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(72) Inventors:  
 • **Mosele, Giuseppe**  
**60316 Frankfurt am Main (DE)**  
 • **Teeäär, Raivo**  
**11214 Tallinn (EE)**

(74) Representative: **Prinz & Partner mbB**  
**Winterstrasse 2**  
**22765 Hamburg (DE)**

(71) Applicant: **European Central Bank**  
**60314 Frankfurt am Main (DE)**

(54) **PAPER INCORPORATING AN EMBEDDED FOIL AND METHOD FOR MANUFACTURING**

(57) The invention relates to a valuable document (10) comprising fibrous material (20) and methods of manufacturing the valuable document (10). The fibrous material (20) comprises a registered elongate strip of foil (30) embedded in the thickness of the fibrous material (20), the elongate strip of foil (30) being at least partially perforated in order to be permeable for fibers (33) of the

fibrous material (20), wherein the elongate strip of foil (30) is exposed in that it is uncovered or substantially uncovered by fibers (33) of the fibrous material (20) in an exposed area on at least one side of the valuable document so as to provide a window area (32) comprising a security element of the elongate strip of foil (30) which is in register with the window area (32).

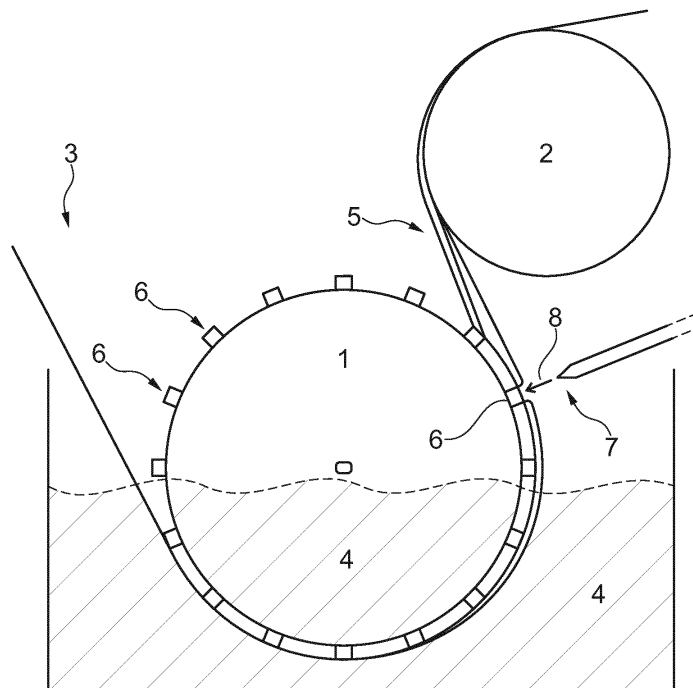


Fig. 1

## Description

**[0001]** The present invention relates to a valuable document comprising an embedded foil and a method of manufacturing the valuable document. More specifically, the present invention relates to paper, such as security paper, containing a strip embedded in the thickness of the paper, to security documents made from such paper and to methods of making such paper.

## BACKGROUND

**[0002]** It is known in the art to incorporate pads or strips of a foil into a paper (or paper-like) substrate of security or valuable documents, as for example banknotes. These parts of foil can comprise security elements that may be arranged in so called windows. The foil and in particular the security elements prevent simple copying of the banknotes by copying machines. The combination or integration of foil into a paper substrate during manufacturing generally creates challenges regarding the properties of the valuable document and the security element.

**[0003]** GB 1365876 A discloses a security paper in which a porous tape is incorporated as a security element. The tape or strip is incorporated in the paper while the paper is made on a cylinder mould papermaking machine. In such a machine paper is deposited on a mesh which rotates in a paper furnish whilst liquid flows from the furnish into the mesh.

**[0004]** EP 0 070 172 A1 discloses regions offering a differing obstacle to fiber deposition, e.g. regions of permeability and regions of impermeability, along a strip or tape. The strip or tape is incorporated in a paper on a cylinder mould-making machine so that some regions, e.g. the permeable regions are embedded in the thickness of the paper and others, e.g. the less permeable regions, are exposed on one surface of the paper. However, creating such "exposed areas" in which the strip or tape is overlaid by little or none of the fiber material making up the sheet creates further problems during manufacturing.

## SUMMARY

**[0005]** It is an object of the invention to provide a valuable document or security document comprising a strip of foil being embedded in the thickness of the paper substrate and having at least one window area in which the strip is at least partially exposed (free from fibers of the paper substrate) and the window has an improved quality compared with the prior art. "Quality" or "window quality" relates to the sharpness of the borders of the window and to a desired absence of fibers on each window. It is also an object of the invention to provide improved methods of manufacturing such a valuable document.

**[0006]** According to an aspect of the invention, a valuable document comprising fibrous material (also referred to as paper web or paper substrate), in particular

paper, is provided. The fibrous material comprises a registered elongate strip (or band, wide thread) of foil being partially embedded in the thickness of the fibrous material. The elongate strip of foil is at least partially perforated (porous) in order to be permeable for fibers of the fibrous material. The elongate strip of foil is exposed or uncovered in a window area on at least one side of the valuable document. The terms "exposed" or "uncovered" mean that the window area is at least partially free or clean of fibers of the fibrous material so as to provide a window area for a security element of the elongate strip of foil which is in register with the window.

**[0007]** The exposed or uncovered areas can generally and at least partially be generated by a watermarking technique.

**[0008]** However, in an advantageous aspect, the exposed or uncovered area may also be generated by selective local repulsion of fibers, the local repulsion being induced by application of a fluid (in form of a jet through a nozzle), in particular compressed air and/or water. The fluid may be applied continuously and/or pulse-wise in pulses of adjustable duration and/or synchronized in relation to the target position of the window.

**[0009]** The uncovered area can at least partially be generated by locally selective inhibition of substrate formation on the elongate strip of foil. The locally selective inhibition can also be physically and/or chemically induced. The locally selective inhibition can further at least partially be induced by local surface treatment of the elongate strip of foil.

