Innovation, Sciences et Développement économique Canada
Office de la Propriété Intellectuelle du Canada

Innovation, Science and Economic Development Canada
Canadian Intellectual Property Office

CA 2991552 C 2023/08/15

(11)(21) **2 991 552**

(12) **BREVET CANADIEN**
CANADIAN PATENT

(13) **C**

(86) **Date de dépôt PCT/PCT Filing Date:** 2015/07/07
(87) **Date publication PCT/PCT Publication Date:** 2016/01/14
(45) **Date de délivrance/Issue Date:** 2023/08/15
(85) **Entrée phase nationale/National Entry:** 2018/01/05
(86) **N° demande PCT/PCT Application No.:** GB 2015/051964
(87) **N° publication PCT/PCT Publication No.:** 2016/005736
(30) **Priorités/Priorities:** 2014/07/07 (GB1412067.9); 2014/09/05 (GB1415728.3); 2014/11/10 (GB1419991.3)

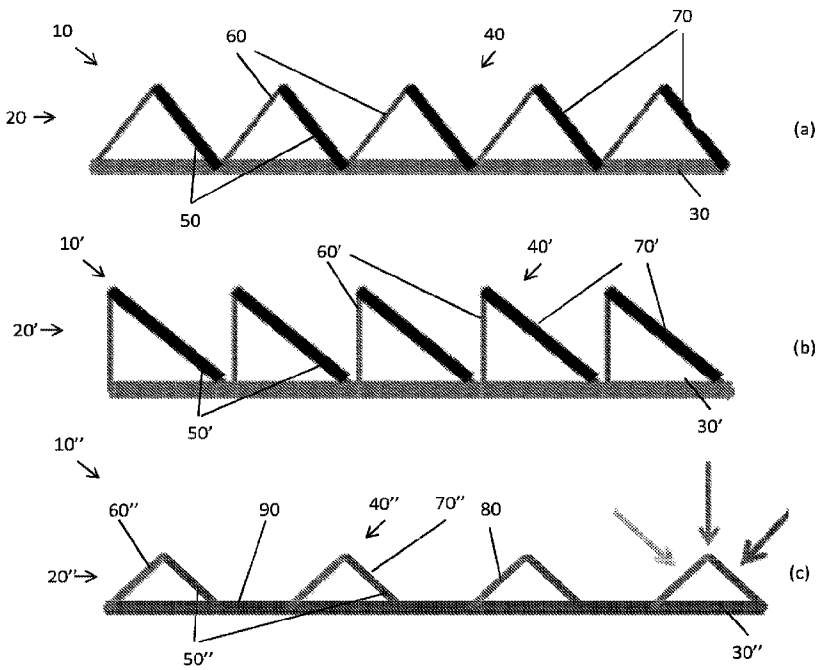
(51) **Cl.Int./Int.Cl.** ***B42D 25/324*** (2014.01), ***B42D 25/351*** (2014.01), ***B42D 25/373*** (2014.01), ***B42D 25/387*** (2014.01), ***B42D 25/425*** (2014.01), ***B42D 25/45*** (2014.01)

(72) **Inventeur/Inventor:**
SPINKS, GARY DONALD, GB

(73) **Propriétaire/Owner:**
SECURITY FIBRES UK LIMITED, GB

(74) **Agent:** OSLER, HOSKIN & HARCOURT LLP

(54) **Titre : AMELIORATIONS DE DOCUMENTS DE SECURITE**
(54) **Title: IMPROVEMENTS IN AND RELATING TO SECURITY DOCUMENTS**



(57) **Abrégé/Abstract:**
A method of manufacturing a security device (10) for a security document. The method comprising: providing a substrate (20) having a face (30), the face including a plurality of first walls (50),each first wall (50) being orientated in a first direction and a plurality of second walls (60), each second wall (60) being orientated in a second, different direction; and directing a flow of particles to form a layer of material (70) on one of either (i) each of the plurality of first walls (50) or (ii) each of the plurality of second walls (60).

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
14 January 2016 (14.01.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/005736 A1

(51) International Patent Classification:
B42D 25/324 (2014.01) *B42D 25/387* (2014.01)
B42D 25/351 (2014.01) *B42D 25/425* (2014.01)
B42D 25/373 (2014.01) *B42D 25/45* (2014.01)

(21) International Application Number:
PCT/GB2015/051964

(22) International Filing Date:
7 July 2015 (07.07.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
1412067.9 7 July 2014 (07.07.2014) GB
1415728.3 5 September 2014 (05.09.2014) GB
1419991.3 10 November 2014 (10.11.2014) GB

(71) Applicant: **D. W. SPINKS (EMBOSSING) LIMITED** [GB/GB]; 26 Red Lion Square, London WC1R 4AG (GB).

(72) Inventor: **SPINKS, Gary Donald**; D. W. Spinks (Embossing) Limited, 26 Red Lion Square, London WC1R 4AG (GB).

(74) Agent: **CRITTEN, Matthew Peter**; Abel & Imray, 20 Red Lion Street, London, WC1R 4PQ (GB).

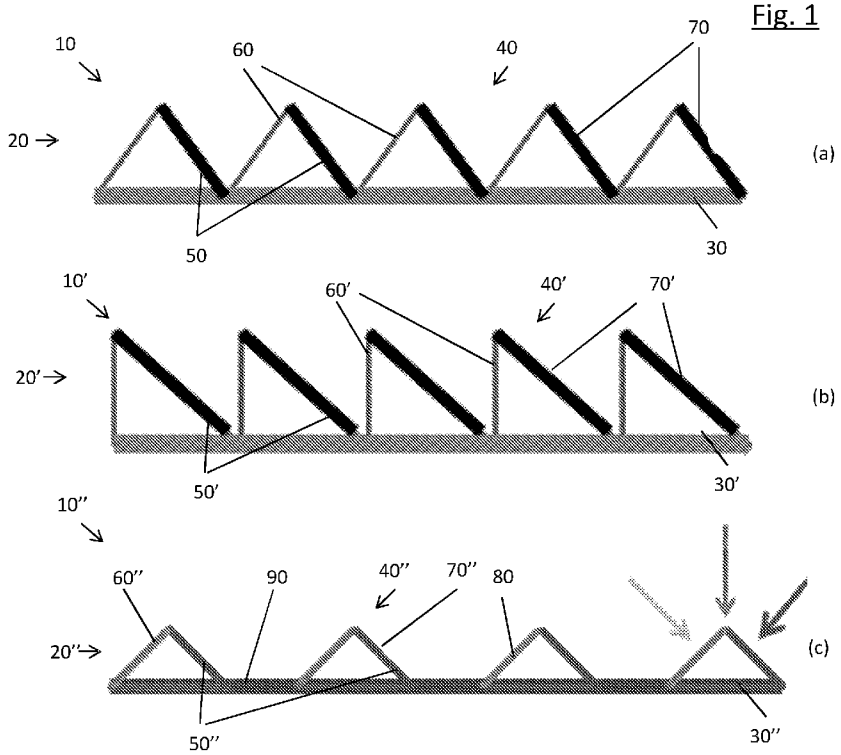
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: IMPROVEMENTS IN AND RELATING TO SECURITY DOCUMENTS

Fig. 1



(57) Abstract: A method of manufacturing a security device (10) for a security document. The method comprising: providing a substrate (20) having a face (30), the face including a plurality of first walls (50),each first wall (50) being orientated in a first direction and a plurality of second walls (60), each second wall (60) being orientated in a second, different direction; and directing a flow of particles to form a layer of material (70) on one of either (i) each of the plurality of first walls (50) or (ii) each of the plurality of second walls (60).

WO 2016/005736 A1

WO 2016/005736 A1

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

Improvements in and relating to security documents

Technical Field

The present invention concerns improvements in and relating to security documents. More particularly, this invention concerns a security device for a security document and a method of manufacturing a security device for a security document.

Background of the Invention

Security documents, for example banknotes, passports, lottery tickets, some certificates and other items of potentially high value, are targets for counterfeiters, who seek to produce counterfeit copies of the security documents and thus illegally benefit from the high value of the genuine items. Security documents typically include various security devices or features that are difficult for a counterfeiter to simulate; such devices include holograms, security threads, and security fibres. In order to increase the burden for the counterfeiter, security documents have traditionally included fine detailing in their design.

In order to be effective, a security device must exhibit characteristics that are easily identified by a user seeking to verify the authenticity of the security document concerned whilst increasing the burden for a potential counterfeiter. To that end, many security devices exhibit a fluorescent response.

GB2300596 discloses a security feature in the form of a composite material comprising a transparent or translucent substrate and two fluorescent components, one on each side of

the substrate, which fluoresce UV light at different visible colours, and a UV light absorber. Consequently, when the security device is viewed alternately in transmitted and reflected ultraviolet light the fluorescent colour perceived by the viewer changes, and, when the material is viewed in either transmitted or reflected ultraviolet light, the fluorescent colour perceived by the viewer changes when the composite material is turned over. The method of producing the security feature comprises the step of applying a resin composition to a porous transparent or translucent substrate, which composition comprises a fluorescent pigment and a fluorescent die. In the disclosed examples, the fluorescent coatings are screen printed on the substrate.

GB24906063A discloses a planar security device such as a security thread or a security fibre, for use in a paper security document. The security device includes a composite material having a first and second side, and comprises: a substrate; a first fluorescent layer on the first side of the substrate; a layer of UV absorbent material on the first fluorescent layer; and a fluorescent layer on the layer of UV absorbent material. When the security device is viewed alternately in transmitted and reflected ultraviolet light the fluorescent colour perceived by the viewer will change, and, when the material is viewed in either transmitted or reflected ultraviolet light, the fluorescent colour perceived by the viewer changes when the composite material is turned over. The fluorescent regions and the UV absorbent material may be one of printed layers or coatings which are printed or coated so that no adhesive layers are required. In the example of security fibres disclosed in GB2490603A, the security devices are mixed into the pulp during manufacture of the security document. When the security device is in the form of a thread, the thread is composed of a thin strip of transparent polyester substrate. The fluorescent coatings consist of a

fluorescent pigment or dye incorporated into a binder material and applied to the substrate by a contact printing process. An opaque metallic foil may be applied to the opposite face of the substrate by a cold foil stamping process. The thread is then inserted into the security document during manufacture of the paper, for example by threading the device into the document using a roller. In other embodiments, the security device is applied to the formed security document, for example by printing or coating.

Both of the above disclosures describe examples of security features which exhibit an effect described herein as a "transmission colour switch" effect. When a first side of the device is viewed in reflected UV light, one fluorescent layer fluoresces strongly, but the other fluorescent layer fluoresces only weakly, if at all, because the UV absorbent material prevents the UV light from passing through to that other fluorescent layer. On the other hand, when the first side of the device is viewed in transmitted UV light, the fluorescent layer that previously fluoresced strongly, now fluoresces only weakly if at all, because the UV absorbent material prevents the UV light from passing through to it. The other fluorescent layer, however, now fluoresces strongly because the UV light falls directly on and excites that fluorescent layer. Because the fluorescence is in the visible spectrum, the fluorescence passes through the UV absorbent material and is visible to the viewer. If one fluorescent layer fluoresces in a first colour, and the other fluorescent layer fluoresces in a second colour, then when the illumination of the device changes from reflected to transmitted UV light, the effect perceived by the viewer is that the visible fluorescence changes colour.

The transmission colour-switch materials of GB2300596 and GB2490603A provide a striking and readily recognisable effect, providing good protection from counterfeiters. However, in

order for the effect to be produced, the light must be transmitted from one side of the material to the other through the structure of the security device, which places limitations on the range of materials from which the device can be constructed. Consequently, it would be advantageous to provide an improved security device that is still harder for counterfeiters to simulate.

The burden on counterfeiters is also increased when legitimate produces of security documents have a variety of security devices and effects from which to choose. Consequently, it is advantageous to provide new security devices per se, particularly security devices which generate a new effect.

Summary of the Invention

According to a first aspect of the invention, there is provided a method of manufacturing a security device for a security document, the method comprising: providing a substrate having a face, the face including a plurality of first walls, each first wall being orientated in a first direction and a plurality of second walls, each second wall being orientated in a second, different direction; and directing a flow of particles to form a layer of material on one of either (i) each of the plurality of first walls or (ii) each of the plurality of second walls.

According to a second aspect of the invention provides a security device for a security document, the device comprising a substrate having a face, the face including a plurality of first walls, each first wall being orientated in a first direction and a plurality of second walls, each second wall being orientated in a second, different direction, at an angle to the first direction, wherein there is a layer of material on each of the plurality of first walls or each of the

plurality of second walls or each of both the plurality of first walls and the plurality of second walls.

According to a third aspect of the invention there is provided a security device for a security document, the device having a front side and a back side and comprising a plurality of indentations, each indentation having a first wall and a second wall, each wall having a front face on the front side of the device, wherein the front faces of the first walls are orientated in a first direction and the front faces of the second walls are orientated in a second, different, direction, and wherein the first walls are fluorescent in a first visible colour when exposed to ultraviolet light and the second walls are fluorescent in a second, different, visible colour when exposed to ultraviolet light such that the device fluoresces in the first colour when exposed to ultraviolet light incident on the first wall and the device fluoresces in the second colour when exposed to ultraviolet light incident on the second wall.

According to a fourth aspect of the invention there is provided a method of producing a security device for a security document, the method comprising the steps of

(i) providing a security material having a front side and a back side and comprising a first layer and a second layer wherein the first layer is fluorescent in a first visible colour when exposed to ultraviolet light and the second layer is fluorescent in a second, different, visible colour when exposed to ultraviolet light;

(ii) forming a plurality of indentations in the security material, each indentation having a first wall and a second wall, each wall having a front face on the front of the device, the front face of the first wall being orientated in a first direction and comprising material from the first layer and the

front face of the second wall being orientated in a second, different, direction and comprising material from the second layer.

