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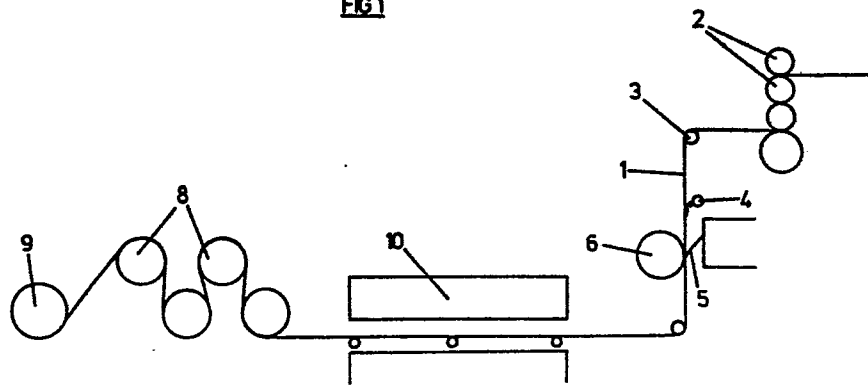
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(54) **Improvements in coating methods.**

(57) A method of coating a support (1) with microcapsules, especially in manufacturing pressure-sensitive recording paper, by dispensing hydrophobic-walled microcapsules in water, applying the dispersion to the support (1) and removing excess dispersion by passing the support (1) past a flexible blade (5) thereby also to spread and smooth the coating.

FIG 1



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Improvements in Coating Methods

This invention relates to a method of coating a support with microcapsules, especially but not exclusively in the preparation of pressure-sensitive recording papers.

- 5 In recent years there has been a considerable increase in the use of pressure-sensitive recording papers which act by virtue of a coating of microcapsules, containing a colour former such as crystal violet lactone, on one face of a first sheet of the paper, and a coating of a colour
10 developer such as clay on a face of a second sheet. The colour former and developer are reactive to form a coloured product. Rupture of the microcapsules when the two coated faces are in contact releases the colour former for reaction with the developer, producing a coloured area
15 on the second sheet in the area of rupture.

Many techniques have been proposed for applying the microcapsule coating, but in each case it has been considered essential to avoid excessive shear being applied to the
20 microcapsules themselves, and it has therefore been advocated to use an air-knife technique. In this a suspension of the microcapsules in water is applied in excess to the paper as it passes in continuous form through a coating machine, and the excess is then removed by passing
25 the paper with its applied suspension past a fine blast of

air. The air blast is controlled at a velocity sufficient to remove all but a predetermined thickness of the suspension from the paper.

5 The air-knife technique is very reliable and accurately controllable, and avoids mechanical damage of the microcapsules. However, a disadvantage is that the suspension must be of low solids content otherwise the air blast is insufficient to remove the excess accurately. The coated
10 paper emerging from the air-knife is therefore very wet, and this leads to swelling of the paper. As a result the image on the copies can be of poor definition and it is necessary to provide large drying apparatus. These coating machines therefore occupy considerable areas, primarily due
15 to the amount of drying needed. Further, the coating applied by the air-knife technique is relatively rough in surface finish, and the coated paper has to be calendered to provide an acceptable smoothness. This can be done when the coating is the colour developer, but the calender-
20 ing process ruptures microcapsules and cannot therefore be performed on the sheet coated with colour former. The colour former-coated sheet has had to remain rough.

It has previously been proposed in, for example, production
25 of magazine-quality paper, to coat the paper on each side with starch by application of a blade-coating technique. Blade coating has been found to produce a much smoother surface finish than air-knife coating, but such a technique has never before been used industrially in the application
30 of a microcapsule coating in view of the much greater mechanical forces applied by the blade to the paper and coating material. Blade coating has therefore been regarded as necessarily resulting in rupture of the microcapsules and has not been considered to be a practical proposition.
35 This has been emphasised by the use of gelatin-walled

microcapsules; gelatin is hydrophilic and swells on absorption of water, thus weakening the integrity of the microcapsules when wet and making them more likely to rupture under blade coating.

