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(54) **A MULTI-PAGE DOCUMENT WITH SECURITY FEATURES INTEGRATING PAGES THEREOF AND A METHOD OF SECURING SUCH A DOCUMENT**

(57) The present invention provides a multi-page document, such as a passport booklet, with security features integrating selected pages of the document. The multi-page secured document (100) according to the invention comprises a first document sheet (110) on or in which a first security feature (111) is provided including a first security element (117) and, preferably, a second security element (118) and a second document sheet (120) on or in which a third security element (122) is preferably provided and a third document sheet (130) provided on at least part of the sheet with a window (139) with a reading element (131) for reading the first security feature (111) and preferably, when the third security element (122) is present, with a co-forming element (132). Reading element (131) serves to enable reading of the first security feature (111), creating together with it the first

optical security feature (115). The co-forming element (132) serves to co-form, with the third security feature (122), the second optical security feature (127). Both the first and second security element (118) may contain an indication, for example, such as an image, pattern, motif, background or sign, while the third security element (122) may, together with the co-forming element, form a marking, preferably personalized, such as an image, sign, pattern or background. The present invention also relates to a method of securing multi-page secured documents (100) with an increased level of security and increased functionality, in particular due to the presence of security features integrating the pages of the document, the security features including compatible elements located on or in different sheets of the multi-page secured document (100) and having the option for their personalization.

EP 4 681 932 A1

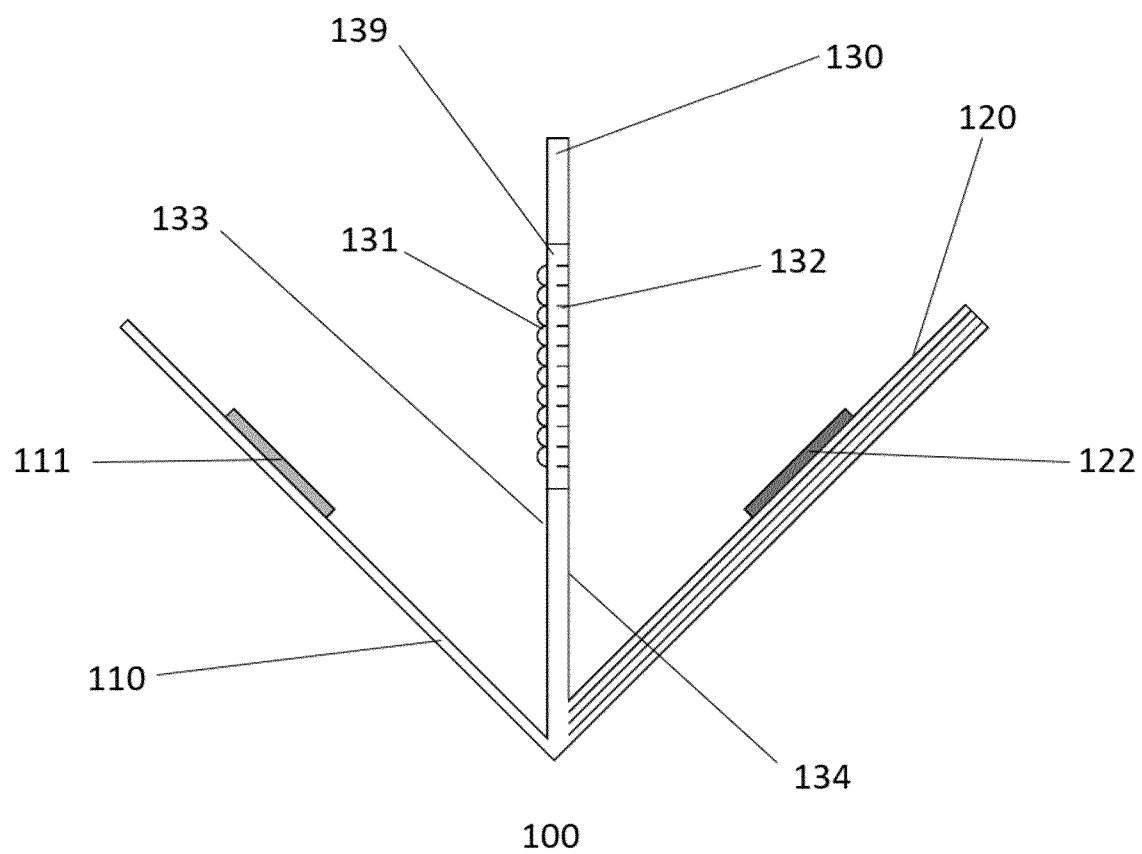


Fig. 3

Description

Field of the invention

[0001] The present invention provides a multi-page document, such as a passport booklet, with security features integrating selected pages of the document. The document includes a first document sheet on or in which there is a first security element and, preferably, a second security element providing the first security feature, a second document sheet on or in which there is preferably a third security element, and a third document sheet provided on at least part of the sheet with a window with a reading element and, preferably, with a co-forming element. The reading element serves to enable reading of the first security feature, creating together with it the first optical security feature. The co-forming element serves to co-form, with the third security feature, the second optical security feature. Both the first and second security elements may contain an indication, for example, such as an image, pattern, motif, background or sign, while the third security element may, together with the co-forming element, form a marking, preferably personalized, such as an image, sign, pattern or background. The present invention also relates to a method of securing multi-page secured documents with an increased level of security and increased functionality, in particular due to the presence of security features integrating the pages of the document, the security features including compatible elements located on or in different sheets of the multi-page secured document and having the option for their personalization.

Prior art

[0002] Secured documents and secured booklets, especially identification documents confirming the existence of specific rights, legal relationships, or legal events expressed on specific information media, are currently an indispensable element of life in developed countries. Their importance is constantly increasing, because such documents find many uses, and their number is growing incessantly.

[0003] Many of these identification documents consist of one or more pages on which specific information is provided. Additionally, these pages are often equipped with security features intended to protect the documents containing such pages against forgery attempts. Many of these security features also carry the above-mentioned important information, in particular information about the holder of the identification document.

[0004] Passports are a special type of such identification documents. A passport booklet usually consists of a cover and many pages permanently joined together, usually by a seam running along a stitch line, where said stitch line may be additionally secured by a cover glued at the outside. Such a passport booklet contains at least one secured page and/or data page (sometimes referred to

as a personalization page, a personalized page or a holder's page), which carries personal data and bears a photo of the holder of the identification document. In particular, solutions in which the secured page is also the data page are useful. The pages present in the passport booklet, not constituting data carriers and permanently connected to each other, are called visa pages. Visa pages are usually made of paper. Visa pages may be provided with numerous additional security features, in particular security fibers or microprints.

[0005] All pages of the identification document, including the security pages, data page and visa pages, are bound within the cover to create a book-like document. Such covers are designed in such a way that they enable the inner pages of the document to be attached to the cover by gluing the data pages with the visa pages and end-paper joined together. A cover provides the front and back sides of a document, each typically comprising a multi-layered structure to protect the document from unwanted external influences.

[0006] The data page is usually the first or last page of the permanently joined pages of a passport booklet and is located between one of the permanently joined pages and the cover (such as between the visa page and the cover). Such a data page, which in practice is also a security sheet, contains, for example, personal data of the holder of a passport identification document.

[0007] The data page may be made of a fibrous substrate, however to increase the security of such a document, such a substrate is usually protected, in particular it is bonded to a polymer laminate layer, as well as, in specific embodiments, it may be made of a polymer laminate. In still other embodiments, the data page may be formed from a laminate of a secured fibrous substrate (paper) and a polycarbonate film. Such a secured and/or data page usually contains one or more security elements, such as, for example, watermarks, security features applied by printing, in particular, depending on the surface of the page, by ink-jet or laser marking, threads or security fibers, security printing, in particular using OVI inks and the like.

[0008] Alternatively, the data page may be made of a plastic material, in particular a multi-layer plastic sheet, which material is typically polycarbonate. Plastic sheets are more durable than sheets made from a fibrous base. During the production of such a sheet, a certain number of thin plastic layers are overlapped and permanently bonded together. Where the security and/or data page is a plastic sheet, the security features may additionally include security elements used successfully as security features typical of card documents, including, for example, tactile embossing on the card surface and the like.

[0009] Multi-page secured documents may contain security features that often carry hidden information, including information encoded in images. These include documents for which it is beneficial to simultaneously provide additional authentication of a specific document and encode or encrypt the information in such a way that it

can be read, in particular decoded or decrypted, using an appropriate device enabling its reading, such as a decoder and/or a specific reading mechanism, especially decoding. In many solutions, in order to read the encrypted information, it is necessary to place a hand-held decoder above it. In practice, however, the use of such additional external devices enabling reading of the security feature is not too practical.

[0010] Frequently, people checking multi-page secured documents, e.g. officers checking in travelers during passport control, acting under time pressure, may not be able to verify the correctness of all security features present in a multi-page document. Typically, such people primarily browse data pages containing information identifying the document holder. Therefore, it is extremely important to introduce as many security elements as possible on the data page and its adjacent pages, in particular those that carry important data such as personal data. In a situation where some of such data is encoded in security elements in a way that requires the use of special conditions to read them or an element (device) enabling such reading, it is desirable that such an element enabling quick reading of a given security device should be an integral element of the document itself. This approach not only makes it easier to control the document and read the security features present in the document, but also makes it extremely difficult to replace the data page, which, by containing elements that ensure quick and reliable reading of information contained in adjacent pages, must be perfectly aligned with these pages.

[0011] It is clear from the above that there is a need for improved multi-page secured documents in which more than one security feature is present on a personalized page and/or on adjacent pages, where preferably at least two of the security features are integrated and can support various data, in particular authentication data, which data is optically encoded and their reading does not require the use of external equipment, because either it is readable with the naked eye, or the multi-page document is equipped with a visualizing or revealing device necessary to read it, such as lens array, filters and diffraction gratings. The present inventors found that it would be particularly advantageous to provide a solution which, by placing a device ensuring reading of security elements in one of the pages of the document, in particular in the data page, would integrate such a page with the booklet, preventing the replacement of one page while maintaining the possibility of reading the security features located on other pages adjacent to the page containing the element enabling reading of these security features.

[0012] Numerous methods of securing documents are known in the art, according to which more than one security element, or a security element and an additional element enabling reading of such security element, are incorporated into the document, providing the desired security feature after assembly.

[0013] For example, systems for securing multi-page documents are known, including security elements and various devices facilitating or enabling reading of the security element, in particular decoding devices (decoders) enabling decoding information encoded in the document which is placed on two different pages of the multi-page document. For example, WO 99/01291 discloses a value document which is provided with at least one verification element and at least one security element, the security element being verifiable by means of the verification element. The security element and the verification element overlap briefly only to perform security verification, without creating a permanent connection. As described, when the security element and the verification element are superimposed, for example, *moiré* patterns are created. An exemplary document according to WO 99/01291 is a passport, which can be checked, for example, by checking two facing pages. In addition, one page may be provided with a verification element, for example with a film with a lenticular raster on a part of the surface or on the entire surface, while the other page with a security feature intended for analysis may be provided, for example, with hidden, invisible raster structures. Authenticity is checked by the proper positioning of one page on the other. As disclosed in the specification, the functionality of the window or windows integrated with the document is decisive. This does not substantially add to thickness of the document, because the detection means and the security feature on the document are located at different locations in the document rather than directly on top of each other.

[0014] An analogous solution in which a security element to be read requires the use of an additional element located on another document sheet is described in EP2384898, which discloses a security element for securities, value documents and the like, including a base, that is at least partially transparent or translucent, a printed pattern, which has the structure of a linear grid, which grid encodes the image and is arranged in a first layer on the base, and a decoder, which also has the structure of a linear grid, wherein the decoder is placed in a second layer on the base spaced from the first layer, or is placed at a side of the printed pattern, or is delivered on a separate medium.

[0015] Yet another solution including a decoder and a decoded element is disclosed in US20030015866. According to the disclosure contained herein, a system is known comprising a first insert and a second insert, preferably made of cellulose, joined together by a common edge, wherein hidden information is applied to said first insert, and at least a portion of said second insert is impregnated with a transparent composition to form a transparent window provided with a decoder, said first and second inserts being adapted to align the decoder with said hidden information, thereby making said hidden information visible.

[0016] Further, the publication of the application EP3685311 discloses a method for authenticating a data

carrier, wherein said data carrier is equipped with authentication data, which data includes at least two optically encoded pieces of data, the first and second one, where both pieces of data include a hidden, invisible or unreadable image, that can be viewed by a decoding device under certain lighting conditions in which the second optically encoded piece of data - remains invisible or illegible to the naked eye. As described herein, the decoding device used to decode the optical security data may include an array of lenses spaced at regular or irregular intervals.

[0017] The publication WO 2022/053268, in turn, relates to a multi-sheet document comprising the first sheet on or in which there is a first optical security feature comprising an optically encoded hidden image or mark which is visible at least in a specific optical spectrum, the second document sheet on or in which a second optical security feature including an optically encoded hidden image or mark that is visible at least over a specified spectral range, and a third document sheet including a layer stack consisting of a plurality of layers connected to a substrate layer with a decoding element that is at least partially transparent over a specified spectral range for decoding both the first and second optical security features, and wherein the document sheets are movably connected to each other such that the first security feature is located opposite the decoding element, and can at least partially overlap the decoding element, and the second security feature may at least partially overlap the decoding element and each of the two hidden images or signs may be optically decoded using the decoding element over a specific spectral range. In this solution, the decoding element has a subregion that is at least partially transparent over a specific spectral range, and a structure superimposed on this subregion with lower or no transparency over the particular spectral range compared to the subregion, such that when decoding the first or the second security features, specific surface areas of the hidden image or sign to be decoded are selectively provided with appropriate security feature, such that the corresponding hidden images or signs can be recognized by means of the exposed surface areas. Therefore, as disclosed in the publication WO 2022/053268, reading of all hidden images or signs contained in optical security requires the use of this decoder, however, it is the same decoder, formed in a sub-area by the structure of at least part of the layers from the layer stack, which significantly limits the type and the number of images or signs hidden in optical security features.

[0018] A similar solution was disclosed in the publication of the international application WO 2020/212230, which describes a multi-page document in which the element decoding the marking is a lens array. However, the degree of security provided by such a solution is still unsatisfactory. The decoder proposed in the publication WO 2020/212230 is homogeneous, and both security elements constitute security features of the same type and degree.

[0019] Another document, WO 2017/060684 discloses a multi-page document including a personalized page containing personal data hinged to an adjacent page, wherein the adjacent page includes a fibrous substrate and a first security element including at least one region exposed to the surface of the substrate and the personalized side includes a plastic substrate and a second security element, wherein the second security element is located at least partially in the at least one transparent window in the plastic substrate. As described, the personalized page and the adjacent page are arranged such that, when superimposed, the first and second security elements are visible in at least one transparent window of the personalized page when viewed in reflected light. According to one preferred embodiment of the invention, the second security element comprises a lens array. However, the solution described in the publication WO 2017/060684 does not ensure a very high level of security due to the actual use of only a single system of security elements, where the security element located on the adjacent page, constituting the visa page, can only be perceived in combination with the second security element of the document.

