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(54) A method of manufacturing a fibrous substrate incorporating an elongate element

(57) This invention is directed to improvements in manufacturing substrates, such as paper, incorporating an elongate impermeable element which is exposed at windows in both surfaces of the substrates and a substrate made therefrom. The invention comprises a method of making a fibrous substrate comprising the steps of bringing a first surface of an elongate flexible impermeable element into contact with primary window forming means provided on a moving cylinder mould support surface. Secondary window forming means provided on a secondary moving surface are brought into contact with an opposing surface of the element. Fibres are deposited onto the support surface and element to form a fibrous substrate. The deposition of fibres is carried out in such a manner that as the fibres are deposited onto the support surface the elongate element is incorporated in the substrate. A first set of windows is formed in one surface of the substrate at the point of contact of the element with the primary window forming means, in which windows the element is at least partially exposed, and a second set of windows is formed in an opposing surface of the substrate in which the elongate element is also at least partially exposed.

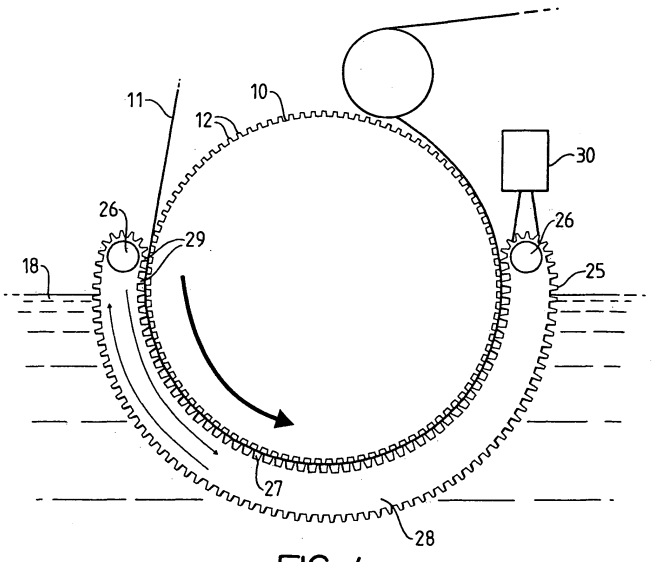

FIG. 4

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Description

[0001] This invention is directed to improvements in manufacturing substrates, such as paper, incorporating an elongate impermeable element which is exposed at windows in both surfaces of the substrates and a substrate made therefrom.

[0002] It is generally known to include elongate elements in paper or other substrates, usually as a security feature. Such elements can be threads, strips or ribbons of, for example, plastics film, metal foil, metallised plastic, metal wire. These elongate elements are included in the thickness of the substrate to render imitation of documents produced therefrom more difficult. These elements help in the verification of the documents as they render the view of the documents in reflected light different from that in transmitted light. To increase the security provided by the inclusion of such an elongate element, it is also known to endow the element itself with one or more verifiable security features properties over and above its presence or absence. Such additional features include demetallised indicia, security printing, magnetic properties, electrical conductivities, the ability to absorb x-rays, fluorescence, optically variable effects and thermochromic behaviour.

[0003] As a further security feature, it has been found to be particularly advantageous to provide windows in one side of the surface of the substrate, which expose such elongate elements at spaced locations. Examples of methods of manufacturing paper incorporating security elements with or without windows are described below. It should be noted that references to "windowed thread paper" include windowed paper incorporating any elongate security element.

[0004] EP-A-0059056 describes a method of manufacture of windowed thread paper on a cylinder mould papermaking machine. The technique involves embossing the cylinder mould cover to form raised regions and bringing an impermeable elongate security element into contact with the raised regions of the mould cover, prior to the contact entry point into a vat of aqueous paper stock. Where the impermeable security element makes intimate contact with the raised regions of the embossing, no fibre deposition can occur. After the paper is fully formed and couched from the cylinder mould cover, water is extracted from the wet fibre mat and the paper is passed through a drying process. In the finished paper the contact points are present as exposed regions which ultimately form windows, visible in reflected light, on one side of the paper, which is most often used as banknote paper.

[0005] As the exposed regions of the elongate element can be used to display indicia or overt security features, it is considered to be an advantage in some applications to expose as big a surface area of the element as possible. Thus attempts have been made to wholly and partially embed elements which are wider than the more frequently used elements, which fall in the range of 0.5mm to 2.00mm.

