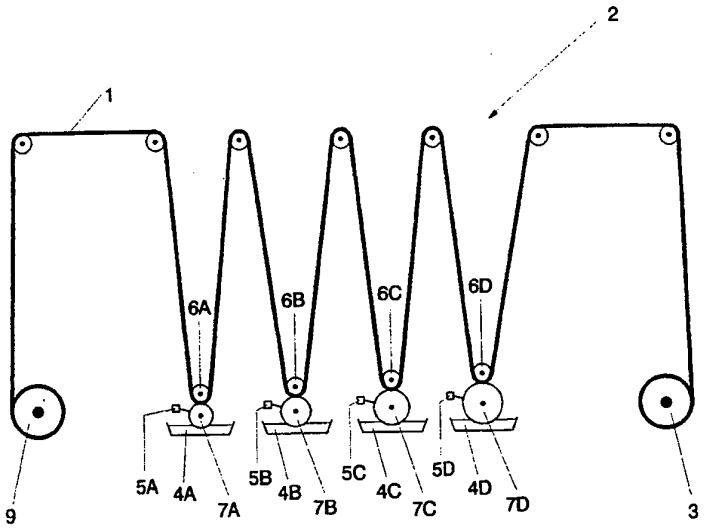
(54) Title: PRINTING METHOD, MATERIAL PRINTED THEREBY AND A PROCESS OF MAKING A PRINTED MATERIAL



(57) Abstract

A method of printing a composite image on a material (1), the composite image comprising two or more image parts (8A, 8B, 8C, 8D) provided by two or more printing elements. Each printing element carries an image part (8A, 8B, 8C, 8D) of the composite image to be printed and each image part (8A, 8B, 8C, 8D) has a respective repeat length (Ra, Rb, Rc, Rd). The repeat lengths (Ra, Rb, Rc, Rd) are independently different from each other, whereby each image part (8A, 8B, 8C, 8D) is repeatedly printed at its own repeat length (Ra, Rb, Rc, Rd). In a further aspect, the composite image may be printed in one or more transfer or sublimation dyes to provide an image carrying substrate (10) intended to be transferred to a material (11) to be printed by bringing the material (11) and the image carrying substrate (10) together, and vaporising the dye(s).

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Printing method, material printed thereby and a process of making a printed material

The present invention relates to a method of printing designs onto a material such as paper, fabric, mesh or netting and more particularly, to a method of printing a random design having a long repeat length of the pattern.

In some applications it is desirable to produce a design which either has a non-repeating pattern, i.e. a random, or a pattern in which the repeating features are wide apart resulting in a pattern having a long design repeat. One particular application for a non-repeating pattern or a pattern in which the repeating feature are much wider apart than in normal practice is in the production of printed camouflage. A non-repeating pattern, or a pattern with a long repeat length, makes visual and electronic recognition of such a design as a camouflage more difficult.

Conventional printing processes used for continuous production of printed materials involve one or more print cylinders continuously contacting the material to be printed, with the cylinders (if more than one is provided) being of the same diameter, and thus the same repeat length, so that the images printed by the different cylinders can be aligned. Continuously repeating patterns are printed on the materials, with the maximum repeat length of the pattern being equal to the circumference of the cylinder(s). Accordingly, a regular repeating pattern is unavoidable when using a conventional continuous printing process.

The present invention provides a method of printing a composite image on a material. The composite image comprises a two or more identical or different image parts provided by two or more printing elements. Each printing element carries an image part of the composite image to be printed and each image part has it own repeat length. The repeat lengths of the image parts are

independently different from each other, whereby each image part is printed at its own repeat length repeatedly onto the material.

Embodiments of the present invention involve 4-10, preferably 6-8 printing elements consisting of rotatable print cylinders each having a respective circumference which defines the repeat length of the image part carried thereon. Accordingly, a printing cylinder circumference of 1.5 metre give a repeat length of 1.5 metre and, similarly, a printing cylinder circumference of 1.1 metre will give a repeat length of 1.1 metre. In one preferred embodiment of the present invention, a printing press is provided with six printing elements each carrying an image part having the respective repeat lengths: 1.5 metre (1st image part), 1.1 metre (2nd), 1.4 metre (3rd), 0.9 metre (4th), 1.3 metre (5th) and 0.85 metre (6th). The repeat lengths for image part combinations are as listed below:

1st and 2nd:	33 metres
1st, 2nd and 3rd:	231 -"-
1st, 2nd, 3rd and 4th:	2079 -"-
1st, 2nd, 3rd, 4th and 5th:	27027 -"-
1st, 2nd, 3rd, 4th, 5th and 6th:	153153 -"-

The combined repeat length for a printed image embodying above six different repeat lengths is 153153 metres.The repeat length of the overall combined pattern has thus been greatly increased from what would be available from a printing device provided with a conventional single printing element or with a plurality of elements of the same repeat length. It is also evident that additional printing elements will further and proportional to the number and repeat length of the printing elements increase the repeat length of the overall combined pattern. The number of printing elements, the repeat lengths as well as the individual location in the printing press can, of cause, be varied.

