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(54) **Intaglio printing plate**

(57) 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, said portion being provided with at least one first set of asymmetrical furrow elements, each said furrow element having a first side wall and an opposite sec-

ond side wall, the average slope of said first side wall being different from the average slope of said second side wall, and the slopes of said first side walls of said set of furrow elements being substantially equal amongst themselves and the slopes of said second side walls of said set of furrow elements being substantially equal amongst themselves.

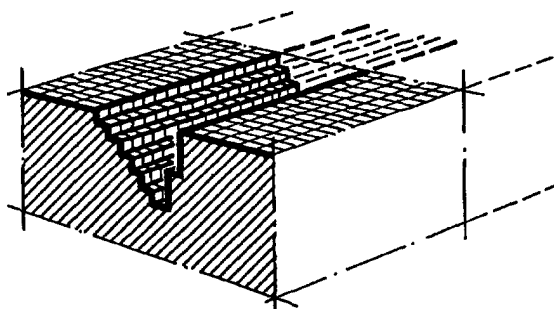


FIG.2b

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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] 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 ink-
ing, 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".

[0007] 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.

[0008] 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.

[0009] 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.

[0010] 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.

[0011] 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.

[0012] 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.

[0013] 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.

[0014] 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.

[0015] 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 upon intaglio printing and/or embossing, wherein said plate portion is provided with at least one first set of asymmetrical furrow elements, each said furrow element having a first side wall and an opposite second side wall, the slope of said first side wall being different from the slope of said second side wall, wherein the slopes of said first side walls of said set of furrow elements are substantially equal amongst themselves and the slopes of said second side walls of said set of furrow elements are substantially equal amongst themselves.

[0016] 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° .

[0017] Preferably, said asymmetrical furrow elements of said first set are contiguous and define at least one first area, said first area defining an alphanumerical or

an other easily recognisable graphical sign.

[0018] 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.

[0019] In the areas recognisable as alphanumerical 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.

[0020] In embodiments where the furrow elements of the first set are segments, the plate portion generating a control element comprises preferably a second area with a second set of asymmetrical furrow segments having first and second opposite side walls with unequal slopes, the furrow segments of said second set being parallel to the furrow segments of said first set, the side walls with the higher 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 having the same orientation.

[0021] 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. 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.

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.

[0022] 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.

[0023] In a preferred embodiment, the asymmetrical furrow elements of said second set are dots and their side walls with the lower slope are oriented crosswise

relatively to the corresponding side walls of said first set of dots.

[0024] 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.

[0025] 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.

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.

[0026] 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.

[0027] The Applicant's co-pending Application WO 03/103962, the content of which is incorporated herein by reference, 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.

[0028] 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.

[0029] 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.

[0030] 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.

[0031] Fig. 1a, 1b and 1c show profiles of grooves en-

graved 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.

[0032] 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.

[0033] 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 hold 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 dig-

ital 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.

[0034] 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.

[0035] 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.

[0036] Fig. 4 illustrates the optical effect of the inven-

tion 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.

[0037] 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.

[0038] 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.

[0039] 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.

[0040] 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.

[0041] 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.

[0042] 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.

[0043] 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.

[0044] 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.

[0045] Those skilled in the art will recognise that several other arrangements are feasible without departing from the scope of the present invention:

[0046] 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.

[0047] The above examples of control elements are made by merely embossing a homogeneously pre-inked flat surface by means of a dry plate. 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, **characterised in that** said portion is provided with at least one first set of asymmetrical furrow elements, each said furrow element 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, and **in that** the slopes of said first side walls of said set of furrow elements are substantially equal amongst themselves and the slopes of said second side walls of said set of furrow elements are substantially equal amongst themselves.