**[0010]** In an advantageous aspect, the locally selective inhibition can be provided by a hydrophobic or superhydrophobic layer/structure. If a superhydrophobic layer is used, the water droplet/solid surface snap-in forces - measured e.g. using the micro balance in a tensiometer - become zero because the surface tension of the water, hence its internal cohesion, is stronger than the reference surface wettability. Another way to define superhydrophobic is that the advancing angle of the droplet on a reference surface (not its static angle) is greater than 145° when the liquid is water.

**[0011]** The exposed or uncovered area can also be generated by removal of fibers by suction, in particular discontinuous suction.

**[0012]** According to an aspect, some additional fibers can be arranged or locally accumulated in off-limit zones in order to compensate fiber depletion on vicinal areas of the window.

**[0013]** The accumulation may also be referred to as "bump" of fibers created between two windows. This area is also referred to as "off-limit" zone. Another reason for the accumulation or bump of fibers consists in compensating the thickness difference brought in by the short former layer (if a short former layer is used).

**[0014]** The substrate or the plies of the substrate, in case of a multi layer substrate, may comprise cellulose fibers particularly cotton fibers and/ or organic synthetic fibers and/ or mineral fibers. The substrate can generally

be fibrous as for example any paper-like substrate.

**[0015]** A groove (or depression) can be arranged on one of the surfaces of the substrate. The groove, the embedded foil strip and, at least partially, the bumps can be aligned with each other such that the groove is at least substantially superposed. In other words, the groove and the bumps can substantially match and mutually compensate each other, if they are viewed perpendicular to the surface of the substrate (cross-sectional view).

**[0016]** In a configuration, in which a mould layer and short former layer are used, the width of the groove on the side of the short former layer can be slightly lower than the width of the elongate strip of foil. The short former layer can advantageously cover the area along the borders of the elongate strip of foil after it is fully embedded in the mould layer. In this case, the short former layer may not directly touch or get in contact with the elongated strip of foil. It just covers the fine layer of fibres of the mould layer that covers/embeds the strip.

**[0017]** Furthermore, residual fibers can be removed by a rotating brush. Still further, areas of accumulated fibers can also be evened up by the rotating brush.

**[0018]** In another aspect, the fibrous material can comprise two layers, a mould layer and a short former layer and the elongate strip of foil is embedded in the mould layer. This aspect is advantageous, as it has turned out that a two layer configuration has better properties than a single layer configuration.

**[0019]** The at least one exposed or uncovered area can advantageously be arranged in the short former layer.

**[0020]** The elongate strip of foil can be transparent or semi-transparent at least in the area of the window such that fibers of the mould layer are visible through the window from the side of the short former layer.

**[0021]** The window can at least horizontally (in a first direction) be in register with the elongate strip of foil. However, it is more advantageous if all components, i.e. paper web, strip of foil, window areas, exposed areas and any eventual layer of the paper web are in register.

**[0022]** The elongate strip of foil can comprise at least one opening (perforation) in the area of the window. The fibers of the mould layer can then protrude through at least one opening towards the side of the short former layer. This provides increased flexibility regarding the creation and properties of security features in the window area. In particular, new tactile or haptic effects may be created that cannot easily be copied.

**[0023]** The invention also provides a method of manufacturing a substrate for a valuable document and a method of manufacturing a valuable document. An at least partially porous or perforated strip of foil can be provided in a paper mould around a first cylinder. The first cylinder partially resides in a pulp. A paper web is generated from the pulp on an outer wall of the first cylinder by rotating the first cylinder. The pulp is dewatered through a permeable outer wall of the first cylinder. During the previous steps, the strip of foil is kept in register with

the paper web, and fibers of the pulp/ paper web are actively removed from one side of a window area of the strip of foil. At the other side, which is the one in direct contact with the mould cover, the fibers deposition is prevented/inhibited. The advantageous valuable document can then be manufactured from the substrate.

#### BRIEF DESCRIPTION OF DRAWINGS

**[0024]** Further aspects and characteristics of the present invention will ensue from the following description of the embodiments with reference to accompanying drawings, wherein

FIG. 1 is a simplified representation of a mould for manufacturing a valuable document according to an embodiment;

FIG. 2 is a simplified representation of a valuable document according to an embodiment;

FIG. 3 is a cross sectional view of a cut along line A-A through the valuable document of FIG. 2;

FIG. 4 is a cross sectional view of a cut along line A-A through the valuable document of FIG. 2 according to another embodiment.

FIG. 5 is a cross sectional view of a cut along line B-B through the valuable document of FIG. 2;

FIG. 6 is a simplified representation of a valuable document according to an embodiment, and

FIG. 7 is a cross sectional view of a cut along line C-C through the valuable document of FIG. 6.

FIG. 8 is another cross sectional view of a cut along line C-C through the valuable document of FIG. 6 according to another embodiment.

#### DETAILED DESCRIPTION OF EMBODIMENTS

**[0025]** FIG. 1 is a simplified representation of a paper mould for manufacturing a valuable document according to an embodiment. There is a first cylinder 1 and some other cylinders, only one of which is shown as a second cylinder 2. The elongate registered strip of foil 3 is fed to the first cylinder 1. The pulp 4 surrounds the first cylinder partially. The first cylinder 1 is made of a mesh of wires such that the pulp 4 tends to flow towards the mesh of the first cylinder 1. The fibers in the pulp 4 are held back by the mesh of wires on the first cylinder 1 and deposit on the outside of the first cylinder 1 thereby creating a paper web 5. An at least partially porous or perforated strip of foil 3 allows the fibers to extend through the openings (not visible here). Areas free of fiber can either be created by covering specific points, areas, or locations

etc. on the wire mesh of the first cylinder. This is roughly indicated by elements 6 which may merely plug some or all openings in the wire mesh of the first cylinder 1. This locally prevents the pulp 5 from draining towards the inside of the first cylinder 1 such that in those selectively chosen locations, no or less fibers accumulate. Furthermore, the elements 6 also touch the surface of the elongate strip of foil 3 thereby preventing the fibers still flowing in the turbulent pulp mass to enter in contact with the surface of the strip of foil 3 at this location (the location of the elements 6). The results can be locally thinner areas (watermarking), openings or holes in the paper web 5. The same principle applies to the strip of foil 3. If the strip of foil is locally impermeable for the liquid in the pulp, this also prevents the fibers from depositing outside the strip of foil 3 in those impermeable areas or at least reduces the amount of fibers that accumulate in those areas.

