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(54) Laser heat-treated cellulose element, security paper comprising said element, security document comprising said paper and method for embedding a cellulose element in a security paper

(57) The present invention relates to a laser heat-treated cellulose element, security paper comprising said element, security document comprising said paper and method for embedding a cellulose element in a security paper, wherein the cellulose element has a laminar configuration and comprises plant fibers and at least one laser heat-treated area (2, 3, 4), wherein the plant fibers located in said heat-treated area are degraded due to said heat treatment.

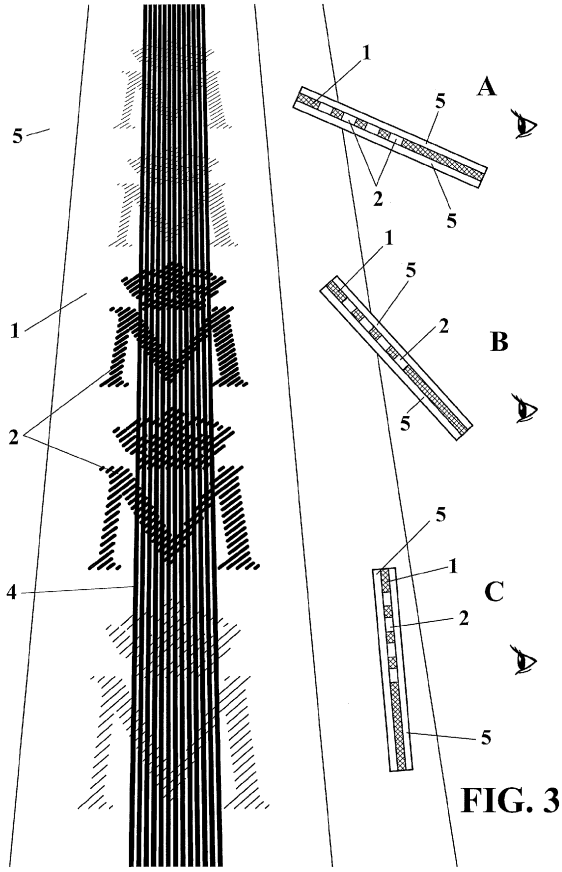

FIG. 3

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Description

Technical Field of the Invention

[0001] The present invention can be applied in the security document industry, and more specifically in the area of visual recognition security elements intended for verifying the authenticity of security documents.

Background of the Invention

[0002] Security documents incorporating both through holes and watermarks obtained from thickness differences due to the accumulation of a different amount of cellulose fibers when producing the document are known in the area of security documents incorporating visual security elements today.

[0003] In the first case, for example, international application number WO-9718092-A1 describes a security document in which perforations have been made by means of a laser beam generating a pattern recognizable formed by holes such that the presence of the holes can be easily detected by the eye without needing magnification systems, while at the same time being hardly observable by reflection without optic aids for observation.

[0004] International application number WO-9526274-A1 likewise describes a carrier containing patterns that can be readily recognized by the human eye formed by holes created by a laser beam and they can also be perceived with the naked eye or they may have shapes or irregularities that are so minor that special apparatuses verifying that the hole was made with laser technology and not with conventional mechanical methods are required.

[0005] International application number WO-2006099971-A1 in turn describes producing paper with a plurality of plies where at least one of them is paper and where in each of said plies there can be holes that can overlap one another when the successive plies of paper are overlain both during processes for producing paper in simultaneous plies and in processes for rolling previously produced paper webs. The technology used for making these holes is based on incorporating electrotypes in the wire fabric of the paper machine, these holes being completely perceivable due to the transmission of light.

[0006] On the other hand, in the second case, i.e., in the case of watermarks, there are patent applications, such as for example European patent application number EP-0549384-A1, which describes the technique of producing single-tone watermarks, usually known as electrotypes, which generate on one face of the paper a reduced amount of cellulose fibers present as the result of the inability to deposit said fibers in specific pre-established areas during the process of producing the paper, as there are impermeable parts placed in the wire fabric that prevent the deposition thereof. These watermarks are uniform, i.e., they have a single tone, and are visible by transparency with the naked eye but unperceivable by reflection.

[0007] Multitone watermarks which are generated by means of different depositions of cellulose fibers depending on the variable deformation in heights and depths generated in the wire fabric of the paper machine are also known.

[0008] In any case, producing these security documents with visually noticeable elements involves making perforations in the document as such, with the subsequent acceleration in the deterioration of the document that it entails, in addition to the need to often surface treat the security paper for its protection, which has limitations when they are observed by reflection, or including a watermark, with the subsequent limitations and making the process more expensive all entailed by the foregoing.

[0009] On the other hand, Spanish patent application number 200500563 relates to a security strip, a security paper incorporating said strip and a security document and banknote incorporating said paper. Said document describes a security strip which is formed by a cellulose carrier web formed by plant fibers to which security elements are added for visual observation, said elements including, for example, dyes or expandable agents such as those described in Spanish patent application number 200400256. According to the invention described in Spanish patent application number 200500563, the cellulose strip is fixed between the plies of a paper substrate in the wet area of the paper machine such that bonds form between the cellulose fibers of the outer faces of the strip and the cellulose fibers of the substrate.

Description of the Invention

[0010] A first aspect of the present invention relates to a laser heat-treated cellulose element, which allows obtaining a visually noticeable security element which can be embedded in a security paper, which allows obtaining surprising visual effects relating to their observation either by transparency or by reflection, all in an economical and simple manner.

