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(54) **INTAGLIO PRINTING PLATE**

TIEFDRUCKPLATTE

PLAQUE D'IMPRESSION EN CREUX

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EP 1 748 900 B1

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Description

[0001] The present invention concerns an engraved plate for intaglio printing of sheets of security papers, comprising a plate portion generating on each said security paper a control element upon intaglio printing. The invention relates also to a process for manufacturing an aforesaid plate and to a security paper imprinted by means of an aforesaid plate.

[0002] The term "security paper" primarily designates here banknotes, but also designates documents of any kind having a financial value, such as cheques, lottery tickets, title deeds and the like, or identity documents such as passports, ID cards, driving licences and the like.

[0003] The term "control element" designates any sign readable either by human beings or by a specific machine. Such control elements comprise individualised identity markings, such as serial numbers or code bars. They also comprise markings that are difficult to manufacture and to reproduce, but which may be checked as far as quality parameters like colorshade, thickness, consistency and the like are concerned. Among these, optically variable markings which may be easily checked by the human eye upon merely handling an illuminated security paper, that is to say by lay users without necessitating a specific detection equipment, are particularly valuable in so far as such control elements cannot be reproduced by means of commonly available equipments, such as photocopiers, scanners and similar copying machines.

[0004] Among various processes used in the security printing industry, intaglio printing is a preferred technique, because it provides prints of high quality. Additionally, intaglio printing provides an embossing of the printed sheet which may be felt by the human hand. Its feel is different from the feel of a sheet imprinted by another technique. Thus, it provides a quite simple control element to the touch against coarse counterfeits like photocopies.

[0005] It was also already proposed in the past to make use of the embossings produced at the surface of a security paper sheet upon intaglio printing to generate an optical variable effect.

[0006] EP 0429782 discloses a process to emboss a film applied on a security document, said film comprising an optically variable microstructure, typically a patch with a diffracting microstructure, with a tridimensional profile.

[0007] US 3,887,742 discloses a process to emboss a substrate to form a plurality of lines providing an asymmetric profile and wherein the space between said lines are filled with ink.

[0008] When an intaglio imprint formed of inked lines co-operatively defining a visible pattern is seen from an acute angle of view in a plane perpendicular to the lines, the inked lines forming ribs above the substrate surface occlude more or less the spaces between them, whereas they do not occlude these spaces when seen from an angle of view normal to the substrate surface. Documents

US 4,033,059 (R.G. Hutton et al.) and US 4,124,947 (A. Kuhl et al.) disclose several embodiments of a technique based on this effect, using intaglio printing elements printed in an ink which contrasts with the colour of the underlying paper. The intaglio pattern elements comprise at least two arrays, one of which constitutes an image of readily recognisable form, and the other array constitutes a background. The two arrays differ in orientation or in overall sizes, that is to say in heights and spacings of the ribs. Varying orientation and heights of the pattern elements, in combination with inking, results in an image portion which blends with the background portion if viewed from one range of angles of view but which appears as a readily recognisable image from another range of angles of view. Such an image appearing or disappearing when the angle of view is changed is called a "latent image" or a "transient image".

[0009] If an observer tilts a security document bearing a control element of this type, he may see an image distinguishable from the background when he sees the surface of the security paper from an acute angle of view. The image disappears at approximately normal angles of view, and the same image appears again at acute angles of view opposite the first acute angles of view. With other variants of this technique, the observer may not see such image at acute angles of view, the image appearing only at approximately normal angles of view.

[0010] Although the technique described in the two documents mentioned above has certain advantages over other methods of detecting counterfeits, several problems remain. First, in order to become visible, the image must be inked with the colour of the raised portion of the image being necessarily different from the colour of the underlying document substrate. If a colour photocopy is made, the colours of the copy are the same as the ones of the original, and this make detection of a counterfeit more difficult, although of course the latent image effect is lost.

[0011] A second problem is that great care must be taken to create an image that is clearly visible from one angle of view, and essentially invisible from a second angle of view. Unless great care is taken in creating the image, it will be more or less visible from any angle of view.

[0012] Further, besides the drawbacks of the above-described techniques, it is an aim of the present invention to offer a control element exhibiting a variable optical effect differing from those of the latent images of the state of art. It is a further aim to offer such a control element, whose implementation necessitates a sophisticated equipment which is hardly accessible to forgers.

[0013] Now, the present inventors have found that not only the overall size and the angles from which said embossings are illuminated and viewed, but also the shape of the embossings may determine the visual aspect of the security paper surface: this aspect varies depending upon the slope of the flanks of the embossings. The inventors found in particular that a sheet area bearing a

set of asymmetric embossings, one flank of which has a high average slope and an other one has a low average slope, if viewed sideways, may appear dark if viewed from one side of the embossings and appear bright if viewed from the other side.

[0014] Thus, according to one aspect, the invention is directed to a security paper bearing a control element consisting of an area portion obtained by intaglio printing or embossing, wherein said portion is provided with at least one first set of asymmetrical embossing elements, each said embossing element having a first flank and an opposite second flank, the average slope of said first flank being different from the average slope of said second flank, wherein the slopes of said first flanks of said set of embossing elements are substantially equal amongst themselves and the slopes of said second flanks of said set of embossing elements are substantially equal amongst themselves.

[0015] By virtue of the control element according to the invention, when the angle of view of an observer examining the security paper varies from a first acute angle of view to opposite acute angles of view, the observer will observe the following sequence:

- the image defined by the first set of embossing elements in a dark shade, $\Rightarrow$ more or less complete disappearance of the image, $\Rightarrow$ reappearance of the image in a bright shade, or vice versa; whereas, with a control element bearing a latent image of the prior art, he would observe a sequence:
- image in dark shade, $\Rightarrow$ disappearance of the image, $\Rightarrow$ reappearance of the image in the same dark shade.

[0016] The shape of the embossings of a security paper surface are directly determined by the shape of the cuts of the intaglio printing plate, namely the furrow elements engraved in the intaglio plate, by means of which the security paper may be imprinted.

[0017] Thus, according to a further aspect, an object of the invention is an engraved plate for intaglio printing or embossing of sheets of security papers, comprising a plate portion generating on each said security paper a control element, wherein said plate portion is provided with at least one first set of asymmetrical furrow elements defining a first area conveying information, each said furrow element of the first set having a first side wall and an opposite second side wall, the average slope of said first side wall being different from the average slope of said second side wall, wherein the average slopes of said first side walls of said first set of furrow elements are substantially equal amongst themselves and the average slopes of said second side walls of said first set of furrow elements are substantially equal amongst themselves, wherein said plate portion is further provided with a second set of asymmetrical furrow elements defining a second area, each furrow element of the second set having

a first side wall and an opposite second side wall, the average slope of said first side wall being different from the average slope of said second side wall, wherein the average slopes of said first side walls of said second set of furrow elements are substantially equal amongst themselves and the average slopes of said second side walls of said second set of furrow elements are substantially equal amongst themselves, and wherein the side walls with the lower average slope of the furrow elements of said first set and the side walls with the lower average slope of the furrow elements of said second set have different orientations.

[0018] Conveniently, the average slope of said first walls has a value of between 60° and 90° and the average slope of said second side walls has an average value of between 1° and 50° , preferably between 10° and 25° .

[0019] Preferably, said first area defines an alphanumeric or an other easily recognisable graphical sign.

[0020] The furrow elements providing the optical effect according to the invention may present various configurations. They may consist of elongated straight segments, elongated curved segments, in particular portions of circles, short segments or pinpoint asymmetrical recesses, which may be considered and termed as dots.

Furrow segments generate ribs with a steep flank and a gentle flank; furrow dots generate asymmetrical pyramidal toothlike protrusions on the security paper surface.

[0021] In the areas recognisable as alphanumeric signs or graphical signs by the human eye, the furrow elements are preferably contiguous. If the furrow elements are segments, the latter are preferably parallel and contiguous over their whole length or at least a part thereof. If the furrow elements are in form of dots, they may be spread over an area, preferably almost in point contact the ones with the others.

[0022] At least a second set of furrow elements having opposite side walls of unequal average slopes and defining a second area is further provided, the side walls with the lower average slope of the furrow elements of the first set having a different orientation than the side walls with the lower average slope of the furrow elements of the second set. The furrow elements of the second set may again advantageously be furrow segments or have the form of dots. Depending on the way the at least two distinct sets of furrow elements are combined, one can enhance the optical effect created by the first set or convey two distinct informations.

[0023] In embodiments where the furrow elements of both the first and second sets are furrow segments, the furrow segment of said second set may be parallel to the furrow segments of the first set, the side walls with the lower slope of the furrow segments of said first set and the side walls with the lower slope of the furrow segments of said second set being oriented in opposite directions.

[0024] According to a preferred embodiment, for enhancing the contrast effect, said second area may surround said first area, thereby constituting a background for the image defined by the first area. In this case, the

second area will convey basically the same information as the first area, however in a contrasting manner. A user, upon merely tilting a security paper provided with this control element, will observe the following sequence:

- bright image on dark background, $\Rightarrow$ melting of the image with the background, $\Rightarrow$ reappearance of the image in dark shade on a bright background.

