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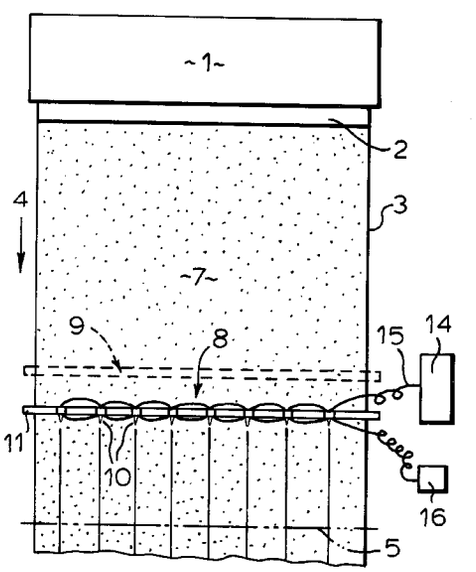
(54) Security paper.

(57) A method of production of a security paper on a Fourdrinier machine, wherein the moving paper web being formed has applied to it from above, preferably in advance of the dry line, one or more jets of a fluid security marking composition of viscosity such that, while the composition retains sufficient integrity to provide a discrete, continuous or discontinuous, linear security feature at the surface of the finished paper, part of the composition is drawn into the paper web as the water is drawn out of it, uniting the resulting security feature with the fibres of the web.

FIG.6



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This invention relates to security paper of the kind having a security strip, thread or band united with the paper.

Security paper of this kind is well known, for example in bank notes, and is commonly made by moulding or casting techniques on cylinder machines. On such machines it is easy to incorporate a pre-formed security strip to give a securely retained and distinctive identifier.

In U.K. patent specification No. 696 673 there are less well known but nevertheless published proposals, for cylinder machines, where "units" of identifying material are deposited in the web by injection while it is in the soft, partly formed state. The materials include polymers, precipitated from solution, immiscible with water. The "units", which include continuous lines, lie within the finished web.

Neither pre-formed security strips nor the injection technique are applicable to continuous production on a Fourdrinier machine - that is to say a machine wherein a fluid furnish of fibre and other paper-making components is applied to a continuous permeable travelling belt or "wire" and the aqueous phase of the furnish drawn out until a continuous self-supporting paper web has formed for removal from the belt and subsequent drying. In particular a pre-formed strip is difficult or impossible to apply and contact of the web with an injection nozzle would disrupt it leading to web breaks.

To overcome these problems the invention provides a method of production of a security paper on a Fourdrinier machine wherein the web has applied to it from above, preferably in advance of the dry line, one or more jets of a fluid, pigmented or other security marking composition of viscosity such that, while the composition retains sufficient integrity to provide a discrete security feature at the surface of the finished paper, part of the composition is drawn into the web as the aqueous phase of the furnish is drawn out of it, uniting the resulting security feature with the fibres of the web.

Broadly, paper is made by laying down a dispersion of fibres from a headbox on a Fourdrinier wire. As the dispersion proceeds down the wire, water is removed from it by natural drainage and vacuum so that a fibrous web progressively consolidates and develops strength on the wire. This consolidation and strengthening is caused partly by mechanical integration of the fibres but more importantly by hydrogen bonding which confers added strength on the sheet as the water is removed. On the wire, there is a position at which the web changes in appearance from being shining and obviously charged with free water to having merely the dull appearance of moist paper. This position is the "dry line"; before it the web can be regarded as a dispersion of fibres in water, after it as a body of fibres in contact with each other, with water in the interstices. There is however no sudden reduction in water content at the dry line; removal of water continues and maximum strength is achieved when the sheet has been fully dried to a stable moisture content and reeled up at the end of the machine.

In use of the present invention the aim is to apply the security feature in such a way that it integrates in the body of the web without disrupting the fibrous structure. Thus if there were some way subsequently to remove the applied material, the fibrous material in the zone where it had been applied would ideally be no different in thickness or density to that in the remainder of the sheet.

If in carrying out the invention the jet were applied too early on the paper machine wire, the effect would be that the fibrous structure of the sheet would be disrupted and in the extreme the end product would constitute a series of strips of paper bonded together along their length by strips of applied material.

If on the other hand the material were applied too late, then it would remain wholly on the surface somewhat like a printed line. This would lead to problems further down the paper machine as the sheet dried, in that the surface feature would shrink more than the underlying paper sheet, resulting in a tendency for the sheet to curl about its longitudinal axis, and it would in any event give poor security.