[0011] The cellulose element proposed by the invention has a laminar configuration and comprises plant fibers, i.e., it consists of paper.

[0012] According to the invention, the security cellulose element comprises at least one laser heat-treated area in which the plant fibers located in said heat-treated area are degraded due to said heat treatment.

[0013] According to a preferred embodiment, the cellulose element is in the form of a web, strip or band, these terms

being considered as equivalents.

[0014] The possibility that the heat-treated area consists of through holes, the effects of which will be described below, is contemplated.

[0015] The possibility that the degradation of the heat-treated area consists of non-through holes, the effects of which will be described below, is also contemplated.

[0016] The possibility that the degradation of the heat-treated area consists of burning only the plant fibers located superficially on the security cellulose element, the effects of which will be described below, is also contemplated.

[0017] A second aspect of the invention relates to a security paper comprising at least one substrate in which at least one cellulose element such as that described above is embedded, where said at least one substrate has enough opacity to prevent the passage of light such that the amount of light going through the assembly formed by substrate and security cellulose element is similar when the light goes through the heat-treated area and when it goes through the non heat-treated area.

[0018] It is understood that substrate is a term equivalent to base paper.

[0019] A third aspect of the invention relates to a security document comprising a security paper corresponding to the second aspect of the invention.

[0020] Security paper is understood as that paper which is ready to be printed or processed such that a security document, an identification document or a valuable document are obtained. The term security document or item refers to that which has particular features assuring its origin and, therefore, its authenticity. These security documents or items include all those used by public administrations and their public agencies, as well as those used in the private sector, when they circulate massively between citizens and businesses, and they contain means or devices for identification, authentication or anti-counterfeiting, commonly referred to as security elements.

[0021] Finally, a fourth aspect of the invention relates to a method for embedding a security cellulose element, like that corresponding to the first aspect of the invention, in a security paper like that corresponding to the second aspect of the invention.

[0022] According to the invention, the method comprises inserting the security cellulose element during a wet forming phase for forming the substrate or sheet of paper and after separating said formed sheet of paper from a wire mesh constituting a paper sheet forming apparatus.

[0023] As can be seen in view of the data relating to wet tensile strength provided below in the preferred embodiment of the invention, the cellulose element can be dispersed or broken down in water, so unlike a security thread, the cellulose element cannot be inserted according to the known methods for embedding a security thread in the substrate at the beginning of the forming process for forming said substrate or sheet of paper. Until now, there has been no method whereby a cellulose element, i.e., also consisting of paper, is embedded in a paper substrate.

[0024] The present invention allows providing a cellulose strip with visually noticeable security features, unlike the strip described in Spanish patent application number P200500563, without requiring the use of any additional type of material such as dyes, fibrils, expandable agents, but said features are formed when certain cellulose fibers which are thermally engraved by means of a laser light source degrade in a localized and controlled manner. Depending on the type and features of the laser beam, the heat increase produced can cause alterations in the color of the cellulose fibers by marking the paper from the surface burning thereof or cutting with perforation in the paper after complete burning of the cellulose fibers of the engraved area. Both the color changes and the holes generated and the combination of both effects in areas close to one another produce surprising and unexpected visual effects depending on specific designs of the areas to be degraded when the security strip is embedded in the paper according to the technique described in P200500563.

[0025] In the case of areas with holes, visual observation with the naked eye and with magnifying means only by reflection and not by transmission can be achieved when the sample of paper with the embedded strip is placed between the observer and a source of light.

[0026] In the case of color changes, a visual effect equivalent to that of a conventional watermark but without the generation of thickness differences typical of this security element is achieved, having the advantage that since it remains inside the substrate it is less susceptible to deterioration than the watermark due to the handling of the security document with which said substrate is produced.

[0027] In the case of the combination of both effects, there is a high contrast between light and dark areas of the area engraved by the laser beam which is much better than that obtained by conventional multitone watermarks.

[0028] The object to be patented is the laser heat-treated cellulose strip, the method of inserting the security strip in the paper substrate during its formation in the wet area of the paper machine, the security paper containing the security strip embedded therein and the security document produced with said security paper.

[0029] The possibility that the cellulose element comprises expandable agents selectively distributed in the pulp or on the surface forming a figure or legend is contemplated, such that when heat and pressure are applied during the phase for producing the security paper containing said cellulose element, said expandable agents expand such that the surface of the cellulose element has a curved and continuous embossment, according to the distribution of the expandable

agents, being recognizable both by sight and by touch. It is also contemplated that the cellulose element comprises any of the security elements described in Spanish patent application number 200500536, including dyes, or any other addition of security elements to the cellulose element itself in combination with the laser treatment thereof.

[0030] Therefore, the invention consists of thermally degrading in specific and located points or areas of a strip of paper made up of cellulose fibers of a plant origin with a laser beam to obtain perforations in said paper when the burning is complete and affects the entire thickness of the engraved area of paper or color changes when the burning is partial and only affects the surface of the engraved area. In summary, the perforations generate areas of through holes throughout the entire thickness of the strip of paper whereas in the color changes, the laser beam does not go through the paper. The non-through holes, i.e., the perforation having certain thickness, generate a tone or color change on the surface of the non-perforated area.