[0020] A security document in the form of a booklet is also known from EP3785927 which describes such an identification document, in particular a passport booklet, with a plastic data page and a paper page following or preceding said plastic data page, in which document the data page with the plastic material comprises a transparent window area in which the window information representing the laser marking is placed, and said paper page, at least in the closed state of the identification document, in the area adjacent to the window area of the plastic data page is modified with an indicator substance. In this area, according to the information from the window, there is paper information overlapping the window representing the marking that is produced by depositing the material resulting from the laser marking of the data page with the data. A material depositing substance is used as an indicator substance, which deposits and holds the material formed during laser marking.

[0021] Similarly, a multi-page secured document is provided by a solution disclosed in EP3256331, wherein the document comprises a first page of the document which is provided with a light-transmitting window, a second page of the document which includes a security feature disposed in a predetermined area, the position of the top of the predetermined area on the second document page corresponding to the position of the light transmitting window of the first document page, such that when the first document page and the second document page are connected, the security feature can be read through the light transmitting window, wherein an additional security feature is formed in the light transmitting window and wherein the security feature and the additional security feature in the light transmitting window are complementary to each other to provide the full security feature so that together they form a pattern that becomes

visible when both sides of a multi-page document are folded together in accordance with their intended use, wherein the additional security feature transmits light over a specific range of wavelengths, so that the security feature can be read through an additional security feature. However, according to the disclosure of EP3256331, an additional security feature in a further wavelength range has an absorbing or reflective effect, whereby the additional security feature can be read in the next wavelength range. Then, while the security feature or additional security feature in the wavelength range of visible light can be read completely or fully, only parts of the security feature or additional security feature can be read in the IR or UV wavelength range.

[0022] In turn, the publication EP1827868 describes a data carrier comprising two layers with metallic coatings that overlap each other at least partially, with markings with perforations made in both metallic coatings, the perforations in both layers with metallic coatings being offset from each other, which makes them visible and contrasting with metallic coatings when viewed from a certain angle.

[0023] The document WO2017100838 discloses a data carrier including a first periodic array of image elements disposed on a first surface and a first periodic array of revealing elements on a second surface. The two systems of elements mentioned above extend in different directions, which gives the effect of optical variability when the carrier is rotated or the viewing angle is changed. One of the advantages of such systems is the possibility of using such systems of elements on a transparent surface or using a transparent window in a data carrier.

[0024] Yet another solution for securing multi-page documents such as a passport booklet is disclosed in EP3838611, which relates to a security element for a data carrier comprising at least one layer, wholly or partly transparent, with a thickness of at least 0.03 mm, wherein at least one layer the security element is at least partially susceptible to markings by printing or laser marking,

which security element comprises:

- a security pattern, wherein the security pattern is arranged on the surface of the layer of the security element in such a way that the area of the security pattern at least partially overlaps the transparent area of the security element, so that the security pattern is at least partially visible on both sides of the security element,

and wherein the security pattern comprises at least two security markings, and each security marking consists of bands arranged at intervals such that the corresponding edges of the bands constituting a given security marking are spaced equidistantly, and

each band constituting one security mark is adjacent on each side to a band forming another security mark;
and/or

- a revealing element, provided that the location of the revealing element coincides at least partially with the transparent area of the security element, such that the revealing element is at least partially visible from both sides of the security element,

wherein the revealing element includes a plurality of parallel opaque lines and transparent lines acting as gaps between the opaque lines, wherein the period of the revealing element is the sum of the width of the opaque line and the width of the transparent line

wherein the security pattern and/or revealing element is applied by printing or laser marking, and above or below the applied security pattern and/or reading element, at a distance of at least 0.03 mm, within the same layer or in another layer of the security element, there is another surface susceptible to markings by printing or laser marking,

wherein the security element does not contain any reflective material at least in the transparent area.

[0025] Other security features are also successfully used in documents with security features, including multi-page secured documents. An example of such commonly used security elements are angle effect security elements. One such security feature is described in WO1995019890, which discloses a security device consisting of a substrate having a light reflecting portion which is provided with a linear structure, which linear structure defines a plurality of segments, and each segment is formed by a corresponding set of substantially parallel lines, which lines of at least three segments extend in different directions, and where each line is formed by or contains ink that does not completely penetrate the spaces between the lines, or which is sufficiently transparent between the lines so as not to obscure a light-reflecting surface, each the segment making the incident light reflect from the surface in a non-diffractive manner and varying with the change of the angle of incidence of light.

[0026] Further, the publication EP3880488, relating to hidden images printed using the steel engraving technique, discloses a security feature with an angular effect for a secured document, including a substrate with a convex structure created by superimposing at least two images, one of the images being defined by at least one array of lines extending in the first direction, the other image being defined by an array of lines extending in the second and third directions together to create an angular effect, the first, second and third directions being different. As de-

scribed in EP3880488, the convex structure is determined by the resulting image with an angular effect by performing one of three logical operations on the first and second images, which operations include negation of implication, simultaneous negation and inverse implication. As described, in practical embodiments of the invention a standard ink or, optionally, an optically variable ink is used. In preferred embodiments, the angular protection comprises two images, each image being defined by an array of two grids, preferably grids of parallel lines of constant width and spacing between the lines, which grids are set at an angle of 90° with each other, the grids of the lines of the first image being rotated relative to the grid lines of the second image by 45°.

[0027] However, the solutions known in the art, while simultaneously applied to single-sheet documents with security features, do not provide a sufficient level of security for multi-layer documents. When such security elements are used on different sheets of multi-page documents, even in combination they do not fully fulfill the function of effectively securing the document. Moreover, in the event of forgery attempts, each of the individual security elements, located on different sheets of a multi-layer document with security features, acts as a separate, independent security feature, and thus, in the event of changes made to the data of the document holder on the personalized page/data page data, there is no need to make changes to the remaining pages of the document. It should be emphasized that most crimes related to counterfeiting of this type of documents concern the data page.

[0028] The present inventors found that only integration of at least two different security features with a reading element placed on another page of a multi-page document ensures high document security that prevents replacement of a single page, especially a data page, without leaving traces of tampering with the document. The inventors have observed that it is particularly advantageous to integrate two or more different security features by placing security elements and/or corresponding reading/co-forming elements enabling or facilitating their reading/forming, in particular reading encoded information in security elements on different pages of a multi-page secured document, where at least one of the reading elements and co-forming elements is placed on a personalized page. It is advantageous if each of the at least two security elements is made by a different technique, in particular selected from steel engraving, embossing, laser marking, offset or digital printing. This solution makes it difficult to obtain high-quality counterfeit documents. It is also particularly advantageous when at least one of the security features is a carrier of information such as personal data of the document holder, and when at least one security element and/or reading element and/or co-forming element of the complex optical security feature or the complex security feature of the document is placed on or within the personalized page/data page. In specific embodiments of the invention, in which the se-

curity element is an element personalizing the document, such security element is produced by laser marking or digital printing.

5 The gist of the invention

[0029] The present invention provides a multi-page document with security features 100, preferably a passport booklet, comprising:

a first document sheet 110, on or in which there is a first security feature 111 is provided including a first security element 117 and, preferably, a second security element 118; and

a second document sheet 120, on or in which, preferably, a third security element 122 is provided; and

a third document sheet 130 provided on at least part of the sheet with a window 139 with a reading element 131 for reading the first security feature 111 and preferably, when present, a third security element 122, with a co-forming element 132 for co-forming the second optical security 127 with the third security element 122;

wherein:

the first document sheet 110, the second document sheet 120, and the third document sheet 130 are permanently movably connected to each other such that the multi-page secured document 100 can assume both open configurations, including a reading configuration and a co-forming configuration, and a closed configuration;

and wherein

- the first security feature 111 provided on or in the first document sheet 110 in the closed configuration of the multi-page document adjoins the window 139 of the third document sheet 130 such that the first security feature 111, when observed in the reading configuration through the window 139 of the third document sheet 130, is at least partially visible, and
- a third security element 122, when present, provided on or in the second document sheet 120 in the closed configuration of the multi-page document adjoins the window 139 of the third document sheet 130, such that the third security element 122, when observed in the co-forming configuration through the window 139 of the third document sheet 130, is at least partially

visible;
and wherein

- the first security feature 111 is:

the first security element 117, including a marking such as, for example, an image, pattern, motif or sign, which is a hidden, invisible or illegible element when observed without the use of a reading element in the co-forming configuration of the multi-page secured document, and is readable in the reading configuration of the multi-page secured document through the reading element 131 and, preferably,

the second security element 118, which is a security element with an angular effect, which element is visible and legible when viewed without the use of the reading element 131 in the co-forming configuration of the multi-page document directly on the first document sheet 110 when viewed from an angle;

wherein the first security element 117 of the first security feature 111, and preferably, the second security element 118 of the first security feature 111, together with the reading element 131, form a first optical security 115 visible in the reading configuration of the multi-page secured document 100 through the window 139 of the third document sheet 130; and wherein

- the third security element 122, when present, is an element consisting of an array of parallel lines, and the co-forming element 132 is an element consisting of an array of parallel lines matching that present in the third security element 122, and
- either the third security element 122 or the co-forming element 132 includes marking such as, for example, an image, pattern, motif or sign, preferably constituting or containing personalized data,

and the third security element 122 together with the co-forming element 132 forms a second optical security 127, visible in the co-forming configuration of the multi-page secured document 100 through the transparent window 139 of the third document sheet 130.

[0030] According to the invention, the second security element 118 is a visible and legible element when viewed without the use of the reading element 131 in the co-forming configuration of the multi-page document directly on the first document sheet 110 when viewed from an angle. However, the second security element 118 of the first security feature 111 in preferred embodiments forms, together with the first security element 117 of the first security feature 111 and the reading element 131, a first optical security 115 visible in the reading configuration of the multi-page secured document 100 through the window 139 of the third document sheet 130, where the second security element 118 can only be partially visible through the window 139, and where partial visibility of the optical security means, in accordance with the present invention, that the security feature includes markings that also extend beyond the area of the window, which can be fully observed directly on the first document sheet 110.

[0031] Preferably, the reading element 131 is applied to or starting from the first page 133 of the third document sheet 130, and the co-forming element 132 is applied to or starting from the second page 134 of the third document sheet 130. In alternative embodiments, the reading element 131 is applied to or starting from the second page 134 of the third document sheet 130, and the co-forming element 132 is applied on or starting from the first page 133 of the third document sheet 130.

[0032] According to a preferred embodiment, the first security feature 111 consists only of the first optical security element 117, which together with the reading element 131 constitutes the first optical security 115.

[0033] According to another preferred embodiment, the first security feature 111 is a combination of the first security element 117 and the second security element constituting together with the reading element 131 the first optical security 115.

[0034] Preferably, the reading element 131 is an array of lenses, more preferably an array of lenses with a frequency ranging from 100 μm to 250 μm , for example an array of lenses with the parameters of radius (μm) - depth (μm) - frequency (μm): 195-50-120 or 100 -55-190 or 90-50-175 or 120-50-245 or 60-30-115 or 70-40-135 or 120-65-220 or 80-30-130.

[0035] Also preferably, the first security element 117 is an element made by steel engraving or offset printing.

[0036] Preferably, the second security element 118 is a security element with an angular effect printed by steel engraving. In particularly preferred embodiments, the second security element 118 is consisting of

- a first array (first grid) of parallel lines and
- a second array (second grid) of parallel lines positioned relative to the first array of parallel lines at an angle of $90^\circ \pm 15\%$, preferably $90^\circ \pm 10\%$, more preferably $90^\circ \pm 5\%$, most preferably at an angle of 90° . In the most preferred embodiments of the invention, the first security feature 111 comprises the first se-

curity element 117 and the second security element 118 which is an angular effect element, and the reading element 131 is an array of lenses, wherein the frequency of background lines of the first security element 117 differs from the frequency of the reading element 131 by a value ranging from 1%, preferably to 2% of the frequency of the reading element 131, and the line thickness of the first security element 117 is equal to about half of the frequency value, most preferably 0.5 of the frequency value.

[0037] Preferably, the co-forming element 132 is a linear element comprising an array of lines parallel to each other, preferably straight lines.

[0038] Preferably, the third document sheet 130 is a sheet containing at least in the window area 139 at least one layer of a laser markable plastic material, preferably a polymer such as polycarbonate (PC), polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC) or polyurethane (PU), preferably the third document sheet (130) is a sheet containing polycarbonate (PC), more preferably all the layers of the third document sheet 130 are formed from a plastic material.

[0039] Also preferably, the co-forming element 132 is located on the surface or within the volume of at least one single layer of the window 139 of the third document sheet 130, preferably extending to the thickness of at least one layer of the window 139 of the third document sheet 130, more preferably extending to the thickness of at least two layers of the window 139 of the third document sheet 130, most preferably extending through the thickness of all layers of the window 139 of the third document sheet 130.

[0040] In a preferred embodiment, the co-forming element 132 is an array of parallel lines applied by laser marking or offset printing, preferably containing an image, pattern, motif or sign, adapted to the array of lines of the third security element 122.

[0041] Preferably, the third security element 122 is an element applied by steel engraving printing, offset printing or digital printing.

[0042] The invention also provides a method for securing a multi-page secured document 100, preferably a passport booklet, containing a first document sheet 110, a second document sheet 120, and a third document sheet 130, where the first document sheet 110, second document sheet 120 and third document sheet 130 are permanently movably connected together in such a way that the multi-page secured document 100 can assume both open configurations, including a reading configuration and a co-forming configuration, and a closed configuration,

and which method comprises:

- a) applying on or in the first document sheet 110 a first security feature 111 comprising:

- a first security element 117, where the first security element 117 is a hidden element, invisible or illegible when observed without the use of a reading element 131, and, preferably,
- a second security element 118, where the second security element 118 is a visible and legible element when observed without the use of the reading element 131 when viewed at an angle;

b) optionally applying a third security element 122 on or in the second document sheet 120;

c) providing, in the third document sheet 130, a window 139 including at least one layer of laser markable plastic material, preferably a polymer such as polycarbonate (PC), polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC) or polyurethane (PU), preferably the third document sheet 130 is entirely a sheet of polycarbonate (PC);

d) providing the window 139 on its surface or in its volume with the reading element 131 which is adapted to the first security feature 111, for reading the first security feature 111 and, if the third security element 122 is present, with a co-forming element 132 which is compatible with the third security element 122 for co-forming the second optical security element 127;

wherein the reading element 131 and the co-forming element 132 are applied either on different sides of the third document sheet 130 or in the volume of the document sheet 130, preferably they are at least partially overlapping in the area of the window 139;

and wherein the first security feature 111 is applied in the area of the first document sheet 110 such that the first security feature 111, when viewed through the window 139 of the third document sheet 130, when the third sheet 130 adjoins, with the first page of the third sheet 133, the first document sheet 110, is visible at least in part, and, when present

- the third security element 122 is applied in an area of the second document sheet 120 adjacent to the window 139 of the third document sheet 130 such that the third security element 122, when viewed through the window 139 of the third document sheet 130, when the third sheet 130 adjoins, with the second page of the third sheet 134, the second document sheet 120, is visible at least partially;

and wherein steps a) and b) are carried out in any

order, preferably steps a) and b) are carried out sequentially.

