(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 555 139 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
20.07.2005 Bulletin 2005/29

(51) Int Cl.[7]: **B42D 15/00**

(21) Application number: **05075081.9**

(22) Date of filing: **10.01.2005**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR LV MK YU

(30) Priority: **15.01.2004 NL 1025258**

(71) Applicant: **DE NEDERLANDSCHE BANK N.V.**
1017 ZN Amsterdam (NL)

(72) Inventors:
- **De Heij, Henricus Anthonius Maria**
  2082 EB Santpoort Zuid (NL)
- **van Gelder, Alwin Hendrikus Bernardus Theodorus**
  1017 ZN Amsterdam (NL)
- **Buitelaar, Thomas**
  1902 GR Castricum (NL)

(74) Representative: **De Hoop, Eric**
Octrooibureau Vriesendorp & Gaade B.V.
P.O. Box 266
2501 AW Den Haag (NL)

(54) Security document provided with a watermark

(57) The invention relates to a security document (1) provided with a watermark, wherein the watermark extends over the full security document (1) and as regards translucency shows a continuous brightness variation over the security document (1) that is visually not or hardly visible under visible light, and/or using infrared radiation and/or ultraviolet radiation.

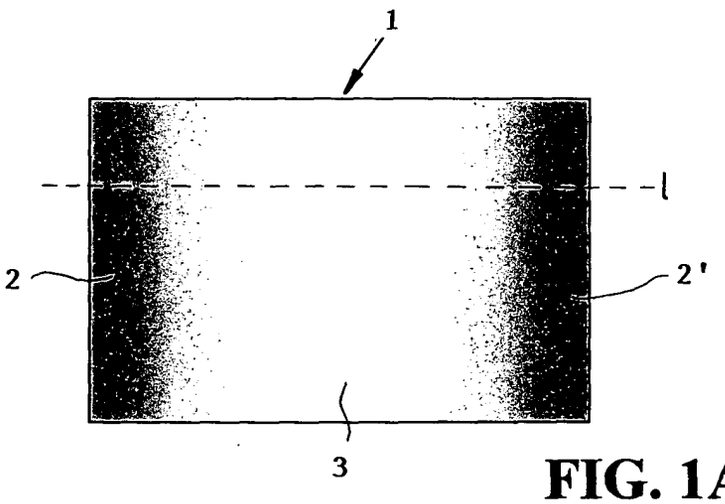

FIG. 1A

EP 1 555 139 A1

Description

[0001] The invention relates to a security document provided with a watermark, a sheet of printing paper for such a security document, a method for processing and/or detecting the watermark in such a security document and software for carrying out said method.

[0002] Many security characteristics are provided on security documents, particularly banknotes. The various security characteristics serve various security purposes. There are for instance security characteristics on the basis of which the public can easily verify whether for instance a banknote is authentic. An example of such a security characteristic is among other things the well-known watermark, such as for instance described in EP-A-1.273.461 of the applicant, the security thread and the holograms and foil parts that are disposed on the banknotes.

[0003] In addition security characteristics are disposed on quite some security documents, which characteristics can only be made visible using particular aids, for instance at a bank. Furthermore there are security characteristics that can for instance only be perceived by a central bank, and there are particular security characteristics relating to criminal investigation matters that can only be perceived with highly particular means.

[0004] However, there is a need for new and additional security characteristics.

[0005] In addition there is a problem with for instance banknotes, namely that strips are cut out of banknotes and a new banknote is compiled using said strips. It is an object of the invention to offer a new, additional security characteristic.

[0006] It is a further object of the invention to offer a solution for among others the said attempts at fraud.

[0007] The invention regards a security document provided with a watermark, wherein the watermark extends over the full security document and shows a continuous brightness variation over the security document that is visually not or hardly visible under visible light, and/or using infrared radiation and/or ultraviolet radiation.

[0008] As the watermark extends over almost the full security document, a correct choice of the brightness and the variation thereof, enables the creation of a security characteristic that visually cannot or hardly be seen.

[0009] In addition the specific watermark, as it extends over almost the full security document, offers the possibility of offering a security characteristic which enables to easily perceive first of all whether an attempt at fraud has been made, and in particular whether an attempt at fraud has been made wherein the carrier of the security document, that means the paper or optionally the synthetic material, has been changed physically.

[0010] A watermark is a change of mass provided in a carrier, usually paper. By holding the carrier "against the light", that means in front of a source of (artificial or day)light, a generally known watermark is visible. In addition the known watermark usually is also visible under infrared radiation. The watermark according to the invention however, has such a brightness variation that it will not be visible in the usual manner without using aids. Moreover, also in order to render it virtually invisible, it extends over almost the full banknote.

[0011] Preferably the brightness variation of the watermark according to the invention as regards translucency (transmission) is hardly visible to the human eye at visible light. The watermark on the other hand can indeed be made discernible at light visible to the human eye by using aids, such as by means of equipment such as image recorders such as digital (line scan) cameras. It can also be opted for that a watermark, whether or not as regards translucency, can be discerned by means of equipment using infrared radiation (IR) or ultraviolet radiation (UV). The watermark can be made such that it can be made visible by means of aids under either visible light, or under IR radiation, or under UV radiation or possibly under a combination thereof. In case of visible light perception will usually take place in translucency (transmission), when using IR or UV perception can optionally take place under striking light. In the directly recorded image the brightness variation is not or hardly visible. By increasing the contrast by means of aids or image processing, the brightness variation can indeed be made visible.