2. A plate as claimed in claim 1, 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°.
3. A plate as claimed in claim 1 or claim 2, wherein said asymmetrical furrow elements of said first set are contiguous and define at least one first area, said first area defining an alphanumeric or a graphical sign.
4. A plate as claimed in claim 3, wherein said asymmetrical furrow elements are parallel segments extending over said first area.
5. A plate as claimed in claim 4, comprising in a second area, a second set of asymmetrical furrow segments having first and second opposite side walls with unequal average slopes, the furrow segments of said second set being parallel to the furrow segments of said first set, the side walls with the highest 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 having the same orientation.
6. A plate as claimed in claim 5, wherein said second area surrounds said first area.
7. A plate as claimed in claim 5, wherein said second set of furrow segments is offset versus said first set and occupies a second area defining a second sign.
8. A plate as claimed in claim 3, wherein said asymmetrical furrow elements of said first set are dots distributed over said first area.
9. A plate as claimed in claim 8, comprising a second set of asymmetrical furrow elements having first and opposite second side walls with unequal average slopes, 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 having different orientations.

10. A plate as claimed in claim 9, wherein the asymmetrical furrow elements of said second set are dots surrounding said first set and wherein their side walls with the lower average slope are oriented in opposite directions relatively to the corresponding side walls of said first set.

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11. A plate as claimed in claim 10, comprising a third set of asymmetrical dots and a fourth set of asymmetrical dots surrounding said third set, said third and fourth sets having their side walls with the lower average slope in opposite directions and crosswise to said first and second sets.

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12. A plate as claimed in claim 9, comprising a first, a second, a third and a fourth set of asymmetrical furrow elements in form of dots, with their respective side walls with the lower average slope orientated crosswise.

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13. A plate as claimed in claim 12, wherein said first, second, third and fourth set define a first, second, third and fourth area, each said area defining a sign wherein said areas overlap at least partially and wherein in the overlapping portions, the dots of said first, second, third and/or fourth set are arranged in alternating relationships.

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14. A process of manufacturing an engraved plate as claimed in anyone of the preceding claims, wherein an 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.

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15. A process as claimed in claim 14, **characterised in that** 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 portion generating said controlled element on said security paper.

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50
16. 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 13.

55
17. 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 13.

