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(54) **MULTILAYERED SECURITY ELEMENT WITH VARIABLE OPTICAL EFFECT AND A COUNTERFEIT-PROOF DOCUMENT**

MEHRSCHICHTIGES SICHERHEITSELEMENT MIT VERÄNDERLICHEM OPTISCHEM EFFEKT UND FÄLSCHUNGSSICHERES DOKUMENT

ÉLÉMENT DE PROTECTION MULTICOUCHE POSSÉDANT UN EFFET OPTIQUE ALTERNANT, ET DOCUMENT PROTÉGÉ CONTRE LES CONTREFAÇONS

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Description

Field of Technology

[0001] The present invention relates to counterfeit-proof documents having multilayered security markings. Counterfeit-proof documents may be documents of value, such as cheques, stock certificates, banknotes, excise stamps, special federal stamps and identification documents such as passports, ID cards, etc.

Background Art

[0002] To make fraud and counterfeiting more complicated, protected documents are normally provided with a security marking, such as watermarks, holograms, diffractive/refractive nanograms, fluorescent signs, security threads, etc.

[0003] However, a problem with many conventional markings is that they can be produced or easily forged, and/or they can hardly be verified by an unskilled person without technical equipment. The object of the present invention is to provide security markings capable to create unusual optical effects that become apparent without any special equipment.

[0004] Conventional security elements are based on microlens raster structures. In such security elements optical images are formed by superposition of two or more micro-raster structures, one or more of which comprises microlens grids, while the others are raster structures having the same spatial periods as the microlens grids; nodes of the grids comprise repeating micro-images produced by printing methods or precision stamping methods. In these cases moiré effects are used. There are several types of such effects, e.g. effects of "moiré magnification" with orthogonal or collinear (parallel) shift of parallax of observed magnifies optical images. This type of moiré effects is typical to micro-raster structures with spherical or pseudo-spherical lenses in nodes of raster grids.

[0005] US 2005/0180020 A1, 18.08.2005, discloses a micro-optic system in the form of a polymer film that when viewed by unaided eye(s) in reflective or transmitted light projects one or more images which show various visual effects such as: orthoparallactic movement; appear to lie on a spatial plane deeper than the thickness of the polymer film; appear to lie on a spatial plane above a surface of the polymer film; oscillate between a spatial plane deeper than the thickness of the polymer film and a spatial plane above a surface of the film as the film is azimuthally rotated; transform from one form, shape, size, color (or some combination of these properties) into a different form, shape, size, or color; appear to have realistic three-dimensionality. The films in the security element are highly counterfeit resistant because of their complex multi-layer structure and their high aspect-ratio elements.

[0006] Another option of using microlens structures allows stereo-vario effects to be created. Such effects are attained using linear (lenticular) cylinder micro-raster lens structures. In this case, printed or embossed images are formed at a distance of about three focal distances from the plane of the lenticular raster and don't represent a grid of micro-images, as in the previous case, but are formed by several uniquely aligned printed or embossed images (normal, non micro-raster grid images). Each image is divided into strips having a width of about a period of the lenticular raster, and the images are aligned (with every other strip in accordance with a predetermined rule of symmetry variation in the strips) to form an integral image. When such a complex printed image is viewed through a lenticular lens raster at different angles different images will be seen; vario or stereo effects can be thereby created, including effects of movement of the viewed images. The systems will show no optical moiré magnification.

[0007] One of the major drawbacks of the microlens structures is that they are disposed on the external surface of the security element (they cannot be covered with a protective layer otherwise the required optical effects will be lost). This fact causes, first, rapid and uncontrolled wear (abrasion) of the raster, and, second, possible appearance of transparent layers of liquid, grease, etc. on the raster surface. Therefore, quality of the viewed changing images may be dramatically impaired, or images may disappear at all.