Further embodiments of the method according to the invention involve printing elements consisting of rotatable print cylinders each having a respective circumference which defines the repeat length of the image part carried thereon. Means are suitably provided to drive the print cylinders with matched speeds and to pass material past the cylinders to receive the composite image therefrom.

Consequently, by using printing devices as described above a printed material may be produced, the material carrying a composite image made of a plurality of image parts, the image parts each having different repeat lengths, the repeat lengths of the image parts not being multiples of each other. This imparts a very random effect to the printed composite image. If each image part is a random or quasi random image, such as a camouflage image, the resultant printed image is very random and thus difficult to recognise as camouflage.

In another aspect of the present invention there is provided a printing method comprising transfer means to transfer at least one image from the an image carrying substrate to a material to be printed. In such an embodiment, at least one of the print elements is inked with transfer and/or sublimation dye to provide a printed material working as an image carrying substrate. The composite image is preferably printed on paper using one or more of said dyes and the composite image is transferred from the paper (the transfer paper) to a material, such as paper, cardboard, textiles, fabric, mesh, netting, metal foils or plastic films and foils or the like, and a very long repeat length pattern can, accordingly, be applied directly to the material.

In a transfer process as above, a transfer paper, printed in one or more transfer and/or sublimation dyes, is together with the material to be printed passed between for instance the

exterior of a rotating heated drum or the like and a continuous belt or the like biased against the exterior of the drum. The heated drum vaporises sublimation dye(s) on the transfer paper turning the dyes into gas, which gas transfers to the material thereby providing a mirror image of the pattern on the transfer paper.

Embodiments of the present invention including a transfer printing system, can, furthermore, be provided with feeder means to interpose at random time intervals and/or at random locations one or more masking elements, such as masking sheets, to prevent a portion of the image masked by the masking element to be transferred to the material. The masking elements are interposed between the image carrying substrate and the material to be printed when these pass between for instance the heated drum and the belt of a transfer printing system as disclosed above. The masking elements may be plain or carry an image printed thereon in transfer and/or sublimation dye. Each of the masking elements may be identical, or there may be a plurality of different types of masking elements, for instance may each masking element carry its own image, such as a random or a quasi random camouflage image. Each masking element may have a regular polygon, square, rectangular or triangular shape or the shape may be the same as the shape of the image printed thereon, such as a random or quasi random shape, or may be of a different shape.

The masking elements may, as disclosed above, carry images printed in one or more transfer and/or sublimation dyes. When such a masking element is interposed between a transfer paper and for instance a fabric, the image on the masking element is transferred to the fabric in the area adjacent the masking element rather than the image printed on the transfer paper. This produces a new feature in the printed material which was not present in the image on the transfer paper. Plain masking elements result in corresponding unprinted areas.

The feeder means for interposing of masking elements may be computer controlled and the computer is suitably associated with a random number generator. The masking elements can thus be positioned randomly and a truly random image is transferred to the material. Alternatively, the computer can be programmed to interpose masking elements at certain intervals to produce a long repeat, pre-determined image that could not be achieved without using for instance at least one printing cylinder with a circumference of at least 3 metres.

A printed material wherein the composite image is a camouflage design has a number of military camouflage applications. It is also envisaged that the material may be produced in wide widths for applications, such as uniforms, camouflage nettings, air strip covers, aircraft and helicopter covers, ship covers, tank covers or similar or other military camouflage purposes. Such a material printed on both sides is reversible and can therefore be used as a camouflage fabric in two contrasting landscapes.

A material printed according to the present invention may also be used for production of articles such as decor papers for thermosetting laminates, plastic foils or plastic films, wall-papers or a wall claddings, carpetings or floor claddings, articles of clothing or decorative textiles.

The material to be printed may be paper, cardboard, textiles, fabric, mesh, netting, metal foil, plastic film or foil and the material working as image carrying substrate most suitably consists of paper, cardboard, fabric, textile, mesh or netting.