[0006] Whilst the above-mentioned method has been commercially extremely successful, difficulties have been found in incorporating wider security elements as the impermeable nature of the security elements block the flow of liquid through the mesh and the point where it lies, thereby interfering with the deposition of fibres. Where the security element is wider than the typical length of the paper fibres used, the fibres are unable to bridge the security element, which therefore becomes exposed in pin holes or defects on the opposite side of the paper to the windows.

[0007] EP-A-0070172 proposes an alternative method of making paper having an elongate security element embedded therein, providing elements which have regions of permeability and regions of impermeability. This method enables much wider element to be embedded in paper. When incorporated into paper on a cylinder mould making machine, the permeable regions are embedded in the thickness of the paper and the less permeable regions are exposed at one surface thereof. This method can be used for elongate elements having a width from 0.5mm to the full width of the sheet, which could be 5000mm.

[0008] EP-A-0229645 describes a method using two cylinder moulds to produce two separate plys of paper, with a security thread introduced in between the two layers. The option of incorporating holes in both layers by, for example, incorporating drainage restriction devices on the mould covers is disclosed in the specification. The resulting holes can be registered to produce windows on each side of the thread. This method has a major drawback in that the two cylinder moulds need to be exactly the same diameter and linked by a registration system which renders production of the paper extremely expensive. This document also fails to teach how to actually achieve registration.

[0009] Based on the desire to be able to display as much information or indicia as possible in the exposed regions, it has also been recognised that it would be highly advantageous to be able to expose the elongate element on both sides of the paper, or other substrate, in which it is embedded. EP-A-0059056 suggests that this could be achieved by using sufficiently large impervious projections on the cylinder mould. The disadvantage with the method described in this specification is that the holes produced by the drainage limiting devices need to be covered up and this means that rather wide threads have to be used, which increases the cost of the paper. Another disadvantage of this method is that the windows on each side necessarily coincide.

[0010] It is therefore an object of the present invention to provide an improved method of embedding an elongate element within a fibrous substrate such that the element is exposed at both sides of the substrate in an alternating or coincident manner.

[0011] The invention therefore provides a method of making a fibrous substrate comprising the steps of bring-

ing a first surface of an elongate flexible impermeable element into contact with primary window forming means provided on a moving cylinder mould support surface, bringing secondary window forming means provided on a secondary moving surface into contact with an opposing surface of the element, depositing fibres onto the support surface and element to form a fibrous substrate, the deposition of fibres being carried out in such a manner that as the fibres are deposited onto the support surface the elongate element is incorporated in the substrate, wherein a first set of windows is formed in one surface of the substrate at the point of contact of the element with the primary window forming means, in which windows the element is at least partially exposed, and a second set of windows as formed in an opposing surface of the substrate in which the elongate element is also at least partially exposed.

[0012] The invention also provides apparatus for making a fibre substrate comprising a moving cylinder mould support surface provided with primary window forming means, means for bringing an elongate flexible impermeable element into contact with said primary window forming means, and a secondary moving surface provided with secondary window forming means, means for depositing fibres on to the support surface and element to form a fibrous substrate incorporating the elongate element, a first set of windows being formed on one surface of the substrate at the point of contact of the element with the primary window forming means in which windows the element is at least partially exposed, the secondary moving surface being located such that the secondary window forming means rotate in contact with a second surface of the elongate element, such that a second set of windows is formed in an opposing surface of the substrate in which the elongate element is also at least partially exposed.

[0013] The invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

Fig. 1 is a cross-sectional side elevation of a schematic of a typical cylinder mould vat for use in manufacturing paper;

Fig. 2 is a detailed illustration of the encircled section of the cylinder mould of Fig. 1;

Fig. 3 is a cross sectional side elevation of a piece of paper made on the apparatus of Fig.1;

Fig. 4 is a cross sectional elevation of a schematic of an alternative elongate modified cylinder mould vat for use in the method of the present invention; and

Figs. 5 and 6 are cross sectional side elevations of two alternate pieces of paper made on the apparatus of Fig. 4.

[0014] The method of manufacturing a fibrous substrate incorporating as elongate element, according to a known method, is illustrated with reference to Figs. 1 and 2. The method used is a cylinder mould process, such as in described EP-A-0059056.

