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(71) Applicant: **Mackaay, Johannes Anthonius**
3766 ZD Soest (NL)

(72) Inventor: **Mackaay, Johannes Anthonius**
3766 ZD Soest (NL)

(74) Representative:
de Vries, Johannes Hendrik Fokke
De Vries & Metman
Overschiestraat 180
1062 XK Amsterdam (NL)

(54) Method of screen printing and group of screens for use in this method

(57) The invention relates to a process for screenprinting one or more colours of ink on a substrate. A halftone pattern is provided on a screen for each colour of ink, and the ink is forced through the screen provided with the halftone pattern and onto the substrate. The diagonal screen orientation of the screen and the orientation of the halftone pattern include an angle of +30° or -30°. The best value for the number of lines per centimetre of the pattern equals (Z/n) x cos 30° or Z/2 x (1/n + 1/n+1) x cos 30°, wherein Z is the number of wires per centimetre of the screen and n is an integer. A group of screens for use with this screenprinting process comprises two types of screens, with the diagonal screen orientations of the screens of the two different types including an angle of 30°.

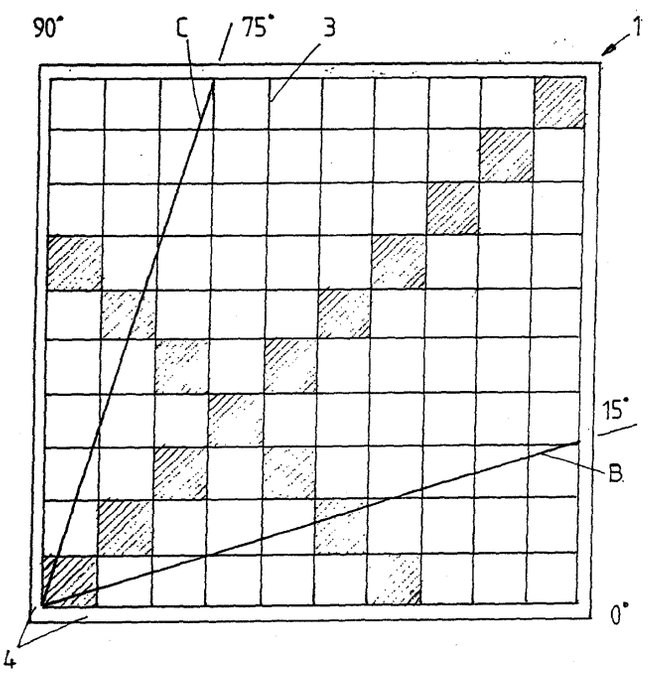

Fig.1

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Description

[0001] The invention relates to a process for screen-printing one or more colours of ink on a substrate, wherein a halftone pattern is provided on a screen for each colour of ink and the ink is forced through the screen provided with the halftone pattern and onto the substrate.

[0002] Such a method is known, for example from EP-A-0 761 434. In screen-printing a colour image, the colour image is usually split into four halftone images having the colours cyan, black, magenta and yellow. Said four halftone images are each recorded in a film pattern or halftone pattern, which film pattern is transferred to a screen. Then the four screens are each used for printing the respective halftone image of the colour image on the substrate in the associated colour. It is a known fact that the interfering patterns of the halftone images being printed on each other by subsequent screens and interference between the pattern of the screen and the pattern of the film pattern of the halftone image may lead to moiré patterns.

[0003] It is known that the formation of damaging moiré patterns can be prevented by having the various halftone patterns include an angle of 30° with each other. It is usual, for example, to arrange the so-called halftone angles at angles of 15°, 45° and 75°, respectively, with respect to each other. As long as the three contrasting primary colours cyan, magenta and black include an angle of 30° with each other, no objectionable form of moiré will occur between said primary colours. The colour yellow, being a non-contrasting colour, can be oriented at an angle of 0° between the other colours. In the process according to EP-A-0 761 434, it is attempted to avoid damaging moiré patterns by using screens having mutually different geometries, with three different screens being used, for example, the second screen including an angle of 30° with the first screen and the third screen including an angle of 60° with the first screen. To avoid interference between the halftone pattern and the screen, this known process employs a so-called frequency-modulated halftone technique. Said frequency-modulated halftone technique is difficult to use in screen-printing, however, and leads to uncontrollable density variations in the midrange.

