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(54) SECURITY DEVICES AND METHODS OF MANUFACTURE THEREOF

SICHERHEITSVORRICHTUNGEN UND VERFAHREN ZUR HERSTELLUNG DAVON

DISPOSITIFS DE SÉCURITÉ ET LEURS PROCÉDÉS DE FABRICATION

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Description

Field of the Invention

[0001] This invention relates to security devices, suitable for establishing the authenticity of objects of value, particularly security documents, and their methods of manufacture. In particular, the invention relates to security devices incorporating optically variable effect generating relief structures such as holograms and diffraction gratings.

Background to the Invention

[0002] Optically variable effect generating relief structures such as holograms and diffraction gratings have been used widely over the last few years to impart security to documents of value such as banknotes, credit cards, passports and the like. Conventionally, the structure is provided on a transfer foil and then hot stamped from the transfer foil onto the final document substrate. An early example of this approach is described in US-A-4728377.

[0003] More recently, such structures have been used in combination with transparent window features formed in the document substrate to allow the optically variable effect to be viewed through the document. The window may take the form of an aperture through one or more layers of the document substrate or may comprise an optically transparent region of the document substrate. An example of an optically variable effect generating relief structure located in a window region formed as an aperture in a document is given in CA-C-2163528. An example of an optically variable effect generating relief structure located in a window region formed as a transparent region of a document (here, a polymer banknote) is given in WO-A-2008/031170.

[0004] Placing a security device in a window has the advantage that the device can be viewed from both sides of the document. As such it is desirable that a secure visual effect is exhibited by both sides of the security device, in order to increase the difficulty of counterfeiting. Examples of devices in which both sides exhibit a secure effect are disclosed in CA-C-2163528, US-A-2005/0104364, US-A-2007/0114787, CA-A-2717775, CA-A-2611195, EP1972462 and US2003/0175545. However, there is an ever-present need to improve the security level of such devices in order to stay ahead of would-be counterfeiters.

[0005] WO 2014/184559 A1 discloses a security document incorporating security features in the form of optically variable effect-generating relief structures. WO 2014/184560 A1 discloses security documents having polymer substrates and security devices provided thereon incorporating optically variable effect-generating relief structures. EP 1972462 A2 discloses a security film with a sign visible in transmitted light.

Summary of the Invention

[0006] In accordance with the present invention, there is provided a security device as defined in claim 14 and a method of manufacturing a security device as defined in claim 1.

[0007] Advantageously, the manufactured device appears to present two different secure visual effects (one visible from each side of the device), in exact register with one another. When viewed through the first layer, the appearance of the optically variable effect is dictated by the appearance of the formable material, which in preferred embodiments, comprises an optically effective substance (such as a colour tinted embossable lacquer) as will be explained in more detail below. When the device is viewed from the opposite side, the appearance of the optically variable effect appears different, being due to the reflection enhancing material. Thus the impression of two different yet precisely registered devices can be achieved through the provision of a single device in a manner which is very difficult to imitate.

[0008] The high degree of registration is achieved by using a pattern defining substance which impedes retention of subsequently applied layers to define those parts of the layered device in which the formable material and any overlaying reflection enhancing material will be retained. It is therefore preferable that the pattern defining substance is applied in register with the relief structure formed in step (d).

[0009] Moreover, the use of a pattern defining substance in this way has the benefit that each of the steps defining the end locations of the formable material and reflection enhancing material can be performed using similar or the same type of application techniques (e.g. printing or coating) and hence all can be performed in a continuous, in-line process. This further enhances the achievable registration and simplifies the manufacturing process.

[0010] The pattern defining substance could operate according to various different mechanisms, including inhibiting adhesion of the reflection enhancing material to the substrate and/or obstructing deposition of the reflection enhancing material onto the substrate in the first place. Depending on the type of pattern defining substance used, no further steps beyond deposition may be necessary to achieve the desired result. For instance, the pattern defining substance may repel the formable material such that no deposition of the reflection enhancing material occurs in the areas to which the pattern defining substance has been applied. In other cases, there may be some deposition of the formable material in these areas.

[0011] Preferably, the reflection enhancing material is a metal or alloy, or a material with a refractive index which differs from that of the formable material by at least 0.3, more preferably 0.5 (known as "high refractive index (HRI)" materials). Examples of suitable metals or alloys include aluminium, copper, nickel, chrome, aluminium-copper allows, silver, gold, etc. By "high refractive index" (HRI) materials, we mean materials having an index of refraction which exceeds that of the transparent base layer by a numerical value of preferably 0.5 or more. Since the refractive index of the base layer will typically fall in the range of 1.45 - 1.55, then a high refractive index material will be one with an index of preferably 2.0 or more. In practice high refractive index materials with good visual transparency will have an index in the range 2.0 to 2.5. Examples of suitable HRI materials include zirconium dioxide and zinc sulphide and titanium dioxide.

[0012] This may become detached subsequently without any positive intervention, but in preferred implementations, the method further comprises, after step (e):

(f) removing the formable material and any reflection enhancing material overlaying the formable material from regions of the device in which the pattern defining substance was applied.

[0013] The sequence of steps therefore may be (d), (e), (f) or (e), (f), (d) as will be explained in more detail with reference to the examples described below.

[0014] The removing step may be achieved by using a liquid (e.g. a solvent such as water) or gaseous (e.g. air jet) substance). Where a liquid is used, preferably the liquid has the capacity to dissolve the pattern defining substance (e.g. the mask is soluble within the washing liquid) and the formable material is permeable to the washing liquid to enable the washing liquid to reach the pattern defining substance.

[0015] In preferred embodiments, the pattern defining substance comprises a soluble mask, such as soluble ink (comprised of an appropriate binder and pigment combination), which does not adhere strongly to the substrate or can be dissolved by application of a solvent (aqueous or otherwise), thereby impeding adhesion of the reflection enhancing material applied thereto to the substrate. In this case a washing step may be required and the formable material should enable the solvent to reach the pattern defining substance. Examples of a suitable soluble mask in the form of a heavily pigmented ink are described in WO-A-9913157. Various mechanisms may be adopted but in one example, the soluble mask is configured such that, when coated with a thin deposited layer of formable material (e.g. embossable lacquer) and any applied reflection enhancing material (e.g. metal), the pattern defining substance creates small holes or discontinuities in the overlaid lacquer and metal film by virtue of the fact that the lacquer and metal film is not thick enough to continuously over coat the pigment grains in the mask. When immersed in a suitable solvent (preferably water) the solvent enters through these holes, dissolving the pigment such that the overlying metal layer disbands. In order for this mechanism to operate effectively, the pigment grain dimensions are preferably greater than the thickness of the lacquer and metal film. For instance, preferred pigment grain sizes may be in the range of greater than or equal to about 100 nm, and less than 500 nm. The upper limit on this range takes into account that in typical designs the minimum line with of a reflective region will be of the order of 500 nm, and the grain size should be less than this in order to permit adequate resolution of the desired pattern. Other examples of suitable soluble masks are disclosed in US-A-5142383, EP-A-1023499 and US-A-3935334.

[0016] Preferably, the formable layer comprises one or more optically effective substances such as a UV-responsive substance or a visible colorant for example. In preferred embodiments, the one or more optically effective substance(s) impart a coloured tint to the formable material, which colour is visible under illumination at visible wavelengths. In this way the two different appearances of the device can be checked for without the need for any special illumination. It should be noted that the term "colour" used herein should be taken to encompass optical effects which are invisible under ambient illumination conditions (i.e. visible illumination wavelengths), and become apparent only under illumination at specific non-visible wavelengths such as UV or IR, as well as colours which are visible in visible light. In addition the term "colour" encompasses all hues and tones which are visible, including black, grey and silver as well as chromacities such as red, blue, green etc.

[0017] The terms "at least partially translucent" or "transparent" indicate that the material in question is substantially clear, with low optical scattering - i.e. items on one side of the material can be seen through it, from the other - but not necessarily colourless. For instance, an at least partially translucent or transparent material may carry a coloured tint.

[0018] For example, the formable material may be at least visually semi-transparent (i.e. transmits wavelengths in the visible range),

[0019] The term "formable" means that any forming technique could be used to provide the relief in the formable material. For example, the optically variable effect generating relief structure is formed in the surface of the formable material by embossing or cast-curing, preferably UV cast-curing. In other words, the formable material may be an embossable or curable material. In preferred embodiments, the formable material forms a thin film or a patterned screen as will be explained in more detail below.

[0020] In some preferred examples, the formable material comprises a thermoplastic polymer, such as an embossing lacquer carried thereon. In such cases, the relief structure may be formed in the surface of the thermoplastic by conventional embossing techniques using heat and pressure, for example.

[0021] In other preferred implementations, the formable material may comprise a curable polymer, preferably a UV-curable polymer. For instance, the relief could be cast-cured into a coating of UV-curable resin. In still further embodiments, the formable material could comprise a curable thermoplastic polymer (i.e. a thermoplastic polymer with a curing agent added) such that, after embossing, the relief can be fixed by curing. The application of radiation can generally be more accurately controlled than that of heat, e.g. through the use of appropriately directed radiation sources and/or masks.

[0022] Optionally, the first layer may also comprise a formable material such as a thermoplastic polymer, for instance forming part of a substrate web of e.g. polyester, or which may act as a support for the security device as a whole or even for a security document of which the security device will ultimately form part. Preferably, the formable material forms a layer with a thickness of between 0.5 and 5 microns, more preferably between 0.5 and 2 microns.

[0023] In such cases, the relief structure will optionally be present in the first layer underlying the e.g. colour tinted formable material, the two layers being formed simultaneously. The layer of formable material is usually thin, for example 0.5-1 micron in order to ensure it is permeable such that the solvent can penetrate it. The advantage of additionally forming the relief structure in the underlying first layer is that deeper relief structures can be used such as those with a depth of greater than 1 micron. Preferably formable layers are embossed with a die carrying the relief structure, wherein the die advantageously forms part of an embossing roller. If multiple devices are to be formed on a substrate web (later to be divided into individual security documents each carrying one of the devices), the embossing roller may preferably carry the relief structure in the form of a repeating pattern. The repeat periodicity is preferably matched to that of the document repeat length and/or width.

[0024] In some embodiments, the formable material comprises one or more optically effective substance(s) which are visible only under illumination at selected wavelengths outside the visible spectrum, preferably ultraviolet or infrared wavelengths. This provides for a more covert security feature which can be checked by eye or by machine.

[0025] In still further embodiments, the formable material comprises one or more optically effective substance(s) which undergo a change in appearance in response to changes in one or more of temperature, pressure, strain or electrical potential. For example, thermochromic, piezochromic or electrochromic substances could be used. In each case the varying appearance of the substance may be visible within or outside the visible spectrum, and may change from one to the other.

[0026] Preferably, the optically effective substance(s) comprise dyes and/or pigments. Dyes are preferred in order to preserve the optical clarity of the layer(s). The optically effective substance(s) could be provided uniformly across the formable material. However in some embodiments the complexity of the security device may be further enhanced by arranging one or more of the substances to appear as a pattern.

[0027] Advantageously, the formable material may be a printed layer, preferably formed by gravure printing, flexographic printing or slotted die printing. In this way, the formable material can be laid down in any desirable form through control of the printing apparatus using well-known printing techniques. Gravure printing is most preferred due to the high resolution that is achievable. Printing techniques enable precise control of the shape or pattern in which the formable material is laid down. However, in other embodiments, the formable material could be applied by coating, deposition or transfer techniques.

[0028] In preferred embodiments, the lateral extent of the retained formable material and that of the reflection enhancing layer defines a secure or decorative shape or pattern, preferably a fine line pattern, or an item of information, preferably a number, letter, alphanumerical text, a symbol or a graphic.

[0029] Preferably, the formable material is registered to the relief structure. The location of the formable material is defined by the pattern defining layer being registered to the relief structure. It will be appreciated however that they do not have to be directly superimposed and there could be regions of the formable material without a relief. That is, the pattern defining substance has been laid down in register with the relief structure having the result that the two items will be in substantially the same relative position to one another on each security device made to the same design (e.g. a series of such devices). This increases the difficulty of counterfeiting since a document displaying a different alignment between the optically variable effect and the lateral extent of the reflection enhancing layer and formable material (which will be the same) will be readily distinguished from genuine devices.

[0030] As noted above, the formable material and the reflection enhancing layer could define any shape or pattern and in preferred examples the reflection enhancing layer (and the second transparent layer, since this will have the same lateral extent) includes at least two laterally offset regions which are visibly discontinuous. This increases the complexity of the device and hence the difficulty of forgery.

[0031] In many preferred embodiments, the reflection enhancing layer is substantially opaque such that the formable material cannot be seen therethrough. However, in other embodiments, the reflection enhancing layer may be semi-transparent, achieved for example through the use of an extremely thin layer of reflection enhancing material. In this case the formable material may be apparent through the reflection enhancing material when the device is viewed in transmitted light. However, in all cases the formable material should be substantially hidden by the reflection enhancing material when the device is viewed in reflection through the first transparent layer.

[0032] By arranging the reflection enhancing layer to be semi-transparent in this way, additional effects can be achieved. For example, the apparent colour of the security device viewed from one side may be different depending on whether the device is being viewed in reflected or transmitted light. When viewed in reflection through the first side of the device, the light reflected by the reflection enhancing layer dominates the appearance of the device and effectively conceals the colour of the formable material behind it such that the device appears to have the colour of the reflection enhancing layer. When viewed in transmission from the same side, the colour of the formable material will be visible through the reflection enhancing layer, thereby appearing to change the colour of the device.

[0033] The formable material may be applied as a continuous layer in each region of the shape or pattern to be defined. In this case, where the pattern defining substance is removed by a solvent as explained above, the formable material must be permeable to the solvent. In other embodiments, the formable material may comprise a screened working of discontinuous elements. By providing the formable material in a pattern which is detectable either to the naked eye or to a machine, the security level of the device is further increased. In such case, the formable material does not need to be permeable to a solvent but will allow a solvent to reach the underlying pattern defining substance through the gaps in the screen. The screen therefore enhances the permeability of the formable material to a solvent in which the pattern defining substance is dissolved. Typically the screen elements would be too small to be individually discerned by the naked eye. The reflection enhancing material would by definition be arranged according to the same screen. In this way the optically variable effect may appear semi-transparent from both sides of the device, in reflection and/or transmission. However it should be noted that this configuration will not lead to the additional colour effect described above unless the reflection enhancing layer is also formed sufficiently thinly so as to be intrinsically semi-transparent.

[0034] Preferably, the reflection enhancing layer is applied in a continuous layer over the relief structure. However, the reflection enhancing layer could be applied in a patterned manner e.g. through the use of a repellent coating applied to selected regions of the relief before application of the reflection enhancing material. The reflection enhancing layer may thus be defined by the pattern defining layer which can be patterned in the region of the relief. The deposition of the reflection enhancing material can be achieved using any appropriate deposition technique but generally a non-selective deposition technique will be preferred for simplicity. That is, the technique will result in the deposition of a contiguous layer of the reflection enhancing material across the entire area of the substrate which is exposed to the deposition process. In many cases, this will be the entire first surface of the substrate (although this is not essential). Preferably, the reflection enhancing material is deposited by vacuum deposition, suitable techniques including electron beam vapour deposition, vapour deposition from a resistively heated source (e.g. a boat source), pulsed laser vapour deposition, evaporative vapour deposition and sputtering, as well as chemical vapour deposition methods. Evaporative vapour deposition techniques from resistively heated or electron beam sources are generally preferred.

[0035] In particularly preferred implementations, the reflection enhancing layer comprises one or more metals or alloys thereof, preferably copper, aluminium, nickel, chrome or any alloys thereof (e.g. nickel-chrome alloys). Metal reflective layers, preferably laid down by vacuum deposition (encompassing sputtering, resistive boat evaporation or electron beam evaporation for example), or by chemical vapour deposition, achieve highly specular reflection and hence a very bright replay of the optically variable effect. In other advantageous implementations, the reflection enhancing layer could comprise any of:

- an optical interference thin film structure;
- a layer containing metallic particles, optically variable particles or optically variable magnetic particles;
- a photonic crystal layer; or
- a liquid crystal layer.

[0036] Such materials can be used to provide the device with additional visual effects, e.g. exhibiting different colours at different viewing angles ("colour shift"), which will appear superimposed on the visual effect produced by the relief structure.

[0037] The reflection enhancing layer follows the contour of the relief structure and preferably has a thickness less than the profile depth of the relief structure. For example, typical diffractive relief structures such as holograms may have profile depths of the order of 50 to 500 nm, more often between 80 and 150 nm. In contrast, the reflection enhancing layer preferably has a thickness between 5 and 100 nm. For instance, a layer of aluminium having a thickness of around 10 to 30 nm is suitable for providing a virtually fully opaque reflective layer. A layer of aluminium with a thickness around 5 to 10 nm can be used to provide a semi-transparent reflection enhancing layer.

