(12) PATENT (11) Application No. AU 199883356 B2
(19) AUSTRALIAN PATENT OFFICE (10) Patent No. 740397

(54) Title
Diffractive surface pattern

(51)[6] International Patent Classification(s)
G06K 019/16 B42D 015/10

(21) Application No: 199883356 (22) Application Date: 1998.06.04

(87) WIPO No: WO98/55964

(30) Priority Data

(31) Number	(32) Date	(33) Country
1368/97	1997.06.06	CH

(43) Publication Date : 1998.12.21
(43) Publication Journal Date : 1999.02.18
(44) Accepted Journal Date : 2001.11.01

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OPI DATE 21/12/98 APPLN. ID 83356/98
AOJP DATE 18/02/99 PCT NUMBER PCT/EP98/03324

AU9883356

(51) Internationale Patentklassifikation 6 :
G06K 19/16, B42D 15/10

A1

(11) Internationale Veröffentlichungsnummer: WO 98/55964

(43) Internationales Veröffentlichungsdatum: 10. Dezember 1998 (10.12.98)

(21) Internationales Aktenzeichen: PCT/EP98/03324

(22) Internationales Anmeldedatum: 4. Juni 1998 (04.06.98)

(30) Prioritätsdaten:
1368/97 6. Juni 1997 (06.06.97) CH

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(81) Bestimmungsstaaten: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO Patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), eurasisches Patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), europäisches Patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI Patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

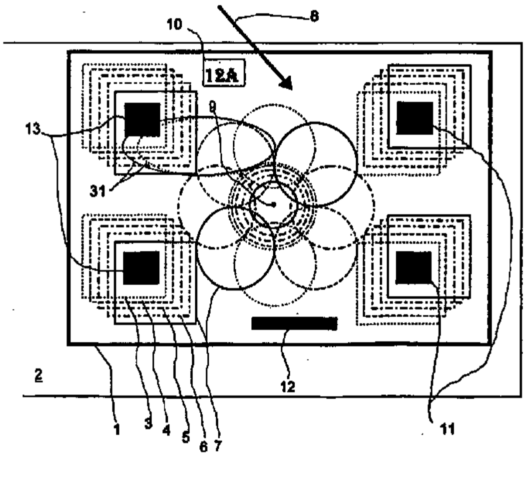
Veröffentlicht
Mit internationalem Recherchenbericht.

(54) Title: DIFFRACTIVE SURFACE PATTERN

(54) Bezeichnung: DIFFRAKTIVES FLÄCHENMUSTER

(57) Abstract

According to the invention, a surface pattern (1) has N visually recognisable patterns consisting of diffractionally effective, microscopically fine relief structures or flat reflective surfaces, or comprising absorbent or dispersive structures. The N patterns together contain at least one common independent surface element (11). Said surface element (11) is divided into surface parts, said surface parts being arranged in a predetermined structure which is independent of the N patterns. Said arrangement of the surface parts is not visible to the naked eye. Each surface part is covered with an individual, microscopically fine diffraction structure or alternatively, a structure which has an absorbent or dispersive property or which is a flat reflective surface. The relief structures, diffraction structures and other structures are embedded in a plastic laminate (20) and the optical effect of said structures can be increased with a reflective layer (21). The surface pattern (1) is applied to a document (2) as a security element and enables said document to be recognised by machine in a reading device.



DIFFRACTIVE SURFACE PATTERN

The invention relates to surface patterns of the kind with N visually perceptible patterns comprising surface portions with microscopically fine relief structures having an optical-diffraction effect, planar mirror surfaces or absorbent or scattering structures, whose optical effectiveness is determined by a reflection layer on the structures, and which are embedded into a laminate of plastic material and to that surface pattern.

Such surface patterns are suitable as security and authenticity features on documents such as for example back notes, value-bearing papers or securities and bonds, identity papers, passes, credit and other identity cards, smart cards in any form and so forth.

Patent specifications EP-A 105 099, EP-A 330 738, EP-a 375 833 and EP-A 537 439 discloses optical-diffraction security features which are embossed in plastic material, with N patterns and extremely fine filigree structures such as for example guilloche patterns, the image content of which changes in a predetermined fashion upon being turned about an axis. Those security features do not involve machine-readable information.

Such security features are embedded in a laminate of plastic material (EP-A 401 466) and can be glued onto a substrate.

Volume holograms are also known (H.J. Caulfield: "Handbook of Optical Holography", pages 202–204, 28–119, Academic Press, Inc., 1979, ISBN 0-12-165350-1). Starting from a light-sensitive film or foil, the hologram is produced by exposure with reference and object beams from a laser, wherein the interferences between the reference beam and the object beams produce local changes in the refractive index in the foil, which are present locally in the form of closely stepped places arranged in a Venetian blind-like configuration (= "fringes") within the thick, light-sensitive layer. After development the film is practically transparent while at the same time under predetermined conditions the light which penetrates into the film is diffracted with a high degree of efficiency at the fringes.