[0015] A porous support surface, in the form of a cylinder mould cover 10, is produced in a known way. The mould cover 10 has raised portions 12 (see Fig. 2), formed by embossing. The raised portions 12 are spaced around the mould cover 10 and intimate contact of an impermeable elongate security element 11 therewith restricts the draining of the water content of the paper slurry through the mould cover 10 at the points of contact. This prevents or substantially reduces the deposition of fibres and defines the shape of the windows 14 formed in the final substrate 16. In this specification the term "window" includes a transparent or translucent region in the substrate of a predefined shape and occurrence.

[0016] In a known manner, the cylinder mould cover 10 is rotated in a vat of fibrous stock 10 as illustrated in Figure 1, and fibres are continuously deposited thereon in a known manner to form a continuous web of substrate 16. The stock 18 may comprise fibres of natural materials, such as cotton, synthetic fibres or a mixture of both. As the cylinder mould cover 10 rotates, a flexible elongate impermeable element 11, is brought into contact with the raised portions 12 of the cylinder mould cover 10 above the level of the stock, i.e. before any fibres have been deposited on the mould cover 10. As the mould cover 10 rotates, the elongate element 11 is introduced into the stock, and is partially embedded in the substrate as it forms. The fibres deposit in the valleys between raised portions 12 to form bridges 20, under which the element 11 is embedded, between the windows 14 formed at the point of contact between the element 11 and raised portions 12. The continuous fibrous substrate (or web) is moved along continuously as it is formed, its direction of travel being known as the "machine direction".

[0017] The method of the present invention requires the use of an additional moving belt 25 which is located, as shown in Fig. 4 such that a length, such as an upper run 27 of the belt is in contact with the substrate being formed. The belt 25 is a continuous belt, which preferably runs around a pair of rollers 26, with the upper run 27 following the same directional path as the cylinder mould cover 10 and moving at the same speed. The belt 25 returns along the lower run 28. The belt 25 is provided with raised portions 29, which are similar to the raised portions 12 of the cylinder mould cover 10. The raised positions 29 are brought into contact with an opposing (rear) surface of the elongate element 11 to the (front) surface which is in contact with the raised portions 12 on the cylinder mould cover 10 above the level of the stock 18. The belt 25 is at least partly impermeable, for example comprising or having regions of metal or rubber, which prevents the fibres from depositing at the intimate points of contact between the raised portions 29 and element 11. The dimensions and location of the belt 25 may be

selected so that the raised portions 29 contact the rear surface of the element 11 in synchronization with the contact between the raised regions 12 and the front surface of the element 11, which produces windows 14a,14b in each side of the substrate 16 in perfect register, as show in Fig. 5. Alternatively, they can be selected so that the raised portions 29 contact the rear surface of the element 11 at points where there is no contact on the front surface of the element 11 with raised portions 12. This leads to alternating the windows, such as shown in Fig. 6, in which the windows 14a are formed in one surface of the substrate 16 and the windows 14b are formed in the opposing surface. Bridges 20a,20b are formed between the windows 14a,14b respectively.

[0018] Thus, substrates made according to the present invention are advantageous in that it is possible to increase the exposure of the element 11, not just on one surface of the substrate, but two sides, which means that it can be used to its best extent. This is important because these elements 11 can be expensive to provide.

[0019] The cylinder mould cover 10 may be laid out according to three alternative methods:-

- the first layout for a substrate which is to be web printed, in which the raised portions 12 are continuously and evenly spaced around the circumference of the mould cover 10. In this form no gap (inter-sheet gap) is provided by the layout of the raised portions 12 for the margins of the sheets which are eventually cut from the web. Where a plurality of documents, say bank notes, are then cut from each of these sheets, the pattern of the raised portions 12 may optionally provide for an inter-document gap;

- the second layout is for a substrate sheet which is to be printed, as opposed to web printed, and thus includes an irregularity in the pattern of the raised portions 12 both at the inter-document and inter-sheet areas;

- the third layout is similar to that of the second, but with the added complication that adjacent sheets are laid out with the window 14 and bridge 20 positions interchanged. It is the so-called 1-2 layout.