[0038] Preferably, the optically variable effect generating relief structure comprises a diffractive device which comprises a structure operating in either the first order of diffraction or zero order diffraction, and which would be categorised as a form of form of DOVID (diffractive optically variable image device) as described in Optical Document Security, 2nd edition by Van Renesse and includes spatial domain oriented structures, graphical domain oriented structures, pixel domain oriented structures, track oriented structures, vector oriented structures and time domain oriented structures. Examples include a 3D hologram, a Kinegram™ or an Exelgram. Alternatively the optically variable effect generating relief structure may comprise a non-diffractive micro-optical structure such as 1D and 2D periodic faceted reflective structures (i.e. forms of micro-mirrors). Non-diffractive optical structures typically are of much larger dimensions to those mentioned above in relation to holographic devices, with profile depths of between 2 and 50 microns. Examples of faceted reflective structures suitable for the current invention include, but are not limited to, a series of parallel linear prisms with planar facets arranged to form a grooved surface, a ruled array of tetrahedra, an array of square pyramids, an array of corner-cube structures, and an array of hexagonalfaced corner-cubes. A second preferred type of micro-optical structure is one which functions as a microlens including those that refract light at a suitably curved surface of a homogenous material such as plano-convex lenslets, double convex lenslets, plano-concave lenslets, and double concave lenslets. Other suitable micro-optical structures include geometric shapes based on domes, hemispheres, hexagons, squares, cones, stepped structures, cubes, sawtooth structures, faceted structures or combinations thereof.

[0039] Preferably, step (d) further comprising forming the surface of the first layer in at least one fourth region separate from and optionally adjacent to the at least one third region such that it follows the contours of a second optically effect generating relief structure. In this case, the reflection enhancing material is preferably also applied over the at least one fourth region. This increases the complexity of the security device with a correspondingly increased degree of security.

[0040] In some embodiments, the method further comprising the steps of:

(f1) removing the formable material and any residual reflection enhancing material overlaying the formable material in areas in which the pattern defining substance was applied;

> providing, in register with the retained formable material, a second layer which is at least partially translucent or transparent; and
> providing, in register with the second relief structure, a third layer which is at least partially translucent or transparent, wherein the third layer comprises one or more optically effective substances which impart a coloured tint to the third layer, which colour is preferably different from the colour of the formable material, and preferably, washing the device to remove any residual reflection enhancing material in areas in which the second layer was not applied.

[0041] Advantageously, this results in a device which on one side may display a first colour (dictated by the colour of the formable material) in register with a metallic region. On the reverse side, the same device may present a second, different colour (dictated by the colour of the third transparent layer), in register with a metallic region. This further increases the complexity of security of the device since such a striking effect is difficult to reproduce by counterfeiters.

[0042] In alternative embodiments, the method further comprising the steps of:

(f2) removing the formable material and any residual reflection enhancing material overlaying the formable material in areas in which the pattern defining substance was applied;

> applying a fourth layer comprising a thermoplastic polymer or a curable polymer, preferably a UV-curable polymer, the fourth layer being at least partially translucent or transparent;
> forming the surface of the first layer in at least one fifth region separate from the third region on the surface of the first layer aligned with the at least a partially translucent or transparent region and in which the formable material is not applied, such that it follows the contours of a third optically variable effect generating relief structure;
> applying a second reflection enhancing material over the fourth layer to form a reflection enhancing layer which follows the contours of the third relief structure; and
> providing, in register with the third relief structure, a fifth layer which is at least a partially translucent or transparent, wherein the fifth layer comprises one or more optically effective substances which impart a coloured tint to the fifth transparent layer, which colour is preferably different from the colour of the formable material, and preferably, removing any residual reflection enhancing material overlaying the fifth layer in areas not covered by the fifth layer.

[0043] Such methods also result in devices which on one side may display a first colour (dictated by the colour of the formable material) in register with a metallic region. On the reverse side, the same device may present a second, different colour (dictated by the colour of the fifth transparent layer), in register with a metallic region.

[0044] The first layer may take a number of forms depending in part on how the security device is to be incorporated or applied to an object of value. In some embodiments the first layer forms an integral part of a substrate, preferably a security document substrate or a security article substrate. If the device is to be formed independently of the security document or other object of value to which it is to be applied, the device preferably further comprises one or more transparent adhesive layers. These may form the outermost layer of the device on either or both sides. By selecting a transparent adhesive, the appearance of the optically variable effect is not diminished.

[0045] Where the security device is formed as a security article, the security article including the device may be incorporated into or applied to a security document by any conventional technique, such as hot stamping, cold adhesion, laminating, incorporation into paper-making process, etc. The security device is preferably arranged to overlap at least partially and preferably fully with a window region of the document which may have a paper or polymer substrate, e.g. an aperture or a transparent portion, which may be formed before or after incorporation of the security device. Alternatively, a transferrable structure such as a security thread, transfer foil, or patch may include a carrier releasably attached to the security device.

Brief Description of the Drawings

[0046] Preferred embodiments of security devices and manufacturing methods in accordance with the present invention will now be discussed with reference to the accompanying Figures, in which:-

Figure 1 is a schematic cross-section of a security article equipped with a security device according to the invention;
Figure 2 is a schematic cross-section of a security article incorporating another security device according to the invention;
Figure 3 is a plan view of the security article of Figure 1;
Figure 4 is a flowchart indicating selected steps of a method for manufacture of a security device according to the invention;
Figures 5a to 5g schematically depict components of a security device at various stages of manufacture;
Figures 6a to 6d schematically depict components of a further security device at various stages of manufacture, the device comprising a colour tinted layer applied as a patterned screen;
Figures 7a to 7d schematically depict components of a further security device at various stages of manufacture, wherein the steps of forming the relief structure and applying the reflection enhancing material are reversed compared to the method of Figures 5a to 5g;
Figures 8a to 8j schematically depict components of a further security device at various stages of manufacture;
Figures 9a to 9k schematically depict components of a further security device at various stages of manufacture;
Figure 10 is a plan view of a security article comprising at least two holograms formed by including relief structures in at least two adjacent regions, according to Figures8j, or 9k for example;
Figures 11a and 11b depict an exemplary security document in accordance with the present invention, Figure 11b showing a cross-section along the line XX' in Figure 11a;
Figures 12a and 12b depict a further exemplary security document incorporating a security device in accordance with the present invention, Figure 12b being a cross-section along line XX' in Figure 12a;
Figures 13a, 13b and 13c depict a further exemplary security document incorporating a security device in accordance with the present invention, Figures 13b and 13c depicting alternative cross-sections of the security document taken along line XX' in Figure 13a.

Description of Embodiments

[0047] The present description will focus on security documents provided with integral security devices having optically variable effect generating relief structures which give rise to diffractive optical effects, such as holograms or diffraction gratings. However, it should be appreciated that in other embodiments the relief structure may be a non-holographic micro-optical structure, such as a prismatic structure. Examples of prismatic structures suitable for the security devices of the sort presently disclosed include, but are not limited to, a series of parallel linear prisms with planar facets arranged to form a grooved surface, a ruled array of tetrahedral, an array of square pyramids, an array of corner cube structures, and an array of hexagonal faced corner cubes. Another preferred type of micro-optical structure is one which functions as a micro lens, including those that refract light at a suitably curved surface of a homogeneous material such as plano-convex lenslets, double-convex lenslets, plano-concave lenslets and double-concave lenslets. Other suitable micro-optical structures include geometric shapes based on domes, hemispheres, hexagons, squares, cones, stepped-structures, cubes or combinations thereof.

[0048] Figure 1 shows a security article 1 such as a transfer foil, security thread, patch, or similar which includes a security device 10 carried on a support layer 2a (here the lower surface, facing observer B). Typically, the support layer 2a acts as a release sheet or strip from which the device 10 is detached upon application to a security document, in which case the support layer 2a can take any convenient form such as a (opaque, translucent or transparent) polymer or paper web. The support layer 2a may be transferred with the security device onto the security document for example when the security device is applied over an aperture in the security document substrate. Alternatively, the support layer 2a may for example be an integral part of a security document, e.g. a polymer banknote substrate, or a layer of an identity card. If the support layer 2a is to remain in situ when the device is put in circulation, the support layer 2a should be transparent at least in regions at which the security devices are to be formed. The substrate could however be opaque in other regions, e.g. carrying one or more opacifying layers 15 defining window regions 11 in which the devices are to be formed, as illustrated in Figure 3 for example.

[0049] A release layer (not shown) may be provided between the support layer 2a and security device 10 to assist in the detachment of the security device 10 from the support layer 2a upon application of the device 10 to a security document. For example, where the transfer is to take place by hot stamping, the release layer may comprise a release coat such as a layer of wax or similarapplied to the support layer 2a prior to the application of the other functional layers.

[0050] The security device 10 comprises an at least partially translucent or transparent substrate 2b, such as a polymer film and a coloured tinted layer 3 which is a formable material, such as an embossable lacquer. In the example of Figure 1, a holographic (or other optically variable) relief structure 4 is formed solely in the colour tinted layer 3 disposed on the substrate 2b across a region R_1.

[0051] In the example of Figure 2, the relief structure 4 formed within the colour tinted layer 3 as well as the underlying substrate 2b which is also made of an appropriate formable material, typically a thermal embossing lacquer. The support layer 2a may also be formable and comprise for example a thermoplastic layer such as polyesterpolyethylene teraphthalate (PET), polyethylene, polyamide, polycarbonate, poly(vinylchloride) (PVC), poly(vinylidenechloride) (PVdC), polymethylmethacrylate (PMMA), polyethylene naphthalate (PEN), polystyrene, or polysulphone; or an embossing lacquer layer, such as a PMMA-based resin.. The device requires at least one formable layer (2a or 2b) which is not subsequently released as will be explained below in more detail. In other words, it is possible to provide a single formable support layer (e.g. 2a) without an additional formable layer (e.g. 2b). It will also be appreciated that forming the relief in the underlying substrate 2b (or support layer 2a) is dependent on the thickness of the colour tinted layer 3. The colour tinted layer 3 (and optionally the substrate 2b, as shown in Figure 2) can be formed of any suitable material in which a relief structure 4 can be formed, for example a conventional embossing lacquer such as a thermoplastic polymer or a radiation curable resin. The colour tinted layer 3 includes a colorant such as a suitable dye which imparts a tint to the layer 3. The tint may or may not be visible to the human eye under illumination at visible wavelengths. For example, the colorant could be invisible unless irradiated with selected wavelengths outside the visible spectrum, such as UV or IR, and could be phosphorescent, fluorescent or luminescent. However, in the most preferred examples, the colorant is visible under ambient lighting conditions in order that the colour effect is readily apparent without the need for specialist equipment.

[0052] The relief structure 4 is formed into the colour tinted layer 3 in Figure 1 (as well as in the substrate 2b in Figure 2, depending on the thickness of the colour tinted layer) using an appropriate conventional technique such as embossing under the combined action of heat and pressure, or cast curing, in which the colour tinted layer 3 is coated as a relatively fluid resin onto the support layer 2a and a shaped die applied to the fluid resin having the desired relief shape. The resin flows to accommodate the die thereby taking on the desired relief shape and is simultaneously or subsequently hardened, e.g. by curing with radiation such as UV. The colour tinted layer 3 typically comprises a single homogenous film of resin. A formable substrate 2b may comprise multiple layers including at least a protective coating layer (commonly termed a "scuff layer) which will cover the hologram in use and an embossing layer which is usually of a material which is mechanically softer and/or of lower glass transition temperature than the protective layer. Typically, a formable substrate 2b is between 1 and 5 microns thick, preferably between 1 and 3 microns thick.

[0053] The colour tinted layer 3 carries a reflection enhancing material 5 such as a metal film (e.g. aluminium or copper). The colour tinted layer 3 has been formed so as to follow the contours of surface relief 4 defining an optically variable effect generating structure such as a hologram or diffraction grating (as discussed further above), and the reflection enhancing material 5 follows the contours of the relief.

[0054] The colour tinted layer 3 and reflection enhancing material 5 are substantially in register with one another (in region R_1=R_3) and any other layers such that their relative locations do not vary substantially between one banknote and another of the same type for example. For instance, the position tolerance of the colour tinted layer 3 and reflection enhancing material 5 and any other layers may be as low as +/- 100 to 200 microns or exceptionally less from one document to the next.

[0055] Optionally, the reflection enhancing material may be covered with a protective coating (not shown) which may optionally contain a security substance (e.g. a fluorescent, luminescent or phosphorescent material).

[0056] The security device 10 is visible from both sides of the security article 1 as illustrated by observers A and B. Figure 3 shows a plan view of the security document of Figure 1 as viewed by observer B. The document 1 has a window 11 inside which the security device 10 extends across the region R_3 which here has the form of a sun-shaped symbol. In other cases, the region R_3 may define an alternative indicia such as a letter, number or graphic, and the region R_3 could extend to cover the whole window 11 (although this is less preferred). As viewed by observer B, the sun-shaped symbol has a metallic appearance, which is dictated by the reflection enhancing material 5.

[0057] From the opposite side of the security document 1, observer A sees the same optically variable effect although the content of the hologram will appear reversed (i.e. a mirror image of that seen from the position of observer B) due to the fact that the reverse side of relief 4 is being viewed. However, the colour of the optically variable effect and the device as a whole will appear different from that seen from position B since it will be determined by the colour tinted layer 3 (which is at least semi-transparent) in combination with the reflection enhancing layer 5.i.e a coloured metallic appearance will be observed from position A where the colour is determined by the tint in the formable material. Thus, two different optically variable appearances can be observed from the two sides of the device. The result is therefore a particularly effective security device since the impression is given of there being two security devices of different colour in exact register with one another. This would be extremely difficult to imitate utilising two devices since the necessary level of registration would not be obtainable. As a result, the security level is significantly enhanced.

[0058] A preferred method for manufacturing a security device such as that shown in Figure 1 will now be discussed with reference to Figures 4 and 5a to 5g. Figure 4 is a flowchart depicting selected steps of the method. Figures 5a to 5g depict a security device made according to the described method, at various stages of production for cross reference with Figure 4.

[0059] In the first step S101, a pattern defining substance 6 is applied to a first surface of a first transparent layer, in this case represented by an embossable substrate 2b on a transparent carrier 2a as shown in Figures 5a and 5b. The pattern defining substance 6 is laid down across areas of the substrate in which the colour tinted layer 3 is ultimately not desired, in this case outside of region R_1 as shown in Figure 5b. The pattern defining substance 6 can comprise any material which impedes adhesion of the colour tinted layer 3 (typically an embossable resin lacquer) to the underlying substrate 2b (and any overlying layers such as a reflection enhancing material 5 in this example). In a preferred embodiment, the pattern defining substance 6 comprises a soluble mask, such as soluble ink. One exemplary type of soluble ink is heavily pigmented ink as disclosed in WO-A-99-13157. Mechanisms by which soluble masks operate vary but in one example, the pigment grains in the mask are sufficiently large that when a layer of metal or other reflection enhancing material is deposited on top of the ink, holes are formed through the deposited layer. As such, during subsequent washing with a solvent such as water, the fluid can pass through the deposited layer, reaching and dissolving the pigment. This leads to detachment of the colour tinted layer 3 from the substrate in the regions where the soluble mask is present. Further examples of suitable soluble masks are given in US-A-5142383, US-A-3935334 and EP-A-1023499.

[0060] With the pattern defining substance 6 in place, in step S102, colour tinted material 3 is deposited onto the first surface 2a of the substrate 2 to form a layer of colour tinted material 3 which extends over the window R_1 defined by the pattern defining substance 6 and neighbouring regions of the substrate, including portions covered by pattern defining substance 6 as shown in Figure 5c. The colour tinted layer 3 is applied in region R_2, which second overlaps at least in part the first region R_1 in order that the colour tinted layer 3 can be deposited onto and strongly bond to at least part of the substrate 2b. The overlapping portions of the first and second regions R_1, R_2 define a third region R_3 in which ultimately the formed relief structure 4 is present. The third region R_3 in which the relief structure is formed may be coincident with the first region R_1, but this is not essential.

[0061] In cases where the pattern defining substance comprises a soluble mask dissolvable in a solvent such as water, the colour tinted layer 3 should be permeable to the solvent. The colour tinted layer 3 may be applied as a continuous coating layer as shown in Figure 5b or may be printed in distinct regions. In some embodiments, as shown in Figures 6b to 6d, the colour tinted material is applied in a patterned screen 30. The region of the substrate 2b onto which colour tinted layer 3 is applied (i.e. the overlapping parts of regions R_1 and R_2, termed the third region, R_3) exhibits the desired optically variable effect.