Swiss patent specification No. 653 160 discloses a value-bearing document or bond or security paper with machine-readable optical authenticity marking which consists of diffraction structures, which are composed of mutually joined surface portions involving predetermined diffraction structures. It is suggested that coarse relief for a diffraction structure be distributed to a large number of surface portions. The information content however can be easily falsified by cutting up and re-assembling the authenticity marking. An important feature is statistical, simultaneous detection of the information from the entire authenticity marking if the entire surface of the authenticity feature is irradiated with parallel light.

The security feature can have first diffraction elements which in accordance with EP-A 360 969 differ from the surrounding further diffraction elements only by virtue of their value of the azimuth, which is higher by 180° (asymmetry). [An authenticity feature can be provided with a piece of information] with such mirror-symmetrical pairs of diffraction elements

amended sheet

markings. The document had only the authenticity marking which consists of diffraction structures, which are composed of mutually joined surface portions involving predetermined diffraction structures. It is suggested that coarse relief for a diffraction structure be distributed to a large number of surface portions. The information content however can be easily falsified by cutting up and re-assembling the authenticity marking. An important feature is statistical, simultaneous detection of the information from the entire authenticity marking if the entire surface of the authenticity feature is irradiated with parallel light.

The security feature can have first diffraction elements which in accordance with EP-A 360 969 differ from the surrounding further diffraction elements only by virtue of their value of the azimuth, which is higher by 180° (asymmetry). An authenticity feature can be provided with a piece of information with such mirror-symmetrical pairs of diffraction elements. A surface pattern of that kind suffers from the same disadvantage as Swiss patent specification no. 653 160.

The object of the present invention is to provide a surface pattern in the form of an optical-diffraction security feature which has information that can be easily read out for identification of the surface pattern and which cannot be forged or which is very difficult to forge.

Accordingly, in a first aspect, the present invention provides a surface pattern with N visually perceptible patterns comprising surface portions with microscopically fine relief structures having an optical-diffraction effect, planar mirror surfaces or absorbent or scattering structures, whose optical effectiveness is determined by a reflection layer on the structures, and which are embedded into a laminate of plastic material characterised in that

the N patterns together have at least one independent common surface element,

the common surface element is so subdivided into surface portions that an arrangement of the surface portions which is structured in a predetermined manner and which is independent of the N patterns cannot be discerned with the naked eye, and each of the surface portions contains a microscopically fine diffraction structure or a structure with absorbent or scattering properties or is a planar mirror.

In a second aspect, the present invention provides use of a surface pattern of the first aspect as a security element for a document and for identification of the document in a reading device.

Embodiments of the invention are described in greater detail hereinafter with reference to the drawings in which:

Figure 1 shows a surface pattern,

Figures 2a–d show surface elements,

Figure 3 shows a reading device with the surface pattern,

Figure 4 shows a linear surface array,

Figure 5 shows a quadratically defined surface array, and

Figure 6 shows an arrangement of script images in the surface pattern.

Referring to Figure 1. shown therein is a surface pattern 1 which is applied in the form of a security element to a document 2. The surface pattern 1 has N visually perceptible patterns which are composed of surface portions or other graphic elements with microscopically fine relief structures which have an optical-diffraction effect, flat mirror surfaces or with absorbent or scattering structures. N is an integer > 0, for impressive optical motion effects N is selected to be between 6 and 30. Configurations of the N patterns are described in above-mentioned specifications EP-A 105 099, EP-A 330 738, EP-A 375 833 and EP-A 537 439. For considerations relating to the drawing, Figure 1 shows the N patterns by lines 3 to 7 in different forms (by dots, dashes, dot-dashes and so forth). In actual fact an observer viewing the surface pattern 1 from the viewing direction 8 perceives in each case only a single one of the N patterns in brilliant colours, upon rotation about the line normal to the plane of the drawing (shown by the point 9) of the surface pattern 1 when lit with daylight; in this example, in the transition from one pattern to the next, the position of the visible squares and circles on the surface pattern 1 changes or circles with the centre point 9 and involving changing radii are successively visible. Script images 10 of a corresponding configuration also have the same motion effects.

The N patterns contain together at least one independent common surface element 11 which is not part of the N patterns. A plurality of those surface elements 11 can be arranged in side-by-side relationship, with or without a spacing, and form a band-shaped linear first surface array or configuration 12 of the height of a surface element 11. In another embodiment a compact second surface array or configuration 13 involves the shape of a quadrangle (square, rectangle, rhombus) or another surface configuration of any definition. Surface elements 11 which are not interconnected and which are delimited in any fashion can be arranged distributed over the entire surface pattern 1 or in a loose group.