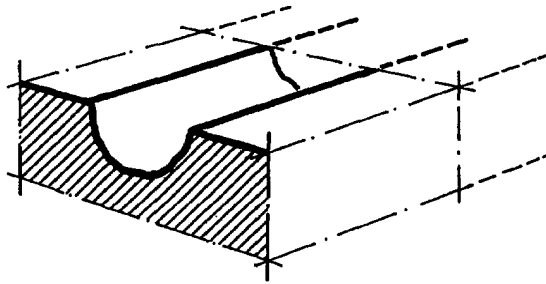


FIG. 1a

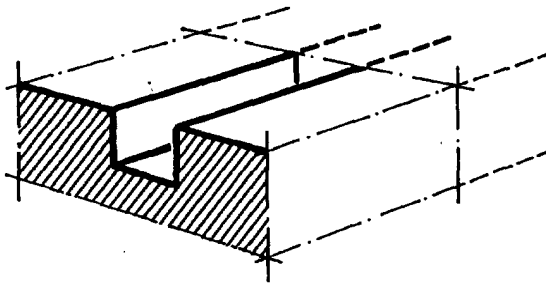


FIG. 1b

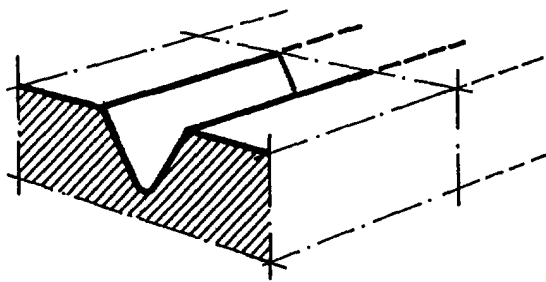


FIG. 1c

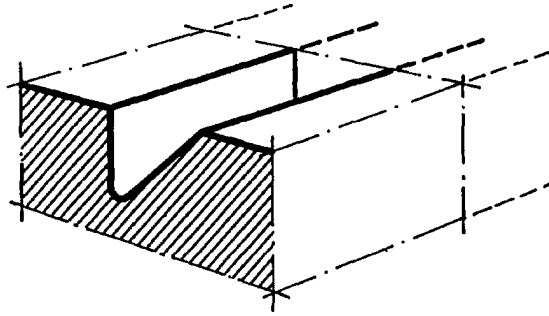


FIG. 2a

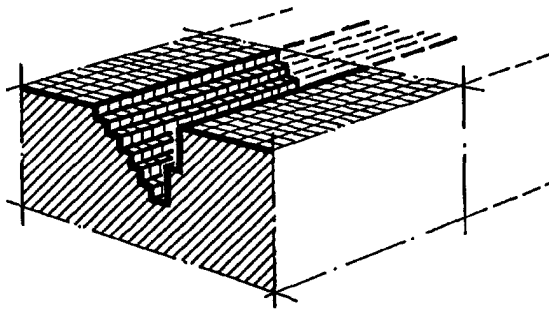


FIG. 2b

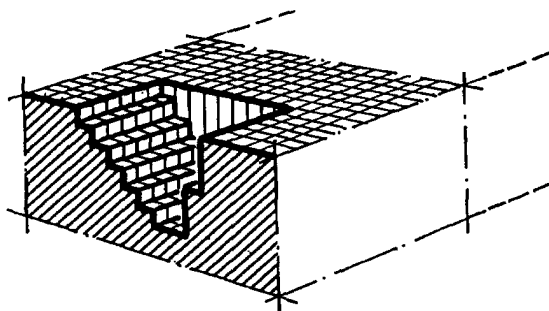


FIG. 2c

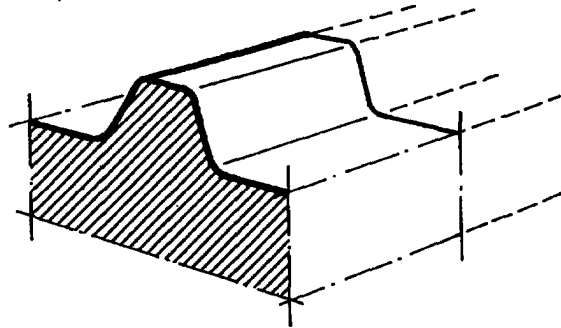


FIG. 3a

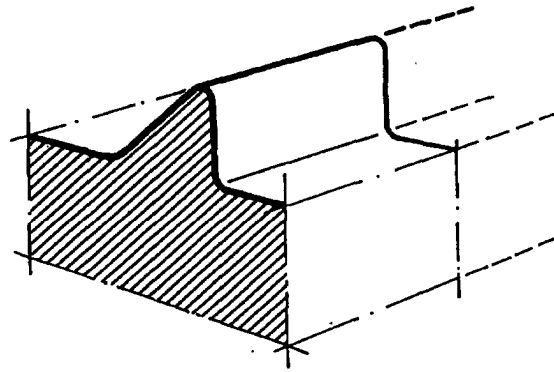


FIG. 3b

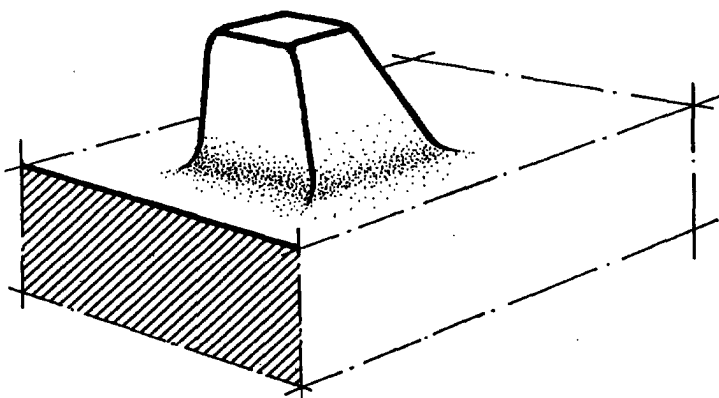