In order that the present invention may be more fully understood, embodiments thereof will now be described in conjunction with appended drawings, wherein like reference numerals have been applied to like parts throughout the various figures and wherein:

- Figure 1 is a schematic side view of a rotary multi-cylinder printing press set up to produce printed materials according to an embodiment of the method of the present invention.

- Figure 2 illustrates a portion of a length of material (paper) printed with an example of a pattern produced by the printing press of Figure 1.

- Figure 3 is a diagrammatic side view of a transfer printing device set up to produce printed materials according to an embodiment of the method of the present invention, which embodiment includes an image carrying substrate and masking elements; and

- Figure 4 is a diagrammatic front view of the printing device of Figure 3.

Figure 1 illustrates a schematic version of a gravure printing press 2 set up to embody the method of the present invention. The printing press 2 comprises as print elements four rotating printing cylinders 7A, 7B, 7C, 7D. It can be seen that a supply reel 9 of paper 1 or the like to be printed is fed through the printing press 2 and an image is printed onto the paper 1 by each of the four rotating cylinders 7A, 7B, 7C, 7D. The printed paper 1 is transferred to a second reel 3 for storage. All four printing cylinders 7A, 7B, 7C, 7D have individually different circumferences and are each provided with an engraved or embossed image part. Printing cylinder 7A has the smallest circumference and printing cylinder 7D has the largest circumference, whilst printing cylinders 7B and 7C have different circumferences between those of printing cylinder 7A and 7B. Ink or dye is applied to each of the printing cylinders 7A, 7B, 7C, 7D by rotating the surface of each cylinder 7A, 7B, 7C, 7D through a respective inking or dyeing reservoir 4A, 4B, 4C, 4D such that

the entire surface of the printing cylinder 7A, 7B, 7C, 7D is covered with ink or dye. As the printing cylinders 7A, 7B, 7C, 7D rotate and the inked surface leaves the inking reservoir 4A, 4B, 4C, 4D doctor blades 5A, 5B, 5C, 5D remove any excess ink or dye from each of the printing cylinders 7A, 7B, 7C, 7D. (In alternative embodiments ink or dye may be applied to the printing cylinders 7A, 7B, 7C, 7D by for instance inking rollers.) The paper 1 provided from the supply reel 9 is sandwiched between the first printing cylinder 7A and an impression cylinder 6A and is pulled through the nip between the two cylinders 7A and 6A by the rotation of the printing cylinder 7A. The pressure between the impression cylinder 6A and the printing cylinder 7A causes the image part engraved on the printing cylinder 7A to be printed onto the paper 1. The image of each of the printing cylinders 7B, 7C, 7D is similarly applied, in turn, to the paper 1 as it passes through each pair of printing cylinders 7B, 7C, 7D and their respective impression cylinders 6B, 6C, 6D so that a composite image is produced. A variable drive is provided to rotate each of the printing cylinders 7A, 7B, 7C, 7D at a matched printing cylinder surface speed so that the paper 1 is drawn through each of the cylinder pairs at the same speed. Because each of the printing cylinders 7A, 7B, 7C, 7D has a different circumference, each cylinder has a different so called repeat length which is equivalent to the respective circumference of each of the printing cylinders 7A, 7B, 7C, 7D.

Figure 2 illustrates a schematic example of a length of paper 1 which has been printed by a printing press 2 equivalent to that of Figure 1. For the sake of clarity of explanation, the width of the paper 1 is illustrated as being divided into four equal longitudinal strips 1A, 1B, 1C, 1D, each of which has been printed on by a separate one of the four printing cylinders 7A, 7B, 7C, 7D. In practice, each of the printing cylinders 7A, 7B, 7C, 7D normally prints the respective image part across the entire width or a selected width of the paper 1 as appropriate.

The four strips 1A, 1B, 1C, 1D show the image parts 8A, 8B, 8C, 8D printed by printing cylinders 7A, 7B, 7C, 7D, in the present simple example consisting of four different markers. Each image part 8A, 8B, 8C, 8D, is repeatedly printed along respective strip 1A, 1B, 1C, 1D. The distance between each of the image parts 8A is the repeat length R_a of printing cylinder 7A which is equivalent to the circumference of said printing cylinder. The repeat length R_b of printing cylinder 7B, which prints the image part 8B, is equivalent to the circumference of printing cylinder 7B and adjacent image parts 8B are spaced apart by the repeat length R_b. Similarly, printing cylinders 7C and 7D print repeating spaced apart image parts 8C and 8D. If, in a simplified example, the repeat lengths R_a, R_b, R_c and R_d correspond to printing cylinder 7A, 7B, 7C, 7D circumferences of 2, 3, 5 and 7 units, the repeat lengths for each printing cylinder 7A, 7B, 7C, 7D are 2, 3, 5 and 7 units, respectively. The combined repeat length of the two printing cylinder 7A and 7B, (R_{ab}) is in this specific example, 6 units, equivalent to $3R_a$ or $2R_b$. This means that every 6 units of length along the printed paper 1, the image comprising the image parts 8A and 8B repeats itself. By providing the third printing cylinder 7C, the combined repeat length of the three printing cylinders 7A, 7B and 7C, (R_{abc}) is 30 units and by providing the fourth printing cylinder 7D, the overall combined repeat length of the four printing cylinders 7A, 7B, 7C, 7D is further increased to 210 units.