A fifth aspect of the invention provides a security document including a security device according to any of the preceding aspects of the invention. The security document may for example be an identity document (e.g. a passport or identity card), a value document or a bank note.

A sixth aspect of the invention provides a method of manufacturing a security device for a security document, the method comprising providing a substrate having a face, the face including a plurality of first walls, each first wall being orientated in a first direction and a plurality of second walls, each second wall being orientated in a second, different direction, wherein there is a layer of material on each of the plurality of first walls or each of the plurality of second walls or each of both the plurality of first walls and the plurality of second walls.

It will of course be appreciated that features described in relation to one aspect of the present invention may be incorporated into other aspects of the present invention. For example, the method of the first aspect of the invention may incorporate any of the features described with reference to the security device of the second aspect of the invention and vice versa.

Brief Description of the Drawings

Various embodiments of the invention will now be described, by way of example only, with reference to the accompanying schematic drawings of which:

Figure 1 is a schematic drawing of three example security devices according to the invention;

Figure 2 is a schematic drawing of a fourth example security

device according to the invention;

Figure 3 is a schematic drawing of a fifth example security device according to the invention;

Figure 4 is a schematic drawing of three stages in an example method of making a sixth example security device according to the invention;

Figure 5 is a schematic drawing of an eighth example security device according to the invention;

Figure 6 is a schematic drawing of a ninth example security device according to the invention;

Figure 7 is a schematic drawing of a tenth example security device according to the invention;

Figure 8 is a schematic drawing of a twelfth example security device according to the invention;

Figure 9 is a plan-view schematic drawing of a portion of a thirteenth example security device according to the invention;

Figure 9a is a schematic plan view of a security document include a security device according to a fourteenth example embodiment of the invention;

Figure 9b is a schematic cross-sectional view of a security device in accordance with the fourteenth example embodiment;

Figure 9c is a schematic cross-sectional view of a security device in accordance with the fourteenth example embodiment;

Figure 10 is a security transfer for use in manufacturing a security device in accordance with the fourteenth example embodiment; and

Figure 11 is a flow chart of the process for manufacturing a security device in accordance with the in accordance with the fourteenth example embodiment.

Detailed Description

A first aspect of the invention provides a method of manufacturing a security device for a security document, the method comprising: providing a substrate having a face, the face including a plurality of first walls, each first wall being orientated in a first direction and a plurality of second walls, each second wall being orientated in a second, different direction; and directing a flow of particles to form a layer of material on one of either (i) each of the plurality of first walls or (ii) each of the plurality of second walls.

The walls may be considered to form a corrugated structure.

The device may be suitable for inclusion in the security document. The device may be suitable for attachment (for example adhesion) to the security document. It will be appreciated that where the device is suitable for inclusion in and/or attachment to the security document, the device may be included and/or attached with the layer facing towards the front or the back of the security document. It may be that it is not necessary to incorporate the security device into the security document or to attach the security device to the security document. For example, the device may be a security document.

The device may have a front surface and a back surface and comprise a plurality of indentations, each indentation being defined by the first wall and the second wall, each wall having a front face on the front surface of the device, wherein the front faces of the first walls are orientated in a first direction and the front faces of the second walls are orientated in a second, different, direction.

The security device may be a thin film (for example, a film having a thickness of 12-40 microns). The security device may, for example, be a device selected from the following: an overlay; a thread (for example a windowed thread), fibre or planchette for embedding in a security

document; a tear tape; a transfer film; or a laminating film. The security device may be a film that can be adhered to paper or another substrate to provide anti-counterfeiting or anti-forgery effects.

The substrate may be a paper substrate. The substrate may be a polymer substrate. The substrate may be in the form of a thread, tape, fibre, planchette, or film, for example a film that can be adhered to paper or another substrate. The substrate may be colourless. The substrate may be transparent to visible and/or UV light. The substrate may be colourless and transparent. The substrate may be made from a fluorescent material. The substrate may be opaque to visible and/or UV light.

Where the substrate is a sheet it will have two faces.

There may be an image, for example indicia, printed on the face of the substrate. The image may be visible in visible light. The image may be visible only in UV light. The method may include printing a pattern or image on the structure, for example by non-impact printing.

The walls may define, alone or in combination with further walls, a pattern of indentations and/or protrusions on the face. The pattern may be a one-dimensional pattern (i.e. a pattern having translational symmetry along an axis of the face, that is, vary in one direction and not vary in an orthogonal direction, along the axis. The pattern may be a two-dimensional pattern (i.e. a pattern not having translational symmetry across the face).

The walls, alone or in combination with further walls, may extend across the full width of the face. The walls may for example define indentations, grooves, or channels in the substrate.

Each of the first and second walls, alone or in combination with further walls, may form a closed loop. The walls may define the sides of indentations in the substrate.

It may be that the walls define, alone or in combination with further walls, the footprint of an indentation (i.e. the shape of the indentation when viewed in plan). It may be that each indentation has a polygonal footprint, for example a square, pentagonal, or hexagonal footprint. It may be that the indentation has a more complex footprint having one or more indentations, projections and/or lobes. It may be that the plurality of indentations form a repeating pattern across the surface of the device. For example, it may be that each indentation has a hexagonal footprint and the plurality of indentations form a honeycomb pattern across the surface of the device.

The walls may be flat or curved.

The method of the invention may include the step of forming the walls by embossing the substrate. The method may include the step of forming the walls by embossing a varnish, for example a UV curable varnish, on the substrate.

The method may include the step of forming a layer of material, e.g. a metalized layer, on the face prior to forming the walls.

The orientation of the wall is the direction in which the major surface of the wall faces.

The first and second directions may cross each other; that is a normal from the major surface of the first wall may cross a normal from the major surface of the second wall.

The first direction may be parallel to the face of the substrate (i.e. the first wall may perpendicular to the face of the substrate). The second direction may be between 20 degrees and 70 degrees, for example between 30 degrees and 60 degrees, from a direction parallel to the face of the substrate. The first direction may be between 20 degrees and 70 degrees, for example between 30 degrees and 60 degrees, from a direction parallel to the face of the substrate.

The first and second walls may be in contact with each other. The first and second walls may be in contact with each other at their upper edges (i.e. the edges furthest displaced from the body of the substrate). The first and second walls may be in contact with each other at their lower edges. The first and second walls may form a continuous sequence of alternating first and second walls across the face of the sheet. The continuous sequence may be periodic, for example with a pitch of 10 microns to 50 microns, preferably 20 microns to 40 microns, preferably about 25 microns. The first and second walls may be spaced apart at their lower edges. There may be regions of flat substrate between pairs of the first and second walls.

The particles may be metal (for example aluminium) particles. The particles may be photo-sensitive (for example silver halide or bromide crystals). The particles may be titanium dioxide. The particles may form a fluorescent material, for example they may be manganese-doped zinc sulphide. The particles may form a coloured material which is visible in visible light.

The directing of the flow of particles may be by sputtering, plasma etching, plasma enhanced vacuum coated deposition (PEVCD) or ion-assisted deposition. (In plasma etching, the plasma can form a layer by generating etch products at room temperature from chemical reaction between elements of the etched material and reactive species generated by the plasma.) The sputtering may for example be ion-beam sputtering, reactive sputtering, high-target-utilisation sputtering, high-power impulse magnetron sputtering (HIPIMS), gas flow sputtering, or RF sputtering.

The layer may block UV light and transmit visible light. The layer may block visible light and transmit UV light. The layer may be reflective to UV light. The first layer may be reflective to visible light. The first layer may be a metal,

for example an aluminium, coating. The layer may be a resist layer, e.g. a layer of amorphous hydrogenated silicon carbide. The resist layer may be formed over a printed layer. The resist layer may be formed over a metalized layer. The method may include the step of forming images on the walls by chemical etching or curing with UV or blue light.

The layer may be a material (e.g. titanium dioxide) that is both receptive to ink-jet or other non-impact printing of images and at the same time provides an opaque surface to prevent any image on the substrate beneath the first layer being visible and also prevent transmission of UV light to the opposite face of the substrate from the face on which the walls are formed.

The layer may be a patterned layer. For example, the layer may show a repeating image and/or a single image. The layer of each of the plurality of first walls or each of the plurality of second walls or each of both the plurality of first walls and the plurality of second walls may show a portion of an image such that when the plurality of walls are viewed together the complete image is displayed.

The method may include the step of etching (e.g. laser etching) or ablating (e.g. laser ablating) a layer of material, which may for example be a visible or transparent carbonised layer, for example a carbon layer produced from a carbon plasma produced by focusing laser radiation on a graphite target. For example, the method may include the step of selectively etching or ablating a layer of material from one of either (i) each of the plurality of first walls or (ii) each of the plurality of second walls, such that the layer of material remains on one of either (i) each of the plurality of first walls or (ii) each of the plurality of second walls.

The method may include the step of exposing a photosensitive layer to light in order to produce an image.

The method may include the step of metalizing a face of the substrate.

It may be that the layer is on the first walls but not the second walls. It may be that the layer is on the second walls but not the first walls.

It may be that the layer blocks viewing of an image on a face of the substrate at certain viewing angles. It may be that the layer is visible when viewed from certain angles and the image on the face of the substrate is visible when viewed from certain, different angles. It may be that for some viewing angles both the layer and the image are visible. It may be that the image is formed on the face of the substrate opposite to the layer of material.

The method may further comprise directing a flow of particles to form a further, second layer of material. The further layer of material may be on one or more selected from: the first walls, the second walls, a portion of the substrate between the first walls and the second walls. At least part of the further layer of material may be formed on top of, or underneath, the layer of material. For example, the layer of material may be a material that blocks UV light but not visible light and the further layer may be a fluorescent material. When UV light is incident on the fluorescent material, it will emit visible light; thus, if the fluorescent material is on a first side of the UV blocking layer, and the fluorescent material is illuminated with UV light from that first side, the emitted visible light will pass through the UV blocking material but the UV light will not. A third layer of material, being a fluorescent material that emits visible light of a different colour from that of the further layer of material may be provided on the other side of the UV blocking material, so that, if the third layer of material is illuminated with UV light from that other side, it emits visible light which passes through the UV blocking layer but

the UV light will not. The appearance of the device may change depending on the side that is illuminated with UV light and/or the side from which it is viewed. The behaviour may be similar to the "colour-switch" phenomenon known in the prior art. However, when the "colour switch" layers are provided on the first or second walls, the optical effect is different from that in the prior-art devices, because the appearance of the device will depend on the angle of viewing and/or illumination, and not just the side of the device that is viewed or illuminated.

The first walls may have a colour. The second walls may have a colour. The first walls may have a first colour and the second walls may have a second, different, colour. The colour of the first walls may be different from the colour of the substrate. The colour of the second walls may be different from the colour of the substrate. The colour of the device may be a combination of colours of at least two selected from: the colour of the first walls, the colour of the second walls, the colour of the substrate. The combination may change with viewing angle.

The first wall may be provided with a pattern, for example a coloured pattern. The second wall may be provided with a pattern, for example a coloured pattern. At least one face of the substrate may be provided with a pattern, for example a coloured pattern. The face with the pattern may be the face on which the walls are formed. The face with the pattern may be the face on which the walls are not formed.

The pattern may be provided, for example, by non-impact printing, for example by a method of printing employing electrostatic imaging which attracts toner, for example xerography and laser printing.

It may be that a first colour is visible when the device is viewed in a direction against the orientation of the first walls. It may be that a second colour is visible when the

device is viewed in a direction against the orientation of the second walls. It may be that a third colour is visible when the device is viewed in a direction perpendicular to the face of the substrate. It may be that the colour or colours that are visible change as direction of viewing the device changes.

The device may be colourless in visible light. The device may be translucent or transparent in visible light.

The method may include the step of providing a covering layer which extends over a portion of the substrate. The covering layer may extend over the first and second walls. The covering layer may be spaced apart from the first and second walls. The covering layer may be substantially planar. The covering layer may be provided on the opposite surface of the substrate to the layer formed by directing the flow of particles. The covering layer may be provided on the rear surface of the substrate. Thus, the covering layer may be provided on the surface of the substrate opposite the first and second walls. The covering layer may have a colour. The covering layer may be a patterned layer. The covering layer may comprise an image. It may be that the layer formed by directing the flow of particles blocks viewing of the covering layer, for example of the image or pattern of the covering layer, at certain angles. The covering layer may be at least partially transparent to visible and/or UV light. The covering layer may be opaque to visible and/or UV light. The covering layer may have one or more portions which are opaque to visible and/or UV light and/or one or more portions which are at least partially transparent to visible and/or UV light. The covering layer may be provided by printing, for example impact or non-impact printing. The security device may include more than one covering layer, for example two covering layers.

The method may include the step of laminating, varnishing or encapsulating the substrate after the other steps of the

method have been carried out. Advantageously, example devices according to the invention can be laminated, varnished or encapsulated without affecting their visual performance and hence their effectiveness as security devices. (In contrast, if prior-art lens arrays, Fresnel lenses, or lenticular lenses which rely on the diffraction of light in order to function, are coated with varnish, encapsulated or even contaminated by dirt or oil in everyday use then their visual performance badly deteriorates.) The step of laminating, varnishing or encapsulating the substrate may include filling the indentations formed by the first and second wall. The step of laminating, varnishing or encapsulating the substrate may provide a substantially planar outer surface on the front side of the device.

As discussed above, the method may include the step of providing a covering layer which extends over a portion of the substrate. The method may include the step of providing the covering layer such that the layer formed by directing the flow of particles is located between the face of the substrate and the covering layer. The covering layer may be on the front surface of the device. The covering layer may be formed after the step of laminating, varnishing or encapsulating the substrate. The covering layer may be formed on the substantially planar outer surface. The covering layer may be substantially planar.