[0008] There are methods for creating floating images by forming a system of diffractive/refractive relief structures on the surface or in the bulk of security elements (RU 2111550 C1, 20.05.1998). A relief structure in the form of a system of incisions (grooves) with the configuration and shape calculated through a special program is formed in a transparent layer on the surface or in the bulk of a security element. These systems form a complex combination of flat Fresnel lenses which form variable images "floating" above or below the surface of the security element. The images can be viewed both in transmitted and reflected light. These structures however suffer from low brightness and contrast of the viewed images at small sizes of the security elements.

[0009] There are security elements using holographic methods to create changing images that are seen as the viewing direction and lighting of the security element are varied (RU 2345900 C2, 10.02.2009). In these elements several holographic images are formed on the surface or within the bulk of the security element using various optical reference frequencies (grids). However, with the small size of security elements (which is typical for special printing products, such as securities, security threads in banknotes, excise stamps and special stamps, etc.) the contrast and brightness of the viewed images worsen, movement of images becomes fuzzy and indistinct. Viewing the images becomes complicated due to their "rainbow" nature resulting from the high spatial frequencies of the grids and diffraction of falling non-monochromatic light on them. Special measures are required to increase

the contrast, brightness and sharpness of the viewed images and to enable more reliable perception of their changes (movements).

[0010] WO 2005/106601 A2 pertains to improved optically variable devices.

Summary of the Invention

[0011] The object of the invention is to enhance the security of products through providing a novel optical effect which renders the counterfeit-proof (protected) product more readily identifiable and is based observation of relative movement of images as the viewing angle varies.

[0012] The object is accomplished by a multilayered security element according to claim 1. Preferred embodiments are detailed in the dependent claims.

[0013] The object is further accomplished in a counterfeit-proof document, such as a cheque, stock certificate, banknote, excise stamp, special federal stamp, passport, ID card and another similar product, comprising at least one security element defined above.

[0014] In an embodiment of the counterfeit-proof document the security element is made in the form of a stripe or a local thin-film element placed on the surface of the counterfeit-proof document, or a thin-layer structure covering the counterfeit-proof document, or a security thread embedded into the counterfeit-proof document.

[0015] The invention substantially resides in the fact that in a security element comprising a flexible carrier layer with optically variable structures containing two or more groups of repeating images that move and/or change as the viewing angle varies, the optically variable structures are formed so that when the viewing angle varies different groups of images, that are located closely to each other at a distance of about the size of visible images, move relative to each other.

[0016] In embodiments, as already mentioned, images belonging to different groups move in parallel to the plane of the viewing angle variation so that the images come nearer or farther relative to the viewer; images belonging to different groups move perpendicular to the plane of the viewing angle variation so that the images move to the right or left of the viewer; images belonging to different groups move in different axial directions with respect to the plane of the viewing angle variation, or the movement of images belonging to different groups is combined with a smooth change in geometric parameters of the images, such as inclination angles to the longitudinal axis of the security element or their linear dimensions.

[0017] The optically variable structures comprise microlens raster structures, diffractive/refractive structures or holographic structures.

[0018] A counterfeit-proof document, such as a cheque, stock certificate, banknote, excise stamp, special federal stamp, passport, ID card and another similar product, comprises at least one security element defined above.

[0019] The security element can be made in the form of a stripe, or a local thin-film element disposed on the surface of the counterfeit-proof document (protected) document, or a thin-layer structure covering the protected document, or a security thread embedded into the protected document.

Brief Description of the Drawings

[0020]

FIG. 1 shows variants of changes in images formed by holographic threads at different viewing angles, that is, the process of the aforementioned changing (moving) of symbols S_1 and S_2.

FIG. 2 shows photographs of holographic images viewed at different angles, the images being formed on an actual security element such as a holographic thread. Here, symbols S_1 and S_2 are represented as digits "100" spaced apart at some distance (1-2 mm) along the thread and changing their visible location and orientation depending on the viewing angle.