Figure 2a to 2d show examples of the surface elements 11, in which respect it is noted here that the illustrated surface elements 11 are shown as rectangles only for reasons of representation in the drawing. The surface element 11 is subdivided into surface portions 14, 15 and has an arrangement of the surface portions 14, 15, which is independent of the N patterns and which is structured in a predetermined manner and which is not perceptible with the naked eye, that is to say at least one dimension of the surface portions 14, 15 is smaller than 0.3 to 0.4 mm. Each surface portion 14 and 15 respectively is occupied with a single, microscopically fine diffraction structure or with a structure which has absorbent or scattering properties, or is a flat mirror. Hereinafter the structures of the surface portions 14, 15, said structures not being specified in greater detail, are identified as the "partial structure". The surface pattern 11 in Figure 2a is subdivided into two equally sized surface portions 14, 15. The surface portion 14 is occupied by the partial structure "a", while the surface portion 15 is occupied by the partial structure "b". The size of the surface element 11 is for example 0.5 mm wide and 0.6 to 0.8 mm high. For the person viewing the surface pattern 1 (Figure 1) those surface portions 14, 15, if they are occupied by a diffraction structure, because of the high level of intensity of the light diffracted at the diffraction structure, are visible as striking spots of colour and can interfere with the image impression of the respective visible pattern. Damage to the surface of the surface element 1 within the surface portion 14 or 15 respectively can appreciably reduce the luminous power of the partial structure.

If the surface elements 11 are more finely subdivided, for example as shown in Figures 2b, 2c and 2d, then the intensity of the surface element 11 decreases, from the point of view of the observer. In Figure 2b the surface element 11 is subdivided with an arrangement of the inclinedly disposed band-shaped surface portions 14, 15, 16. The partial structures "a", "b" and "c" are associated with the surface portions 14, 15 and 16 and form a cyclically changing succession abc abc abc. The smaller dimension of the individual surface portions 14, 15, 16 is in the region of 50 μm. If the partial structures "a", "b" and "c" are in the form of diffraction structures, they differ in terms of at least one grating parameter so that the observer generally sees a mixed or secondary colour with less brilliance. In Figure 2c the surface element 11 is subdivided into regular pixels 17 whose largest dimension does not exceed 0.3 mm. That arrangement of the cyclically interchanged partial structures "a", "b", "c" and "d" in the surface portions 14, 15, 16, 18 is a modification of the arrangement shown in Figure 2b, which can be better integrated into one of the known surface patterns (EP-A 375 833). Figure 2d shows an arrangement of band-shaped surface portions 14, 15, at least 30 μm wide, with the two cyclically interchanged partial structures "a" and "b". The examples illustrated here of the arrangement of the partial structures in the surface element 11 and the nature of the subdivision of the surface element are an incomplete selection.

In Figure 3 the surface pattern 1 (Figure 1) is glued onto the document 2, with a layer of adhesive between the laminate 20 and the document 2 providing the adhesive bond. A relief 19 of the surface pattern 1 includes the surface portions with the microscopically fine relief structures and with absorbent or scattering structures or with planar mirrors of the N patterns and the partial structures of the surface elements 11. The relief 19 is embedded in a laminate 20 of transparent plastic material. The relief 19 can be covered with a reflection layer 21 to enhance the optical effectiveness.

In the region of the surface elements 11, in place of the fine subdivision into surface portions 14 (Figure 2a), 15 (Figure 2a), 16 (Figure 2b), it is also possible to use a relief structure 19 which is known from WO 97/27504, in which case the diffractive relief structure 19 is produced from a superimposition of corresponding simple diffraction gratings and has the same diffraction properties as the finely subdivided surface element 11.

Instead of the reliefs 19 which are replicated by embossing and the therefore completely identical surface patterns 1, it is possible to produce similar surface patterns 1 using the technology of the above-mentioned volume holograms 30, for example also in the form of individual portions; that procedure is suitable in particular for the production of individual security features with individual, machine-readable information. The volume hologram 30 is recorded in the form of a pattern of interferences of coherent reference and object beams in a light-sensitive layer, the "foil", which is thick in comparison with the wavelength of the light, wherein upon development of the exposed light-sensitive layer in the foil the pattern of the interferences involves local changes in the refractive index in the form of closely stepped planes arranged in a

Venetian blind configuration (= "fringes"). Those fringes act as a light-diffracting structure 30'. As no reflection layer 21 is required the volume holograms 30 have inherent transparency. This configuration of the surface pattern 1 affords the advantage that, after the security feature is glued on the document 2, images and text or other indicia of the document 2 still remain visible through the volume hologram.

Multiple exposures under different conditions in production of the volume hologram 30 makes it possible to produce in the region of the surface elements 11 in the same volume a plurality of systems of fringes which act in a similar manner to the superimposed relief structures which are known from WO 97/27504.