**[0026]** The main disadvantage of known techniques of watermarking as previously described is the poor quality of the window areas. The borders of the window areas are not sharp enough and some fibers always remain within in the window area and on the strip of foil 3 in those areas.

**[0027]** In order to improve the quality of the windows or window areas, at least one nozzle 7 (but usually more in a row) is provided that is configured to clean the window area from the remaining fibers and to sharpen the borders of the window. Through the nozzle 7, a fluid 8, as for example water or air or a mixture of water and air is supplied to the surface of the window area. This removes remaining fibers and cleans the window. Furthermore, the borders of the window area can become sharper. In other words, the exposed or uncovered area (window area) is generated by selective local repulsion of fibers and, in this embodiment, the local repulsion is induced by application of a fluid 8, advantageously in form of a jet through the nozzle 7. The fluid can be compressed air and/or water.

**[0028]** In other, more general words, an at least partially porous or perforated strip of foil 3 can be provided in a paper mould 4 around a first cylinder 1. The first cylinder 1 partially resides in the pulp 4. A paper web 5 is generated from the pulp 4 on an outer wall of the first cylinder 1 by rotating the first cylinder 1. The pulp 4 is dewatered through a permeable outer wall (wire mesh) of the first cylinder 1. During these steps, the strip of foil 3 is kept in register with the paper web 4, and fibers of the pulp 4/ paper web 5 are actively removed from a window area of the strip of foil 3.

**[0029]** In one embodiment, the removal of the fibers can be performed by the previously described nozzle 7 and a fluid 8 supplied from the nozzle 7. The fluid 8 from the nozzle 7 can be applied continuously and/or pulse-wise in pulses of adjustable duration and/or synchronized in relation to the target position of the window.

**[0030]** The nozzle 7 (or a plurality of nozzles 7) can advantageously be a conic stream nozzle. In case the

fluid is water, the water pressure may be 0 to 10 bar, advantageously 0.2 to 3 bar and the distance from the mould can be from 2 cm to 25 cm, conveniently from 4 cm to 18 cm from the mould cover surface. In case the fluid is air/ compressed air, the pressure may be 0 to 10 bar, advantageously 0.2 to 3 bar and the distance from the mould can be 2 cm to 25 cm, advantageously 4 cm to 18 cm.

**[0031]** The speed of the first cylinder 1 may need to sustain variations to comply with production/ quality needs. It is therefore necessary that the devised system for the creation of windows on the substrate in order to reveal the embedded strip of foil 3 is

a) as a minimum, tolerant to speed variations of +/- 10 m/ min and/ or

b) configured to be adjusted to the speed variations to optimize the performance even beyond the speed limits indicated above.

**[0032]** The adaptive capability should include:

1) variation of frequency of opening and closing of the valve(s) used to manage machine speed variations, but also necessary to tune the spraying time and pace in case of multiple windows per notes, of different banknote dimensions (i.e. windows spacing may vary), windows with different shapes (i.e. differently elongated windows),

2) variations of the orientation angle of the nozzle(s) (with chances of rotation speed of the mould cover, the impact angle of the jets need to vary to preserve the shape and cleanness of the window),

3) distance of the nozzle 7 to the surface,

4) controlled variation of the spraying pressure and

5) controlled variation of the sprayed fluid composition and besides that,

6) the capability of the nozzle 7 to stay relatively clean in very turbulent environments at high speed to prevent fibers encrusting over its surface that could introduce defects on the paper (self-cleaning).

**[0033]** In an aspect of the invention, the amount fibers (density) can be increased and then the pressure of the jet of fluid can be increased. This reduces the risk that the paper web is negatively affected. The pulp density at the cleaning point (lead by pulp consistency at inlet and drainage and wet-end chemistry driven) needs to be adjusted to allow the fibers to be removed. This is due to the fact that too dry pulp could be resistant to removal, as well as too diluted pulp could "reform" and cover the window again right after the cleaning action.

**[0034]** In still another aspect of the invention, the position of the window areas on the strip of foil and the respective positions of elements 6 are optimized

**[0035]** The maximum possible distance between the protruding elements 6 (for example in the shape of coins) is dependant on the mould cover diameter. It is essential that the inserted strip of foil 3 is never tangent to the mould cover surface, which happens when two elements 6 are too far spaced away from each other. A defect could be introduced at the tangent point for the strip of foil 3 and paper formation maybe disturbed. In order to prevent this effect, it might be necessary to introduce extra elements 6, the function of which is not to open a window but just to support the strip of foil 3 in its way around the mould cover without touching the mesh. Typically this is often necessary at the junction of two consecutive banknote sheets as the gap between two banknotes and therefore two secure windows happens to be longer due to the sheet edges that are normally cut out during the banknote finishing process. Paper machines with a mould of smaller diameter are more prone to this event due to geometrical reasons.

**[0036]** The uncovered area or exposed area of the window can at least partially be generated by locally selective inhibition of substrate formation on the elongate strip of foil. The locally selective inhibition can be physically and/or chemically induced. The locally selective inhibition can be induced by local surface treatment of the elongate strip of foil. The locally selective inhibition can be provided by a hydrophobic or super-hydrophobic layer/structure. If a super-hydrophobic layer is used, the water droplet/solid surface snap-in forces - measured e.g. using the micro balance in a tensiometer - become zero because the surface tension of the water, hence its internal cohesion, is stronger than the reference surface wettability. Another way to define super-hydrophobic is that the advancing angle of the droplet on a reference surface (not its static angle) is greater than 145° when the liquid is water.

**[0037]** Super-hydrophobic coatings could be based on, consist of or comprise at least one out of the following components:

- Manganese oxide polystyrene (MnO<sub>2</sub>/PS) nano-composite,
- Zinc oxide polystyrene (ZnO/PS) nano-composite,
- Precipitated calcium carbonate,
- Carbon nano-tube structures,
- Silica nano-coating,
- Cyclopentasiloxane or similar
- functionalized poly acryl amides, or

- from biological sources, or

- could be generated by applying a physical nano-structure (lotus effect) where conveniently spaced "nano-pillars" of pseudo-conical shape or fractal-like shape are introduced.