As regards the position of the security feature at the surface of the paper the invention is concerned to produce a paper sheet having a linear feature integrated with the structure of the sheet, without disruption of the fibres. The feature need not be continuous but it should be within and not on the surface. In such a sheet, the security characteristic arises from the integration, which cannot for example be achieved in a printing process in which a line of pigmented material or ink is applied. In a practical context, an intending forger would need a paper machine and not merely a, printing machine in order to reproduce the product.

By use of the invention a security feature can be formed in a way almost impossible to imitate by subsequent application of a strip to paper already made and not, of course, given by use during manufacture of a fully pre-formed strip with which the paper fibres cannot unite. Further, wide and ready variation of the characteristics of the strip is possible for different customers or different batches, very distinctive strips being readily provided by use of what is in substance an ordinary papermaking machine used in the ordinary way. Thus while the strip is most simply applied continuously to lie in the direction of travel of the web, there are other possibilities as claimed later herein. Flow of the fluid can for example be pulsed or otherwise interrupted to give a discontinuous strip, or for example applied through a head that instead of being fixed moves to and fro across the direction of travel of the web giving a regular or irregular change of the lie of the strip in the web. Combined with pulsed flow an oscillating head can for example give a strip in the form of multiple spaced

lengths each aligned across or angled to the direction of travel in a wholly new form of product, or multiple heads can give a lattice effect.

A variety of specific materials may be present in the composition to give security or identifying features, for example coloured, fluorescent or photochromic materials or chemical verification materials undergoing characteristic reaction with test compounds subsequently applied. In particular pigments may be present, such as metallic pigments to give the effect of the metallic strips present in many banknotes, or fluorescent pigments reacting to test light of appropriate wavelength.

Where particulate materials such as pigments or fillers are present, use of a binder is desirable and polyvinyl alcohol, starch, carboxymethylcellulose, sodium alginate, gelatin, polyurethane polyvinylacetate and xanthan gums are suitable. They may serve also as convenient viscosity modifiers, binding being in fact a secondary function. Viscosity control in this way permits accurate control of the width of the stripe and of its general appearance. However, a viscosity modifier not having binding properties, for example polyacrylic acid, could be used. Further, depending on the particulate materials to be applied, a range of other additives such as dispersants and defoamers, and pH adjusters such as caustic soda or acetic acid as required, may also be added to the mix. Examples of dispersants are polycarboxylic acid salts such as "Dispex" (trade name) or sodium hexametephosphates such as "Calgon" (trade name). Defoamers may be hydrocarbon, silicone, oil or water based.

In applying the composition there are a number of factors to take into account. Viscosity is desirably in the range 100 - 10,000 cps (Brookfield, 20°C), preferably 200 - 1000 cps, to meet the criteria of security feature integrity and uniting with the paper fibres set out above. The jets may be angled to the web, for example at 5 - 30 included angle in the direction of movement of the web. Such angles readily achieve adequate penetration for integration with the web, without excessive thinning (watermarking) or even cutting of the web in the manner of a water-jet knife, but equally for example jets perpendicular to the web have been used. The nozzles delivering the composition are placed clear of the web, desirably at 0.5 - 10cm above it and preferably 0.5 - 2cm and normally about 1cm above to provide good control of the jets but without risk of contact with the web. Jet size is such as to pass the composition without blockage while providing enough material to form the desired security feature, and 0.8mm or lmm nozzles are for example suitable. Jet velocity does not have to accord particularly with web speed, it merely being necessary to ensure that the energy with which the jet strikes the web is not sufficient to disrupt it having regard to the degree of inter-fibre bonding which has taken place at the point of contact of the jet, and also that sufficient but not an excess of material to form the desired security feature is applied. If the web runs faster than the jet for example, the jet will "draw down" in width or thickness as compared to its initial dimensions. Jet velocities of 25% above or below the web speed have for example been used with success.

Desirably the finished security feature does not project significantly above the surface in the finished paper and does not displace a significant part of the fibre web from which the paper is being formed. As already discussed generally, the effect of applying the jet will depend on the substance of the web at the point of application. If the jet is applied too far from the dry line the web will be fully formed and the composition will not penetrate; if it is applied too near the initial point at which the furnish is laid down on the Fourdrinier wire the fibrous web will be too weak to resist fibre displacement by the composition and excessive weakness will be introduced in the finished paper. Preferably application is in advance of the dry line for ready penetration without viscosity requirements in the composition being hard to meet. A judgment must be made according to the nature of the furnish and of the composition, the machine speed, the size of security feature required and so on, none of which will give difficulty to the skilled man operating with the guidance of the parameters set out.