[0012] According to the invention the watermark extends over almost the full security document. In such cases this means that the watermark extends over the full width and the full length. As will also become clear from the figures, the brightness may vary over the length only, the width only, or a combination of both.

[0013] The watermark according to the invention can also be combined with the already known visible watermark, such as a portrait watermark that is for instance used in banknotes.

[0014] In an embodiment of the security document according to the invention the brightness of the watermark varies periodically or aperiodically undulatory. As regards production technology such a variation is easy to realise. In addition such a variation can rather easily be made such that visually the watermark cannot or hardly be seen.

[0015] In another or further embodiment the brightness of the watermark varies continuously along the longitudinal axis of the security document, the latitudinal axis of the security document, one or more diagonals of the security document, from a point on the security document either circular or not, or a combination thereof. Each one of these options offers its own additional options. Especially brightness variations varying along both axes, and particularly differently along both axes, offer additional options, as will become clear further below in this description.

[0016] In a further or additional embodiment the

brightness of the watermark varies undulatory along a line in the plane of the security document, which line may or may not be imaginary.

[0017] In a further or additional embodiment the security document is further provided with a group indication for distinguishing groups of security documents. Such a group indication may for instance be a denomination code (for instance 50) and/or a model code (for instance Euro series 2) and/or a code regarding the manufacturer of the paper and/or another code.

[0018] In yet another or further embodiment the security document is further provided with a location indication which is unique for each specimen or a specimen of the security document within a sheet of printing paper (for instance the position of a banknote in a sheet of printing paper). According to an embodiment thereof, the brightness variation of the watermark along a line in the plane of the security document, which line may or may not be imaginary, depends on the group indication or at least on a part or subset of the specimen indication. In an embodiment a brightness variation characteristic is selected from the group of the first derivative of the brightness variation, the second derivative of the brightness variation and a combination of the first and second derivative depending on the group indication or at least a part or subset of the specimen indication.

[0019] In a further or another embodiment the security document has been obtained from a sheet of printing paper with a plurality of security documents, wherein the original position of the security document on the sheet of printing paper can be deduced from the brightness variation of the security document.

[0020] In a further or another embodiment the security document has been obtained from a sheet of printing paper having columns and rows of similar security documents, wherein the brightness variation of each security document has a predetermined relation with the column and/or row of the security document on the sheet of printing paper so that the row and/or column from which the security document originates can be deduced.

[0021] In a further or alternative embodiment the security document according to the invention is further provided with an indication that may or may not be visible. Said indication, for instance disposed by means of printing, security foil, or another characteristic, may have a relation with one of the above-mentioned characteristics of the watermark according to the invention, for instance a mathematic or other logic relation. For instance a value indication on the security document may have been disposed on the security document by means of printing, or the security document may have been provided with a further, visually visible watermark in which an image or another value has been disposed. The value or other property of said image or said characteristic can be related to characteristics of the watermark according to the invention that cannot or hardly be seen visually. For instance, in case of a banknote, the banknote may be provided with a value indication, such as 10.- Euro, 20.- Euro and 50.- Euro, and a characteristic of the watermark according to the invention can be related thereto. For instance the value of the first or second derivative may depend on the value indication of a banknote.

[0022] In an embodiment the security document is a banknote.

[0023] The invention further relates to a method for processing a watermark in a security document as described above, for verification or determination of authenticity, wherein a image recording of the security document is made and stored in a first memory, a brightness variation is determined along a predefined line in the plane of the security document, and at least one parameter is determined from the brightness variation. By means of a measurement parameters can be determined that visually cannot be determined at all, such as for instance the first and second derivative of the brightness variation along a line.

[0024] In an embodiment of said method the image recording is normalised with respect to a reference image for determining the brightness variation.

[0025] In an embodiment thereof use is made of a so-called 'vision system' , camera system or the like.

[0026] The invention furthermore regards computer software for, once implemented on a computer, carrying out the method steps of the method as described above.

[0027] The invention further regards a sheet of printing paper on which several security documents according to the above description can be printed in rows and columns, comprising a watermark over almost the entire sheet of printing paper having an almost continuously varying brightness variation which visually is not or hardly visible under visible light and/or using infrared radiation, and/or using ultraviolet radiation and which along a line, that may or may not be imaginary, selected from the group consisting of the length, the width and the diagonals of the sheet of printing paper varies almost undulatory, wherein a position or positions of minimum and/or maximum values of the brightness of the watermark along the line are situated at a different location per security document.

[0028] This results in a yet more refined security. Moreover the brightness variation, or a parameter thereof, can be coupled to other characteristics of the security document, such as for instance a group indication or group code (denomination, model, manufacturer). A place/location indication can also be given (column and/or row on the sheet of printing paper). In case of a banknote for instance a denomination indication or serial number. The brightness variation may be periodical or aperiodical.