**[0038]** A particularly advantageous type of hydrophobic coating should be at least partially transparent or better fully transparent.

**[0039]** In another embodiment, the exposed or uncovered area can be generated by removal of fibers by suction, in particular discontinuous suction.

**[0040]** In still another embodiment, some additional fibers can be arranged or locally accumulated in off-limit zones in order to compensate fiber depletion on vicinal areas of the window.

**[0041]** Furthermore, residual fibers can be removed by a rotating brush. Still further, areas of accumulated fibers can also be evened up by the rotating brush.

**[0042]** In another embodiment, the fibrous material can comprise two layers, a mould layer and a short former layer and the elongate strip of foil 3 can be embedded in the mould layer. The at least one exposed or uncovered area can then advantageously be arranged in the short former layer.

**[0043]** The window should at least horizontally (in a first direction) be in register with the elongate strip of foil 3. However, it is preferable that the strip of foil 3 is completely in register with the paper web and all layers of the paper web (for example mould layer and short former layer). In register means that the relative positions of paper web 5, strip of foil 3, exposed areas (or uncovered areas and respective window areas and security elements in the window areas are all as precise and reliable as possible.

**[0044]** The mutual registration (tolerance) of the window areas with respect to the substrate in vertical and horizontal (in the direction of the width and the length of the banknote) should have a minimum of about 2.5 mm in each direction, advantageously 1.5 mm in each direction, and more advantageously 1.0 mm in each direction.

**[0045]** The elongate strip of foil 3 can be transparent or semi-transparent at least in the area of the window such that fibers of the mould layer are visible through the window from the side of the short former layer.

**[0046]** FIG. 2 is a simplified representation of a valuable document 10 according to an embodiment. The valuable document 10 is manufactured from the paper web 5 comprising the elongate strip of foil 3 as shown in FIG. 1. The valuable document 10 comprises the strip of foil 30 which is embedded in the thickness of the paper web 20 also referred to as paper substrate 20. The strip of foil 30 comprises perforations 31. Although shown in this representation, the perforations 31 are covered by fibers of the fiber substrate 20. The perforations 31 are advantageously arranged in parallel vertical lines/ columns. The distribution and spacing of the perforations 31 is further-

more such that at least a continuous portion of the film (strip of foil 3) is preserved without any perforation interposed within this portion. This assists in maintaining adequate resistance to the strip deformation upon pulling for embedding, for the integrity of the geometry and for registration management. There is further a window area 32 in which the strip of foil 30 is exposed or uncovered. Two lines, A-A and B-B are shown indicating two virtual cuts for the cross sectional views of FIG. 3, 4 and FIG. 5.

**[0047]** FIG. 3 is a cross sectional view of a cut along line A-A through the valuable document 10 of FIG. 2. The cut along line A-A relates to the off-limit zone. Accordingly, outside the window area 32 (not visible here) the strip of foil 30 is covered by fibers that protrude through the perforations/holes/openings 31 and thereby secure the strip of foil 30 and also accumulate on both sides of the strip of foil. The strip of foil 31 is embedded in the thickness of the paper substrate 20 or fibrous material 20. The shown configuration relates to monolayer substrate. The height HB indicates the height of the accumulated fibers, i.e. the height by which the accumulated fibers (or the bump) extend over the (normal) surface of the substrate without accumulated fibers.

**[0048]** Just as an option, the substrate 20 can have a double layer configuration including a short former layer 35 and a mould layer 36. This configuration is shown in FIG. 4. The short former layer 35 would then subsequently be placed on top of the mould layer 36. The strip of foil 30 is, however, still integrated or embedded in the mould layer 36. The short former layer does, however, not cover the area G as indicated in FIG. 4 above the embedded strip of foil 30. In an embodiment the short former layer 35 may overlap the edges of the embedded strip of foil (30) to a certain extent. In comparison with the embodiment shown in FIG. 3, the height HB of the accumulated fibers or the bump can be lower than the height HB in a monolayer configuration as shown in FIG. 3. However, also a single layer configuration can be used for the paper substrate 20.

**[0049]** FIG. 5 is a cross sectional view of a cut along line B-B through the valuable document 10 of FIG. 2. This cross sectional view shows a virtual cut through the window area 32. The window area 32 is exposed or uncovered on both - opposite - sides of the valuable document 10. The lateral sides of the strip of foil 30 are embedded in the thickness of the substrate 20 and fibers 33 of the substrate protrude through the perforations/holes/openings 31 on the lateral sides. There are no further perforations/opening/holes within the window area 32. The paper substrate 20 can be a single layer paper substrate. However, also a multi layer configuration can be used. A short former layer 35 may be placed on top of the mould layer 36. The short former layer 35 could then have a continuous opening horizontally registered with the embedded strip (strip of foil (30) in register with the window area 32.

**[0050]** FIG. 6 is a simplified representation of a valuable document 10 according to another embodiment. As

described with respect to FIG. 2, the strip of foil 30 is embedded in the thickness of the substrate 31. The main difference with respect to the embodiment of FIG. 2 consists in the opening 34 in the window area 32 which becomes apparent from the cross sectional view along line C-C shown in FIG. 7.

**[0051]** FIG. 7 is a cross sectional view of a cut along line C-C through the valuable document of FIG. 6. The window area 32 comprises a perforation/through hole/opening 34. The lateral sides of the strip of foil 30 are embedded into the thickness of the substrate 20. Fibers 33 of the substrate protrude through these perforations/holes/openings 31. Furthermore, the window area 32 is only directed to one side and covered on the opposite side by fibers 33. In this embodiment, but also in any other embodiment, it is generally possible to expose the window area 32 of the strip of foil 30 to either one side of the valuable document 10 or to both sides of the valuable document 10. The fibers 33 may even extend over the top surface of the window area on the side on which the window area is mainly exposed. This provides the possibility to create additional optical, haptic, tactile or other effects thereby improving security. Also in a two or multi layer configuration of the substrate 20, this additional configuration can be advantageously used. The elongate strip of foil 30 can comprise at least one opening (perforation) 34 in the area of the window. The fibers 33 of the mould layer 36 can then protrude through the at least one opening 34 towards the side of the short former layer 36. This also provides increased flexibility regarding the creation and properties of security features in the window area. In particular, new tactile or haptic effects may be created that cannot easily be copied.