[0062] At step S103, an optically variable effect generating relief structure 4 is formed in the surface of the colour tinted layer 3 as shown in Figure 5d. Optionally, the relief structure 4 may additionally be formed into the underlying formable substrate 2b depending on the thickness of the colour tinted layer 3 (an example of which was shown in Figure 2). The relief structure 4 may be formed through a conventional embossing process, e.g. involving forming the surface relief 4 (by impressing a cylindrical image forming die (e.g. an embossing roller) into a thermoplastic layer 3 through the combined action of heat and pressure. Alternatively, the colour tinted layer 3 could be an embossable lacquer or a cast cure resin. For example, the layer 3 may be applied as a viscous liquid coating or film of monomer which is contacted by an image forming die or roller. The surface relief 4 is cast into the film by the simultaneous or near simultaneous exposure of the layer 3 to radiation (e.g. UV radiation), causing polymerisation. The surface relief 4 is thus set into the layer 3. UV curable polymers employing free radical or cationic UV polymerisation are suitable for the UV casting process. Examples of free radical systems include photo-crosslinkable acrylate-methacrylate or aromatic vinyl oligomeric resins. Examples of cationic systems include cycloaliphatic epoxides. Hybrid polymer systems can also be employed combining both free radical and cationic UV polymerization. Cast cure processes such as this are particularly preferred where the colour tinted layer 3 has a relatively low glass transition or softening temperature, e.g. biaxially orientated polypropylene (BOPP) which softens at temperatures around 85°C. Structures embossed into such materials may be vulnerable to damage should the device encounter high temperatures during circulation.

[0063] In the next step S104, a reflection enhancing material is applied to the relief 4 to form a reflection enhancing layer 5 (Figure 5e). The reflection enhancing layer 5 conforms to the surface relief 4 and this is replicated in the reflection enhancing layer's opposite side, thus rendering the optically variable effect visible from both sides of the device (layer 3 being transparent or semi-transparent). In order to achieve good conformity, the thickness t_1 of the reflection enhancing layer 5 is preferably less, more preferably substantially less, than the profile depth d of the relief profile 4. For instance, the relief 4 may have a profile depth d of between 50 and 500 nm, whilst the reflective layer 5 may have a thickness of between 10 and 100 nm, preferably 10 to 30 nm. In some cases the thickness of the reflection enhancing layer may be kept very thin, e.g. 5 to 10 nm, in order to render it semi-transparent. This provides for the possibility of a further colour effect whereby the apparent colour of the device changes when viewed from the same side in reflected as compared to transmitted light.

[0064] In an alternative embodiment as will be described with reference to Figures 7a to 7d, the order of steps S103 (forming the relief structure) and S104 (applying the reflection enhancing material) may be reversed. In other words, the colour tinted layer 3 may be embossed prior to or after depositing the reflection enhancing material 5.

[0065] In order to obtain bright holographic replay, the reflection enhancing layer 5 is preferably a metal layer formed of one or more metals and/or alloys, e.g. aluminium, copper, nickel and/or chrome (or any alloy thereof). If desired, two or more metals or alloys could be laid down in a pattern of different regions to collectively form the layer 5, as described in EP-A-1294576. In other cases, the reflection enhancing material could comprise an optical interference thin film structure, a layer containing metallic particles, optically variable particles or optically variable magnetic particles, a photonic crystal layer, or a liquid crystal layer. Materials of this sort not only provide the requisite reflective properties but may impart an additional optical effect to the device, e.g. exhibiting different colours depending on the angle of view. For example, the reflection enhancing layer could comprise a multilayer structure of alternating high and low refractive index dielectric layers resulting in an optical interference structure which exhibits different colours when viewed in reflection as compared with when viewed in transmission.

[0066] The reflection enhancing material(s) could be laid down by any appropriate technique but vacuum deposition is preferred. It should be noted that whilst typically the reflection enhancing layer 5 will be applied directly to the first colour tinted layer 3 and therefore will be in contact with the surface of the element in which the relief structure 4 is formed, the reflection enhancing layer 5 could be spaced from that element by an intermediate transparent layer or the like, provided that the intermediate layer is sufficiently thin so that the reflection enhancing layer again follows the surface relief contour.

[0067] Depending on the nature of pattern defining substance 6, the colour tinted layer 3 (and any overlaying reflection enhancing material 5) may not settle on the pattern defining substance 6. In other cases, some residual embossable lacquer 3 and residual reflection enhancing material 5 may remain on the pattern defining substance 6 in which case a removal step, such as washing step S105 (and Figure 5f), may be performed. This may involve for example washing the surface of substrate 2b with a liquid (e.g. water) or a gaseous substance, such as an air jet. Alternatively, a mechanical action such as vibration may be used as the removal step. Where a liquid is used, preferably the liquid has the capacity to dissolve the pattern defining substance (e.g. the soluble mask is soluble within the washing liquid) and the colour tinted layer 3 is permeable to the liquid to allow it to reach the pattern defining substance 6 underneath it.

[0068] This causes detachment of the colour tinted layer 3 and overlaying reflection enhancing material 5 from the substrate 2b in the areas where pattern defining substance 6 is present, resulting in the same final structure shown in Figure 5g. The region of the remaining colour tinted layer 3 to which the reflection enhancing material 5 is applied (i.e. the overlapping parts of regions R_1 and R_2, termed the third region, R_3) exhibits the desired optically variable effect.

[0069] Figures 6a to 6d schematically depict a variation of a method according to the invention wherein a security device 10' is formed using the same technique as described above, except a patterned screen of colour tinted material 30 is applied instead of a continuous layer 3 as described with reference to Figures 5c to 5g above. Advantageously, using a screen 30 enhances permeability of the colour tinted layer. The method steps of Figures 6a to 6d is the same as that described with the Figures 5a to 5g, the detailed description of which is not repeated here. The patterned screen of colour tinted material 30 in this example is a thin screen of colour tinted material with a typical thickness of 0.5 to 5 microns, preferably 0.5 to 2 microns. The width of the lines or the diameter of the dots forming the screen 30 are preferably in the range 20-200 microns and the spaces between the dots or lines are also in the range 20-200 microns. Accordingly, the dimensions of the screen 30 are such that it is not readily observable with the naked eye. The reflection enhancing material 50 is applied over the screen 30 in a similar manner as indicated above.

[0070] Figures 7a to 7d schematically depict components of a further security device 10" at various stages of manufacture, wherein the steps of forming the relief structure (S103) and applying the reflection enhancing material (S104) are reversed compared to the method of Figures 5a to 5g described above. In this example, the substrate 2b is a formable (e.g. embossable) layer as described above in regions R_1=R_3 and an additional relief structure 40 is provided in at least one adjacent region R_4 not comprising the colour tinted layer 3, as shown in Figure 7d. In this example, the relief structures 4, 40 are formed at the same stage (depicted by Figure 7d), for example with a die carrying the relief structure, wherein the die advantageously forms part of an embossing roller. The device as shown in Figure 7d is not preferrable as there is no reflection enhancing layer associated with relief structure 40 therefore the optically variable effect generated by the relief structure will not be readily apparent. A further metallised layer may be added to 40 as a later step or the same process may be applied, as shown in Figures 8a-8g, so that both relief structures have a metallised layer.

[0071] The result is a security device as described above with an additional, adjacent, region displaying an optically variable effect to the observers. If substrate 2b is clear and colourless, the optically variable effect in region R_4 will be the same for both observers A and B. Advantageously, the security device 10" may displays a central region R_1=R_3 (e.g. with a colour tint as viewed by observer A and a metallic appearance as viewed by observer B) in register with adjacent regions R_4 exhibiting the same effect from either view point A or B. Accordingly, the security of the device is increased since such an effect is difficult to reproduce by counterfeiters.

[0072] Figures 8a to 8j schematically depict components of a further security device 10'" at various stages of manufacture. Figures 8a to 8c respectively illustrate the same method steps as Figures 5a to 5c described above. In this example, the substrate 2b is a formable (e.g. embossable) layer as described above. In Figure 8d, in addition to forming a relief structure 41 in region (R_1=R_3) comprising the colour tinted layer 3, at least a further relief structure 42 is formed in an adjacent region R_5 not comprising the colour tinted layer. In this example, the relief structures 41, 42 are formed at the same stage (depicted by Figure 8d), for example by embossing structures 41 and 42 simultaneously. Preferably structures 41 and 42 are embossed with a die carrying the relief structure, wherein the die advantageously forms part of an embossing roller.

[0073] Next, as shown in Figure 8e, a reflection enhancing layer 52 is applied to the substrate 2b as described above with reference to step S104, covering region (R_1=R_3) comprising the colour tinted layer 3, as well as the at least one adjacent region R_5 not comprising the colour tinted layer. Following the formation of the relief structure 41, a reflection enhancing layer 52 such as a metal is applied, preferably by vacuum metallisation (as described above with reference to S104 of Figure 4 for example). The reflection enhancing layer 52 respectively conforms to the relief structures 41 and 42. As shown in the Figure 8e, the metallisation covers the full area of the device 10"'.

[0074] Figures 8f and 8g depict the removal of residual colour tinted layer 3 and any overlaying residual refection enhancing material in region (R_1=R_3) as described above (with reference to step S105 of Figure 4 for example). Further, as shown in Figure 8h a second layer 22 which is at least partially translucent or transparent is preferably printed over the device 10 in region (R_1=R_3) (left hand side of the device). The layer 22 may in practice be formed of multiple layers laminated to one another, and this applies to all "layers" mentioned throughout this disclosure. In this example, the second layer 22 is a clear alkali resistant mask printed in register with the coloured lacquer 3 (with a register tolerance achievable by normal printing techniques i.e. +/- 100 microns). The thickness of the second transparent layer 22 is 0.5-5 microns and preferably 1-2 microns. Most preferably, the material forming layer 22 is suitable for acting as a etch resist, with the layer 22 protecting the reflection enhancing layer 52 during a subsequent etching step shown in Figure 8j, in which those regions of the reflection enhancing layer 52 which are not covered by the third layer 24 are removed.

[0075] Further, as shown Figure 8i, a third layer 24 which is at least partially translucent or transparent is applied over the reflection enhancing layer 23 across a region R_5 (right hand side of the device). The third layer 24 is preferably laid down in the form of a decorative or secure shape or pattern, such as letters, numbers, symbols or other indicia, or a shape or fine line pattern. As in the previous examples, it is preferable that the shape or pattern includes at least two visibly discontinuous regions - i.e. areas of the pattern which are sufficiently large and spaced by a sufficient distance that they can be individually distinguished by the naked eye. This increases the complexity and visual impact of the design. Within each such region (which appears continuous and unbroken, to the naked eye), the third layer 24 can be applied in a contiguous, all-over layer, or could be applied as a screened working - that is, an array of spaced screen elements. The dimensions of such a screen are typically sufficiently small that the elements cannot be individually distinguished by the naked eye, and the region appears as if the layer is continuous. Nonetheless, this can be used to make the device semi-transparent since light can be transmitted through the screen.

[0076] Similar materials may be used for layers 22 and 24, for example they may be both etch resists. Layer 22 in region R1 may be colour tinted but preferably it is not to contrast with the colour of layer 24 region R5. As shown in Figures 8h-8j, layers 22 and 24 do not follow the relief structure at the outermost surface i.e. the outer surface is flat.

[0077] In order to achieve a high degree of control over the arrangement of the third layer 24, the material is preferably laid down using a printing technique such as gravure printing. However, other application techniques such as coating, deposition or transfer methods could be used as appropriate. In this example, the third layer 24 includes an optically effective substance such as a colorant typically in the form of a dye or pigment (a dye is preferred in order to preserve the optical clarity of the layer). Various different types of colorant may be used which may or may not be visible to the human eye under normal illumination conditions. For example, the colorant could be visible or detectable only under selected non-visible radiation wavelength such as ultraviolet or infrared. However, in the most preferred embodiments, the colorant is visible under ambient white light and imparts a coloured tint to the layer 24, e.g. red, blue, green etc.

[0078] If desired, a multi-coloured arrangement of transparent materials containing different colorants could be used to form the layer 24. For example, one half of the layer 24 may appear red, whilst the other laterally offset half may appear blue, resulting in a visible pattern. In some cases, the entire layer 24 may have the same visible colour, with selected portions thereof additionally carrying a UV or IR active substance. The different colours could be arranged in any desired pattern, e.g. defining indicia, or different colours could be used to highlight different regions of the optically variable area. Some individual areas of layer 24 could contain no optically effective substance. Patterned arrangements such as this can be achieved by laying down two or more transparent materials, at least one containing an optically effective substance, in registration with one another in accordance with the desired design, e.g. by printing.

[0079] Any of the optically effective substances may if desired be responsive to nonoptical stimuli such as temperature, pressure, strain, electrical potential or any combination thereof. For instance, the substance could be thermochromic, piezochromic or electrochromic, undergoing a change in appearance as the relevant parameter changes. In this case, the optically effective substance may only be visible or detectable under certain stimulus conditions (e.g. within a certain temperature range).

[0080] The colorant or other optically effective substance is dispersed within a clear material to make up layer 24, such as a polymeric binder or resin. Suitable examples include vinyl resins such as UCAR™ VMCA Solution Vinyl Resin or UCAR™ VCMH Solution Vinyl Resin, both of which are supplied by The Dow Chemical Company and which are carboxy-functional terpolymers comprised of vinyl chloride, vinyl acetate and maleic acid. Most preferably, the material forming layer 24 is suitable for acting as a etch resist, with the layer 24 protecting the reflection enhancing layer 52 during a subsequent etching step shown in Figure 8j, in which those regions of the reflection enhancing layer 52 which are not covered by the third layer 24 are removed. Where the reflection enhancing layer 52 is a metal, typically this removal step is achieved by immersing the structure in an etchant solution which dissolves or otherwise removes the uncovered metal. For example, where the reflection enhancing layer is aluminium, sodium hydroxide can be used as the etchant. Where the reflective layer is copper, an acidic etchant is typically used, such as (i) a mixture of Hydrochloric acid 50%v and Ferric chloride (40 Baume) 50%v, at room temperature; or (ii) a mixture of Sulphuric acid (66 Baume) 5-10%v and Ferrous sulphate 100g/litre, at 40 to 60 degrees C. Other etchants may also be used such as nitric acid but generally the above systems are the most convenient to work with. The exemplary materials mentioned above for forming the third transparent layer 24 (UCAR™ VMCA and UCAR™ VMCH) are suitable etch resists for both of these etch systems. In order to fully protect the reflection enhancing layer 52, the third transparent layer 24 preferably has a thickness of t_z the order of 0.5 to 5 microns, more preferably 1 to 2 microns. However, the thickness required will depend on the selected materials and etchant.

[0081] Other techniques such as laser ablation or (reactive) ion etching could be used to remove the uncovered material of the reflection enhancing layer 52 and these may be particularly preferred where the layer is not solely a metal or alloy layer, such as metallic ink or an interference layer structure as mentioned above. In each case the second transparent layer would still be used to define the bounds of the area in which the layer is removed. Where the reflection enhancing layer 52 is an interference thin film structure (e.g. metal/dielectric/metal), etching techniques may be used for removal in the same manner as a metal reflective layer. In this case, not all the layers of the interference thin film structure may be removed by the etching.

[0082] Advantageously, the resulting device 10'" of Figure 8j viewed by observer A may therefore display a first, coloured, holographic region (left hand side, R_1=R_3), as dictated by the colour of the colour tinted layer 3, in register with a metallic holographic region (right hand side, R_5). On the reverse side, when viewed by observed B, the device 10'" presents a second coloured holographic region (right hand side, R_5), as dictated by the colour of the third layer 24, in register with a metallic holographic region (left hand side, R_1=R_3). This further increases the security of the device since such an effect is difficult to reproduce by counterfeiters.

[0083] The method depicted by Figures 9a to 9k depicts an alternative method to the method of Figures 8a to 8j described above for producing a device 10"" with optical effects displayed in front and back colours in register with opposing metallic regions. The steps of Figures 9a, 9b, 9c respectively correspond to those of steps 5a, 5b, 5c and 8a,8b,8c described above. The method depicted in Figures 9a to 9k differs from the method of Figures 8a to 8j in that the first and second relief structures 43, 44 (on the left and right hand side of the device respectively) are formed in separate relief forming stages, in Figures 9d and 9h, respectively. In the example of Figures 8a to 8j, the second relief structure 42 is formed into layer 2b and a third layer 24, typically an alkali resist layer, is subsequently applied and serves to protect the reflection enhancing material 52 from being removed (e.g. etched) by a second removal step (i.e. demetallisation) as described with reference to Figure 8j.

[0084] As shown in Figure 9g, the second layer 22' (which is at least partially translucent or transparent) is applied throughout all regions of the device 10'''. In this example, layer 22' is a thermoformable layer (rather than an alkali resist layer as described with reference to Figures 8h to 8j above). The thermoformable layer 22' can be formed with a second relief structure 44 (Figure 9h) at temperature and pressure sufficiently below that of the coloured tinted layer 3, that the relief 43 previously formed into the coloured tinted layer 3 is not degraded.

[0085] Preferably, a post cure process applied (Figure 9h) to either the coloured tinted layer 3 after forming the second relief structure 44 the thus elevating its softening temperature to a value where it is not impacted by the first forming of the relief structure 43 (i.e. first embossing phase in Figure 9e). Alternatively, a post cure process may be applied after forming the second relief structure 44 (i.e. the embossing of the layer 22') such that in its pre cure phase it has a much lower softening temperature than the colour tinted layer 3 and can be 'soft embossed' and then cured to a more durable state.