[0004] The object of the invention is to provide a process of the kind referred to in the introduction, in which the occurrence of damaging moiré patterns can be avoided when using an analog or amplitude-modulated halftone technique.

[0005] According to the invention, the process is to that end characterized in that the diagonal screen orientation of the screen and the orientation of the halftone pattern include an angle of +30° or -30°.

[0006] The invention is based on the perception that damaging moiré patterns can be avoided by a correct selection of the position of the halftone pattern relative to the diagonal screen orientation, wherein an angle of +30° or -30° is preferred. The term "diagonal screen orientation" is understood to mean the diagonal that includes an angle of 45° with the orientation of the screen wires.

[0007] According to the invention it is furthermore of major importance to select the correct proportion between the number of wires per centimetre of the screen and the number of lines per centimetre of the halftone pattern. According to the invention, it is advantageous if the number of lines per centimetre of the halftone pattern varies within a range whose upper limit is defined by the step function value of (Z/n) x cos 30° or Z/2 x (1/n + 1/n+1) x cos 30°, wherein Z is the number of wires per centimetre of the screen and n is an integer, plus one line, and the lower limit is defined by said step function value minus two lines. Preferably, the number of lines per centimetre of the halftone pattern equals the aforesaid step function value.

[0008] It is important in this connection that the number of wires per centimetre of the screen be determined after tensioning of the screen has taken place.

[0009] According to the invention, the best results in one-colour printing are obtained if the diagonal screen orientation is 75° and the halftone pattern orientation is 45°.

[0010] According to the invention, two types of screens can be used in four-colour printing, which screens have a diagonal screen orientation of 45° and 15°, respectively, the orientation of the halftone patterns being 75° or 15°, respectively, with the screens of the first type, and the orientation of the halftone pattern(s) being 45°, 15° or 0° with the screens of the second type. One set of screens thus comprises screen wires tensioned at right angles, whilst the other set of screens comprises screen wires tensioned at an angle of 30°. Screens having a diagonal screen orientation of 45° may be used for three colours, for example cyan, black and yellow, with the halftone patterns for two colours, for example black and yellow, being oriented at an identical angle of 15°, whilst a screen having a diagonal screen orientation of 15° or 75° may be used for one colour, for example magenta, with the halftone pattern for said colour being oriented at an angle of 45°.

[0011] If the ration between the number of wires per centimetre of the screen and the number of lines per centimetre of the halftone pattern is higher than five, it is possible to use the same type of screens having a diagonal screen orientation of 45° for all colours, in which case the halftone patterns are arranged at angles of 15°, 45° and 75°.

[0012] Alternatively, two types of screens may be used in four-colour printing, wherein the screens of the first type have a diagonal screen orientation of 45° and wherein a diagonal screen orientation of 15° is simulated with the screens of the second type by selecting the number of wires per centimetre Z_2 of the screens of the second type so that the ratio of the number of wires per centimetre Z_1 of the screens of the first type to Z_2 cor-

responds to cos 30° or 1/cos 30°, or that a ratio corresponding to cos 30° or 1/cos 30° is obtained by combining a diagonal screen orientation between 45° and 15° with the proportion Z_1:Z_2. This alternative makes it possible to simulate the desired angle of 30° between the diagonal screen orientations when large screen dimensions are used, in which case it is not possible to tension the screen at an angle of 30°, for example because the screening cloth does not have the required dimensions.

[0013] The invention furthermore provides a group of screens for use in the above-described screen printing process, wherein each screen has a diagonal screen orientation, wherein according to the invention the group of screens comprises two types of screens, with the diagonal screen orientations of the screens or the diagonal screen orientation and the simulated diagonal screen orientation of the screens of the two different types including an angle of 30°.