**[0052]** In the previously described embodiments, a valuable document 10 comprising fibrous material 20, in particular paper, is provided. The fibrous material 20 or paper substrate 20 comprises a registered elongate strip (or band, wide thread) of foil 30 being partially embedded in the thickness of the fibrous material 20. The elongate strip of foil 30 is at least partially perforated (porous) in order to be permeable for fibers of the fibrous material. The elongate strip of foil 30 is exposed or uncovered in a window area 32 on at least one side of the valuable document 10. The terms "exposed" or "uncovered" mean that the window area 32 is at least partially free or clean of fibers of the fibrous material so as to provide a window 32 area for a security element of the elongate strip of foil 30 which is in register with the window 32.

**[0053]** FIG. 8 is a cross sectional view of a cut along line C-C through the valuable document of FIG. 6 according to another embodiment. The difference with respect to the embodiment shown in FIG. 7 is that the fibers 33 now protrude through the opening 34 in the strip of foil 30 in the opposite direction. This means that in one embodiment, the fibers protrude from the side of the mould layer 36 towards the side of the short former layer 35, while in the embodiment shown in FIG. 8 the fibers protrude from the side of the short former layer towards the

side of the mould layer 36. However the fibers which protrude through the opening 34 still belong to the mould layer 36 regardless from which side they protrude through the opening 34.

### Claims

1. A valuable document (10) comprising fibrous material (20), the fibrous material (20) comprising a registered elongate strip of foil (30) embedded in the thickness of the fibrous material (20), the elongate strip of foil (30) being at least partially perforated in order to be permeable for fibers (33) of the fibrous material (20), wherein the elongate strip of foil (30) is exposed in that it is uncovered or substantially uncovered by fibers (33) of the fibrous material (20) in an exposed area on at least one side of the valuable document so as to provide a window area (32) comprising a security element of the elongate strip of foil (30) which is in register with the window area (32). 10
2. The valuable document according to claim 1, wherein the exposed area is generated by selective local repulsion of fibers (33), the local repulsion being induced by application of a fluid (8), in particular compressed air and/or water. 15
3. The valuable document according to claim 2, wherein the fluid (8) is applied continuously and/or pulse-wise in pulses of adjustable duration and/or synchronized in relation to a target position of the window area (32). 20
4. The valuable document according to any previous claim, wherein the exposed area is at least partially generated by locally selective inhibition of substrate (20) formation on the elongate strip of foil (30). 25
5. The valuable document according to claim 4, wherein the locally selective inhibition is physically and/or chemically induced. 30
6. The valuable document according to claim 4, wherein the locally selective inhibition is induced by local surface treatment of the elongate strip of foil (30). 35
7. The valuable document according to claim 4, wherein the locally selective inhibition is provided by a hydrophobic or super-hydrophobic layer/structure. 40
8. The valuable document according any to claim 1, wherein the exposed area is generated by removal of fibers (33) by suction, in particular discontinuous suction. 45
9. The valuable document according to any previous claim, wherein residual fibers are removed by a rotating brush. 50
10. The valuable document according to claim 2, wherein areas of accumulated fibers are evened up by the rotating brush. 55
11. The valuable document according to any previous claim, wherein the fibrous material (20) comprises a mould layer (36) and a short former layer (35) and the elongate strip of foil (30) is embedded in the mould layer (36).
12. The valuable document according to claim 11, wherein the at least one exposed area is arranged in the short former layer (35).
13. The valuable document according to claim 12, wherein the elongate strip of foil (30) is transparent or semi-transparent at least in the area of the window (32) such that fibers (33) of the mould layer (36) are visible through the window (32) from the side of the short former layer (35).
14. The valuable document according to any previous claim, wherein the elongate strip of foil (30) comprises at least one opening (34) in the area of the window (32) and fibers (33) of the mould layer (36) protrude through the at least one opening (34) towards the side of the short former layer.
15. The valuable document according to any previous claim, wherein fibers (33) are locally accumulated in off-limit zones in order to compensate fiber depletion on vicinal areas of the window (32).
16. A method of manufacturing a substrate for a valuable document (10), the method comprising: providing an at least partially porous or perforated strip of foil (3) in a paper mould around a first cylinder (1) which partially resides in a pulp (4); generating a paper web (5) from the pulp on an outer wall of the first cylinder (1) by rotating the first cylinder (1) and dewatering the pulp (4) through a permeable outer wall of the first cylinder (1); keeping the strip of foil (3) in register with the paper web (5), and actively removing fibers (33) from a window area of the strip of foil (3).