[0020] The consequence of this is that the belt 25, when used to form windows 14b on the rear surface of the substrate 16 registered to the windows 14a, on the front surface needs to have a length that is the same as the 1-2 sheet pattern it is superimposed on. In the case of the 1-2 layout, only mould covers 10 designed to produce an even number of sheets can be used. A further consequence of this is that the belt 25 needs to be registered to either the repeat length of the front side window 14a the repeat length of the note, the repeat length of the 1 sheet or the repeat length of the 2 sheet. In order to enable the belt 25 to accommodate different sheet and document sizes, it may be constructed in a modular fashion, using a similar principal to that of a bicycle chain. The length can then be adjusted to suit whichever product is being manufactured. To enable perfect registration to be achieved, a "sprocket" embossing can be produced in a margins of the mould cover 10 which is used to drive the rollers 26. This is an embossing that mirrors the mould cover layout and will have a special band running over it which has the same window forming layout as the belt 25. However it has different window forming means that sit within the cover embossings as opposed to over the embossings, as is the case with a normal window forming means, to enable it drive the belt 25.

[0021] Registration may also be achieved by electronic sensor connected to an electric drive that drives the rollers 26 and is linked to a registration mark on the cylinder mould 10.

[0022] In order to ensure that the belt 25 remains clean, a spray 30 may be provided downstream of the cylinder mould cover 10 to wash the belt 25 as it separates away from the substrate 11.

[0023] The belt 25 may be wider than the security element 11. If the rear side windows 14b are coincident with the front side windows 14a, a hole will be created on either side of the element 11. Alternatively, the width of the belt 25 may be the same width as the security element 11. In this case the security element 11 is windowed across its entire breadth, but the belt 25 does not cause thinner, or aperture, zones adjacent security element 11. As a further alternative, the belt 25 may be narrower than the security element 11, such that the security element 11 is windowed only in an area covering part of its breadth. In any of these embodiments, the security element 11 and the belt 25 may have a guiding device to ensure that they meet at a predetermined position across the width of the cylinder mould 10.

[0024] Although figure 4 shows the belt 25 returning to the front of the vat within the vat, it is possible for it to return beneath the vat, or alternatively on either or both sides of the cylinder mould 10 above the level of the stock 18. This can be achieved using a series of appropriately positioned pulleys or guides.

[0025] The raised portions 29 on the belt 25 may be bars or bars at an angle. They may also be in the form of other shapes, such as triangles or stars. Furthermore, they may also be in the form of narrower windows 14b than the security element 11. In addition, the rear side windows 14b may also have a greater or lesser pitch than the front side windows 14a.

[0026] The elongate elements 11 are preferably made of clear polyester although other materials may be used, such as polyethylene or polypropylene, and may have a constant or variable width.

[0027] Elongate security elements 11 typically have a layer of adhesive, which help the embedment within the substrate.

[0028] The elongate elements 11 can contain a wide variety of known security features which may include the following:-

- a metallic layer, indicia or designs, which appear dark, when the substrate is viewed in transmitted light, compared to the lighter, partly light-transmitting, substrate. When viewed in reflected light, the shiny metallic parts will be clearly seen in the windows;

- de-metallised indicia or designs, which may comprise areas of substantially removed metal to take advantage of the transparency of the base film and provide a large area of transparent window;

- holographic or diffractive designs, which may comprise areas of full metal and half-tone screens to provide partial transparency and/or no metal;

- front to back print registration, in which features are printed which would clearly exhibit Moiré patterns from both front and back if a counterfeit were attempted. Alternatively, such patterns could be produced on a transparent film prior to insertion of the element 11 into the paper as a security feature itself. The exact reproduction of such patterns are very difficult to mimic;

- luminescent, iridescent, thermochromic, liquid crystal or magnetic materials;

- designs or indicia created by printed inks;

- dichroic materials which can have different colours when viewed in transmission and refection, for example as described in GB-A-1552853. These materials are particularly useful where the windows 14a, 14b on the front and back of the substrate 10 coincide to form an aperture (as shown in Figure 5);

- thin film interference devices, as described in EP-A-227423 or liquid crystal polymer films or liquid crystal pigmented inks, such as described in EP-A-435029 or EP-A-863815.