In particular examples, as detailed hereafter, compositions containing fluorescent particles were applied on a single wire Fourdrinier producing a white, woodfree uncoated grade paper. The strip produced was well integrated into the finished sheet, and some of the fluorescent particles were visible on the sheet surface. There was no apparent penetration through to the wireside surface. Nor was there any tendency for the sheet to curl in the vicinity of the strip, and there was minimal disruption to the fibres of the web (manifested through an almost imperceptible watermarking effect). Inspection of the papermachine felt revealed no transfer of carrier material or fluorescent particles.

To test performance characteristics of the finished paper, the paper was cut to A4 size and topside printed using a Heidelberg offset litho press. No runnability or transfer problems were reported and the particles had a good fluorescent response to stimulation from an ultraviolet light source, being visible within the sheet and on the surface. Microscopic examination of sectioned examples of the paper showed that the carrier material did not replace fibres at its point of application, which could result in localised physical weakness in the region of the strip. A controlled degree of diffusion into and on the surface of the mobile pulp was shown, so that distribution density of the security feature decreased out from the point of application.

Carrier material for a pigment is typically a standard binder so that the web strength is preserved, although in any event minimal fibre disruption is caused under optimum conditions, as shown in Fig. 1 of the accompa-

nying drawings where A is point of application, B the surface of the sheet and C pigment particles in a carrier (the drawing is not to scale). Fig. 2 shows the angle between the lie D of the fluid composition jets and the direction of travel E of the Fourdrinier wire.

The drawings also show in Figs. 3 - 5 examples of different security feature dispositions. In Fig. 3 there are multiple lines in the machine direction. In Fig. 4 there are pairs of overlapping wave forms from oscillating jets and in Fig. 5 a lattice from pulsed jets moving oppositely across the machine direction. Figs. 4 and 5 further show how watermarks W formed by a dandy roll can be "framed" by the new security feature S.

Equipment to produce such security features is shown in Fig. 6 and 7.

In these last figures the fibre stack, headbox slice and wire of a Fourdrinier machine are schematically shown at 1, 2 and 3, with the direction of wire travel at 4 and an example of the dry line position at 5. The paper web being formed is indicated at 6. The whole of this is per se well known.

Above the wire are mounted arrays of jets, one indicated generally at 8, the other outlined at 9 (Fig. 6 only) and situated close to 8 but not so as to interfere with its operation. The jets 10 in each array, eight in number, pivot at 12 on the bar 11 on which they are mounted, for individual adjustment, and each bar can be pivoted as a whole about its longitudinal axis to vary the angle at which the composition to be applied meets the web. The bars are mounted for variation of their position along the wire, as schematically indicated at 13, and the mounting itself provides for reciprocative movement of the bars in their length by means of a slide and operating cam (not shown).

As schematically indicated, the jets are fed by a mix supply unit diaphragm pump 14 though a line 15. A controller 16 operates individual valves within each jet to give intermittent or continuous flow from all or selected jets as required. Multiple security features as in Fig. 3 are applied by continuous operation of the jets at a fixed position, only one set of jets being needed. For a feature as in Fig. 4, both sets of jets are in continuous operation with reciprocation over short oppositely directed travels. For a feature as seen in Fig. 5 single jets are in operation in each set, traversing in opposite directions; they move across the web delivering the composition, then rapidly back with the jet shut off before beginning a new pass. Traverse speeds are adjustable to allow for various machine speeds and watermark spacings.

The particular conditions of the examples, using a typical furnish for a security paper, were:-

Example 1

Furnish	:	55% eucalpytus 25% softwood Kraft 20% cotton linters
Jet application relative to dry line	:	1-2 metres before
Angle	:	5° to plane of web
Height above web	:	1cm
Nozzle diameter	:	1mm

Machine speed was 100 - 110 mpm, total running time approximately 30 minutes. The composition applied, at 0.5 l/min (calculated jet velocity 80 - 100 m/min), was a polyvinyl alcohol binder solution acting as a carrier for dispersed solid fluorescent particles:-

Carrier material	:	'Gohsenol' NM-14 (trade name) polyvinyl alcohol from Nippon Gosei, 7 wt.% solution in water
Pigment	:	Blue, yellow, red fluorescent pigment as described in the applicant's EPA 0 226 367, ex their Ivybridge Mill, at 0.5 wt.% related to the carrier material
Viscosity	:	250cps (Brookfield 18°C, spindle 5,speed 20)

A security feature 1 cm wide was produced, integrated in the body of the paper web at its surface.