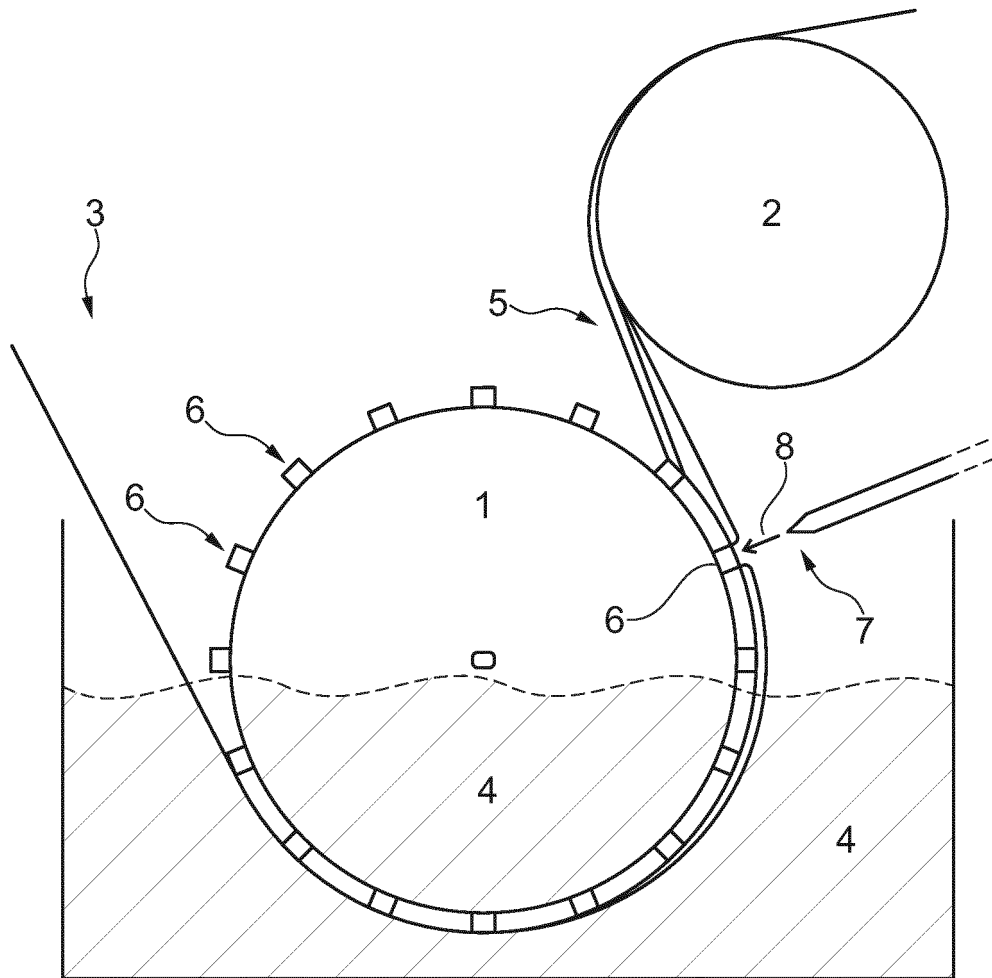


Fig. 1

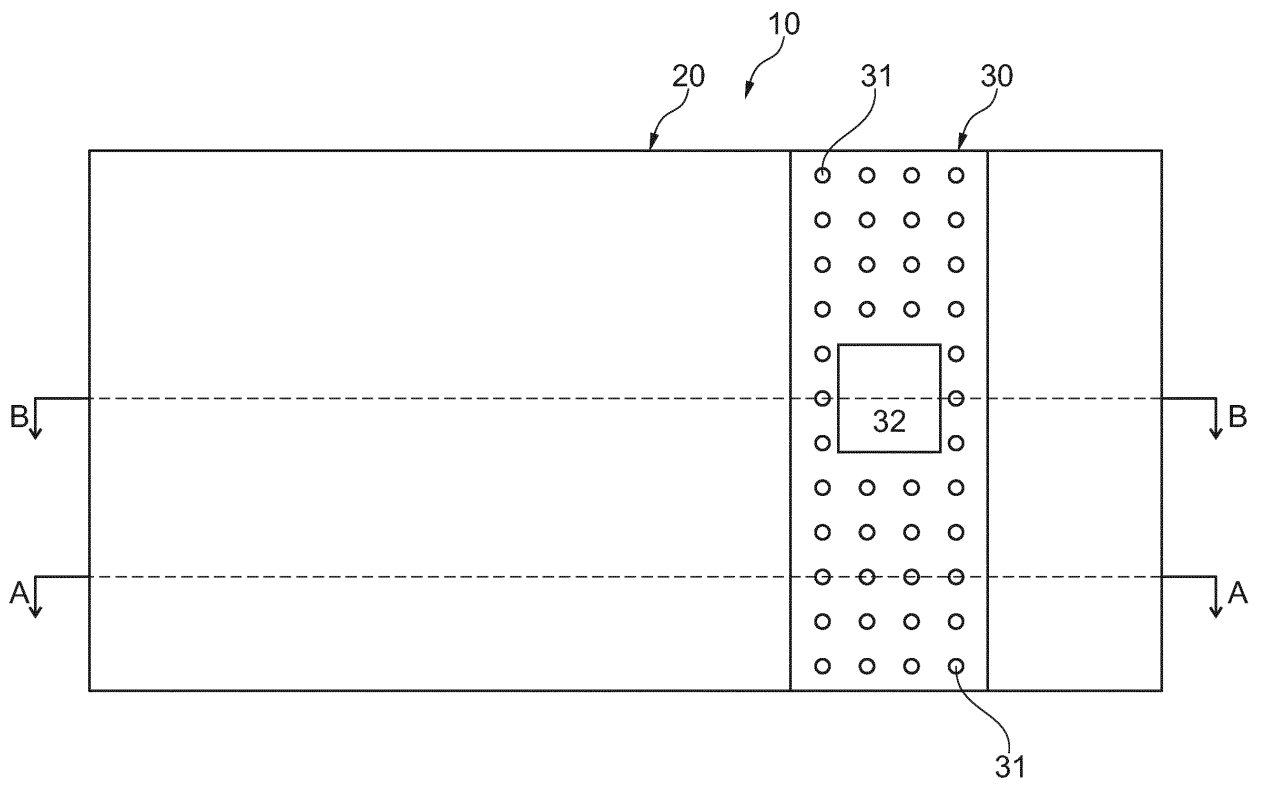


Fig. 2

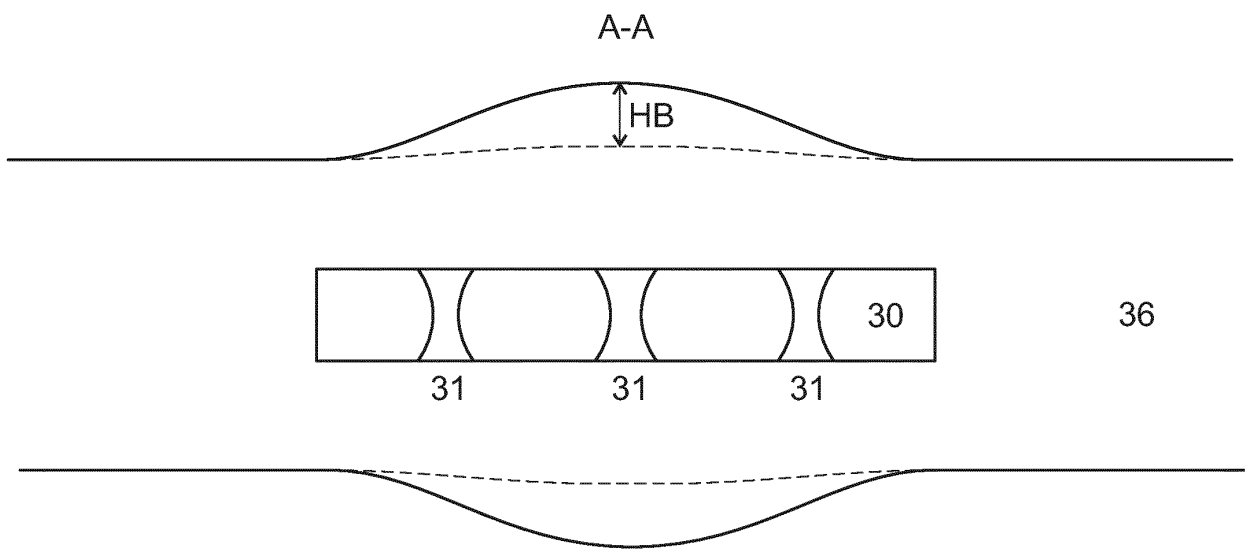


Fig. 3