Best Embodiment of the Invention

Example 1

[0021] On the surface of a holographic foil a rainbow holographic relief is produced using digital "dot matrix" methods or analog holography methods; when viewed at a certain viewing angle α_0 the rainbow holographic relief forms an image of two symbols S_1 and S_2 spaced apart at a distance l_0. As the viewing angle α_0 varies at an angle $\Delta\alpha$, the viewed image changes so that the distance between the symbols increases by a value Δl When the viewing angle is further increased by $\Delta\alpha$ the distance between the symbols increases to $l_0+2\Delta l$ With further increase in the viewing angle by $n\Delta\alpha$ the distance between the viewed symbols will increase accordingly by $n\Delta l$. Starting from a value of n=M the sign of Δl can be changed and the distance between the symbols will begin decreasing. At sufficiently small values of $\Delta\alpha$ and Δl and a smooth change in the viewing angle symbols S_1 and S_2 will appear to move first away of each other and then towards each other. Therewith movement of the symbols will be easier recognized owing to physiological peculiarities of vision. In course of the movement the symbols may further change their shape, size and orientation (as shown in the second and third lines of symbolic images in FIG. 1), which further improves the perception of movement of the symbols.

Example 2

[0022] Similarly to the above embodiment of an optical variable structure based on a rainbow holographic element in Example 1, floating images with differently directed movement of their fragments can be formed in diffractive/refractive structures such as a combination of

Fresnel lenses aligned with each other or a thin-film nano-prismatic system of diffractive optical elements. In the first case, floating images are formed by structures produced by embossing with master dies that are manufactured by precision engraving of concentric annular grooves (incisions) having a predetermined profile, which form a system of intersecting Fresnel lenses. The engraving has a resolution (typical size of groove profile) of about 1 - 10 μm. In the second case, the structure which forms floating images is manufactured using electronic, ionic, or laser nano- lithographic printers with a resolution of about 10-100 nm. The structure comprises nano-sized hills and pits distributed according to a predetermined law.

Example 3

[0023] Floating images with differently directed movement of groups of individual fragments can be also formed in optical elements based on microlens raster structures and micro-image grid systems. In this case, the observed movement character of the magnified moiré images is defined by properties and orientation of micro-image and microlens grids. In a simplest embodiment, certain local areas of a micro-image raster having dimensions of about 10 - 100 spatial periods (typical size of a spatial period of grids is generally 10-100 μm) are left free of micro-images. When viewed, these areas will appear to float above the plane with moving magnified patterns of micro-images, i.e. an apparent differently directed movement of the local areas relative to remote moving background images will be formed.

Industrial Applicability

[0024] The present invention makes it possible to simplify the process of detection of counterfeited and forged documents since the security of products can be enhanced owing to the provision of a novel optical effect which renders the protected product more readily identifiable and is based on observation of relative movement of images as the viewing angle varies.

Claims

1. A multilayered security element comprising a flexible carrier layer with optically variable structures containing two or more groups of repeating images that move and/or change as a viewing angle varies, **characterized in that** the optically variable structures in the form of a combination of Fresnel lenses aligned with each other, are formed so that when the viewing angle varies different groups of images and/or different fragments of one group of images and/ or different groups of the images move relative to each other, wherein different fragments of one group and/or different groups of the images move in different axial directions with respect to the plane of the viewing angle variation.

2. A multilayered security element according to claim 1, **characterized in that** the movement of images belonging to different groups is combined with a smooth change in geometric parameters of the images, such as inclination angles to the longitudinal axis of the security element or their linear dimensions.

3. A multilayered security element according to any one of claims 1 to 2, **characterized in that** the element is made in the form of a stripe, or a local thin-film element, or a security thread, or a thin-layer coating structure.

4. A counterfeit-proof document, such as a cheque, stock certificate, banknote, excise stamp, special federal stamp, passport, ID card and other similar item, comprising at least one security element as defined in any one of claims 1 to 3.

5. A counterfeit-proof document according to claim 4, **characterized in that** the security element is made in the form of a stripe or a local thin-film element disposed on the surface of a protected document.

