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(71) Applicant: **Polska Wytwornia Papierow**
Wartosciowych S.A.
00-222 Warszawa (PL)

(72) Inventors:
• **GAWEL, Kamil**
05-807 Podkowa Lesna (PL)
• **WOJTKOWSKI, Robert**
05-220 Zielonka (PL)

(74) Representative: **Patpol Kancelaria Patentowa Sp.**
z o.o.
Nowoursynowska 162J
02-776 Warszawa (PL)

(54) **SECURITY ELEMENT FOR IDENTIFICATION DOCUMENTS, IN PARTICULAR IDENTITY DOCUMENTS, AND A DOCUMENT COMPRISING SUCH SECURITY ELEMENT**

(57) The invention relates to a security element for identification documents, in particular identity documents containing a hard substrate susceptible to laser marking, comprising:

- a first security feature of the security element applied by laser marking to a hard surface;
- a second security feature of the security element applied by laser marking to a hard surface;

wherein the first security feature is a document-individualizing, information-bearing textual security feature, and the second security feature is a document-individualizing, information-bearing security feature in the form of an image wherein the first security feature includes an array of a plurality of the same images that constitute the second security feature, preferably images on the micro-structure level, where each image corresponds to a single dot that, together with the other dots in the array, constitutes a globally perceptible, information-bearing textual security feature, and wherein at least the first security feature is perceptible to the naked eye. The present invention also provides an identification document incorporating the security element according to the invention.

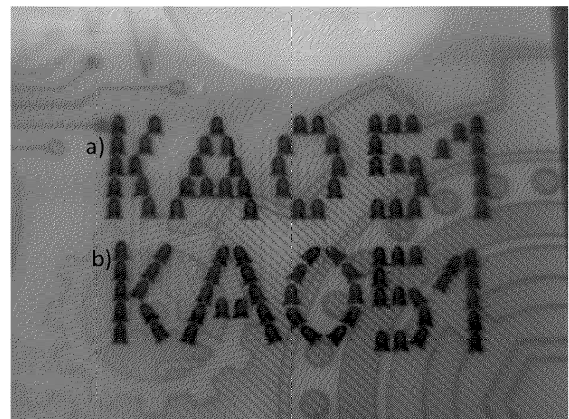


Fig. 6

Description

Technical Field

[0001] The present invention relates to a security element for identification documents, in particular identity documents, comprising a hard substrate susceptible to laser marking, a first security feature of the security element applied to the hard substrate by laser marking and a second security feature of the security element applied to the hard substrate by laser marking, the first security feature constituting a document-individualizing, information-bearing textual security feature, and the second security feature constituting a document-individualizing, information-bearing security feature in the form of an image. The present invention also provides an identification document incorporating the security element according to the invention.

Prior Art

[0002] Secured documents, such as securities or 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 the developed countries. Their importance is constantly increasing because such documents have many applications, the number of which is systematically growing.

[0003] Moreover, despite the constant digitization of all spheres of human life, it still seems to be impossible without physical documents confirming the identity of their holder, especially in such important situations as opening a bank account enabling the use of convenient digitized payments, receiving important correspondence, administrative court proceedings, or moving, especially outside the country.

[0004] In light of this ever-increasing widespread use of these documents, it is important that a person relying on a particular identification document has the greatest possible confidence, preferably certainty, that the identification document has not been altered and/or is not counterfeited. Therefore, in order to prevent counterfeiting, forgery or unauthorized reproduction, such documents are equipped with numerous safeguards aimed at preventing the introduction of inauthentic documents to the market.

[0005] In the field of data carriers for security documents, such as individualizing documents, numerous solutions are commonly used to secure them, the task of which is, among other things, to guarantee the possibility of unambiguous identification of the holder of such a document. This is particularly important in relation to the group of identification documents constituting the holder's identity documents (hereinafter referred to as "identity documents"), the key role of which in today's society is undisputed, and their universality results from the fact that they are used on daily basis, in various circumstances,

in which it is necessary to confirm specific data of the holder using such a document, including, in particular, verification of her/his name and surname, date of birth, image, or even confirmation of her/his access to a specific area or network (security cards, including smart and contactless cards), or possession of certain qualifications, such as, for example, a driving license. As mentioned above, identity documents also enable their holders to move freely and conveniently. For example, airplane passengers are required to show an identity document during check-in, security checks or before boarding. Moreover, because we live in a constantly changing cashless society, identity documents are also used to make various payment transactions, but it should be emphasized that the term identity document also includes documents such as credit cards or bank or debit cards. Absolutely specific examples of an identity document of exceptional importance are those that contain specific information such as the data of the document holder, such as an ID card, passport and driving license. Examples of such information that personalizes an identity document include the name of the document holder, home address, date of birth, signature and photograph.

[0006] The vast majority of the identification documents mentioned above include a polymer substrate, in particular a polycarbonate or polyvinyl chloride substrate, with at least one security marking applied to it. To prevent forgeries, documents such as an ID card, driving license or passport are often equipped with sufficient first-level security features, visible to the naked eye, enabling a quick initial visual verification of the document's authenticity, and with additional second-level security features. To increase the security of turnover of such documents, more than one security element is generally used, and it is desirable that such elements provide different levels of protection. In the field of security features, it is also important to always be one step ahead of counterfeiters, especially thanks to known and recognizable, but constantly improved, security elements.

[0007] For the purposes of this application, the term "identity document" should be defined broadly to include credit cards, bank cards, phone cards, passports, driving licenses, network access cards, employee ID cards, debit cards, security cards, visas, immigration documentation, national ID cards, citizenship cards, social security cards, security badges, certificates, ID cards or identification documents, voter registration cards, police ID cards, border crossing cards, membership cards, gun permits or badges, etc.

[0008] Many of these identity documents, such as driving licenses, ID cards or bank or access cards, contain, in addition to important information relating to the identity of the holder, such as, for example, her/his name and surname, address, date of birth, signature and her/his photo; cards or documents, may additionally contain other variable data (i.e. personal data for a specific card or document) and immutable data (i.e. data common to a large number of cards, such as batch numbers, bank

numbers, etc.). Additionally, as mentioned above, such documents may be equipped with other elements, including those containing hidden information, thus constituting second-level security, such as a photographic image. Such elements can be applied using various techniques, including, but not limited to, printing using technologies such as dye diffusion thermal transfer (D2T2), inkjet printing, thermal transfer, laser xerography, offset printing, gravure printing or indigo printing. However, these printing techniques are not the only ways of applying markings and information to identity document data carriers. Currently, laser beams are widely used for this purpose, in particular for marking, writing, bar coding and engraving many hard substrate materials, including plastic substrates. It should be emphasized that laser engraving or marking provides a wide range of possibilities for surface modification, including writing or engraving the document surface with identification marks, characters, text, tactile markings, patterns and photographs.