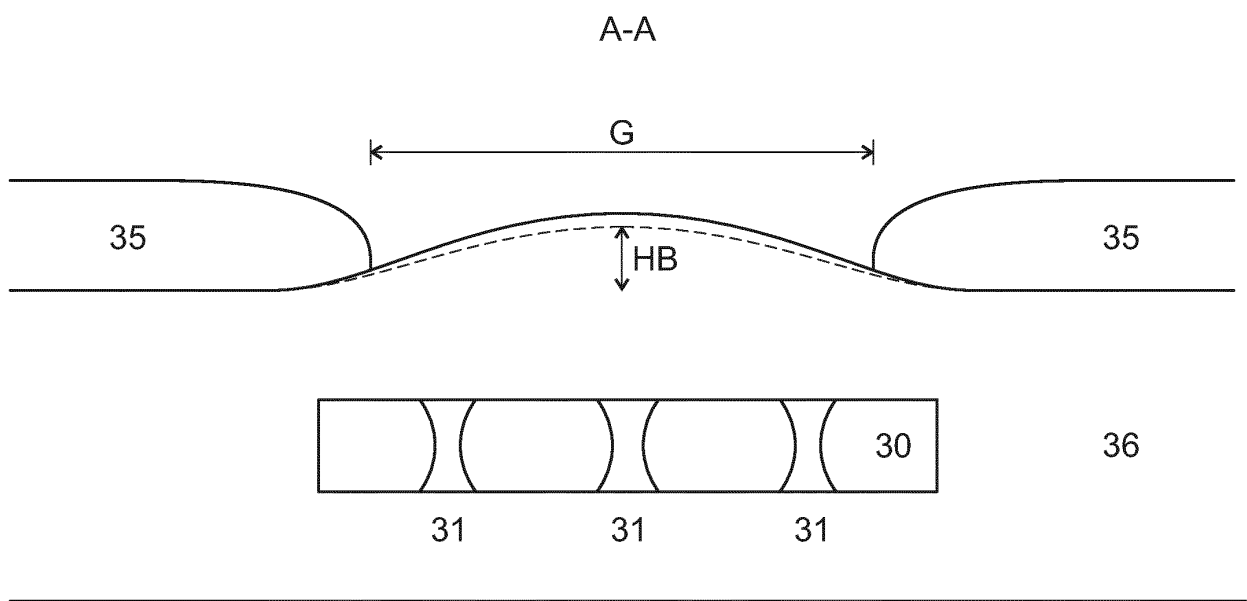


Fig. 4

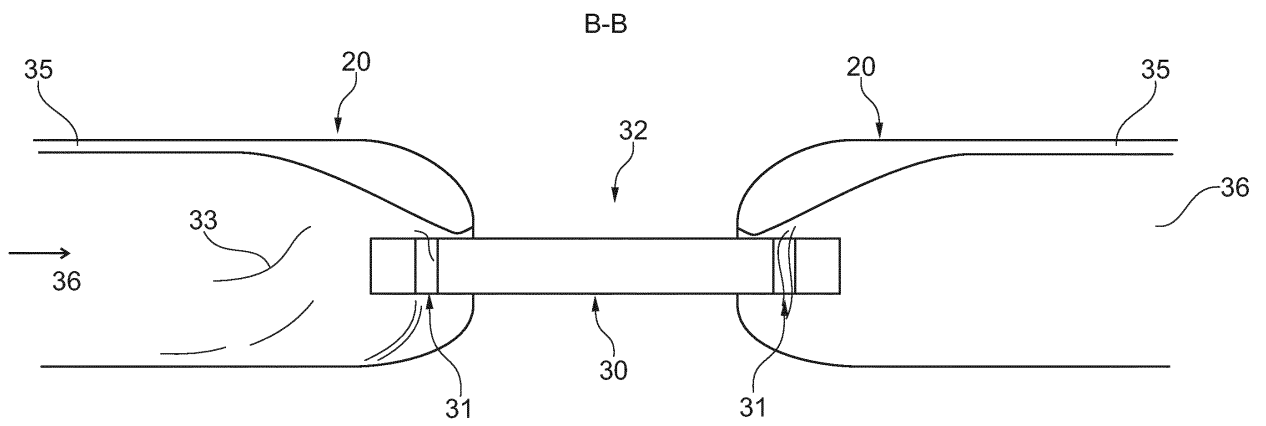


Fig. 5

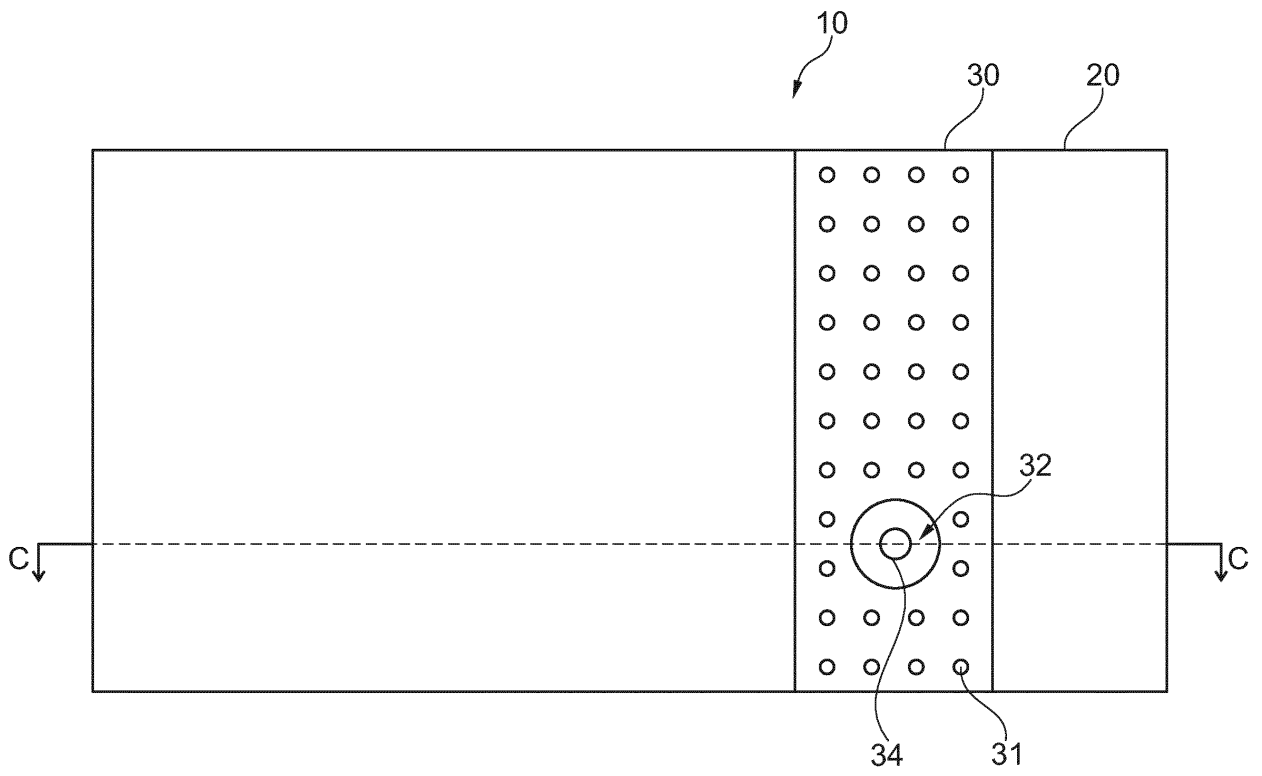


Fig. 6