FIG. 3c

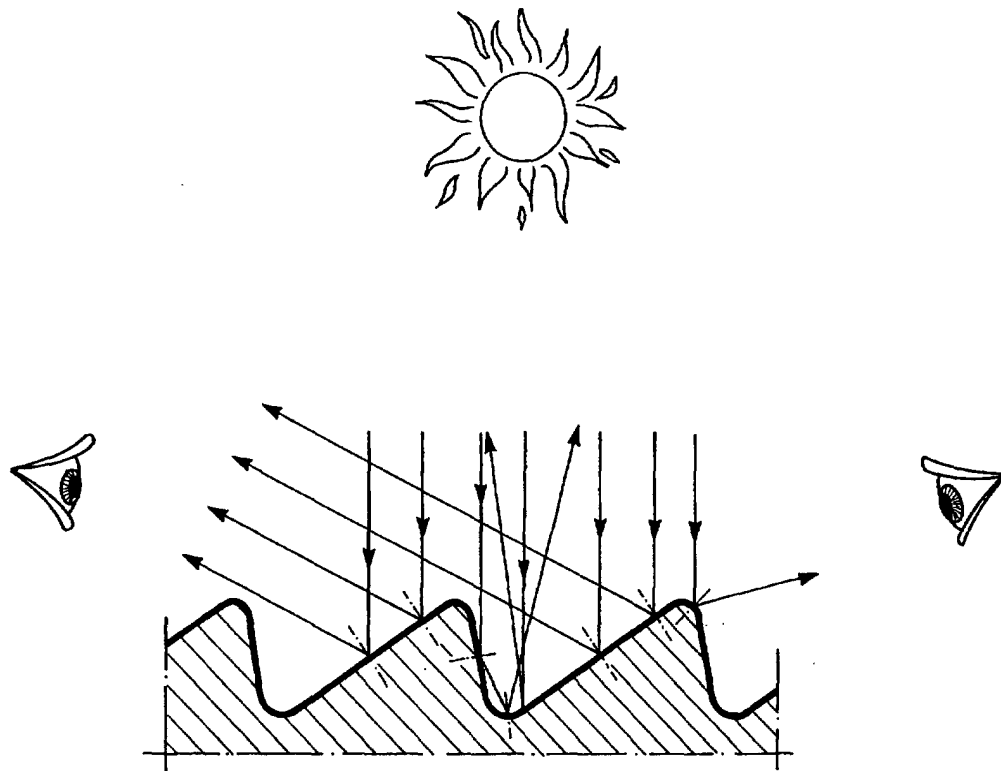


FIG.4

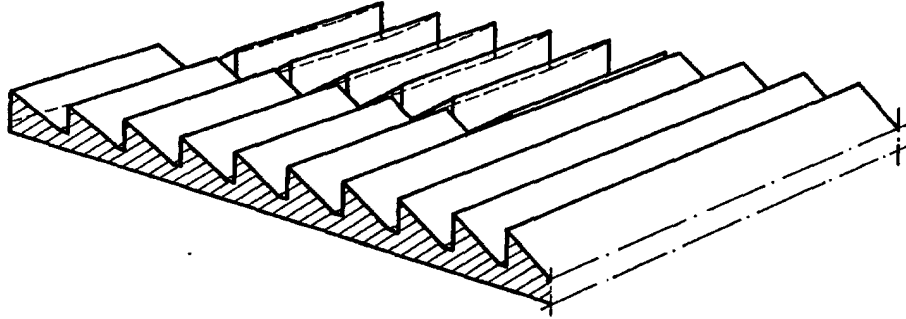


FIG.5

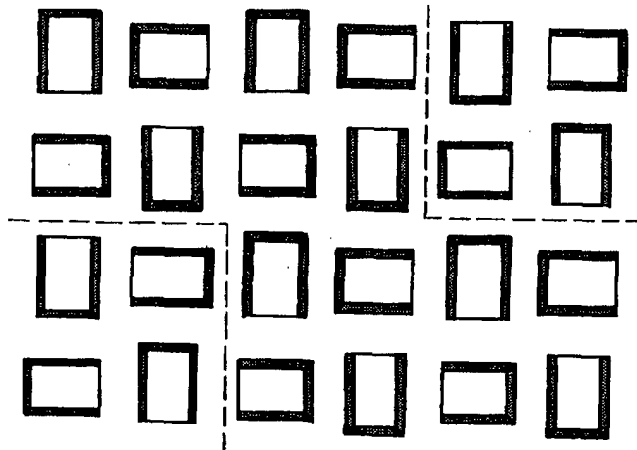


FIG.8

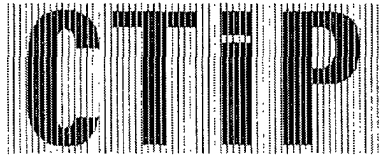
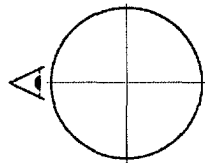


Fig. 6 a

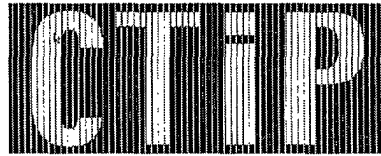
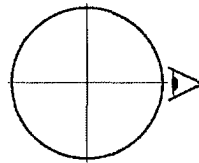


Fig. 6 b

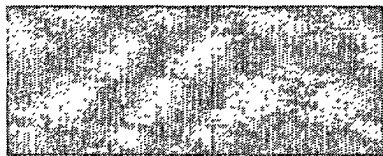
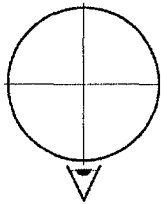


Fig. 6 c