[0014] The invention will now be explained in more detail with reference to the drawing. In the drawing:

Fig. 1 very schematically shows a screen that is tensioned at right angles, which screen is used for four-colour printing in one embodiment of the process according to the invention; and

Fig. 2 shows a screen that is tensioned at an angle of 30°, which is used in this embodiment of the process according to the invention.

[0015] Figs. 1 and 2 are schematic, strongly enlarged views of two screens 1,2, screen 1 being tensioned at right angles and screen 2 being tensioned at 30°. This means that the screen wires 3 of the screen 1 extend perpendicularly to and parallel to the frame members 4, whilst the screen wires 3 of the screen 2 include and angle of 30° with the horizontal frame member 4 in the drawing.

[0016] According to this embodiment of the process according to the invention, two screens 1 and two screens 2 are used for screen-printing an image in four-colour print. The screens 1 are used for printing the halftone images in cyan and black, for example. The film pattern (or dot pattern) of the colour cyan is provided at an angle of 75° on the first screen 1, for example, as indicated by the line C in Fig. 1. The halftone pattern of the colour black is provided at an angle of 15° on the second screen 1 in that case, as is indicated by the line B in Fig. 1. This means that the cyan and black halftone patterns include an angle of +30° and -30°, respectively, with the diagonal screen orientation of 45°. The diagonal screen orientation is indicated by the hatched screen openings in the drawing.

[0017] Similarly, the patterns of the colours yellow and magenta are arranged at an angle of 15° (the line Y in Fig. 2) and 45° (the line M in Fig. 2), respectively, on the first and the second screen 2. Said halftone patterns, too, include an angle of +30° and -30° with the diagonal screen orientation of 75°. In addition, the three contrasting colours cyan, black and magenta include an angle of 30° with each other as well. In this way the occurrence of damaging moiré patterns is entirely avoided. In this case the colour yellow is arranged at the same angle as the colour black, which does not present any problems in the case of a normal colour separation. If a PCR or UCR colour separation is used, the colour yellow is arranged at an angle of 0°.

[0018] Alternatively, the three colours cyan, black and yellow can be printed by means of three screens 1 tensioned at right angles, with the halftone patterns being arranged at angles of 75°, 15° and 15°, and the colour magenta is printed by means of a screen 2 tensioned at an angle, with the halftone pattern extending at an angle of 45°.

[0019] According to the invention it is furthermore of major importance to select the correct ratio between the number of wires per centimetre of the screen and the number of lines per centimetre of the halftone pattern. According to the invention, the number of lines per centimetre of the halftone pattern varies within a range whose upper limit is defined by the step function value (entier function or INT) of (Z/n) x cos 30° or Z/2 x (1/n + 1/n+1) x cos 30°, wherein Z is the number of wires per centimetre of the screen and n is an integer, plus one line, and whose lower limit is defined by said step function value minus two lines. The number n is indicated as the ratio value, the ratio between the number of screen wires and the number of patterns lines, i.e. the number of screen wires per dot. By using this factor (cos 30°), the position of the dot pattern with respect to the diagonal screen orientation is taken into account in the determination of the ratio screen wires/pattern. For a ratio value higher than n=3, the function (Z/n) x cos 30° will suffice for determining the range for the number of pattern lines.

[0020] According to the invention, the number of wires per centimetre after tensioning of the screen is preferably taken as a starting point for determining the number of wires per centimetre of the screen. Tests have shown that the number of wires per centimetre of the screen after tensioning may be a few per cent lower than the number of wires per centimetre that is stated for the screen material that is used.