The method may include the step of providing a covering layer (see above). The method may include the step of providing a first covering layer located on the opposite side of the substrate to the face. The method may include the step of providing a second covering layer wherein the layer of material formed by directing the flow of particles is located between the second covering layer and the face. The substrate may be located in-between the first and second covering layers. The second covering layer may have a different colour

to the first covering layer. In use, at least part of the second covering layer may be visible through an at least partially transparent portion of the first covering layer. The second covering layer may include a pattern and/or image. The pattern and/or image of the second covering layer may form a latent image when viewed along with the pattern and/or image of the first covering layer. It may be that the layer formed by directing the flow of particles is viewed through the second covering layer.

The method may include the step of providing more than one covering layer on the same side of the substrate. For, example the method may comprise the step of providing a stack of covering layers on one side of the substrate. Each stack of covering layers may comprise at least two covering layers. Each covering layer in a stack may have different properties to every other layer in the stack. For example a stack may comprise a first covering layer that is transparent and which fluoresces in a first colour under UV light and a second covering layer that is opaque to visible and/or fluorescent light.

A second aspect of the invention provides a security device for a security document, the device comprising a substrate having a face, the face including a plurality of first walls, each first wall being orientated in a first direction and a plurality of second walls, each second wall being orientated in a second, different direction, at an angle to the first direction, wherein there is a layer of material on each of the plurality of first walls or each of the plurality of second walls or each of both the plurality of first walls and the plurality of second walls.

The angle between the first direction and the second direction is not zero or 180 degrees.

It may be that the layer of material is on one of either (i) each of the first walls or (ii) each of the second walls.

The substrate can be the security document. It can be that the substrate is not the security document.

It may be that the orientation of the walls provides a different visual effect when the device is viewed in a direction towards the first walls from the visual effect provided when the device is viewed in a direction towards the second walls. The first wall may be provided with a pattern, for example a coloured pattern. The second wall may be provided with a pattern, for example a coloured pattern.

It may be that the device is not a device wherein the first walls are fluorescent in a first visible colour when exposed to ultraviolet light and the second walls are fluorescent in a second, different, visible colour when exposed to ultraviolet light such that the device fluoresces in the first colour when exposed to ultraviolet light incident on the first wall and the device fluoresces in the second colour when exposed to ultraviolet light incident on the second wall.

It may be that the device is not a security device, for a security document, of the following form: the device having a front side and a back side and comprising a plurality of indentations, each indentation having a first wall and a second wall, each wall having a front face on the front side of the device, wherein

the front faces of the first walls are orientated in a first direction and the front faces of the second walls are orientated in a second, different, direction, and wherein

the first walls are fluorescent in a first visible colour when exposed to ultraviolet light and the second walls are fluorescent in a second, different, visible colour when exposed to ultraviolet light such that the device fluoresces in the first colour when exposed to ultraviolet light incident on the first wall and the device fluoresces in the second

colour when exposed to ultraviolet light incident on the second wall.

It may be that the device is a security device, for a security document, the device having a front side and a back side and comprising a plurality of indentations, each indentation having a first wall and a second wall, each wall having a front face on the front side of the device, wherein

the front faces of the first walls are orientated in a first direction and the front faces of the second walls are orientated in a second, different, direction, and wherein the first walls are fluorescent in a first visible colour when exposed to ultraviolet light incident on the first wall, and wherein the second walls are not fluorescent in a second, different, visible colour when exposed to ultraviolet light so the device does not fluoresce in the second colour when exposed to ultraviolet light incident on the second wall.

According to a third aspect of the invention there is provided a security device for a security document, the device having a front side and a back side and comprising a plurality of indentations, each indentation having a first wall and a second wall, each wall having a front face on the front side of the device, wherein the front faces of the first walls are orientated in a first direction and the front faces of the second walls are orientated in a second, different, direction, and wherein the first walls are fluorescent in a first visible colour when exposed to ultraviolet light and the second walls are fluorescent in a second, different, visible colour when exposed to ultraviolet light such that the device fluoresces in the first colour when exposed to ultraviolet light incident on the first wall and the device fluoresces in the second colour when exposed to ultraviolet light incident on the second wall.

Thus, the present invention provides a security device providing an effect referred to herein as an "angular colour

switch" effect. Depending on the direction from which the device is viewed the first wall or the second wall will be visible and accordingly the device will fluoresce in the first or second visible colour when exposed to ultraviolet light. Consequently, the effect perceived by the viewer is that the visible fluorescence changes colour when the same side of the device is viewed from different angles in reflected ultraviolet light. Moreover, as the appearance of the device is generated by the indentations, more complex and higher-resolution patterns can be achieved compared with patterns produced by intaglio printing.

It may be that each indentation has a third wall. It may be that each third wall has a front face on the front side of the device. It may be that the front faces of the third walls are orientated in a third, different, direction. It may be that the third walls are fluorescent in a third, different, visible colour when exposed to ultraviolet light. Thus it may be that the device fluoresces in the third colour when exposed to ultraviolet light incident on the third wall.

It may be that each indentation has a further wall. It may be that each further wall has a front face on the front side of the device. It may be that the front faces of the further walls are orientated in a further, different, direction. It may be that the further walls are fluorescent in a further, different, visible colour when exposed to ultraviolet light. Alternatively, it may be that the front faces of a further wall fluoresces in the first, second or third visible colour.

It may be that the front face of the wall is the major surface of the wall. It may be that the direction of orientation of a face is defined as the direction of the normal of the face.

It may be that the security device has a front side and a back side. It may be that the width and height of the

security device are very much greater than the thickness of the device. Although the security device includes a series of indentations it will be understood that the security device is substantially planar. Thus, it may be that the security device has a front surface on the front side of the device.

It may be that the security device appears as a series of lines when viewed in ultraviolet light. It may be that the device is in the form of any one of an insignia, a pattern, a complex shape, an irregular shape or an image. For example it may be that the device is in the form of a letter or number.

It may be that the each indentation includes a first side and a second side. It may be that each first side is a first wall. It may be that each second side is a second wall. It may be that each first side is formed by the front face of a first wall. It may be the each second side is formed by the front face of a second wall. Thus, it may be that each indentation has a first side and a second side consisting of the front face of a first wall and the front face of a second wall respectively.

It may be that each indentation includes a third (or further) side(s). It may be that the third (or further) side(s) consists of a third (or further) wall. It may be that each third (or further) side is formed by the front face of a third (or further) wall.

It may be that the each indentation extends across the surface of the device to form a groove. It may be that the each groove contains a first wall and a second wall visible in ultraviolet light. Thus, it may be that each grove appears as a line across the surface of the device.

It may be that the sides of each indentation form a closed loop. Thus, it may be that the walls of each indentation form a closed loop. It may be that the first, second, third (if present) and further (if present) walls define a closed loop. It may be that the each of the first

and second walls defines, at least in part, the footprint of an indentation.

It may be that each indentation has a first wall and a second wall visible in ultraviolet light. It may be that the each indentation extends across the surface of the security device. Thus, it may be that each first and second wall forms a line or groove across the surface of the device. It may be that the first side and the second side meet at the apex of the indentation, for example where the indentation is in the form of a groove. Thus, it may be that the cross-section of the indentation is entirely defined by the first side and the second side. It may be that the indentations have a triangular cross section. Thus, it may be that the grooves have a triangular cross section. It may be that the indentations have a cross section in the form of an equilateral triangle. Thus, it may be that the grooves have a cross section in the form of an equilateral triangle. It may be that the grooves have a substantially uniform cross-section along their length

It may be that each third side is substantially parallel to the face of the security document. Thus, where the indentation is in the form of a groove, it may be that the cross-section of the indentation is defined by the first side, the second side and the third side. It may be that the indentations have a square cross section. It may be that the grooves have a square cross section. It may be that indentations have a rectangular cross section. It may be that the grooves have a rectangular cross section. It may be that the indentations are castellated.

It may be that the device has between 100 and 400 lines per 25 mm. It may be that the device has between 200 and 300 lines per 25 mm. It may be that the lines form any one of an insignia, a pattern, a complex shape, an irregular shape or an image.

It may be that the depth of the indentations is less than 15 μm. It may be that the depth of the indentations is more than 10 μm. It may be that the width of the indentation at the widest point is less than 300 μm. It may be that the width of the indentation at the widest point is more than 100 μm. It may be that the length of the indentation is very much greater than the width of the indentation.

It may be that the difference in orientation between the first and second walls (i.e. the difference between the first and second directions) is a result of the difference in the angle of inclination of each of the first and second walls with respect to the surface of the security device. It may be that each first wall is inclined at an angle of less than 90 degrees to the surface of the security device. It may be that each second wall is inclined at an angle of less than 90 degrees to the surface of the security device. It may be that each first wall is inclined at an angle of more than zero degrees to the surface of the security device. It may be that each second wall is inclined by an angle of more than zero degrees to the surface of the security device. It may be that each first wall is non-parallel with the surface of the security device. It may be that each first wall is non-perpendicular to the surface of the security device. It may be that each second wall is non-parallel with the surface of the security device. It may be that each second wall is non-perpendicular to the surface of the security device. It may be that the angle of inclination with respect to the surface of the security device between the first wall and the second wall of each indentation is less than 90 degrees.

Additionally or alternatively, it may be that the difference in orientation between the first and second walls (i.e. the difference between the first and second directions) is a result of the angular rotation of the walls about the normal of the surface of the security device (i.e. about an

axis extending perpendicular to the face of the device). For example, it may be that the first, second, third (if present) and further (if present) walls are all substantially perpendicular to the surface of the security device and the difference in direction between each of said walls is a result of differences in the angle of rotation of each wall.

It may be that each indentation on a first side of the device has a complementary indentation on the opposite side of the device. Thus, it may be that an indentation on the front of the device has a complementary indentation on the back of the device. It may be that the indentations on the front of the device tessellate with the indentations on the back of the device. It may be that each first wall is formed from the sides of two complementary indentations. It may be that each second wall is formed from the sides of two complementary indentations. It may be that each third wall is formed from the side of two complementary indentations. It may be that the indentations, or grooves, form a series of ridges and furrows. Thus, it may be that the security device is corrugated.

The front faces of the first walls are orientated in a first direction. The front faces of the second walls are orientated in a second direction. It may be that the front faces of the first walls are orientated towards a first side of the security device. It may be that the front faces of the second walls are orientated towards a first side of the security device. Thus, it may be that the front faces of the first wall and the front faces of the second walls are orientated towards the same side of the security device. It may be that the first direction is substantially parallel or substantially perpendicular to the surface of the security device. It will be understood that in the case of the front faces of the first walls being orientated in a direction substantially parallel or perpendicular to the surface of the

security device, the front faces of the front walls can still be termed as being orientated towards the same side as the front face of a second wall located on the same side of the device. It may be that the second direction is at an angle of less than 90 degrees from the substantially planar surface of the security device. It may be that the angle between the first direction and the second direction is less than 90 degrees. It may be that the first direction is at an angle of more than 5 degrees to the surface of the security device. It may be that the second direction is at an angle of more than 5 degrees to the surface of the security device.

It may be that the first walls include a first layer wherein the first layer is fluorescent in a first visible colour when exposed to ultraviolet light. It may be that the second walls include a second layer wherein the second layer is fluorescent in a second, different colour, when exposed to ultraviolet light. It may be that the second walls further include the first layer. It may be that the second walls include the first layer and the second layer. It may be that the first layer is present beneath the second layer at the second walls; thus, when viewing the front face of the device, it may be that the first layer is behind the second layer at the second walls. It may be that the first layer extends across substantially the majority of the area occupied by the security device. It may be that the second layer is not present in the areas of the device which form the first walls. It may be that the second layer is only present in the areas of the device which form the second walls.

It may be that the second walls further include an intermediate layer, between the first layer and the second layer where the intermediate layer is opaque to ultraviolet light but transmits visible light. It may be that the third walls further include an intermediate layer, between the first

layer and the third layer where the intermediate layer is opaque to ultraviolet light but transmits visible light.

It may be that the intermediate layer is transparent. It may be that the intermediate layer is present between the first layer and the second layer beneath the second walls. Alternatively, it may be that the first layer is opaque to ultraviolet light but transmit ultraviolet light. Thus, it may be that a transmission colour switch effect is produced at the second wall without the need for an intermediate layer.

It may be that the structure of the second walls includes the second layer and the first layer. It may be that the structure of the second walls also includes the intermediate layer. Thus, it may be that the structure of the device at the second walls is, in order from front to back; second layer, intermediate layer, first layer.

It may be that the first and second walls are substantially planar.

It may be that the security device is affixed to a security document. It may be that the security document is substantially planar. It may be that the security document has a front face. It may be that the security document is principally formed from a security document substrate. It may be that the security device is formed on the front face of the security document. It may be that the security document is a bank note. It may be that the security document is a passport. It may be that the security device is substantially invisible when viewed in visible light. It may be that the front surface of the security device is substantially parallel to the front surface of the security document.

It may be that the first walls include the security document substrate. It may be that the security document substrate fluoresces in the first colour. It may be that the security document substrate is the first layer. It may be that the security document substrate is the first walls. It

may be that the structure of the device at the second walls is, in order from front to back; second layer, intermediate layer, security document substrate.

It may be that the security document substrate is opaque to ultraviolet light but transmit visible light. Thus, it may be that the security document substrate is the first layer and also fulfils the function of the intermediate layer. In this case, it may be that the structure of the device at the second walls is, in order from front to back; second layer, security document substrate. Thus, the structure of the security device is simplified.

According to a fourth aspect of the invention there is provided a method of producing a security device for a security document, the method comprising the steps of

(i) providing a security material having a front side and a back side and comprising a first layer and a second layer wherein the first layer is fluorescent in a first visible colour when exposed to ultraviolet light and the second layer is fluorescent in a second, different, visible colour when exposed to ultraviolet light;

(ii) forming a plurality of indentations in the security material, each indentation having a first wall and a second wall, each wall having a front face on the front of the device, the front face of the first wall being orientated in a first direction and comprising material from the first layer and the front face of the second wall being orientated in a second, different, direction and comprising material from the second layer.