[0009] A particularly useful type of security feature are laser-engraved markings on plastic laminates or cards. In the laser engraving process, data is written by, for example, blackening (charring) laminated films that are sensitive and susceptible to laser marking, such as, for example, polyvinyl chloride (PVC) or polycarbonate (PC) films. Additionally, the laser engraving effect can be varied depending on the engraving depth. In the case of flat engraving, blackening is achieved only in the area of a specific layer. Another option is relief laser engraving for tactile markings.

[0010] Such marking is generally performed using one of the harmonics of the Nd:YAG laser (1064 nm, 532 nm or 355 nm). Lasers used industrially for this application are sources powered axially by diodes. In combination with galvanometric mirrors, they can be used to apply a number of information: for example, images, in particular photographs, can be applied using such a laser. Typically, such photographs are engraved on laser-markable plastic substrates in grayscale, at resolutions ranging from 300 to 900 dpi (dots per inch). Laser engraving can also be successfully used to apply textual information, and such text may or may not be engraved with tactile writing. Typically, in such a process, the laser power used for nanosecond pulses is approximately 0.1 J/cm².

[0011] Taking into account the widespread availability of devices that are a source of laser radiation to counterfeiters, the protection by a text itself may be subject to numerous manipulations leading to a change in the authentic document. For example, characters used in textual security elements can be easily transformed (e.g. it is easy to transform the number "3" into "8" or the letter "c" into "o", etc.) or new laser-engraved elements can be introduced, for example, at the beginning or end of text added as a security element. Therefore, the textual security features themselves, which are necessary as they reflect the data of the document holder or the individual numbers of a given document, are slowly losing their importance. Unfortunately, this problem persists and re-

mains relevant in the case of engraved images, for example, photographs of the document holder. For example, the image of the holder of an identification document, laser-applied to a hard polymer substrate, can be modified by adding elements such as a beard, mustache, more abundant hair, or by modifying cheeks or ears. Modification of images, including photographs or characters, therefore seems simple to achieve on identification documents, such as laser-engraved cards on a polymer substrate, in particular identity documents such as ID cards.

[0012] Additionally, depending on the need, security elements can be obtained on a polymer substrate using several different methods or even a combination of different methods, including engraving or laser marking, selected depending on the specific polymer substrate used, including, in particular, the presence and the type of additives present in the polymer substrate, for example colored pigments, or the characteristics of the laser used to apply the security element. The security features achieved by these methods may take the form of various markings, including light, dark or colored markings. In the case of polymer substrates that are not *per se* susceptible to carbonization or have low tendency to carbonization, such as, for example, polyolefin and high-density polyethylene (HDPE) substrates, clear markings can be obtained as a result of the foaming of the resin occurring under the influence of heat generated by the laser energy. Other polymers, such as polycarbonate (PC), ABS or polystyrene, have a much greater tendency to carbonize than to foam, and therefore security elements applied by laser engraving or marking take the form of dark markings.

[0013] In the prior art, it is also known to create markings by applying an image consisting of individual, dot elements, commonly referred to as pixels, to a substrate. This term is also used in this sense herein.

[0014] Using such single dot elements, both textual and graphic markings aimed at personalizing documents can be obtained. For example, the substrate may be provided with a graphic such as that corresponding to the image of the document holder. The most frequently used method for this purpose is laser engraving. When colored pigments or pigments of various shades of gray are present in the substrate material, the images produced by treating the photosensitive material with laser light may be color images or grayscale images. Typically, in order to place graphic markings on a substrate using laser engraving, the graphics to be placed on the substrate must first be subjected to an image rasterization process leading to its transformation into a system of raster dots. Typically, applying an image, which is to be a graphic security element, to a substrate susceptible to laser marking, is carried out using single laser pulses or a sequence of laser pulses, where a single laser pulse or a single sequence of pulses corresponds to a single pixel. Laser marking manifests itself in a change in the coloring of the substrate susceptible to marking, usually in the blackening of the substrate in the area exposed to the

laser pulse. Generally, the generated coloring intensity, in the case of a pigment-containing substrate, or the gray scale coloring intensity, in the case of a carbonizable substrate, depends on the energy of the pulse or sequence of laser pulses. This method can be used to obtain numerous, even very complex, monotone or multi-color graphics and can be successfully used, as for example in the case of the present invention, to apply security elements to a hard polymer substrate susceptible to laser marking.

[0015] For example, from the document EP2851207B1 i.a. a document is known with a security feature on a polycarbonate base, which security feature is a marking produced using a laser, for example using a green laser with a beam length of 532 nm. Such markings consist of many pixels. The carbon particles of the polycarbonate substrate undergo a reaction under the influence of the laser, resulting in the formation of black pixels in places exposed to the laser pulses. Depending on the number of laser pulses used, the size and shape of the resulting pixels may change.

[0016] In turn, from the publication US7789311 B2 applying of markings constituting security elements is known by creating an image by forming pixels using laser engraving and/or marking techniques. By forming pixels using this laser engraving method, it is possible to precisely control the color saturation of the applied pixels with high accuracy. As indicated in the description, darkening or "whitening" can be made with a laser even on a finished, laminated document with security features, especially an identity document.

[0017] Similarly, US 2009/0127844 A1 discloses a security element for securities, security documents and the like, comprising a laser markable transparent or translucent layer in which, through the action of laser radiation, identifiers visually perceptible to the naked eye are introduced in the form of both images as well as patterns, letters and/or numbers.

[0018] However, as mentioned above, laser application of graphics or textual elements personalizing an identity document carries a relatively high risk of forgery. Since it is often necessary to include specific data on the document of the holder of an identity document, such as her/his name, surname, place of residence or PESEL number, or to enter identification numbers or other numerical data enabling its individualization, numerous efforts have long been undertaken to reduce the likelihood of falsifying or forging a document. Therefore, a number of solutions are known from the prior art, which are intended to prevent the rewriting or modification of letters or laser-applied images, in particular the image of the document holder (reproduction of her/his photograph).