[0031] When the cellulose strip is embedded completely between the plies of a substrate such as that formed by security paper covering the holes in the strip on both faces, due to the opacity of the substrate, greater than 90%, compared to the opacity of the strip, usually around 40%, the phenomenon is inverted in relation to what occurs when the strip is not embedded and the areas with holes or the pattern generated by the assembly thereof are no longer visible by transparency. In other words, the substrate has enough capacity to prevent the passage of light such that the amount of light going through the assembly of the substrate and the strip is similar both when the light passes through the area of holes and through the area without holes. Furthermore, the holes are visible by reflection due to the uneven dispersion of the light when it goes through the substrate and strip with or without holes.

[0032] In the case of color changes, a multitone visual effect is achieved depending on the degree of heat engraving of the laser beam on the cellulose fibers of the surface of the strip which, prior to that engraving, has been treated on the surface of the opposite face by a protective ply, for example by means of printing, sizing or coating systems for the purpose of reaching sufficient mechanical strength so that the unwinding tension and subsequent embedding are still possible without the strip breaking.

[0033] Points or areas with more or less burned area depth which will acquire different yellowish, brownish or black tones will be obtained with the laser heat engraving or marking. This multitone feature can reproduce the visual sensation of conventional watermarks.

[0034] In a conventional watermark generated from a wire fabric of a paper machine, the different fibrous accumulation caused by protrusions or grooves made on said fabric will lead to lighter or darker tones, respectively, but always the color of the paper pulp which in turn will depend on the combination of colorants chosen to provide the generated paper with the desired color. In other words, conventional watermarks always have the same color as the paper containing them but varying the degree of whiteness depending on the existing multitones.

[0035] In contrast, the strip with the image generated by controlled heat degradation has no increase in fiber accumulation, but rather a chemical alteration of the heat-degraded fibers takes place. This is the first difference in relation to conventional multitone watermarks.

[0036] On the other hand, when introducing the strip with the areas containing the aforementioned color changes, the image formed has a different color than the substrate containing it which allows establishing a second difference with respect to conventional watermarks.

[0037] Finally, when the image is generated in the strip and the strip is arranged within the substrate, a greater level of protection against abrasion or wear is achieved, which is the third difference in relation to conventional watermarks.

[0038] In the case of combining both effects (holes and color changes), there is a high contrast between light areas (holes) and dark areas (multitones due to a different degree of heat engraving) of the area in which the laser beam has been applied which is much greater than that obtained by conventional multitone watermarks, although when the strip is introduced in the substrate, the lightest areas corresponding to the holes will no longer be visible by transparency and the complete image with all the holes (which are now seen as dark) and superficially burned areas (multitone) will be obtained when it is viewed by reflection, generating a type of image having a configuration that is different from those known until now.

Description of the Drawings

[0039] To complement the description that is being made and for the purpose of aiding to better understand the features of the invention according to a preferred practical embodiment thereof, a set of drawings is attached as an integral part of said description where the following has been depicted with an illustrative and non-limiting character:

Figure 1 shows a schematic view of the heat-treated cellulose element according to the first aspect of the invention, in which making a motif by means of through holes, as well as the visual behavior of the cellulose element according to different inclinations (A, B, C) can be seen, reflection phenomena for approximate angles of observation less than 30° in view A and between 30°-60° in view B having been depicted in views A and B, whereas the transparency phenomenon between approximately 60°-120° has been depicted in view C.

Figure 2 shows a schematic view like that of Figure 1, in which the cellulose element is embedded in a paper substrate and the visual behavior of the assembly according to different angles of inclination of the observer (A, B, C) can be seen.

Figure 3 shows a schematic view like that of Figure 2, in which the cellulose element is additionally subjected to heat treatment producing the color and shape of dark parallel lines of the same tone; multitones have not been depicted so as to not complicate the visual interpretation of the drawings.

Figure 4 shows a cross-section of the cellulose element in which all the possible effects created by means of laser heat treatment, i.e., through hole, non-through hole and burning only the plant fibers located superficially, have been depicted, in the case of the non-through hole, how certain discoloration of the cellulose fibers takes place can be seen.

Figure 5 shows a schematic perspective view of equipment in which the method for embedding a cellulose element in a security paper according to the fourth aspect of the invention can be carried out, where several webs of the cellulose element are unwound from the reels containing them, being directed from the inside towards the point of overlapping of the two plies of paper generated by each cylindrical sheet forming apparatus.

Preferred Embodiment of the Invention

[0040] In view of the discussed figures, how the production of different visual effects is adjusted by combining the following parameters can be seen in one of the possible embodiments of the invention, according to experimental results:

1.- PARAMETERS OF THE CELLULOSE ELEMENT (1)

[0041]

Parameter	Effect produced	Possible range	Preferred range
Width	Embedding capacity	5 -100 mm	10 - 35 mm
Thickness	Embedding capacity	33 - 66 microns	44 - 55 microns
Bendtsen porosity (x4 sheets)	Capillarity	> 2000 ml/min	> 2500 ml/min
Grammage	Embedding capacity	15 - 30 g/m^2	20 - 25 g/m2
Dry tensile strength	Prevent breaking while embedding	SL: 20 - 35 N/15 mm ST: 8 - 25 N/15 mm	SL: 25 - 30 N/15 mm ST: 10 - 20 N/15 mm
Wet tensile strength	Prevent breaking while embedding	SL: 0 - 5 N/15 mm	SL: 0 - 2 N/15 mm
Opacity	Visibility of the optic effect	30% - 60%	35% - 45%

2.- PARAMETERS OF THE GRAPHIC DESIGN TO BE DEGRADED IN THE CELLULOSE ELEMENT (1)