[0043] Preferably, a lens array is introduced as the reading element 131. 5

[0044] Preferably, the first security element 117 and/or the third security element 122 are applied by steel engraving, offset or digital printing techniques. Particularly preferably, the first security element 117 is applied by steel engraving printing. 10

[0045] Also preferably, a security feature with an angular effect is applied as the second security element 118, more preferably the security feature with an angular effect is applied by steel engraving printing.

[0046] Preferably, a linear element consisting of a array of lines parallel to each other, preferably straight lines, is applied as the co-forming element 132. In a preferred embodiment of the method, the co-forming element 132 is applied by laser marking or offset printing. 15

[0047] Preferably, both the first security element 117 and the third security element 122 are applied by printing, preferably steel engraving or offset printing. Particularly preferably, as the first security element 117, arrays of parallel lines are introduced and as the third security element 122, a linear element is introduced, comprising arrays of lines parallel to each other, more preferably straight lines. 20 25

[0048] In a particularly preferred embodiment of the method according to the invention, the second security element 118 is applied by steel engraving printing, more preferably in the form of a security feature with an angular effect. 30

[0049] In one particularly preferred embodiment, the invention provides a multi-page secured document, such as a passport booklet 100, comprising: 35

a first document sheet 110 on or in which there is a first security feature 111 including a first security element 117 and 40

a second document sheet 120 and

a third document sheet 130 provided on at least part of the sheet with a window 139 with an integrated single reading element 131 for reading the first security feature 111, 45

wherein:

the first document sheet 110, the second document sheet 120 and the third document sheet 130 are permanently movably connected to each other such that the multi-page secured document 100 can assume both open configurations, including a reading configuration or a co-forming configuration, and a closed configuration; 50 55

and wherein

- the first security feature 111 located in the area of the first document sheet 110 in the closed configuration of the multi-page document is adjacent to the window 139 of the third document sheet 130 such that the first security feature 111, when observed in the reading configuration through the window 139 of the third document sheet 130, is at least partially visible;

and wherein

- the first security feature 111 comprises

a first security element 117, including a marking such as, for example, an image, pattern, motif or sign, which is a hidden, invisible or illegible element when observed without the use of a reading element in the co-forming configuration of the multi-page secured document, and is readable in the reading configuration of the multi-page secured document through the reading element 131, and

wherein the first security element 117 of the first security feature 111 forms, together with the reading element 131, a first optical security 115 visible in the reading configuration of the multi-page secured document 100 through the window 139 of the third document sheet 130. In a preferred implementation of such an embodiment of the invention, the second document sheet 120 is provided with a third security element 122, which means that on the second document sheet 120 or in the second document sheet 120 in the area adjoining, in the closed configuration of the multi-page document, the window 139 of the third document sheet 130, there is a third security element 122 which, when observed in the co-forming configuration by the window 139 of the third document sheet 130, is at least partially visible;

and wherein

either the third security element 122 or the co-forming element 132 includes a marking such as, for example, an image, pattern, motif or sign, preferably constituting or containing personalized

data

and the third security element 122 together with the co-forming element 132 forms a second optical security 127, at least partially visible in the co-forming configuration of the multi-page secured document 100 through the window 139 of the third document sheet 130.

[0050] Exemplary implementations of security features for this embodiment of the invention are shown in Fig. 6A) and Fig. 5 AF).

[0051] In another particularly preferred embodiment, the invention provides a multi-page secured document, such as a passport booklet 100, comprising:

a first document sheet 110 on or in which there is a first security feature 111 including a first security element 117 and a second security element 118; and

a second document sheet 120; and

a third document sheet 130 provided on at least part of the sheet with a window 139 with an integrated single reading element 131 for reading the first security feature 111;

wherein:

the first document sheet 110, the second document sheet 120, and the third document sheet 130 are permanently movably connected to each other such that the multi-page secured document 100 can assume both open configurations, including a reading configuration and a co-forming configuration, and a closed configuration;

and wherein

- the first security feature 111 located in the area of the first document sheet 110 in the closed configuration of the multi-page document adjoins the window 139 of the third document sheet 130 so that the first security feature 111, when observed in the reading configuration through the window 139 of the third document sheet 130, is at least partially visible;

and wherein

- the first security feature 111 comprises

a first security element 117, including a marking such as, for example, an image, pattern, motif or sign, which is a hidden,

invisible or illegible element when observed without the use of a reading element in the co-forming configuration of the multi-page secured document, and is readable in a reading configuration of the multi-page secured document through the reading element 131 and

a second security feature 118 that is a security feature with an angular effect, which feature is visible and readable when viewing the first security feature 111 from an angle other than a right angle to the first document sheet 110 without using a reading element in the co-forming configuration of the multi-page document directly on the first document sheet 110;

wherein the first security element 117 of the first security feature 111 forms, together with the reading element 131, a first optical security 115 visible in the reading configuration of the multi-page secured document 100 through the window 139 of the third document sheet 130. In a preferred implementation of such an embodiment of the invention, the second document sheet 120 is provided with a third security element 122, which means that on the second document sheet 120 or in the second document sheet 120 in the area adjoining, in the closed configuration of the multi-page document, the window 139 of the third document sheet 130 there is a third security element 122 which, when observed in the co-forming configuration through the window 139 of the third document sheet 130, is at least partially visible;

and wherein

either the third security element 122 or the co-forming element 132 includes a marking such as, for example, an image, pattern, motif or sign, preferably constituting or containing personalized data

and the third security element 122 together with the co-forming element 132 forms a second optical security 127, at least partially visible in the co-forming configuration of the multi-page secured document 100 through the window 139 of the third document sheet 130.

[0052] Exemplary implementations of security features for this embodiment of the invention are shown in Fig. 6B) and Fig. 5 AF).

[0053] In another particularly preferred embodiment, the invention provides a multi-page secured document, such as a passport booklet 100, comprising:

a first document sheet 110 on or in which there is a first security feature 111 including a first security element 117 and a second security element 118; and

a second document sheet 120; and

a third document sheet 130 provided on at least part of the sheet with a window 139 with an at least double (heterogeneous) integrated reading element 131 for reading the first security feature 111;

wherein:

the first document sheet 110, the second document sheet 120, and the third document sheet 130 are permanently movably connected to each other such that the multi-page secured document 100 can assume both open configurations, including a reading configuration and a co-forming configuration, and a closed configuration;

and wherein

- the first security feature 111 located in the area of the first document sheet 110 in the closed configuration of the multi-page document adjoins the window 139 of the third document sheet 130 so that the first security feature 111, when observed in the reading configuration through the window 139 of the third document sheet 130, is at least partially visible,

and wherein

- the first security feature 111 comprises
 - a first security element 117, including a marking such as, for example, an image, pattern, motif or sign, which is a hidden, invisible or illegible element when viewed without the use of a reading element in the co-forming configuration of the multi-page secured document, and is readable in a reading configuration of the multi-page secured document through the reading element 131 and
 - a second security element 118 that is a security element with an angular effect, which element is visible and readable when viewing the first security feature

111 from an angle other than a right angle to the first document sheet 110 without using a reading feature in the co-forming configuration of the multi-page document directly on the first document sheet 110;

wherein the first security element 117 of the first security feature 111 is visible through the first region of the reading element 131 and the second security element 118 of the first security feature 111 is visible through the second region of the reading element 131; and

wherein the first security element 117 of the first security feature 111, and the second security element 118 of the first security feature 111 form, together with the reading element 131, a first optical security 115 visible in the reading configuration of the multi-page secured document 100 through the window 139 of the third document sheet 130. In a preferred implementation of such an embodiment of the invention, the second document sheet 120 is provided with a third security element 122, which means that on the second document sheet 120 or in the second document sheet 120 in the area adjoining, in the closed configuration of the multi-page document, the window 139 of the third document sheet 130, there is a third security element 122 which, when viewed in the co-forming configuration through the window 139 of the third document sheet 130, is at least partially visible;

and wherein

either the third security element 122 or the co-forming element 132 includes a marking such as, for example, an image, pattern, motif or sign, preferably constituting or containing personalized data

and the third security element 122 together with the co-forming element 132 forms a second optical security 127, at least partially visible in the co-forming configuration of the multi-page secured document 100 through the window 139 of the third document sheet 130.

[0054] Exemplary implementations of security fea-

tures for this embodiment of the invention are shown in Fig. 6C) and Fig. 5 AF).

[0055] Within the meaning of the present invention, the terms "transparent" or "translucent" or "lucid" or "completely transmitting light" are considered to have the same meaning. In particular, a transparent area should be considered an area which, at least in the visible radiation range, does not interfere with visual observation and verification of the physical characteristics of the object placed directly behind it, and its transmittance is at least 70 %, preferably at least 80 %, more preferably at least 90 %, most preferably at least 95 %. In particular, it is a substrate in which all layers of such a substrate do not interfere with visual observation and verification of the physical characteristics of the object placed directly behind it, and their transmittance is at least 70 %, preferably at least 80 %, more preferably at least 90 %, most preferably at least 95 %.

[0056] Within the meaning of the present invention, a reading element is any element or combination of elements enabling and/or facilitating the reading of the marking, for example an image, pattern, motif or sign or background contained in the security element, which image, pattern, motif, sign or background is invisible, or barely visible when observing the document sheet at a right angle to the plane of this sheet without using the reading element. The reading element may have a visualizing or revealing function. The term single reading element means that the reading element is homogeneous and within it is not possible to isolate structurally different components. A double reading element means that the reading element is heterogeneous and within it two structurally different components (areas) can be isolated that together provide a reading element. Similarly, a triple reading element is a reading element within which we can distinguish three structurally different areas together providing a reading element. Thus, the term at least one reading element means that one or more structurally differentiated areas can be isolated within the element constituting the reading element.

[0057] According to the present invention, a visualizing element is any element that facilitates reading of the marking, for example an image, pattern, motif or sign or background contained in the security element together with which it constitutes optical security, which image, pattern, motif, sign or background is poorly visible when observing a document sheet provided with a security element at a right angle to the plane of this sheet without using a reading element. The visualizing element and the security element are located on or in different sheets of a multi-page secured document. In the case of a security element that is an element with an angular effect, the element visualizing such a security element is a lens array thanks to which it is possible to read the image constituting the angular effect through the window without the need to observe the document from an appropriate angle. By viewing through the visualizing element, the angular effect image is visible even when the docu-

ment is viewed perpendicularly to the plane of the document sheet.

[0058] Moreover, according to the present invention, a revealing element is any element enabling reading of the marking, for example an image, pattern, motif or sign or background contained in the security element together with which it constitutes optical security feature, which image, pattern, motif, sign or background is invisible when observing a document sheet with a security element without using a reading element. The revealing element and the security element are located on or in different sheets of a multi-page secured document. In the case of a security element, revealing, consisting in ensuring the readability of such a security element, occurs, for example, when it is observed through a lens array. An invisible image contained in the security element then appears.

[0059] According to the present invention, the co-forming element is, in turn, any element that, together with the security element, co-forms an optical security feature, providing a specific marking only when both co-forming and security elements are put together. The co-forming element and the security element are located on or in different sheets of a multi-page secured document. In the case of the co-forming element according to the present invention, the co-forming element is an element consisting of an array of parallel lines co-forming an optical security feature together with the security element consisting of an array of parallel lines matching the one present in the co-forming element.

[0060] According to the present invention, "matching" two elements or features should be understood as a situation in which these elements or these features in combination provide/create a new element forming an integral whole. Similarly, elements that, when assembled, provide/create a new functional element constituting an integral whole are considered compatible with each other.

[0061] Therefore, the term "matching" herein should in particular be understood as such mutual arrangement of an array of parallel lines and/or motifs of the security element and the co-forming element, which arrangements are applied on or in separate pages of the security document, such that when these arrays are superimposed and observed through the window, a marking appears. Such a marking creates a new, integral whole and can be any image, pattern, sign or background, as well as their combinations, and can be personalized. Thus, by appropriately matching the array of lines or motifs of the co-forming element and the lines or motifs of the security element, i.e. selecting the parameters creating these arrays - their thickness, inclination in relation to each other, or spacing - a coherent, comprehensive marking is obtained, often being a carrier of information. Since the co-forming element and the security element can be applied independently to different pages of the security document in the process of producing the security document, thus both on each of the

pages before they are assembled, as well as at the stage after they are joined together, such possibility ensures not only obtaining accurate fit of the arrays of the security element and the co-forming element, but also including important personalized data of the document holder in the optical security feature.

[0062] For the purposes of the present invention, a closed configuration of the multi-page secured document means a configuration in which all the sheets of the multi-page secured document closely adjoin each other over the entire surface of the sheet, and in which closed configuration of the multi-page secured document the first document sheet, the second document sheet and the third document sheet are placed on top of each other to form a stack of sheets in such a way that the first document sheet and the second sheet adjoin the third document sheet, being located on its opposite pages.

[0063] For the purposes of the present invention, an open configuration of the multi-page secured document means a configuration in which at least two adjacent sheets do not adjoin each other. In the case of the present invention, of the many possible open configurations, two different open configurations are particularly important:

- a first open configuration of the multi-page secured document, hereinafter referred to as the reading configuration, which means a configuration in which the first document sheet and the third document sheet are placed on top of each other to form a stack of sheets in such a way that the first document sheet adjoins the third document sheet with its entire surface, and the second document sheet does not adjoin at all the opposite page of the third document sheet, and in which configuration it is possible to observe the first security feature on or in the first document sheet through a window provided in the third document sheet.
- a second open configuration of the multi-page secured document, hereinafter referred to as the co-forming configuration, which means a configuration in which the second document sheet and the third document sheet are placed on top of each other to form a stack of sheets in such a way that the second document sheet adjoins the third document sheet with its entire surface, and the first document sheet does not adjoin at all the opposite page of the third document sheet, and in which configuration it is possible to observe the third security element provided on or in the second document sheet through a window provided in the third document sheet, and it is possible to observe the second security element, in particular at an angle other than a right angle to the document plane, without using a reading element.

[0064] According to the present invention, the term "window" in a multi-page secured document is understood to mean a transparent area in the personalized

page (data page) of such a multi-page secured document.