Machine identification of the document 2 in a reading device which is described in Swiss application No 1397/97 is advantageous in particular in relation to bank notes and passes of all kinds. In order to permit secure optically machine reading, the diffraction structures of the surface elements 11 (Figure 1) and the surface arrays 12 (Figure 1), 13 (Figure 1) which are composed thereof have at least one spatial frequency f_B which is not used in the microscopically fine relief structures of the N patterns or an integral multiple of the spatial frequencies f_R used for the relief structures, that is to say the spatial frequency $f_B \neq m \bullet f_R$ for m = 1, 2, 3, ...; the number m is the ordinal of the diffraction effect. If diffracted light of the k-th diffraction order is detected in the reading device, then selection of the spatial frequency f_B is further restricted as the exclusion rule $k \bullet f_B \neq m \bullet f_R$ for m = 1, 2, 3, ... and k = 1, 2, ... must also apply for that k-th diffraction order. The spatial frequencies f_B and f_R are from the range of 0 to about 3500 lines/mm, that is to say from a planar mirror to grating structures which can just still be shaped in the plastic material of the laminate 20.

It is possible besides the separate spatial frequencies f_B and f_R also to provide separate azimuth regions φ_B, φ_R for the diffraction structures of the surface elements 11 and the relief structures of the N patterns.

In the reading device a light source 22 produces monochromatic light 23 of a predetermined wavelength λ from the infra-red or visible range of the spectrum of electromagnetic waves. The light 23 which is incident on the surface pattern 1 is diffracted at the large number of surface portions 14 (Figure 2), 15 (Figure 2), 16 (Figure 2), 18 (Figure 2) with the diffraction structures of the spatial frequency f_B; in this example, in the first diffraction order (m = 1). In Figure 3 an arrow 24 specifies the direction of the light of the wavelength λ, which is diffracted at the diffraction structures. The diffraction structures of the surface portions 14, 15, 16, 18 can differ by the azimuth φ ($0^\circ \leq \varphi < 360^\circ$) and the profile of the diffraction structure (symmetrical and asymmetrical gratings, sine, rectangular, triangular and sawtooth profile with $(f_B)^{-1} \leq 3 \bullet \lambda$ or $(f_B)^{-1} > 3 \bullet \lambda$). The light diffracted at the surface portions 14, 15, 16, 18 with the same azimuth φ of the diffraction structure is deflected symmetrically with respect to the incident light 23 and impinges on the photodetectors 25, 26. The incident light 23 and the two photodetectors 25, 26 arranged symmetrically with respect to the incident light 23 establish a diffraction plane 100 with the azimuth θ of the surface portions 14, 15, 16, 18 to be detected, which at the same time is the plane of the drawing in Figure 3.

The relief structures of the N patterns have other spatial frequencies and for each pattern another azimuth so that the incident light 23 which is diffracted at the N patterns is deflected into other angular ranges Γ, ϑ which are delimited by conical surfaces, and does not reach the photodetectors 25, 26. Those conical surfaces have as a common axis the direction of the zero diffraction order; in Figure 3 of the drawing that axis is in anti-parallel relationship with the incident light 23.

The reading device in above-mentioned Swiss application No 1397/97, for the same azimuth θ ($0^\circ \leq \theta < 180^\circ$) of the diffraction plane 100 with which a partial structure is associated, can distinguish at least three states of the diffracted light, more specifically diffracted at the symmetrical grating or at one of the two asymmetrical gratings with the azimuths φ and φ + 180°. If in contrast the partial structure has an absorbent or scattering property or if it is a flat mirror, that involves a further state which can be detected by the reading device, "no diffraction structure". Accordingly the surface patterns 14, 15, 16, 18 with the same partial structures determine at least four states. If for example the surface element 11 contains surface portions 14, 15 with two different partial structures "a", "b" (Figures 2a, 2d), 16 various states can be represented with the surface element 11 which serves as an information element. It is to be added that in this case two respective photodetectors 25, 26 are to be arranged in the reading device in the two diffraction planes 100 corresponding to the parameters of the two partial structures "a" and "b". With the information elements, the identity of the surface pattern 1 of a document 2 can be encoded and securely detected with the reading device. If in a surface element 11 T denotes the number of different partial structures which are used in the surface portions 14, 15, 16, 18 and which respectively define Z states, the surface element 11 (as information element 29) has E various states, wherein $E = Z^T$. If the surface array 12 (Figure 1) or 13 (Figure 1) includes a plurality of surface elements 11, for example the number F, then E^F various states of the information can be theoretically used for optically machine-readable encoding of the surface pattern 1.