[0042]

Parameter	Effect produced	Possible range	Preferred range
Geometry of the discoloring	Visual by reflection	Unlimited	Continuous areas in the form of lines, dots or speckles
Geometry of the holes	Visual by reflection	Polygons, circles, ovals, lines	Lines, circles
Distances between holes	Generation of an optical illusion	0.1 - 1.0 mm	0.1 - 0.2 mm
Perforated width	Generation of an optical illusion	0.1 - 10 mm	0.2- 1 mm

3.- PARAMETERS OF THE LASER AND THE ADJUSTMENT THEREOF FOR DEGRADATION

[0043]

Parameter	Effect produced	Possible range	Preferred range
Laser source	Heat degradation of the strip	Nd:YAG; Ho:YAG; Er:YAG; Tm:YAG; Organic colorant; Excimer; CO_2	Nd:YAG; CO_2
Wavelength	Heat degradation of the strip	100 - 11000 nm	9000 - 11000 nm
Type of head	Heat degradation rate	Fixed, Galvanometer	Galvanometer
Axes of the head	Heat degradation rate	2-3	2-3
Pulse power	Scope of the heat degradation	100 - 2000 W	125 - 250 W
Spot diameter	Geometry of the heat degradation	2 - 50 mm	2-5 mm

[0044] With respect to the manner of integrating the cellulose element into the substrate (5), the indications provided in Spanish patent application number 200500563 are followed, but considering the parameters of integration and of the substrate (5) provided in the following tables.

4.- PARAMETERS OF THE SUBSTRATE (5)

[0045]

Parameter	Effect produced	Possible range	Preferred range
Thickness	Embedding capacity	84 - 144 microns	102 - 108 microns
Bendtsen porosity (x4 sheets)	Capillarity	5 - 50 ml/min	10 - 35 ml/min
Grammage	Embedding capacity	70 - 150 g/m^2	85 - 100 g/m^2
Dry tensile strength	Prevent breaking while forming the sheet and winding the substrate itself	SL: 45 - 135 N/15 mm ST: 30 - 75 N/15 mm	SL: 75 - 120 N/15 mm ST: 45 - 65 N/15 mm
Wet tensile strength	Prevent breaking while forming the sheet and winding the substrate itself	SL: 15 - 65 N/15 mm ST: 7 - 35 N/15 mm	SL: 30 - 45 N/15 mm ST: 15 - 30 N/15 mm
Plies	Embedding capacity	2 - 4	2
Production rate	Embedding tension	40 - 100 m/min	45 - 55 m/min
Opacity	Visibility of the optic effect	85% - 99%	92% - 96%

5.- PARAMETERS OF INSERTION OF THE CELLULOSE ELEMENT (1) IN THE SUBSTRATE (5)

[0046]

Parameter	Effect produced	Possible range	Preferred range
Distance to the surface of the substrate	Pulling the strip through the substrate	<15mm	5 - 8 mm
Initial air pressure	Driving the strip towards the substrate	1.50 - 2.00 bar	1.70 - 1.80 bar
Air pressure	Keeping the strip embedded while producing the substrate	0.2 - 0.5 bar	0.25 - 0. 35 bar

Embodiments:

A. CUTTING OR PERFORATING:

[0047] Burning with perforation by means of through holes (2) having the geometry of lines generating the optical illusion of the figure corresponding to the emblem of the Fábrica Nacional de Moneda y Timbre (National Mint and Stamp Factory), as depicted in Figures 1 to 3, was carried out on a cellulose element (1) 18 mm wide, 22 g/m^2 in grammage, 48 microns thick, with a Bendtsen porosity of 2600 ml/min (x4 sheets), a dry tensile strength of 28 N/15 mm in the longitudinal direction (SL) and 17 N/15 mm in the transverse direction (ST), and a wet tensile strength of 0.2 N/15 mm in the longitudinal direction, the value of which is the same in the transverse direction. The lines had a perforated width of 0.15 mm and a distance between them of 0.1 mm.

[0048] The burning was performed with a CO_2 laser source with a wavelength of 10000 nm and a power of 150 W, through a 3-axis galvanometer head and a spot diameter of 2 mm.

[0049] The cellulose element (1) generated by these means obtained an observation by transparency and by reflection corresponding to the desired graphic design.

[0050] This cellulose element (1) was subsequently embedded between the two plies of a cotton paper substrate (5) when both plies are coming out of their corresponding sheet forming apparatuses (7) of the paper machine and a final substrate of 87 g/m^2, 106 microns thick, with 94% opacity was obtained at a production rate of 48 m/min.

[0051] To achieve the correct embedding of the cellulose element (1) a device for unwinding the reel containing the cellulose element (1) in the form of strip driving said strip with air at a pressure of 1.75 bar was used to place the cellulose strip (1) at a distance of up to 8 mm from one of the two plies of the substrate (5). Once the strip (1) is adhered between the two plies of paper as a result of the capillarity and fluid transfer phenomena of the cellulose pulp, the tension of the cellulose strip (1) was maintained at the same unwinding rate as the production rate of the substrate and with a supply air pressure of 0.3 bar.

[0052] In summary, the method according to the invention as illustrated in Figure 5 comprises inserting the security cellulose element (1) during a wet forming phase (6) for forming the substrate (5) and after separating said formed sheet of paper from a wire mesh constituting a paper sheet forming apparatus (7).