[0025] Thus, the invention permits to realise a sort of flip-flop effect. Both the image area and the background area may be uniformly inked by means of the same colour prior to embossing the sheet with a dry plate. This will not prevent the flip-flop effect, but the image will be impossible to copy by means of a photocopy machine. The effect will be particularly enhanced when the side walls with the lower average slope of the furrow elements of the first set and the side walls with the lower average slope of the furrow elements of the second set are oriented in opposite direction.

[0026] If the furrow elements of the first set are dots, then the plate portion generating the control element may comprise a second set of asymmetrical furrow elements having first and opposite second side walls with unequal slopes, the side walls with the lower slope of the furrow elements of said first set and the side walls with the lower slope of the furrow elements of said second set having different orientations, advantageously opposite orientations.

[0027] In a particularly preferred embodiment of a plate portion consisting of asymmetrical dots, said plate portion comprises a first, a second, a third and a fourth set of asymmetrical furrow elements in form of dots, each set with their respective side walls with the lower slope orientated crosswise to the corresponding side walls of two other sets. Said first, second, third and fourth set define a first, second, third and fourth area. Said areas may overlap at least partially; in the overlapping portions of said areas, the dots of said first, second, third and/or fourth set are arranged in alternating relationships. With such a configuration, it is possible to convey four distinct informations in an overlapping relationship, depending on the angle of view.

[0028] Traditionally, the manufacture of intaglio plates is a long and complex process, which begins with the hand engraving of a steel or copper plate, making a copy of this first plate, adding by chemical engraving other elements, making several plastic imprints of this final original plate, welding them together, and going through an important number of galvanic bathes to obtain the final product, namely the intaglio printing plate to be mounted on the machine. Some improved processes permit to shorten the manufacturing process.

[0029] EP 0 322 301 proposes an electro-erosion step for engraving intaglio plates. WO 96/26466 describes a method of manufacturing polymeric precursor plates of intaglio printing plates by photo-ablation. The aforesaid methods provide cuts of sufficient quality as far as the

macroscopic optical aspect of the printed image is concerned, but do not permit a precise control of the microscopic shape of the cuts, in particular control of the slopes of the flanks or sidewalls of the cuts differently for one flank and the opposite flank.

[0030] Thus, a further object of the invention is a process of manufacturing an engraved plate as defined above, wherein a non-engraved plate is submitted to a programmed engraving process by a computer controlled engraving tool, the slope of the side walls of the furrow elements engraved by said tool being programmed by said computer.

[0031] The Applicant's co-pending Application WO 03/103962 discloses a method of manufacturing an engraved plate for intaglio printing of sheets of security papers, wherein a non-engraved plate is submitted to a programmed engraving process by a computer controlled engraving tool, wherein said programmed engraving process engraves said non-engraved plate according to the three-dimensional guiding pixel data (X, Y, Z) of a master depth-map of one said sheet, wherein said master depth-map is generated by at least one computer stored original depth-map, said original depth-map consisting of a three-dimensional raster image of at least a portion of one said security paper, and wherein an elementary engraving step is associated to each three-dimensional pixel data. The engraving tool is a laser-engraving machine.

[0032] The plate engraved by this process may be an intaglio printing plate, which is generally a metallic plate. The engraved plate may also be a precursor of an intaglio printing plate, and may be made of or comprise an upper layer of polymer. The intaglio printing plate is thereafter derived from the precursors by techniques known in the art. The plate may be flat or cylindrical.

[0033] Since one pixel is much smaller than the width of the furrow elements embodied within the frame work of the present invention, the engraving of one furrow element profile necessitates a plurality of adjustable elementary engraving steps and therefore the process permits to engrave stepwise the side walls of the furrow elements, the respective depths (Z) of adjacent steps determining the average slope of a said side wall.

[0034] Other particulars and advantages of the invention will further appear to those skilled in the art from the following description of preferred embodiments, referring to the drawings, in which:

- Fig. 1a, 1b and 1c illustrate schematically the profile of three cuts obtained by state of the art methods of production of intaglio plates;
- Fig. 2a, 2b and 2c illustrate schematically three profiles of cuts obtained by methods embodying the present invention;
- Fig. 3a, 3b and 3c illustrate schematically embossings obtained by means of cuts of Fig. 2a, 2b and 2c;

- Fig. 4 illustrates schematically the optical effect on the viewer's eye inspecting a control element according to the invention from opposite sides;
- Fig. 5 illustrates schematically, at an enlarged scale, a control element composed of two adjacent sets of furrow segments;
- Fig. 6a, 6b, 6c and 6d show a first example of the optical effect exhibited by asymmetric embossings, obtained by means of furrow segments;
- Fig. 7a, 7b, 7c and 7d show a second example of the optical effect exhibited by asymmetric embossings, obtained by means of furrow segments;
- Fig. 8 illustrates schematically, at an enlarged scale, a control element composed of four groups of dots;
- Fig. 9a, 9b, 9c and 9d show a third example of the optical effect exhibited by asymmetric embossings, obtained by means of furrow dots;
- Fig. 10a, 10b, 10c and 10d show a fourth example of the optical effect exhibited by asymmetric embossings, obtained by means of furrow dots.

[0035] Fig. 1a, 1b and 1c show profiles of grooves engraved in an intaglio plate by traditional methods:

- Fig. 1a represents a groove obtained by chemical etching. The width is well-defined by the portion of the surface from which a protective layer was removed before etching. The overall depth is defined by the etching time. However, this chemical etching process does not permit to select a precise geometrical shape of the side walls of the groove.
- Fig. 1b represents the profile of a groove obtained by engraving a plate by means of a cylindrical drill tool.
- Fig. 1c shows the profile of a groove engraved by a conical drill tool.

[0036] As well-known to those skilled in the art of printing, usually in an intaglio printing process, grooves such as those shown in Fig. 1a, 1b and 1c are filled with printing ink, and the paper sheet and the plate are pressed together under high pressure. The paper penetrates into the grooves and fills them more or less. After separation of the sheet from the plate, the surface of the paper bears an embossed rib reproducing approximately the shape of the groove. The reproduction of the shape of the groove is approximate, in as more as relaxation occurs to a certain extent upon pressure release. The profile of the remaining rib is therefore an intermediate shape between a U and a V. Anyway, this profile is substantially

symmetric, like the engraved grooves of Fig. 1a, 1b and 1c.

[0037] Fig. 2a, 2b and 2c illustrate profiles of furrow elements embodying the present invention:

- Fig. 2a shows a furrow profile obtained by a mechanical drill tool. This drill tool may be the same as the drill tool used for engraving groove of Fig. 1c. For producing the groove of Fig. 2a, the rotation axis of the tool is not held vertically to the surface of the plate, but in an inclined relationship, and thus the resulting profile is asymmetric.
- Fig. 2b is a schematic representation of a furrow profile made by a process of the type disclosed in the Applicant's Patent Application WO 03/103962. The engraving laser tool can be selected for example among the excimer lasers and the YAG lasers, engraving the plate pixel by pixel. The area of one pixel is much smaller than the size of the groove: the size of a pixel is typically of about 3 μm , whereas the depth of the groove is typically of between 5 and 100 μm , and the width of the groove is typically of between 10 and 300 μm . Several elementary engraving steps at varying programmed depth define a side wall profile and its average slope: Fig. 2b is obviously schematic, for explanatory purposes. The squares and steps of the drawing represent the digital pixel data (X, Y, Z) provided to the engraving machine. The real laser engraving process does not produce a right angled flight of steps, but a more or less smoothed curve profile having the desired average slope.
- Fig. 2c represents as above, pixel data for producing a furrow element in form of a dot covering a substantially rectangular surface of about 50 to 400 μm edge length; the maximal depth may be set at 5 to 100 μm . On three sides of the recess, the side walls are steep. The fourth side wall has a generally smooth slope, obtained by engraving steps at progressively, pixel by pixel varying depths. The cuts of Fig. 2b and 2c may be obtained by processing respectively three-dimensional line patterns, and three-dimensional raster patterns. In addition, the depth of the individual pixels are determined by computer calculation so as to generate differences in the slopes of the side walls, and thereby the asymmetrical character of the furrow elements. After generation of an original depth-map pertaining to one security paper, including the inventive control area and other parts of the security paper that shall be imprinted by the intaglio printing process, this original depth-map is repeated in rows and columns so as to cover all the prints of the plate. As disclosed by WO 03/103962, the resulting master depth-map may contain corrected pixel data to compensate for the sheet distortion during intaglio printing.

Fig. 3a, 3b and 3c show the profiles of embossing elements generated on a security paper sheet after contact under pressure by the herein before described cuts.

- A symmetric embossing profile like Fig. 3a may be obtained by means of the cuts of Fig. 1a, 1b and 1c.
- An asymmetric embossing profile like Fig. 3b may be generated either by furrow segment of Fig. 2a or furrow segment of Fig. 2b. Indeed, the steps engraved pixel by pixel in groove of Fig. 2b are so small that the fibrous structure of a paper sheet does not follow them exactly and, upon relaxing, the surface of a paper does not retain these microscopic steps. And thus, the rib of Fig. 3b presents a steep average left flank profile and a smoother average right flank profile.
- Fig. 3c illustrates the toothlike profile remaining after pressing the security paper sheet into dot of Fig. 2c and removing it. The tooth of Fig. 3c represents a blurred reproduction of the dot of Fig. 2c. The essential feature is that three flanks of the tooth of Fig. 3c are steep and the fourth flank is smooth.