Example 2

Furnish	:	55% eucalpytus 25% softwood Kraft 20% cotton linters
Jet application relative to dry line	:	1-2 metres before
Angle	:	5° to plane of web
Height above web	:	1cm
Nozzle diameter	:	1mm

Machine speed was as before 100 - 110 mpm, total running time approximately 30 minutes. The composition applied, in the same way as before, was a polyvinyl alcohol binder solution as a carrier for dispersed solid fluorescent particles:-

Carrier material	:	'Gohsenol' NM-14 polyvinyl alcohol from Nippon Gohsei, 7 wt.% solution in water
Pigment	:	'Lumilux' Green N-F (trade name, Hoechst) at 0.5 wt.% related to the carrier material
Potassium iodate	:	Aldrich Chemical Co., 0.3 to 0.4 wt.% in the carrier material
Viscosity	:	280 cps (Brookfield 18°C, spindle 5,speed 20)

Potassium iodate is a strong oxidising agent, used in aqueous solution to give the concentrations of PVA and iodate noted above. It is present for the purposes more fully described in the present applicant's EPA O 391 542. That application discloses a security paper authenticating system that comprises in combination a security paper carrying both starch and an iodate salt, typically potassium iodate, and an authenticating composition comprising an acidic solution of an iodide salt, typically potassium iodide. The starch is applied at the size press in manufacture of the paper. The system is such that on applying the authenticating composition to authentic security paper, as by a pen, brush or stamp pad, iodine is generated and a characteristic starch-iodine colouration is produced. The authenticating composition is preferably aqueous or part-aqueous, and is preferably made acidic by means of a weak organic acid such as tartaric acid. It preferably also contains an antioxidant such as ascorbic acid.

Claims

1. A method of production of a security paper on a Fourdrinier machine, wherein the moving paper web being formed has applied to it from above, preferably in advance of the dry line, one or more jets of a fluid security marking composition of viscosity such that, while the composition retains sufficient integrity to provide a discrete, continuous or discontinuous, linear security feature at the surface of the finished paper, part of the composition is drawn into the paper web as the water is drawn out of it, uniting the resulting security feature with the fibres of the web.

2. A method according to claim 1, wherein the jet(s) of security marking composition are applied with a regular or irregular component of motion transverse to the direction of travel of the paper web.

3. A method according to claim 2, wherein the security feature is applied coordinated with the position of regularly spaced watermarks previously formed in the web.

4. Security paper having a discrete, continuous or discontinuous linear security feature at its surface, united with the fibres of the paper web.

5. Security paper according to claim 4, wherein the security feature is regularly or irregularly angled to the

production axis of the paper.

6. Security paper according to claim 5, wherein the security feature is coordinated with the position of regularly spaced watermarks previously formed in the web.