It may be that the security material further includes an intermediate layer sandwiched between the first layer and the second layer. It may be that the intermediate layer is opaque to ultraviolet light but transmit visible light.

It may be that the security material further includes a third layer. It may be that the third layer is fluorescent in a third, different, visible colour when exposed to ultraviolet light. It may be that each indentation includes a third wall, having a front face orientated in a third, different, direction and comprising material from the third layer.

It may be that the step of providing the security material includes providing a security transfer mounted on a transfer substrate. It may be that the security transfer includes the second layer. It may be that the security transfer further includes the intermediate layer. It may be that the security transfer further includes the first layer. It may be that the security transfer includes a release layer. It may be that the security transfer includes an adhesive layer. It may be that the step of providing the security material includes affixing the security transfer to the face of the security document. It may be that the security transfer is affixed to the security document by stamping a die against the transfer substrate. It may be that the stamping head is hot during the stamping process. Alternatively, it may be that the stamping head is cold (for example at room temperature) during the stamping process. It may be that the die has a shape corresponding to a portion of the security transfer, so that only that portion of the security transfer is affixed to the face of the security document by the stamping of the die. It may be that the method further includes removing the transfer substrate from the security transfer, leaving the second layer affixed to the intermediate layer. It may be that the method includes removing the transfer from the security transfer, leaving the second layer and the intermediate layer affixed to the first layer. It may be that the transfer substrate is a film or a foil. Thus, it may be that the security transfer enables the security material to be created easily.

It may be that the step of providing the security material includes directing a flow of particles to form a layer of material on one of either (i) each of the plurality of first walls or (ii) each of the plurality of second walls.

It may be that the indentations are formed by deforming the security material. It may be that the first layer is deformed to create the indentations. It may be that the second layer is deformed to create the indentations. It may be that the third layer is deformed to create the indentations. It may be that the intermediate layer is deformed to create the indentations. Thus, it may be that all of the material used in the security device is subject to a degree of deformation. It may be that the deformation caused by the embossing die creates the indentations and the discontinuities in the second layer, leaving a first wall formed by the first layer. It may be that the step of forming the plurality of indentations in the security document is carried out by embossing the document using an embossing die. It may be that the method thus provides a means of creating detailed images with a much greater resolution than could be achieved by, for example, intaglio printing.

It may be that the steps of providing the security material and forming the indentations are carried out simultaneously. It may be that a single die is used to simultaneously affix the security transfer to the security document and emboss the security document to create the indentations.

Alternatively, it may be that the step of forming the indentations includes removing material from the second layer in order to create the first wall. It may be that the method further includes removing material from the intermediate layer in order to create the first wall. It may be that the method further includes removing material from the first layer in order to create the second wall.

It may be that the method includes removing material from the security device using a laser. For example, it may be that the method includes using a laser to ablate material from the security device. It may be that the method includes using a laser to remove the material in the region of the first wall. It may be that the method includes using a laser to remove material in the region of the second wall. It may be that the method includes removing the second layer from the intermediate layer using a laser. It may be that the method further includes removing the intermediate layer from the first layer using a laser. Thus, it may be that the method includes using a laser to remove the second layer and the intermediate layer, from the first layer in order to create the first wall.

A fifth aspect of the invention provides a security document including a security device according to any of the preceding aspects of the invention. The security document may for example be an identity document (e.g. a passport or identity card), a value document or a bank note.

A sixth aspect of the invention provides a method of manufacturing a security device for a security document, the method comprising providing a substrate having a face, the face including a plurality of first walls, each first wall being orientated in a first direction and a plurality of second walls, each second wall being orientated in a second, different direction, wherein there is a layer of material on each of the plurality of first walls or each of the plurality of second walls or each of both the plurality of first walls and the plurality of second walls.

The method may include the step of forming the layer of material on the first, second, or both the first and the second, walls. The method may include the step of directing a flow of particles onto the first, second, or both the first and the second, walls to form the layer of material.

Alternatively, the method may include the step of forming the layer of material on the substrate and then forming the pluralities of walls, for example by embossing the substrate. The method may include the step of directing a flow of particles onto the substrate to form the layer of material.

The method may include the step of ablating the layer of material. The method may include the step of wet-etching the layer of material. The method may include the step of depositing further layers of material on the substrate and/or on the first plurality, second plurality or both the first and second plurality of walls.

Thus, for example, the layer of material may be a metalized layer provided by embossing a metallised film to create the pluralities of walls. The method may then include ablating, wet-etching or depositing other layers of materials onto the chosen facets.

Any features described with reference to an aspect of the invention are equally applicable to any other aspect of the invention, except for if such a combination is nonsensical.

In a first example embodiment of the invention, a security device 10 (Fig. 1(a)) for a security document comprises a substrate 20 having a reverse face 30 and an obverse face 40. The obverse face 40 has been embossed using a stamp having rows of adjacent ridges of triangular cross-section, to form in the face grooves defined by a plurality of first walls 50 and a plurality of second walls 60. The first walls 50 are orientated in a direction about 60 degrees from a direction parallel to the face 40 of the substrate 20. The second walls 60 are also orientated in a direction about 60 degrees from a direction parallel to the face 40 of the substrate 20, but in opposite directions; that is, a normal from the first wall 50 crosses a normal from the second wall 60, in this example at about 60 degrees. The first walls 50 and the second walls 60 are in contact with each other at

their upper edges and their lower edges. The first walls 50 and second walls 60 form a continuous sequence of alternating first and second walls. Thus the first walls 50 and second walls 60 define ridges that are triangular in cross-section, and form between themselves grooves that are also triangular in cross-section. A layer 70 of fluorescent material is formed on the first walls 50 but not on the second walls 60.

When the first example device 10 is illuminated with UV light along or against the general direction in which the first walls 50 face, the layer 70 fluoresces. When the first example device 10 is illuminated with UV light along or against the general direction in which the second walls 60 face, the layer 70 fluoresces only a little, or not at all. Also, when the device 10 is generally illuminated with UV light, the layer 70 fluoresces, forming fluorescent stripes that are more visible when viewed in or against the direction in which the first walls 50 face than when viewed in or against the direction in which the second walls 60 face. Thus, as the device 10 is tilted under UV illumination, or a UV light source is moved around it, its appearance changes, creating a striking visual effect.

This embodiment (and all other embodiments described herein) may be attached to and/or included in a security document with the layer facing towards the front or the back of the security document. Alternatively, the substrate may be a security document substrate such that the security device is the security document.

A second example device 10′ (Fig. 1(b)) is similar to the first, comprising a substrate 20′ having a reverse face 30′ and an obverse face 40′. The obverse face 40′ has been embossed using a stamp having rows of adjacent ridges of triangular cross-section, to form in the face grooves defined by a plurality of first walls 50′ and a plurality of second walls 60′. In this example, the first walls 50′ are

orientated in a direction parallel to the faces 30', 40' of the substrate, so the first walls 50' stand perpendicular to the faces 30', 40'. The second walls 60' are orientated in a direction about 45 degrees from a direction parallel to the faces 30', 40'. The first walls 50' and the second walls 60' are in contact with each other at their upper edges and their lower edges. The first walls 50' and second walls 60' form a continuous sequence of alternating first and second walls. Thus the first walls 50' and second walls 60' are ridges that are right-angled triangles in cross-section, and form between themselves grooves that are also triangular in cross-section. A layer 70' of fluorescent material is formed on the first walls 50' but not on the second walls 60'. The behaviour of the second example device 10' as it is tilted under UV illumination, or a UV light source is moved around it, is similar to that of the first example device 10, but with the change in the visibility of fluorescent layers 70' of the second device 10' being different from the change in the visibility of fluorescent layer 70 of the first device 10 because of the different geometry of their structures.

A third example device 10'' (Fig. 1(c)) comprises a substrate 20'' that fluoresces in a first colour. The substrate 20'' has a reverse face 30'' and an obverse face 40''. The obverse face 40'' has been embossed using a stamp having rows of adjacent ridges of quadrilateral (truncated triangular) cross-section, to form in the face 40'' three-sided grooves defined by a plurality of first walls 50'' and a plurality of second walls 60''. In this example, the first walls 50'' and the second walls 60'' are orientated in the same directions as the first walls 50 and the second walls 60 of the first example device 10, and they are in contact with each other at their upper edges. However, the first walls 50'' and the second walls 60'' are not in contact with each other at their lower edges. Rather, the first walls 50'' and

the second walls 60'' are spaced apart from each other at their lower edges. The first walls 50'' are directionally coated with a first fluorescent material 70'', which fluoresces in a second colour. The second walls 60'' are directionally coated with a second fluorescent material 80, which fluoresces in a third colour. Regions 90 of the substrate 20'' between pairs of the first walls 50'' and the second walls 60'' are exposed.

When the third example device 20'' is illuminated with UV light, the first walls 50'', second walls 60'' and exposed regions 90 form a sequence of alternating fluorescent stripes. The proportion of each of the first, second and third colours that fluoresces and/or is visible depends on the angle of illumination by the UV light and the angle along which the device 20'' is viewed. When viewed from a distance, the visible colours blend into each other, creating a different combined colour, which changes with UV illumination angle and/or viewing angle, creating another striking visual effect.

A fourth example device 110 (Fig. 2) comprises a substrate 120 having a reverse face 130 and an obverse face 140. The substrate 120 is thinner than the substrates 20, 20', 20'' of the previous examples. It is not embossed, but rather is coated with a layer of a varnish 165 that is etched to form in the varnish 165 grooves defined by a plurality of first walls 150 and a plurality of second walls 160. The orientation and shape of the structure formed by the first walls 150 and second walls 160 is similar to that of the first example device 10, i.e. a continuous array of ridges and grooves, each approximately equilateral triangles in cross-section. In this fourth example device, a fluorescent image 195, invisible in visible light, is provided on the substrate 120. A layer 170 of aluminium is formed on the first walls 150 by directionally coating them using plasma enhanced vacuum coated deposition (PEVCD). The metalized layer 170 blocks

both visible and UV light. When the device 110 is viewed towards the first walls 150 (from A), the metalized layer 170 blocks the image 195 from view. When the device 110 is viewed towards the second walls 160 (from B), the image 195 is visible under UV illumination, unless the UV light is from the direction of A, when it is blocked by the metalized layers 170, preventing fluorescence of the image 195. Thus, different proportions of the image 195 and the metalized layers 170 are visible from different viewing angles, creating another striking visual effect.

A fifth example device 210 (Fig. 3) comprises a substrate 220 having a reverse face 230 and an obverse face 240. The substrate 220 is a transparent film, which has been embossed to form a plurality of first walls 250 and a plurality of second walls 260. The orientation and shape of the structure formed by the first walls 250 and second walls 260 is similar to that of the first example device 10, i.e. a continuous array of ridges and grooves, each approximately equilateral triangles in cross-section. The first walls 250 are directionally coated in a first fluorescent material 270 that fluoresces in red and the second walls 260 are directionally coated in a second fluorescent material 280 that fluoresces in yellow-green. In this example, the red fluorescent material is manganese-doped zinc sulphide (ZnS) and the yellow-green fluorescent material is Europium-doped strontium aluminate ($SrAl_2O_4$) but the skilled person will readily identify alternative fluorescent materials. Under UV illumination, the apparent colour of the fifth example device 210 changes from red when viewed from direction in which only the first walls 250 are visible, to a mixture of red and yellow-green (appearing generally orange-green) when viewed from a direction in which both the first walls 250 and the second walls 260 are visible, to yellow when viewed from a direction in which only the second walls 260 are visible. As the

substrate 220 is transparent, the changes of colour with viewing angle are visible whether the device 210 is viewed from the reverse face 230 or the obverse face 240, again creating a striking effect.

A sixth example device 310 (Fig. 4) comprises a substrate 320 having a reverse face 330 and an obverse face 340. The substrate 320 is a transparent film, which has been embossed to form a plurality of first walls 350 and a plurality of second walls 360. Prior to embossing, a fluorescent pattern 395 has been printed on the reverse face 330 and a metalized layer 343 has been applied to the obverse face 340 (Fig. 4(a)). The orientation and shape of the structure formed by the first walls 350 and second walls 360 is similar to that of the first example device 10, i.e. a continuous array of ridges and grooves, each approximately equilateral triangles in cross-section. A printed layer 347 of a fluorescent material is applied by non-impact printing to both the first walls 350 and the second walls 360, and a resist layer 370 of amorphous hydrogenated silicon carbide is applied to the second walls 360, by PEVCD, on top of the printed layer 347 (Fig. 4(b)). Wet chemical etching is used to remove the metalized layer 343 and the printed layer 347 from the first walls 350; the resist layer 370 protects those layers on the second walls 360, so they are retained there. The device 310 is colourless in daylight, with only the transparent film visible when the device is viewed from A and only the metalized layer 243 on the second walls 360 visible when the device is viewed from B. Under ultraviolet light, the fluorescent pattern 395 is visible when the first walls 350 are viewed from A and the colour of the fluorescent material of the printed layer 347 is visible when the second walls are viewed from B. The pattern 395 thus provides a latent image, visible only under UV light and when viewed from certain angles. A further feature is that when the device 310 is illuminated with UV light from

directions B, the metalized layer 243 prevents all or most of it from reaching the fluorescent pattern 395, resulting in the fluorescent pattern fluorescing only weakly or not at all. The resulting changes in the appearance of the device 310 with viewing angle and UV illumination angle provide a particularly striking visual effect.