[0038] Fig. 4 illustrates the optical effect of the invention on the user's eye. Fig. 4 represents schematically two contiguous parallel ribs under illumination by a light beam perpendicular to the security paper sheet. The light source is schematically represented by a little sun at the top of the figure. A human eye is schematically represented both on the left side and on the right side of Fig. 4. It may be easily seen from the figure that much more light is reflected and sent to the eye on the left side than to the eye on the right side, and thus when the security paper is viewed from the side to which the smooth flank of the ribs are oriented, it gives an impression of brightness, whereas, when viewed from the opposite side, it gives an impression of darkness. The difference in the optical aspects between the dark and the bright sides is enhanced if the portion of the security paper sheet bearing the control element according to the invention is imprinted with a dark ink, black, dark brown and the like, selected among brilliant and satin-finished inks; the effect appears less striking when dull ink is used.

[0039] Those skilled in the art, upon considering the reversed light path, that is to say upon inverting the light source and the user's eye in Fig. 4, will easily recognise that if the viewer inspects the paper sheet from a normal angle and if he illuminates the paper sheet from an acute angle, respectively from the left side and from the right side, he will respectively get an impression of brightness and an impression of darkness.

[0040] Fig. 5 represents schematically an enlarged view of a part of a control element comprising an area A1 where the smooth flanks are oriented to the left, and an area A2 where the smooth flanks are oriented to the

right of the figure. Area A1 occupies the upper left side of the figure, and area A2 occupies the right side and the lower side of the figure. When viewed from the left, A1 appears bright, and A2 appears dark, and vice versa from the right side; since both the ribs of areas A1 and A2 are asymmetrical, the contrast bright/dark is enhanced.

[0041] Fig. 6a, 6b, 6c and 6d show a first example of a control element obtained by means of an area of a plate engraved with two sets of parallel furrow segments. The first set forms the letters CTIP and the second set surrounds the area occupied by the letters, thus forming the background. The slopes of the side walls are arranged so that in the embossed control element, the portions of the ribs corresponding to the letters CTIP present their smooth flank to the left side of the figure, whereas the rib portions forming the background present their smooth flank to the right side of the figures. The control element is always illuminated from a normal angle to the sheet. In the four positions shown by Fig. 6a, 6b, 6c and 6d, schematically illustrated by the four little eyes, the control element is observed at acute angles respectively from the left, the right, the top and the bottom side. The left/right flip-flop effect is clearly shown by Fig. 6a and 6b. It is worthwhile to notice that if viewed and illuminated in a plane parallel to the ribs as shown by Fig. 6c and 6d and this would happen in a photocopy machine -, no substantial contrast appears.

[0042] Fig. 7a, 7b, 7c and 7d show a further example of embossings obtained by means of furrow segments according to the invention. The four positions of the observer and the position of the light source are the same as in Fig. 6a, 6b, 6c and 6d. A first set of furrow segments generates ribs with a smooth flank portion oriented to the left, so that, if they are viewed from the left side, bright letters ONE appear. A second set of furrow elements, in offset position versus the first set of furrow elements, produces embossed rib segments with their smooth flank oriented to the right, so that, viewed from the right side, the letters CTIP appear. The remaining surface of the rectangular control element bears mere symmetric embossings with steep flanks. Fig. 7c and 7d show that viewing from the top or the bottom side do not provide any contrasted image.

[0043] Fig. 8. shows schematically a portion of a security paper sheet on which rectangular pyramidal embossings of the dot type are distributed. The pale portion of each rectangle represents schematically the smooth flank, and the black portion represents schematically the opposite steep flank. Obviously, the two other flanks are also steep. As may be seen in Fig. 8, the rectangular dots are arranged in repeating groups of four dots, each dot being disposed crosswise to the neighbours, providing a periodically alternating relationship. One may observe that, by way of an example, the orientation of the dots at the left lower and upper right corners of Fig. 8 differs from the rest of the figure. The dots, whose smooth flanks are oriented in the same direction, generate altogether an image which may represent a letter, a figure, or any other

graphical sign. Those skilled in the art will easily understand that by this arrangement in groups of four dots, four different signs may be generated at the same location on the security paper sheet, each of the four signs appearing as a bright sign, surrounded by a darker background, only when viewed in one specific direction.

[0044] Fig. 9a, 9b, 9c and 9d present an example of a control element combining several overlapping sets of dots. The position of the light source and the four positions of the observer are the same as in the preceding examples. A first set of dots is spread over an area subdivided in four subareas, so as to correspond to the four letters CTIP; the smooth flanks of the first set are oriented to the left. A second set of dots is spread over the remaining area of the control element, and their smooth flanks are oriented into the opposite direction. As shown in Fig. 9a and 9b, the letters CTIP appear respectively bright on a dark background and dark on a brighter background when viewed respectively from the left and from the right. Thereby, these two sets of dots produce a flip-flop effect similar to the effect described concerning Fig. 6a, 6b, 6c and 6d. A third set of dots is spread over an area subdivided into three subareas, so as to form the letters ONE. The smooth flanks of the third set of dots are oriented to the bottom of Fig. 9a, 9b, 9c and 9d, that is to say at 90° vs. the first and second set. A fourth set of dots is spread over the remaining surface of the control element, their smooth flanks being oriented in the opposite direction of those of the third set. Thereby, when viewed respectively from the top and the bottom, as shown in Fig. 9c and 9d, the third and fourth sets let appear ONE respectively as bright on dark background or dark on bright background with a flip-flop effect crosswise to the first flip-flop effect.

[0045] Finally, a more sophisticated example of this kind of arrangement is shown by Fig. 10a, 10b, 10c and 10d. The position of the light source and the four positions of the viewer are the same as above. The first set of dot-like embossings present their smooth flank to the bottom, so as to exhibit the word ONE in bright shade when observed from that direction. The second set of dot-like embossings present their smooth flank to the left, so that the word TWO is distinguishable when the paper is observed at an acute angle from that direction. The third set of dot-like embossings present their smooth flank to the top, permitting to distinguish the word THREE. The fourth set of dots present their smooth flank to the right, so that the word FOUR appears upon viewing from said direction. The embossings that do not participate to any of the signs ONE, TWO, THREE, FOUR, are mere symmetric embossings with steep flanks.

[0046] The high density of information per surface unit, that is to say the small size and precise shaping of the individual dots required for forming such a superposition of images, necessitates the use of a computer controlled, pixel by pixel engraving process with a laser tool. Counterfeits by hand-held mechanical tools are not feasible.

[0047] Those skilled in the art will recognise that sev-

eral other arrangements are feasible without departing from the scope of the present invention:

[0048] The dots of a dot assembly forming a control element are not limited to dots having a rectangular base. For example round, triangular or hexagonal bases with corresponding conical or pyramidal asymmetric protrusions can be made, so that the most striking differences in optical aspects are not viewed from opposite directions or directions being crosswise, but at different angles. In other words the dot-shaped furrow elements may be shaped as asymmetric conical or pyramidal engravings with at least one side wall portion having a more gentle slope than other side wall portions, so as to generate a varying optical effect depending on the angle of view.

[0049] The above examples of control elements are made by merely embossing a homogeneously pre-inked flat surface by means of a dry plate. In this case, it is particularly advantageous to apply a background layer on the security paper, prior to embossing, by an offset or silk-screen printing process or by a stamping process. This background layer should preferably be a dark-coloured layer, an optically variable layer or a metallized layer, as this will enhance the optical effect of the embossing. Polychrome effects may be obtained by simultaneously printing and embossing the surface of a security paper sheet by means of an inked intaglio plate bearing asymmetric cuts according to the invention.