[0065] It is to be understood that, as used herein, the terms "hue", and "shade", and "color" are used interchangeably to refer to the various lengths of reflected light perceived by an observer. To sum up, with regard to the phenomenon of color perception, it should be assumed that two different hues/shades/colors differ from each other because light is emitted or absorbed by one shade at a specific wavelength, which is different from the wavelength characteristic of the other shade. Thus, determining that an object differs in color means that light emitted or absorbed by one object has a specific wavelength, which is different from the wavelength of light emitted or absorbed by the other object.

[0066] According to this description, the term "line frequency" in printing should be understood as the distance between the first edge of the printed line and the first edge of the adjacent line. If a printed element contains lines in more than one color in a repeatable order, then, according to this description, the frequency is defined as the distance between the first edge of the line of one of the colors and the first edge of the next line of the same color, which corresponds to the sum of the line thicknesses that can be distinguished between two lines of the same color in all colors and the distance between them. For example, if a printed element contains printed lines in three colors, the frequency will have a value equal to the sum of three printed line thicknesses, which are lines of different colors, and three distances between the lines.

[0067] The term "marking frequency" should be understood as the distance between the first edge of the line marked during laser marking and the first edge of the adjacent line.

[0068] The term "frequency of the lens array", also known as the pitch of the lens, should be understood as the width of one lens in the array.

[0069] As used herein, whenever reference is made to an "image" or "pattern" it is meant to be understood as a generally visually legible marking, either without the use of the reading or co-forming element, or through the use of appropriate visualizing, revealing or co-forming tools, often carrying a specific information that is embraced for observation by an observer under normal conditions of observing the marking. Such markings include both realistic and abstract motifs, in particular linear motifs. Examples of realistic motifs include, in particular, portraits, landscape, plant and animal motifs. Realistic motifs can also be images of coats of arms, buildings and flags. Abstract motifs include all other graphic forms of marking, in particular those that constitute specific patterns, signs or codes. Other specific examples of abstract motifs are text or individual letters or numbers. According to the present invention, it is possible that under normal lighting and without the use of any reading elements or additional devices, only fragments of markings, such as, for example, fragments of a pattern, such as linear patterns, text,

letters or numbers, are visible, and they become fully visible only after being read by the appropriate reading element. The marking according to the invention may consist of a specific pattern, single or multi-colored, in particular a single or multi-colored background. In particular, such patterns may constitute signs which, when assembled with an appropriate component, create a background image of a uniform or variable color, which highlights any other images or patterns present on or in the obtained marking or gives the impression of movement.

[0070] In accordance with this description, the symbol $\pm$ or $+/-$ should be understood as defining the range of values that a given quantity may take. For example, the statement that a given value is $X \pm Y\%$ should be understood as corresponding to the statement that the given

value is in the range $(X - \frac{Y}{100} \text{ to } X + \frac{Y}{100})$.

[0071] Any layer whose characteristics can be changed by exposure to a laser should be considered a layer susceptible to laser marking. In particular, layers of a film susceptible to laser modification and layers of a paint susceptible to laser modification, including a laser of a specific wavelength, can be considered layers susceptible to laser marking. Particular layers susceptible to laser marking are layers of film and paint susceptible to modification with a laser at a wavelength of light in the UV or IR range, or other layers whose spectral characteristics of reflected and transmitted light in a specific range, for example in the visible light range, can be changed as a result of processing such a layer with laser light.

[0072] The present invention will be described in greater detail below with reference to specific embodiments of the invention and to the Drawings and Figures illustrating the invention.

Brief description of the Drawing

[0073] The invention is illustrated in the Drawing, in which:

Fig. 1 shows a view of a multi-page secured document 100 in the form of a passport booklet in the open configuration, showing the first document sheet 110, the second document sheet 120 and the third document sheet 130, and the first page of the third document sheet 133.

Fig. 2 shows a schematic cross-sectional view of the third document sheet 130 in the area of the window 139 with the reading element 131 (A) and the co-forming element 132 visible, in the laser marked with a blackening effect (B and C), offset printed (D), and laser marked without a blackening effect (E) versions.

Fig. 3 shows a schematic side-sectional view of a

multi-page secured document 100 in the form of a passport booklet in the open configuration in the area of the window 139, the first security feature 111 and the third security element 122.

Fig. 4 shows a schematic view of a multi-page secured document 100 in the form of a passport booklet in the open configuration.

Fig. 5 shows a graphical visualization of the second optical security 127 (obtained/observed in the co-forming configuration) which is the assembly of the third security element 122 and the co-forming element 132, in six different embodiments, in which the marking provided by the second optical security 127 is present in the third security element 122 (as shown in the panels A, D, E and F) or in the co-forming element 132 (as shown in the panel B, C, and in the panel B' showing a photograph of the embodiment of the invention shown in panel B), respectively, and in which the superposition of the third security element 122 and the background of the co-forming element 132 either creates a marking in the form of a background that differs in color/shade from the color/shade present in the second optical security 127 of the marking, thereby emphasizing the markings present in the second optical security 127 (the panels A, B, D, E and F), or else does not provide a background highlighting the marking present in the second optical security 127 (the panel C).

Fig. 6 shows a graphical visualization of three implementations of the first optical protection 115 (observed in the reading configuration), which is composed of the first security feature 111 with the reading element 131. The panel A) shows a graphical visualization of a superposition containing a hidden image of the first security element 117 (invisible when observing the first document sheet 110 in the co-forming configuration) with the reading element 131, the first security element 117 being an element revealed by the reading element 131 in the form of a lens array acting as a revealing element in the reading configuration.

The panel B) shows a graphical visualization of the implementation of the first optical protection feature 115 and the panel B' shows a photograph of the implementation of the first optical protection 115. The upper diagram of the panels B and B' is shown in the reading configuration, and the lower diagram of the panels B and B' in a view from an angle other than the right angle to the first document sheet 110 in the co-forming configuration. According to this embodiment, the first security feature 111 includes the first security element 117 and the second security element 118, where the first security element 117 is an element revealed by the reading element 131 in the form of a lens array serving as the revealing

element in the reading configuration, and the second security element 118 is a security element with an angular effect, visible in the co-forming configuration at an angle other than the right angle to the first document sheet 110 without the use of the reading element 131.

Fig. 6 in the panel C) shows an embodiment in which the first security feature 111 includes the first security element 117 and the second security element 118 with an angular effect, which second security feature 118 can be observed on the first document sheet 110 in the co-forming configuration without using the reading element only at an angle other than the right angle to the page of the document which is the carrier of the first security feature 111, while the heterogeneous reading element 131 present in the third document sheet 130 may contain a revealing and visualizing element next to each other, which will enable reading in the reading configuration of both the first security element 117 and the second security element 118 regardless of the first security feature viewing angle.

Fig. 7 shows a diagram for obtaining the first security feature 111 as shown in Fig. 6B), including the first security element 117 and the second security element 118, which first security element 117 is an element revealed by the reading element 131 in the form of a lens array serving as a revealing element in the reading configuration, and the second security element 118 is an angular effect element, visible when viewing the first document sheet 110 in the co-forming configuration at an angle other than the right angle to the document sheet on which the second security element 118 is applied, and invisible by the reading element 131.

Detailed description of the invention

[0074] An embodiment of the present invention will be described in the context of a specific multi-page secured document, namely a passport booklet as shown in Fig. 1 and Figs. 3-4. However, the invention is suitable for use in any other multi-page secured document which contains information, for example, in the form of personal data of the holder of such document, and which comprises, but is not limited to, vehicle cards, various types of membership booklets and ID cards.

[0075] As shown in Fig. 1 and Figs. 3-4, showing a passport booklet in the open configuration, such a booklet includes the first document sheet 110, which in a practical implementation of the invention constitutes an endpaper permanently connected to the covering material of the cover, and the second document sheet 120, which in a practical implementation of the invention constitutes a visa page of the passport adjacent at the one side to the remaining sheets of the multi-page secured

document, at least part of which are other visa pages of the passport, and the third document sheet 130 constituting a personalized page/data page having the first page of the third document sheet 133 adjacent to the endpaper and constituting a title page of the document and the second page of the third document sheet 134, adjacent to the visa page and constituting the personalized page of the document. The first document sheet 110, the second document sheet 120, the third document sheet 130 and the remaining sheets of the multi-page secured document are permanently movably connected to each other in such a way that the multi-page secured document 100 can assume both open configurations, where at least two adjacent sheets do not adjoin each other, and a closed configuration in which all adjacent sheets adjoin closely each other over the entire surface of the sheet, in which closed configuration of the multi-page secured document, the first document sheet 110, the second document sheet 120 and the third document sheet 130 are placed on top of one another by forming a stack of sheets such that both the first document sheet 110 and the second document sheet 120 adjoin, in the closed configuration of the multi-page document, the third document sheet 130 while being situated on opposite pages of the third document sheet 130, the first document sheet 110 adjoining the first page 133 of the third document sheet 130 and the second document sheet 120 adjoining the second page of the third document sheet 130 opposite in relation to the plane of the third document sheet 130.

[0076] On the endpaper there is the first security element 117 and the second security element 118 of the first security feature 111 constituting, together with the reading element 131, the first optical security 115. Further, on the visa page there is the third security element 122 of the second optical security 127. The page with data in the window area 139 is provided with the reading element 131, enabling reading the first security feature 111, providing the first optical security 115, and the co-forming element 132, which, together with the third security element 122, co-forms the second optical security 127. The reading element 131 and the co-forming element 132 are integrated not only with the window 139, but also with each other, in a particular embodiment they constitute one element, the reading element 131 being consistent with the first security feature 111, and serving to read either the first security element 117 of the first optical security 115 or the first security element 117 and the second security element 118 of the first optical security 115, and the co-forming element 132 being consistent with the third security element 122 of the second optical security 127, and serving to co-form with the third security element 122 the second optical security 127. In a specific embodiment of the present invention, the reading element 131 is a lens array.

[0077] In practical implementations of the invention, the second security feature 127 includes the third security element 122 applied to or in the second sheet 120 of

the multi-page secured document, such as a visa page of the passport booklet, and the co-forming element 132, which elements include at least one marking of the second optical security 127, and which marking may include an image, design, background, motif or sign or combinations thereof. The third security element 122 consists of patterns of lines or motifs with a specific frequency; and

the co-forming element 132 is placed in the window 139 of the third document sheet 130,

wherein the co-forming element 132 also includes a set of applied parallel lines/motifs with a defined frequency and areas without lines/motifs acting as gaps located between the applied lines/motifs, and

wherein the co-forming element 132 is applied to or in the markable plastic substrate of the third sheet 130 of the multi-page secured document 100 by laser marking or printing. An array of parallel lines/motifs can be obtained, for example, by marking with a blackening effect, but in some embodiments such marking does not involve a change in the color of the substrate. Marking can, for example, be carried out by offset printing. In other embodiments, the array of parallel motifs may constitute an array of lenses, in a particularly preferred case also constituting a reading element 131. In such an embodiment, the functions of the gaps will be performed by unmodified areas of the substrate between the printed lines or lenses.

[0078] Preferably, the orientation of the lines of the third security element 122 relative to the lines of the co-forming element 132 in the plane defined by the sheets of the multi-page document 100, in particular in the plane of the third sheet 130 constituting the personalized page of the document, is rotated by an angle of no more than $\pm 5^\circ$. There are possible embodiments in which the orientation of the lines of the third security element 122 relative to the lines of the co-forming element 132 in the plane defined by the sheets of the multi-page document 100, in particular in the plane of the third sheet 130 constituting the personalized page of the document, is rotated by an angle of more than $\pm 5^\circ$.

[0079] Both the third security element 122 and the co-forming element 132 may be applied in whole or in part during the production of the sheets of the multi-page document with the security features 100, before they are permanently joined together in a movable manner, and also after the sheets of the multi-page document with the security features 100 are permanently joined together.

[0080] The third security element 122 may be made by printing using printing techniques well known in the art, for example, gravure printing, screen printing, offset printing, digital printing, or by laser marking, if the second document sheet 120 is made of a material susceptible to

laser marking. If, in practical implementation, the security element is applied by offset printing, multi-colored inks can be used for printing, especially when the goal is to obtain a rainbow effect in the background, then the lines are most preferably printed in three basic colors.

[0081] In practical implementations of the present invention, the co-forming element 132 is most often applied either on or in the window 139 of the third document sheet 130, which window is made of a laser markable plastic, after permanently movably joining together the sheets of a multi-page secured document. The window material may be a single layer made of a laser-markable plastic material, or a layered system including multiple layers, at least one of which is made of a laser-markable plastic material. Thus, in practical implementations, the co-forming element 132 is applied by printing or laser marking. In a special case, the document may not contain the co-forming element 132 and the function of the co-forming element 132 may be performed by the reading element 131 and vice versa.

[0082] In embodiments of the invention, the entire third document sheet 130 is made of a laser markable plastic material, preferably a polymer such as polycarbonate (PC), polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC) or polyurethane (PU). In particularly preferred embodiments of the present invention, the third document sheet 130 is a sheet formed of polycarbonate (PC). However, the third document sheet 130 may also be a multilayer system including layers of fibrous material, and only in the window area it may be made of the above-mentioned raw materials, such as a plastic material. Moreover, the third document sheet 130 may also be a layered system in which only some of the layers will be plastic layers. In some embodiments, the third document sheet 130 is a composite system formed from a fibrous material blended or coated with a plastic layer.

[0083] In many practical embodiments of the present invention, some of the security elements are applied during the personalization of the document. Thus, the second optical security 127 contains, in preferred embodiments of the invention, personalized data of the holder of a multi-page secured document, such as, for example, name, surname, date of birth, document holder number or individual document number, etc.

[0084] Specific implementations of the reading elements 131 and co-forming elements 132 are shown in Fig. 2. As shown in Fig. 2, a particularly preferred combination of revealing or visualizing elements of the reading element 131 is an array of lenses located on the first side of the third sheet 133 which, depending on the form of the first security feature 111, fulfils either the function of visualizing, or revealing one of the security elements of the first security feature 111, and a set of parallel lines applied on the other side of the third sheet 134 by laser marking with a blackening or transparent effect, or offset printing, acting as the co-forming element 132, where the period of the co-forming element 132 is the sum of the line width and the width of the space between adjacent lines

applied in part of the volume, to an incomplete depth (Figs. 2 B, D, E) of the window 139 of the third document sheet 130 as well as those applied in the entire volume (Fig. 2 C), to the full depth of the window 139 of the third document sheet 130.