6. A counterfeit-proof document according to claim 4, **characterized in that** the security element is made in the form of a thin-layer structure covering a protected document.

7. A counterfeit-proof document according to claim 4, **characterized in that** the security element is made in the form of a security thread embedded into a protected document.

Patentansprüche

1. Mehrschichtiges Sicherheitselement, das eine flexible Trägerschicht mit optisch variablen Strukturen umfasst, enthaltend zwei oder mehr Gruppen von sich wiederholenden Bildern, die sich bewegen und/oder verändern, wenn ein Blickwinkel variiert, **dadurch gekennzeichnet, dass** die optisch variablen Strukturen in Form einer Kombination von miteinander ausgerichteten Fresnellinsen so ausgebildet sind, dass sich, wenn der Blickwinkel variiert, unterschiedliche Gruppen von Bildern und/oder unterschiedliche Fragmente einer Gruppe von Bildern und/oder unterschiedliche Gruppen von Bildern in Bezug aufeinander bewegen, wobei sich unterschiedliche Fragmente einer Gruppe und/oder unterschiedliche Gruppen der Bilder in Bezug auf die Ebene der Blickwinkelvariation in unterschiedliche Axialrichtungen bewegen.

2. Mehrschichtiges Sicherheitselement nach Anspruch 1, **dadurch gekennzeichnet, dass** die Bewegung von Bildern, die zu unterschiedlichen Gruppen gehören, mit einer glatten Änderung von geometrischen Parametern der Bilder wie z. B. Neigungswinkel zur Längsachse des Sicherheitselements oder deren linearen Abmessungen kombiniert ist.

3. Mehrschichtiges Sicherheitselement nach einem der Ansprüche 1 bis 2, **dadurch gekennzeichnet, dass** das Element in Form eines Streifens oder eines lokalen Dünnschichtelements oder eines Sicherheitsfadens oder einer Dünnschichtbeschichtungsstruktur hergestellt ist.

4. Fälschungssicheres Dokument wie ein Scheck, ein Aktienzertifikat, eine Banknote, eine Banderole, ein spezieller Bundesstempel, ein Pass, ein Personalausweis und ein anderes ähnliches Element ist, das zumindest ein Sicherheitselement nach einem der Ansprüche 1 bis 3 umfasst.

5. Fälschungssicheres Dokument nach Anspruch 4, **dadurch gekennzeichnet, dass** das Sicherheitselement in Form eines Streifens oder eines lokalen Dünnschichtelements hergestellt ist, der bzw. das auf der Oberfläche eines geschützten Dokuments angeordnet ist.

6. Fälschungssicheres Dokument nach Anspruch 4, **dadurch gekennzeichnet, dass** das Sicherheitselement in Form einer Dünnschichtstruktur hergestellt ist, die ein geschütztes Dokument bedeckt.

7. Fälschungssicheres Dokument nach Anspruch 4, **dadurch gekennzeichnet, dass** das Sicherheitselement in Form eines Sicherheitsfadens hergestellt ist, der in ein geschütztes Dokument eingebettet ist.

Revendications

1. Elément de sécurité multicouche comprenant une couche de support souple avec des structures optiquement variables contenant deux groupes ou plus d'images répétitives qui se déplacent et/ou changent alors que l'angle d'observation varie, **caractérisé en ce que** les structures optiquement variables, sous la forme d'une combinaison de lentilles de Fresnel alignées les unes par rapport aux autres, sont formées de sorte que, lorsque l'angle d'observation varie, différents groupes d'images et/ou différents fragments d'un groupe d'images et/ou différents groupes des images se déplacent les uns par rapport aux autres, dans lequel les différents fragments d'un groupe et/ou les différents groupes des images se déplacent dans différentes directions axiales par rapport au plan de variation de l'angle d'observation.

2. Elément de sécurité multicouche selon la revendication 1, **caractérisé en ce que** le déplacement d'images appartenant à différents groupes est combiné avec une variation régulière des paramètres géométriques des images, tels que les angles d'inclinaison par rapport à l'axe longitudinal de l'élément de sécurité ou leurs dimensions linéaires.