Claims

1. An engraved plate for intaglio printing or embossing of sheets of security papers, comprising a plate portion generating on each said security paper a control element, wherein said plate portion is provided with at least one first set of asymmetrical furrow elements defining a first area conveying information, each said furrow element of the first set having a first side wall and an opposite second side wall, the average slope of said first side wall being different from the average slope of said second side wall, wherein the average slopes of said first side walls of said first set of furrow elements are substantially equal amongst themselves and the average slopes of said second side walls of said first set of furrow elements are substantially equal amongst themselves, wherein said plate portion is further provided with a second set of asymmetrical furrow elements defining a second area, each furrow element of the second set having a first side wall and an opposite second side wall, the average slope of said first side wall being different from the average slope of said second side wall, wherein the average slopes of said first side walls of said second set of furrow elements are substantially equal amongst themselves and the average slopes

- of said second side walls of said second set of furrow elements are substantially equal amongst themselves,
and wherein the side walls with the lower average slope of the furrow elements of said first set and the side walls with the lower average slope of the furrow elements of said second set have different orientations.
2. A plate as claimed in claim 1, wherein said first area defines an alphanumerical or a graphical sign.
 3. A plate as claimed in claim 1 or 2, wherein said asymmetrical furrow elements of the first set are parallel furrow segments extending over said first area.
 4. A plate as claimed in claim 1 or 2, wherein said asymmetrical furrow elements of the first set have the form of dots distributed over said first area.
 5. A plate as claimed in claim 3 or 4, wherein said parallel furrow elements of the first set are contiguous.
 6. A plate as claimed in claim 4, wherein each dot of the first set is shaped as an asymmetric concial or pyramidal engraving with at least one side wall portion having a more gentle slope than other side wall portions.
 7. A plate as defined in claim 1, wherein said asymmetrical furrow elements of the second set are parallel furrow segments extending over said second area.
 8. A plate as claimed in claim 1, wherein said asymmetrical furrow elements of the second set have the form of dots distributed over said second area.
 9. A plate as claimed in claim 7 or 8, wherein said parallel furrow elements of the second set are contiguous.
 10. A plate as claimed in claim 8, wherein each dot of the second set is shaped as an asymmetric concial or pyramidal engraving with at least one side wall portion having a more gentle slope than other side wall portions.
 11. A plate as claimed in claim 1, wherein both the furrow elements of the first set and the furrow elements of the second set are parallel furrow segments extending respectively over said first area and said second area.
 12. A plate as claimed in claim 11, wherein the furrow segments of said second set are parallel to the furrow segments of said first set and wherein the side walls with the lower average slope of the furrow segments of said first set and the side walls with the lower average slope of the furrow segments of said second set are oriented in opposite directions.
 13. A plate as claimed in claim 1, wherein both the furrow elements of the first set and the furrow elements of the second set have the form of dots distributed respectively over said first area and said second area.
 14. A plate as claimed in claim 13, wherein the side walls with the lower average slope of the furrow elements of said first set and the side walls with the lower average slope of the furrow elements of said second set are oriented in opposite directions.
 15. A plate as claimed in claim 1, 11 or 13, wherein said second area surrounds said first area and conveys the same information as said first area in a contrasting manner.
 16. A plate as claimed in claim 1, 11 or 13, wherein said second set of furrow elements is offset with respect to said first set of furrow elements so that said first and second areas partially overlap.
 17. A plate as claimed in claim 16, wherein said second area conveys information which is different from the information conveyed by the first area.
 18. A plate as claimed in claim 17, wherein said second area defines an alphanumerical or a graphical sign.
 19. A plate as claimed in claim 13, further comprising a third set of asymmetrical furrow elements having the form of dots distributed over a third area, each furrow element of the third set having a first side wall and an opposite second side wall, the average slope of said first side wall being different from the average slope of said second side wall, wherein the slopes of said first side walls of said third set of furrow elements are substantially equal amongst themselves and the slopes of said second side walls of said third set of furrow elements are substantially equal amongst themselves, and wherein the side walls with the lower average slope of the furrow elements of said third set have a different orientation than the side walls with the lower average slope of the furrow elements of said first and second sets.
 20. A plate as claimed in claim 19, further comprising a fourth set of asymmetrical furrow elements having the form of dots distributed over a fourth area, each furrow element of the fourth set having a first side wall and an opposite second side wall, the average slope of said first side wall being different from the average slope of said second side wall, wherein the slopes of said first side walls of said fourth set of furrow elements are substantially equal amongst themselves and the slopes of said second side walls of said fourth set of furrow elements are substantially equal amongst themselves.

amongst themselves and the slopes of said second side walls of said fourth set of furrow elements are substantially equal amongst themselves, and wherein the side walls with the lower average slope of the furrow elements of said fourth set have a different orientation than the side walls with the lower average slope of the furrow elements of said first, second and third sets.

21. A plate as claimed in claim 20, wherein the side walls with the lower average slope of the furrow elements of said third set and the side walls with the lower average slope of the furrow elements of said fourth set are oriented in opposite directions.

22. A plate as claimed in claim 20, wherein the side walls with the lower average slope of the furrow elements of said first, second, third and fourth sets are oriented crosswise.

23. A plate as claimed in claim 20, 21 or 22, wherein said first, second, third and fourth areas at least partially overlap each other.

24. A plate as defined in claim 23, wherein each of said first, second, third and fourth areas defines a distinct alphanumeric or graphical sign.

25. A plate as claimed in anyone of the preceding claims, wherein the slope of said first walls has an average value of between 60° and 90° and the slope of said second side walls has an average value of between 1° and 50°, in particular 10° and 25°.

26. A plate as claimed in anyone of the preceding claims, wherein said furrow elements have a width of between 5 to 500 microns.

27. A plate as claimed in anyone of the preceding claims, wherein said furrow elements have a depth of between 5 to 100 microns.

28. A process of manufacturing an engraved plate as claimed in anyone of the preceding claims, wherein a non engraved plate is submitted to a programmed engraving process by an engraving tool controlled by a computer, the average slope of the side walls of the furrow elements engraved by said tool being programmed by said computer.

29. A process as claimed in claim 28, wherein said programmed engraving process engraves said non-engraved plate according to the three dimensional guiding pixel data (X, Y, Z) of a master depth-map of one said sheet, wherein said master depth-map is generated by at least one computer stored original depth-map, said original depth-map consisting of a three-dimensional raster image of at least said plate

portion generating said control element on said security paper.

30. A process as claimed in claim 29, wherein the engraving tool is a laser engraving tool.

31. A process as claimed in claim 29 or 30, wherein the resulting furrow elements engraved by the engraving tool exhibit a stepped profile.

32. A process as claimed in claim 31, wherein the stepped profile exhibits individual steps having a size of less than 5 microns.

33. A security paper bearing a control element obtained by intaglio printing of a sheet by means of an engraved intaglio plate as claimed in anyone of claims 1 to 27.

34. A security paper bearing a control element obtained by embossing a sheet by means of an engraved intaglio plate as claimed in anyone of claims 1 to 27.

35. A security paper as claimed in claim 34, wherein the control element is embossed on a background layer applied on the security paper prior to embossing.

36. A security paper as claimed in claim 35, wherein the background layer is a dark-colored layer, an optically variable layer or a metallized layer.

37. A security paper as defined in claim 35 or 36, wherein the background layer is applied onto the security paper by an offset or silk-screen printing process or by a stamping process.

Patentansprüche

1. Gravierte Platte für den Intaglio-Druck oder das Prägen von Sicherheitspapierbögen mit einem Plattenteil, der auf jedem Sicherheitspapier ein Kontrollelement erzeugt, wobei der Plattenteil mit mindestens, einem ersten Satz asymmetrischer Furchenelemente versehen ist, die einen ersten, Information übertragenden Bereich bilden, wobei jedes Furchenelement des ersten Satzes eine erste Seitenwand und eine gegenüberliegende zweite Seitenwand hat und die durchschnittliche Steilheit der ersten Seitenwand sich von der der zweiten Seitenwand unterscheidet; wobei die durchschnittlichen Steilheiten der ersten Seitenwände des ersten Satzes von Furchenelementen untereinander im Wesentlichen gleich sind und die durchschnittlichen Steilheiten der zweiten Seitenwände des ersten Satzes von Furchenelementen untereinander im Wesentlichen gleich sind; wobei der Plattenteil weiterhin mit einem zweiten