Figures 3 and 4 illustrate an embodiment of the present invention, wherein an image is printed on a material by means of an image carrying substrate, in this embodiment a roll of transfer paper 10, printed in transfer or sublimation dyes by a printing press 2 as described with reference to Figures 1 and 2. The transfer paper 10 together with a fabric 11 is passed around the exterior of a rotating heated drum 12. A first roller 13, in combination with a second roller 14 biases a continuous belt 15 towards a major part of the outer surface of the drum 12,

thus pressing the transfer paper 10 and the fabric 11 towards the exterior of the drum 12. The transfer paper 10 comes into contact with the heated surface of the drum 12. The drum 12 and the belt 15 force the transfer paper 10 and the fabric 11 into contact with one another. The heated drum 12 vaporises the sublimation or transfer dye(s) on the transfer paper 10 turning the dyes into gas, which gas transfers to the fabric 11 thereby providing the fabric 11 with a mirror image of the the transfer paper 10 image. In this embodiment of the present invention, there is provided, in the transfer printing system, means to introduce masking elements 19 in the form of sheets, between the transfer paper 10 and the fabric 11 when the transfer paper 10 and the fabric 11 pass between the heated drum 12 and the belt 15 of a transfer printing system. The masking sheets 19 may carry an image printed thereon in transfer or sublimation dye or the masking sheets 19 may be plain. The masking sheets 19 are introduced by feeder means 16 in the form of a sheet feeder mounted on a trolley 17 which is movable along tracks 18 which extend parallel to the rotational axis of the heated drum 12 and adjacent the heated surface of the drum 12. The sheet feeder 16 is manoeuvrable along the tracks 18 to alter its position relative to the rotational axis of the heated drum 12. The trolley 17 supporting the sheet feeder 16 is moved along the tracks 18 by a servomotor 21 controlled by a computer 20 associated with a random number generator, which thus positions the sheet feeder 16 along the tracks 18 in random positions. The sheet feeder 16 itself is actuated at random intervals and at the control of the computer 20. The masking sheets 19 are thus fed by the sheet feeder 16 at random intervals and at random positions relative to the rotational axis of the drum 12 between the transfer paper 10 and the fabric 11. When a masking sheet 19 is interposed between the transfer paper 10 and the fabric 11, the transfer or sublimation dye carried on the transfer paper 10 will not penetrate the masking sheet 19 and hence the dye from the transfer paper 10 will not impinge on

the fabric 11 thereby causing an area equivalent to the surface area of the masking sheet 19 to not be printed on the fabric 11. Should the masking sheets 19 carry an image printed in a transfer or sublimation dye, the image on the masking element is transferred to the fabric in the area adjacent the masking element rather than the image printed on the transfer paper.

While particular embodiments of the invention have been shown, it will be understood, of course, that the invention is not limited thereto since many modifications may be made, and it is, therefore, contemplated to cover by the appended claims any such modifications as fall within the true spirit and scope of the invention.

CLAIMS

1. A method of printing a composite image onto a material (1), wherein the composite image comprises two or more identical or different image parts (8A, 8B, 8C, 8D) provided by two or more printing elements, each printing element carrying an image part (8A, 8B, 8C, 8D) of the composite image to be printed, each image part (8A, 8B, 8C, 8D) having a respective repeat length (Ra, Rb, Rc, Rd), the repeat lengths (Ra, Rb, Rc, Rd) of the image parts (8A, 8B, 8C, 8D) being independently different from each other, whereby each image part (8A, 8B, 8C, 8D) is printed at its own repeat length (Ra, Rb, Rc, Rd) repeatedly on the material (1).

2. A method according to claim 1, wherein the printing elements are 4-10, preferably 6-8, in number, each printing element carrying an image part and each printing element having an individual repeat length being independent of each other.

3. A method according to claims 1 or 2, wherein the number of the printing elements are 6 giving the repeat lengths 1.5 metre, 1.1 metre, 1.4 metre, 0.9 metre, 1.3 metre and 0.85 metre.