3. Elément de sécurité multicouche selon l'une quelconque des revendications 1 à 2, **caractérisé en ce que** l'élément est réalisé sous la forme d'une bande, ou d'un élément à films minces local, ou d'un fil de sécurité, ou d'une structure de revêtement à couches minces.

4. Document anti-contrefaçon tel qu'un chèque, un certificat d'action, un billet de banque, une vignette, un timbre fédéral spécial, un passeport, une carte d'identité et un autre article similaire, comprenant au moins un élément de sécurité selon l'une quelconque des revendications 1 à 3.

5. Document anti-contrefaçon selon la revendication 4, **caractérisé en ce que** l'élément de sécurité est réalisé sous la forme d'une bande ou d'un élément à films minces local disposé sur la surface d'un document protégé.

6. Document anti-contrefaçon selon la revendication 4, **caractérisé en ce que** l'élément de sécurité est réalisé sous la forme d'une structure à couches minces recouvrant un document protégé.

7. Document anti-contrefaçon selon la revendication 4, **caractérisé en ce que** l'élément de sécurité est réalisé sous la forme d'un fil de sécurité intégré dans un document protégé.

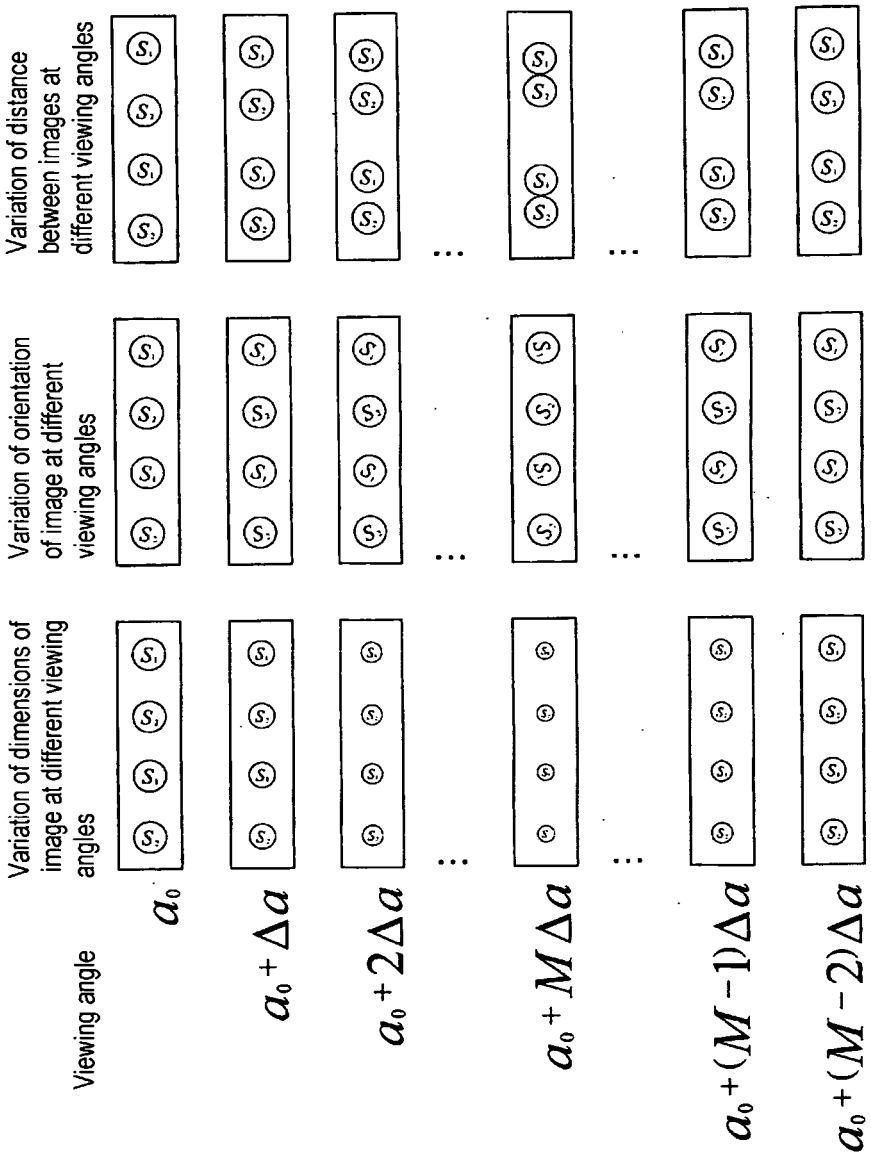
Variation of dimensions of image at different viewing angles
Variation of orientation of image at different viewing angles
Variation of distance between images at different viewing angles
Viewing angle
a_0
$a_0+\Delta a$
$a_0+2\Delta a$
$a_0+M\Delta a$
$a_0+(M-1)\Delta a$
$a_0+(M-2)\Delta a$