[0085] Fig. 5 shows the second optical security 127, which is a combination of the third security element 122 in the form of an offset print placed on the second sheet of a multi-page document 120 in the form of parallel lines, with the co-forming element 132 in the form of laser-engraved, parallel lines placed in the window 139 of the third sheet of the multi-page document 130 (in the personalized page). Fig. 5 shows six different embodiments of the present invention, where the individual panels respectively show:

A) The third security element 122 printed by offset printing, which consists of parallel, multi-colored lines, some of which are shifted relative to the others by a certain distance and may have a different frequency, with these lines creating an image/pattern visible without the use of the co-forming element 132 against the background of the parallel lines, and thus includes a marking visible without the use of the co-forming element 132, containing an image, pattern, motif or sign on a background different from this image/pattern, while the co-forming element 132 applied using the laser marking with a blackening effect consists only of an array of lines parallel to each other. After superimposing the third security element 122 and the co-forming element 132, the parallel lines of the third security element 122 and the co-forming element 132 create a clear marking which includes, in addition to the marking element such as an image, pattern, motif or sign, also the background (in the figure it is the RP pattern and the background).

B) The third security element 122 printed by offset printing consists only of multi-colored lines parallel to each other, while the co-forming element 132, applied using the laser marking with a blackening effect, consists of parallel lines, some of which are shifted relative to the others by a certain distance and these lines create respectively visible image/pattern against the background of parallel lines. When the third security element 122 and the co-forming element 132 are superimposed, the parallel, multi-colored lines of the third security element 122 and the parallel lines of the co-forming element 132 form a clear marking including, in addition to the marking element such as an image, pattern, motif or sign also a background (in the figure, the RP pattern, also the background).

C) The third security element 122 printed by offset printing consists only of multi-colored lines parallel to each other, while the co-forming element 132, ap-

plied using the laser marking with a blackening effect, consists of parallel lines creating a visible marking such as an image, pattern, motif or sign. When the third security element 122 and the co-forming element 132 are superimposed, the parallel multi-colored lines of the third security element 122 and the parallel lines of the co-forming element 132 form a distinct marking including said image, pattern, motif or sign (in the figure, the RP pattern observed against a background of multi-colored lines of the third security element 122).

D) The third security element 122 printed by offset printing, which consists of single-color lines parallel to each other, the thickness of which is modulated in such a way that the thickened line fragments create the image/pattern visible without the use of the co-forming element, while the co-forming element 132 applied using the laser marking method with a blackening effect consists only of an array of parallel lines with a frequency equal to the frequency of the lines of the third security element 122. After superimposing the third security element 122 and the co-forming element 132, the parallel lines of the third security element 122 and the co-forming element 132 create a clear marking on the background (D1). When the lines of the co-forming element 132 are moved in a direction perpendicular to the lines of the third security element 122, for example due to a more prominent opening of the booklet document and the resulting slight shift of the page containing the co-forming element 132, or an inclination of the booklet document and the resulting parallax effect, the lines of the co-forming element 132 cover the shoulders of the lines of the third security element 122, making the marking invisible (D2).

E) The third security element 122 printed by offset printing consists of parallel, alternating lines of a first color, e.g., blue, and a second color, e.g., red, which lines contain local curvatures creating a relief image/pattern visible without the use of the co-forming element, while the co-forming element 132 applied by laser marking with a blackening effect consists only of an array of parallel lines with a frequency twice as low as the frequency of the lines of the third security element 122. The observer, while observing the third security element 122 in the reading configuration, perceives it in a third color, e.g. violet, which is a combination of the first and second colors. When the third security element 122 and the co-forming element 132 are superimposed, the parallel lines of the third security element 122 and the co-forming element 132 form a clear marking. Depending on the mutual arrangement of the lines of the third security element 122 and the co-forming element 132, the marking may be in the first color against the background of the second color (E1), or in the second

color against the background of the first color (E2), or in the third color with a border in the first color against the background of the third color (E4), or in the third color with a border of the second color on the background of the third color (E3). Moreover, when changing the mutual arrangement of the lines of the third security element 122 and the co-forming element 132, for example by tilting, opening or closing the booklet document, a "pumping" effect is observed, i.e. a smooth increase or decrease of the thickness of the marking lines.

F) The third security element 122 printed by offset printing, which consists of an array of repeating graphic motifs, essentially invisible without magnification, while the co-forming element 132, applied by laser marking with a blackening effect, consists only of an array of parallel lines with a frequency different from the frequency of the lines of the third security element 122 by approx. 5-10%. After superimposing the third security element 122 and the co-forming element 132, an array of repeating motifs of the third security element 122 and the co-forming element 132 creates a distinct marking by the principle of moiré magnification. Furthermore, when changing the mutual orientation of the lines of the third security element 122 and the co-forming element 132, for example by tilting, opening or closing the booklet document, an effect of movement of the marking in a direction perpendicular to the lines of the co-forming element 132 is observed.

B') A photograph of the implementation of the invention shown in Fig. 5B

[0086] Further, Fig. 6 illustrates in the panel A) the visual effect provided by the first security feature 111 of the first optical security 115 using a lens array as the reading element 131. While the first security element 117 of the first security feature 111 is not visible when viewing the first document sheet 110 in the co-forming configuration from all viewing angles, the first security feature 117 becomes visible and distinct when revealed (read) using the window 139 of the reading element 131 acting as the revealing element. The use of the reading element 131 integrated in the document enables reading the markings contained in the first security element 117, in particular an image, pattern, motif or sign(s).

[0087] In the event that the first security feature 111 present in or on the first document sheet 110 includes, in addition to the first security element 117, also a second security element 118 with an angular effect, visible when viewing the first document sheet 110 in the co-forming configuration without the use of the reading element, this first optical security feature carries a number of different pieces of information, in particular in the form of various images, patterns, motifs or signs. This solution is illustrated in Fig. 6 B). In the implementation of the invention

shown in Fig. 6 B), the second security element 118 of the first security feature 111 is an angle security which, as shown in both panels B) and B') (where panel B' is a photograph of the subject embodiment), is visible without use of the reading element at a viewing angle other than the right angle to the document sheet 110. In such a situation, when viewing the second security element 118 in the co-forming configuration at the right angle to the surface of the first document sheet 110, no image, pattern, motif or sign will be visible. However, when the surface is tilted relative to the viewing direction, the second security element 118 will become visible. Further, analogously, as discussed above with respect to the implementation of the invention shown in Fig. 6, the panel A), the first security element 117 is visible and distinct when revealed (see Fig. 6, the panels B) and B')) using the reading element 131 located in the area of the window 139 in the form of a lens array. The use of the reading element 131 integrated with the document makes it possible to read in the reading configuration the information contained in the first security element 117, in particular an image, pattern, motif or sign(s).

[0088] Fig. 6 C) further illustrates a particular implementation of the invention in which the first security feature 111 present in or on the first document sheet 110 includes the first security element 117 and a second security element 118 with an angular effect, which second security element 118 can be observed on the first document sheet 110 in the co-forming configuration without the use of the reading element only at an angle other than the right angle to the page of the document constituting the carrier of the first security feature 111, while the heterogeneous reading element 131 present in the third document sheet 130 may include a revealing and visualizing element that enables reading in the reading configuration of both the first security element 117 and the second security element 118 regardless of the viewing angle of the first security feature 111. In such a situation, by observing the first security feature 111 through the reading element 131 in the reading configuration through the window 139 of the third document sheet 130, we can see all the markings covered by the first security feature 111, i.e. the first security element 117 and the second security element 118.

[0089] An exemplary method for producing a multi-page secured document of the invention is described below with reference to the specific embodiments discussed above. However, it is obvious to the one skilled in the art that appropriate security and reading elements and co-forming elements can be successfully applied in various combinations to specific pages of the document, with one limitation being that those security elements introduced into the document which, by necessity of their application, are applied by laser marking, must be entered on the data page of a multi-page document 100 with security features.

1. Production of the first security feature 111

[0090] Formation of the first security feature 111 takes place at the design and printing stage using the steel engraving or offset technique. In accordance with the present embodiment of the invention, the first security feature 111 is obtained, as shown in Fig. 7, by assembling various security elements including the first security element 117 and the second security element 118. However, only the first security element from the above-indicated elements can be successfully used as the first security feature. Thus, in particular embodiments of the invention, the first security feature 111 is the first security element 117.

a. Designing the first security element 117 to be revealed by means of the reading element 131 which constitutes a lens array.

[0091] The first security element 117 consists of:

- a first grid (a first array) of parallel lines, which lines, after the security element is revealed, will constitute the background for the hidden image (background lines), and
- the second identical grid (a second array) of parallel lines, which lines, after the security element is revealed, will constitute the revealed image - stars as in Fig. 6 B (image lines):
 - > wherein the parallel lines of the first and second grids of parallel lines having a thickness preferably ranging from 50 μm to 200 μm are offset from each other by half the distance between the lines. In alternative embodiments, this distance may be different, in particular less or more than half the distance between the lines, in particular half the distance between the lines $\pm 15\%$, preferably $\pm 10\%$ and most preferably $\pm 5\%$ of the distance between parallel lines,
 - > and wherein, most preferably, the angle of the first grid of parallel lines (a background) and the second identical grid of parallel lines (stars) is 0° .

[0092] The frequency of the first grid of parallel lines (the background) is greater than the frequency of the lenses used to read the image and to reveal it, by 1%. In other alternative embodiments of the invention, the frequency of the first grid of parallel lines (the background) is lower than the frequency of the lenses used to read the image and to reveal it, by 1%. In still other embodiments, the frequency of the first grid of parallel lines (the background) is higher or lower than the frequency of the lenses used to read the image by more than 1%, the difference not exceeding 2%. If the frequency of the lines and the lens array were the same, there would be embodi-

ments in which the image would not be revealed. Further, if the frequency of the first grid of parallel lines (the background) used was higher or lower than the frequency of the lenses used to read the image by more than 2%, the *moiré* effect would increase, making the image less clear. The thickness of the line is preferably equal to half the frequency value of the lenses used to read the image. In other alternative embodiments, this thickness may differ slightly from the value equal to half the frequency of the lens array used to read the image and be higher or lower than half the frequency of the lens array used to read the image by 15%, preferably by 10%, more preferably by 5% of this value.

[0093] In another embodiment of the invention, in which there is no second security element 118 and there is only the first security element 117 revealed by means of the reading element 131 which is a lens array (as shown in Fig. 6A) which serves as a revealing element for the first security element 117, said first security element 117 consists of:

- a first grid of parallel lines, which lines, after the security element is revealed, will constitute the background for the hidden image (background lines), and
- a second identical grid of parallel lines, which lines, after the security element is revealed, will constitute a hidden image - the PWPW logo as in Fig. 6A (image lines), and which lines are inclined towards the background lines by a small angle. In the solution shown in Fig. 6A, the angle of inclination relative to the background line is 15° . In other alternative embodiments, this angle is preferably in the range of 10° to 18° .

b. Designing the second security element 118.

[0094] The second security element 118 in the form of a security element with an angular effect consists of:

- a first grid of parallel lines (a background) and
- a second grid of parallel lines at 90° to the first grid. In other alternative embodiments of the invention, the angle between the lines of the first grid and the second grid may vary from 90° , however, it is preferably $90^\circ \pm 15\%$, more preferably $90^\circ \pm 10\%$, most preferably $90^\circ \pm 5\%$.

[0095] In embodiments of the invention, when the second security element 118 is a security element with an angular effect (as shown in Fig. 6C) visualized by the reading element 131 which is a lens array, in such an embodiment the frequency of the background lines and the image lines of the second security element 118 differs from the frequency of the lenses by a value ranging from 1% to 2% of the frequency of the lenses, and the thickness of the lines is equal to half the frequency value

(analogously as described above for the frequency of the first grid of parallel lines (the background) of the first security element 117).

[0096] c. Combining the first security element 117, which is revealed by the reading element 131, which is an array of lenses, and the second security element 118, which is an element with an angular effect in the form of a grid of parallel lines.

[0097] The design of one of the security elements is converted into a negative and superimposed on the image of the other security element. It is important that the lines of the second security element 118, which is a security element with an angular effect, and the first security element 117 revealed by the reading element 131, form an acute angle with each other. According to the described embodiment of the invention, this angle is preferably 45°. Alternative embodiments use arrays, in which this angle is in the range of 30° to 60°, preferably 40° to 50°, with the most preferred angle being close to 45°, for example 43°, 44°, 46° or 47°.

[0098] The resulting design is transferred to a printing plate, and then, in the printing process, printing is performed on sheets of a secured document. According to an exemplary embodiment of the present invention, this printing is performed on endpaper.

[0099] According to an exemplary embodiment of the present invention (shown in Fig. 7), the first security element 117 is converted into a negative and revealed by means of the reading element 131, which first security element 117 consists of a grid of parallel lines (including a hidden image - stars). The negative is superimposed on the second security element 118 with an angular effect, which consists of two grids of parallel lines inclined at 90° to each other and at 45° to a horizontal line, which is a line parallel to the longer side of the multi-page secured document. Thanks to this arrangement, it is possible to observe on the first document sheet 110 in the configuration of co-forming the image hidden in the second security element 118, which is a security element with an angular effect, at an angle other than the right angle to the first document sheet 110, visualized in Fig. 6B in the form of signs, letters forming the inscription PL.

2. Printing an element printed with offset or digital printing - production of the third security element 122

[0100] According to an exemplary embodiment of the present invention, the third security element 122 is applied to the paper intended for a first visa page, i.e. the second document sheet 120 (or in alternative embodiments of the present invention, to the endpaper, i.e. the first document sheet 110), in the form of an offset element or a digital print containing parallel lines relative to each other. The parallel lines of the third security element 122 are printed in three primary colors: cyan, magenta and yellow. In other alternative embodiments of the invention, these lines are printed in other, but at least two, different colors, where embodiments are preferred in which the

printed lines are lines in three different colors, the most preferred of which is the above-mentioned color system: cyan, magenta and yellow.

[0101] The frequency of the printed lines of the third security element 122 must be lower than the frequency of the lines of the co-forming element 132 applied in the window 139 of the personalized page constituting the third document sheet 130. Preferably, the sum of the line thicknesses of all colors of the third security element 122 and the distance between them constitutes 85-95% of the line frequency applied by laser marking with the blackening effect of the co-forming element 132.

[0102] In one possible embodiment, the third security element 122 printed by offset printing contains parallel lines that do not create a specific pattern or mark on a specific background (Fig. 5B and Fig. 5C). In an exemplary embodiment, the thickness of the lines is 50 µm and the distance between them is 35 µm. The lines are printed in three colors: cyan, magenta and yellow.

[0103] In other alternative embodiments of the invention, the lines printed by offset printing of the third security element 122 may form a specific image, motif or pattern on a specific background, such as a graphic or alphanumeric pattern as shown in Fig. 5A (RP) and Figs. 5D and 5E (PL). The image, motif or pattern on the background can be obtained in various ways, for example by printing:

- An array of parallel lines shifted relative to the background lines, with the same or different frequency than the background lines (5A),
- An array of lines parallel to each other, the thickness of which is modulated in such a way that the thickened line fragments create an image/pattern (5D) visible without the use of a reading element,
- An array of substantially parallel lines that contain local curvatures creating an image/relief pattern visible without the use of a reading element (5E),
- An array of repeating graphic motifs (5F).