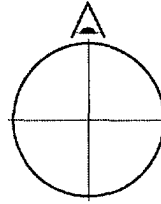


Fig. 6 d

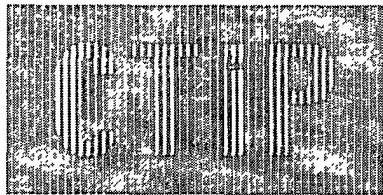
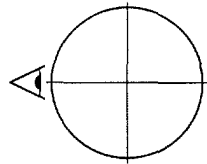


Fig. 7 a

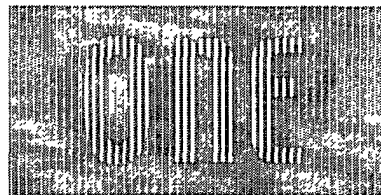
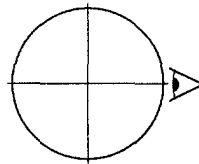


Fig. 7 b

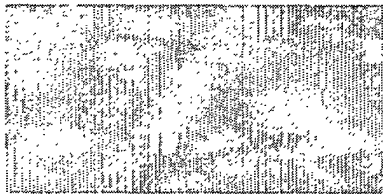
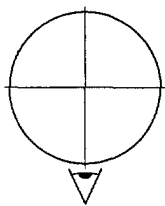


Fig. 7 c

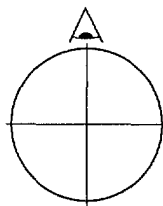


Fig. 7 d

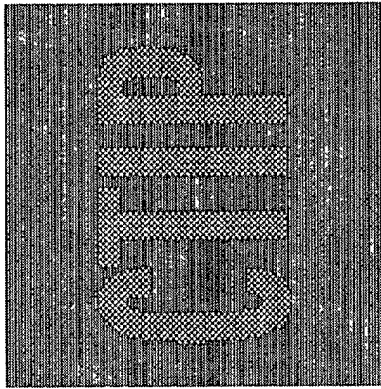
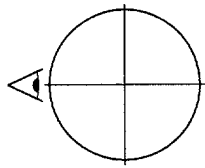