A seventh example device (not shown) has substantially the same structure as the sixth example device. However, instead of printing a layer of fluorescent material (layer 347 of the sixth embodiment) over both the first and second walls, a red pattern, visible in visible light, is printed across both the first and second walls. A second, blue, pattern is printed on the reverse face of the device instead of the fluorescent pattern layer 395 of the sixth embodiment. The metalized layer and etching process are as described in relation to the sixth embodiment. Under visible light, when the device is viewed towards the first walls the red pattern is visible. When the device is viewed towards the second walls the blue pattern is visible. When the sixth example device is viewed at angles at which both the first walls and second walls are visible, the first walls and second walls form a sequence of alternating differently patterned stripes. The relative width of the two sets of stripes depends on the angle along which the device is viewed. The resulting changes in the appearance of the device with viewing angle provide another striking visual effect.

An eighth example device 410 (Fig. 5) comprises a substrate 420 having a reverse face 430 and an obverse face 440. The substrate 420 is a transparent film, which has been embossed to form a plurality of first walls 450 and a plurality of second walls 460. Prior to embossing, a fluorescent layer 414 which fluoresces blue has been applied to the reverse face 430. The orientation and shape of the structure formed by the first walls 450 and second walls 460

is similar to that of the first example device 10, i.e. a continuous array of ridges and grooves, each approximately equilateral triangles in cross-section. A UV absorbing layer 412 is deposited on the first walls 450 by sputtering. The UV absorbing layer 412 transmits visible light. The structure formed by the first walls 450 and second walls 460 is encapsulated in a layer of transparent varnish 416 to form a flat surface 418 on the obverse side of the substrate 420. A printed layer 422 of a fluorescent material which fluoresces green is applied to the flat surface 418. Under UV light, when the obverse side of the device 410 is viewed towards the second walls 460 the device appears blue-green as both the fluorescent layers 422 and 414 fluoresce. When the obverse side of the device 410 is viewed towards the first walls 450 the device appears green when viewed in direct UV light and blue when viewed in transmitted UV light as the UV blocking layer 412 prevents substantially all the UV light reaching one the other of the two fluorescent layers 422,414. Thus, the colour of the first walls appears to "jump" from blue to green (or vice versa) when source of illumination is switched from one side of the device to the other. When the eighth example device 410 is viewed at angles at which both the first walls 450 and second walls 460 are visible, the first walls 450 and second walls 460 form a sequence of alternating fluorescent stripes. The relative width of the two sets of stripes depends on the angle along which the device 410 is viewed. When viewed from a distance, the visible colours blend into each other, creating a different combined colour, which changes with UV illumination angle and/or viewing angle. These effects (colour jumping and variation of colour) provide another striking visual effect.

A ninth example device 710 (Fig. 6) has substantially the same structure as the eighth example device but with the addition of a layer 715, which is opaque to both UV and

visible light, extending across the reverse face of the fluorescent layer 714. Consequently, the fluorescent layer 714 which is formed on the reverse face 730 of the substrate 720, is sandwiched between the substrate 720 and the opaque layer 715. When the ninth example device 710 is viewed at angles at which both the first walls 750 and second walls 760 are visible, the first walls 750 and second walls 760 form a sequence of alternating fluorescent stripes. The relative width of the two sets of stripes depends on the angle along which the device 710 is viewed. When viewed from a distance, the visible colours blend into each other, creating a different combined colour, which changes with viewing angle providing another striking visual effect.

A tenth example device 510 (Fig. 7) comprises a substrate 520 having a reverse face 530 and an obverse face 540. The substrate 520 is a transparent film, which has been embossed to form a plurality of first walls 550 and a plurality of second walls 560. Prior to embossing, a flat layer 524, which appears red in visible light, has been applied to the reverse face 530. The orientation and shape of the structure formed by the first walls 550 and second walls 560 is similar to that of the first example device 10, i.e. a continuous array of ridges and grooves, each approximately equilateral triangles in cross-section. A layer 570 of titanium dioxide is formed on the first walls 550 by directionally coating them using plasma enhanced vacuum coated deposition (PEVCD). The titanium dioxide layer 570 blocks both visible and UV light. The titanium dioxide layer 570 appears white when viewed in visible light. The structure formed by the first walls 550 and second walls 560 is encapsulated in a layer of transparent varnish 516 to form a flat surface 518 on the obverse side of the substrate 520. A printed patterned layer 522 is applied to the flat surface 518. The printed layer 522 contains a repeating pattern of blue semi-circles 522a and transparent

semi-circular windows 522b against a white background. The pattern is in register with the indentations with one blue semi-circle for each pair of first walls 550 and second walls 560. When the device 510 is viewed towards the second walls 560 (from B), the flat red layer 524 is visible through the transparent semi-circular windows 522b such that the device appears as a repeating pattern of half-blue, half-red circles against a white background as shown in Fig. 7b. When the device 510 is viewed towards the first walls 550 (from A), the titanium dioxide layer 570 blocks the flat red layer 524 from view, so that only the white colour of the titanium dioxide layer 570 and the printed patterned layer 522 is visible. The device therefore appears as a pattern of blue semi-circles (see Fig. 7c) against a white background. Thus, different patterns are visible from different viewing angles, creating another striking visual effect.

In an eleventh example embodiment of the invention (not shown) a layer of aluminium is formed on the first walls by directionally coating them using plasma enhanced vacuum coated deposition (PEVCD). The aluminium layer replaces the titanium dioxide layer 570 of the tenth embodiment. The structure, production process and function of the eleventh embodiment are otherwise substantially the same as the structure, production process and function of the tenth embodiment. The aluminium layer blocks both visible and UV light and appears silver when viewed in visible light. As in the tenth embodiment, different patterns are visible from different angles. The reflected silver colour of the aluminium layer appears in combination with the blue-semi circles and white background at certain viewing angles. Thus, different patterns are visible from different viewing angles, creating another striking visual effect. While the tenth and eleventh example embodiments have a single-colour lower covering layer and a patterned upper covering layer, in other variations the lower

layer may be patterned in addition to, or instead of, the upper layer.

A twelfth example device 810 (Fig. 8) comprises a substrate 820 having a reverse face 830 and an obverse face 840. The substrate 820 is a transparent film which fluoresces blue in UV light and which has been embossed to form a plurality of first walls 850 and a plurality of second walls 860. The orientation and shape of the structure formed by the first walls 850 and second walls 860 is similar to that of the first example device 10, i.e. a continuous array of ridges and grooves, each approximately equilateral triangles in cross-section. A layer 870 of aluminium is formed on the second walls 860 by directionally coating them using plasma enhanced vacuum coated deposition (PEVCD). The metalized layer 870 blocks both visible and UV light. The structure formed by the first walls 850 and second walls 860 is encapsulated in a layer of transparent varnish 816 to form a flat surface 818 on the obverse side of the substrate 820. A printed layer 822 of a fluorescent material which fluoresces yellow is applied to the flat surface 818. When the device 810 is viewed towards the first walls 850 (from A), the device appears green in both transmitted and reflected UV light as both the substrate 820 and printed layer 822 fluoresce. When the device 810 is viewed towards the second walls 860 (from B), the metalized layer 870 blocks the substrate 820 from view and the device appears yellow. A similar effect is achieved when the reverse face of the device 810 is viewed. Consequently, the appearance of the device will change with viewing angle as described in a number of the other embodiments above, thereby providing a striking visual effect.

Fig. 9 shows a plan view of the obverse face 940 of a thirteenth example device 910. The device 910 comprises a opaque substrate 920 which has been embossed on the obverse face 940 with a stamp to form a plurality of a plurality of

hexagonal indentations which together produce a honeycomb pattern extending across the face. The embossing process forms a plurality of first walls 950, second walls 960, third walls 975 and further walls 976. Each first wall 950, along with a second wall 960, and four further walls 975 defines the side of an indentation. Each of the first 950, second 960, and further 975 walls is perpendicular to the surface of the device 910. An opaque layer of material 970 that fluoresces red under UV light is formed on each of the first walls 950. Similarly, an opaque layer of material 980 that fluoresces blue is formed on each of the second walls 960. Further layers of fluorescent material 976 are applied to each of the further walls. In order clockwise around the side of the indentation the walls are arranged as follows: first wall 950 (red), further wall 976a (green), second wall 960 (blue), further wall 976b(blue), further wall 976c(green), further wall 976d (red). Under UV illumination the apparent colour of the thirteenth example device 910 changes from red when viewed from a direction in which only the first wall 950 and further wall 976d are visible, to blue when viewed in a direction in which only the second wall 960 and further wall 976b are visible and to green when viewed in a direction in which only the further wall 975a or 975c are visible via a series of intermediate colours produced by the combination of colours that arises when more than one set of walls is visible. Accordingly, the more complicated structure of the walls of the thirteenth example device (in comparison to the grooves and ridges of the devices describes above) provides a striking three-colour angle-dependent visual effect. It will be appreciated that indentations having differently shaped footprints may be used to produce a wide variety of effects. It will also be appreciated that more complex wall structures, for example the honeycomb structure, can be combined with the

other effects, for example the colour switch effects, described above.

In a fourteenth example embodiment of the invention, a substantially planar security document 602 (Fig. 9) has a front face 603 and includes a security device 610. The security document 602 is principally formed from a security document substrate 620. In this example the security device 610 is in the form of a star shape. The security device 610 is substantially invisible when the security document 602 is illuminated by visible light, but it becomes visible under UV light as a series of fluorescent straight lines 607 resulting from fluorescence by a plurality of fluorescent walls, as discussed further below.

Fig. 9b shows a cross sectional view of part of the device 610 when completed. The device comprises a plurality of indentations 612 on the front face 640 of the security document 602. In the present embodiment the indentations have a triangular cross-section, the sides of each triangular indentation 612 being defined by a first wall 650 and a second wall 660 opposite the first wall 660. The first wall 650 is perpendicular to the substantially planar front face 640 of the security document 602 and faces in a first direction towards the second wall 660. The second wall 660 is inclined at an angle of less than 90 degrees to the substantially planar front face 640 of the security document 602 and faces in a second direction towards the first wall 650. The first wall 650 is formed by a first layer 606. The first layer 606 in this case is itself formed by the security substrate 620. Thus, the first wall 650 is formed by security substrate 620. The second wall 660 is formed by a second coloured layer 670 with the intermediate layer 647 and substrate 620 lying below the second layer 670. The substrate 620 fluoresces in blue when exposed to ultraviolet light. The second layer 270 fluoresces in red when exposed to ultraviolet light. The

intermediate layer 647 is opaque to ultraviolet light but transmits visible light. In the present embodiment a separate intermediate layer is included; however if the security document substrate is opaque to ultraviolet light but transmits visible light then the intermediate layer is not required.

As the first wall 650 and second wall 660 face different directions, the appearance of the device will vary depending on (i) the direction from which the device is illuminated with ultraviolet light and (ii) the direction from which a viewer observes the device.

A viewer observing the front face 640 of the device 610 from direction A will principally see the first walls 650 of the indentations 612, which as they are formed by the substrate 620 fluoresce in blue when exposed to ultraviolet light. A viewer observing the device from direction B will principally see the second walls 660 of the indentations 612. When viewed in reflected ultraviolet light the second walls 660 will fluorescent red due to the presence of the second layer 670 (while the portion of the first layer 606 beneath the second wall 660 will fluoresce weakly, if at all, due to the presence of the intermediate layer 647 which absorbs the ultraviolet light). Consequently, the device will appear to consist of either blue or red stripes when viewed in ultraviolet light depending on the angle at which it is observed. Hence, the device exhibits an angular colour switch effect.

The presence of the substrate 620 and intermediate layer 647 beneath the second layer 670 at the second wall 660 means that, when viewed in transmitted ultraviolet light, the second wall 660 will fluoresce blue (the visible blue light being transmitted through the intermediate layer 647 while the ultraviolet light is blocked). Consequently, when viewed from

direction B, the device also exhibits a transmission colour switch effect.

Fig. 9c shows a cross-sectional view of the security device 610 at an intermediate stage of production. The device 610 at this stage is substantially planar and includes the first layer 606, being the security document substrate 620, the second layer 670 and the intermediate layer 647 sandwiched between the substrate 620 and the second layer 670. The device 610 when in this intermediate stage of production exhibits a transmission colour switch effect, i.e. it behaves in the same way as the device of GB24906063A. Fig. 9c further shows schematically the manner in which an embossing die E may be used to create the indentations 612 (discussed further below).

The intermediate layer 647 and second layer 670 may be affixed to the substrate 620 as a security transfer 691. Fig. 10 shows the cross-sectional detail of the security transfer 691 in more detail. Security transfer 691 is mounted on a transfer substrate 692. There is a release layer 694 on the substrate 692. The second layer 670 and intermediate layer 647 are formed successively on the substrate 692. The security transfer 691 is affixed to the security document substrate 620 to form the star shaped security device 604 using a dry transfer process. During the affixing, the transfer substrate 692 and release layer 694 are removed from the transfer 691, so that the intermediate layer 647 and second layer 670 remain fixed on the substrate 620. In an example dry transfer process the security transfer 691 is stamped on to the substrate 620 using a die. The stamping with a die may be hot- or cold- stamping, both of which are techniques well-known to the person skilled in the art, and are therefore not described further here.

The security device shown in Fig. 9a is in the shape of a star, whilst the transfer shown in Fig. 10 is rectangular in

shape. The security transfer 691 may be used to create a star shaped security device by using a die having a shape corresponding to the desired shape of the security device. Stamping such a die against the security transfer results in only a portion of the transfer, corresponding to the shape of the die, being affixed to the security document.

Fig. 11 shows a flow chart for a method of producing the device 610 according to the present invention. First the security document substrate 620 including blue fluorescence is provided 1000. The intermediate layer 647 and second layer 670 are then affixed to the substrate 620 using a dry transfer process 1002. The device 610 is then deformed 1004, for example by embossing the device using an embossing die, to form the indentations 612. The process of embossing the device 610 is shown schematically in Fig. 9b. The deformation of the three layers (substrate 620, intermediate layer 647 and second layer 670) creates a discontinuity in the intermediate layer 647 and second layer 670. Consequently, as the embossing die deforms the device 610 to create an indentation 612 a first wall 650 is formed by the substrate 620 alone (the intermediate layer 647 and second layer 670 being absent in this region) and a second wall 660 is formed by the region in which all three layers remain.