[0029] Preferably the brightness variation as regards translucency is not or hardly visible to the human eye.

[0030] In an embodiment of the sheet of printing paper the brightness variation is periodically undulatory. Preferably a continuous function, more preferably a function that can be differentiated twice at least. In a further embodiment the brightness variation is almost sinusoidal.

[0031] The invention further regards a watermark for securing a security document, extending over almost the full security document and showing an almost continuous brightness variation over the security document which is visually hardly visible under visible light, and/or using infrared radiation, and/or ultraviolet radiation.

[0032] In an embodiment the above-mentioned watermark is combined with a watermark that as regards translucency is visible to the human eye at visible light. An example thereof is the generally known watermark in banknotes, such as the portrait watermark. Such a watermark can be considered a coded watermark, but itself is also often provided with an additional code. During detection said watermark will also produce a detectable signal. The two different codes, that means of the known watermark and the watermark according to the invention, thus together form a new code. Said code can be encrypted, so that determination of the authenticity of the security document takes place based on detection of both watermarks.

[0033] In a further embodiment the watermark according to the invention and the visible watermark have been encrypted into a code.

[0034] In an embodiment the brightness variation as regards translucency when using visible light is not or hardly visible to the human eye.

[0035] The invention will be further elucidated on the basis of an exemplary embodiment of a security document and a sheet of printing paper according to the invention, in which:

Figure 1A shows a security document with a brightness varying along the longitudinal line;

Figure 1B shows a security document with a watermark having a brightness varying along the width;

Figure 1C shows a security document wherein a brightness of the watermark varies along a diagonal;

Figure 2A shows a brightness variation of a watermark along a line L that varies almost sinusoidal with one maximum value almost in the centre of the security document;

Figure 2B shows a brightness variation that is almost sinusoidal and has several maximum and minimum values along the line that may or may not be imaginary;

Figure 2C shows a watermark having a non-periodically varying brightness;

Figure 3A shows a watermark having a brightness variation that is non-periodical along the longitudinal axis;

Figure 3B shows a watermark having a brightness variation along the short side of the security document, as a result of which a non-sinusoidal arises along the long side;

Figure 4 shows various deducible characteristics of the brightness variation of the watermark;

Figure 5 shows the effect of compiling a security document from two original security documents in the wrong way;

Figure 6 shows a sheet of printing paper provided with several security documents;

Figure 7A shows a sheet of printing paper provided with an alternative brightness variation;

Figure 7B shows the brightness variation of the watermark of adjacently positioned security documents in one sheet of printing paper;

Figure 8A shows a document along the short axis, which document is compiled from strips cut out of security documents;

Figure 8B shows a security document compiled from strips of authentic security document and a strip of counterfeit security document.

[0036] Figure 1A shows a security document 1 provided with a watermark extending over the full security document 1. In this case it regards a translucency showing the brightness variation. If so desired a print can be disposed on the security document. The brightness of the watermark here varies almost sinusoidal along line L, the longitudinal axis of the security document. The watermark has a first minimum brightness 2, a maximum brightness 3 and a second minimum brightness 2'.

[0037] Figure 1B again shows a security document 1, this time having a watermark again extending over the full security document, wherein this time the brightness varies almost sinusoidal along the imaginary line L over the width of the security document again having a maximum brightness 3 and minimum brightnesses 2 and 2'. In actual practice the brightness differences between the maximum and minimum values and the variation of the brightness between the maximum and minimum values will be such that visually it is not or hardly visible.

[0038] Figure 1C shows an embodiment of the security document 1 provided with a watermark extending over almost the full security document, wherein the brightness along the diagonal L varies almost sinusoidal. The diagonal can both be selected from top left to bottom right and from top right to bottom left.

[0039] Figure 2A shows a curve of the brightness along the imaginary line L indicated in the figures which line varies almost sinusoidal. The wavelength of said si-

nusoid almost corresponds with the length of the security document.

[0040] Figure 2B shows an alternative embodiment wherein the brightness variation shows several maximum values (3, 3') and minimum values (2, 2', 2"). In this case it has to be observed each time that the minimum and maximum brightnesses and the variation between them are such that visually they are not or hardly perceptible.

[0041] Figure 2C shows a curve of the brightness of the watermark along a line L that may or may not be imaginary, wherein the brightness variation is not a sinusoid. The brightness variation again has several maximum values 3, 3'and several minimum values 2, 2', 2".

[0042] Figure 3A shows another alternative embodiment of the watermark, wherein the brightness along the imaginary line L does not vary periodically this time.

[0043] Figure 3B shows another alternative for the brightness variation along imaginary line L, wherein the variation is not sinusoid (banknote for instance has been turned a quarter turn).

[0044] Figure 4 shows various characteristics that can be used for identifying the brightness variation of the watermark according to the invention. For instance the first derivative 13, and as the occasion arises the second derivative 12 may be used as shades of the brightness variation. The positions and values of the first and second derivative may among other things be used to verify the authenticity of the security document.