[0029] The security elements 11 may be oriented, which means that each side of the element 11 may carry different information, materials or optical effects. Examples include:-

- holographic or diffractive materials on a first side of the element 11, with a thin film interference device on a second side;

- liquid crystal film over a black or dark background on a first side and plain metal on a second side;

- different coloured metals on each side, e.g. aluminium on the first side and another metal on the second side. Alternatively one or more coloured transparent lacquers over a metal layer could be used to create a variety of colours;

- a magnetic micrometallised thread, such as described in GB-A-2375078;

- repeating indicia or security features located in either window or bridge regions on one or both sides of the substrate.

[0030] Many other options are available and with such a large exposed area of the element 11 available, it is possible to combine many security or decorative features together on one element 11.

[0031] The substrate described above can be cut and printed to make all forms of documents, including security documents, such as banknotes, cheques, travellers cheques, identity cards, passports, bonds, security labels, stamps, vouchers etc.

Claims

1. A method of making a fibrous substrate (16) comprising the steps of bringing a first surface of an elongate flexible impermeable element (11) into contact with primary window forming means (12) provided on a moving cylinder mould support surface (10), bringing secondary window forming means (2a) provided on a secondary moving surface (25) into contact with an opposing surface of the element (11), depositing fibres onto the support surface (10) and element to form a fibrous substrate (16), the deposition of fibres being carried out in such a manner that as the fibres are deposited onto the support surface (10) the elongate element (11) is incorporated in the substrate, wherein a first set of windows (14a) is formed in one surface of the substrate (16) at the point of contact of the element (11) with the primary window forming means, in which windows the element is at least partially exposed, and a second set of windows (14b) is formed in an opposing surface of the substrate (16) in which the elongate element (11) is also at least partially exposed.

2. A method as claimed in claim 1 wherein the first and second set of windows (14a, 14b) on the opposing sides of the substrate (16) are fully registered such that they are coincident with each other.

3. A method as claimed in claim 1 in which the windows (14a, 14b) on the opposing sides of the substrate (16) are registered such that they are not coincident with each other.

4. A method as claimed in claim 1 in which the windows (14a, 14b) in the opposing sides of the substrate (16) are not formed in register with each other.

5. A method as claimed in any one of the preceding claims in which the elongate element (11) includes indicia or a security feature.

6. A method as claimed in claim 5 in which the indicia or security feature repeats along the length of the element (11) and is located in either window or bridge regions between said windows (14a, 14b) on one or both sides of the substrate.

7. A method as claimed in any one of the preceding claims in which the substrate (16) is paper.

8. A fibrous substrate (16) as made by the method claimed in any one of the preceding claims.

9. A fibrous substrate (16) as claimed in claim 8 in which the impermeable element (11) is substantially identical on both sides.

10. A fibrous substrate (16) as claimed in claim 8 in which opposing sides of the impermeable element (11) have different appearances and/or security features.

11. A fibrous substrate (16) as claimed in claim 8 in which the impermeable element (11) has a different appearance when viewed in transmitted and reflected light.

12. A fibrous substrate (16) as claimed in any one of the preceding claims in which the impermeable element (11) is oriented so that one surface of the element (11) is always exposed in the first set of windows (14a) and an opposing surface of the element is always exposed in the second set of windows (14b) .

13. A security document made from the substrate (16) of any one of claims 8 to 12.

14. Security document as claimed in claim 13 wherein the security document comprises one of a printed bank note, cheque, voucher, certificate of authenticity, fiscal or posted stamp, bond or the like.

15. Apparatus for making a fibre substrate (16) comprising a moving cylinder mould support surface (10) provided with primary window forming means (12), means for bringing an elongate flexible impermeable element (11) into contact with said primary window forming means (12), and a secondary moving surface (25) provided with secondary window forming means (2a), means for depositing fibres on to the support surface (10) and element (11) to form a fibrous substrate (16) incorporating the elongate element (11), a first set of windows (16a) being formed on one surface of the substrate at the point of contact of the element (11) with the primary window forming means (12) in which windows (14b) the element (11) is at least partially exposed, the secondary moving surface (25) being located such that the secondary window forming means (29) rotate in contact with a second surface of the elongate element (11), such that a second set of windows is formed in an opposing surface of the substrate (16) in which the elongate element (16) is also at least partially exposed.