5

Advances have been made in recent years in the manufacture of microcapsules, for example as described in U.K. Patent Nos. 1,292,939 and 1,319,123 of Fuji Photo Film Co. Ltd., whereby the capsule wall material is a synthetic polymer
10 produced in situ, rather than the conventional gelatin. The synthetic polymer wall is hydrophobic and therefore less likely than gelatin to swell when wet. As a result it has now surprisingly been discovered that a coating of such hydrophobic synthetic polymer-walled microcapsules
15 can be applied to paper successfully by techniques other than the air-knife method.

According to the present invention we provide a method of coating a support with microcapsules, comprising providing
20 in a carrier liquid a dispersion of microcapsules having hydrophobic walls, applying the dispersion to the support, passing the support with the applied dispersion past a blade in contact with the dispersion on the support to remove excess of the dispersion, and drying the coated
25 support.

The microcapsules are typically 10-90% by weight of the solids in the coating material, and the balance may be made up of "stilt" and other material. "Stilt" comprises particles of greater size than the microcapsules so that in
30 use they extend further from the support and protect the microcapsules from accidental rupture during transit and storage of the coated support. Starch is a typical stilt material, although others such as glass beads and polymer
35 granules can be used. A further factor of considerable

importance in the use of particulate stilt material in the method of this invention is that the stilt protects the microcapsules during the coating procedure. As the particles are larger than the microcapsules they are struck
5 by the blade in preference to the microcapsules which thus pass below the blade with the minimum of physical contact. In the prior art it has been suggested to use cellulose fibres as the stilt material when air-knife coating, but fibrous material is not recommended in the present inven-
10 tion as it tends to clog the blade by the fibres becoming entangled and causing a build-up. This also tends to cause scoring of the support paper. The preferable particulate material such as starch does not suffer from this disadvantage.

15

The support may be paper and the microcapsules may contain a colourless colour former.

The properties of the microcapsules allow a very high solids
20 content of the dispersion to be achieved, considerably in excess of 25% which is generally the maximum in conventional coating techniques.

The preferred concentration of coating material in the dis-
25 persion is more than 40% and the concentration is preferably selected to make the solids content in the dispersion as high as possible (to minimise the required amount of drying) while still allowing the blade to produce a reasonably smooth coating on the substrate. A solids content of
30 40-60% has been found to be effective in this.

The blade is preferably flexible so as to "spread" the dispersion on the substrate; flexible blades are also to be recommended as they cause less mechanical damage to the
35 microcapsules than do rigid blades and spread the dispersion

more evenly over the substrate surface.

In order that the specified concentration of microcapsule-containing coating material can be achieved without the
5 microcapsules being ruptured by the blade, they should be synthetic polymer-walled rather than gelatin-walled, and the polymer preferably provides physical strength greater than that provided by the conventional gelatin wall.
Examples of suitable materials for producing such a polymer
10 wall are polyurea, polyamide, urea-formaldehyde, melamine-formaldehyde and polyurethane, all of which are hydrophobic.

The hydrophobic walls of the microcapsules used in the present invention resist swelling and weakening when wet,
15 and therefore provide a medium which can be passed through a blade coater without rupture and which allow a sharp image to be achieved in use. The hydrophobic property of the wall material therefore allows the coated support, which may for example be pressure-sensitive recording paper, to
20 retain its microcapsule walls intact, with the result that when the microcapsules contain colourless colour former the colour former does not escape during the coating procedure and undesirable background colouration of the paper is absent when it comes into contact with a sheet containing
25 colour developer.

The blade coating technique provides a considerably smoother surface finish to the coated support than does the conventional air-knife technique and, as paper coated with micro-
30 capsules cannot be calendered for fear of rupturing the microcapsules, this allows a superior product to be obtained. The smooth finish enhances not only the feel and appearance of the coated paper, making it a more commercially-acceptable product, but also the sharpness of
35 the image obtained on rupture of the microcapsules in view

of the more even microcapsule coating.

As well as producing a superior product, the method of this invention allows considerable manufacturing advantages to
5 be gained over conventional and commonly-used coating methods, especially in the saving of space and power for the drying stages. The coating operation can also be conducted at much higher speeds than previously, thus producing an increase in output and greater capacity for the
10 coating machinery. The blade-type coating machinery used in the method of this invention can operate at speeds in excess of 1000 metres of continuous paper sheet per minute, and the reduced drying requirement allows such coating speeds to be coped with without an overall increase in the
15 size of the machine as compared with conventional air-knife machinery. Thus the present method allows great savings to be made both in capital cost of machinery and in running costs.