[0053] After producing the paper substrate (5) with the embedded strip (1), it was found that the optical illusion of the desired image was no longer visible by transparency but only by reflection on one of the faces of the substrate.

[0054] To illustrate the effects achieved with the invention, Figure 1 shows a schematic view of the heat-treated cellulose element (1) according to the first aspect of the invention, in which the making of a motif by means of through holes (2), as well the visual behavior of the cellulose element according to different inclinations can be seen.

[0055] In all of Figures 1 to 3, each of the three views A, B and C depicts a common phenomenon, phenomena of reflection for approximate angles of observation less than 30° in view A and between 30°-60° in view B having been depicted in views A and B, whereas the transparency phenomenon between approximately 60°-120° has been depicted in view C.

[0056] On the other hand, Figure 2 shows a schematic view like that of Figure 1, in which the cellulose element (1) is embedded in a paper substrate (5).

B. MARKING OR DISCOLORING

[0057] A protective ply is provided on a cellulose strip (1) 25 mm wide, 22 g/m^2 in grammage, 48 microns thick, with a Bendtsen porosity of 2600 ml/min (x4 sheets), a dry tensile strength of 28 N/15 mm in the longitudinal direction and 17 N/15 mm in the transverse direction, and a wet tensile strength of 0.2 N/15 mm in the longitudinal direction by means of a rotogravure printing process on one of its faces for the purpose of reaching sufficient mechanical strength so that after heat engraving, the unwinding tension and subsequent embedding are still possible without the strip breaking.

[0058] Then discoloration is performed by means of burned surface plant fibers (4) or by means of non-through holes (3), as can be seen in Figure 4, on the untreated face with the protective ply having a geometry of speckles generating irregular shapes enclosed in rectangular areas.

[0059] The marking or discoloring is done with a CO_2 laser source with a wavelength of 10000 nm and a power of 120 W, through a 3-axis galvanometer head and a spot diameter of 2 mm.

[0060] The cellulose strip (1) generated by these means obtains observation by transparency and by reflection corresponding to the desired random design.

[0061] This cellulose strip (1) was subsequently embedded between the two plies of a cotton paper substrate (5) when both plies are coming out of their corresponding sheet forming apparatuses (7) of the paper machine and a final substrate of 87 g/m^2, 106 microns thick, with 94% opacity was obtained at a production rate of 48 m/min, as schematically depicted in the process carried out in the equipment illustrated in Figure 5.

[0062] To achieve the correct embedding of the cellulose strip (1) a device for unwinding the reel containing the strip

(1) driving said strip (1) with air at a pressure of 1.75 bar was used to place the cellulose strip (1) at a distance of up to 8 mm from one of the two plies of the substrate (5). Once the strip (1) is adhered between the two plies of paper as a result of the capillarity and fluid transfer phenomena of the cellulose pulp, the tension of the cellulose strip (1) was maintained at the same unwinding rate as the production rate of the substrate (5) and with a supply air pressure of 0.3 bar.

[0063] After producing the paper substrate (5) with the embedded strip (1) it is found that the marked areas are visible both by reflection and by transparency.

[0064] For the purpose of illustrating the foregoing, Figure 3 shows a schematic view like that of Figure 2, in which the cellulose element (1) is additionally subjected to heat treatment producing the color and shape of dark parallel lines of the same tone; multitones have not been depicted so as to not complicate the visual interpretation of the drawings, as discussed above; the phenomena depicted in each of the views A, B and C correspond with said same views of Figures 1 and 2.

[0065] In view of this description and set of drawings, the person skilled in the art will understand that the embodiments of the invention that have been described can be combined in many ways within the object of the invention. The invention has been described according to some preferred embodiments thereof, but for the person skilled in the art it will be evident that many variations can be introduced in said embodiments preferred without exceeding the object of the claimed invention.

Claims

1. Laser heat-treated cellulose element, having a laminar configuration and comprising plant fibers, **characterized in that** said security cellulose element (1) comprises at least one laser heat-treated area (2, 3, 4), wherein the plant fibers located in said heat-treated area are degraded due to said heat treatment.

2. Cellulose element according to claim 1, wherein the degradation of the heat-treated area consists of through holes (2).

3. Cellulose element according to any of the preceding claims, wherein the degradation of the heat-treated area consists of non-through holes (3).

4. Cellulose element according to any of the preceding claims, wherein the degradation of the heat-treated area consists of burning only the plant fibers located superficially on the security cellulose element, such that the cellulose element (1) has burned surface plant fibers (4).

5. Cellulose element according to any of the preceding claims, the thickness of which is between 44-55 microns, has a grammage between 20-25 g/m^2 and opacity between 35%-45%.

6. Security paper comprising at least one substrate (5), wherein at least one cellulose element (1) according to any of claims 1 to 5 is embedded, where said at least one substrate (5) has enough opacity to prevent the passage of light such that the amount of light going through the assembly formed by substrate (5) and security cellulose element (1) is similar when the light goes through the heat-treated area (2, 3, 4) and when it goes through the non heat-treated area.

7. Security paper according to claim 6, wherein the substrate (5) has a thickness between 102-108 microns, a grammage between 85-100 g/m^2 and opacity between 92%-96%.

8. Security document comprising a paper according to any of claims 6 and 7.

9. Method for embedding a security cellulose element (1) according to any of claims 1 to 5 in a security paper according to any of claims 6 and 7, **characterized in that** it comprises inserting said security cellulose element (1) during a wet forming phase (6) for forming the substrate (5) and after separating said formed sheet of paper from a wire mesh constituting a paper sheet forming apparatus (7).