The light received by the photodetectors 25, 26 depends inter alia on the total surface area of the surface portions 14 and 15 respectively and so forth with the same partial structure within the surface element 11. In an example as shown in Figure 2d the dimension of the surface element 11 with two partial structures was 0.5 mm in width and 1.2 mm in height or for the total surface area of each partial structure 0.30 mm^2. The partial structure was divided in terms of height into 50 μm high surface portions 14, 15. That gave 12 surface portions 14 with the partial structure "a" and an equal number of surface portions 15 with the partial structure "b". The advantage of this arrangement lies in the virtual impossibility of mechanical separation of the surface portions 14 and 15 and therefore prevents a surface element 11 from being assembled together in a fresh configuration from bits, with fraudulent intent.

As can be seen from Figure 3, the spatial frequency f_B used in the partial structure, relative to the spatial frequencies f_R of the light-diffracting relief structures, involves at least a minimal spatial frequency distance Δf, represented by the arrow 24 in the gap between the two defining conical surfaces of the two angular ranges Γ, ϑ. With a typical spatial frequency f_B, f_R of between 500 and 1000 lines/mm the spatial frequency distance Δf is about Δf = between 20 and 100 lines/mm.

If the document 2 is a thin paper, for example as in the case of bank notes, the laminate 20 follows the rough surface of the paper which often is also creased. The light 23 is then locally no longer perpendicularly incident on the surface pattern 1 and the direction of the arrow 25 deviates from the reference or target direction and can possibly no longer reach the photodetector 25 or 26 respectively. In order to compensate for those effects, the spatial frequency f_B of the diffraction structure within the surface portion 14, 15, 16 or 18 respectively involves a modulation effect, that is to say the spatial frequency f_B does not have an individual value but varies within narrow limit values continuously or step-wise, for example between 500 lines/mm and 520 lines/mm with a nominal frequency of f_B = 510 lines/mm. The diffracted light is no longer parallel but slightly divergent, as is indicated by the shaded region 27. So that the diffracted light received by the photodetectors 25, 26 reliably originates from the partial structures, the exclusion rule $k \bullet f_B \neq m \bullet f_R$ must apply in respect of all spatial frequencies f_B of the modulation range (band width).

Figure 4 shows an embodiment of the linear surface array or configuration 12. In an example, the linear surface array or configuration 12 is a succession of the H surface elements 11 which are arranged successively in a row. They involve the arrangement illustrated in Figure 2d of the surface portions 14, 15 or an arrangement which is turned through 90° (Pos.5). The parameters of the partial structures a to e, which are used in Figure 4, are listed in Table 1. The partial structures "a" and "c" allocate the surface elements 11 as being classified in even and odd positions. The partial structures "d" and "e" represent the information "logic 0" and "logic 1". Identification of the surface elements 11 by their position in the surface array or configuration 12 has the advantage that forgery of the information contained in the surface array or configuration 12, by cutting up the surface array or configuration 12 and re-assembling it, is substantially prevented.

Table 1:

Partial structure	a	b	c	d	e
Spatial frequency f_B	1000 per mm	mirror plane	1000 per mm	600 per mm	600 per mm
Azimuth φ	180°	---	0°	180°	0°
Function	odd bit	start character	even bit	logic 0	logic 1

The surface array or configuration must be optically scanned by a reading device which reads out sequentially as the information also sticks in the place value of the surface elements 11, that is to say in the position thereof in relation to the start character (Pos. H=1). The reading device in the drawing of Figure 3 requires only a single diffraction plane 100 in which are arranged two pairs of the photodetectors 25, 26, symmetrically with respect to the incident light 23. The light which is diffracted at the two partial structures with the spatial frequencies 600 lines/mm and 1000 lines/mm divides the half-space available for the diffracted light of the N patterns into three regions and not into two, as shown.

The incident light 23 is so deformed by a collimator (EP-A 360 969) that, as shown in Figure 4, formed on the surface element 11 is for example an illuminated surface 28 whose dimension along the surface array or configuration 12 is at least 50% of the width of a surface element 11. For reading-out purposes, the incident light 23 is passed along the linear surface array or configuration 12 in such a way that one surface element 11 after the other is read out. The start character permits clear association of the information elements 29 in the surface array or configuration 12. The linear surface array or configuration 12 in this example contains the information "start/010 ... 11". In addition Pos.H can be in the form of a stop character, wherein the partial structures "b" and "c" clearly signal the stop character to the reading device.

The compact second surface array or configuration 13 (Figure 1) is shown by way of example in Figure 5. The surface array or configuration 13 is here composed of six surface elements (Figure 2d) which are subdivided with the arrangements of the surface portions 14 (Figure 2d). 15 (Figure 2d). wherein the five partial structures are combined in the surface elements 11 to give {a. b}. {a. c}. {a. e}. {b. e} and {c. d}. Each partial structure establishes one of at least four states. If the entire surface array or configuration 13 is simultaneously illuminated. a reading device with three diffraction planes 100 (Figure 3) and with five pairs of photodetectors 25 (Figure 3). 26 (Figure 3) detects the state which is predetermined by the selected partial structures. out of 4^5 = 1024 states. Table 2 contains parameters for a predetermined state by way of example.