[0021] By way of example, a screen comprising 165 wires is taken as a starting point. Measurements have shown that the screen comprises an average 152.5 wires per centimetre after tensioning, using a usual tensioning force. At n=2, a value of INT(76,25 x cos 30°) = 66 applies for determining the number of lines per centimetre of the halftone pattern, so that the upper limit is 67 lines per centimetre and the lower limit is 64 lines per centimetre. The best results are obtained with 66 lines per centimetre. When these calculations are carried out for n=1, n=3, n=4, n=5 and n=6, the pattern values with which the best results are obtained are: 22 (n=6), 26 (n=5), 33 (n=4), 44 (n=3), 66 (n=2) and 132 (n=1). The associated ranges for the pattern value are: 20-23

(n=6), 24-27 (n=5), 31-34 (n=4), 42-45 (n=3), 64-67 (n=2) and 128-133 (n=1). In the ranges between n=1 and n=2 on the one hand and n=2 and n=3 on the other hand, suitable pattern values can furthermore be found with the function INT(Z/2 x (1/n + 1/n+1) x cos 30°). Between n=1 and n=2 follows 97-100 and between n=2 and n=3 follows 53-56.

[0022] According to the invention, the use of two types of screens can be rendered possible in an alternative manner. The screens of the first type are tensioned at right angles having a diagonal screen orientation of 45°. The angle of 30° between the diagonal screen orientations is simulated by simulating a diagonal screen orientation of 15° with the screens of the second type. To that end, the number of wires per centimetre Z_2 of the screens of the second type is selected so that the ratio between the number of wires per centimetre Z_1 of the screens of the first type and Z_2 corresponds to cos 30° or 1/cos 30°, wherein the screens of the second type are also tensioned at right angles. This means that coarser or finer screens are used for the screens of the second type. The diagonal screen orientation of 15° can also be simulated by composing the ratio corresponding to cos 30° or 1/cos 30° from a combination of a diagonal screen orientation between 45° and 15° and the proportion $Z_1 : Z_2$.

[0023] It is noted that tests have shown that if a ratio higher than n=5 is used, the same type of screens having a diagonal screen orientation of 45° can be used for all colours, in which case the patterns are arranged at angles of 15°, 45° and 75°.

[0024] Where mention is made of an angle of 30° in the foregoing, this does not mean that this angle is limited to an angle of exactly 30°. A deviation of approximately +3° or -3° is possible without this leading to highly objectionable moiré patterns.

[0025] The invention is not limited to the embodiment as described above, which can be varied in many ways without departing from the scope of the invention as defined in the claims.

Claims

1. A process for screen printing one or more colours of ink on a substrate, wherein a halftone pattern is arranged on a screen for each colour of ink and the ink is forced through the screen provided with the halftone pattern and onto the substrate, **characterized in that** the diagonal screen orientation of the screen and the orientation of the halftone pattern include an angle of +30° or -30°.

2. A process according to claim 1, wherein the number of lines per centimetre of the halftone pattern varies within a range whose upper limit is defined by the step function value of (Z/n) x cos 30° or Z/2 x (1/n + 1/n+1) x cos 30°, wherein Z is the number of wires per centimetre of the screen and n is an integer, plus one line, and the lower limit is defined by said step function value minus two lines.

3. A process according to claim 2, wherein the number of lines per centimetre of the halftone pattern preferably equals the aforesaid step function value.

4. A process according to claim 1, 2 or 3, wherein the diagonal screen orientation is 75° and the pattern orientation is 45° in one-colour printing.

5. A process according to any one of the preceding claims, wherein two types of screens are used in four-colour printing, which screens have a diagonal screen orientation of 45° and 15°, respectively, the orientation of the halftone patterns being 75° or 15°, respectively, with the screens of the first type, and the orientation of the halftone pattern(s) being 45°, 15° or 0° with the screens of the second type.

6. A process according to claim 5, wherein screens having a diagonal screen orientation of 45° are used for three colours, for example cyan, black and yellow, with the halftone patterns for two colours, for example black and yellow, being oriented at an identical angle of 15°, whilst a screen having a diagonal screen orientation of 15° or 75° is used for one colour, for example magenta, with the halftone pattern for said colour being oriented at an angle of 45°.

7. A process according to any one of the preceding claims, wherein it is possible to use the same type of screens having a diagonal screen orientation of 45° for all colours if the ratio between the number of wires per centimetre of the screen and the number of lines per centimetre of the halftone pattern is higher than five, in which case the halftone patterns are arranged at angles of 15°, 45° and 75°.