- Satz asymmetrischer Furchenelemente versehen ist, die einen zweiten Bereich bilden, wobei jedes Furchenelement des zweiten Satzes eine erste Seitenwand und eine gegenüberliegende zweite Seitenwand hat und die durchschnittliche Steilheit der ersten Seitenwand sich von der der zweiten Seitenwand unterscheidet;
wobei die durchschnittlichen Steilheiten der ersten Seitenwände des zweiten Satzes von Furchenelementen untereinander im Wesentlichen gleich sind und die durchschnittlichen Steilheiten der zweiten Seitenwände des zweiten Satzes von Furchenelementen untereinander im Wesentlichen gleich sind; und
wobei die Seitenwände mit der kleineren durchschnittlichen Steilheit der Furchenelemente des ersten Satzes und die Seitenwände mit der kleineren durchschnittlichen Steilheit der Furchenelemente des zweiten Satzes verschieden gerichtet sind.
2. Platte nach Anspruch 1, bei der der erste Bereich ein alphanumerisches oder ein grafisches Zeichen bildet.
 3. Platte nach Anspruch 1 oder 2, bei der die asymmetrischen Furchenelemente des ersten Satzes parallele Furchenabschnitte sind, die über den ersten Bereich verlaufen.
 4. Platte nach Anspruch 1 oder 2, bei der die asymmetrischen Furchenelemente des ersten Satzes die Form von Punkten haben, die über den ersten Bereich verteilt sind.
 5. Platte nach Anspruch 3 oder 4, bei der die parallelen Furchenelemente des ersten Satzes aneinandergrenzen.
 6. Platte nach Anspruch 4, bei der jeder Punkt des ersten Satzes als asymmetrische konische oder pyramidenförmige Gravur gestaltet ist, bei der mindestens ein Seitenwandteil weniger steil ist als andere Seitenwandteile.
 7. Platte nach Anspruch 1, bei der die asymmetrischen Furchenelemente des zweiten Satzes parallele Furchenabschnitte sind, die über den zweiten Bereich verlaufen.
 8. Platte nach Anspruch 1, bei der die asymmetrischen Furchenelemente des zweiten Satzes die Form von Punkten haben, die über den zweiten Bereich verteilt sind.
 9. Platte nach Anspruch 7 oder 8, bei der die parallelen Furchenelemente des zweiten Satzes aneinandergrenzen.
 10. Platte nach Anspruch 4, bei der jeder Punkt des zweiten Satzes als asymmetrische konische oder pyramidenförmige Gravur gestaltet ist, bei der mindestens ein Seitenwandteil weniger steil ist als andere Seitenwandteile.
 11. Platte nach Anspruch 1, bei der sowohl die Furchenelemente des ersten Satzes als auch die Furchenelemente des zweiten Satzes parallele Furchenabschnitte sind, die über den ersten bzw. den zweiten Bereich verlaufen.
 12. Platte nach Anspruch 11, bei der die Furchenabschnitte des zweiten Satzes parallel zu denen des ersten Satzes liegen und die Seitenwände mit der kleineren durchschnittlichen Steilheit der Furchenabschnitte des ersten Satzes und die Seitenwände mit der kleineren durchschnittlichen Steilheit der Furchenelemente des zweiten Satzes entgegengesetzt gerichtet sind.
 13. Platte nach Anspruch 1, bei der die Furchenelemente des ersten Satzes und die des zweiten Satzes die Form von Punkten haben, die über den ersten bzw. den zweiten Bereich verteilt sind.
 14. Platte nach Anspruch 13, bei der die Seitenwände mit der kleineren durchschnittlichen Steilheit der Furchenelemente des ersten Satzes und die Seitenwände mit der kleineren durchschnittlichen Steilheit der Furchenelemente des zweiten Satzes entgegengesetzt gerichtet sind.
 15. Platte nach Anspruch 1, 11 oder 13, bei der der zweite Bereich den ersten Bereich umgibt und auf kontrastierende Weise die gleiche Information wie der erste Bereich vermittelt.
 16. Platte nach Anspruch 1, 11 oder 13, bei der der zweite Satz Furchenelemente gegen den ersten Satz Furchenelemente versetzt so angeordnet ist, dass der erste und der zweite Bereich sich teilweise überlappen.
 17. Platte nach Anspruch 16, bei der der zweite Bereich Information vermittelt, die sich von der vom ersten Bereich übermittelten unterscheidet.
 18. Platte nach Anspruch 17, bei der der zweite Bereich ein alphanumerisches oder ein grafisches Zeichen bildet.
 19. Platte nach Anspruch 13 weiterhin mit einem dritten Satz asymmetrischer Furchenelemente in Form von Punkten, die über einen dritten Bereich verteilt sind, wobei jedes Furchenelement des dritten Satzes eine erste Seitenwand und eine gegenüberliegende zweite Seitenwand hat und die durchschnittliche

Steilheit der ersten Seitenwand sich von der der zweiten Seiten unter scheidet,
wobei die Steilheiten der ersten Seitenwände des dritten Satzes Furchenelemente untereinander im Wesentlichen gleich sind und die Steilheiten der zweiten Seitenwände des dritten Satzes Furchenelemente untereinander im Wesentlichen gleich sind, und
wobei die Seitenwände mit der niedrigeren durchschnittlichen Steilheit der Furchenelemente des dritten Satzes anderes gerichtet sind als die Seitenwände mit der kleineren durchschnittlichen Steilheit der Furchenelemente des ersten und des zweiten Satzes.

20. Platte nach Anspruch 19 weiterhin mit einem vierten Satz asymmetrischer Furchenelemente in Form von Punkten, die über einen vierten Bereich verteilt sind, wobei jedes Furchenelement des vierten Satzes eine erste Seitenwand und eine gegenüberliegende zweite Seitenwand hat und die durchschnittliche Steilheit der ersten Seitenwand sich von der der zweiten Seitenwand unterscheidet,
wobei die Steilheiten der ersten Seitenwände des vierten Satzes Furchenelemente untereinander im Wesentlichen gleich sind und die Steilheiten der zweiten Seitenwände des vierten Satzes Furchenelemente untereinander im Wesentlichen gleich sind; und
wobei die Seitenwände mit der kleineren durchschnittlichen Steilheit der Furchenelemente des vierten Satzes anders gerichtet sind als die Seitenwände mit der kleineren durchschnittlichen Steilheit der Furchenelemente des ersten, des zweiten und des dritten Satzes.
21. Platte nach Anspruch 20, bei der die Seitenwände mit der kleineren durchschnittlichen Steilheit der Furchenelemente des dritten Satzes und die Seitenwände mit der kleineren durchschnittlichen Steilheit der Furchenelemente des vierten Satzes entgegengesetzt gerichtet sind.
22. Platte nach Anspruch 20, bei der die Seitenwände mit der kleineren durchschnittlichen Steilheit der Furchenelemente des ersten, des zweiten, des dritten und des vierten Satzes kreuzweise angeordnet sind.
23. Platte nach Anspruch 20, 21 oder 22, bei der der erste, der zweite, der dritte und der vierte Bereich sich mindestens teilweise überlappen.
24. Platte nach Anspruch 23, bei der der erste, der zweite, der dritte und der vierte Bereich jeweils ein eigenes alphanumerischer oder grafisches Zeichen bilden.
25. Platte nach einem der vorgehenden Ansprüche, bei

der die Steilheit der ersten Wände einen Durchschnittswert zwischen 60° und 90° und die Steilheit der zweiten Seitenwände einen Durchschnittswert zwischen 1° und 50°, insbesondere 10° und 25° hat.

26. Platte nach einem der vorgehenden Ansprüche, bei der die Furchenelemente eine Breite zwischen 5 µm und 500 µm haben.
27. Platte nach einem der vorgehenden Ansprüche, bei der die Furchenelemente eine Tiefe zwischen 5 µm und 100 µm haben.
28. Verfahren zum Herstellen einer gravierten Platte nach einem der vorgehenden Ansprüche, bei der eine nicht gravierte Platte einer programmierten Gravur mittels eines Gravierwerkzeugs unterzogen wird, das ein Rechner steuert, wobei die durchschnittliche Steilheit der Seitenwände der von diesem Werkzeug gravierten Furchenelemente vom Rechner programmiert ist.
29. Verfahren nach Anspruch 28, bei dem der programmierte Gravurprozess die ungravierte Platte nach den dreidimensionalen führenden Bildpunktdaten (X, Y, Z) eines Master-Tiefenbilds ("master depth-map") eines der Bögen graviert, wobei das Master-Tiefenbild durch mindestens ein abgespeichertes Original-Tiefenbild generiert wird, das aus einem dreidimensionalen Rasterbild mindestens desjenigen Plattenteils besteht, der das Kontrollelement auf dem Sicherheitspapier erzeugt.
30. Verfahren nach Anspruch 29, bei dem das Gravurwerkzeug ein Laser-Gravurwerkzeug ist.
31. Verfahren nach Anspruch 29 oder 30, bei dem die vom Gravurwerkzeug eingravierten resultierenden Furchenelemente ein Stufenprofil zeigen.
32. Verfahren nach Anspruch 31, bei dem das Stufenprofil Einzelstufen einer Größe von weniger als 5 µm zeigt.
33. Sicherheitspapier mit einem Kontrollelement, das durch Intaglio-Druck auf einem Bogen mittels einer gravierten Intaglio-Platte nach einem der Ansprüche 1 bis 27 erhalten wurde.
34. Sicherheitspapier mit einem Kontrollelement, das durch Prägen eines Bogens mittels einer gravierten Intaglio-Platte nach einem der Ansprüche 1 bis 27 erhalten wurde.
35. Sicherheitspapier nach Anspruch 34, bei dem das Kontrollelement auf eine Hintergrundschicht geprägt ist, die vor dem Prägen auf das Sicherheitspapier aufgetragen wurde.

36. Sicherheitspapier nach Anspruch 35, bei dem die Hintergrundschrift eine dunkelfarbige Schicht, eine optisch variable Schicht oder eine metallisierte Schicht ist.
37. Sicherheitspapier nach Anspruch 35 oder 36, bei dem die Hintergrundschrift auf das Sicherheitspapier durch Offset- oder Siebdruck oder durch Stempeln aufgetragen wurde.