16. Apparatus as claimed in claim 15 in which the window forming means (12, 2a) comprised raised portions.

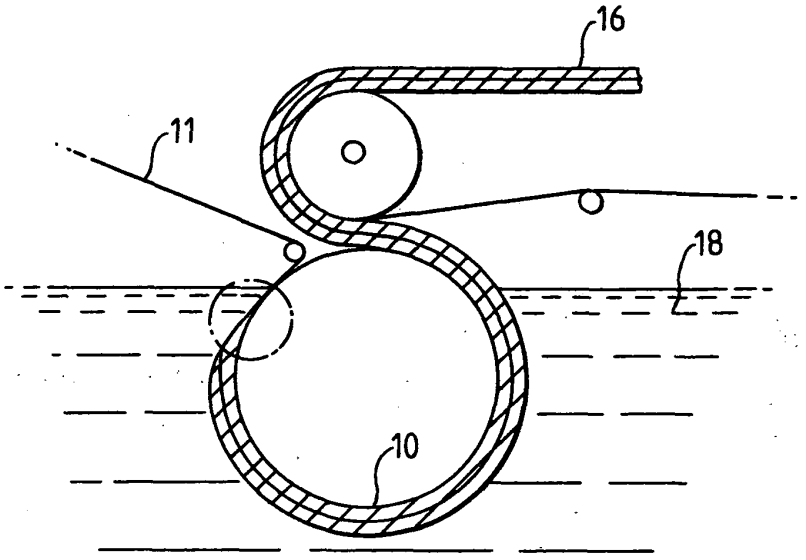

FIG. 1

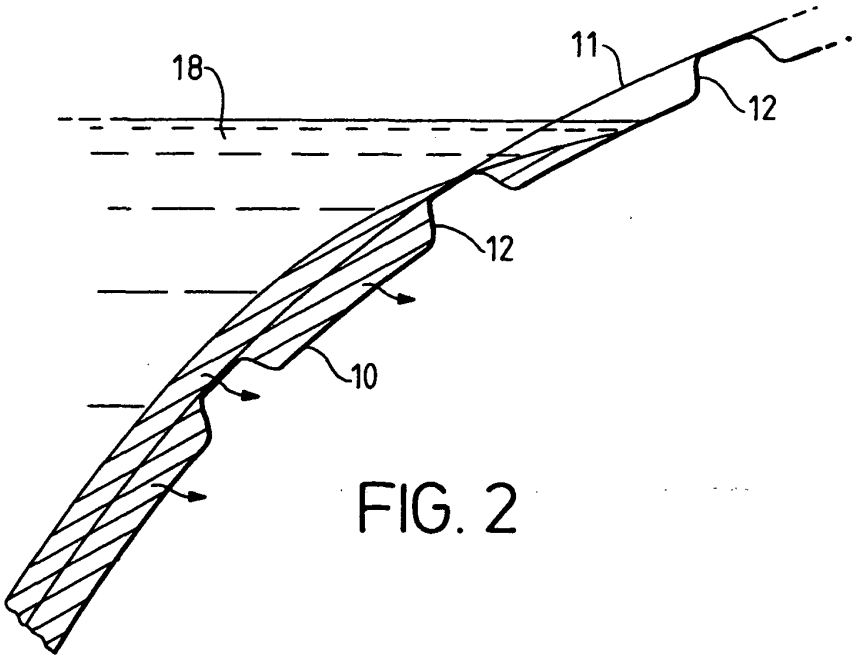