Whilst the present invention has been described and illustrated with reference to particular embodiments, it will be appreciated by those of ordinary skill in the art that the invention lends itself to many different variations not specifically illustrated herein. For example, where an example embodiment device above is described as being produced by directing a flow of particles to form a layer on the substrate, it will be appreciated that such a device can be produced by any other suitable method.

Reference should be made to the claims for determining the true scope of the present invention, which should be

Date reçue / Date received 2021-12-02

construed so as to encompass any such equivalents. It will also be appreciated by the reader that integers or features of the invention that are described as preferable, advantageous, convenient or the like are optional and do not limit the scope of the independent claims. Moreover, it is to be understood that such optional integers or features, whilst of possible benefit in some embodiments of the invention, may not be desirable, and may therefore be absent, in other embodiments.

Date reçue / Date received 2021-12-02

The embodiments of the present invention for which an exclusive property or privilege is claimed are defined as follows:

1. A security device for a security document, the device comprising a substrate having a face, the face including a plurality of first walls, each first wall being orientated in a first direction and a plurality of second walls, each second wall being orientated in a second, different direction, at an angle to the first direction, wherein there is a first layer of material on each of the plurality of first walls or each of the plurality of second walls or each of both the plurality of first walls and the plurality of second walls, and wherein the device is substantially invisible in visible light.

2. The security device as claimed in claim 1, wherein the first layer of material is on one of either (i) each of the first walls or (ii) each of the second walls.

3. The security device as claimed in claim 1 or claim 2, in which the substrate is the security document.

4. The security device according to any one of claims 1 to 3, in which the orientation of the walls provides a different visual effect when the device is viewed in a direction towards the first walls from the visual effect provided when the device is viewed in a direction towards the second walls.

5. The security device according to any one of claims 1 to 4, wherein the layer is a fluorescent layer.

6. The security device according to any one of claims 1

Date Reçue/Date Received 2022-08-04

to 5, wherein the first and second walls define, alone or in combination with further walls, a pattern of indentations and/or protrusions on the face.

7. The security device to claim 6, wherein the indentations and/or protrusions form grooves in the substrate.

8. The security device according to claim 7, wherein the walls form a closed loop.

9. The security device according to claim 8, wherein each indentation has a hexagonal footprint and the plurality of indentations forms a honeycomb pattern across a portion of the surface of the device.

10. The security device according to any one of claims 1 to 9, wherein the second walls include a second layer.

11. The security device according to claim 10, wherein the second walls further include an intermediate layer, between the first layer and the second layer where the intermediate layer is opaque to ultraviolet light but transmits visible light.

12. The security device according to claim 10 or claim 11, wherein the first layer is fluorescent in a first visible colour when exposed to ultraviolet light and the second layer is fluorescent in a second, different, visible colour when exposed to ultraviolet light.

13. A security document including a security device in accordance with any one of claims 1 to 12.

14. The security document according to claim 13, wherein

Date Reçue/Date Received 2022-08-04

the security document is a bank note.

15. A method of producing a security device for a security document, the method comprising the steps of

(i) providing a security material having a front side and a back side and comprising a first layer,

(ii) forming a plurality of indentations in the security material, each indentation having a first wall and a second wall, each wall having a front face on the front of the device, the front face of the first wall being orientated in a first direction and comprising material from the first layer and the front face of the second wall being orientated in a second, different, direction, and wherein the device is substantially invisible in visible light.

16. The method of producing a security device for a security document in accordance with claim 15, wherein the device includes a second layer and wherein the indentations are formed such that the front face of the second walls comprises material from the second layer.

17. The method of producing a security device for a security document in accordance with claim 16, wherein the first layer is fluorescent in a first visible colour when exposed to ultraviolet light and the second layer is fluorescent in a second, different, visible colour when exposed to ultraviolet light.

18. The method of producing a security device according to any one of claims 15 to 17, wherein the step of providing a security material includes affixing one or more layers to the security document substrate using a security transfer.

Date Reçue/Date Received 2022-08-04

19. The method of producing a security device according to claim 18, wherein the security transfer is affixed to the security document by stamping a die against the transfer substrate.

20. The method of producing a security device according to claim 19, wherein a single die is used to simultaneously affix the security transfer to the security document and emboss the security document to create the indentations.

Date Reçue/Date Received 2022-08-04

Fig. 1

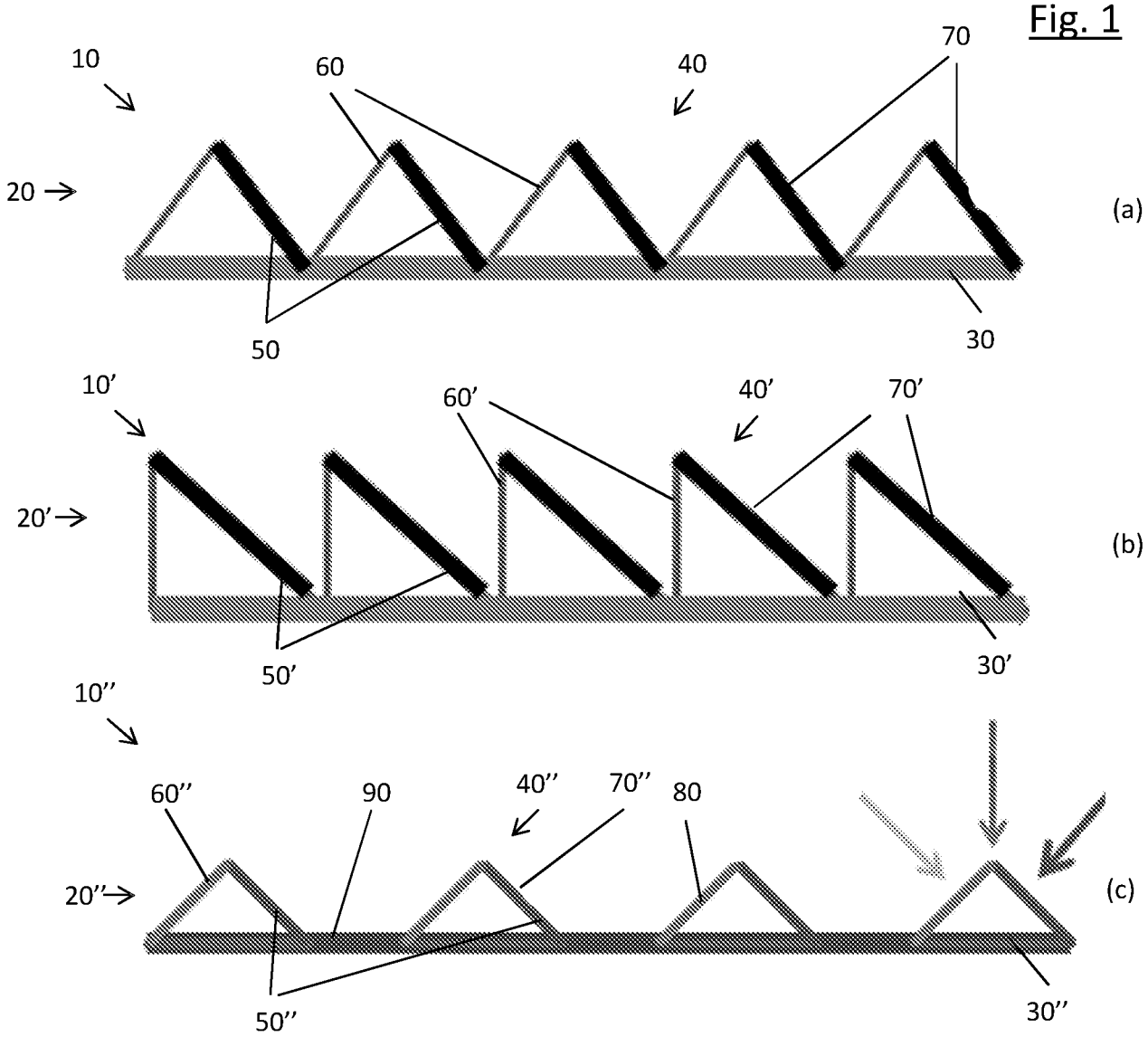

10
60
40
70
20
(a)
50
30
10'
60'
40'
70'
20'
(b)
50'
30'
10''
60''
90
40''
70''
80
20''
(c)
50''
30''