Fig. 9 a

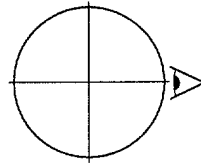


Fig. 9 b

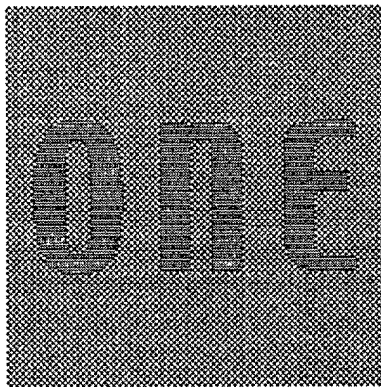
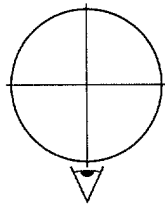


Fig. 9 c

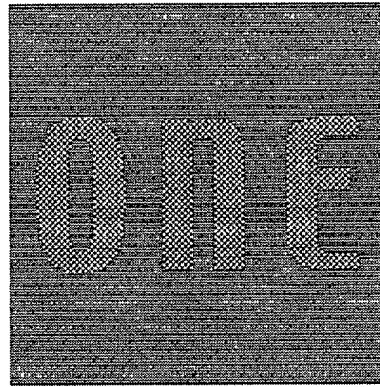
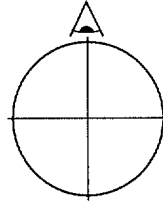


Fig. 9 d

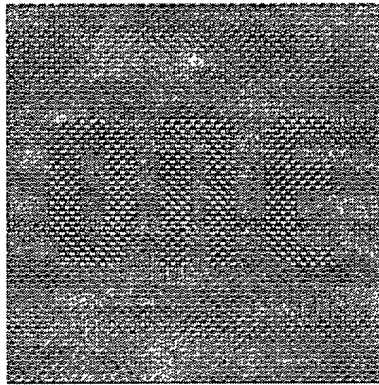
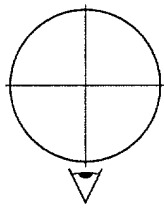


Fig. 10 a

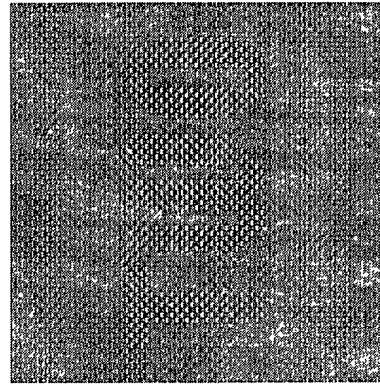
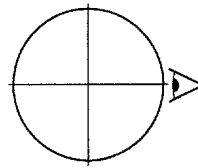


Fig. 10 b

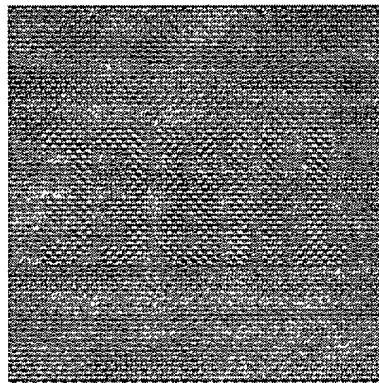
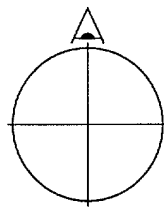


Fig. 10 c

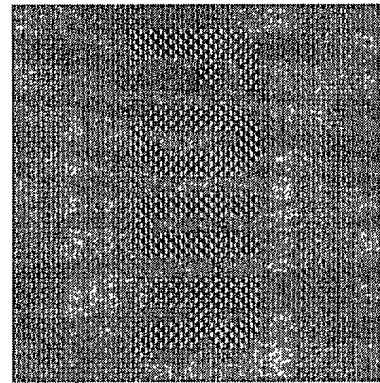
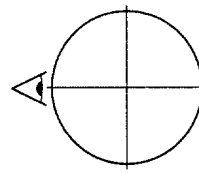


Fig. 10 d



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 40 5179

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The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 18 August 2004	Examiner D'Incecco, R
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03/82 (P04C01)

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