[0086] A UV curable layer 22' may be applied as a viscous liquid coating or film of monomer which is contacted by an image forming die or roller. The surface relief is cast into the film by the simultaneous or near simultaneous exposure of the layer 22' to radiation (e.g. UV radiation), causing polymerisation. UV curable polymers employing free radical or cationic UV polymerisation are suitable for the UV casting process. Examples of free radical systems include photo-crosslinkable acrylate-methacrylate or aromatic vinyl oligomeric resins. Examples of cationic systems include cycloaliphatic epoxides. Hybrid polymer systems can also be employed combining both free radical and cationic UV polymerization. Cast cure processes such as this are particularly preferred where the substrate has a relatively low glass transition or softening temperature, e.g. biaxially orientated polypropylene (BOPP) which softens at temperatures around 85°C. Structures embossed into such materials may be vulnerable to damage should the device encounter high temperatures during circulation.

[0087] As shown in Figure 9i, a second reflection enhancing layer 5 is applied, preferably by vacuum metallisation as described above. It will be appreciated that the second reflection enhancing layer 5 may comprise a metal which is may different than the metal applied in the previous step metallisation step (of Figure 9e). The second reflection enhancing layer 5 follows the relief structure 44 and is typically 10-30 nm thick.

[0088] Figure 9j, a further layer 26 which is transparent or semi-transparent is applied to protect the reflection enhancing layer 53 above relief structure 44. As with layer 24 described with reference to Figures 8i and 8j, layer 26 is suitable for acting as an etch resist, protecting the second reflection enhancing layer 5 (applied in the step of Figure 9i) during a subsequent etching step shown in Figure 9k, in which those regions of the reflection enhancing layer 5 which are not covered by layer 26 are removed. Preferably, layer 26 is tinted with a colour different to the colour of the formable material applied previously (in the step of Figure 9c) so that the device advantageously displays different colours on the left hand side of the device compared to the right hand side. The thickness of layer 26 is 0.5-5 microns and preferably 1-2 microns.

[0089] Figure 10 is a plan view of a security article 1' comprising at least two holograms formed by including relief structures in at least two regions, according to Figures 8j or 9k described above. The device has multiple regions (R_1=R_3) displaying a metallic silver appearance to an observer B due to an applied Al layer representing a reflection enhancing material described above. To an observer A, regions R_1=R_3 appear metallic yellow due to the formable material in regions being yellow tinted in this example. The device has an additional region R_4 or R_5 as referred to above according to Figures 8j or 9k which appear metallic silver (due to the Al layer) from viewpoint A and purple, for example, from viewpoint B. Numeral 50 indicates a region where there is no metal is formed by patterning of the metallisation layer in region R_4 or R_5. For example, in the method described with reference to Figure 8, a pattern defining substance 6 may be applied in the shape indicated by shape 50 in the middle of region R_4. Alternatively, in the method described with reference to Figure 9, shape 50 may be achieve by patterning the coloured resist layer 26 in region R_5.

[0090] Figures 11, 12 and 13 depict examples of security documents in which security devices of the sorts described above have been incorporated. Figure 11 shows a first exemplary security document, here a banknote 140, in (a) plan view and (b) cross-section along line XX'. Here, the banknote 140 is a polymer banknote, comprising an internal transparent polymer substrate 142 which is coated on each side with opacifying layers 143a and 143b in a conventional manner. In some cases, the opacifying layers may be provided on one side of the substrate 142 only. The opacifying layers 143a and 143b are omitted in a region of the document so as to define a window 141, here having a square shape. Within the window region 141 is located a security device 120 in accordance with any of the embodiments discussed above. The outer perimeter of the device 120 is denoted by the dashed circular line surrounding the "sun shaped" optically variable effect region. The security device 120 may be formed integrally in the banknote 140 with the relief structure 122 being formed directly in the surface of transparent substrate 142. Alternatively, the security device 120 may have been formed separately as a security article such as a transfer patch or label.. In this case, the security device 120 may be affixed to the transparent substrate 142 inside the window region 141 by means of the transparent adhesive 125. Application may be achieved by a hot or cold transfer method e.g. hot stamping.

[0091] It should be noted that a similar construction could be achieved using a paper/plastic composite banknote in which the opacifying layers 143a and 143b are replaced by paper layers laminated (with or without adhesive) to an internal transparent polymer layer 142. The paper layers may be omitted from the window region from the outset, or the paper could be removed locally after lamination. In other constructions, the order of the layers may be reversed with a (windowed) paper layer on the inside and transparent polymer layers on the outside.

[0092] In Figure 12, the banknote 140 is of conventional construction having a substrate 144 formed for example of paper or other relatively opaque or translucent material. The window region 41 is formed as an aperture through the substrate 144. The security device 120 is applied as a patch overlapping the edges of window 141 utilising transparent adhesive 125 to join the security article to the document substrate 144. Again, the application of the security device and document could be achieved using various methods including hot stamping.

[0093] Figure 13 depicts a third example of a security document, again a banknote 140, to which a security article 150 in the form of a security thread or security strip has been applied. Three security devices 20 each carried on the strip 150 are revealed through windows 141, arranged in a line on the document 140. Two alternative constructions of the document are shown in cross-section in Figures 13b and 13c. Figure 13b depicts the security thread or strip 150 incorporated within the security document 140. For example, the security thread or strip 50 may be incorporated within the substrate's structure during the paper making process using well known techniques. To form the windows 141, the paper may be removed locally after completion of the paper making process, e.g. by abrasion. Alternatively, the paper making process could be designed so as to omit paper in the desired window regions. Figure 13c shows an alternative arrangement in which the security thread or strip 150 carrying the security device 120 is applied to one side of document substrate 145, e.g. using adhesive. The windows 141 are formed by provision of apertures in the substrate 145, which may exist prior to the application of strip 150 or be formed afterwards, again for example by abrasion.

[0094] Many alternative techniques for incorporating security documents of the sorts discussed above are known and could be used. For example, the above described device structures could be formed directly on other types of security document including identification cards, driving licenses, bankcards and other laminate structures, in which case the security device may be incorporated directly within the multilayer structure of the document.

Claims

1. A method of manufacturing a security device (10), comprising:

   (a) providing a first layer (2b) comprising at least a partially translucent or transparent region;
   (b) applying (S101) pattern defining substance (6) on a surface of the first transparent layer, excluding at least one first region (R1) on the surface of the first layer aligned with the at least a partially translucent or transparent region;
   (c) applying (S102) a formable material (3) to a second region (R2) of the first surface, wherein the second region overlaps at least part of the at least one first region, the overlapping portions of the first and second regions respectively defining at least one third region (R3);
   then performing the steps (d) and (e) in any order:
   (d) forming (S103) the formable material in the at least one third region such that its surface distal from the first layer follows the contours of a first optically variable effect generating relief structure (4) in the at least one first region; and
   (e) applying (S104) a first reflection enhancing material (5) over the formable material to form a reflection enhancing layer which follows the contour of the relief structure;
   wherein the pattern defining substance impedes the retention, in areas to which the pattern defining substance was applied, of the formable material and any overlaying reflection enhancing material.

2. A method according to claim 1, further comprising, after step (e), the step of:
   (f) removing the formable material (3) and any reflection enhancing material (5) overlaying the formable material from regions of the device in which the pattern defining substance was applied.

3. A method according to claim 1 or claim 2, wherein the pattern defining substance (6) comprises a soluble mask which can be dissolved by application of a solvent, thereby impeding adhesion of the formable material to the first layer.

4. A method according to claim 3, wherein the formable material (3) comprises a material permeable to the solvent.

5. A method according to any preceding claim, wherein in step (c), the formable material (3) is applied in a pattern to form a screen.

6. A method according to any of the preceding claims, wherein in steps (b), (c), and/or (e), the respective pattern defining substance (6), formable material (3), and first reflection enhancing layer (5) are applied in register with one another and preferably in register with the relief structure (4) formed in step (d).

7. A method according to any of any of the preceding claims, wherein the formable material (3) comprises one or more optically effective substance(s) which impart to the formable material a visible coloured tint of a first colour.

8. A method according to any of the preceding claims, wherein, in step (e), the reflection enhancing material (5) is applied in a continuous layer over the relief structure.

9. A method according to any of the preceding claims, wherein the first reflection enhancing material (5) comprises any of:

   - one or more metals or alloys thereof preferably copper and/or aluminium;
   - an optical interference thin film structure;
   - a layer containing metallic particles, optically variable particles or optically variable magnetic particles;
   - a photonic crystal layer; or

• a liquid crystal layer.

10. A method according to any of the preceding claims, wherein the first (R1) and/or third (R3) regions define respective indicia such as a character, number, letter, alphanumerical text, symbol, graphic element or the like, preferably being different.

11. A method according to any of the preceding claims, wherein the first layer (2b) is a formable layer and wherein in step (d), forming the formable material (3) comprises forming, in the at least one third region, the surface of the underlying first layer to which the formable material is applied, such that it follows, at least in part, the contours of the first optically variable effect generating relief structure (4), wherein step (d) further comprises forming the surface of the first layer in at least one fourth region (R4) separate from the at least one third region and in which the formable material is not applied, such that it follows the contours of a second optically variable effect generating relief structure.

12. A method according to claim 11, further comprising the steps of:
(f1) removing the formable material (3) and any residual reflection enhancing material overlaying the formable material in areas in which the pattern defining substance (6) was applied;

providing, in register with the retained formable material, a second layer which is at least partially translucent or transparent; and
providing, in register with the second relief structure, a third layer (24) which is at least partially translucent or transparent, wherein the third layer comprises one or more optically effective substances which impart a coloured tint to the third layer, which colour is preferably different from the colour of the formable material.

13. A method according to any of claims 1 to 11, further comprising the steps of:
(f2) removing the formable material and any residual reflection enhancing material overlaying the formable material in areas in which the pattern defining substance (6) was applied;

applying a fourth layer comprising a thermoplastic polymer or a curable polymer, preferably a UV-curable polymer, the fourth layer being at least partially translucent or transparent;
forming the surface of the first layer (2b) in a fifth region separate from the third region on the surface of the first layer aligned with the at least a partially translucent or transparent region and in which the formable material (3) is not applied, such that it follows the contours of a third optically variable effect generating relief structure;
applying a second reflection enhancing material (5) over the fourth layer to form a reflection enhancing layer which follows the contours of the third relief structure; and
providing, in register with the third relief structure, a fifth layer which is at least a partially translucent or transparent, wherein the fifth layer comprises one or more optically effective substances which impart a coloured tint to the fifth transparent layer, which colour is preferably different from the colour of the formable material (3).

14. A security device (10) made in accordance with any of the preceding claims.

15. A security document (1) comprising a security device (10) according to claim 14 wherein the security device is formed in a window (11) of a polymer or paper substrate.

Patentansprüche

1. Verfahren zum Fertigen einer Sicherheitsvorrichtung (10), das Folgendes umfasst:

(a) Bereitstellen einer ersten Schicht (2b), die wenigstens einen teilweise durchscheinenden oder transparenten Bereich umfasst;
(b) Aufbringen (S101) einer musterdefinierenden Substanz (6) auf eine Oberfläche der ersten transparenten Schicht, ausschließlich wenigstens eines ersten Bereichs (R1) auf der Oberfläche der ersten Schicht, die an dem wenigstens einen teilweise durchscheinenden oder transparenten Bereich ausgerichtet ist;
(c) Aufbringen (S102) eines ausbildbaren Materials (3) auf einen zweiten Bereich (R2) der ersten Oberfläche, wobei der zweite Bereich wenigstens einen Teil des wenigstens einen ersten Bereichs überlappt, wobei die überlappenden Abschnitte des ersten beziehungsweise des zweiten Bereichs wenigstens einen dritten Bereich (R3) definieren;
danach Durchführen der Schritte (d) und (e) in beliebiger Reihenfolge:
(d) Ausbilden (S103) des ausbildbaren Materials in dem wenigstens einen dritten Bereich, derart, dass seine Oberfläche von der ersten Schicht den Konturen eines ersten optisch variablen Effekts distal folgt, der eine Reliefstruktur (4) in dem wenigstens einen ersten Bereich erzeugt; und
(e) Aufbringen (S104) eines ersten reflexionsverstärkenden Materials (5) über dem ausbildbaren Material, um eine reflexionsverstärkende

Schicht auszubilden, die der Kontur der Reliefstruktur folgt;
wobei die musterdefinierende Substanz das Zurückhalten in Flächen, auf die die musterdefinierende Substanz aufgebracht wurde, des ausbildbaren Materials und eines beliebigen überlagernden reflexionsverstärkenden Materials behindert.

2. Verfahren nach Anspruch 1, das, nach Schritt (e), ferner den folgenden Schritt umfasst:
(f) Entfernen des ausbildbaren Materials (3) und des beliebigen reflexionsverstärkenden Materials (5), das das ausbildbare Material überlagert, von Bereichen der Vorrichtung, in denen die musterdefinierende Substanz aufgebracht wurde.

3. Verfahren nach Anspruch 1 oder 2, wobei die musterdefinierende Substanz (6) eine lösliche Maske umfasst, die durch Aufbringen eines Lösungsmittels aufgelöst werden kann, wobei dadurch eine Haftung des ausbildbaren Materials an der ersten Schicht behindert wird.

4. Verfahren nach Anspruch 3, wobei das ausbildbare Material (3) ein für das Lösungsmittel durchlässiges Material umfasst.

5. Verfahren nach einem der vorhergehenden Ansprüche, wobei in Schritt (c) das ausbildbare Material (3) in einem Muster aufgebracht wird, um ein Sieb auszubilden.

6. Verfahren nach einem der vorhergehenden Ansprüche, wobei in den Schritten (b), (c) und/oder (e) die jeweilige musterdefinierende Substanz (6), das ausbildbare Material (3) und die erste reflexionsverstärkende Schicht (5) passgerecht zueinander und vorzugsweise passgerecht mit der in Schritt (d) ausgebildeten Reliefstruktur (4) aufgebracht werden.

7. Verfahren nach einem der vorhergehenden Ansprüche, wobei das ausbildbare Material (3) eine oder mehrere optisch wirksame Substanz(en) umfasst, die dem ausbildbaren Material eine sichtbare Farbtönung einer ersten Farbe verleihen.

8. Verfahren nach einem der vorhergehenden Ansprüche, wobei in Schritt (e) das reflexionsverstärkende Material (5) in einer fortlaufenden Schicht über der Reliefstruktur aufgebracht wird.

9. Verfahren nach einem der vorhergehenden Ansprüche, wobei das erste reflexionsverstärkende Material (5) ein Beliebiges der Folgenden umfasst:

- ein oder mehrere Metalle oder Legierungen davon, vorzugsweise Kupfer und/oder Aluminium;
- eine optische Interferenzdünnfilmstruktur;
- eine Schicht, die metallische Partikel, optisch variable Partikel oder optisch variable magnetische Partikel enthält;
- eine photonische Kristallschicht; oder
- eine Flüssigkristallschicht.

10. Verfahren nach einem der vorhergehenden Ansprüche, wobei der erste (R1) und/oder der dritte (R3) Bereich jeweilige Zeichen wie ein Schriftzeichen, eine Zahl, einen Buchstaben, einen alphanumerischen Text, ein Symbol, ein grafisches Element oder dergleichen definieren, die vorzugsweise unterschiedlich sind.

11. Verfahren nach einem der vorhergehenden Ansprüche, wobei die erste Schicht (2b) eine ausbildbare Schicht ist und wobei in Schritt (d) das Ausbilden des ausbildbaren Materials (3) das Ausbilden, in dem wenigstens einen dritten Bereich, der Oberfläche der darunterliegenden ersten Schicht umfasst, auf die das ausbildbare Material derart aufgebracht wird, dass es, wenigstens zum Teil, den Konturen des ersten optisch variablen Effekts folgt, der die Reliefstruktur (4) erzeugt, wobei Schritt (d) ferner das Ausbilden der Oberfläche der ersten Schicht in wenigstens einem vierten Bereich (R4) umfasst, der von dem wenigstens einen dritten Bereich getrennt ist und in dem das ausbildbare Material nicht derart aufgebracht ist, dass es den Konturen eines zweiten optisch variablen Effekts folgt, der die Reliefstruktur erzeugt.

12. Verfahren nach Anspruch 11, das ferner die folgenden Schritte umfasst:
(f1) Entfernen des ausbildbaren Materials (3) und des beliebigen restlichen reflexionsverstärkenden Materials, das das ausbildbare Material in Flächen überlagert, in denen die musterdefinierende Substanz (6) aufgebracht wurde;

Bereitstellen, passgerecht mit dem zurückgehaltenen ausbildbaren Material, einer zweiten Schicht, die wenigstens teilweise durchscheinend oder transparent ist; und
Bereitstellen, passgerecht mit der zweiten Reliefstruktur, einer dritten Schicht (24), die wenigstens teilweise durchscheinend oder transparent ist, wobei die dritte Schicht eine oder mehrere optisch wirksame Substanzen umfasst, die der dritten Schicht eine Farbtönung verleihen, deren Farbe vorzugsweise unterschiedlich von der Farbe des ausbildbaren Materials ist.