10. Method according to claim 9, wherein the distance between through holes (2) in the cellulose element (1) is 0.1-0-2 mm and the perforated width is 0.2-1 mm.

11. Method according to any of claims 9 and 10, wherein the laser wavelength is 9000-11000 nm, with a galvanometer head, wherein the pulse power is 125-250 W, with a spot diameter of 2-5 mm.

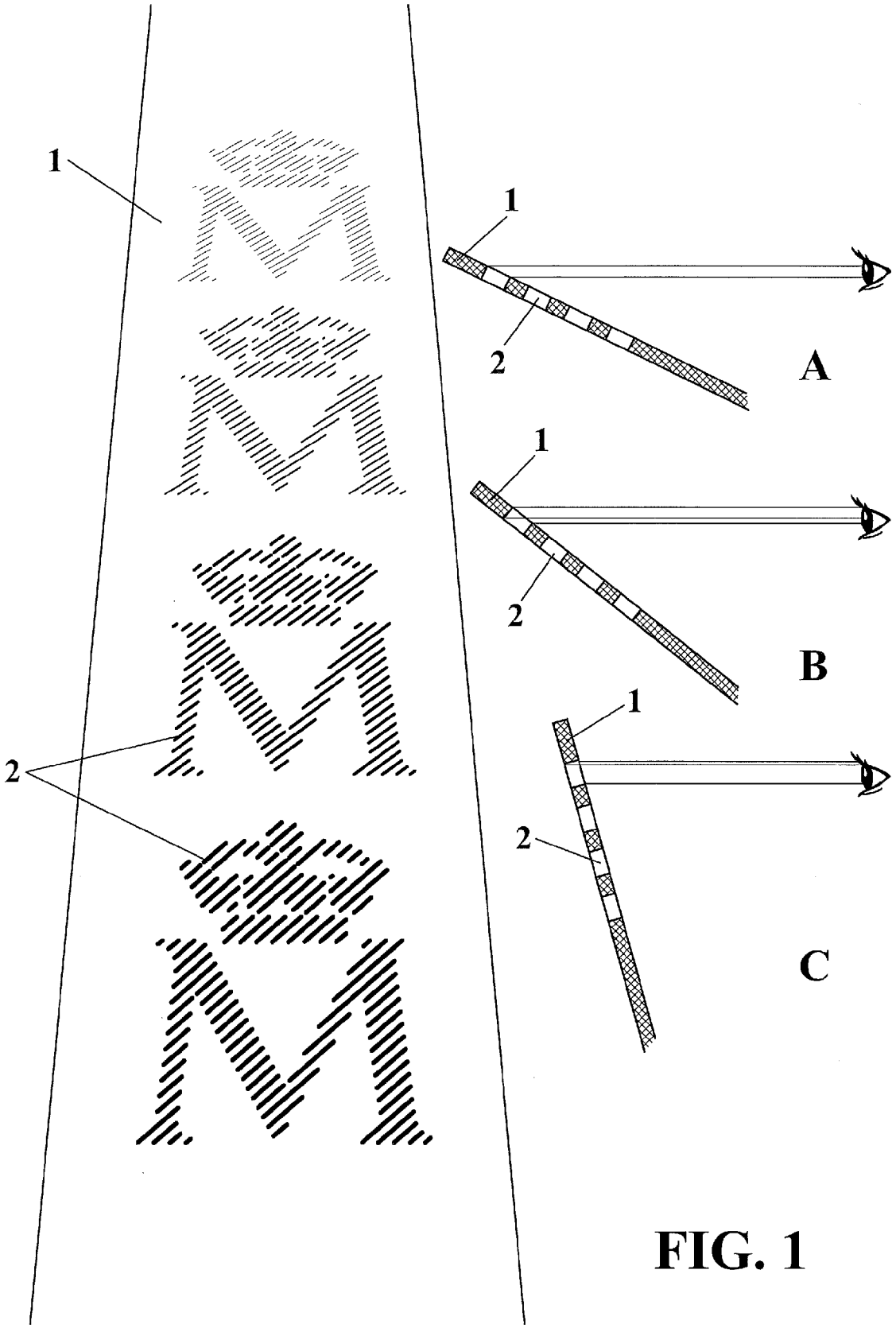

FIG. 1

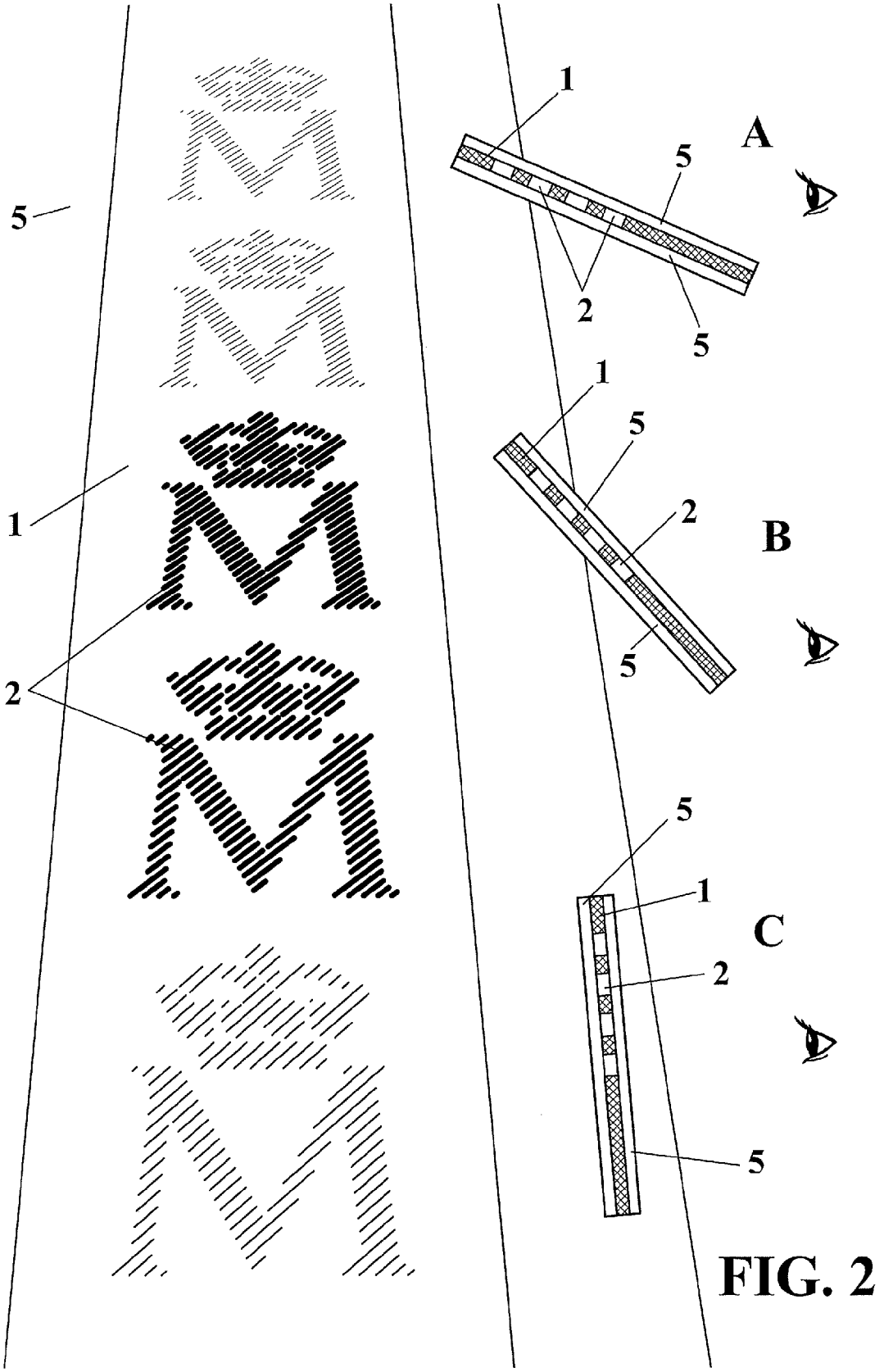

FIG. 2

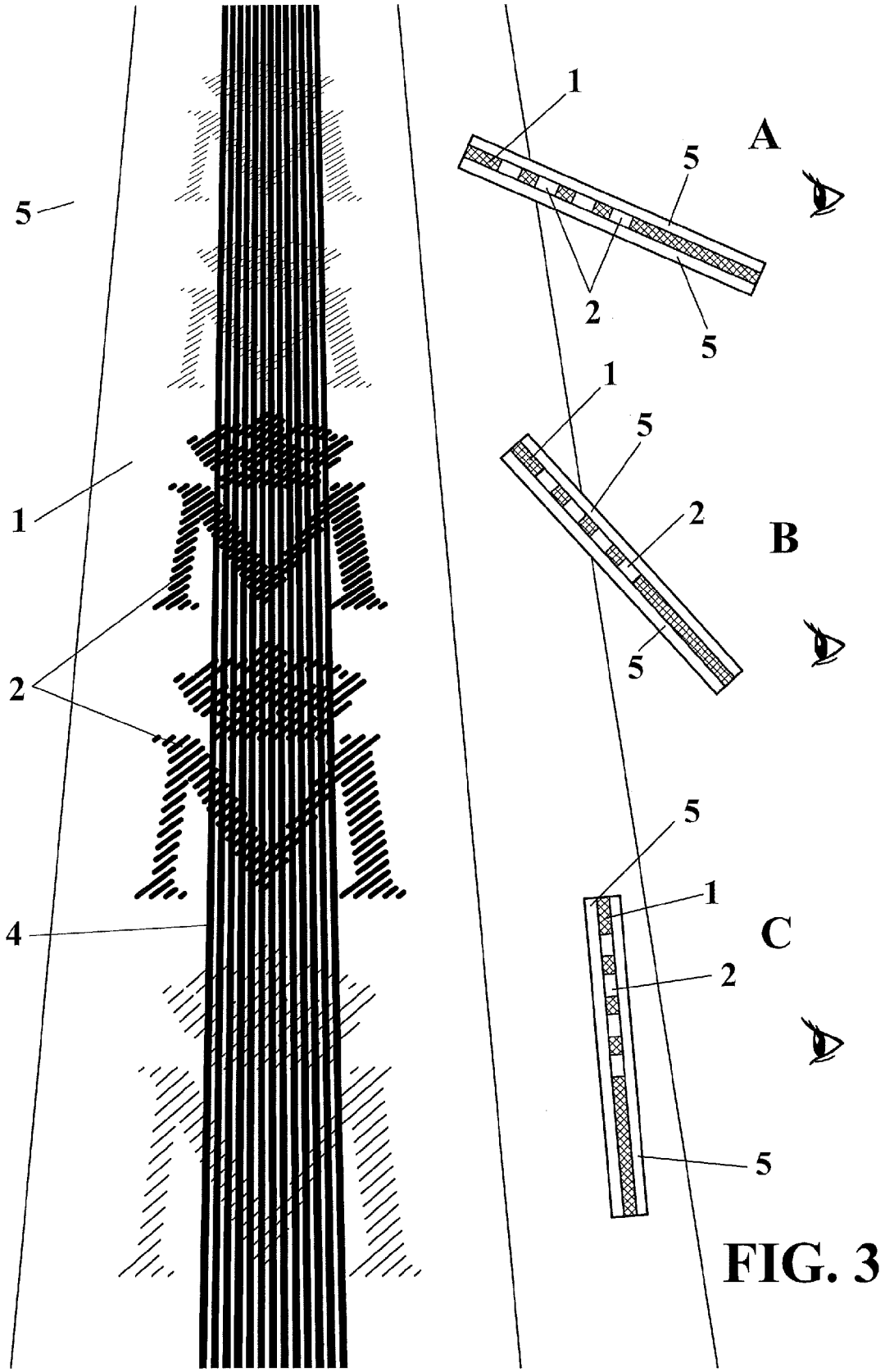

FIG. 3

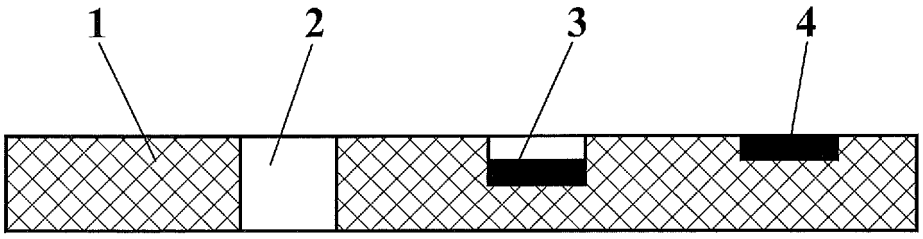