20 A further advantage in the use of the present method is in the ease of controlling and maintaining the equipment used. In conventional air-knife coating it is necessary to make fine adjustments to the velocity of the air blasts and to ensure that the air jets remain clear, otherwise the uniformity of the coating suffers. With blade coating however
25 much less maintenance is required as the blade is a fixed mechanical entity, set at a predetermined pressure against the support, and adjustment after initial setting is rarely needed.

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An embodiment of the invention will now be described by way of example with reference to the accompanying drawings, in which:

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Fig. 1 is a schematic view of a part of a

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coating machine for performing the method of this invention; and
Fig. 2 is a side view of the blade portion of the machine of Fig. 1.

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Referring to the drawings, a continuous length of paper 1 is fed to calendering rollers 2 and passes between them to receive a smooth surface. From the rollers 2 the paper 1 passes round a guide roller 3 and thence downwards past 10 a horizontally-disposed slot orifice 4 through which a dispersion of hydrophobic-walled microcapsules in water is fed onto one face of the paper 1. The paper with its applied dispersion then passes between a flexible steel blade 5 and a driven roller 6, the blade 5 being biased 15 towards the roller 6 on the coated side of the paper 1 so that as the paper passes between them the blade 5 allows only a predetermined depth of dispersion to remain on the paper 1, the excess dispersion remaining in a pool 7 above the blade line of contact between the blade 5 and paper 1 20 and flowing from the ends of the blade 5 into a receiving vessel (not shown) for feeding back to the orifice 4.

The blade 5 is set at an acute angle to the paper 1 where it contacts the roller 6 so that, as the paper passes, the 25 microcapsule coating is spread and smoothed over the surface of the paper. The blade is of similar length to the width of the paper 1 and is about 80mm wide and 0.5mm thick.

After passing the blade 5 the paper coated with the dispersion 30 passes through a drying tunnel 10 until the coating is dry, round heated conditioning rollers 8 and then wound onto a spool 9.

The invention will be further illustrated in the following 35 Examples which describe embodiments of the invention, in

which the machine shown in the drawings was used for coating.

EXAMPLE 1

Polyurethane-walled microcapsules were prepared as described in Example 1 of U.K. Patent No. 1,292,939, and a dispersion of the following components was made up in water:

	microcapsules	100 parts by weight
	granular starch	25 parts by weight
10	polyvinyl alcohol binder	10 parts by weight

The solids content of the dispersion was 45% by weight.

The resulting dispersion was applied to one face of 40 g/m² support paper 1 by applying from the slot orifice 4 an excess of the dispersion continuously onto the paper face as the paper in strip form was run at 1000 metres per minute through the coating machine. After being sprayed the paper passed between the flexible blade 5 and roller 6 which spread the dispersion evenly over the paper face to a constant depth and removed the excess. The coated paper then passed over the drying rollers 8 to remove the water from the dispersion and leave the microcapsules evenly coated on the paper face.

Because of the high percentage of solids in the dispersion and despite the high feed rate of the paper, no additional drying apparatus was needed; thus increased output was obtained at no additional capital cost and greatly reduced heating costs for the drying apparatus.

EXAMPLE 2

The method of Example 1 was followed, with the exception that the feed rate of the paper was 700 metres per minute, and the coating dispersion had 50% solids content. The number of

drying rollers 8 was correspondingly reduced. The dispersion contained the following components in water:

	microcapsules having	
5	urea-formaldehyde walls	100 parts by weight
	glass beads	15 parts by weight
	acrylic latex binder	15 parts by weight,
		calculated as dry
		weight

10

EXAMPLE 3

The method of Example 1 was followed with the exception that the paper feed rate was 600 metres per minute and the coating dispersion had a solids content of 50%. The amount of
15 drying was even less than in Example 2. The dispersion contained the following components in water:

	microcapsules having	
	polyurethane walls	100 parts by weight
20	starch granules	30 parts by weight
	acrylic latex binder	10 parts by weight,
		calculated as dry
		weight

25 EXAMPLE 4

The method of Example 1 was followed with the exception that the paper feed rate was 950 metres per minute and the coating dispersion had a solids content of 60% by weight. The dispersion contained the following components in water:

30

	Microcapsules having	
	polyurea walls	100 parts by weight
	granular starch	40 parts by weight
	polyvinyl alcohol binder	30 parts by weight

In these Examples the microcapsules contained colourless colour-forming material and the coated paper was useful as pressure-sensitive recording paper when in contact with paper coated with colour developer such as activated bentonite clay.