FIG.1

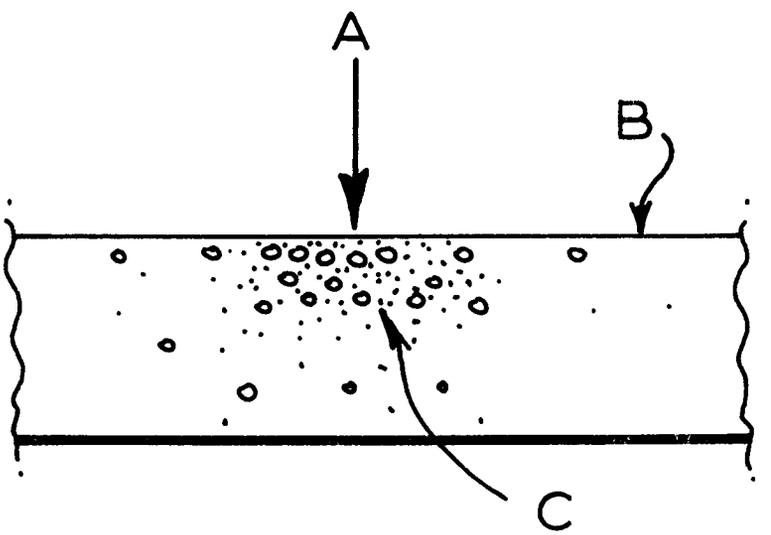


FIG. 3

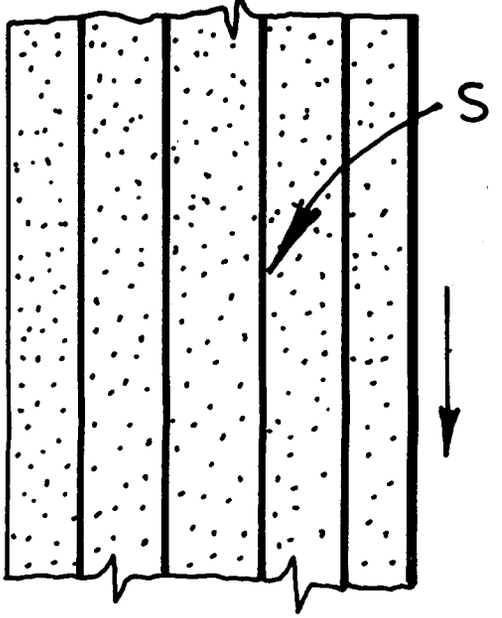


FIG. 2

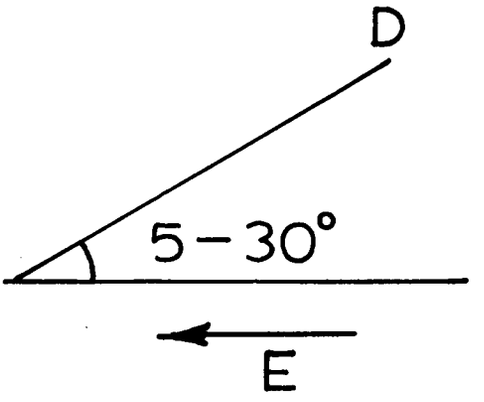


FIG. 5

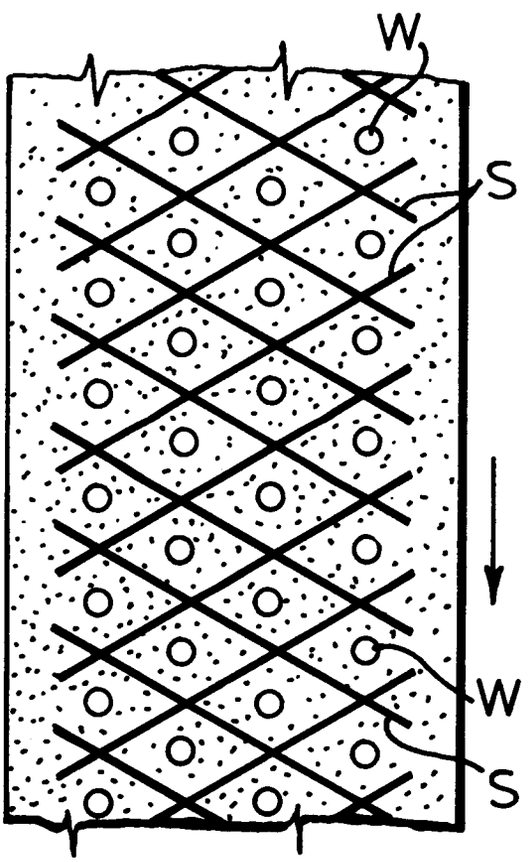


FIG. 4

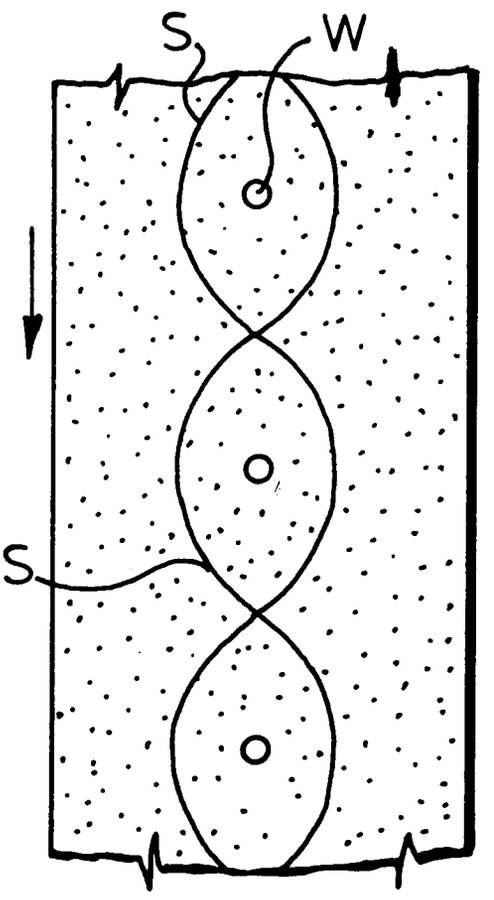


FIG.6

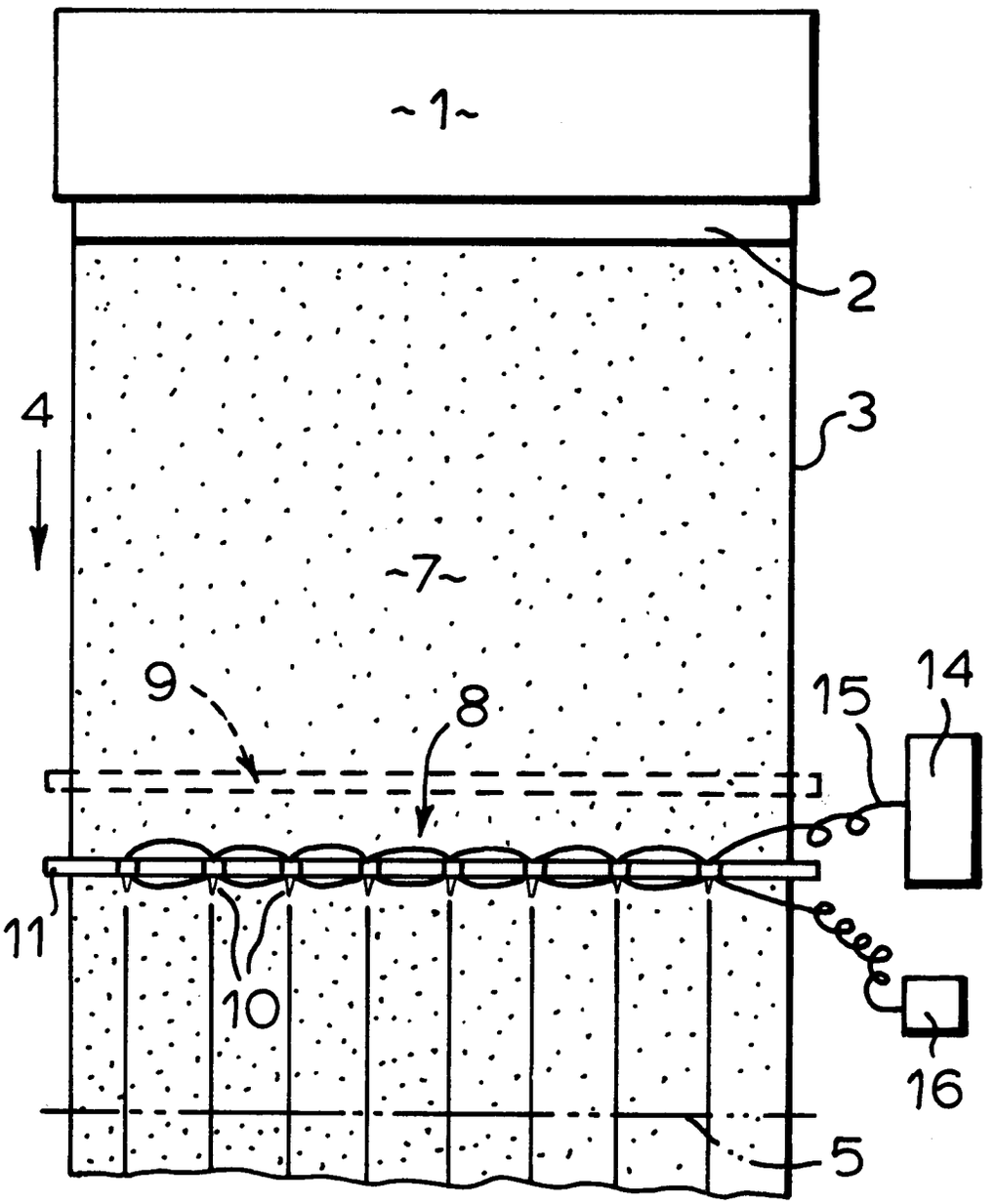
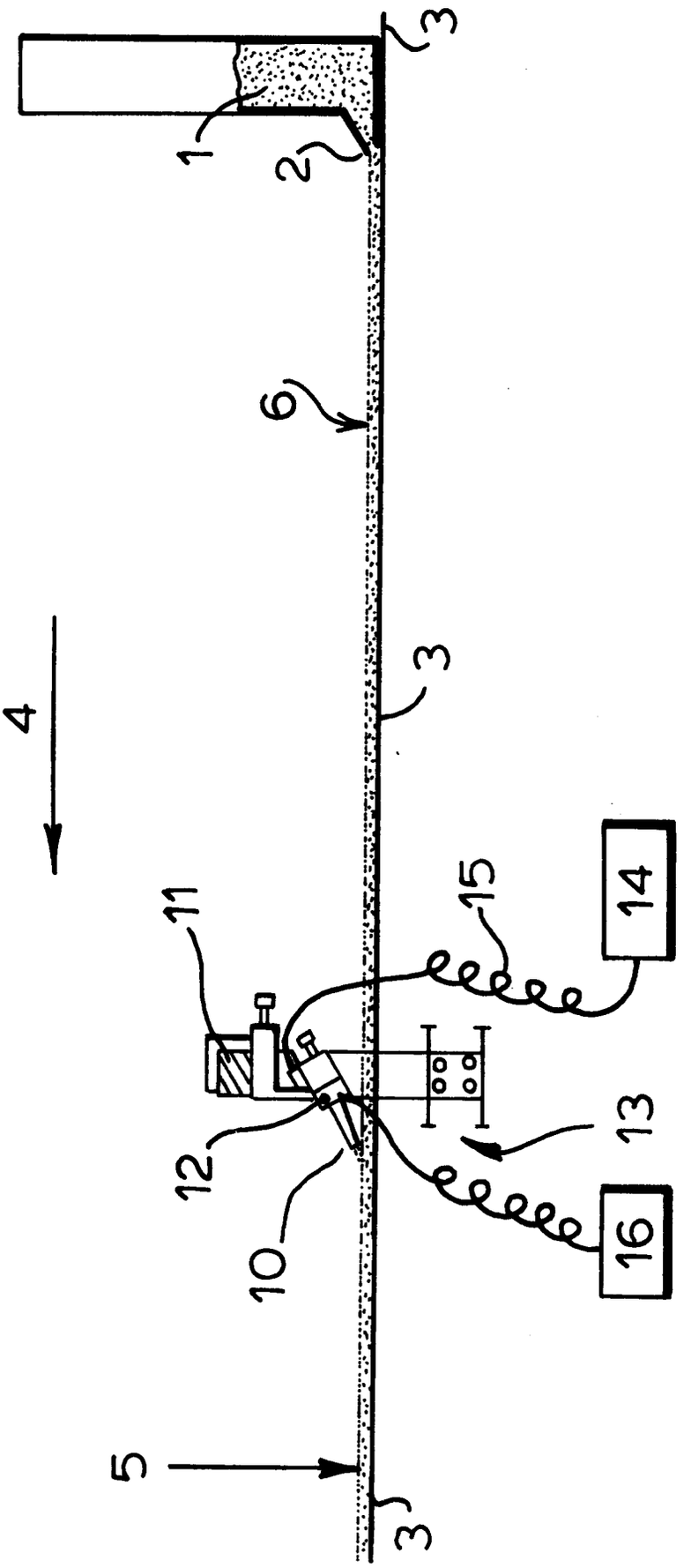


FIG.7



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EUROPEAN SEARCH REPORT

Application Number
EP 93 30 5572

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	FR-A-2 448 983 (GAO GESELLSCHAFT FÜR AUTOMATION UND ORGANISATION MBH) * page 7, line 4 - line 13 *	1,2,4,5	D21H21/40 D21H27/02 D21F11/02 B41M3/14
X A	EP-A-0 490 825 (ZÜRCHER PAPIERFABRIK AN DER SIHL) * the whole document *	4 1	
A	US-A-4 543 157 (JONES ET AL.) * the whole document *	1	
A,D	GB-A-696 673 (PORTALS LTD) * the whole document *		
A	DE-C-422 374 (LIEGESANG)		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)
D21F D21H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 OCTOBER 1993	SONGY Odile

CATEGORY OF CITED DOCUMENTS

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