8. A process according to any one of the preceding claims, wherein the screens of the first type have a diagonal screen orientation of 45° and wherein a diagonal screen orientation of 15° is simulated with the screens of the second type by selecting the number of wires per centimetre Z_2 of the screens of the second type so that the ratio of the number of wires per centimetre Z_1 of the screens of the first type to Z_2 corresponds to cos 30° or 1/cos 30°, or that a ratio corresponding to cos 30° or 1/cos 30° is obtained by combining a diagonal screen orientation between 45° and 15° with the proportion Z_1: Z_2.

9. A process according to any one of the claims 3-8, wherein the number of wires per centimetre of the screen is the number of wires after the screen has

been tensioned.

10. A group of screens for use in a screen printing process according to any one of the preceding claims, wherein each screen has a diagonal screen orientation, **characterized in that** the group of screens comprises two types of screens, with the diagonal screen orientations of the screens or the diagonal screen orientation and the simulated diagonal screen orientation of the screens of the two different types including an angle of 30°.

11. A group of screens according to claim 10, wherein the diagonal screen orientation of the screens of the first type is 45° and that of the screens of the second type is 75°, or wherein the diagonal screen orientation of the screens of the first type is 45° and wherein the second type of screens comprises coarser or finer screens than the first type of screens, said screens of the second type having a diagonal screen orientation between 45° and 15°.