[0019] For example, in order to prevent document forgeries, it has been proposed to add overlapping lines or guilloches to an identifying image, such as the image of the document holder. In such solutions, when additional elements are printed on the document, guilloches are visible as white elements on a black background.

[0020] Other proposed solutions involve introducing additional security elements into the document, such as holograms, or printing information using inks that react to ultraviolet radiation. It is also known to place miniature inscriptions hidden in an image or text and the like. However, such solutions, although they enable obtaining an appropriate level of document security, require the use of additional devices and/or materials, either for their introduction or identification, which leads to an undesirable increase in the costs of introducing a security feature.

[0021] Further useful solutions are disclosed in patents US4234214 and PL2094505T5. As emphasized in these publications, printing made using laser technology does not prevent additional information from being introduced into documents secured with it. Such addition of information makes it possible, for example, to completely change the image corresponding to the image of the document holder by adding more hair, moustache, glasses and the like. Although the graphics and text are indelible, it is possible to add darkened or colored areas, which may lead to modification of data regarding the identity of the document holder, including his/her image. To reduce the possibility of changing a document, solutions have been proposed according to which secure information is recorded in the document as both positive and negative information, and their modification requires simultaneous withdrawal and addition of registration. While adding additional elements or information is relatively easy, for example by introducing additional darkened areas into the printed positive area, modifying the inverted image is much more difficult because it requires introducing areas of complementary color. For example, in the case of gray-scale images, modifying the positive image by darkening additional areas would require making similar changes to the negative image, which in turn would mean adding white as a complementary color. Adding white to a negative image is almost impossible because the image is printed using a laser engraving method, so modifying it would require removing the already engraved dark areas.

[0022] In the case of such a double inscription in positive and negative, it is generally recommended that both security elements (positive and negative) be of the same size and placed on the document so as to make their comparison possible and easy. However, when such solutions are used, they harm the overall readability and aesthetics of the document and limit its practical usefulness (which is extremely important in the case of documents intended for use by the general public).

[0023] Therefore, such solutions also seemed unsatisfactory. This led to the independent search for other solutions that could increase the security of documents provided with them, were easy and cheap to produce and were suitable for providing both graphic and textual security elements carrying document-personalizing information.

[0024] For example, for this purpose, in the prior art it has often been attempted to generate images containing information at the microstructure level, which information

is easy to read with the naked eye, providing a global image, and at close proximity, in particular using assistive devices such as loupes or magnifying glasses, a microstructure carrying additional information is visible. A method of producing such double protections called "Artistic Screening" is disclosed, for example, in a patent US6198545 and in an article by V. Ostromoukhov, R.D.Hersch, "Artistic Design", Siggraph95, Computer Graphics Proceedings, Annual Conference Series, 1995, pp. 219-228. However, the method described in the above-mentioned document requires significant efforts of graphic designers to create a microstructure.

[0025] Yet another method referred to as "Multicolor Dithering" was disclosed in an article by: V. Ostromoukhov, R.D. Hersch, "Multi-Color and Artistic Dithering", Siggraph'99, Computer Graphics Proceedings, Annual Conference Series, 1999, pp. 425-432. This method allows obtaining colored images on a hard surface containing, as dots visualized on the screen, where the image is displayed before being applied, a fine microstructure enabling the reproduction of various shapes, such as signs, logos and symbols, and therefore can significantly prevent counterfeiting. The disadvantage of this method is the need to engage significant IT skills in building 3D functions, discretizing them, renumbering the obtained dithering values and applying the balancing process to them. Moreover, the images obtained with this method do not contain additional information that individualizes the document provided with such an image.

[0026] However, introducing microstructures into images is undoubtedly applicable not only in the field of generating artistic images, but also in the field of generating documents that require protection against forgery. This is especially important when the verification of the document's authenticity is based primarily on visual inspection. While it is easy to provide documents with unique security features, such as encrypted barcodes or other codes, their verification involves the use of electronic means of processing, which in many situations are impractical or inefficient, and may even be unavailable, even if temporarily.

[0027] Due to the above-mentioned need to visually identify the holder of the document and to associate with him/her additional data and authorizations that such a document confirms, many individualizing documents, such as e.g. identity documents, as one of the security elements suitable for visual recognition, are unconditionally provided with an element containing the image of the document holder constituting a reproduction of a photograph. This provides a convenient and publicly available way of linking a document with such security protection to its owner. In turn, due to the rapid development of plastic card printers and progress in digital imaging, which in turn led to the widespread use of identity documents printed on plastic cards, it is necessary to print the holder's image on a hard, polymer substrate. However, with the development of color printers and copiers, it has become easy to forge such documents, unless they are

equipped with security features such as microscopic text. However, the solutions known and commonly used in the field require the creation of complex systems of security elements guaranteeing the creation of an image using techniques such as embossing, ablation and the like. However, these techniques are not very practical when producing documents used widely by the general public.

[0028] The aim of the present invention is to provide a document, in particular an identity document, with a security element, which security element is easy to obtain, unambiguously identifies the document holder by introducing data that individualizes the document holder and/or the rights resulting from possessing the document, and at the same time such a security element is inexpensive, which in turn allows to reduce the costs of producing the document bearing it, allows to verify the authenticity of the document without the use of electronic devices, while significantly hindering the forgery of the document bearing it.

[0029] The present inventors have surprisingly found that it is possible to obtain a protected document, especially an identity document, containing a security element including both graphical and textual security features, which security features can be obtained by the same, widely known and relatively cheap method of laser modification of the markable document substrate material. In particular, it is important that both the graphic and textual security elements contain information that personalizes the document. In specific embodiments of the invention, the graphic security element corresponds to the image of the document holder, which is a reproduction of the image (photograph) of the document holder on a hard polymer substrate. In some embodiments, the graphic security feature of the security element is an image at the microstructure level that is nevertheless easily readable by the naked eye. In even more specific embodiments, the image at the microstructure level can only be read using assistive devices such as loupes or magnifying glasses. Due to the proposed method of simultaneous application of graphic and textual security features of the security element, carried out using laser marking or engraving, this method does not require significant efforts of graphic designers to create both the microstructure itself and the textual security features carrying information and their matching. This method enables the creation of text graphic elements on a hard surface containing, as dots forming the text, a fine microstructure constituting an image, especially corresponding to the image of the holder of the document, which document is to be provided with such a security element. In particularly preferred solutions, graphic images of the microstructure form a matrix in which laser discoloration, in particular in the case of substrates without pigments that undergo carbonization, darkens only those images, constituting dots in the matrix, that create a textual, globally perceptible security feature of the security element, while the remaining images remain not discolored, creating bright spots in the matrix that constitute the background for the textual se-

curity feature. In even more specific embodiments, while the constituent dots of the image textual element constitute a positive security feature, the remaining dots of the matrix constitute a negative security feature. As mentioned above, an attempt to interfere with the integrity of a document with such multi-level security would require interfering with all the images that make up the matrix, not only those that constitute the textual security element and which could be modified by graying/blacking additional image elements, but also the negative images, changes to which would require whitening corresponding to such new image elements. Therefore, the solution proposed by the present inventors is characterized by strong anti-counterfeiting properties of documents with such protection.