Fig. 2

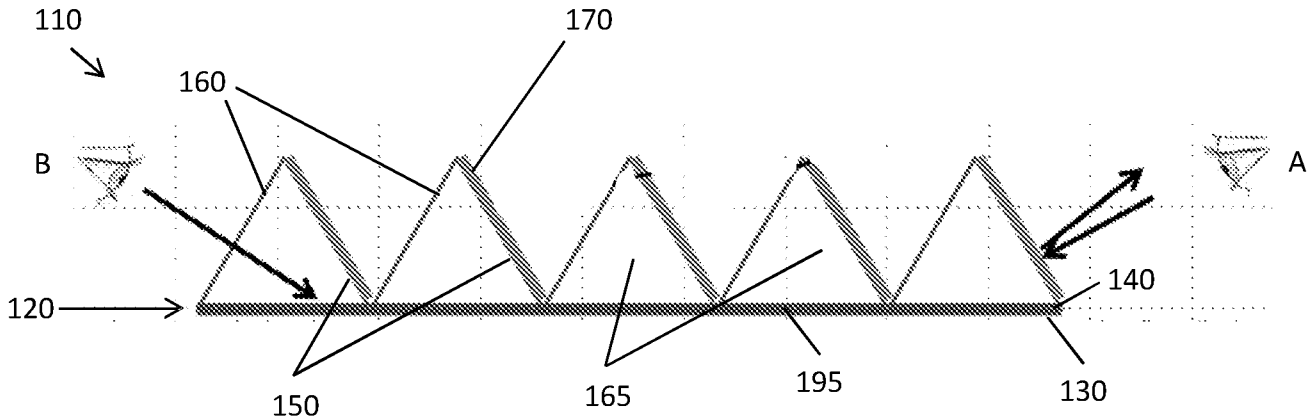

110
170
160
B
A
120
140
150
165
195
130

Fig. 3

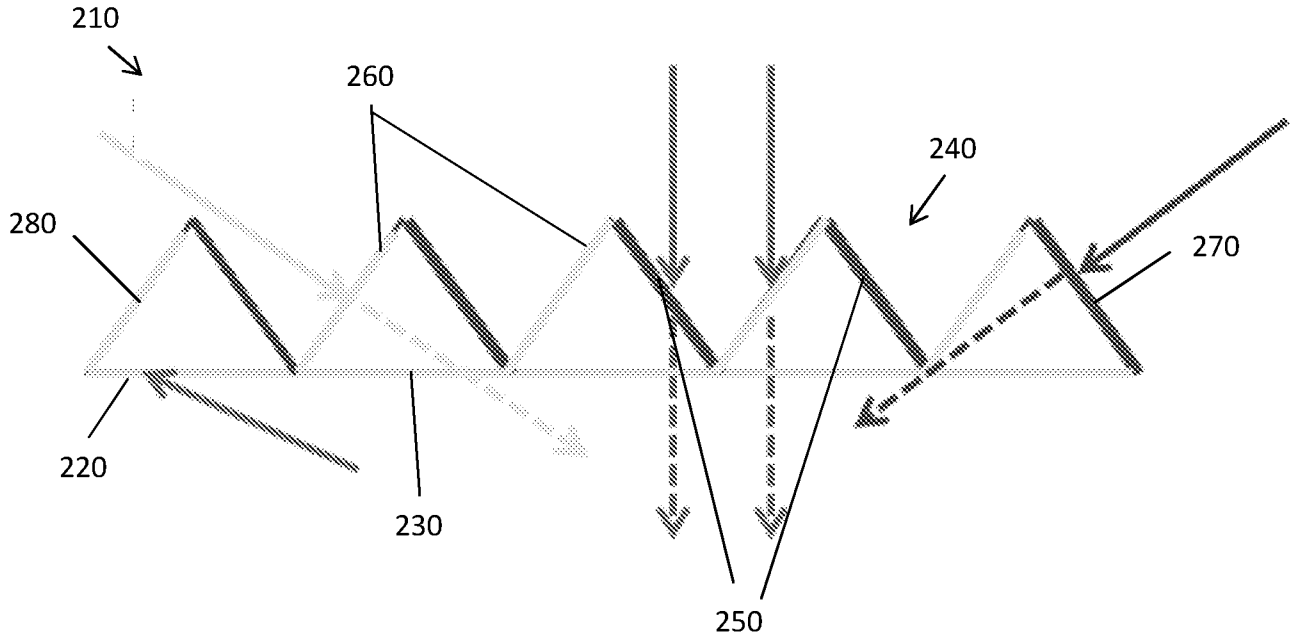

210
260
240
280
270
220
230
250

Fig. 4

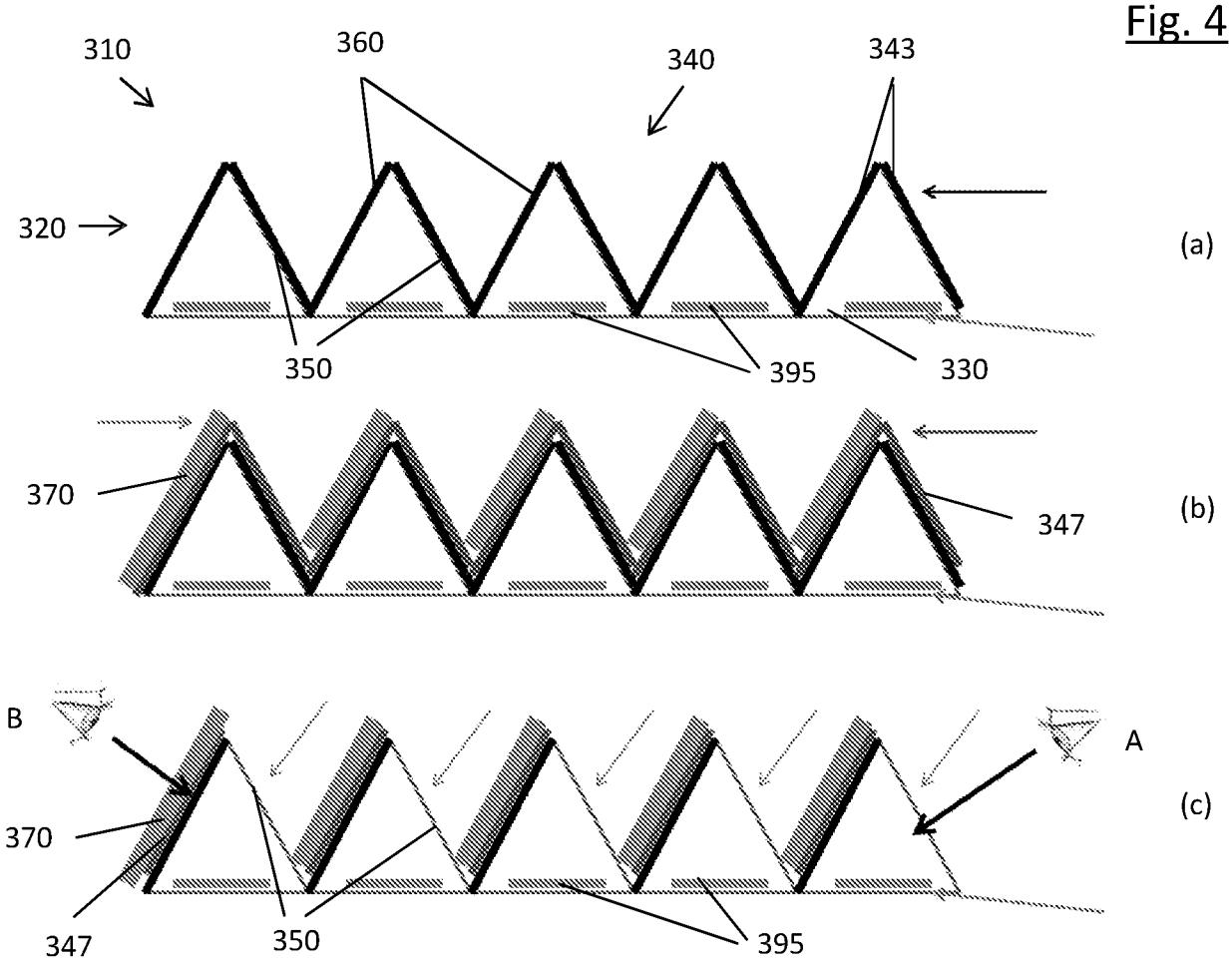

310
360
340
343
320
350
395
330
(a)
370
347
(b)
B
A
370
347
350
395
(c)

Fig. 5

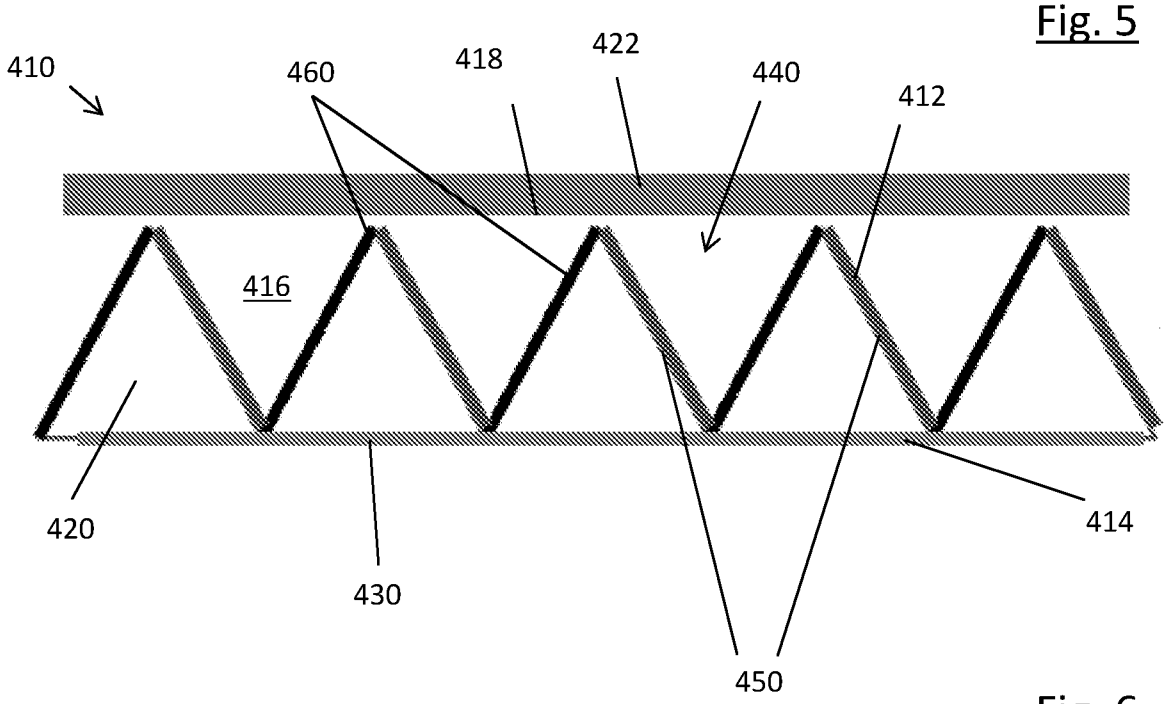

410
460
418
422
440
412
416
420
430
414
450

Fig. 6

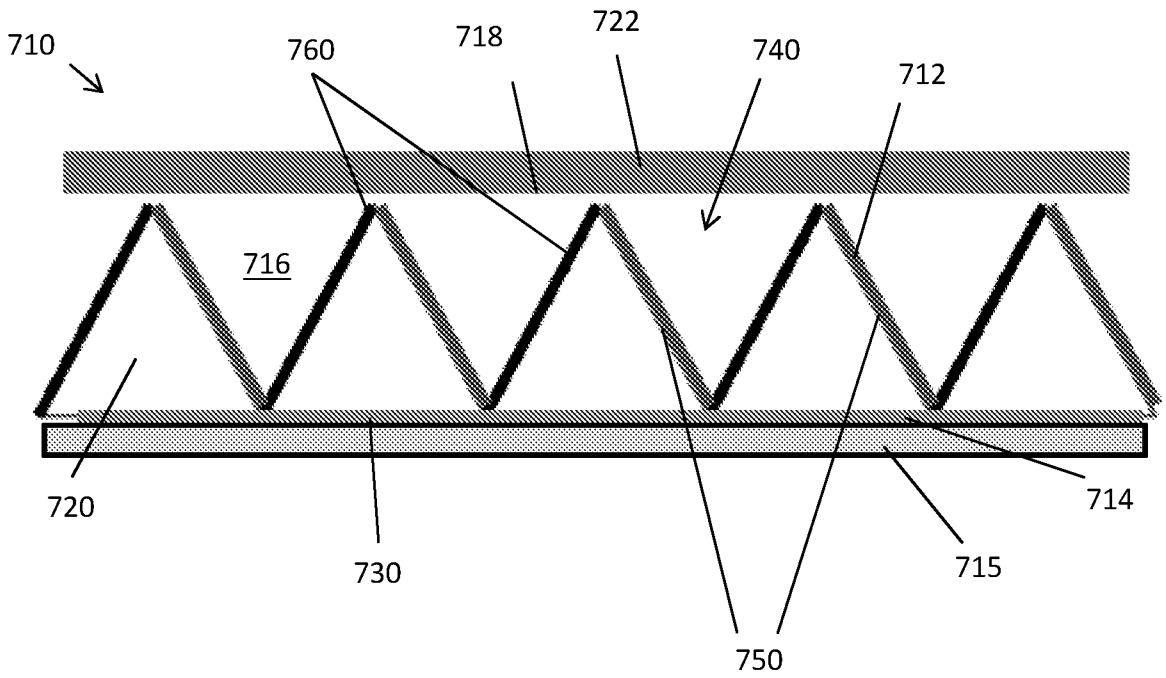

710
760
718
722
740
712
716
720
730
714
715
750

Fig. 7

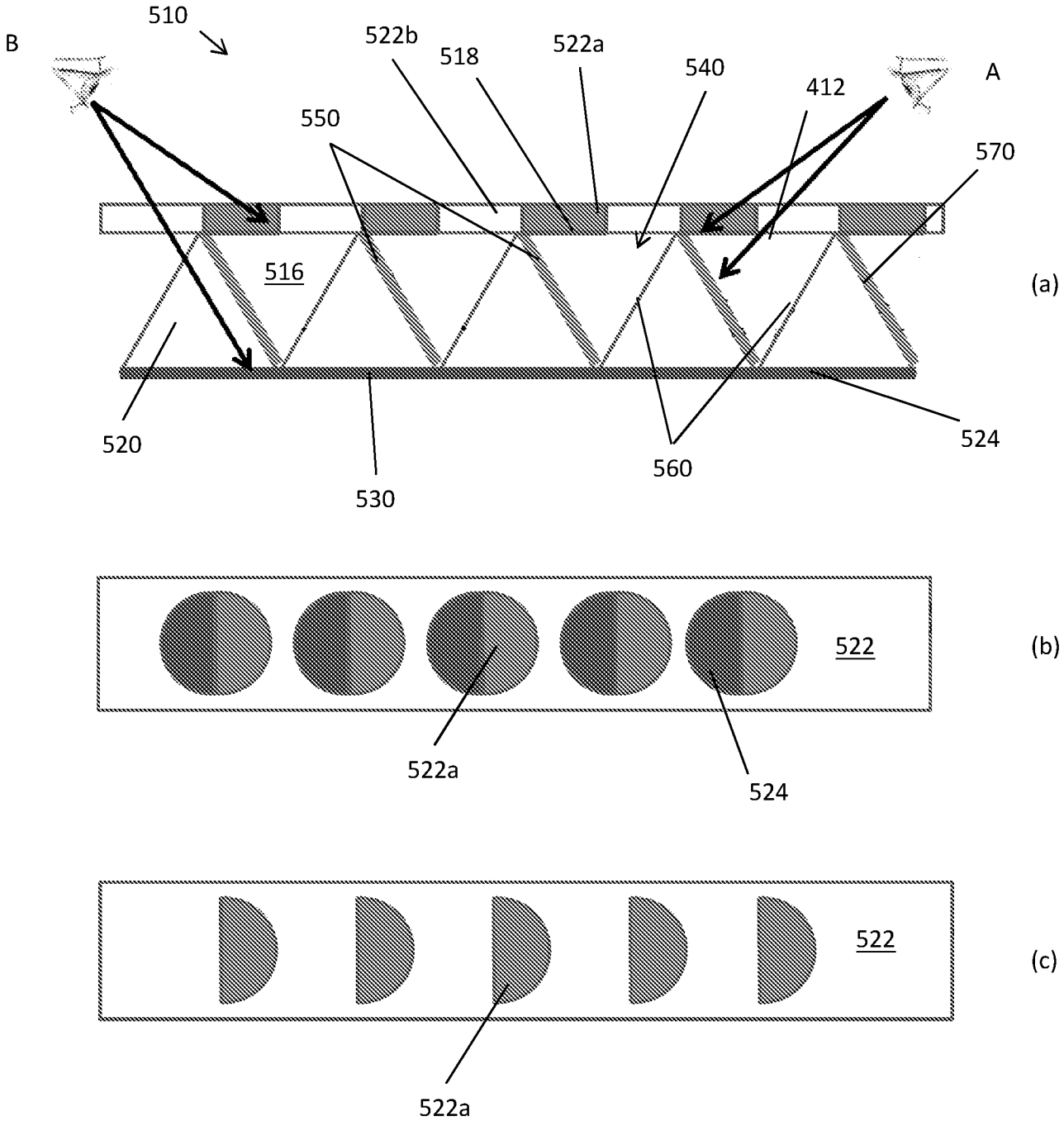

B
510
522b
518
522a
540
412
A
550
570
516
(a)
520
530
560
524
522
(b)
522a
524
522
(c)
522a