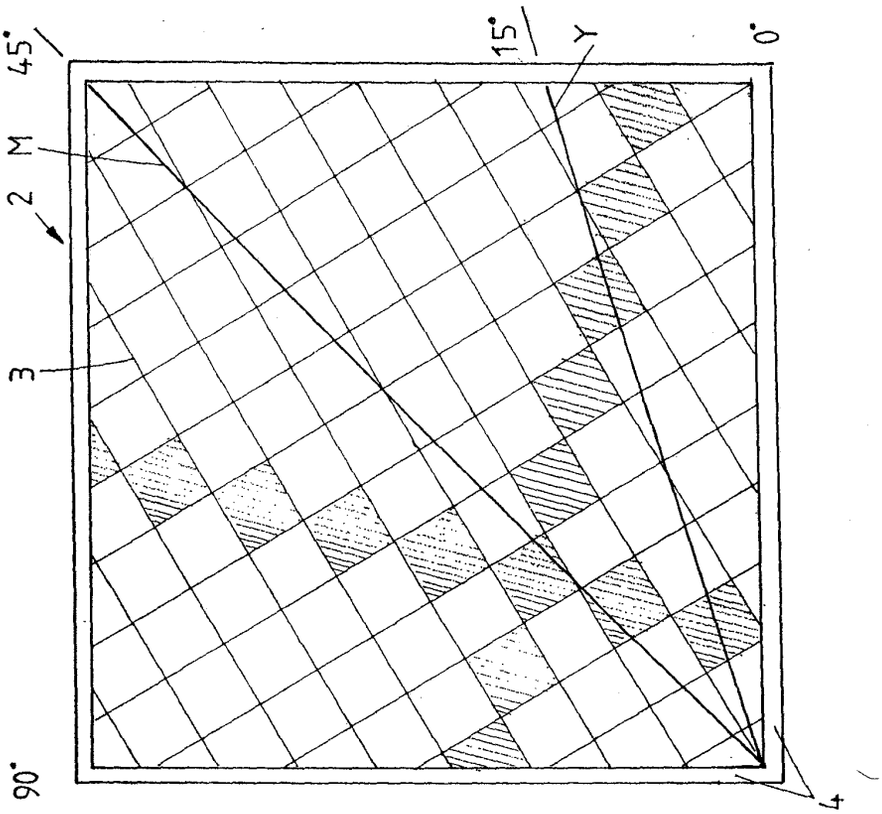

Fig.2

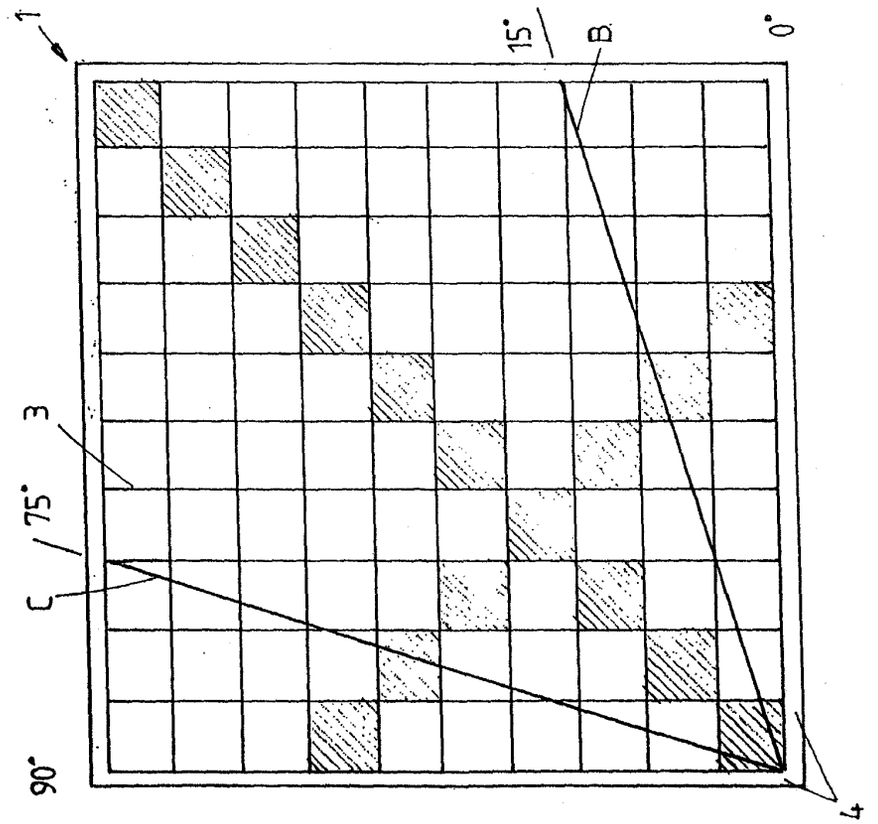

Fig.1

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 10 1383

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X,D	EP 0 761 434 A (AGFA-GEVAERT N.V.) 12 March 1997 (1997-03-12) * column 2, line 50 - line 59 * * column 3, line 23 - line 54 * * column 6, line 34 - column 7, line 14 * * claims 1,6-9 * -----	1-11	B41M1/18 B41M1/12
A	US 5 515 779 A (R.DANBY) 14 May 1996 (1996-05-14) * column 1, line 9 - line 14 * * claims 1-5; figures 1-5 * * column 3, line 54 - column 4, line 42 * -----	1-11	
A	WO 00/56062 A (MEGADOT SYSTEMS LIMITED) 21 September 2000 (2000-09-21) * page 1, line 5 - line 8 * * page 2, line 11 - page 3, line 3; claims 1-21; figures 6-9 * * page 7, line 20 - page 9, line 8 * -----	1-11	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7) B41M H04N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	18 April 2005	Bacon, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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18-04-2005

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0761434 A	12-03-1997	EP 0761434 A1	12-03-1997
		DE 69516515 D1	31-05-2000
		DE 69516515 T2	23-11-2000
		JP 3085911 B2	11-09-2000
		JP 9123583 A	13-05-1997
		US 5953988 A	21-09-1999
US 5515779 A	14-05-1996	AU 3948895 A	06-05-1996
		WO 9611809 A1	25-04-1996
WO 0056062 A	21-09-2000	NZ 334694 A	27-10-2000
		NZ 334695 A	27-10-2000
		AU 3337500 A	04-10-2000
		DE 10084354 T0	11-04-2002
		WO 0056062 A1	21-09-2000

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