[0104] 3. Production of a personalized plastic page constituting the third document sheet 130 with the window 139.

a. Cutting out the window and preparing signatures.

[0105] Holes are formed in a sheet of white, opaque polycarbonate film. Forming the holes is carried out using a standard technique, by mechanical cutting (however, other methods to form the holes will also be suitable). Then, the layers are completed by arranging the individual layers in an appropriate configuration. In this exemplary embodiment, the layers include a layer of white film with holes, and layers of transparent polycarbonate films provided with offset and screen printing, as well as other methods of protection against document forgery,

commonly used in the case of personalized pages with a window. According to the invention, at least one of the transparent films in a structure comprising a stack of different layers forming a composite must be laser-markable, at least in the area of the hole cut in the white, opaque film sheet. Next, a hinge is placed in the signature, enabling a permanent movable connection of the data page with the other pages using a seam. In alternative embodiments, such a hinge is mounted on a signature formed by a stack of layers.

[0106] In yet another alternative process for making a personalized plastic page, polycarbonate films are automatically assembled based on a combination of the roll and sheet processes, with the option of punching holes, automatically filling them with transparent film and integrating a hinge. Moreover, in other alternative embodiments, the process involves feeding a white film with punched holes from the roll.

b. Lamination of personalized pages.

[0107] Subsequently, the signatures are subjected to a lamination process taking place under the conditions of pressure and temperature. According to a preferred embodiment of the invention, lamination is performed *in vacuo* to ensure a uniform block of a material, called a laminate. The area of the opening in the laminate is called a window. A lens array is pressed onto lamination signatures in place of the window 139 on the third document sheet 130 of the multi-page document 100 with security features. In this exemplary embodiment, a lens with a frequency of 195 μm is used. In other alternative embodiments, other frequencies of lens arrays are used, ranging from 100 μm to 250 μm .

4. Production of booklets

[0108] The printed visa pages, endpaper, cover material and personalized page are combined into a booklet of a multi-page document in a standard way. When joining the pages, including the first document sheet 110, the second document sheet 120, and the third document sheet 130, particular care should be taken to fold the pages so that the third security feature 122 on the second document sheet 120 and the first security feature 111 on the first document sheet 110 at least partially overlap the window 139 in the third document sheet 130.

5. Applying the co-forming element 132

[0109] Applying the co-forming element 132 to the third sheet of the multi-page document 130 is carried out at the step of:

a) personalization of the finished booklet by the laser marking technique, using a computer-controlled laser. An exemplary embodiment of the present invention uses a Nd:YAG laser with a wavelength of 1064

nm. In other implementations, it is possible to use various types of lasers, for example a UV laser, a CO₂ laser with a wavelength in the range of 240-11000 nm, preferably with a wavelength of 10600 nm, or an Nd:YAG laser with a wavelength other than the ones mentioned; or

b) production of the third document sheet 130 by providing an offset printed layer in the form of an array of lines.

[0110] The applied parallel lines constituting the co-forming element 132 are characterized by a frequency greater than the frequency of the parallel lines in the third security element 122.

[0111] In various embodiments of the invention, the co-forming element 132 may be:

- A single array of parallel lines with a constant frequency (e.g. the lines form a background without any image/pattern/character, as shown in Fig. 5A and Figs. 5D-F),
- An array of parallel lines consisting of two grids of parallel lines, shifted relative to each other, but with a constant line frequency, the same for both grids, one grid of parallel lines creating a pattern and the other grid of parallel lines, with the same frequency, but shifted relative to the first grid, creating a background (e.g. the lines form the pattern and the background, as shown in Fig. 5B),
- An array of parallel lines with lengths of individual lines and their mutual arrangement chosen so that they create only a specific image/pattern/sign (e.g. the lines form the pattern without a background, as shown in Fig. 5C),

[0112] In the embodiment shown in Fig. 5B', corresponding to the solution disclosed in Fig. 5B, the co-forming element 132 includes two grids of parallel lines created by laser marking with a blackening effect, forming a background and an image/pattern, respectively. The frequency of the lines of the co-forming element 132 is 270 μm , their thickness is about 80 μm , and the offset is half the frequency.

[0113] Although only a few embodiments have been described above, one of skill in the art will appreciate that there is a large number of different embodiments thereof, and the specific embodiments described above are intended to be non-limiting examples and are not intended to limit the scope of the present invention. The foregoing description is intended to provide those skilled in the art with the information necessary to practice the invention as claimed herein, with the understanding that various changes may be made to the specific embodiments described, either in the implementation of the specific elements described in the exemplary embodiments, or in

the methods used. For the convenience of the reader, a list of reference symbols appearing in the Drawings depicting specific embodiments of the invention is provided below.

List of reference symbols:

[0114]

(100) - multi-page secured document;	10
(110) - first document sheet;	
(111) - first security feature;	
(115) - first optical security feature;	
(117) - first security element;	
(118) - second security element;	15
(120) - second document sheet;	
(122) - third security element;	
(127) - second optical security feature;	
(130) - third document sheet;	
(131) - reading element;	20
(132) - co-forming element;	
(133) - first page of the third sheet;	
(134) - second page of the third sheet;	
(139) - window.	25

Claims

1. A multi-page secured document (100), preferably a passport booklet, comprising:
 - a first document sheet (110) on or in which a first security feature (111) is provided including a first security element (117) and, preferably, a second security element (118); and
 - a second document sheet (120) on or in which a third security element (122) is preferably provided; and
 - a third document sheet (130) provided on at least part of the sheet with a window (139) with a reading element (131) for reading the first security feature (111) and preferably, when the third security element (122) is present, with a co-forming element (132) for co-forming a second optical security (127) with the third security element (122);
 wherein:
 - the first document sheet (110), the second document sheet (120), and the third document sheet (130) are permanently movably connected to each other such that the multi-page secured document (100) can assume both open configurations, including a reading configuration and a co-forming configuration, and a closed configuration; and wherein

- the first security feature (111) provided on or in the first document sheet (110) in a closed configuration of the multi-page document adjoins the window (139) of the third document sheet (130) such that the first security feature (111), when observed in the reading configuration through the window (139) of the third document sheet (130) is at least partially visible, and

- the third security element (122), when present, located on or in the second document sheet (120) adjoins, in the closed configuration of the multi-page document, the window (139) of the third document sheet (130) such that the third security element (122), when observed in the co-forming configuration through the window (139) of the third document sheet (130), is at least partially visible;

and wherein

- the first security feature (111) is

the first security element (117), including a marking, such as, for example, an image, pattern, motif or sign, which is a hidden element that is not visible or legible when observed without the use of the reading element in the co-forming configuration of the multi-page secured document, and is readable in the reading configuration of the multi-page secured document through the reading element (131), and preferably,

the second security element (118), which is a security element with an angular effect, which element is visible and readable when viewed without the use of the reading element (131) in the co-forming configuration of the multi-page document directly on the first document sheet (110) when viewed at an angle;

wherein the first security element (117) of the first security feature (111) and preferably the second security element (118) of the first security feature (111) together with the reading element (131) constitute a first optical security (115) visible in the reading configuration of the multi-page secured document.

ment (100) through the window (139) of the third document sheet (130);

- and the third security element (122), when present, is an element consisting of an array of parallel lines, while the co-forming element (132) is an element consisting of an array of parallel lines matching the one present in the third security element (122), and
- either the third security element (122) or the co-forming element (132) includes a marking such as, for example, an image, pattern, motif or sign, preferably constituting or containing personalized data

and the third security element (122) together with the co-forming element (132) provides the second optical security (127), visible in the co-forming configuration of the multi-page secured document (100) through the window (139) of the third document sheet (130).

2. The multi-page secured document according to claim 1, **characterized in that** the reading element (131) is applied on or starting from the first page (133) of the third document sheet (130) and the co-forming element (132) is applied on or starting from the second page (134) of the third document sheet (130).
3. The multi-page secured document according to claim 1 or 2, **characterized in that** the first security feature (111) is the first security element (117) constituting, together with the reading element (131), the first optical security (115).
4. The multi-page secured document according to claim 1 or 2, **characterized in that** the first security feature is a combination of the first security element (117) and the second security element (118) constituting together with the reading element (131) the first optical security (115).
5. The multi-page secured document according to any of the claims 1-4, **characterized in that** the first reading element (131) is a lens array, preferably a lens array with a frequency ranging from 100 μm to 250 μm .
6. The multi-page secured document according to any one of claims 1-5, **characterized in that** the first security element (117) is an element applied by steel engraving or offset printing.

7. The multi-page secured document according to any of the claims 1-6, **characterized in that** the second security element (118) is a security element with an angular effect printed using the steel engraving technique.

8. The multi-page secured document according to claim 7, **characterized in that** the second security element (118) consists of:
 - a first array of parallel lines and
 - a second array of parallel lines positioned relative to the first array of parallel lines at an angle of $90^\circ \pm 15\%$, preferably $90^\circ \pm 10\%$, more preferably $90^\circ \pm 5\%$, most preferably at an angle of 90° .

9. The multi-page secured document according to claim 7 or 8, **characterized in that** the first security feature (111) is the first security element (117) and the second security element (118) being an element with an angular effect, and the reading element (131) is a lens array, wherein the frequency of the background lines of the first security element (117) differs from the frequency of the reading element (131) by a value ranging from 1%, preferably to 2% of the frequency of the reading element (131), and the line thickness of the first security element (117) is equal to approximately half of the frequency value, most preferably 0.5 of the frequency value.

10. The multi-page secured document according to any one of claims 1-9, **characterized in that** the co-forming element (132) is a linear element comprising a array of lines parallel to each other, preferably straight lines.

11. The multi-page secured document according to any of the claims 1-10, **characterized in that** the third document sheet (130) is a sheet containing at least in the area of the window (139) at least one layer of a laser-markable plastic material, preferably a polymer such as polycarbonate (PC), polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC) or polyurethane (PU), preferably the third document sheet (130) is a sheet containing polycarbonate (PC), more preferably all the layers of the third document sheet (130) are formed from a plastic material.

12. The multi-page secured document according to claim 10-11, **characterized in that** the co-forming element (132) is placed on the surface or in the volume of at least one single layer of the window (139) of the third document sheet (130), preferably extending to the thickness of at least one layer of the window (139) of the third document sheet (130), more preferably extending through the thickness of at least two layers of the window (139) of the third

document sheet (130), most preferably extending through the thickness of all layers of the window (139) of the third document sheet (130).

13. The multi-page secured document according to any one of claims 1-12, **characterized in that** the co-forming element (132) is an array of parallel lines applied by laser marking or offset printing, preferably containing an image, pattern, motif or sign, matching the array of lines of the third security element (122). 5 10
14. The multi-page secured document according to any one of claims 1-13, **characterized in that** the third security element (122) is an element applied by steel engraving printing, offset printing or digital printing. 15
15. A method of securing a multi-page secured document, preferably a passport booklet (100), comprising a first document sheet (110), a second document sheet (120), and a third document sheet (130), where the first document sheet (110), the second document sheet (120) and the third document sheet (130) are permanently movably connected to each other in such a way that the multi-page secured document (100) can assume both open configurations, including a reading configuration and a co-forming configuration, and a closed configuration, 20 25
- which method comprises: 30
- a) applying on or in the first document sheet (110) a first security feature (111) comprising: 35
- a first security element (117), wherein the first security element (117) is a hidden element, invisible or illegible when observed without the use of a reading element (131), and preferably 40
 - a second security element (118), wherein the second security element (118) is a visible and legible element when observed without using the reading element (131) when viewed at an angle; 45
- b) optionally applying a third security element (122) on or in the second document sheet (120); 50
- c) providing a window (139) in the third document sheet (130) including at least one layer of a laser markable plastic material, preferably a polymer such as polycarbonate (PC), polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC) or polyurethane (PU), preferably the third document sheet (130) is entirely made of polycarbonate (PC); 55

d) providing the window (139) on its surface or volume thereof with a reading element (131) which matches the first security feature (111), for reading the first security feature (111) and, if the third security element (122) is present, with a co-forming element (132) that matches the third security element (122) to co-form the second optical security (127), wherein the reading element (131) and the co-forming element (132) are applied either on different pages of the third document sheet (130), or in the volume of the document sheet (130), and preferably they at least partially overlap in the window area (139);

and wherein the first security feature (111) is applied in the area of the first document sheet (110) such that the first security feature (111) when viewed through the window (139) of the third document sheet (130) when the third sheet (130) adjoins with the first page of the third sheet (133) the first document sheet (110), is at least partially visible, and, if present,

- the third security element (122) is applied in an area of the second document sheet (120) adjacent to the third document sheet (130) such that the third security element (122) when viewed through the window (139) of the third document sheet (130) when the third sheet (130) adjoins, with the second page of the third sheet (134), the second document sheet (120), is at least partially visible;

and wherein steps a) and b) are carried out in any order, preferably steps a) and b) are carried out sequentially.

16. The method according to claim 15, **characterized in that** the first security element (117) and/or the third security element (122) are applied by steel engraving, offset or digital printing techniques, preferably, arrays of parallel lines are introduced as the first security element (117), and a linear element comprising systems of lines parallel to each other, preferably straight lines, is introduced as the third security element (122).
17. The method of claim 15 or 16, **characterized in that** the second security element (118) is applied by steel engraving printing, preferably in the form of a security feature with an angular effect.
18. The method of any one of claims 15 - 17, **characterized in that** the co-forming element (132) is applied

by laser marking or offset printing technique, preferably as a linear element comprising systems of lines parallel to each other, preferably straight lines.