Fig. 8

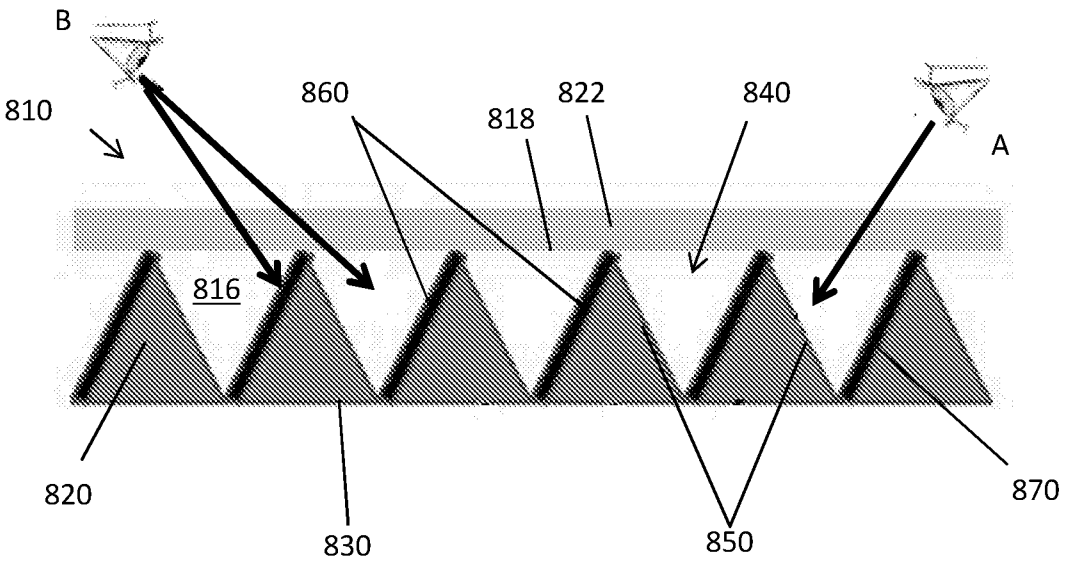

B
810
860
818
822
840
A
816
820
830
850
870

Fig. 9

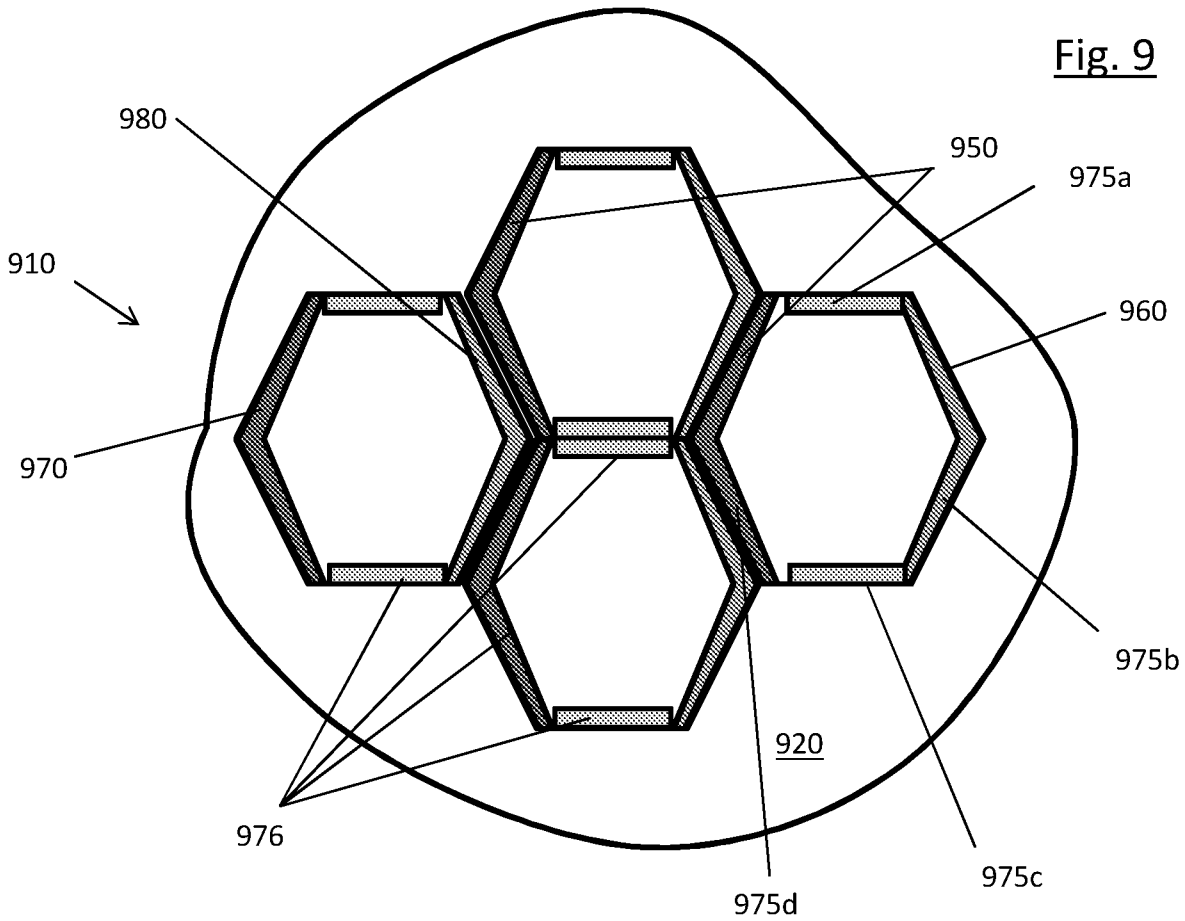

976
980
950
975a
910
960
970
975b
920
976
975c
975d

Fig. 10

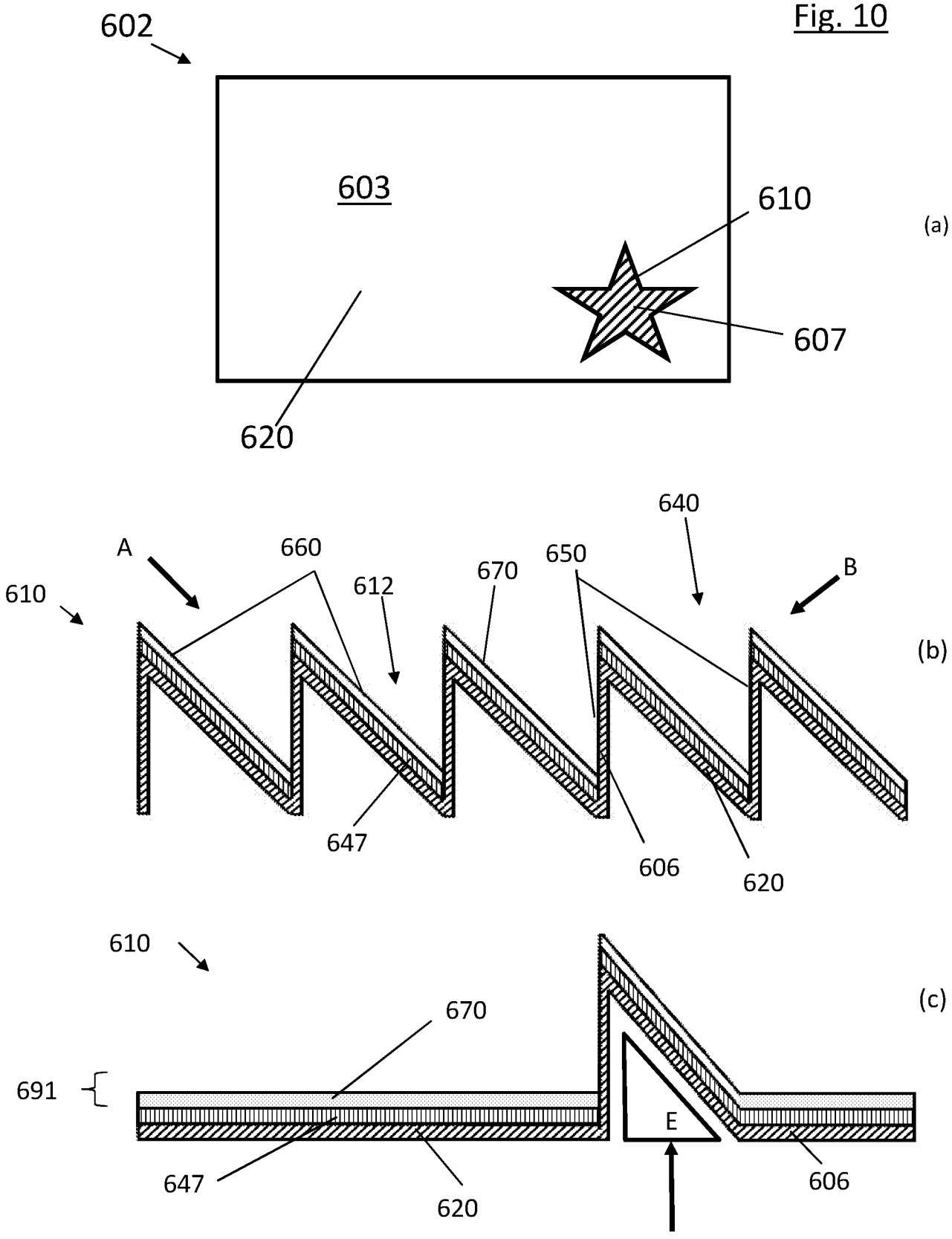

602
603
610
607
620
(a)
610
A
660
612
670
650
640
B
647
606
620
(b)
610
670
691
647
620
E
606
(c)

Fig. 11

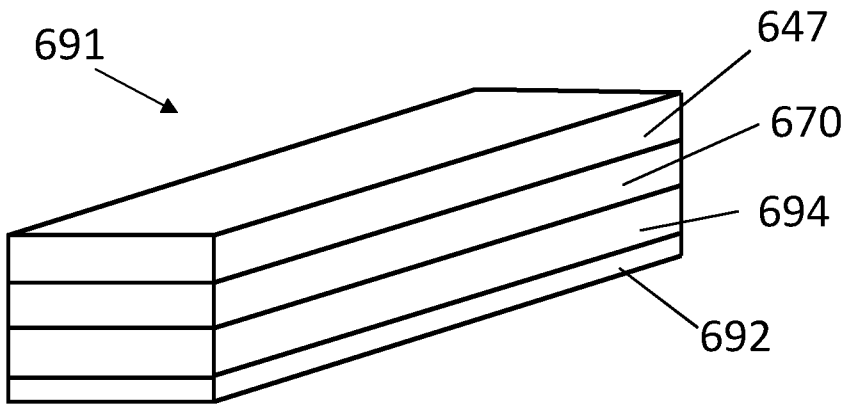
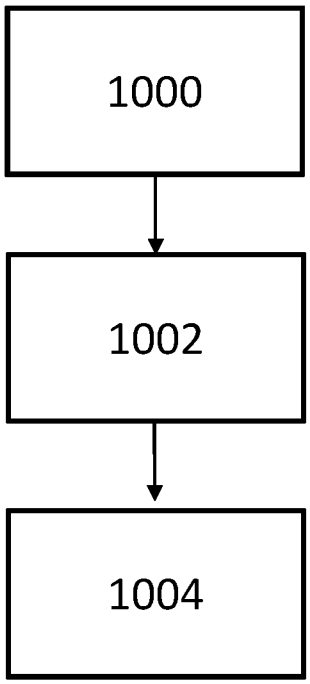
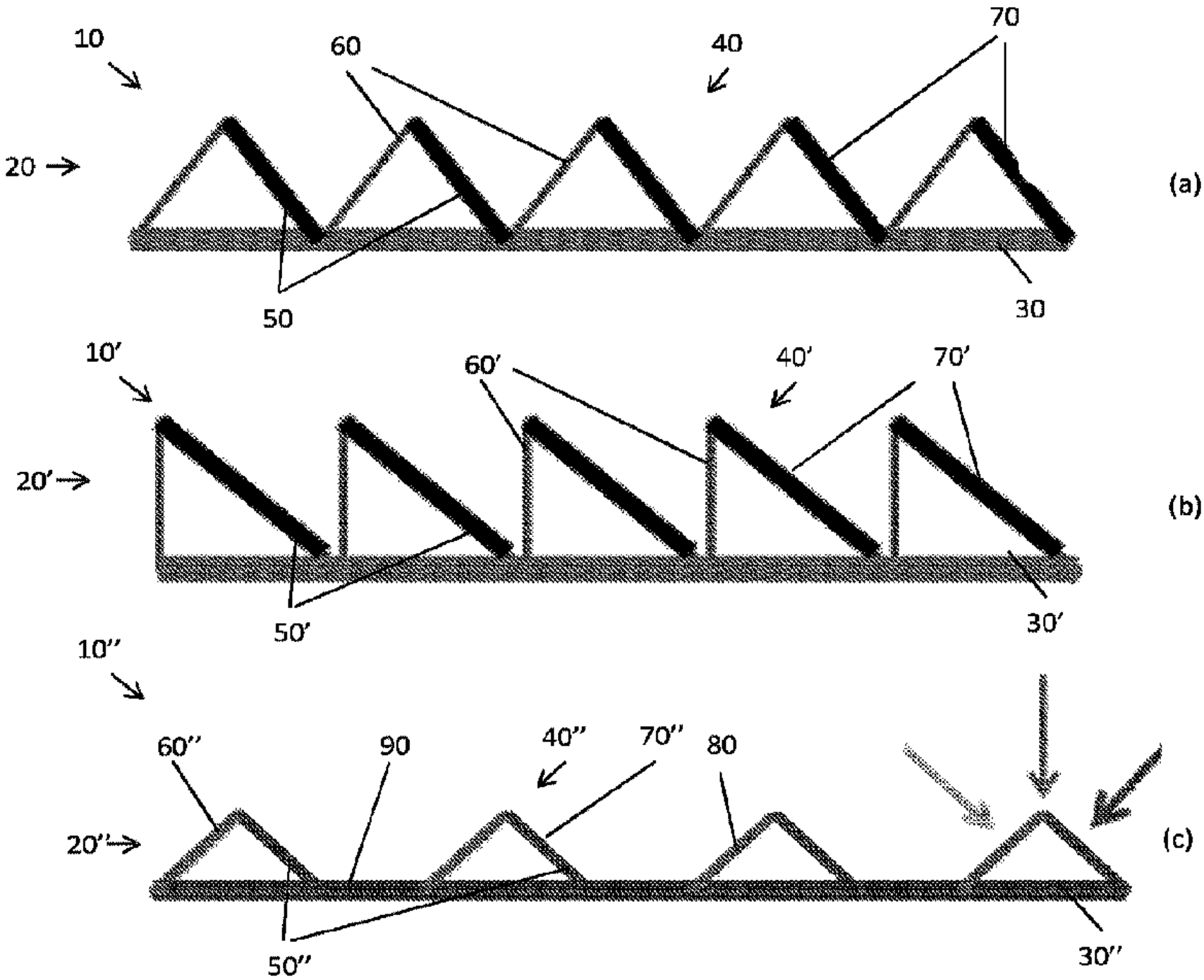


Fig. 12




10
60
40
70
20
(a)
50
30
10′
60′
40′
70′
20′
(b)
50′
30′
10″
60″
90
40″
70″
80
20″
(c)
50″
30″