4. A method according to any of the claims 1 - 3, wherein the printing elements are rotatable print cylinders (7A, 7B, 7C, 7D) each having a respective circumference which defines the repeat length (Ra, Rb, Rc, Rd) of the image part (8A, 8B, 8C, 8D) carried thereby.

5. A method according to claim 4, wherein means are provided to drive the print cylinders (7A, 7B, 7C, 7D) with matched surface speeds and to pass material (1) past the cylinders (7A, 7B, 7C, 7D) to receive the composite image therefrom.

6. A method according to any of the claims 1 - 5, wherein the material (1) is printed with a composite image on both sides to provide a reversible printed material.

7. A method according to any of the claims 1 - 6, wherein at least one of the print elements is inked with a transfer or sublimation dye to provide a printed material (1) working as an image carrying substrate (10).

8. A method according to any of the claims 1 - 6, wherein the composite image is printed on paper with one or more transfer and/or sublimation dyes to provide a printed material (1) working as an image carrying substrate (10).

9. A method according to claim 7 or 8, wherein transfer means to transfer at least one image from an image carrying substrate (10) to a material (11) to be printed is provided.

10. A method according to any of the claims 7 - 9, wherein the image is transferred to the material (11) to be printed by bringing the material (11) and the image carrying substrate (10) together and vaporising the transfer or sublimation dye which defines the image carried on the image carrying substrate (10).

11. A method according to any of the claims 7 - 10, wherein the transfer means comprise a rotatable heated drum (12), which drum (12) is heated to vaporise the sublimation dye, and a belt (15) biased against the exterior of the drum (12) wherein a web, comprising the image carrying substrate (10), and the material (11) to be printed may be received between the belt (15) and the drum (12) simultaneously.

12. A method according to any of the claims 7 - 11 comprising feeder means to interpose at random time intervals and/or at random locations one or more masking elements (19) between the image carrying substrate (10) and the material (11) to be printed.

13. A method according to claim 12, wherein the masking elements (19) are plain thus preventing a portion of the image of the image carrying substrate (10) masked by the masking element (19) to be transferred to the material (11).

14. A method according to claims 12, wherein the masking elements (19) carry at least one printed image, which image is printed in one or more transfer and/or sublimation dyes, whereby at least one image of the masking element (19) is transferred to the material (11) adjacent the area masked by the masking element (19).

15. A method according to claim 14, wherein the masking elements (19) carry identical or a plurality of different printed images.

16. A method according to any of the claims 12 - 15, wherein each masking element (19) has a regular polygon, square, rectangular or triangular shape or a random or quasi random shape.

17. A method according to claim 14 or 15, wherein each masking element (19) has a shape corresponding to the shape of the image printed on the masking element (19).

18. A method according to any of the claims 12 - 17, wherein interposing of masking elements (19) is controlled by a computer (20) associated with a random number generator.

19. A method according to any of the claims 12 - 17, wherein interposing of masking elements (19) is controlled by a computer (20) programmed to interpose masking elements (19) at specified intervals and locations thereby creating a pre-determined image.

20. A method according to claim 19, wherein the repeat length of the pre-determined image corresponds to the use at least one printing cylinder having a circumference of more than three metres.

21. A method according to any of the claims 1 - 20, wherein the material (1, 11) to be printed is paper, cardboard, fabric, textile, mesh, netting, metal foil, plastic foil or plastic film.

22. A method according to any of the claims 7 - 21, wherein the the image carrying substrate (10) is paper, cardboard, fabric, textile, mesh or netting.

23. A method according to any of the claims 1 - 22, wherein the composite image is a camouflage design.

24. A printed material produced by the method of claims 1 - 23, the printed material having one or more military camouflage applications, such as uniforms, camouflage nettings, air strip covers, aircraft and helicopter covers, ship covers, tank covers and/or the like.

25. A printed material produced by the method of claims 1 - 23, the printed material being selected from the group consisting of:

(i) decor papers for thermosetting laminates
(ii) plastic foils or plastic films
(iii) wallpapers or wall claddings
(iv) carpetings or floor claddings
(v) articles of clothing
(vi) decorative textiles.

26. A process of making a printed material by using the method of claims 1 - 23, the printed material having one or more military camouflage applications, such as uniforms, camouflage nettings, air strip covers, aircraft and helicopter covers, ship covers, tank covers and/or the like.