Fig. 1

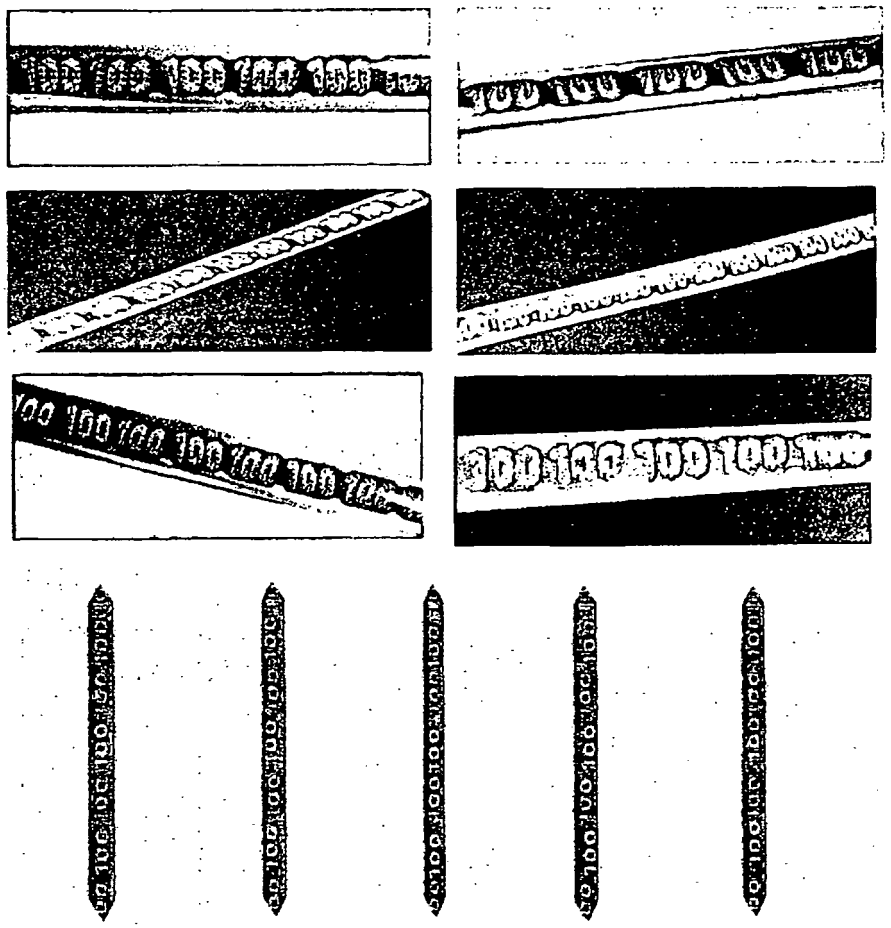

Fig. 2

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- RU 2111550 C1 **[0008]**
- RU 2345900 C2 **[0009]**
- WO 2005106601 A2 **[0010]**