[0045] Figure 5 shows what happens in case of fraud wherein two parts of security documents that originally were not part of the same document are joined. In this case the derivative of the brightness variation will show a step. A machine and maybe even the naked eye, depending on the minimum and maximum brightnesses of the watermark, will be able to perceive this.

[0046] Figure 6 shows an application of the watermark and security document according to the invention on a larger scale, wherein a sheet of printing paper 7 is shown provided with security documents 1 in rows 9 and columns 8. The watermark is disposed over almost the entire sheet of printing paper. Moreover the watermark is periodical, having a period that almost corresponds with the width of a security document.

[0047] Figure 7A shows a security document provided with a watermark over almost the full surface of the sheet of printing paper. The watermark here has a period that does not correspond with the width of a security document, particularly a period selected such that the watermark on each security document has a maximum and a minimum value situated at another position. As a result by detection of the watermark and identification of the minimum and maximum values of brightness, it can be deduced from what position of the sheet of printing paper a security document originates.

[0048] Figure 7B shows a cross-section of various watermarks originating from one sheet of printing paper, wherein it is clearly shown that the derivative varies continuously from the one banknote to the other banknote.

[0049] Figure 8A and 8B show an occurring fraud with for instance banknotes. In this way of committing fraud, the strips are cut from banknotes, each time a slightly bigger strip of a next banknote, wherein the strips are compiled into a new banknote.

[0050] In figure 8A a strip of an authentic banknote is used. It can be seen that by cutting a strip from an existing banknote that has also been provided with a watermark, wherein the watermarks over various banknotes vary differently each time, the brightness of the watermark no longer varies continuously. In another attempt at fraud, based on the same method, instead of a strip of an authentic banknote a strip of a counterfeit banknote is inserted. Said strip is indicated with 18. In this case it can very clearly be seen that the brightness varies discontinuously as the strip 18 is not provided with a watermark at all.

[0051] It will be clear that the above description is included to illustrate the operation of preferred embodiments of the invention, and not to limit the scope of the invention. Starting from the above explanation, many variations that fall within the spirit and the scope of the present invention will be evident to an expert.

Claims

1. Security document (1) provided with a watermark, **characterised in that** the watermark extends over the full security document (1) and shows a continuous brightness variation over the security document (1) that is visually not or hardly visible under visible light, and/or using infrared radiation and/or ultraviolet radiation.

2. Security document according to claim 1, wherein the brightness of the watermark as regards translucency varies periodically or aperiodically undulatory.

3. Security document according to claim 1 or 2, wherein the brightness of the watermark varies continuously along the longitudinal axis of the security document, the latitudinal axis of the security document, one or more diagonals of the security document, from a point on the security document either circular or not, or a combination thereof.

4. Security document according to claim 1, 2 or 3, wherein the brightness of the watermark varies undulatory along a line (l) in the plane of the security document, which line may or may not be imaginary.

5. Security document according to any one of the preceding claims, further provided with a group indication for distinguishing groups of security documents.

6. Security document according to any one of the preceding claims, further provided with a specimen indication which is unique for each specimen of the security document or a specimen or location of the security document within a sheet of printing paper (7).

7. Security document according to claim 5, wherein the brightness variation of the watermark as regards translucency along a line (I) in the plane of the security document, which line may or may not be imaginary, depends on the group indication or at least on a part or subset of the specimen indication.

8. Security document according to claim 7, wherein the brightness variation characteristic selected from the group of the first derivative of the brightness variation, the second derivative of the brightness variation and a combination of the first and second derivative, depends on the group indication or at least on a part or subset of the specimen indication.

9. Security document according to any one of the preceding claims, wherein the security document has been obtained from a sheet of printing paper (7) with a plurality of security documents, wherein the original position of the security document on the sheet of printing paper (7) can be deduced from the brightness variation of the watermark of the security document.

10. Security document according to one or more of the preceding claims, wherein the security document has been obtained from a sheet of printing paper having columns (8) and rows (9) of similar security documents, wherein the brightness variation of each security document has a predetermined relation with the column (8) and/or row (9) of the security document on the sheet of printing paper (7) so that the row and/or column from which the security document originates can be deduced.

11. Security document according to any one of the preceding claims, wherein the security document is a banknote.

12. Security document according to any one of the preceding claims, wherein the brightness variation as regards translucency or in case of transmission of visible light is not or hardly perceptible to the human eye.

13. Method for processing and/or detecting a watermark in a security document (1) according to any one of the preceding claims for verification or determination of authenticity, wherein a image recording of the security document (1) is made and stored in a first memory, a brightness variation is determined along a predefined (I) line in the plane of the security document (1), and at least one parameter is determined from the brightness variation.

14. Method according to claim 13, wherein the image recording is normalised with respect to a reference image for determining the brightness variation.

15. Computer software for, once implemented on a computer, carrying out the steps of the method according to claims 12 or 13.