27. A process of making a printed material by using the method of claims 1 - 23, the printed material being selected from the group consisting of:

(i) decor papers for thermosetting laminates
(ii) plastic foils or plastic films
(iii) wallpapers or wall claddings
(iv) carpetings or floor claddings
(v) articles of clothing
(vi) decorative textiles.

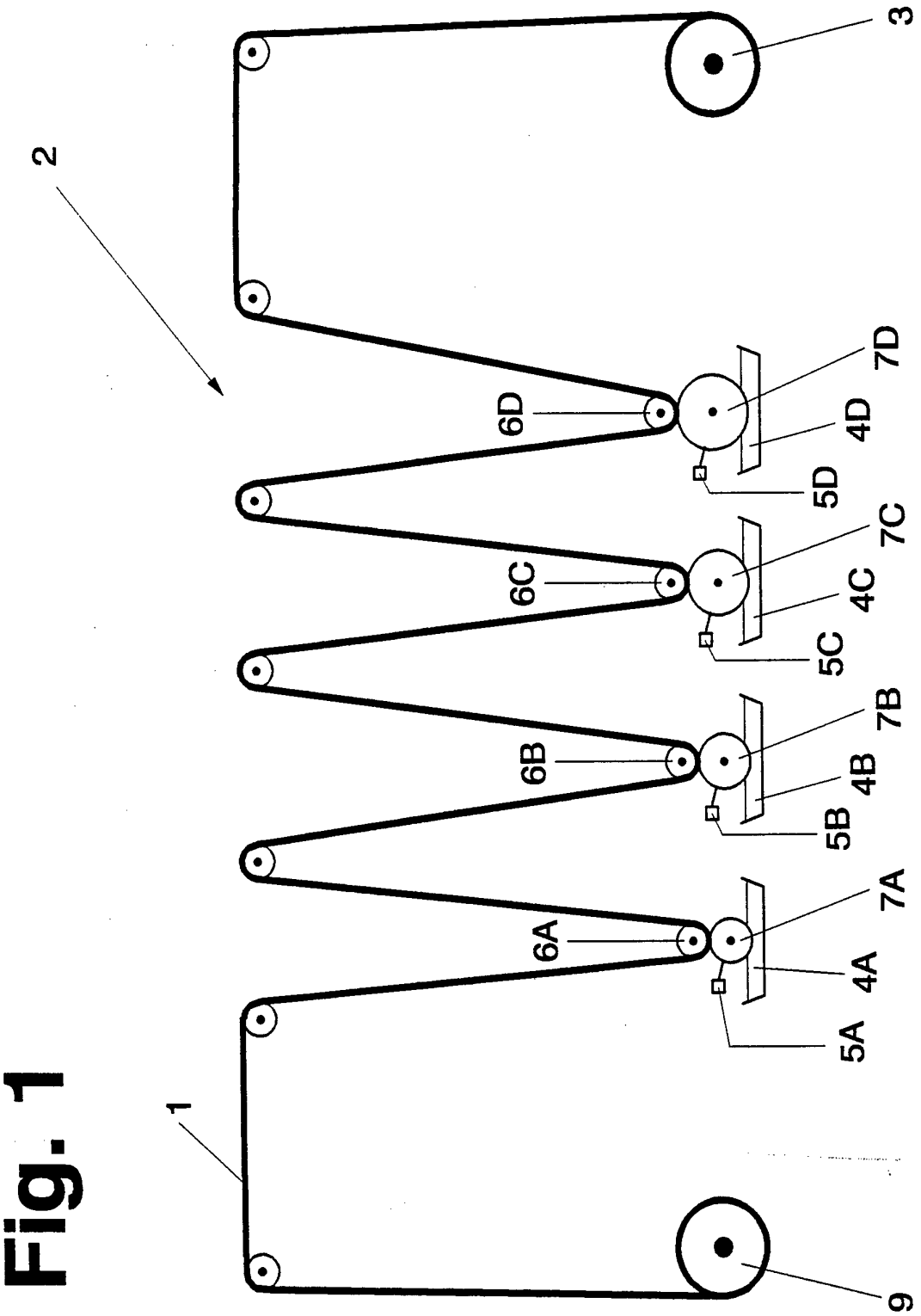


Fig. 1

Fig. 2

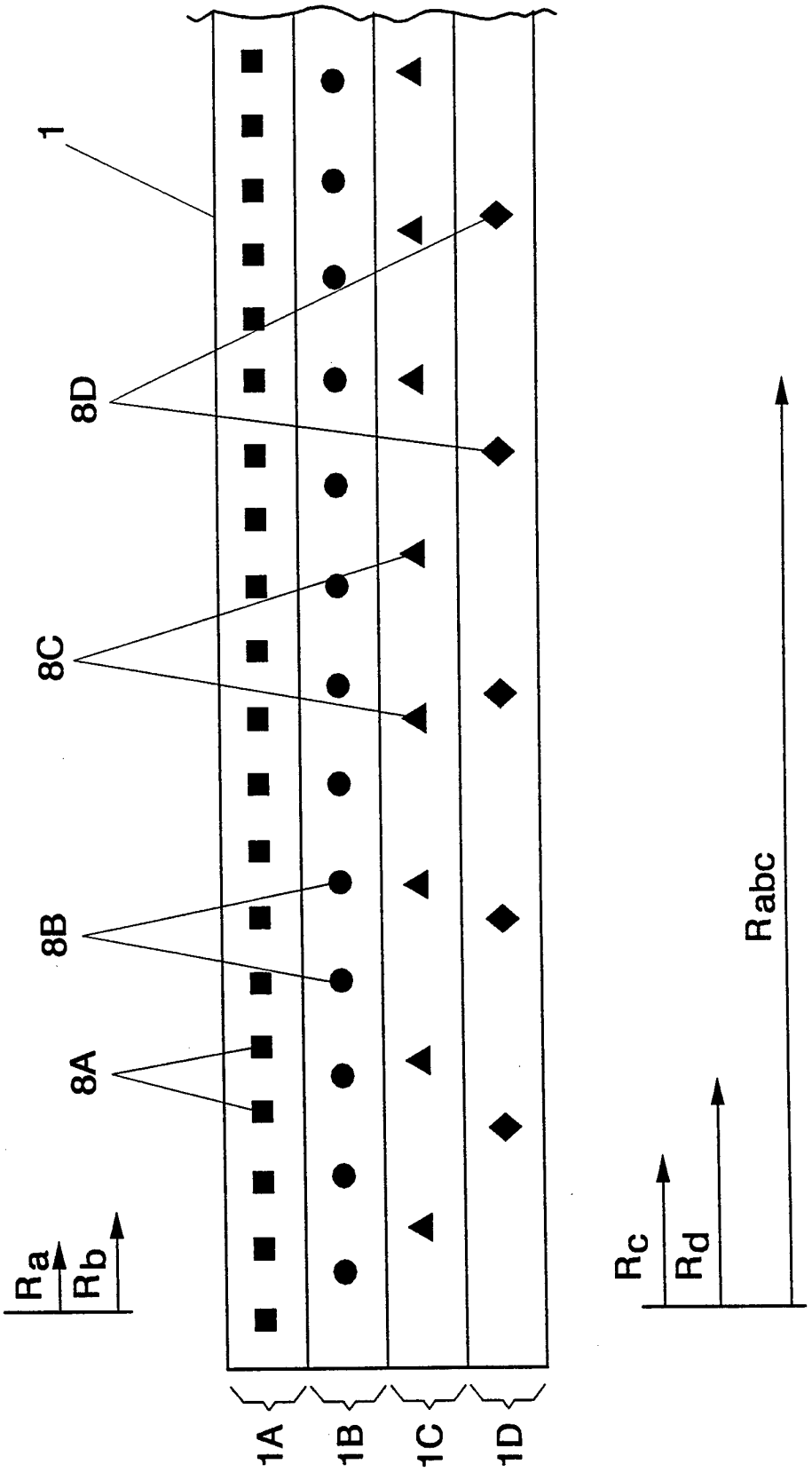


Fig. 3

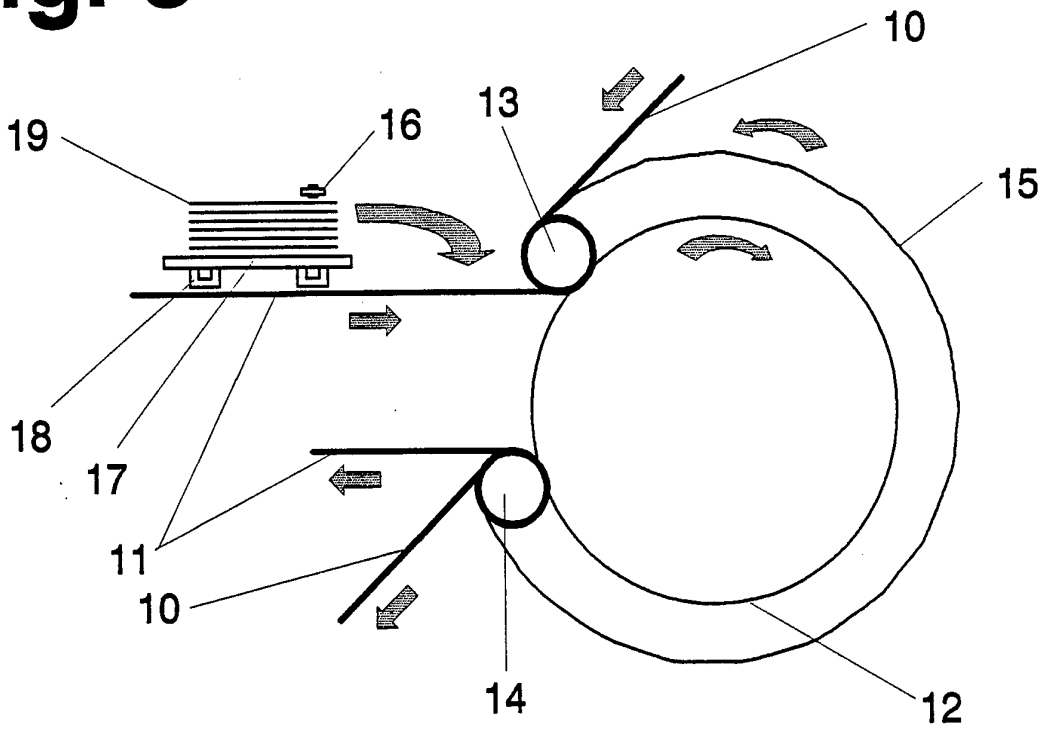
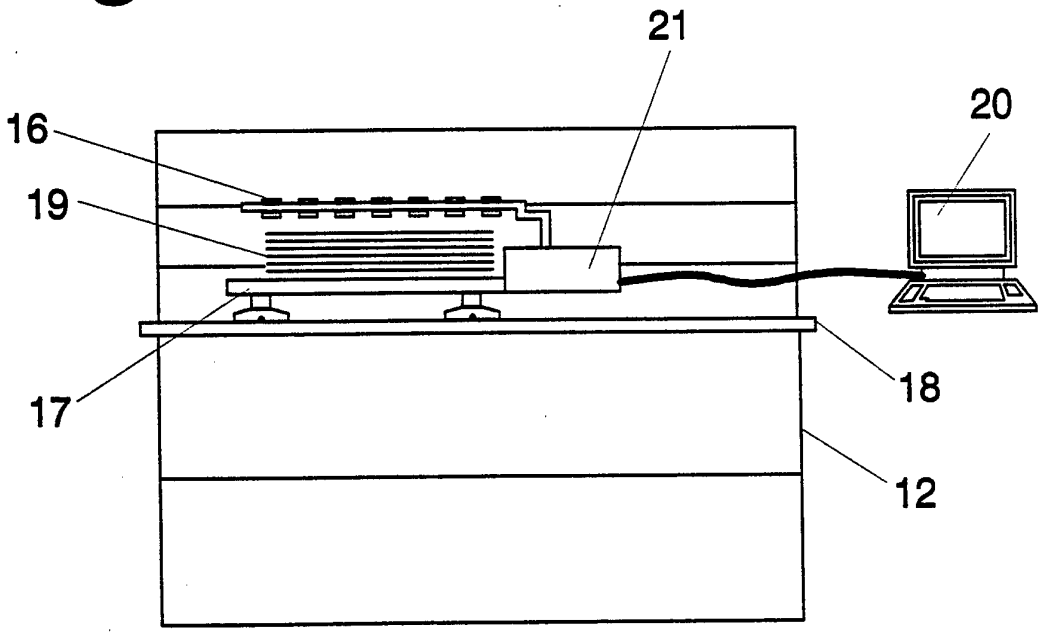


Fig. 4



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 94/00672

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B41M 3/00, B41F 16/00, F41H 3/02
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)

IPC6: B41M, B41F, F41H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Patent Abstracts of Japan, Vol 8,No 28, M-274, abstract of JP, A, 58-187388 (TOPPAN INSATSU K.K.), 1 November 1983 (01.11.83)	1-6,20,21,27
Y		7-11,22-24, 26
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X	GB, A, 2107250 (HAMILTON PUBLICATIONS (BURNLEY) LIMITED), 27 April 1983 (27.04.83), figure 1, abstract	1-4,21
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Y	DE, A1, 2521713 (PERRY, BLAIR L.), 27 November 1975 (27.11.75), figure 1, claims	7-11,22
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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
24 November 1994	05 -12- 1994
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Hans Presto Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 94/00672

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

29/10/94

International application No.
PCT/SE 94/00672

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