13. Verfahren nach einem der Ansprüche 1 bis 11, das ferner die folgenden Schritte umfasst:
(f2) Entfernen des ausbildbaren Materials und des

beliebigen restlichen reflexionsverstärkenden Materials, das das ausbildbare Material in Flächen überlagert, in denen die musterdefinierende Substanz (6) aufgebracht wurde;

Aufbringen einer vierten Schicht, die ein thermoplastisches Polymer oder ein härtbares Polymer, vorzugsweise ein UV-härtbares Polymer, umfasst, wobei die vierte Schicht wenigstens teilweise durchscheinend oder transparent ist;
Ausbilden der Oberfläche der ersten Schicht (2b) in einen fünften Bereich, der von dem dritten Bereich auf der Oberfläche der ersten Schicht getrennt ist, die an dem wenigstens einen teilweise durchscheinenden oder transparenten Bereich ausgerichtet ist und in dem das ausbildbare Material (3) nicht derart aufgebracht wird, dass es den Konturen eines dritten optisch variablen Effekts folgt, der die Reliefstruktur erzeugt;
Aufbringen eines zweiten reflexionsverstärkenden Materials (5) über der vierten Schicht, um eine reflexionsverstärkende Schicht auszubilden, die den Konturen der dritten Reliefstruktur folgt; und
Bereitstellen, passgerecht mit der dritten Reliefstruktur, einer fünften Schicht, die wenigstens eine teilweise durchscheinende oder transparente ist, wobei die fünfte Schicht eine oder mehrere optisch wirksame Substanzen umfasst, die der fünften transparenten Schicht eine Farbtönung verleihen, deren Farbe vorzugsweise unterschiedlich von der Farbe des ausbildbaren Materials (3) ist.

14. Sicherheitsvorrichtung (10), die nach einem der vorhergehenden Ansprüche hergestellt wird.

15. Sicherheitsdokument (1), das eine Sicherheitsvorrichtung (10) nach Anspruch 14 umfasst, wobei die Sicherheitsvorrichtung in einem Fenster (11) eines Polymer- oder eines Papiersubstrats ausgebildet ist.

Revendications

1. Procédé de fabrication d'un dispositif de sécurité (10), comprenant :

(a) la fourniture d'une première couche (2b) comprenant au moins une région partiellement translucide ou transparente ;
(b) l'application (S101) d'une substance définissant un motif (6) sur une surface de la première couche transparente, excluant au moins une première région (R1) sur la surface de la première couche alignée avec l'au moins une région partiellement translucide ou transparente ;
(c) l'application (S102) d'un matériau formable (3) à une deuxième région (R2) de la première surface, dans lequel la deuxième région chevauche au moins une partie d'au moins une première région, les parties chevauchantes des première et deuxième régions définissant respectivement au moins une troisième région (R3) ;
puis le fait d'effectuer les étapes (d) et (e) dans n'importe quel ordre :
(d) la formation (S103) du matériau formable dans l'au moins une troisième région de telle sorte que sa surface distale par rapport à la première couche suit les contours d'une première structure en relief générant un effet optiquement variable (4) dans l'au moins une première région ; et
(e) l'application (S104) d'un premier matériau d'amélioration de réflexion (5) sur le matériau formable pour former une couche d'amélioration de réflexion qui suit le contour de la structure en relief ;
dans lequel la substance définissant le motif empêche la rétention, dans les zones auxquelles la substance définissant le motif a été appliquée, du matériau formable et de tout matériau d'amélioration de réflexion superposé.

2. Procédé selon la revendication 1, comprenant en outre, après l'étape (e), l'étape consistant à :
(f) retirer le matériau formable (3) et tout matériau d'amélioration de réflexion (5) recouvrant le matériau formable des régions du dispositif dans lesquelles la substance définissant le motif a été appliquée.

3. Procédé selon la revendication 1 ou la revendication 2, dans lequel la substance définissant le motif (6) comprend un masque soluble qui peut être dissous par application d'un solvant, empêchant ainsi l'adhérence du matériau formable à la première couche.

4. Procédé selon la revendication 3, dans lequel le matériau formable (3) comprend un matériau perméable au solvant.

5. Procédé selon l'une quelconque des revendications précédentes, dans lequel à l'étape (c), le matériau formable (3) est appliqué selon un motif pour former un écran.

6. Procédé selon l'une quelconque des revendications précédentes, dans lequel dans les étapes (b), (c) et/ou (e), la substance respective définissant le motif (6), le matériau formable (3) et la première couche d'amélioration de réflexion (5) sont appliqués en regard l'un de l'autre et de préférence en regard de la structure en relief (4) formée à l'étape (d).

7. Procédé selon l'une quelconque des revendications précédentes, dans lequel le matériau formable (3) comprend une ou plusieurs substances optiquement efficaces qui confèrent au matériau formable une teinte colorée visible d'une première couleur.

8. Procédé selon l'une quelconque des revendications précédentes, dans lequel, à l'étape (e), le matériau d'amélioration de réflexion (5) est appliqué en une couche continue sur la structure en relief.

9. Procédé selon l'une quelconque des revendications précédentes, dans lequel le premier matériau d'amélioration de réflexion (5) comprend l'un quelconque parmi :

- un ou plusieurs métaux ou alliages de ceux-ci, de préférence du cuivre et/ou de l'aluminium ;
- une structure de film mince à interférence optique ;
- une couche contenant des particules métalliques, des particules optiquement variables ou des particules magnétiques optiquement variables ;
- une couche de cristal photonique ; ou
- une couche de cristal liquide.

10. Procédé selon l'une quelconque des revendications précédentes, dans lequel les première (R1) et/ou troisième (R3) régions définissent des indices respectifs tels qu'un caractère, un nombre, une lettre, un texte alphanumérique, un symbole, un élément graphique ou similaire, étant de préférence différents.

11. Procédé selon l'une quelconque des revendications précédentes, dans lequel la première couche (2b) est une couche formable et dans lequel à l'étape (d), la formation du matériau formable (3) comprend la formation, dans l'au moins une troisième région, de la surface de la première couche sous-jacente à laquelle le matériau formable est appliqué, de telle sorte qu'elle suit, au moins en partie, les contours de la première structure en relief générant un effet optiquement variable (4), dans lequel l'étape (d) comprend en outre la formation de la surface de la première couche dans au moins une quatrième région (R4) séparée de l'au moins une troisième région et dans laquelle le matériau formable n'est pas appliqué, de telle sorte qu'il suit les contours d'une deuxième structure en relief générant un effet optiquement variable.

12. Procédé selon la revendication 11, comprenant en outre les étapes consistant à :
(f1) retirer le matériau formable (3) et tout matériau d'amélioration de réflexion résiduel recouvrant le matériau formable dans les zones dans lesquelles la substance définissant le motif (6) a été appliquée ;

fournir, en regard du matériau formable retenu, une deuxième couche qui est au moins partiellement translucide ou transparente ; et
fournir, en regard de la deuxième structure en relief, une troisième couche (24) qui est au moins partiellement translucide ou transparente, dans lequel la troisième couche comprend une ou plusieurs substances optiquement efficaces qui confèrent une teinte colorée à la troisième couche, laquelle couleur est de préférence différente de la couleur du matériau formable.

13. Procédé selon l'une quelconque des revendications 1 à 11, comprenant en outre les étapes consistant à :
(f2) retirer le matériau formable et tout matériau d'amélioration de réflexion résiduel recouvrant le matériau formable dans les zones dans lesquelles la substance définissant le motif (6) a été appliquée ;

appliquer une quatrième couche comprenant un polymère thermoplastique ou un polymère durcissable, de préférence un polymère durcissable aux UV, la quatrième couche étant au moins partiellement translucide ou transparente ;
former la surface de la première couche (2b) dans une cinquième région séparée de la troisième région sur la surface de la première couche alignée avec l'au moins une région partiellement translucide ou transparente et dans laquelle le matériau formable (3) n'est pas appliqué, de telle sorte qu'elle suit les contours d'une troisième structure en relief générant un effet optiquement variable ;
appliquer un second matériau d'amélioration de réflexion (5) sur la quatrième couche pour former une couche d'amélioration de réflexion qui suit les contours de la troisième structure en relief ; et
fournir, en regard de la troisième structure en relief, une cinquième couche qui est au moins partiellement translucide ou transparente, dans lequel la cinquième couche comprend une ou plusieurs substances optiquement efficaces qui confèrent une teinte colorée à la cinquième couche transparente, laquelle couleur est de préférence différente de la couleur du matériau formable (3).

14. Dispositif de sécurité (10) fabriqué selon l'une quelconque des revendications précédentes.

15. Document de sécurité (1) comprenant un dispositif de sécurité (10) selon la revendication 14, dans lequel le dispositif de sécurité est formé dans une fenêtre (11) d'un substrat en polymère ou en papier.

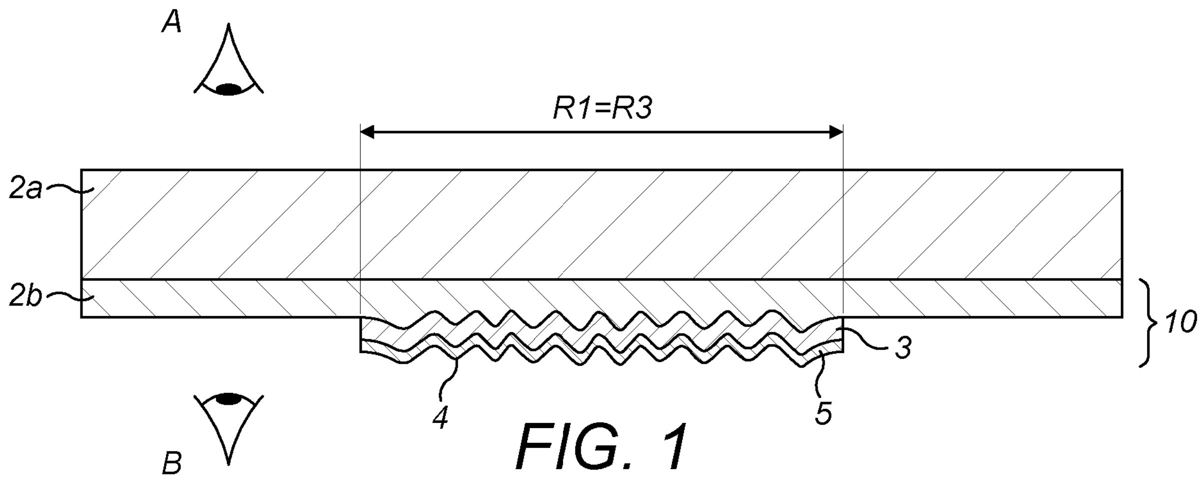

FIG. 1

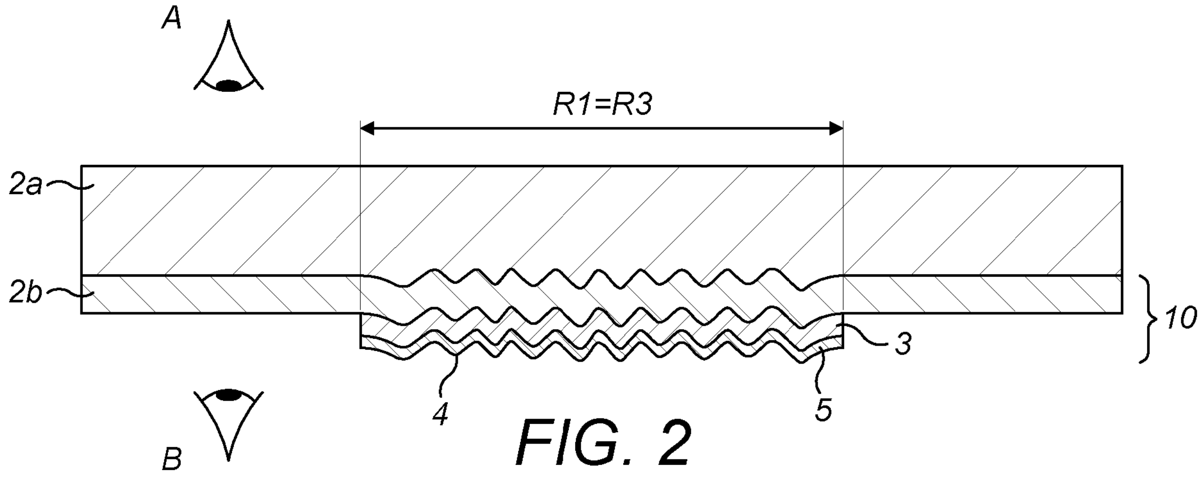

FIG. 2

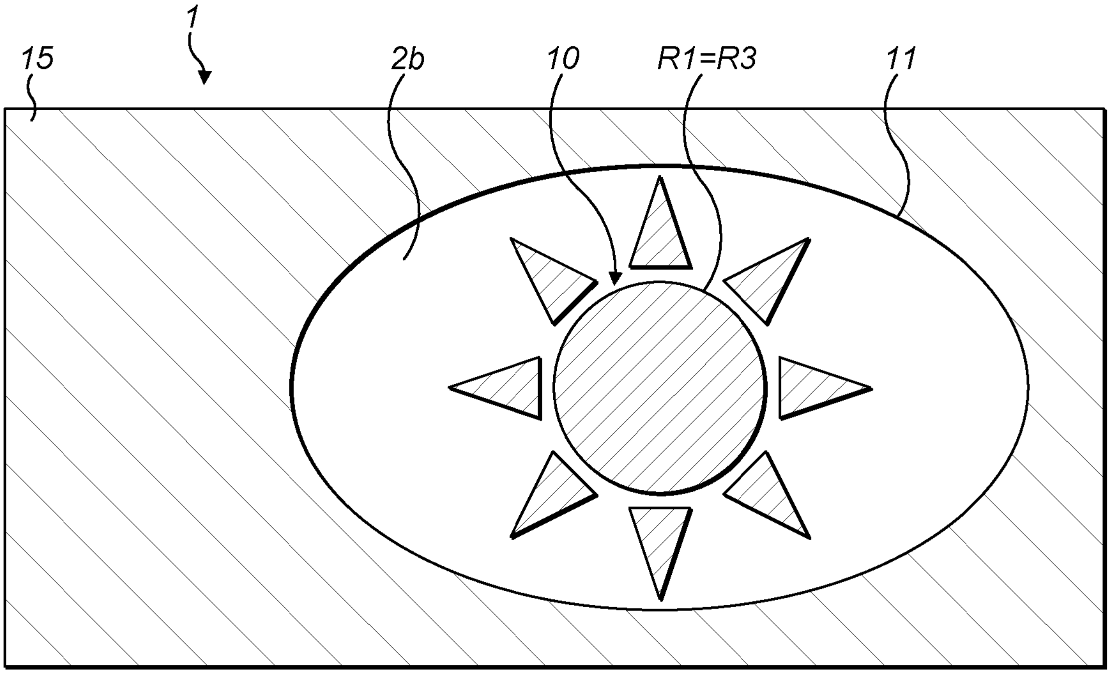
1
15
2b
10
R1=R3
11

FIG. 3

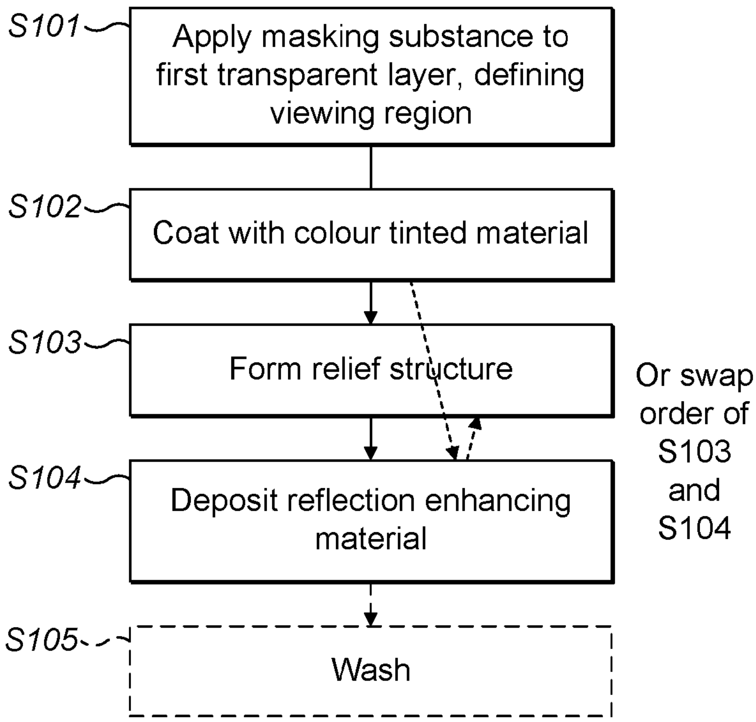
S101
Apply masking substance to first transparent layer, defining viewing region
S102
Coat with colour tinted material
S103
Form relief structure
S104
Deposit reflection enhancing material
S105
Wash
Or swap order of S103 and S104