FIG. 4

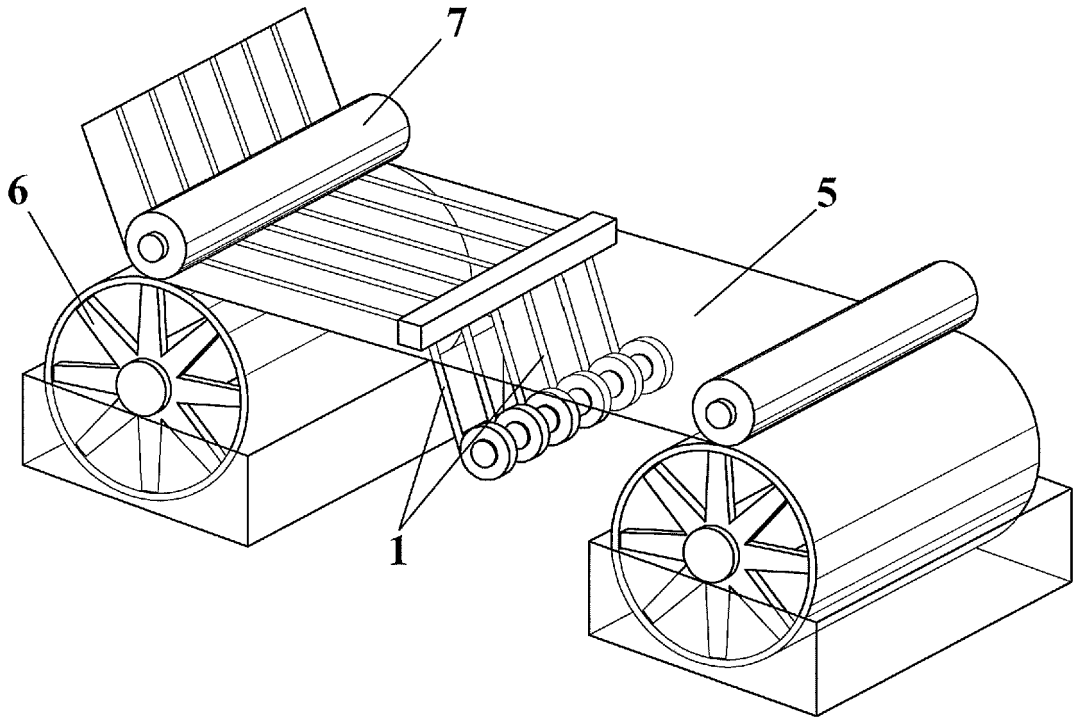

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 12 38 2309

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	GB 2 433 469 A (RUE DE INT LTD [GB]) 27 June 2007 (2007-06-27) * Abstract; page 17, lines 17-24; figures 1-4,7-10 *	1-11	INV. B42D15/00 B41M5/24 D21H21/48
X	US 2011/056638 A1 (ROSSET HENRI [FR]) 10 March 2011 (2011-03-10) * Abstract; paragraphs [0142], [0157], [0271]; figures 4-12 *	1-11	
X	EP 0 070 172 A1 (PORTALS LTD [GB]) 19 January 1983 (1983-01-19) * paragraphs [0013] - [0021] *	1-11	

TECHNICAL FIELDS SEARCHED (IPC)

B42D
D21H
B41M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 December 2012	Callan, Feargel

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
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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

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 38 2309

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18-12-2012

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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