[0030] To sum up, the solution according to the present invention includes at least two security features, one of which is a textual security feature and the other includes an image (graphic element), where both the textual security feature and graphic security feature carry information that individualizes the document, both are applied simultaneously to the document by engraving or laser marking, and where the textual security feature is composed of microstructure-containing images that can be efficiently and simply generated.

[0031] Another object of the present invention is to provide a security feature that will be difficult to forge while maintaining the readability of the document bearing such a security feature and the consistency of the data contained in the document.

[0032] It is true that in the field of securing data carriers for valuable documents, such as identity documents, including ID cards, driving licenses or other personalized cards, solutions in which security is achieved by introducing more than one protective element are commonly used to secure such documents, however, none of the known solutions ensures a high degree of security due to the limited possibility of modifying elements using only one inexpensive method of introducing security features.

[0033] The present inventors have surprisingly found that a security feature providing high level of security can be obtained in a cheap and simple manner by applying a complex security element using a commonly available laser engraving and/or marking technique.

[0034] The invention therefore relates to a security element for identification documents containing a hard substrate susceptible to laser marking, in particular identity documents, comprising:

- a first security feature of the security element applied by laser marking to a hard surface;
- a second security feature of the security element applied by laser marking to a hard surface;

wherein the first security feature is a document-individualizing, information-bearing textual security feature, and the second security feature is a document-individualizing, information-bearing security feature in the form of an

image, wherein the first security feature includes an array of a plurality of the same images that constitute the second security feature, preferably images on the microstructure level, where each image corresponds to a single dot that, together with the other dots in the array, constitutes a globally perceptible, information-bearing textual security feature, and wherein at least the first security feature is perceptible to the naked eye.

[0035] Preferably, the image is an image corresponding to an image of the holder of the identification document, preferably a photograph of the holder of the identification document.

[0036] Equally preferably, the second security feature is only visible to the armed eye, preferably through a magnifying device such as a loupe or a magnifying glass.

[0037] In preferred embodiments, the hard substrate susceptible to laser marking is a polymer substrate, preferably a PC or PVC substrate.

[0038] Preferably, the images constituting the second security feature consist of many pixels, perceived as areas of changed coloring relative to the coloring of the substrate, which are formed in places exposed to laser pulses during laser engraving or marking, and whose size, shape and color saturation are dependent on the number of laser pulses used when engraving or laser marking process. In a particularly preferred embodiment of the invention, the change in coloring of image pixels corresponding to dots perceptible to the naked eye, constituting a textual security element perceptible to the naked eye, is a change in hue and coloring intensity obtained as a result of activation during laser marking of pigments present in the substrate susceptible to laser marking, the pixels colored with respect to the substrate colors corresponding to the laser-processed areas. In another particularly preferred embodiment of the invention, the change in coloring of image pixels corresponding to dots perceptible to the naked eye, constituting a textual security element perceptible to the naked eye, is a change in coloring and its intensity on a gray scale obtained as a result of carbonization of the substrate occurring during laser marking, the darkened/gray pixels corresponding to the laser-processed areas.

[0039] Preferably, an array including a plurality of the same images with a hue changed in relation to the hue of the substrate, comprising the second security feature, forms a matrix in which the first security feature is formed by additionally changing the coloring of the images constituting the first security feature relative to the remaining images constituting the matrix, wherein the matrix images with a color changed in relation to the remaining matrix images correspond to the dots perceptible to the naked eye forming a globally perceptible textual security element constituting the first security feature. Particularly preferably, the matrix includes images constituting a positive image and a negative image, preferably the positive image being images of significantly increased color intensity, preferably in gray scale, which images correspond to the dots forming the security text element per-

ceptible to the naked eye constituting the first security feature, and the negative image being images with significantly reduced color intensity, especially in gray scale, which images correspond to the bright dots of the matrix creating a light background for the textual security element perceptible to the naked eye.

[0040] According to a preferred embodiment of the invention, the image resolution of the second security feature is at least 700 dpi, preferably at least 900 dpi.

[0041] In preferred embodiments of the present invention, spacing of individual pixels in the image is at most 35 μm , preferably at most 30 μm , more preferably at most 20 μm , even more preferably at most 3 μm , and most preferably at most 1 μm .

[0042] Preferably, the image resolution of the second security feature is at least 700 dpi and the distance of individual pixels in the image is from 10 μm to 35 μm , preferably the image resolution of the second security feature is at least 900 dpi and the distance of individual pixels in the image is from 3 μm to 30 μm .

[0043] Equally preferably, the first security feature is formed by an array of images constituting the second security feature, including at least 5 rows of the same images constituting the second security feature, preferably by 5 to 8 rows of the same images constituting the second security feature. The term "row" in this description refers to a horizontal arrangement of elements located in one line (one row), i.e. a line formed by elements adjacent to each other directly (in close proximity) or indirectly horizontally, and the horizontal direction is considered to be the direction defined by the direction of extending the first security feature, in particular the direction of the text which constitutes the textual security element of the first security feature. The term "column", in turn, means a vertical arrangement of elements located in one line, i.e. a line formed by elements adjacent to each other directly (in close proximity) or indirectly vertically, where the vertical direction is considered to be the direction perpendicular to the direction defined by the direction of extension of the first security feature, in particular perpendicular to the direction of the text which constitutes the textual security element of the first security feature. In particular embodiments of the present invention, the matrix formed by the elements of the first security feature may have dimensions of 5-8 rows and 20 or more columns, for example 5-8 rows and 20-30 columns, etc.

[0044] In preferred embodiments of the present invention, the height of the first security feature is at least 1.0 mm and not greater than 5.0 mm, more preferably in the range of 1.0-2.4 mm, most preferably in the range of 1.5-2.2 mm.

[0045] In yet further preferred embodiments of the present invention, the image height of the second security feature is 200 μm or more, preferably 200-300 μm .