Revendications

1. Plaque gravée pour une impression taille-douce ou un embossage de feuilles de papiers de sécurité, comprenant une portion de plaque générant un élément de contrôle sur chacun desdits papiers de sécurité, où ladite portion de plaque est dotée d'au moins un premier ensemble d'éléments de sillon asymétriques définissant une première zone transmettant des informations, chacun desdits éléments de sillon du premier ensemble ayant une première paroi latérale et une deuxième paroi latérale opposée, la pente moyenne de ladite première paroi latérale étant différente de la pente moyenne de ladite deuxième paroi latérale, où les pentes moyennes desdites premières parois latérales du premier ensemble d'éléments de sillon sont sensiblement égales les unes aux autres et les pentes moyennes desdites deuxièmes parois latérales dudit premier ensemble d'éléments de sillon sont sensiblement égales les unes aux autres, où ladite portion de plaque est en outre dotée d'un deuxième ensemble d'éléments de sillon asymétriques définissant une deuxième zone, chaque élément de sillon du deuxième ensemble ayant une première paroi latérale et une deuxième paroi latérale opposée, la pente moyenne de ladite première paroi latérale étant différente de la pente moyenne de ladite deuxième paroi latérale, où les pentes moyennes desdites premières parois latérales dudit deuxième ensemble d'éléments de sillon sont sensiblement égales les unes aux autres et les pentes moyennes desdites deuxièmes parois latérales dudit deuxième ensemble d'éléments de sillon sont sensiblement égales les unes aux autres, et où les parois latérales présentant la pente moyenne la plus faible des éléments de sillon dudit premier ensemble et les parois latérales présentant la pente moyenne la plus faible des éléments de sillon dudit deuxième ensemble présentent des orientations différentes.
2. Plaque selon la revendication 1, où ladite première zone définit un signe graphique ou alphanumérique.
3. Plaque selon la revendication 1 ou 2, où lesdits élé-

ments de sillon asymétriques du premier ensemble sont des segments de sillon parallèles qui s'étendent sur ladite première zone.

4. Plaque selon la revendication 1 ou 2, dans laquelle lesdits éléments de sillon asymétriques du premier ensemble se présentent sous la forme de points répartis sur ladite première zone.
5. Plaque selon la revendication 3 ou 4, où lesdits éléments de sillon parallèles du premier ensemble sont contigus.
6. Plaque selon la revendication 4, où chaque point du premier ensemble se présente sous la forme d'une gravure asymétrique conique ou pyramidale, avec au moins une portion de paroi latérale ayant une pente moins raide que les autres portions de paroi latérale.
7. Plaque selon la revendication 1, où lesdits éléments de sillon asymétriques du deuxième ensemble sont des segments de sillon parallèles s'étendant sur ladite deuxième zone.
8. Plaque selon la revendication 1, où lesdits éléments de sillon asymétriques du deuxième ensemble se présentent sous la forme de points répartis sur ladite deuxième zone.
9. Plaque selon la revendication 7 ou 8, où lesdits éléments de sillon parallèles du deuxième ensemble sont contigus.
10. Plaque selon la revendication 8, où chaque point du deuxième ensemble se présente sous la forme d'une gravure asymétrique conique ou pyramidale, avec au moins une portion de paroi latérale ayant une pente moins raide que les autres portions de paroi latérale.
11. Plaque selon la revendication 1, où les éléments de sillon du premier ensemble et les éléments de sillon du deuxième ensemble sont des segments de sillon parallèles s'étendant respectivement sur ladite première zone et ladite deuxième zone.
12. Plaque selon la revendication 11, où les segments de sillon dudit deuxième ensemble sont parallèles aux segments de sillon dudit premier ensemble et où les parois latérales présentant la pente moyenne la plus faible des segments de sillon dudit premier ensemble et les parois latérales présentant la pente moyenne la plus faible des segments de sillon dudit deuxième ensemble sont orientées dans des directions opposées.
13. Plaque selon la revendication 1, où les éléments de

sillon du premier ensemble et les éléments de sillon du deuxième ensemble se présentent sous la forme de points répartis respectivement sur ladite première zone et ladite deuxième zone.

14. Plaque selon la revendication 13, où les parois latérales présentant la pente moyenne la plus faible des éléments de sillon dudit premier ensemble et les parois latérales présentant la pente moyenne la plus faible des éléments de sillon dudit deuxième ensemble sont orientées dans des directions opposées.
15. Plaque selon la revendication 1, 11 ou 13, où ladite deuxième zone entoure ladite première zone et transmet les mêmes informations que ladite première zone d'une manière contrastée.
16. Plaque selon la revendication 1, 11 ou 13, où ledit deuxième ensemble d'éléments de sillon est décalé par rapport audit premier ensemble d'éléments de sillon de telle sorte que lesdites première et deuxième zones se chevauchent partiellement.
17. Plaque selon la revendication 16, où ladite deuxième zone transmet des informations qui sont différentes des informations transmises par la première zone.
18. Plaque selon la revendication 17, où ladite deuxième zone définit un signe graphique ou alphanumérique.
19. Plaque selon la revendication 13, comprenant en outre un troisième ensemble d'éléments de sillon asymétriques se présentant sous la forme de points répartis sur une troisième zone, chaque élément de sillon du troisième ensemble ayant une première paroi latérale et une deuxième paroi latérale opposée, la pente moyenne de ladite première paroi latérale étant différente de la pente moyenne de ladite deuxième paroi latérale, où les pentes desdites premières parois latérales dudit troisième ensemble d'éléments de sillon sont sensiblement égales les unes aux autres et les pentes desdites deuxième parois latérales dudit troisième ensemble d'éléments de sillon sont sensiblement égales les unes aux autres, et où les parois latérales présentant la pente moyenne la plus faible des éléments de sillon dudit troisième ensemble présentent une orientation différente de celle des parois latérales présentant la pente moyenne la plus faible des éléments de sillon desdits premier et deuxième ensembles.
20. Plaque selon la revendication 19, comprenant en outre un quatrième ensemble d'éléments de sillon asymétriques se présentant sous la forme de points répartis sur une quatrième zone, chaque élément de sillon du quatrième ensemble ayant une première paroi latérale et une deuxième paroi latérale oppo-

sée, la pente moyenne de ladite première paroi latérale étant différente de la pente moyenne de ladite deuxième paroi latérale,

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où les pentes desdites premières parois latérales dudit quatrième ensemble d'éléments de sillon sont sensiblement égales les unes aux autres et les pentes desdites deuxième parois latérales dudit quatrième ensemble d'éléments de sillon sont sensiblement égales les unes aux autres,

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et où les parois latérales présentant la pente moyenne la plus faible des éléments de sillon dudit quatrième ensemble présentent une orientation différente de celle des parois latérales présentant la pente moyenne la plus faible des éléments de sillon desdits premier, deuxième et troisième ensembles.

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21. Plaque selon la revendication 20, où les parois latérales présentant la pente moyenne la plus faible des éléments de sillon dudit troisième ensemble et les parois latérales présentant la pente moyenne la plus faible des éléments de sillon dudit quatrième ensemble sont orientées dans des directions opposées.

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22. Plaque selon la revendication 20, où les parois latérales présentant la pente moyenne la plus faible des éléments de sillon desdits premier, deuxième, troisième et quatrième ensembles sont orientées dans la direction de la largeur.

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23. Plaque selon la revendication 20, 21 ou 22, où lesdites première, deuxième, troisième et quatrième zones se chevauchent au moins partiellement les unes les autres.

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24. Plaque selon la revendication 23, où chacune desdites première, deuxième, troisième et quatrième zones définit un signe graphique ou alphanumérique distinct.

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25. Plaque selon l'une quelconque des revendications précédentes, où la pente desdites premières parois a une valeur moyenne comprise entre 60° et 90° et la pente desdites deuxième parois latérales a une valeur moyenne comprise entre 1° et 50°, en particulier entre 10° et 25°.

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26. Plaque selon l'une quelconque des revendications précédentes, où lesdits éléments de sillon ont une largeur comprise entre 5 et 500 microns.

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27. Plaque selon l'une quelconque des revendications précédentes, où lesdits éléments de sillon ont une profondeur comprise entre 5 et 100 microns.

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28. Procédé de fabrication d'une plaque gravée selon l'une quelconque des revendications précédentes, dans lequel une plaque non gravée est soumise à un procédé de gravage programmé par un outil de

gravage commandé par un ordinateur, la pente moyenne des parois latérales des éléments de sillon gravés par ledit outil étant programmée par ledit ordinateur,

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29. Procédé selon la revendication 28, dans lequel ledit procédé de gravage programmé grave ladite plaque non gravée en fonction des données pixels de guidage tridimensionnelles (X, Y, Z) d'une carte de profondeur maîtresse de l'une desdites feuilles, dans lequel ladite carte de profondeur maîtresse est générée par au moins une carte de profondeur originale stockée dans l'ordinateur, ladite carte de profondeur originale étant composée d'une image matricielle tridimensionnelle d'au moins ladite portion de plaque générant ledit élément de contrôle sur ledit papier de sécurité. 10
30. Procédé selon la revendication 29, dans lequel l'outil de gravage est un outil de gravage au laser. 15
31. Procédé selon la revendication 29 ou 30, dans lequel les éléments de sillon résultant du gravage par l'outil de gravage présentent un profil étagé. 20
32. Procédé selon la revendication 31, dans lequel le profil étagé présente des marches individuelles ayant une taille inférieure à 5 microns. 25
33. Papier de sécurité comportant un élément de contrôle obtenu par impression taille-douce d'une feuille au moyen d'une plaque d'impression taille-douce selon l'une quelconque des revendications 1 à 27. 30
34. Papier de sécurité comportant un élément de contrôle obtenu par embossage d'une feuille au moyen d'une plaque d'impression taille-douce selon l'une quelconque des revendications 1 à 27. 35
35. Papier de sécurité selon la revendication 34, où l'élément de contrôle est embossé sur une couche d'arrière-plan appliquée sur le papier de sécurité avant l'embossage. 40
36. Papier de sécurité selon la revendication 35, où la couche d'arrière-plan est une couche de couleur sombre, une couche optiquement variable ou une couche métallisée. 45
37. Papier de sécurité selon la revendication 35 ou 36, où la couche d'arrière-plan est appliquée sur le papier de sécurité par un procédé d'impression offset ou de sérigraphie ou par un procédé d'estampage. 50