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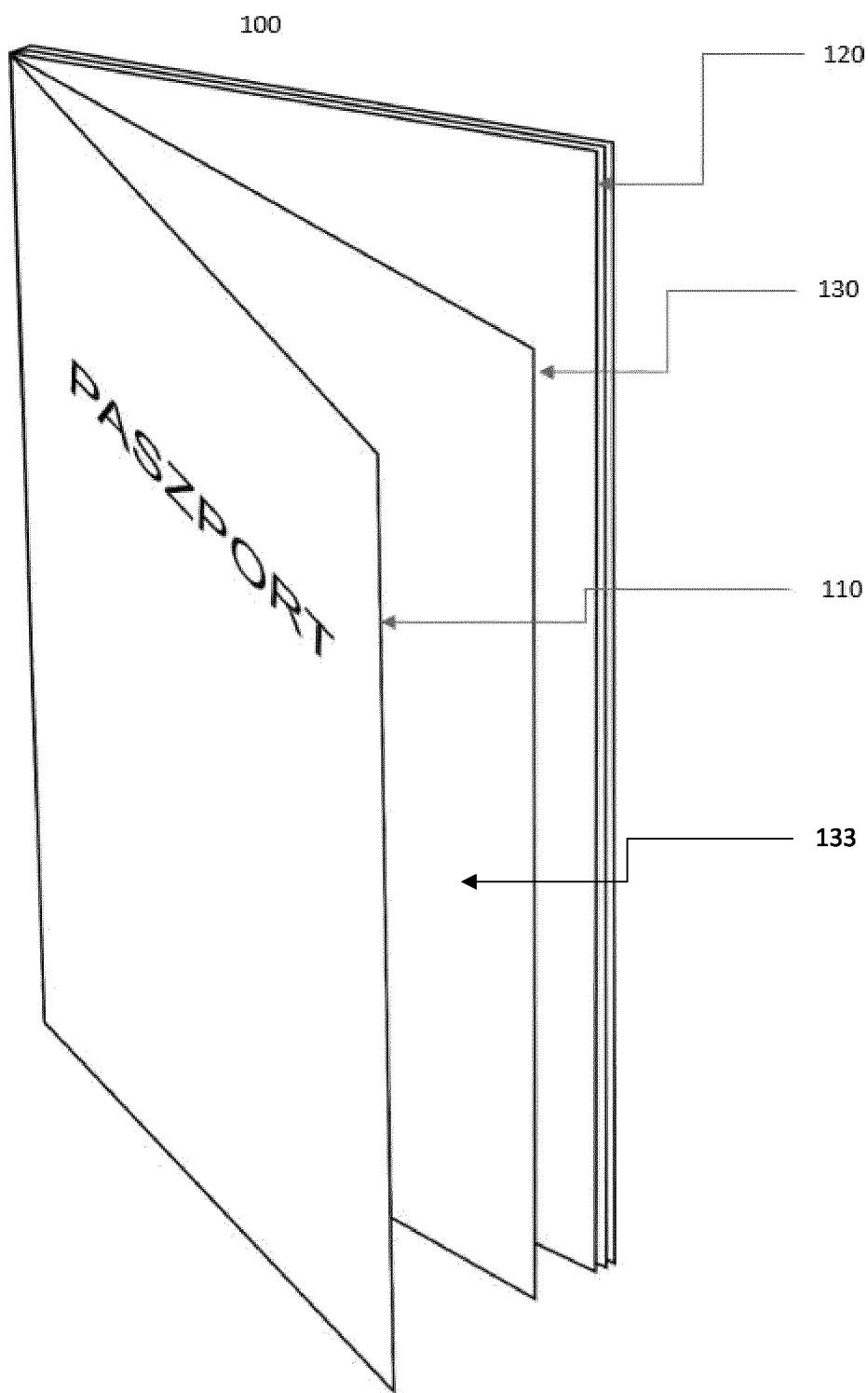