16. Sheet of printing paper (7) on which several security documents (1) according to any one of the preceding claims can be printed in rows (9) and columns (8), comprising a watermark over almost the entire sheet of printing paper (7) and an almost continuously varying brightness variation which visually is not or hardly visible under visible light and/or using infrared radiation, and/or using ultraviolet radiation and which along a line (I), that may or may not be imaginary, selected from the group consisting of the length, the width and the diagonals of the sheet of printing paper varies almost undulatory, wherein a position or positions of minimum (2, 2') and/or maximum values (3) of the brightness of the watermark along the line (I) are situated at a different location per security document (1).

17. Sheet of printing paper according to claim 16, wherein the brightness variation is periodically undulatory.

18. Sheet of printing paper according to claim 17, wherein the brightness variation is almost sinusoidal.

19. Sheet of printing paper according to claims 16, 17 or 18, wherein the brightness variation as regards translucency is not or hardly visible to the human eye.

20. Watermark for securing a security document (1), extending over almost the full security document (1) and showing an almost continuous brightness variation over the security document (1) which is visually hardly visible under visible light, and/or using infrared radiation, and/or ultraviolet radiation.

21. Watermark according to claim 20, as regards translucency when using visible light not being visible or hardly being visible to the human eye.

22. Watermark according to claim 20 or 21 in combination with a watermark which as regards translucency is visible to the human eye at visible light.

23. Watermark according to claim 22, wherein the wa-

termark and the visible watermark have been encrypted into a code.