FIG. 2

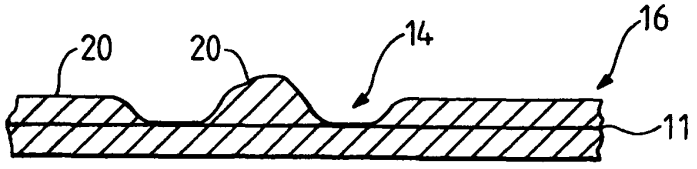

FIG. 3

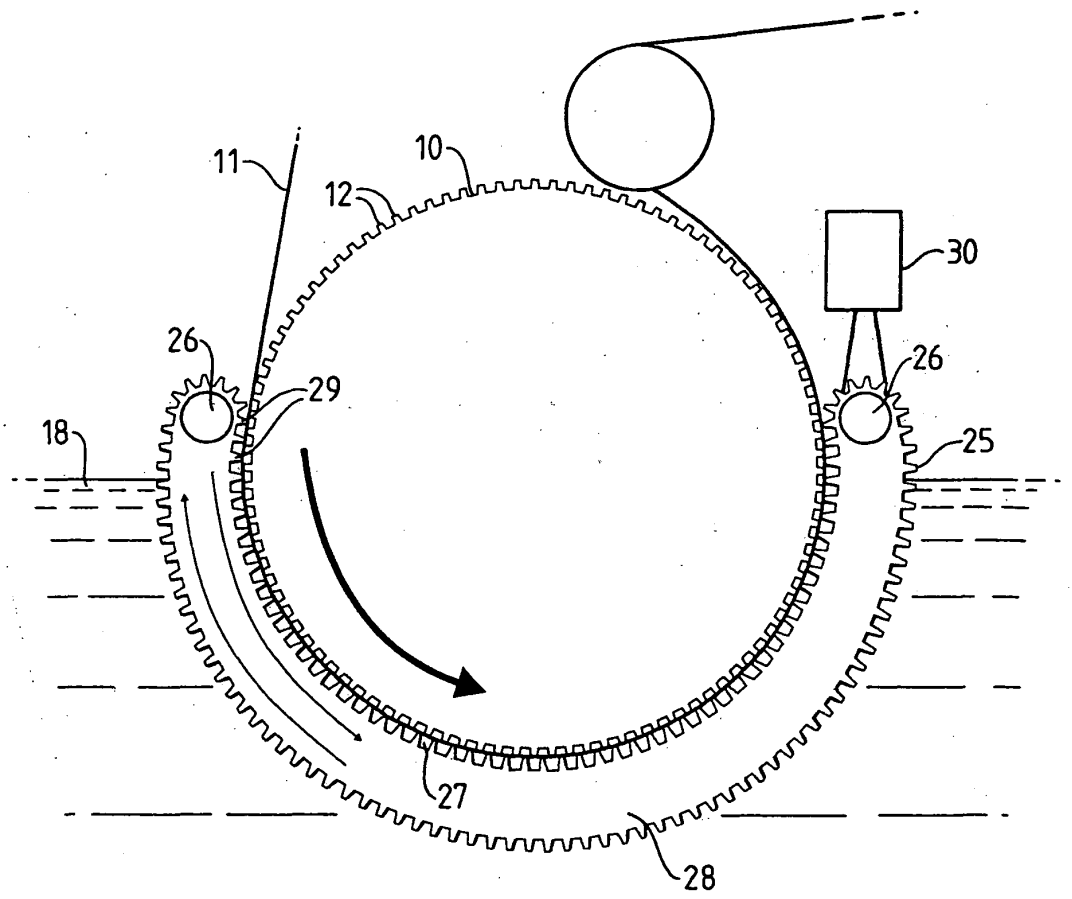

FIG. 4

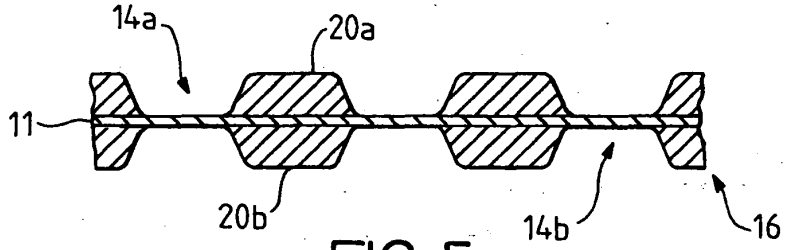

FIG. 5

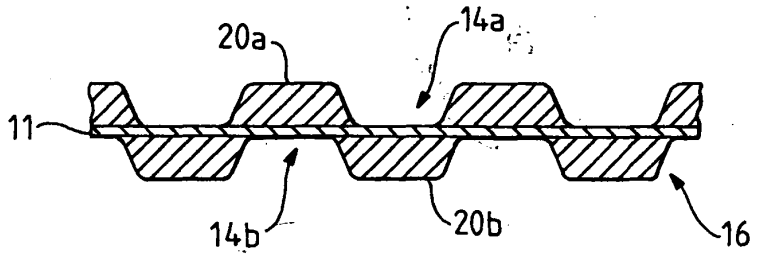

FIG. 6