CLAIMS:

1. A method of coating a support with microcapsules, comprising providing in a carrier liquid a dispersion of
5 microcapsules having hydrophobic walls, applying the dispersion to the support, passing the support with the applied dispersion past a blade in contact with the dispersion on the support to remove excess of the dispersion, and drying the coated support.
- 10 2. A method according to Claim 1, wherein the microcapsules have synthetic walls selected from the group consisting of polyurea, polyamide, urea-formaldehyde, melamine-formaldehyde and polyurethane.
3. A method according to Claim 1 or 2, wherein the dis-
15 persion has a solids content in excess of 25% by weight.
4. A method according to Claim 3, wherein the dispersion has a solids content of more than 40% by weight.
5. A method according to Claim 4, wherein the dispersion has a solids content of from 40 to 60% by weight.
- 20 6. A method according to any one of Claims 1 to 5, wherein the blade is flexible.
7. A method according to Claim 6, wherein the blade is biased against a roller and the support with the applied dispersion passes between the blade and the roller.
- 25 8. A method according to any one of Claims 1 to 7, wherein the dispersion includes particulate material of greater particle size than the microcapsules.
9. A method according to Claim 8, wherein the particulate material is starch.
- 30 10. A method according to any one of Claims 1 to 9, wherein the microcapsules form from 10 to 90% by weight of solids in the dispersion.
11. A method according to any one of the preceding claims, wherein the support is paper and the microcapsules contain
35 a colourless colour former.