[0046] Preferably, the security element according to the invention comprises an additional security feature selected from offset security features, such as offset underprinting.

[0047] The invention also relates to an identification document containing a hard surface susceptible to laser marking and at least one security element according to the invention. Preferably, this document is an identity document, especially an ID card or driving license.

[0048] As used herein, the terms "light" and "radiation" may be used interchangeably and mean a stream of particles emitted, for example, by a laser.

[0049] It is to be appreciated that, as used herein, the terms "hue", "coloring" and "color" are used interchangeably with respect to the security element of the invention to denote 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 colorings/hues/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. The grayscale colors of the monochrome mode in the bitmap describing the applied mark include, in addition to the extreme colors of black and white, a whole range of intermediate colors (grays) with varying levels of brightness and intensity. For the purposes of this description, intermediate colors differing in brightness are assumed to constitute different colors.

[0050] In accordance with the present invention, it is to be understood that the term "intensity" refers to a different degree of saturation of the same or different hue. To sum up, with regard to the phenomenon of perceiving intensity change, it should be assumed that two pixels differ in color intensity because light is emitted or absorbed with different intensity.

[0051] As used herein, the term "hard substrate", "hard surface", etc. refers to any substrate/surface having limited susceptibility to deformation and therefore increased stiffness and strength. In turn, the term "hard polymer substrate" should be interpreted broadly. Thus, for example, the hard polymer substrate may be any single-layer substrate as well as a multi-layer laminate. The substrate may be either a prefabricated element for the production of the target product, or for example a single layer of a polymer substrate which, after marking, provides a protected polymer substrate for further use, including introduction into a multilayer system, in particular a permanently connected multilayer substrate. The substrate may also be an end product, such as an identification document containing at least one mark intended to convey information, such as, for example, an ID card or driving license. A substrate susceptible to laser marking may be any substrate known in the art that is capable of being laser engraved/marked, preferably the one that can be marked with a laser without damaging or otherwise adversely affecting the substrate.

[0052] As used herein, whenever reference is made to an "image" or "marking", it is generally understood to mean any visually and/or machine-readable graphic pattern, often constituting specific information, that is capable of being encompassed by an observer in a normal, single cognitive act. In particular, such patterns may be

simple abstract motifs, such as geometric patterns, their combinations, or realistic motifs, such as images constituting landscape, plant or animal motifs, and especially images corresponding to the image of the holder of the identification document, such as corresponding to a photograph (picture) of the holder of the identification document. Realistic motifs can also be images of coats of arms, buildings, flags. Abstract motifs also include any other graphically presentable markings, in particular those that constitute specific patterns, signs, logos, including registered and unregistered trademarks. However, the list of images indicated above is not exhaustive, as such images or markings within the security element can be laser engraved in any shape.

[0053] As a globally or comprehensively perceptible image, any image that is visible on a macro scale, which is perceived by a single cognitive act by the naked eye of the observer, is considered. A feature or marking is perceptible to the naked eye when it is not necessary to use any additional devices, in particular optical devices such as, for example, a microscope, loupe or magnifying glass.

[0054] Additionally, terms such as negative image and positive image as used herein retain their normal meanings as used in the art. In specific embodiments, a positive image is an image with the same luminance and/or colors (in the case of a color image) as the object depicted in the mirrored photograph/in the photograph, in particular the image of the document holder, while a negative image is an image with inverted luminance and/or colors (in the case of a color image) in relation to the original appearance of the object, in particular the image of the document holder.

Brief description of the Drawing

[0055] The present invention is illustrated below in more detail with reference to selected exemplary embodiments in the Drawing, in which

Fig. 1 shows an exemplary security element obtained by applying an array of microphotographs on a PC substrate to create a visual textual security element recognizable to the naked eye.

Fig. 2 shows an exemplary security element obtained by applying to a PC substrate an array of microphotographs constituting a second security feature, forming a matrix, in which selected microphotographs with a more intense and darker color constitute dots creating a textual security element perceived with the naked eye, constituting the first security feature, and the remaining microphotographs, with a light, less intense color constitute dots forming the background for the textual security element perceptible to the naked eye.

Fig. 3 shows a fragment of a textual security element perceptible to the naked eye obtained by darkening selected microphotographs in a matrix with heights

of a) 1.2 mm and b) 0.8 mm, respectively.

Fig. 4 shows a comparison of microphotographs with different heights of a) 2 mm, b) 1 mm and c) 0.8 mm.

Fig. 5 shows examples of placing a security element according to the invention in an identification document with graphics, such as an identity document without a) and with b) additional electronic security feature.

Fig. 6 shows a comparison of the first security feature, which is a textual security feature made of microphotographs a) without angular rotation and b) with angular rotation of individual microphotographs.

Fig. 7 shows a single 700 μm high microphotograph obtained at 2000 DPI resolution.

EXAMPLES

Materials and equipment

[0056] The tests carried out used PC cards in ID card structures, both with and without offset underprinting, and cards made only of transparent films, susceptible to engraving and/or laser marking. Marking was performed with lasers installed in a color laser personalization device using an infrared 1064 nm TykmaElectrox Vereo 20W laser and a green 532 nm Coherent Matrix 532-7-30 laser.

Methodology of applying the security element

[0057] To obtain the text effect from images corresponding to text dots, which were microphotographs, a technology well known from classic laser personalization was used. The tests employed various, modified process parameters leading to a slight densifying of graphics' pixels, and thus increasing the resolution of the image obtained with this technique. Based on numerous tests, it was found that particularly beneficial effects are achieved using the following process parameters

- the length of the laser light used to generate on a hard polymer substrate susceptible to laser marking and/or engraving is 532 nm;
- repetition frequency is 50 kHz,
- the laser power is 3.5 W (which corresponded to 100% of the power of the Coherent Matrix 532-7-30 laser used in the tests);
- the distance of adjacent pulses, corresponding to the distance between the centers of pixels placed on a hard polymer substrate, is 35 μm , which corresponds to a resolution of at least 700 dpi.

[0058] In the first stage of the process, raster graphics were prepared consisting of images that were microphotographs, i.e. images corresponding to the image of the holder of the identification document - his or her photographs, adjusted to create the appropriate inscription, thus obtaining the source image. For this purpose, a set

of input data defining the desired image in the form of a two-dimensional array of pixels was determined preferably by means of a computer configured to design graphic images, and then such defined input data was transformed, also preferably by a computer configured to perform such transformation, into a coded graphic file constituting the recorded source image, being a bitmap describing the applied marking. Subsequently, such an image was applied to a polymer substrate susceptible to laser engraving or marking, in particular to a carbonizable PC or PVC substrate, by spot irradiation of the polymer substrate with a computer-controlled laser, the beam of which modifies the carbonizable polymer substrates.