Without departing from the idea according to the invention. graphic line elements 31. 32 of the N patterns can extend over the surface of the surface elements 11 and break it up into the two sub-elements 33 and 34. The association with the surface element 11 is determined by the arrangement of the partial structures. Mutually adjoining surface elements can also be spaced by means of an empty strip 35. Such line elements 31. 32 are generally extremely narrow (typically between 30 and 100 μm) and therefore do not interfere with the operation of reading out the surface elements 11 or. as Figure 1 shows. the surface arrays or configurations 12. 13.

Table 2:

Partial structures	a	b	c	d	e
Azimuth angle of the diffraction plane	0°	90°	0°	90°	135°
Azimuth angle φ	180°	270°	0°	---	135°
Diffraction grating	asymmetrical	asymmetrical	symmetrical	mirror	asymmetrical
Spatial frequency f_B	600 per mm	600 per mm	900 per mm	900 per mm	900 per mm

Instead of simple strips in the form of a circular ring or a band, a script image 36 consisting of alpha-numeric characters can also advantageously be selected for the surface portions 14, 15, 16, 17, 18, as shown in Figure 6. The alpha-numeric characters of the script image 36 can have for example the partial structure "a" and the background of the characters can have the partial structure "b". In another embodiment, adjacent script images 36 and the background thereof are separated by the surface portion 16 with a third partial structure "c". Such script images 36 with a height d ≤ 0.3 mm and the use thereof are described in EP-A 330 738.

The most important advantages of the encoding set forth herein by means of a surface array or configuration 12, 13 or a single surface element 11 are summarised once again here:

- scratches, dirt, surface flaws and so forth are scarcely still noticeable as the information-bearing partial structures, without having a conspicuous effect, are distributed over a relatively large surface element 11;

- the information is encoded exclusively with predetermined spatial frequencies f_B so that the reader can easily read out the information even from the surface pattern 1;

- large tolerances in relation to positioning errors of the surface pattern 1 relative to the reading device.

The claims defining the invention are as follows:

1. A surface pattern with N visually perceptible patterns comprising surface portions with microscopically fine relief structures having an optical-diffraction effect, planar mirror surfaces or absorbent or scattering structures, whose optical effectiveness is determined by a reflection layer on the structures, and which are embedded into a laminate of plastic material, characterised in that

the N patterns together have at least one independent common surface element,

the common surface element is so subdivided into surface portions that an arrangement of the surface portions which is structured in a predetermined manner and which is independent of the N patterns cannot be discerned with the naked eye, and

each of the surface portions contains a microscopically fine diffraction structure or a structure with absorbent or scattering properties or is a planar mirror.

2. A surface pattern with N visually perceptible patterns in the form of a volume hologram stored in a foil with microscopically fine structures having an optical-diffraction effect, formed from local changes in the refractive index in the material of the foil, characterised in that

the N patterns together have at least one independent common surface element,

the fine structures of the common surface element with at least one spatial frequency f_B are so arranged that a diffraction pattern which is independent of the N patterns is produced in a small range, which is associated with the spatial frequency f_B of the diffraction angle,

the fine structures of the N visually perceptible patterns have such spatial frequencies f_R whish are different from the spatial frequency f_B, and

the fine structures of the common surface element have at least two different values φ_1, φ_2 of the azimuth.

3. A surface pattern as set forth in claim 1 or claim 2 characterised in that the common surface element is an optically machine-readable information element.

4. A surface pattern as set forth in claim 3 characterised in that in the N patterns a plurality of surface elements form a common group and the information elements of the group form an optically machine-readable code.

5. A surface pattern as set forth in claim 4 characterised in that the surface elements are of equal size and are arranged linearly.

6. A surface patterns as set forth in claim 1 characterised in that that the microscopically fine diffraction structures of the surface portions in the common surface element have at least one spatial frequency f_B and the microscopically fine relief structures of the N patterns, which have an optical-diffraction effect, have spatial frequencies f_R, wherein no integral multiple of the spatial frequencies f_B is an integral multiple of one of the spatial frequencies f_R.

7. A surface pattern as set forth in claim 2 characterised in that no integral multiple of the spatial frequencies f_B is an integral multiple of one of the spatial frequencies f_R.

8. A surface pattern as set forth in claim 6 or claim 7 characterised in that each of the spatial frequencies f_B used in the structures has at least a minimal spatial frequency distance $+/-\Delta f$ in relation to the spatial frequencies f_R.