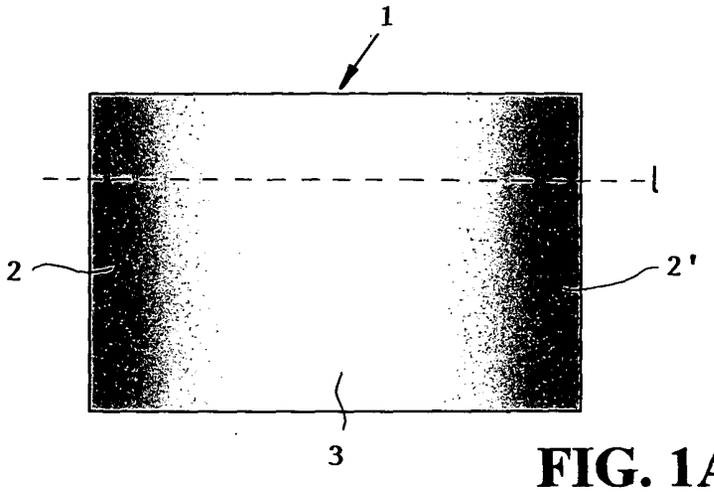

FIG. 1A

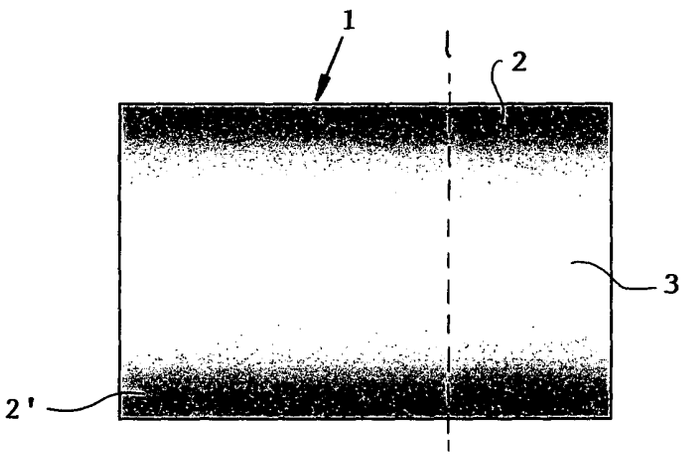

FIG. 1B

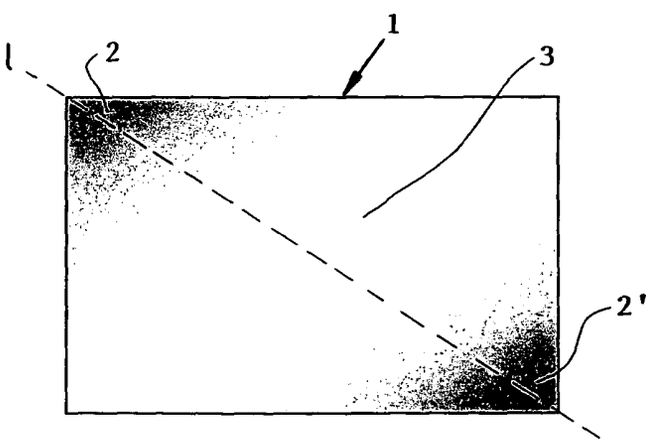

FIG. 1C

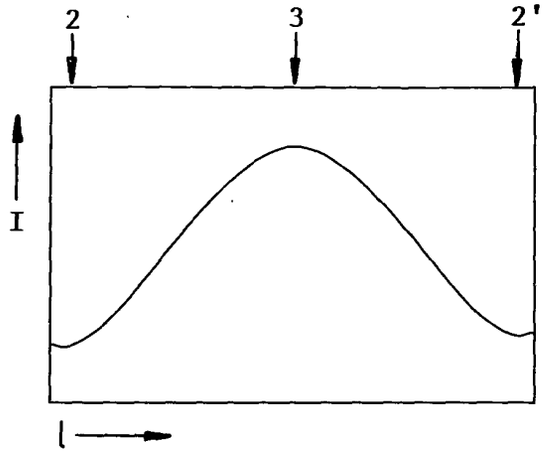

FIG. 2A

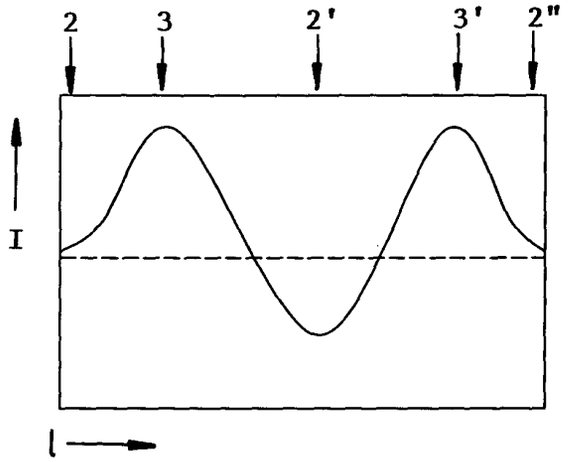

FIG. 2B

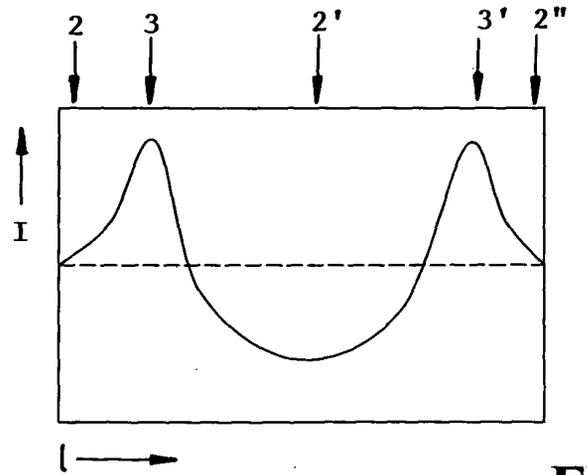

FIG. 2C

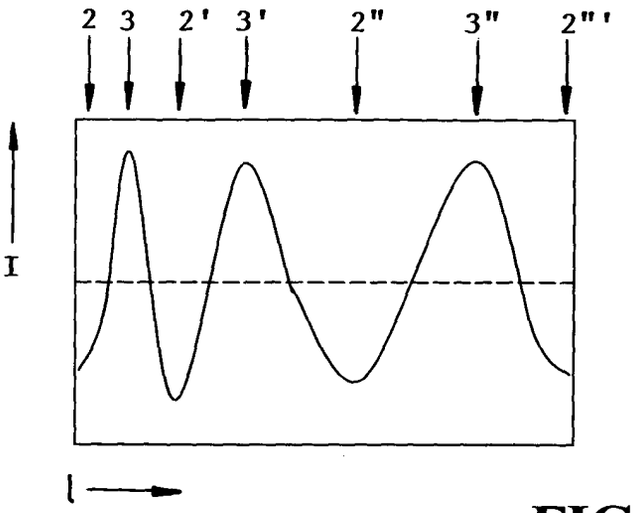

FIG. 3A

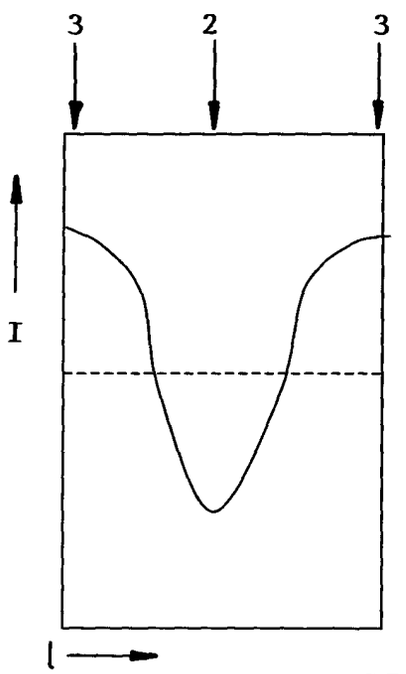

FIG. 3B

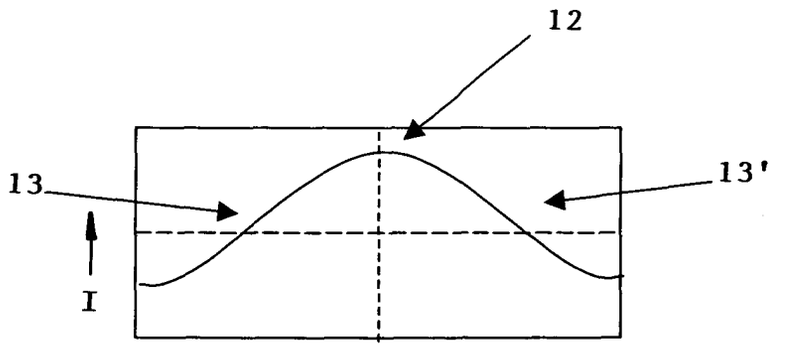

FIG. 4

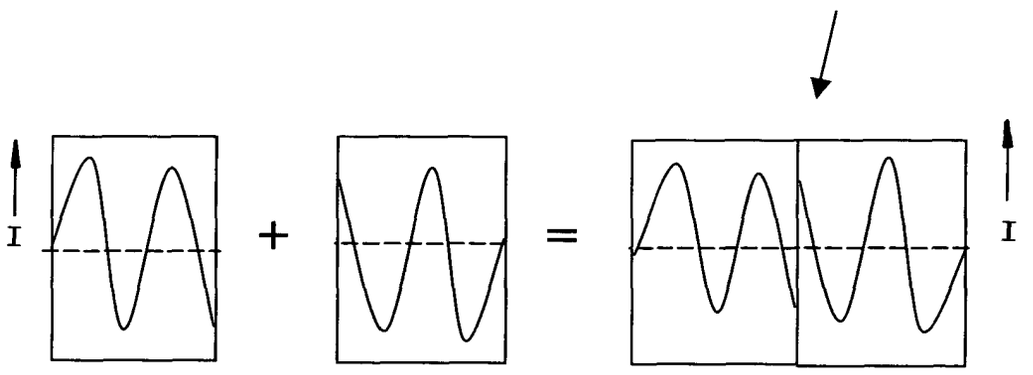

FIG. 5

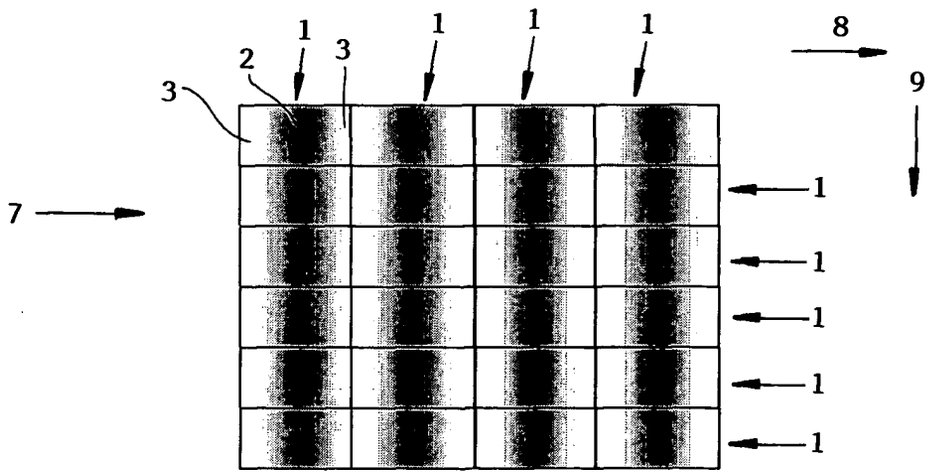

FIG. 6

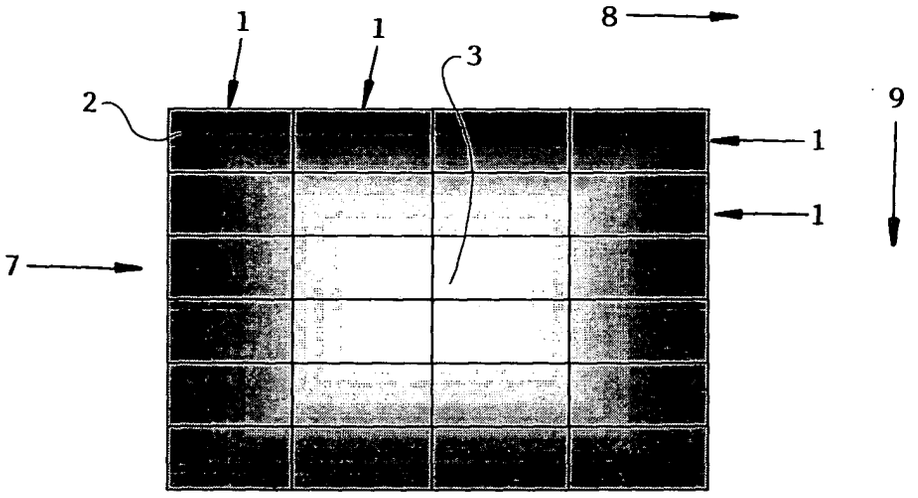

FIG. 7A

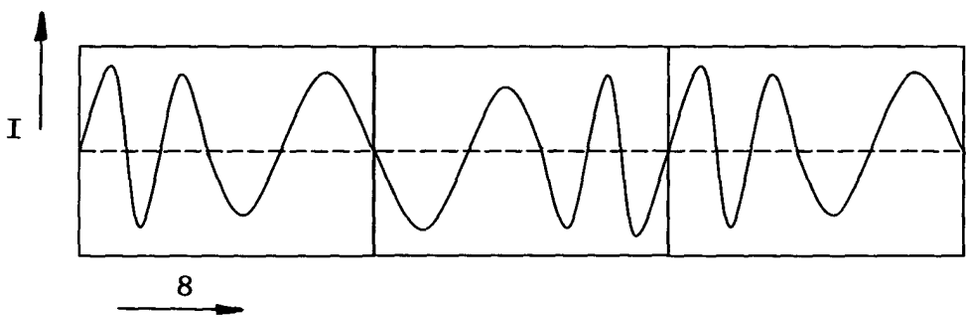

FIG. 7B

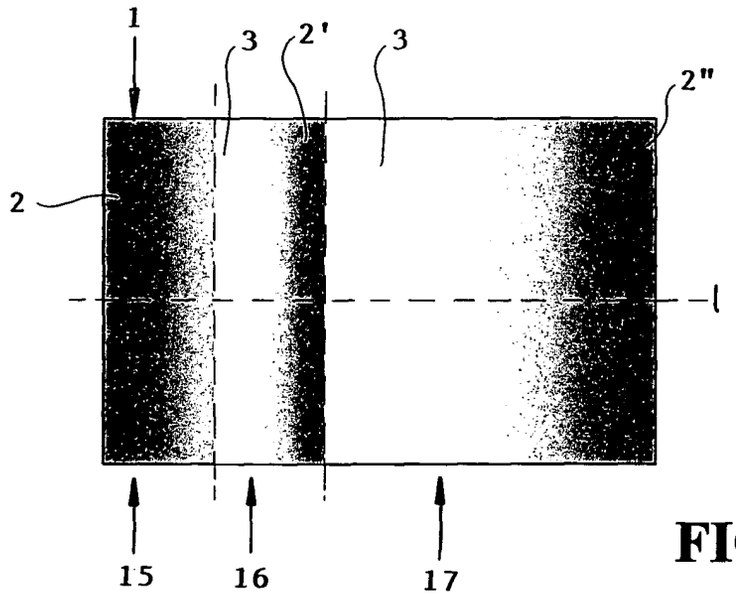

FIG. 8A