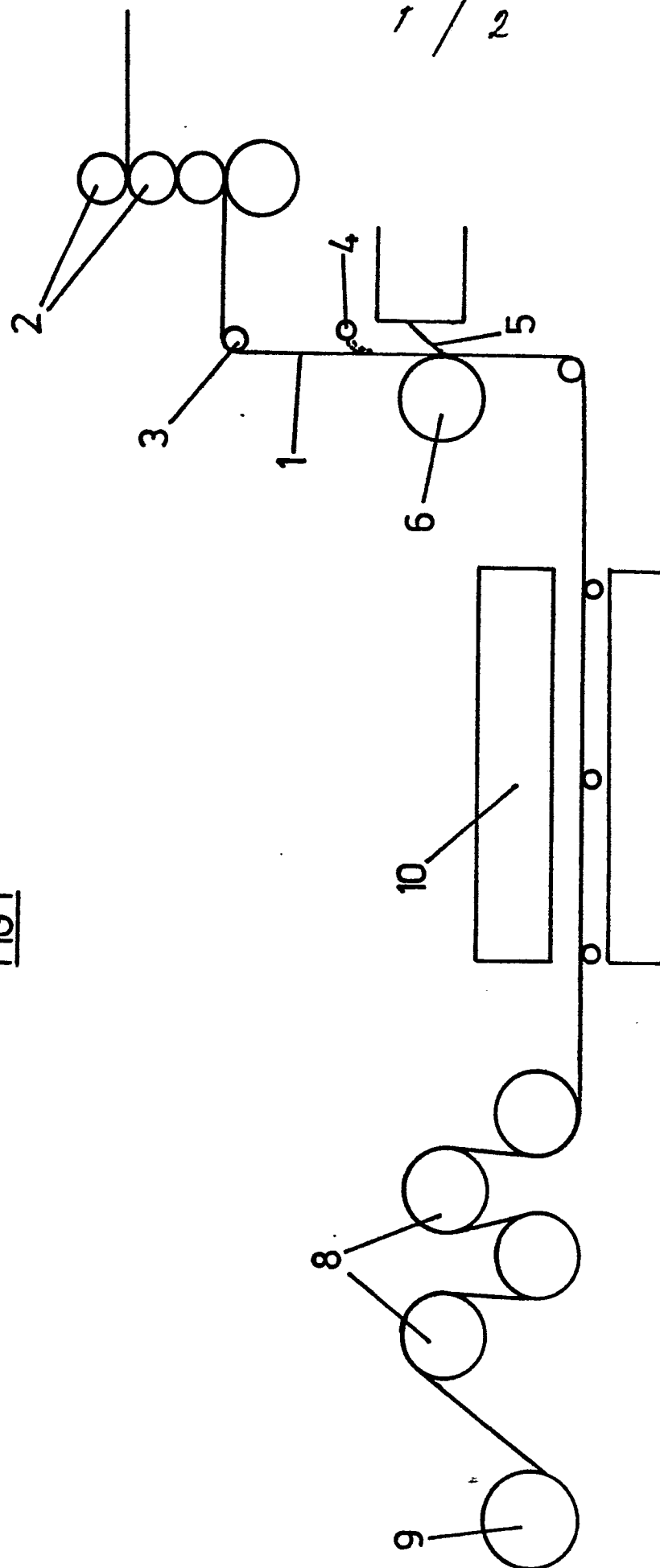
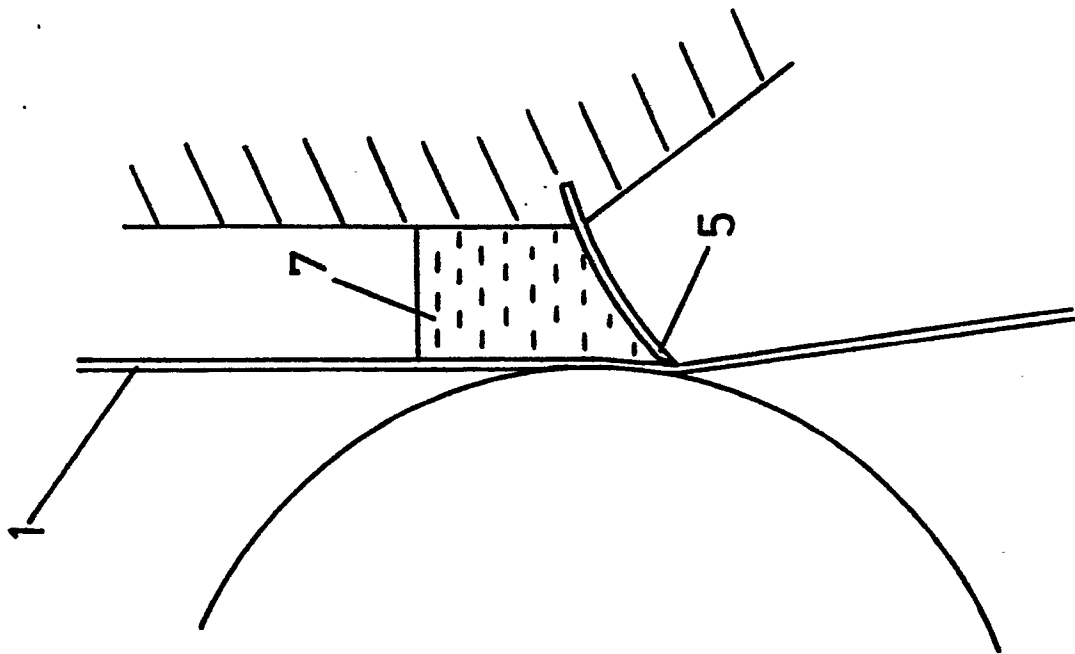
FIG1

FIG 2



European Patent
Office

EUROPEAN SEARCH REPORT

0060114

Application number

EP 82 30 1149

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. 3)
X	US-A-3 897 578 (M.KANDA et al.) *Claim 1; figures 1,2,5a,6a; column 3, line 1 to column 5, line 11, column 6, lines 25-58; examples 1,3*	1-7,10	D 21 H 5/00 B 05 C 11/04
X	GB-A-2 014 481 (APPLETON PAPERS) *Figures 4,5; pages 1-3*	1-10	
X	GB-A-1 339 082 (WIGGINS TEAPE) *Page 1; page 2, lines 1-15,96-120*	1,11	
X	GB-A-2 052 588 (MITSUBISHI PAPER) *Figure 1; page 1; page 2, line 23 to page 3, line 73*	1-10	
			TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
			B 05 C B 05 D B 41 M D 21 H
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 29-04-1982	Examiner NESTBY K.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			