[0059] An exemplary security element obtained in accordance with the invention is shown in Fig. 1, which shows an information-bearing textual security feature, in which the individual dots creating such a textual security feature are microphotographs of the holder of the protected document with a color changed in relation to the color of the hard PC surface on which they are applied. The textual security feature includes vertically 6 images with a vertical height of 5 mm. The height of individual characters in textual security is 800 μm .

[0060] Fig. 2 shows a similar implementation variant of the present invention, except that the textual security feature was obtained by applying on the substrate evenly spaced microphotographs, creating a matrix of 13 rows and 24 columns formed by an array of microphotographs corresponding to individual dots of the matrix. Thus, the matrix includes 13 dots vertically, each of which corresponds to one microphotograph, and 24 dots horizontally, each of which corresponds to one microphotograph. Within the matrix, a textual security feature was applied, which is the first security feature of the security element, and consists of microphotographs with darker shades of gray compared to the remaining microphotographs that do not create textual security feature with light shades of gray. The text protection includes 5 dots vertically, corresponding to 5 microphotographs, each of which is 800 μm high. The height of the textual security feature is 5 mm.

[0061] In a particular embodiment of the security element according to the invention in the form of a matrix, the textual security feature corresponds to a positive image created by images with significantly increased color intensity, and the remaining dots of the matrix are negative images with significantly reduced color intensity not only in relation to positive images, but also in relation to the coloring of the substrate, on which the security element is applied, creating a clear background for the textual security element perceptible to the naked eye.

[0062] It was found in the tests that in order to obtain the first security feature, which is an identification document-individualizing, information-bearing textual security feature including a combination of any numbers and/or letters, the textual security feature should cover 5 or more dots vertically, which corresponded to 5 or more microphotographs in practical implementations of the present

invention. Also it was found that with a larger number of images adjacent to each other vertically and constituting textual security feature dots, especially microphotographs, the unambiguity and global perception of the security element is disturbed, or its readability is significantly reduced. This is due to the fact that either the applied text constituting textual security feature must be higher, which limits the usefulness of such a security element, or the photos must be additionally reduced, which in turn significantly affects their readability. Depending on the specific embodiment and the desired effect, it was found that it is optimal to create a textual security feature covering a vertical array of 5 to 8 images, especially microphotographs. The actual height of the five-dot image corresponding to the microphotographs is approximately 4-5 mm. At such a height of the microphotograph corresponding to the image of the holder of the document, that the security element is intended to protect, the photographs are legible under magnification, for example the one obtained with the use of a loupe or magnifying glass (e.g. 2-6x, in particular 3.5x or more), and the number of dots in the vertical allows to easily obtain textual security feature covering any characters, including letters and numbers. When using a smaller effective laser spot size, such as a few μm , clear microphotographs with a height of 200 - 300 μm were obtained. In such cases, the total height of the textual security feature obtained using microphotographs as dots constituting the text is comparable to the standard height of the textual security feature used in document personalization, and ranges from 1.0 to 2.4 mm, ranging from 1.5 to 2.2 mm in particularly preferred embodiments.

[0063] Examples of microphotographs are shown in Fig. 3, which shows the security elements obtained in accordance with the invention, in which the dots forming the textual security feature were microphotographs having the height of a) 1.2 mm and b) 0.8 mm, respectively. As can be seen in Fig. 3, the textual security feature with the height of less than 1.00 mm is much less clear, and the images constituting such textual security features, microphotographs of the document holder in this case, are devoid of many important details.

[0064] Fig. 4 shows a comparison of microphotographs of different heights: a) 2 mm, b) 1 mm and c) 0.8 mm, illustrating the impact of reducing the laser spot on maintaining the readability of the image with a lower height, which allows for providing textual security feature created from microphotographs of sizes of 1 mm and less.

[0065] By using the security element according to the invention, particularly advantageous protection can be obtained by introducing the security element containing, as a first security feature, a textual security feature formed by dots, which are images constituting a second security feature, which images correspond to the image of the document holder, containing additionally, as one of the individualizing elements, the same image of the document holder that is used in the second security fea-

ture, with the difference that while in the second security feature such an image is a microphotograph, that additional security element is a reflection of the image of the document holder in a normal, commonly macro scale used in identity documents. Such an exemplary document is shown in Fig. 5. The document shown contains, in addition to a photograph in a macro scale of the document holder, a security element according to the invention, wherein the textual security is a number that individualizes the document ("KA051") formed by dots corresponding to a microphotograph of the document holder, which is identical to a photograph placed on a document that can be perceived globally, on a macro scale, and whose specific details, such as the outline of the eyes, facial features, etc. do not require the use of any additional devices for their recognition. Additionally, as shown in Fig. 5, the security element according to the invention can be applied to a bare as well as previously protected substrate, in particular to areas already containing security elements such as, for example, offset underprinting.

[0066] In certain variant embodiments of the security element according to the invention, the array of dots of the first security feature, which is the textual security feature, is formed by images corresponding to the image of the holder of the document for which the security element is intended, positioned in the same direction, the horizontally adjacent images not being vertically shifted relative to each other. This means that the axes of symmetry of each image (vertical and horizontal) are parallel to each other, and in such specific embodiments, adjacent images are placed relative to each other so that the intersections of the axes of symmetry of adjacent images define a substantially parallel line (deviation by ± 3), preferably parallel to the straight line defined by the lowest vertical pixels of the images constituting the textual security feature. Thus, horizontally adjacent images are offset from each other only with respect to the horizontal axis of the first security feature.

[0067] In other embodiments of the security element according to the invention, the array of dots of the first security feature, which is a textual security feature, is formed by images corresponding to the image of the holder of the document for which the security element is intended, positioned in the same direction, with the horizontally adjacent images being shifted relative to each other vertically. This means that the axes of symmetry of each image (vertical and horizontal) are parallel to each other, and in such specific embodiments, adjacent images are placed relative to each other so that the intersections of the axes of symmetry of adjacent images determine a straight line inclined preferably by an acute angle, especially preferably by an angle from 15 to 30, relative to the straight line defined by the lowest vertical pixels of the images constituting the textual security feature. Thus, horizontally adjacent images are offset from each other not only with respect to the horizontal axis of the first security feature, but also with respect to the ver-

tical axis of the first security feature.