Fig. 1

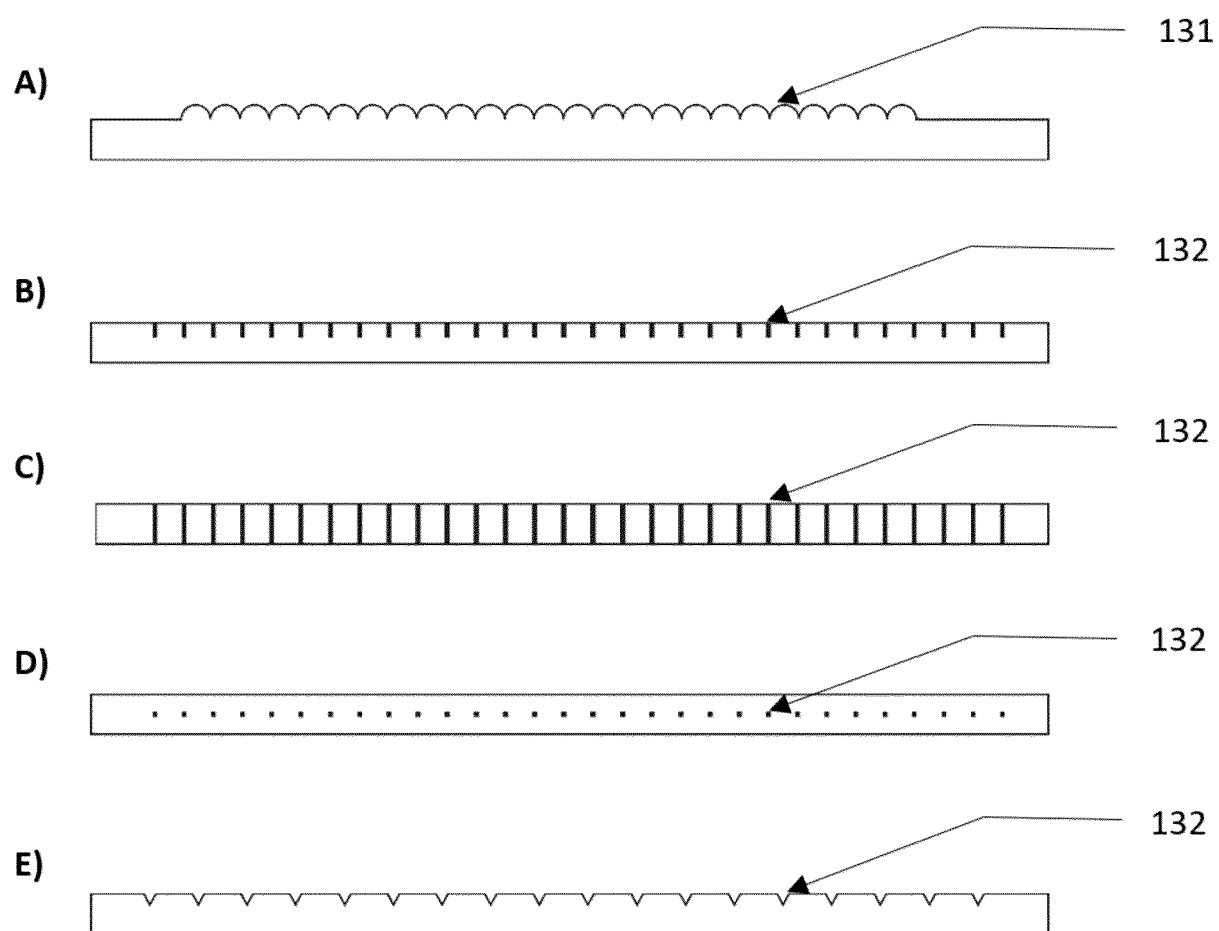


Fig. 2

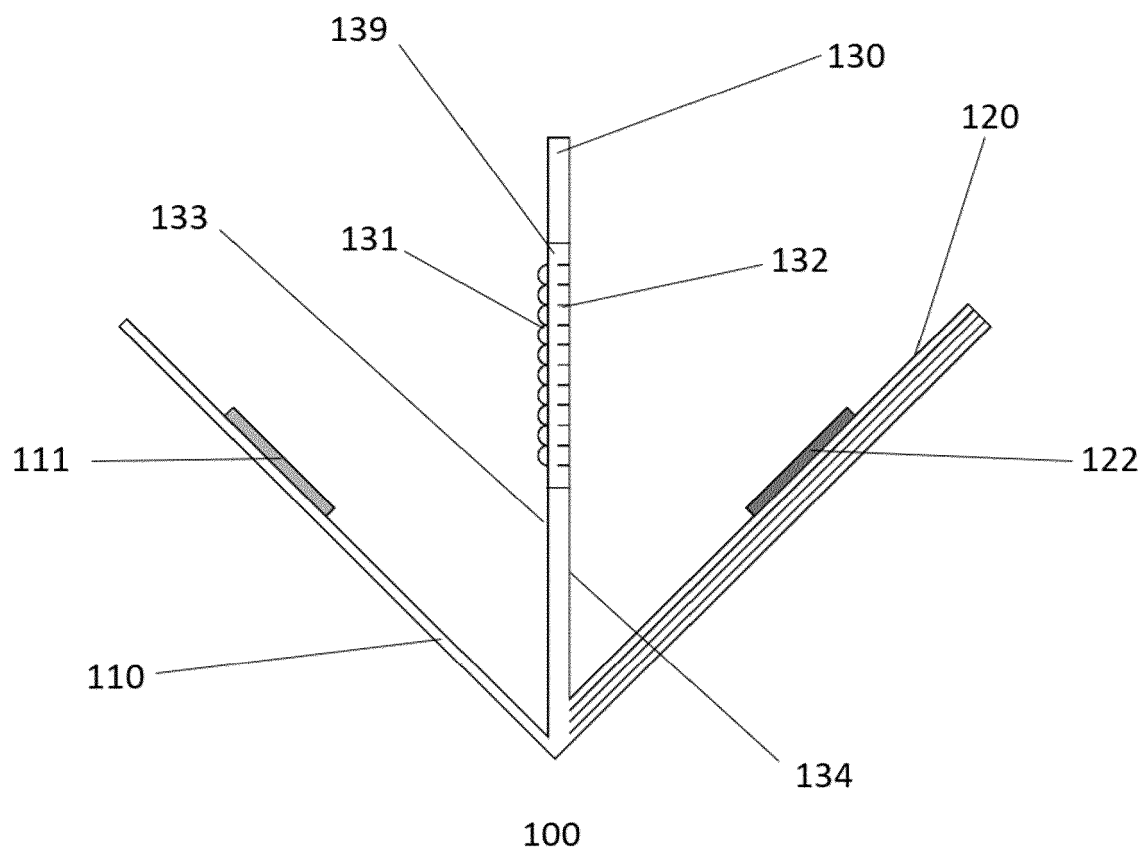


Fig. 3

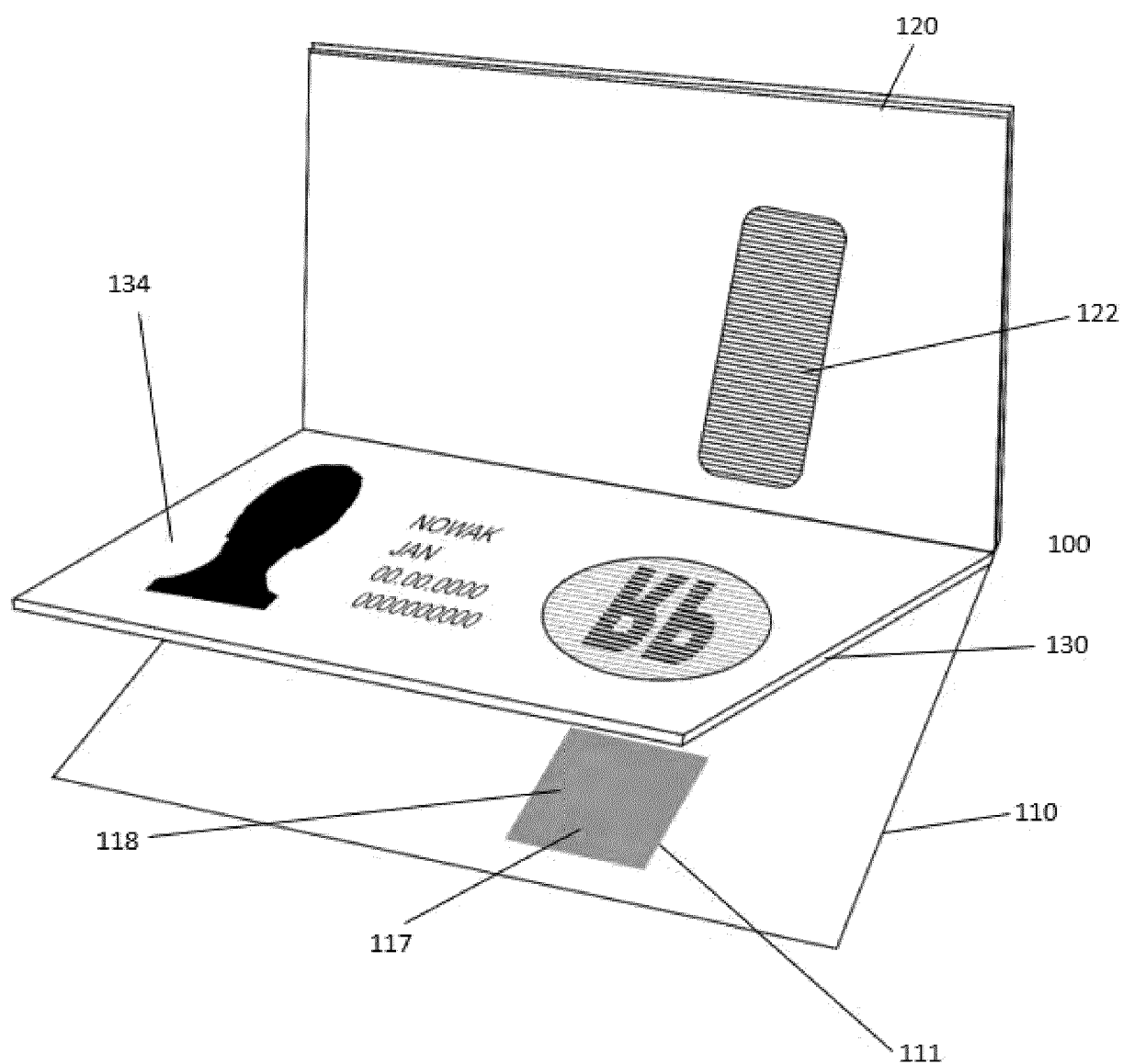


Fig. 4

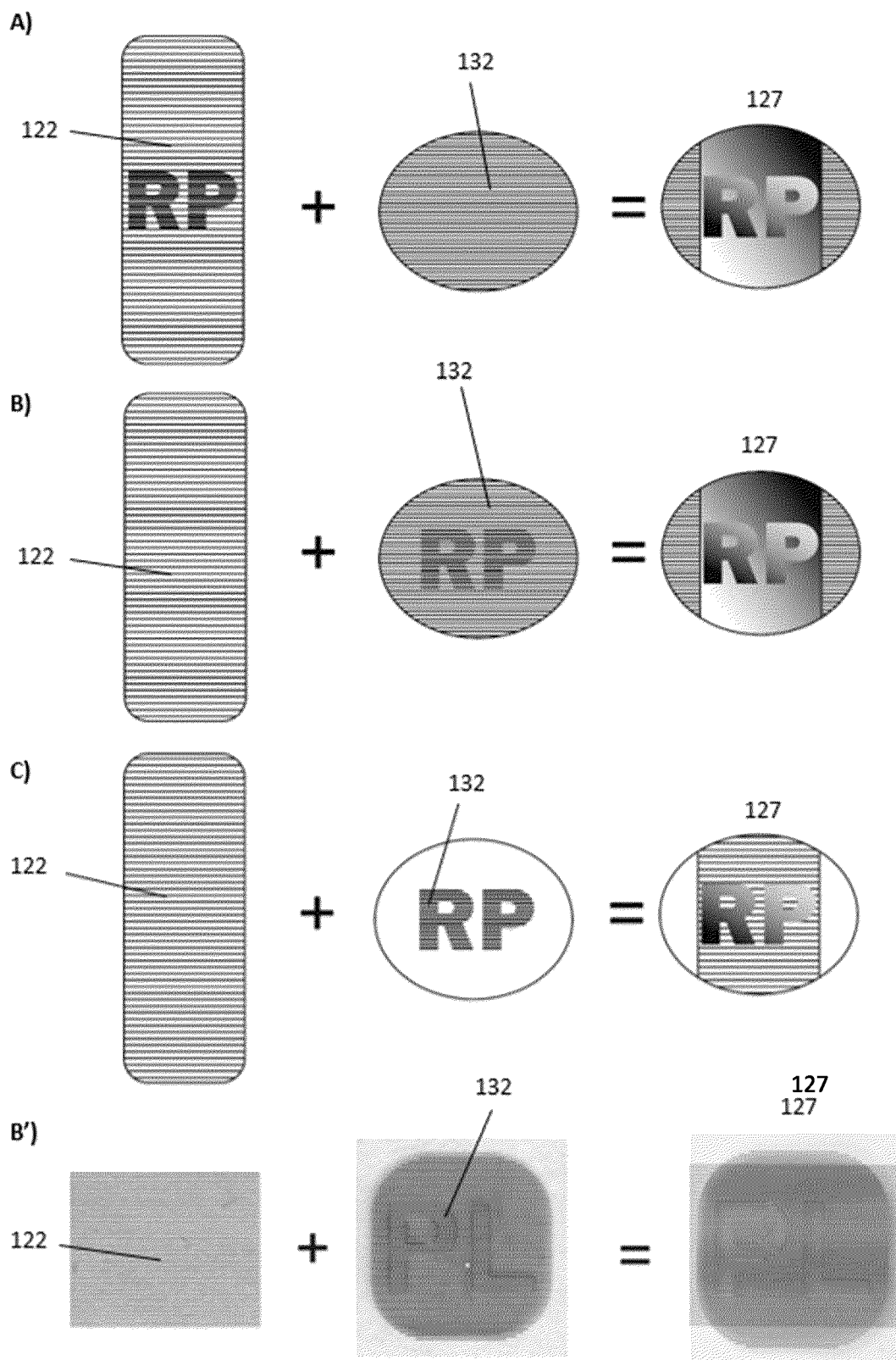


Fig. 5

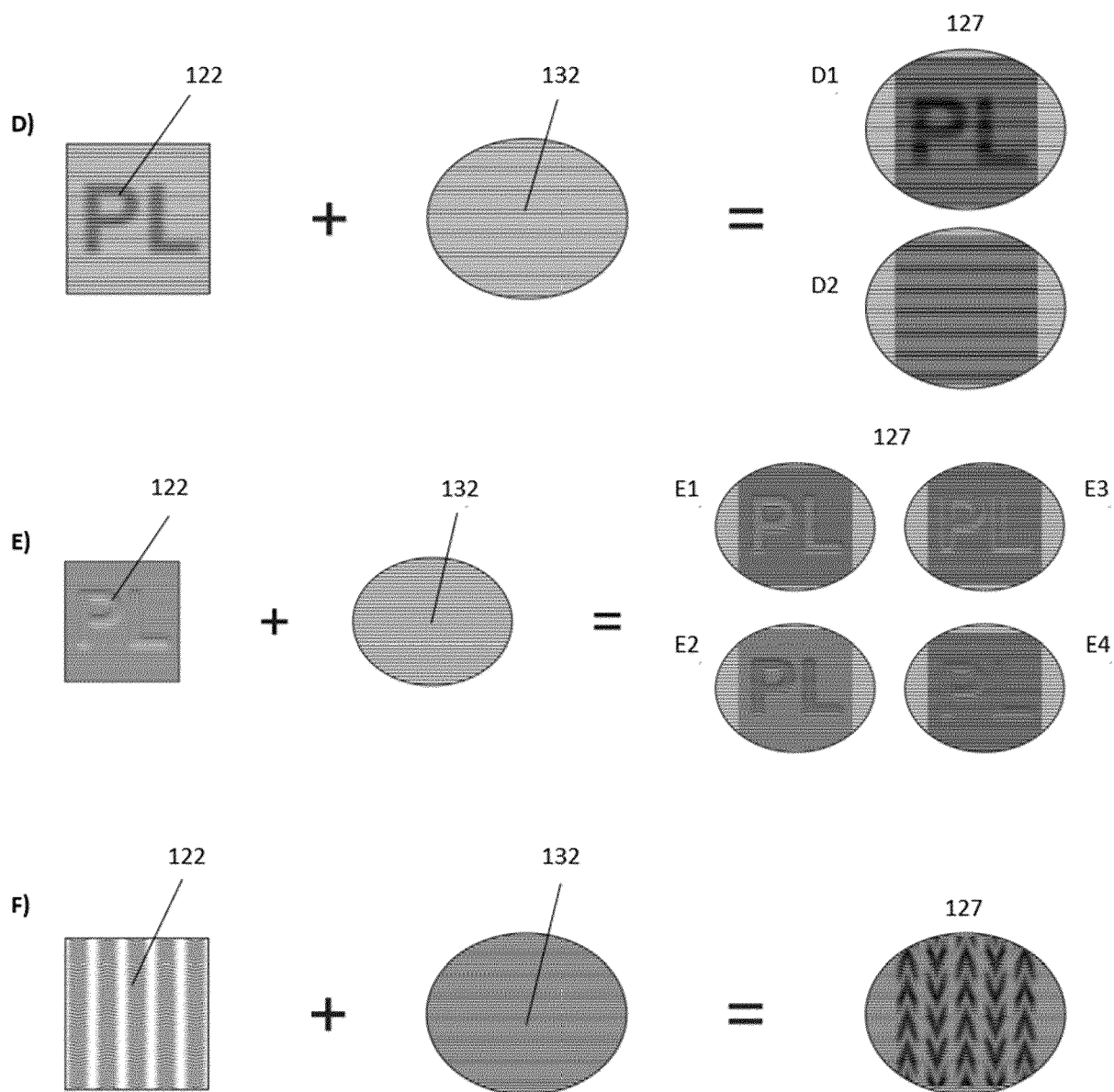


Fig. 5 (c.d.)

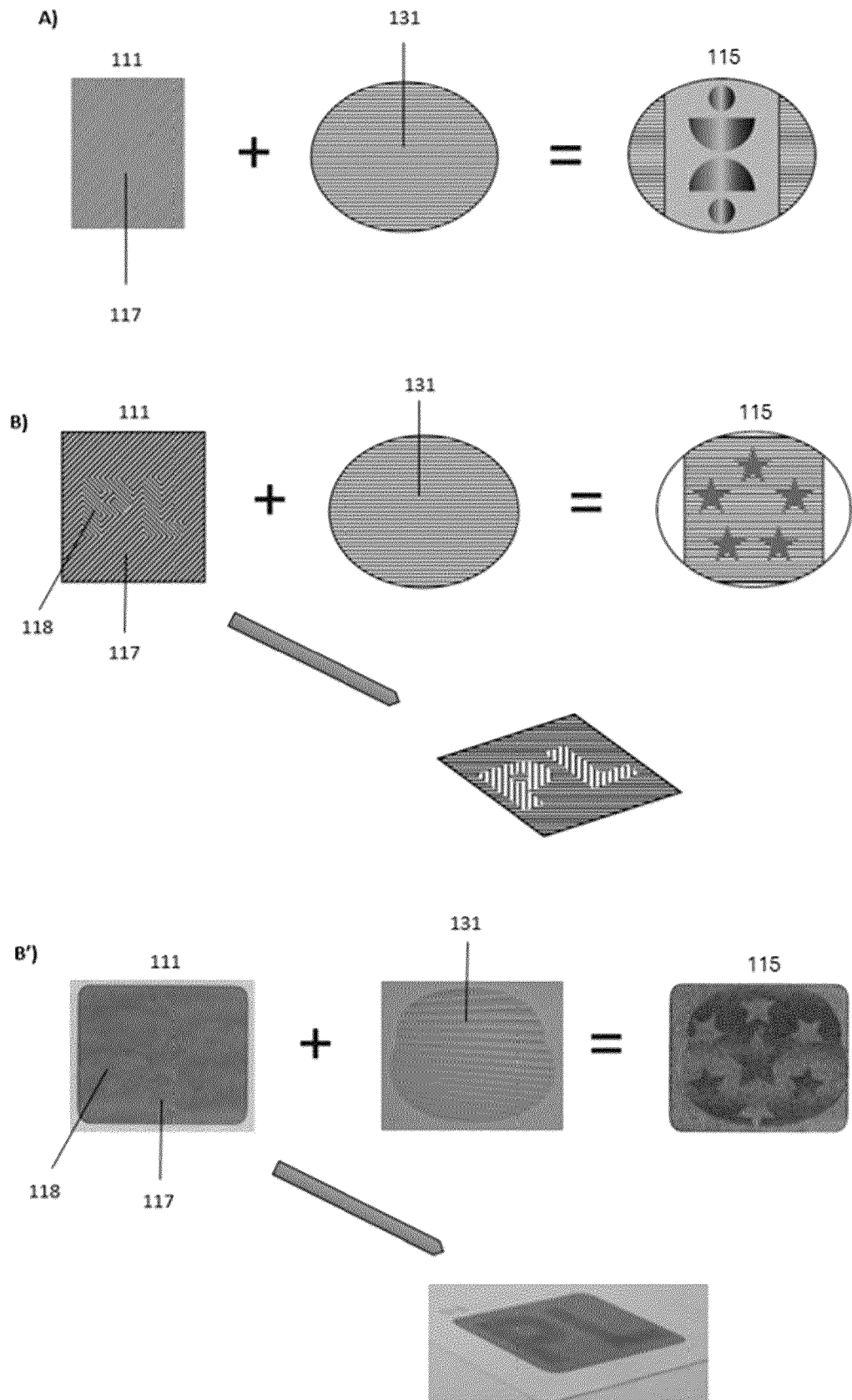


Fig. 6

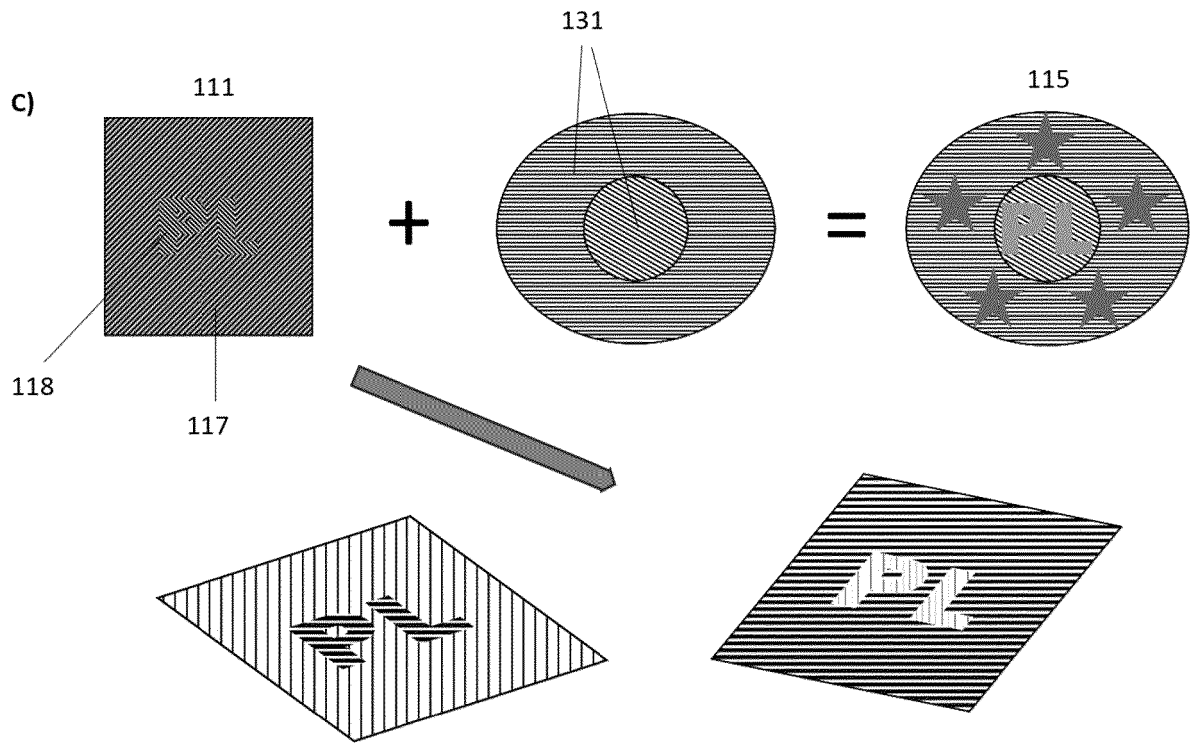


Fig. 6 (c.d.)

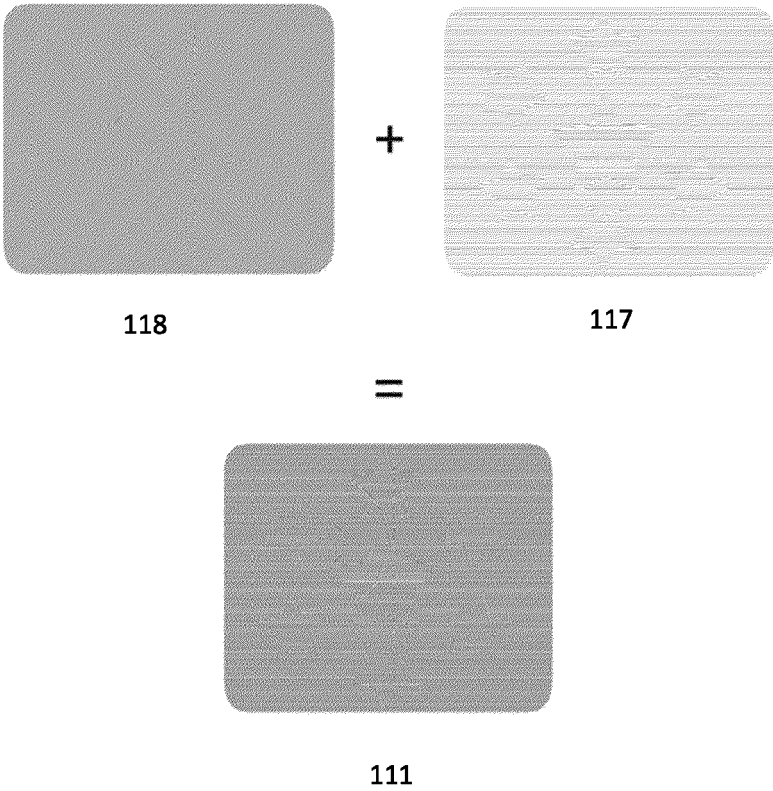


Fig. 7



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Application Number

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Place of search		Date of completion of the search	Examiner
Munich		3 December 2024	Zacchini, Daniela
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