55

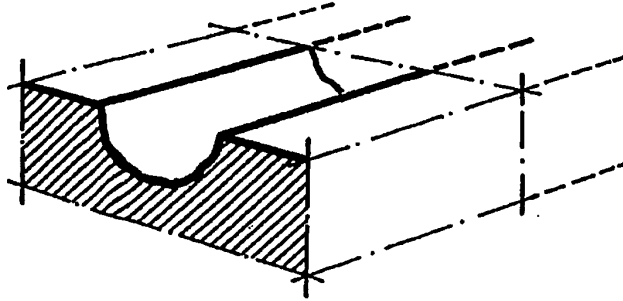


FIG. 1a

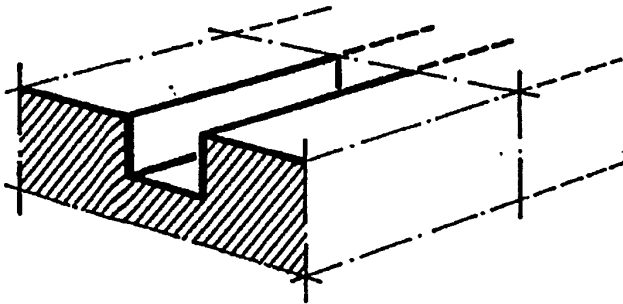


FIG. 1b

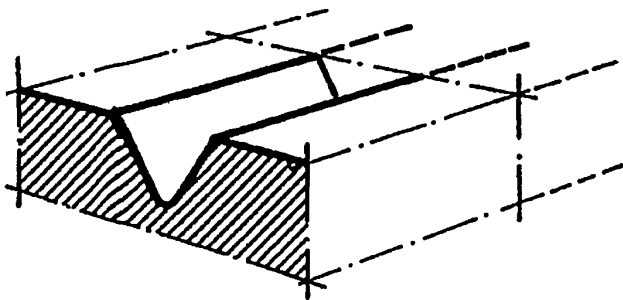


FIG. 1c

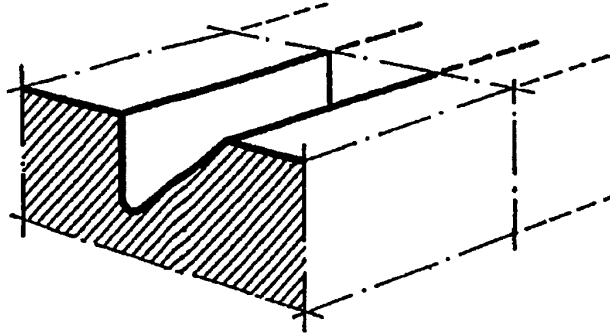


FIG. 2a

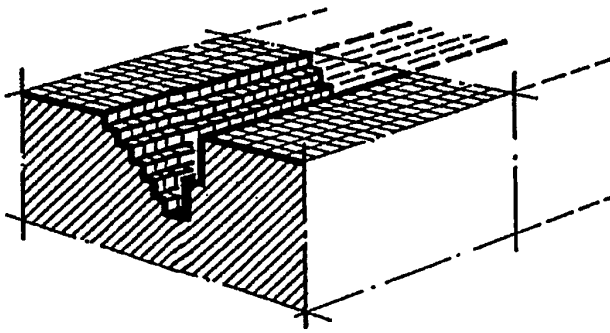


FIG. 2b

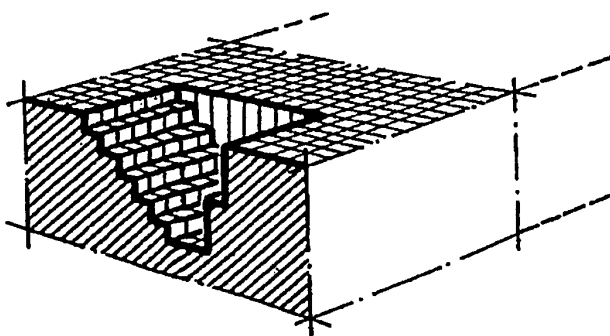


FIG. 2c

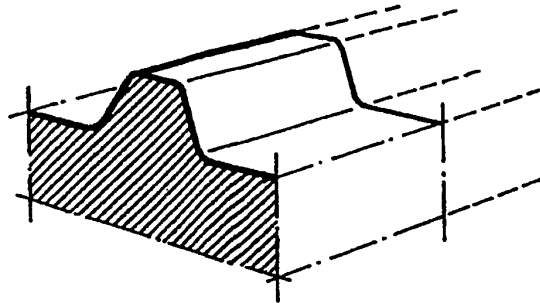


FIG. 3a

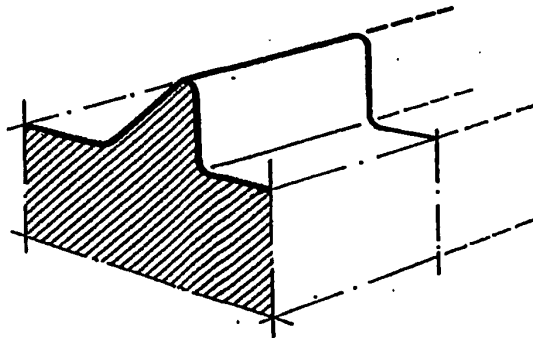


FIG. 3b

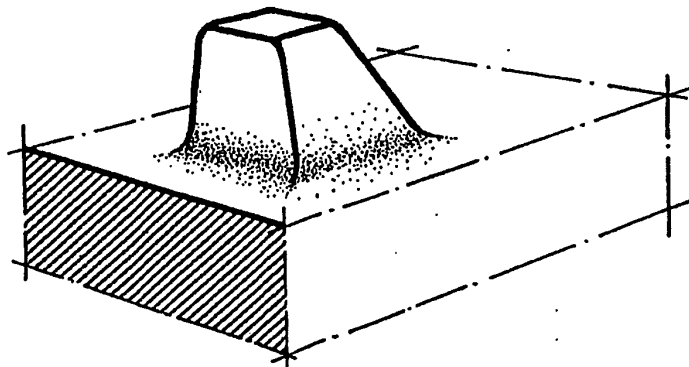


FIG. 3c

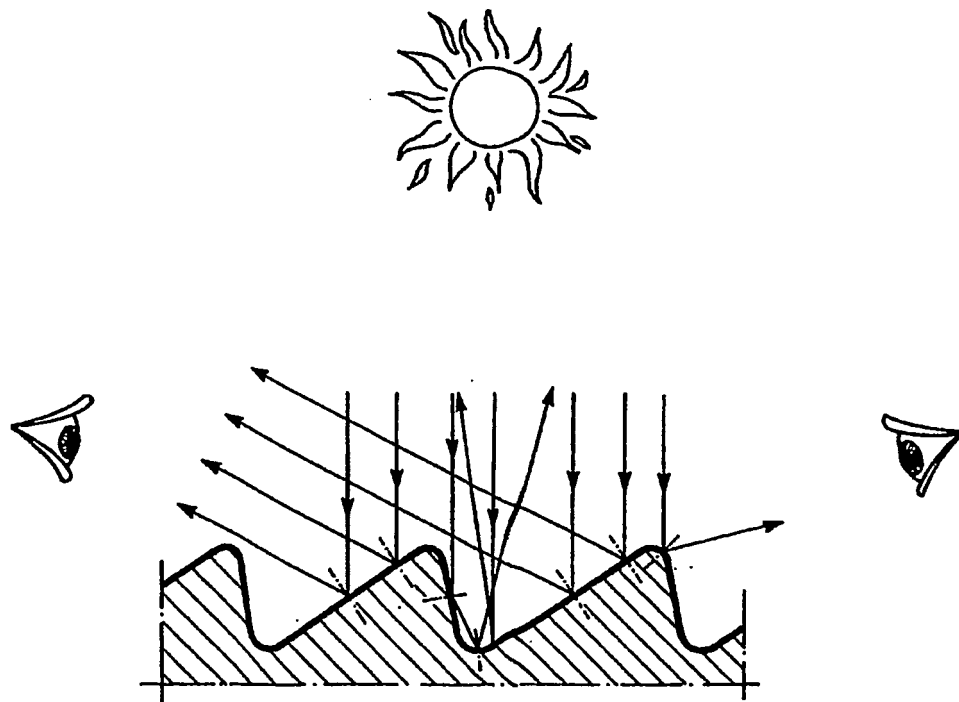


FIG.4

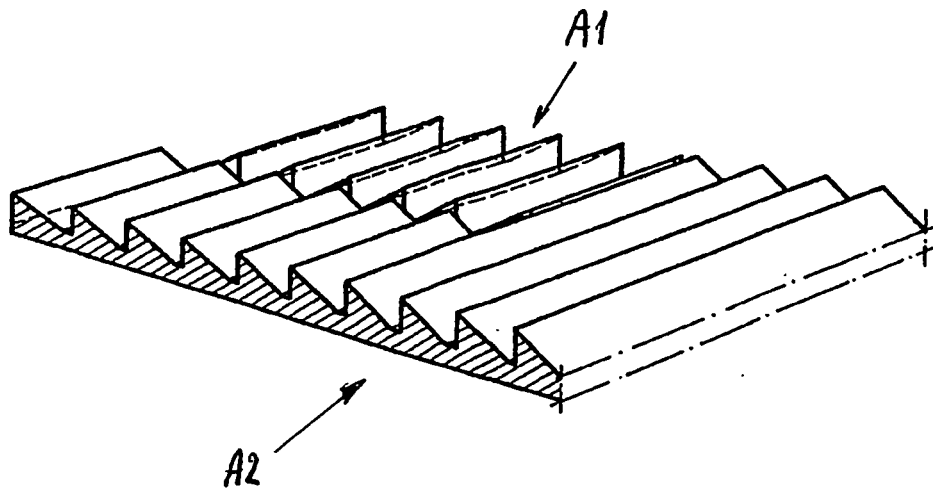


FIG.5

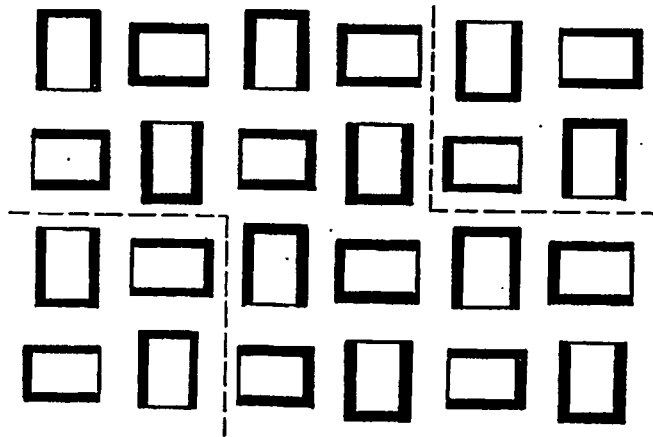


FIG.8

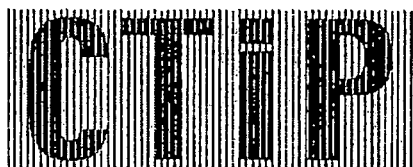
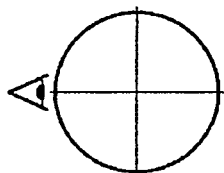


Fig. 6 a

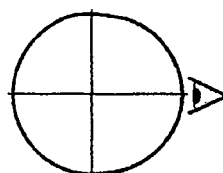


Fig. 6 b

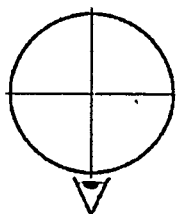


Fig. 6 c

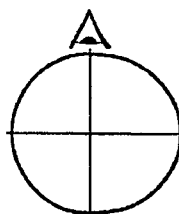