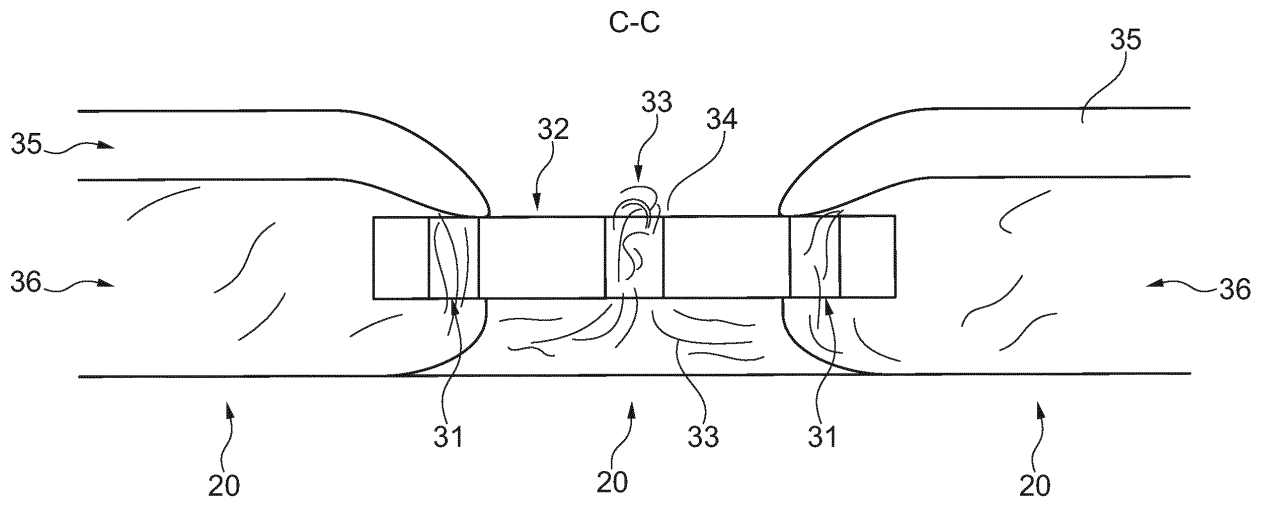


Fig. 7

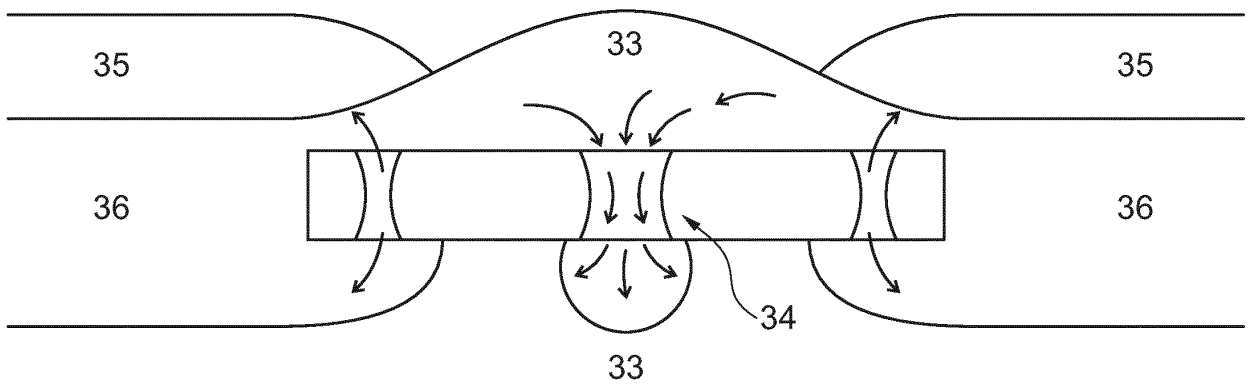


Fig. 8



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