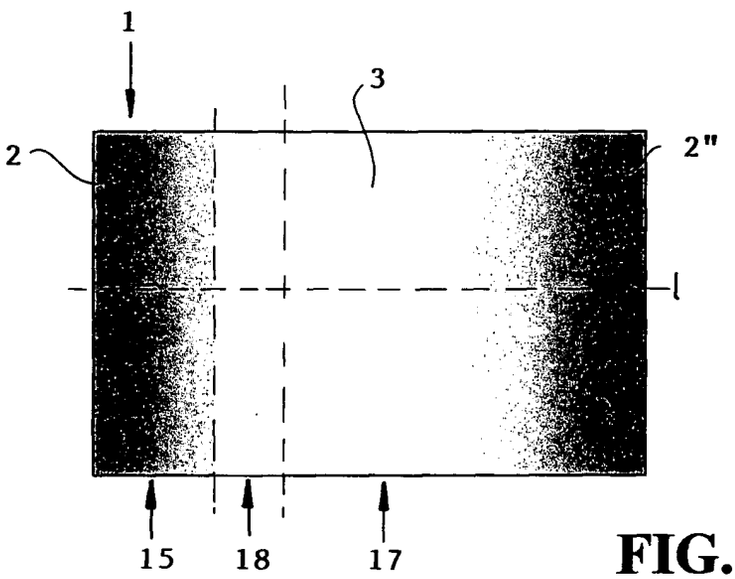

FIG. 8B

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 07 5081

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 A	EP 1 273 461 A (NL BANK NV) 8 January 2003 (2003-01-08) * column 4, line 5 - line 20; figure 1 *	1,20 13,15,16	B42D15/00
X	WO 03/080365 A (GIESECKE & DEVRIENT GMBH ; SCHNEIDER WALTER (DE)) 2 October 2003 (2003-10-02) * page 6, line 10 - line 14; figure 1 *	1,20	
X	H. DE HEIJ: "design and methodology of dutch banknotes" OPTICAL SECURITY AND COUNTERFEIT DETERRENCE TECHNIQUES III, vol. 3973, 27 January 2000 (2000-01-27), - 28 January 2000 (2000-01-28) pages 6-8, XP002295603 SAN JOSE CALIFORNIA USA * page 6 *	1,20	
X	CENTRAL EUROPEAN BANK: "50 euro note" CENTRAL EUROPEAN BANK, no. v14757742291, 1 January 2002 (2002-01-01), XP002329100 EUROPEAN COMMUNITY * the whole document *	1,20	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

B42D
B41M
D21H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	23 May 2005	Evans, A

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 07 5081

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

23-05-2005

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1273461 A	08-01-2003	NL 1018485 C2	08-01-2003
		EP 1273461 A2	08-01-2003
WO 03080365 A	02-10-2003	DE 10213794 A1	09-10-2003
		AU 2003226704 A1	08-10-2003
		BR 0308772 A	28-12-2004
		WO 03080365 A2	02-10-2003
		EP 1494874 A2	12-01-2005

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82