Fig. 6 d

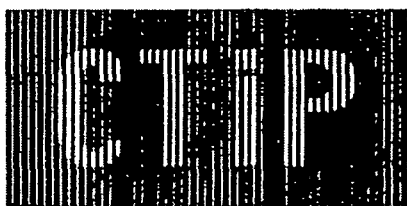
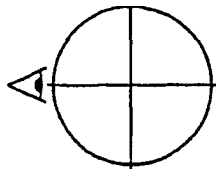


Fig. 7 a

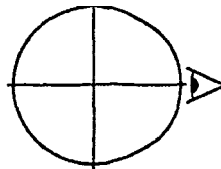


Fig. 7 b

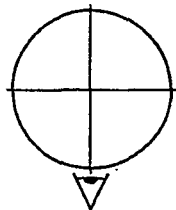


Fig. 7 c

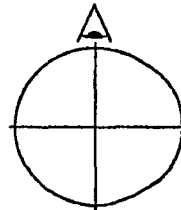


Fig. 7 d

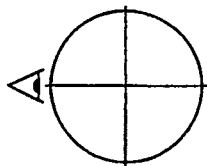


Fig. 9 a

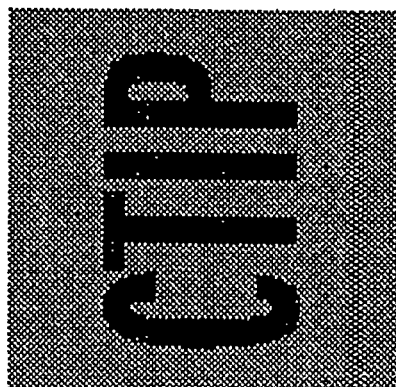
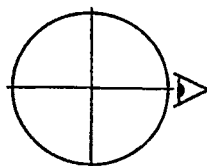


Fig. 9 b

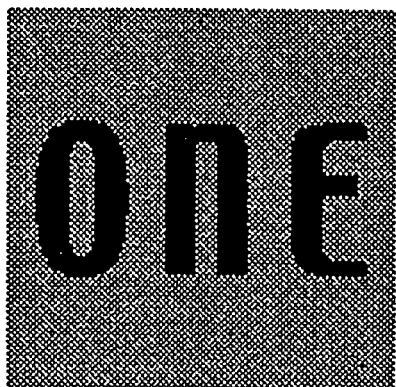
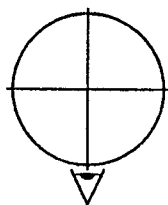


Fig. 9 c

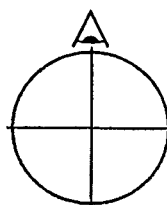


Fig. 9 d

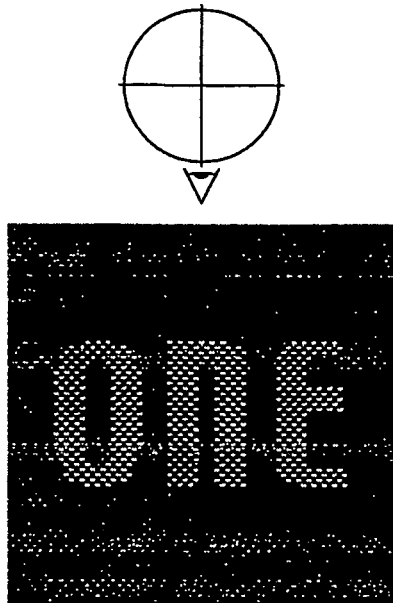


Fig. 10 a

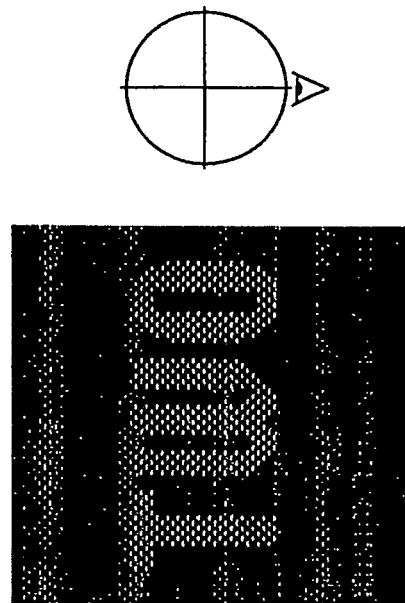


Fig. 10 b

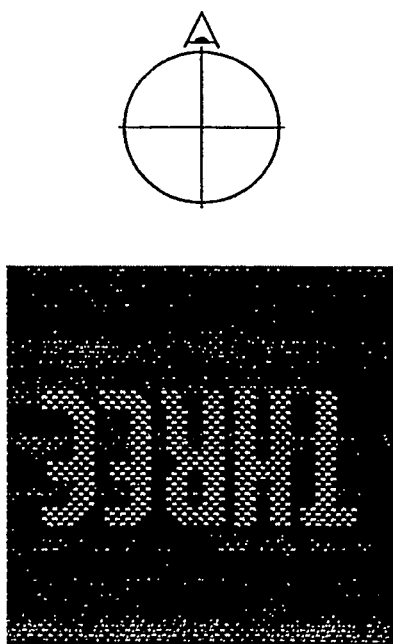


Fig. 10 c

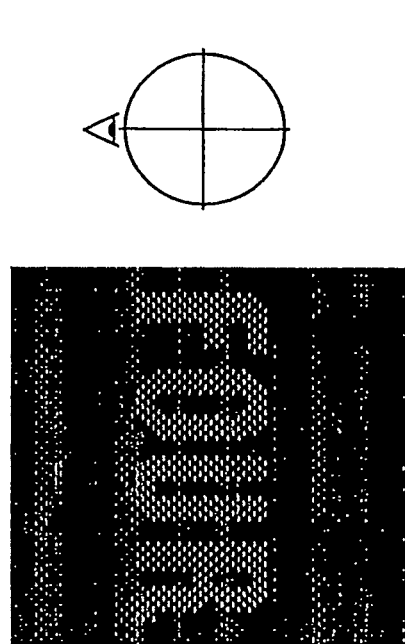


Fig. 10 d

REFERENCES CITED IN THE DESCRIPTION

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