FIG. 4

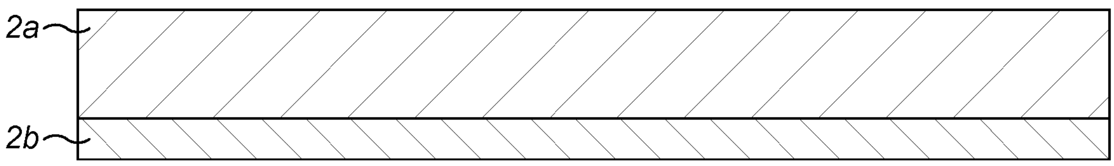

FIG. 5a

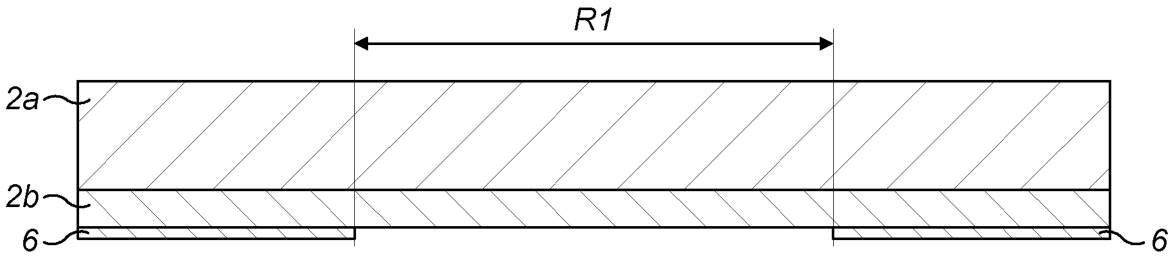

FIG. 5b

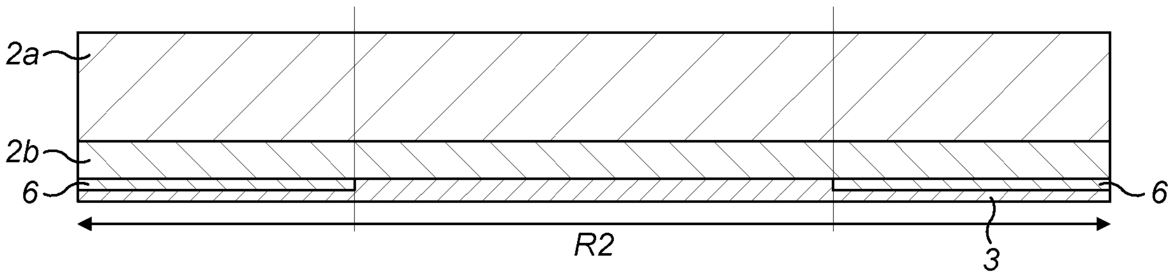

FIG. 5c

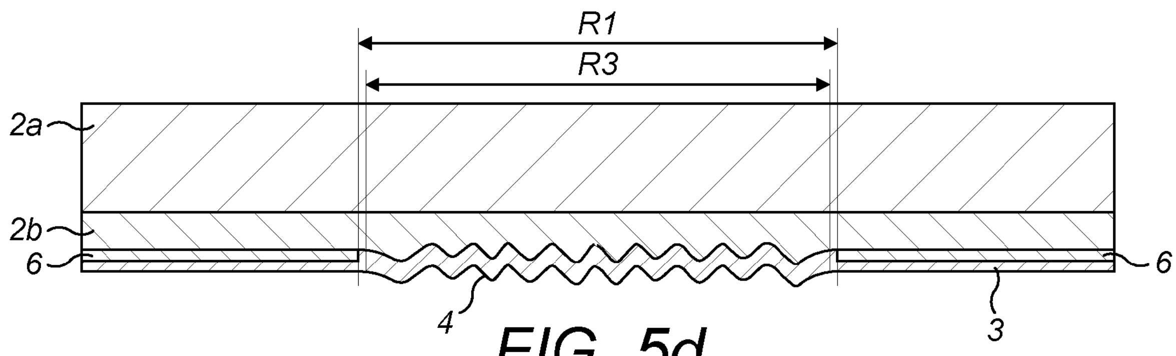

FIG. 5d

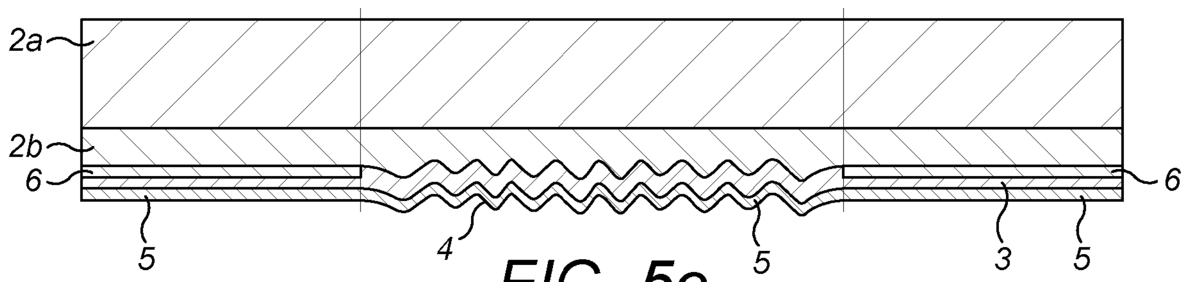

FIG. 5e

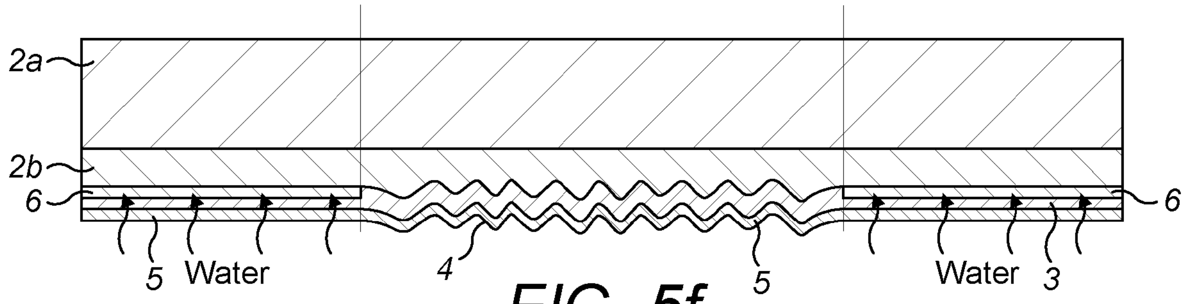

FIG. 5f

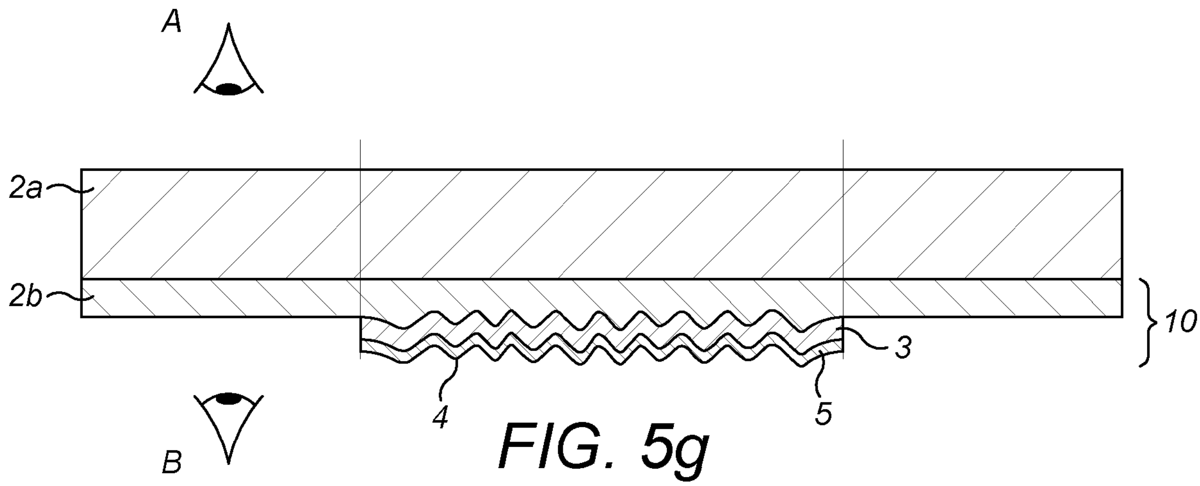

FIG. 5g

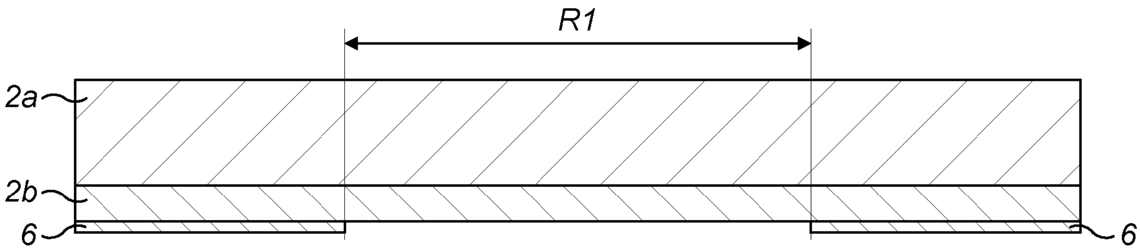

FIG. 6a

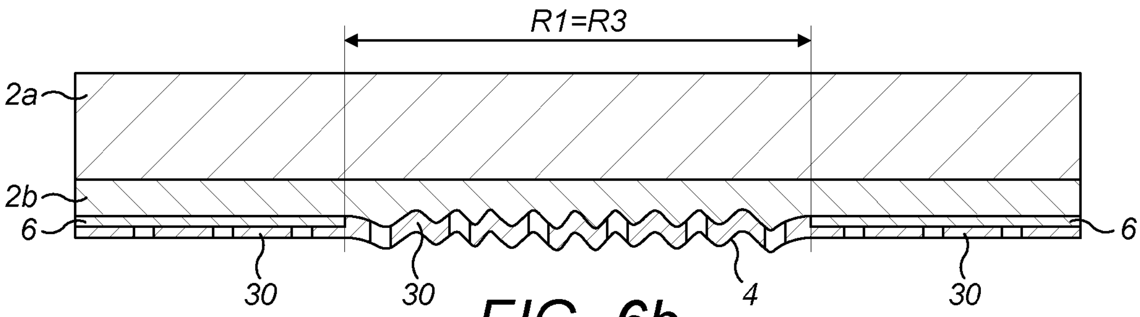

FIG. 6b

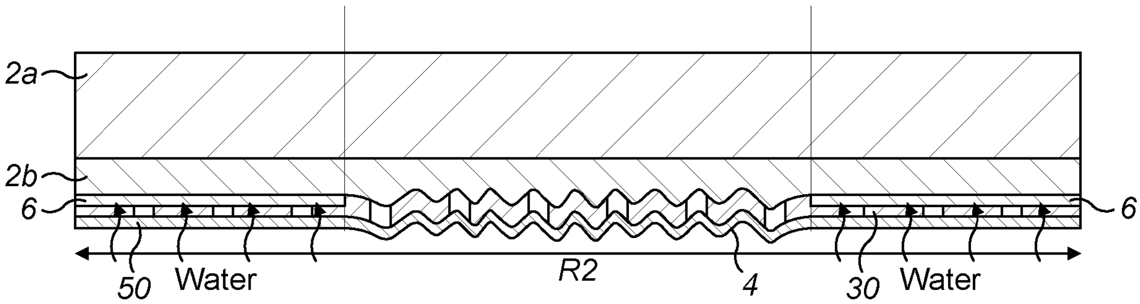

FIG. 6c

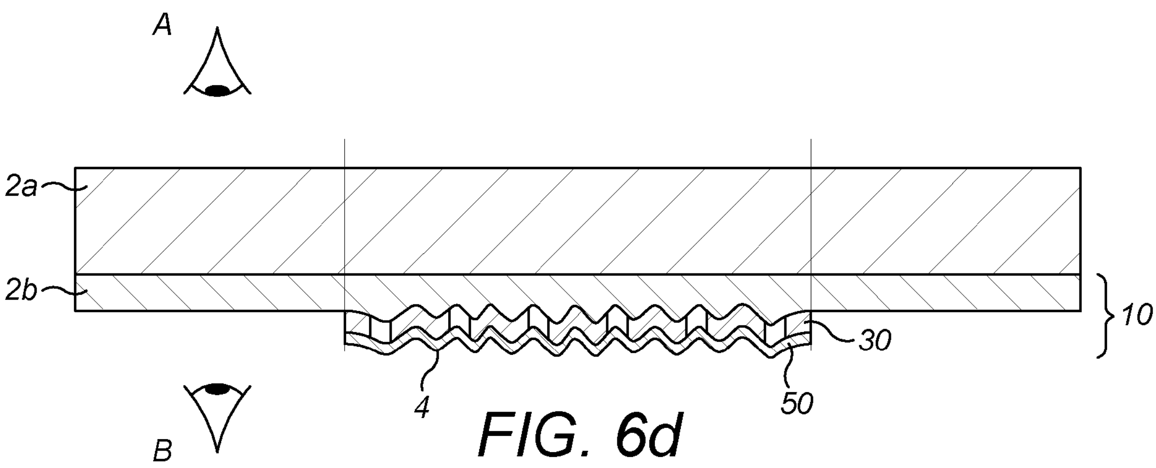

FIG. 6d

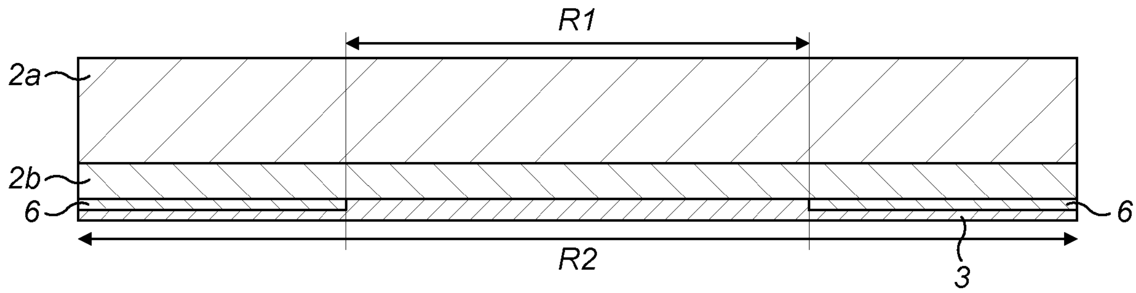

FIG. 7a

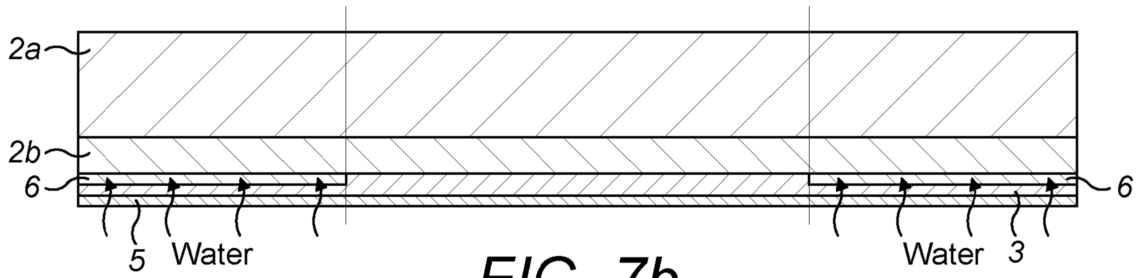

FIG. 7b

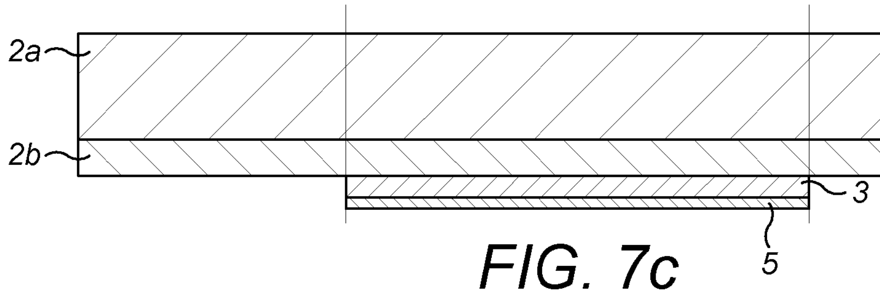

FIG. 7c

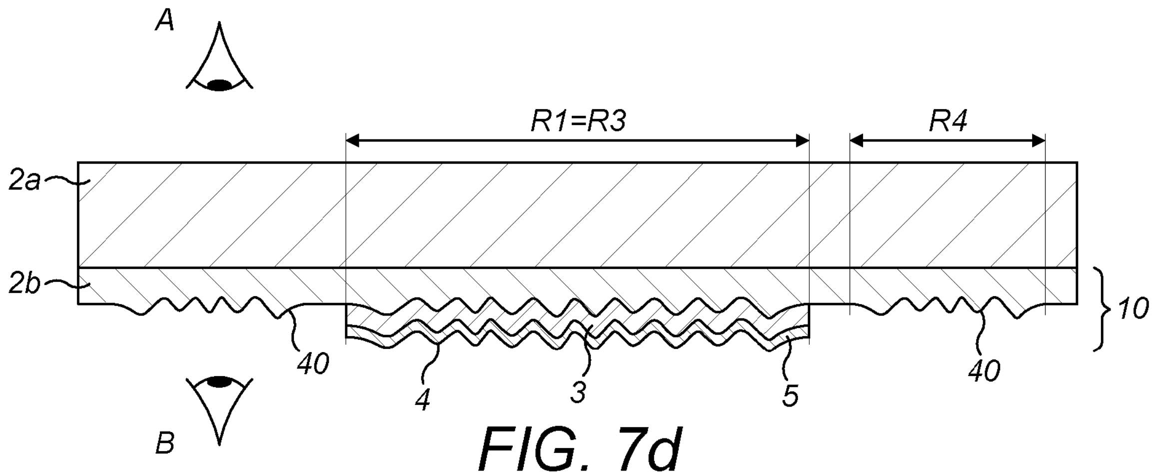

FIG. 7d