[0068] In yet another variant embodiment, shown in Fig. 6 b), individual images were additionally rotated by an appropriate angle. In some embodiments, the rotation angle of each consecutive image constituting the first security feature may be the same. In other embodiments, the rotation angle of each consecutive image constituting the first security feature may be different. As a result of the appropriate angular setting arising from the geometry of individual signs, thanks to the rotation of adjacent images, a slightly different visual effect of the shape of individual signs is obtained, which will ensure the possibility of using the security element according to the invention in numerous applications obtaining various final visual effects while maintaining the desired high level of security.

[0069] As shown above, the present inventors have found that a security element carrying individualizing information can be obtained in a simple and inexpensive way using a commonly available laser engraving and/or marking method by employing infrared and green lasers. In particular, it was found that document personalization can be easily ensured by personalizing the introduced textual security feature consisting of an array of microphotographs of the document holder. As it has been shown, the microphotograph is clearer when using a high image resolution and a small laser spot diameter. However, the security feature obtained with standard parameters is also legible. Increased security is ensured due to the need to modify each of the images constituting the security feature dot, in particular images corresponding to the image of the document holder, that is her/his microphotograph as applied, with the simultaneous need to interfere with the information carried by textual security feature. This is made particularly difficult when the security element comprises a matrix of images formed by the second security feature, in particular a matrix in which the images constituting the dots forming the textual security feature are positive images and all the remaining images of the matrix are negative images.

Claims

1. A security element for identification documents, in particular for identity documents, containing a hard substrate susceptible to laser marking, comprising:
 - a first security feature of the security element applied by laser marking to a hard surface; and
 - a second security feature of the security element applied by laser marking to a hard surface;

wherein the first security feature is a document-individualizing, information-bearing textual security feature, and the second security feature is a document-individualizing, information-bearing security feature in the form of an image, **characterized in that** the

- first security feature includes an array of a plurality of the same images that constitute the second security feature, preferably images on the microstructure level, where each image corresponds to a single dot that, together with the other dots in the array, constitutes a globally perceptible, information-bearing textual security feature, and wherein at least the first security feature is perceptible to the naked eye.
2. The security element according to claim 1, **characterized in that** the image is an image corresponding to the image of the identification document holder, preferably a photograph of the identification document holder.
 3. The security element according to claim 1 or 2, **characterized in that** the second security feature is visible to the aided eye only, preferably is visible through a magnifying device such as a loupe or a magnifying glass.
 4. The security element according to any one of claims 1-3, **characterized in that** the hard substrate susceptible to laser marking is a polymer substrate, preferably a PC or PVC substrate.
 5. The security element according to any one of claims 1-4, **characterized in that** the images constituting the second security feature consist of a plurality of pixels, perceptible as areas of changed coloring relative to the coloring of the substrate, which are formed in places exposed to laser pulses during laser engraving or marking, and whose size, shape and color saturation depend on the number of laser pulses used during laser engraving or marking.
 6. The security element according to claim 5, **characterized in that** the change in the coloring of the pixels of the images corresponding to the dots perceptible to the naked eye constituting the textual security element perceptible to the naked eye, is a change in color and hue intensity obtained as a result of activation during laser marking of pigments present in the substrate susceptible to laser marking, and the pixels colored in relation to the hue of the substrate correspond to laser-processed areas.
 7. The security element according to claim 5, **characterized in that** the change in coloring of the image pixels corresponding to the dots perceptible to the naked eye, constituting the textual security element perceptible to the naked eye, is a change in hue and its intensity on a gray scale obtained as a result of the carbonization of the substrate occurring during laser marking, wherein the darkened/grayed pixels correspond to laser-processed areas.
 8. The security element according to any one of claims
 - 1 - 7, **characterized in that** the array comprising plurality of the same images constituting the second security feature with a changed hue in relation to the hue of the substrate forms a matrix in which the first security feature is formed by an additional change in the coloring of the images constituting the first security feature in relation to the remaining images constituting the matrix, wherein the matrix images with a different hue compared to the remaining matrix images correspond to the dots perceptible to the naked eye creating the globally perceptible textual security element constituting the first security feature.
 9. The security element according to claim 8, **characterized in that** the matrix includes images constituting a positive image and a negative image, wherein, preferably, the positive image consists of images with significantly increased hue intensity, preferably in gray scale, which images correspond to the dots forming the textual security element perceptible to the naked eye constituting the first security feature, and the negative image consists of images with significantly reduced hue intensity, especially in gray scale, which images correspond to the bright dots of the matrix forming a light background for the textual security element perceptible to the naked eye.
 10. The security element according to any one of claims 1-9, **characterized in that** the image resolution of the second security feature is at least 700 dpi, preferably at least 900 dpi.
 11. The security element according to any one of claims 1-10, **characterized in that** the image resolution of the second security feature is at least 700 dpi, preferably at least 900 dpi, and the distance of individual pixels in the image is at most 35 μm , preferably at most 30 μm , more preferably at most 20 μm , and more preferably at most 3 μm , and most preferably at most 1 μm .
 12. The security element according to any one of claims 1-11, **characterized in that** the first security feature is formed by an array of images constituting the second security feature, including at least 5 lines of the same images constituting the second security feature, preferably 5 to 8 lines of the same images constituting the second security feature.
 13. The security element according to any one of claims 1-12, **characterized in that** the height of the first security feature is at least 1.0 mm and not greater than 5.0 mm, more preferably in the range of 1.0 - 2.4 mm, most preferably in the range of 1.5 - 2.2 mm and/or the image height of the second security feature is from 200 μm to 1 mm, preferably 200-300 μm .
 14. The security element according to any one of claims

1-13, **characterized in that** it comprises an additional security feature selected from offset security features such as offset underprinting.

15. An identification document, preferably an identity document, ID card or driving license, **characterized in that** it contains:

- a hard surface susceptible to laser marking;
- at least one security element as defined in any of the claims 1-14.