9. A surface pattern as set forth in one of claims 6 to 8 characterised in that the spatial frequency f_B is of a predetermined bandwidth.

10. A surface pattern as set forth in claim 1 or claim 6 characterised in that the surface element is divided by a plurality of surface portions into piccolos or bands, wherein partial structures in the pixels or bands are cyclically interchanged.

11. A surface pattern as set forth in claim 10 characterised in that the surface element in the surface portions has only two different partial structures.

12. A surface pattern as set forth in claim 10 or claim 11 characterised in that at least one of the surface portions is an alpha-numeric character or a script image.

13. A surface pattern as set forth in one of claims 10 to 12 characterised in that at least one graphic element of at least one of the N patterns extends over a surface element and divides it into sub-elements.

14. A surface pattern substantially as hereinbefore described with reference to the accompanying drawings.

15. Use of a surface pattern as set forth in any one of the preceding claims as a security element for a document and for identification of the document in a reading device.

Dated 7 June, 2001

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SPRUSON & FERGUSON

Fig. 1

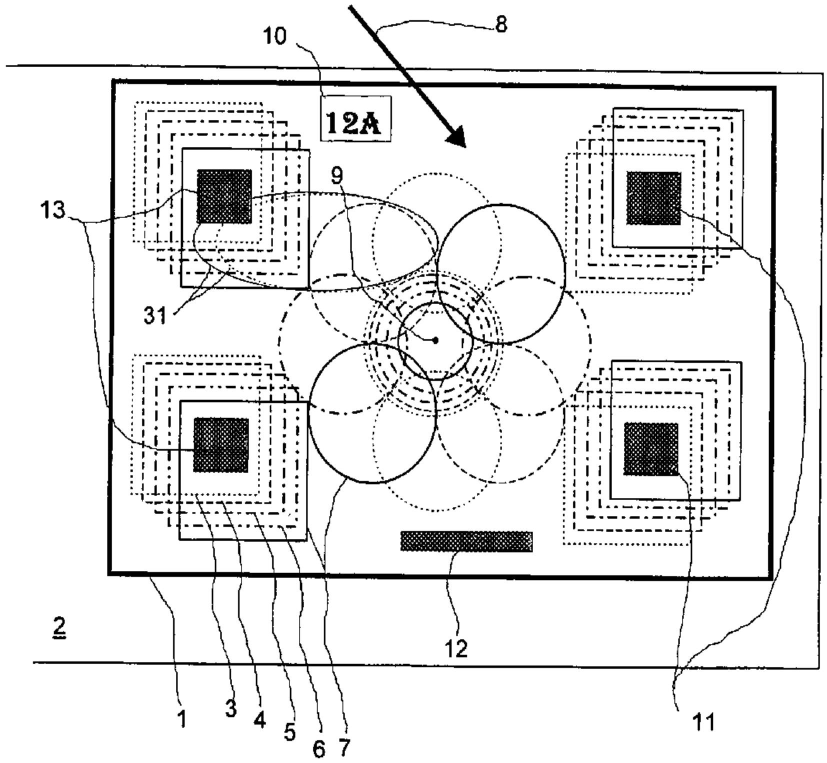


Fig. 2a:

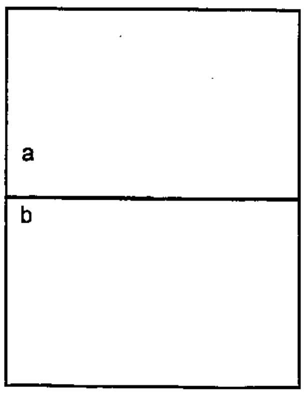


Fig. 2b:

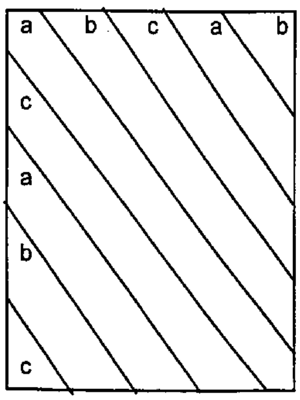


Fig. 2c:

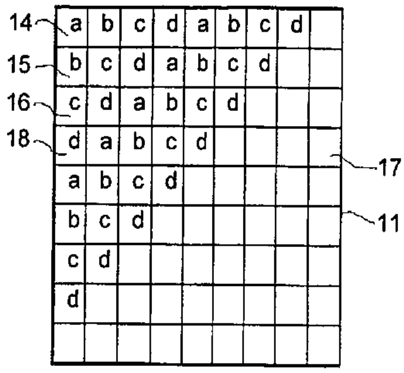


Fig. 2d:

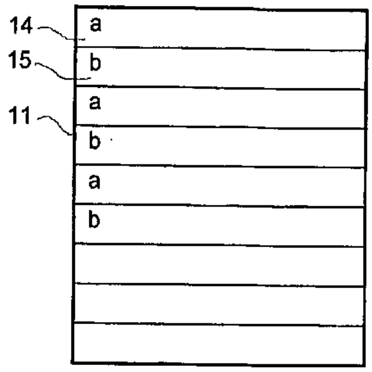
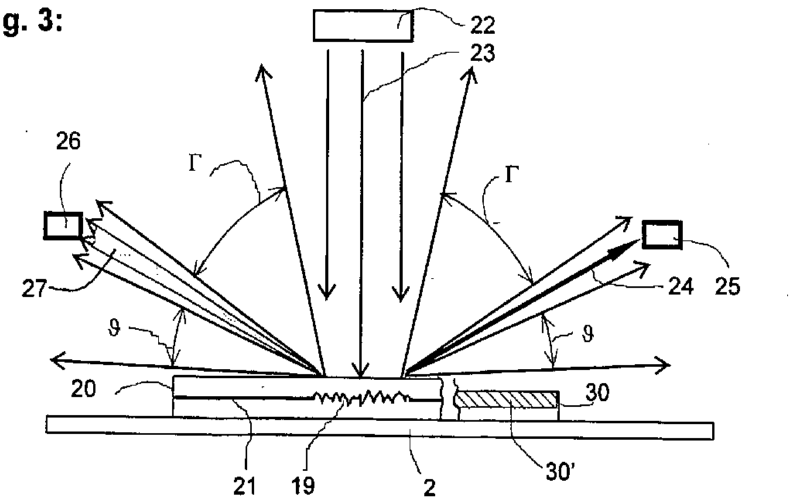


Fig. 3:



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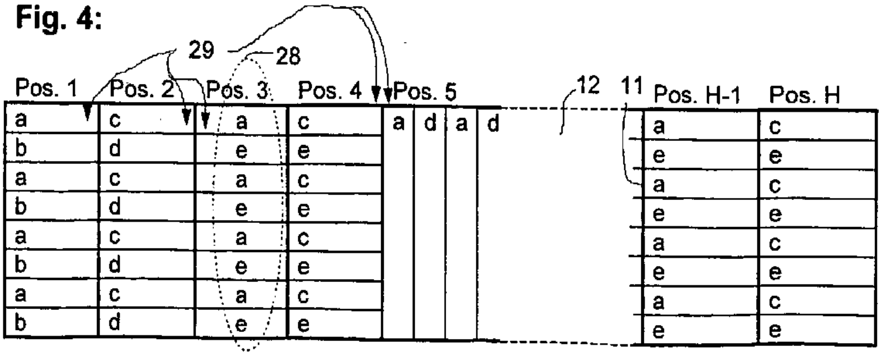

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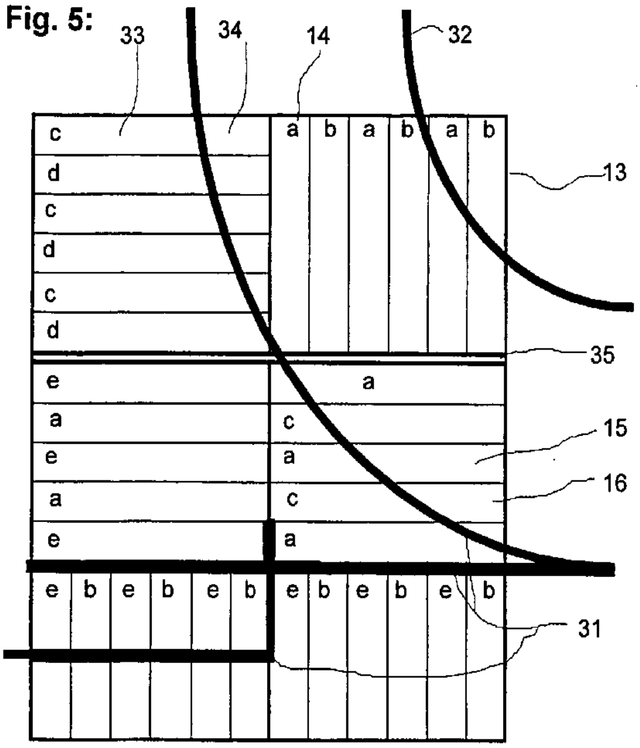
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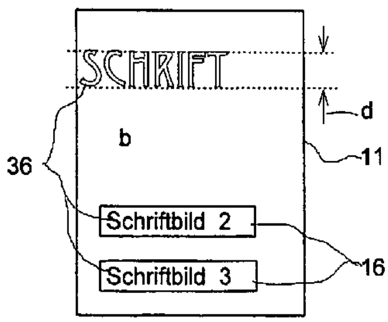
Fig. 6: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Schriftbild 2
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