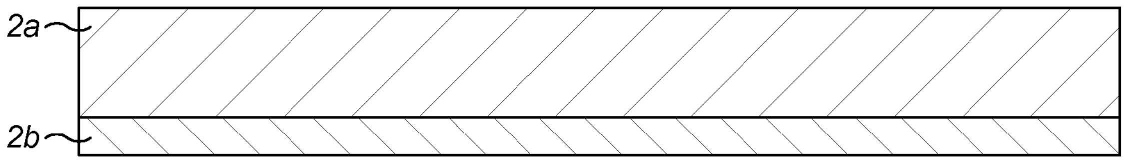

FIG. 8a

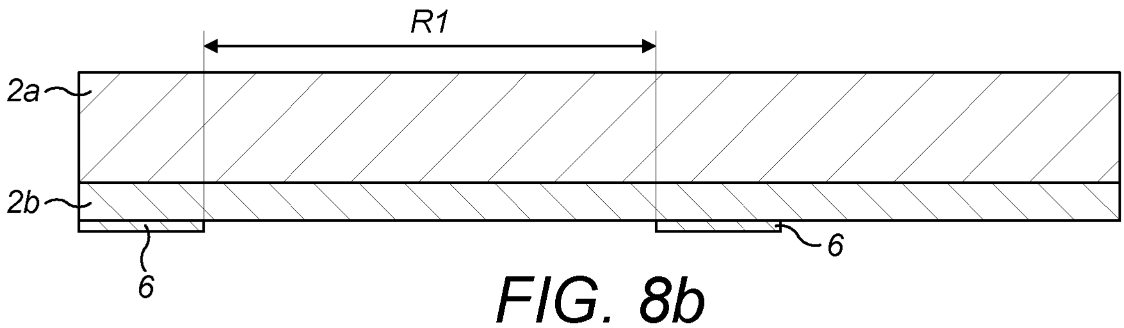

FIG. 8b

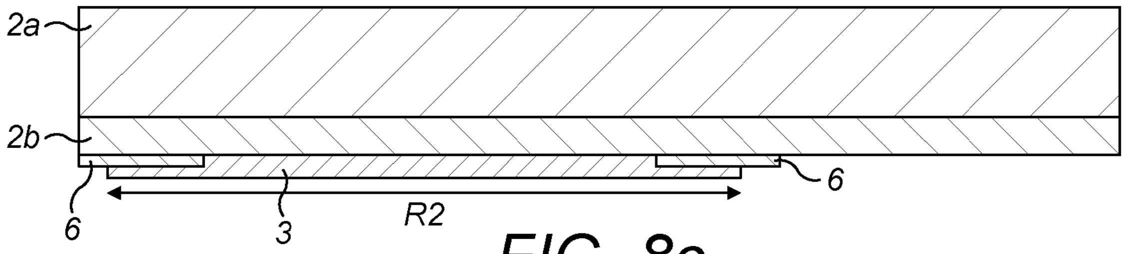

FIG. 8c

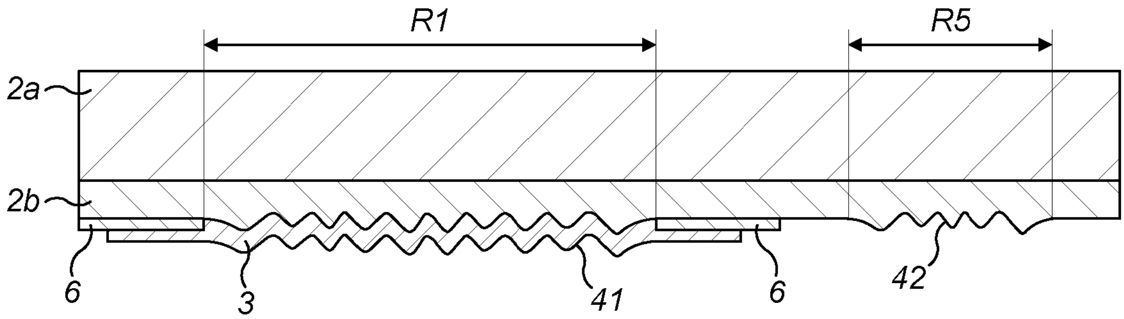

FIG. 8d

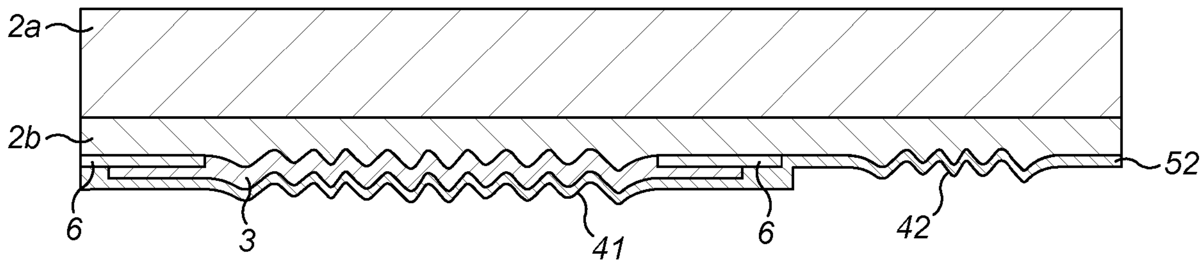

FIG. 8e

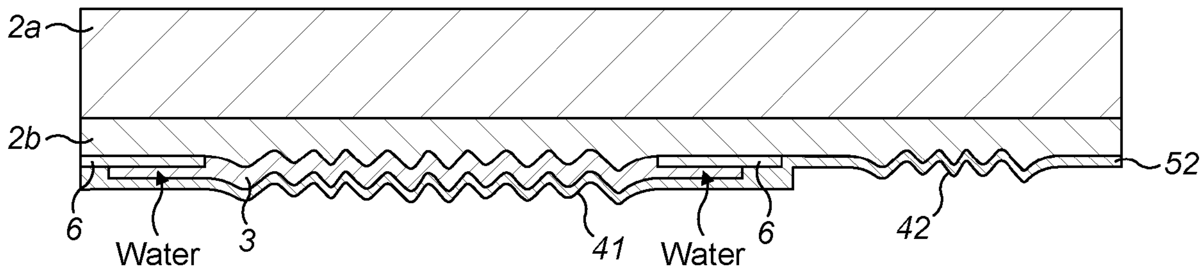

FIG. 8f

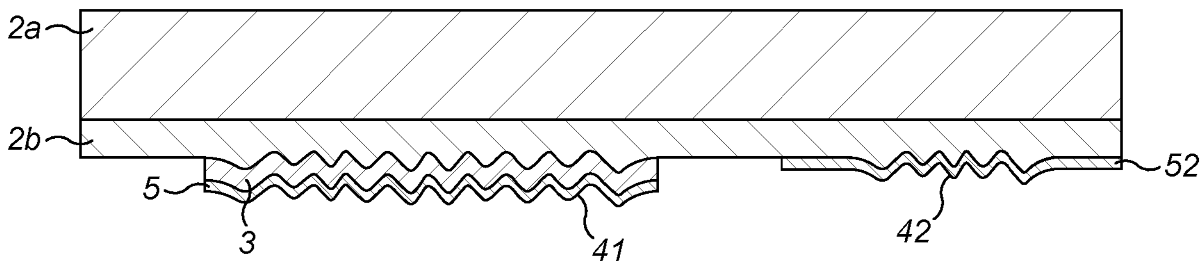

FIG. 8g

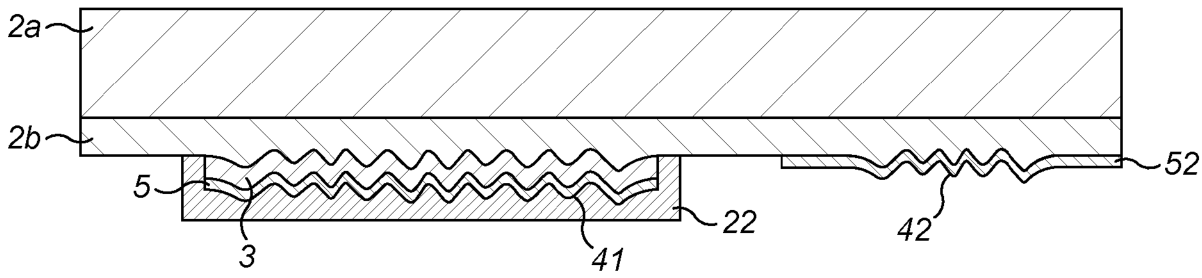

FIG. 8h

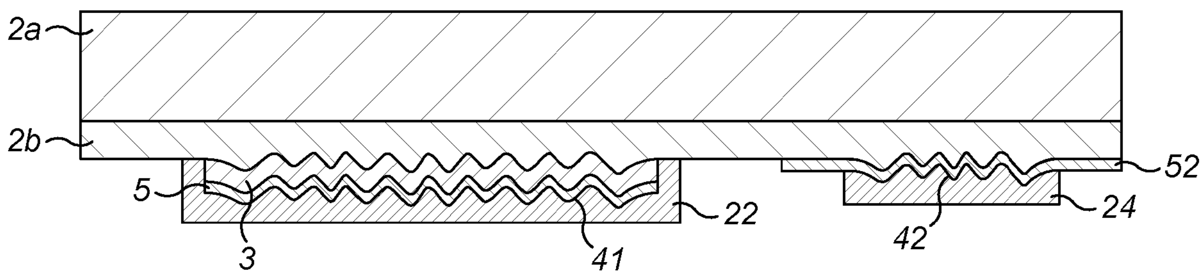

FIG. 8i

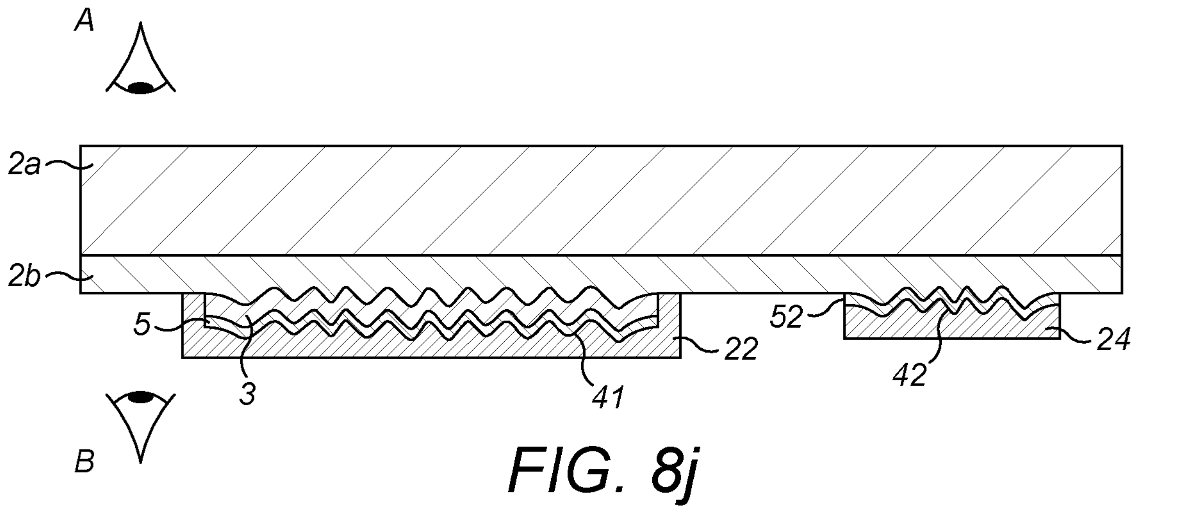

FIG. 8j

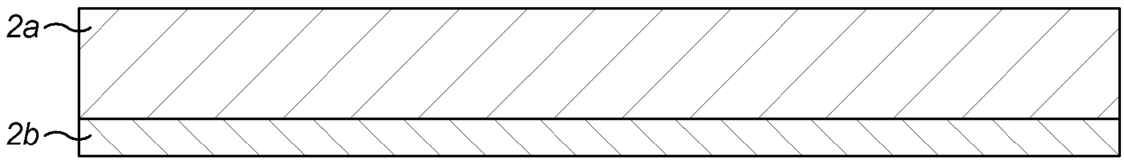

FIG. 9a

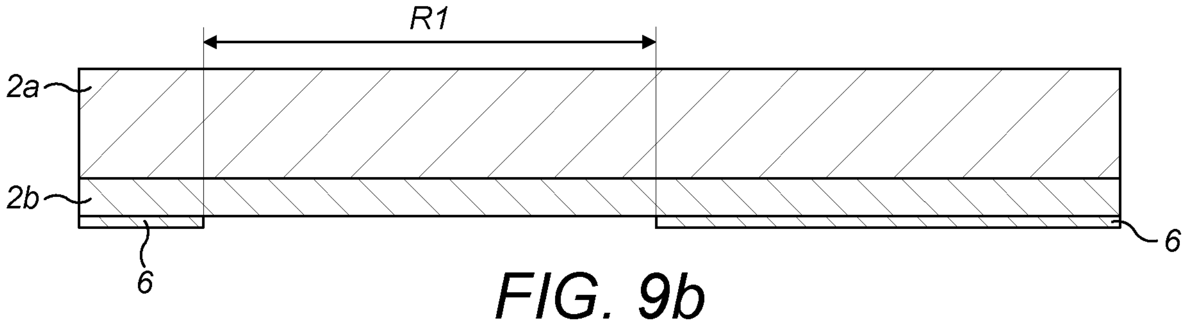

FIG. 9b

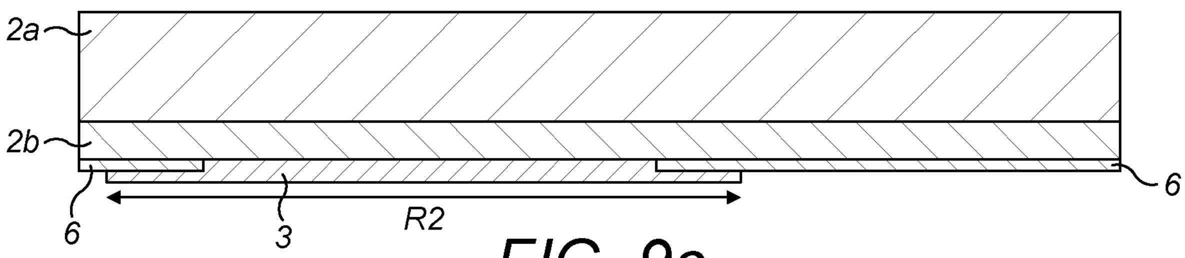

FIG. 9c

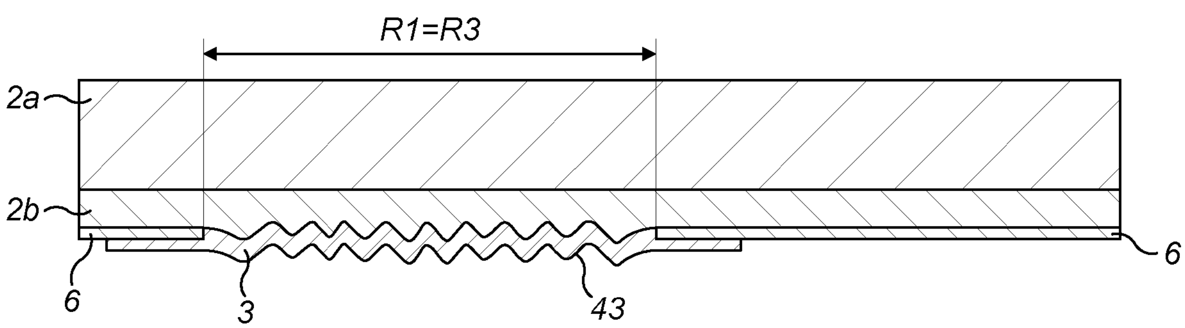

FIG. 9d

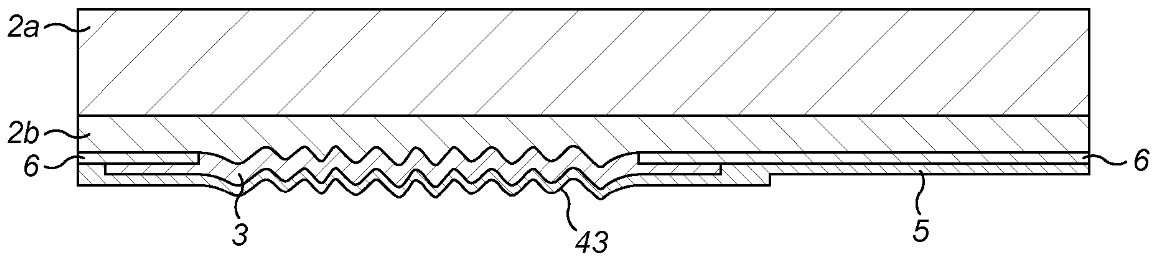

FIG. 9e

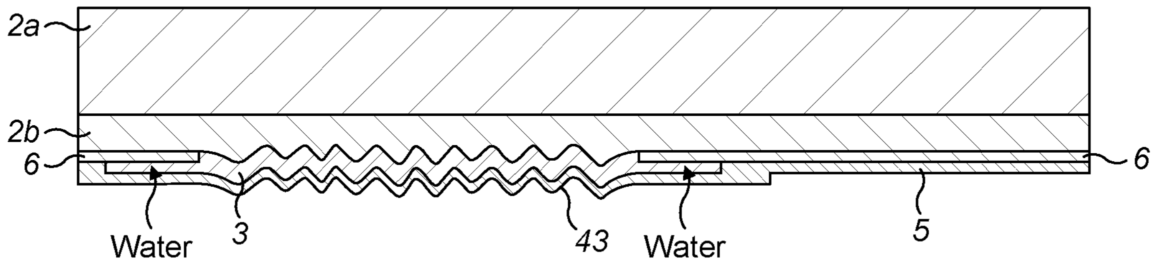