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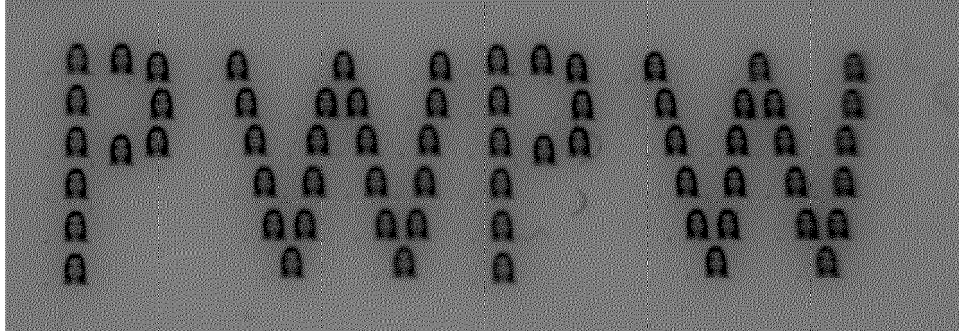


Fig. 1



Fig. 2

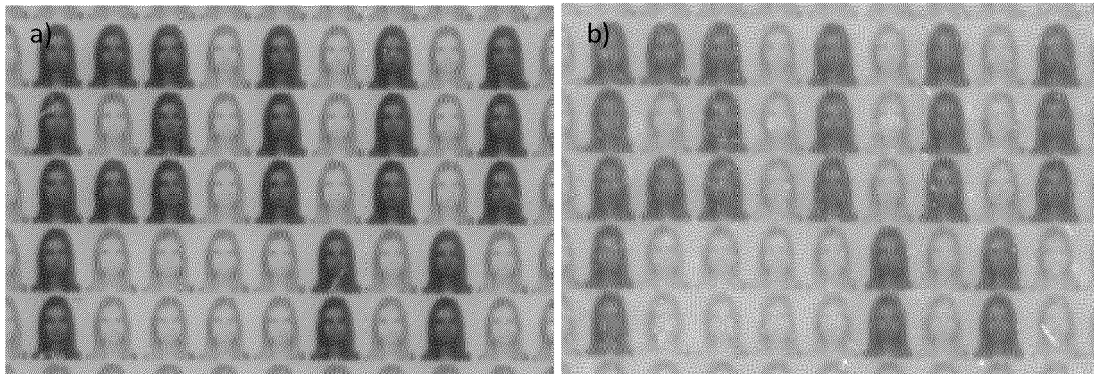


Fig. 3

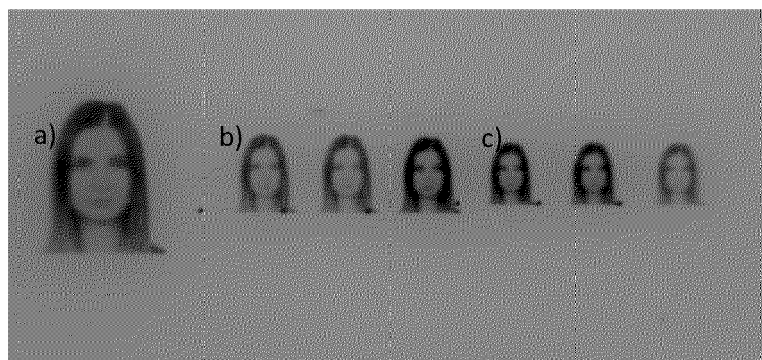


Fig. 4

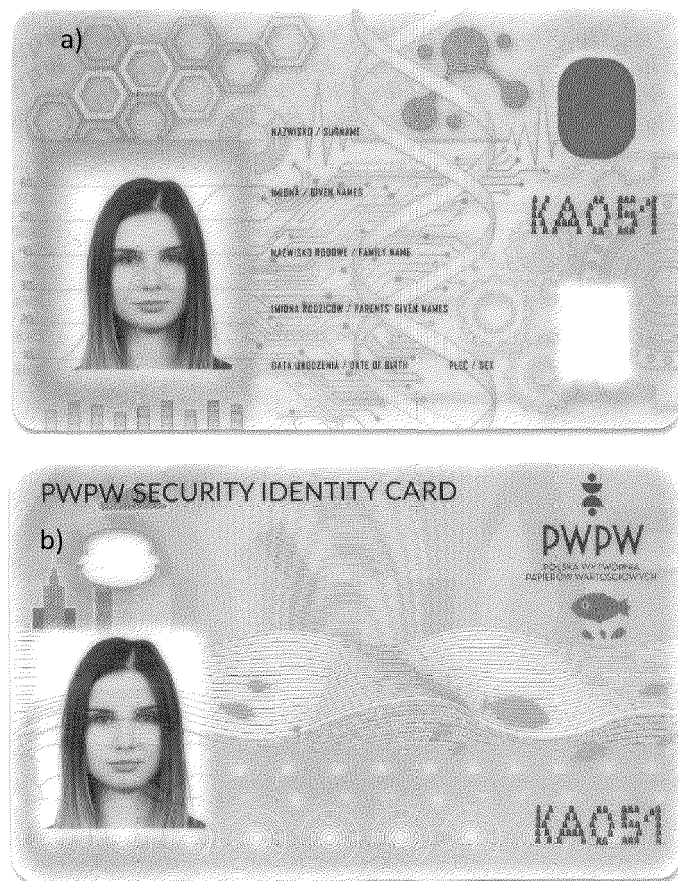


Fig. 5

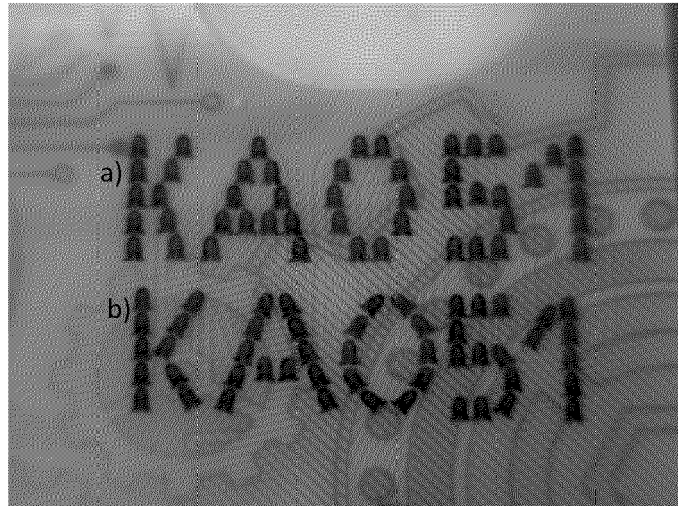


Fig. 6



Fig. 7



EUROPEAN SEARCH REPORT

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 20 March 2024	Examiner Seiler, Reinhold
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