FIG. 9f

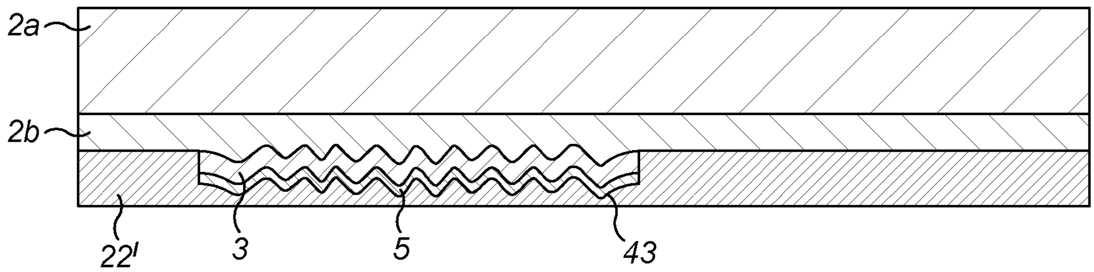

FIG. 9g

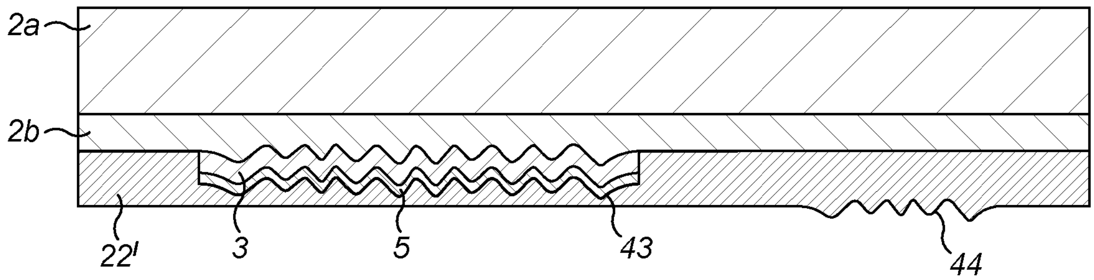

FIG. 9h

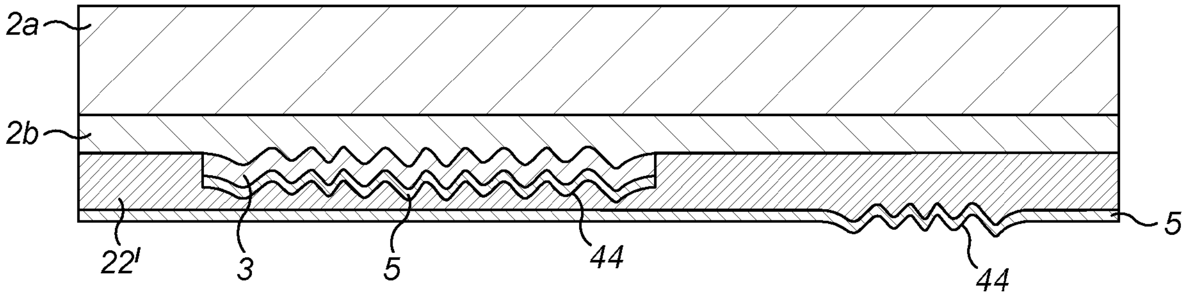

FIG. 9i

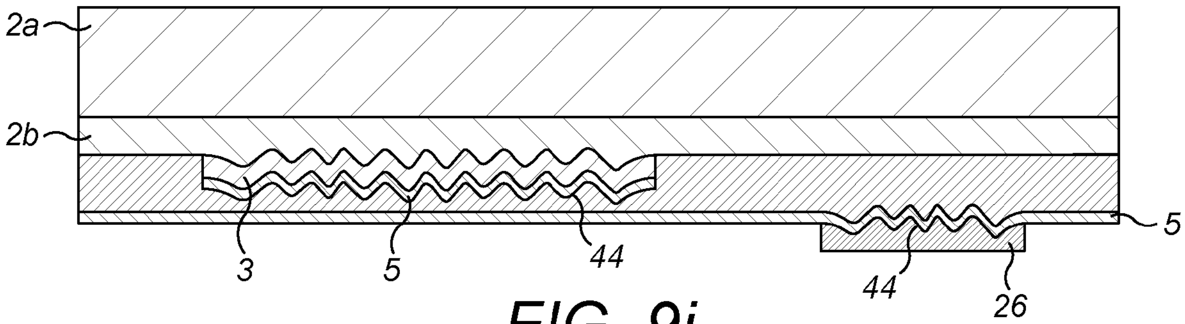

FIG. 9j

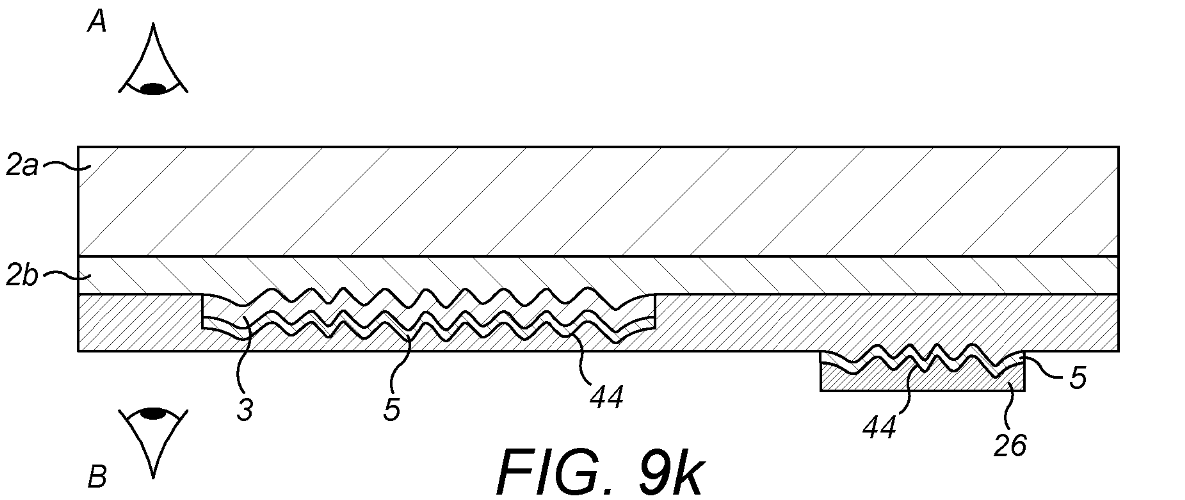

FIG. 9k

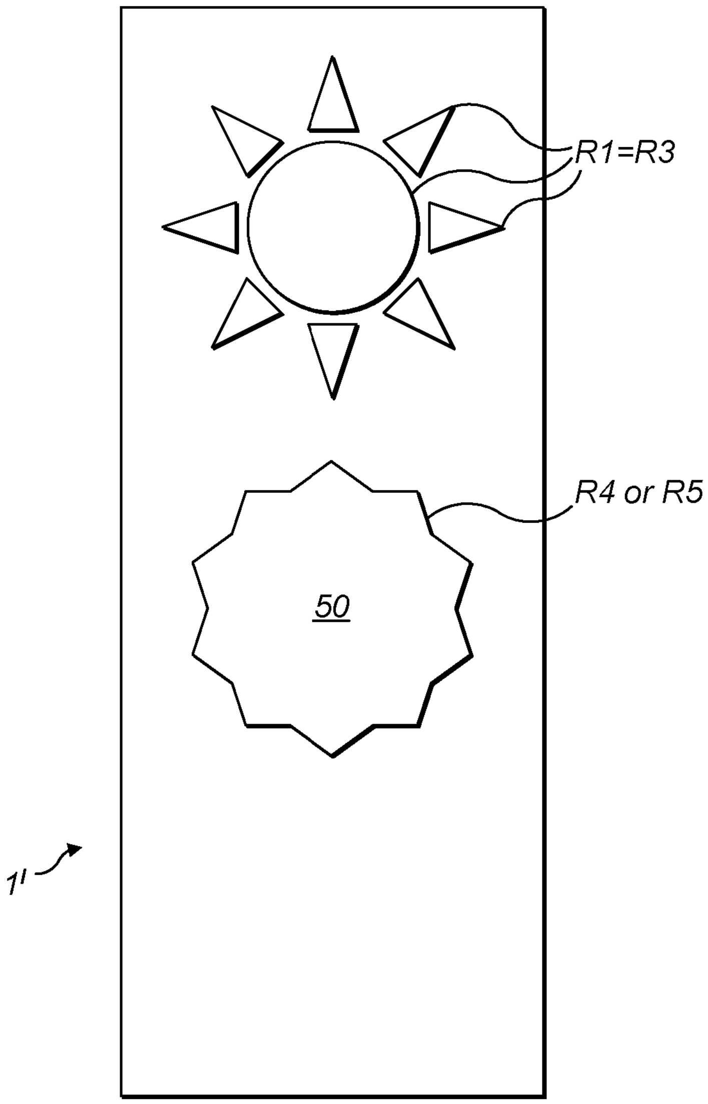

FIG. 10

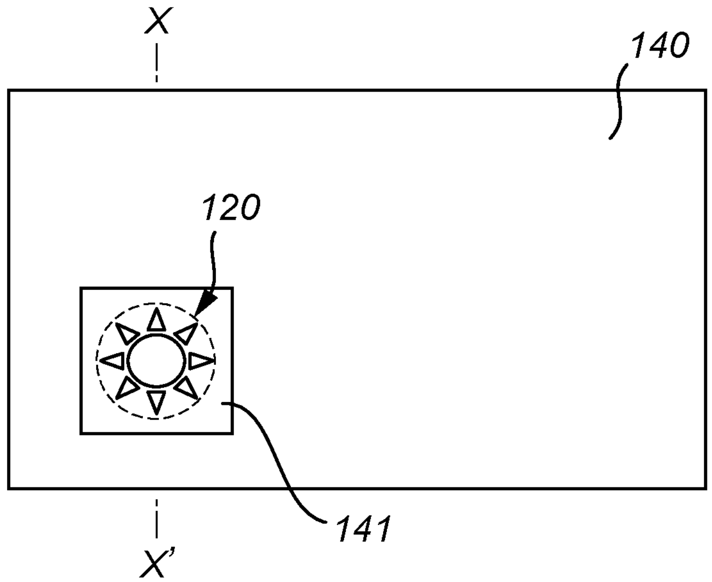

FIG. 11a

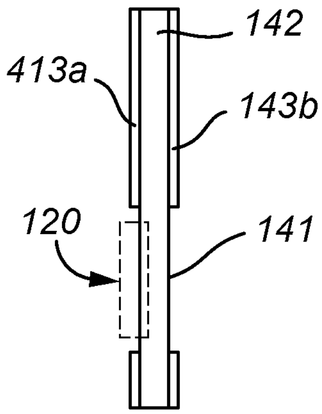

FIG. 11b

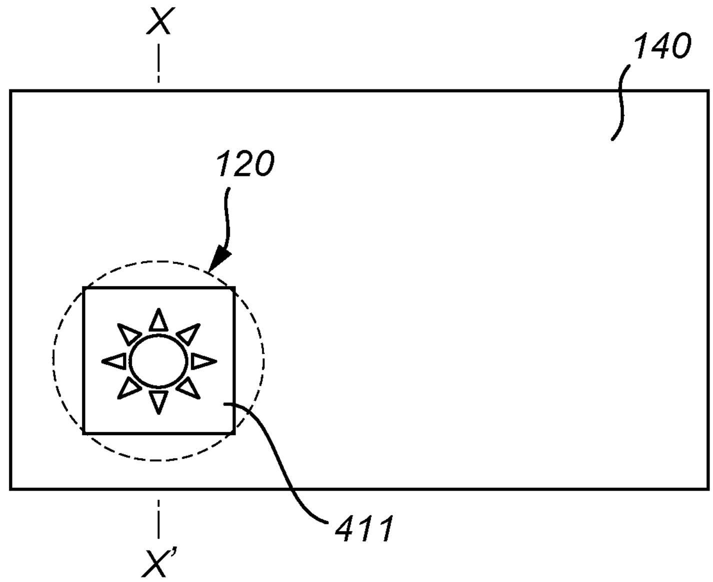

FIG. 12a

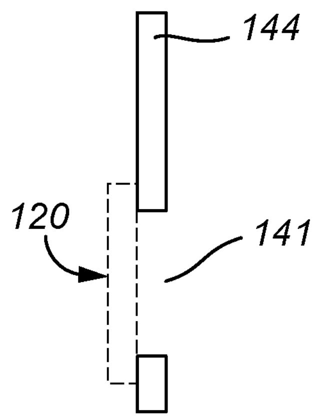

FIG. 12b

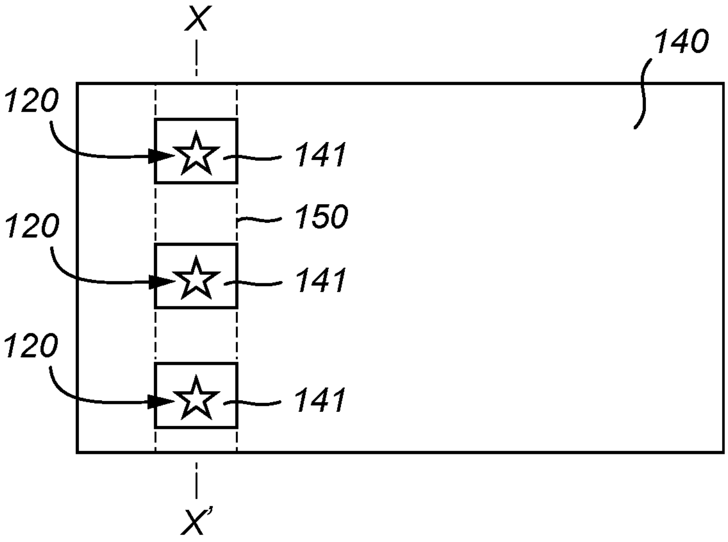

FIG. 13a

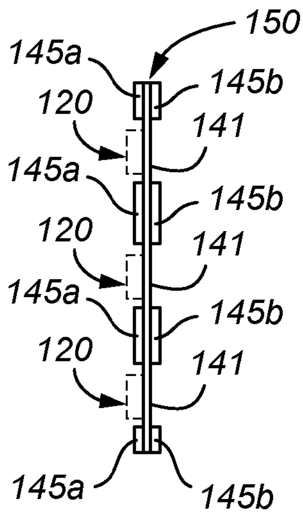

FIG. 13b

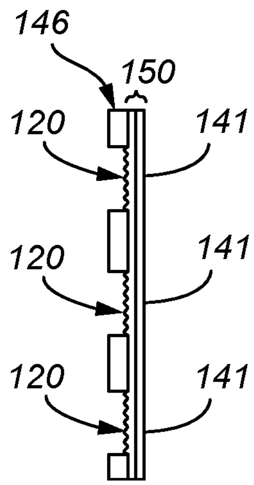

FIG. 13c

REFERENCES CITED IN THE DESCRIPTION

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