(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 027 698**
A2

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **80303515.3**

(22) Date of filing: **06.10.80**

(51) Int. Cl.³: **B 41 M 3/10**
B 41 M 5/10

(30) Priority: **22.10.79 GB 7936520**

(43) Date of publication of application:
29.04.81 Bulletin 81/17

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

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(54) **Sheet material carrying an unobtrusive image and method for its production.**

(57) An unobtrusive image is applied to paper or other sheet material by means of a charged droplet printer, for example an ink jet printer. The unobtrusive image applied may perform the function usually associated with a watermark in paper, but in contrast to a watermark, may be applied to papers during their production on high speed wide deckle machines or to coated papers. The method is particularly suitable for unobtrusively imaging pressure-sensitive copying material.

EP 0 027 698 A2

Croydon Printing Company Ltd.

SHEET MATERIAL CARRYING AN UNOBTRUSIVE IMAGE AND METHOD FOR ITS PRODUCTION

This invention relates to sheet material carrying an unobtrusive image, and to a method for its production. The unobtrusive image may for example be provided to afford an indication of origin. The invention is particularly, but not exclusively, concerned with paper sheet material.

Watermarking by means of a dandy roll and rubber-marking by means of a raised image on a press roll are well-known means of imparting a feint or unobtrusive image to paper so as to indicate its origin.

However, watermarking and rubber-marking add substantially to the cost of the paper, and hence they have been employed chiefly with high quality papers which command a premium price, such as paper for use in prestige stationery. Watermarking and rubber-marking are normally uneconomic for papers which are produced at high speed, and/or on wide deckle paper machines. A further problem is that in the region of the watermark or rubber-mark some properties of the paper are affected, for example density, absorbency, porosity and smoothness. This may be disadvantageous in some circumstances, for example if the paper is subsequently to be coated and a uniform surface for receiving the coating is desirable. In any event watermarking and rubber-marking are of limited value where coated papers are concerned since the watermark or rubber-mark may be obscured by the coating.

It has now been found that printing techniques in which electrically charged marking material droplets are projected through an electric or magnetic field which guides their path on to a material to be printed afford a means of applying a feint or unobtrusive image to coated or uncoated paper or to other sheet material, even where high speeds of production or wide decks are involved. Such printing techniques, which include ink-jet printing and electrostatic screen printing, will hereafter be referred to as charged droplet printing techniques. They are in themselves well-known. Ink-jet printing is described, for example, in an article entitled "Jet Set" in British Printer, June 1980, and in UK Patents Nos. 1 354 890, 1 432 366, 1 461 385, 1 462 193, 1 464 370, 1 479 963, 1 491 234, 1 500 908 and 1 533 659.

According to a first aspect of the invention, there is provided sheet material carrying an unobtrusive image applied by charged droplet printing, preferably ink-jet printing.

According to a second aspect of the invention, there is provided a method of producing sheet material carrying an unobtrusive image, comprising the step of applying the image to the sheet material by means of a charged droplet printer, preferably an ink-jet printer.

The sheet material may for example be paper or coated paper. In a preferred embodiment of the present method, the printer is mounted on the paper-making or paper-coating machine on which the paper or coated paper is produced, whereby the web speed through the printer is the same as the web speed through the machine. Normally, an array of printers will be provided across the width of the web.

The marking material used to produce the feint or unobtrusive image may be an ink or any other material which affords a contrast with the sheet material, for example a resin or other substance which has the effect of transparentizing a paper sheet material to which it is applied.

The invention is particularly suitable for use with pressure sensitive copying material, since the copying material is not subjected to pressure during the printing operations (any alteration of local properties of the base material caused by water or rubber-marking could be particularly detrimental to the functional performance of a pressure-sensitive copying material). The copying material is preferably of the kind in which image-formation occurs as a result of reaction between two individually colourless reactants which are brought into contact with one another under the influence of imaging pressure to form a coloured product. In the most commonly used system of the kind just described, one of the reactants (the "colour former") is contained in solution in microcapsules which are rupturable under the influence of pressure to release their contents into contact with the other reactant (the "colour developer").

Pressure sensitive copying systems employing microcapsules in the manner just described may be of the self-contained or transfer type. In the transfer type, an upper sheet is coated on its lower surface with a coating of microcapsules containing colour former solution and a lower sheet is coated on its upper surface with colour developer. Intermediate sheets coated with colour developer on their upper surfaces and microcapsules containing colour former solution on their lower surfaces are provided if more than one copy is required. In the self-contained type, one surface of the sheet carries a coating composition containing

both microcapsules and colour developer. Alternatively, the microcapsules and the colour developer may both be present within the thickness of the sheet. As an alternative to the use of microcapsules (except in the last-mentioned embodiment) the colour former solution may be present as globules in a pressure-rupturable coated matrix, for example of gelatine, or wax.

The present method may be used to apply a feint or unobtrusive image to either surface of the upper, lower or intermediate sheets of a transfer system as just described or to either surface of a self-contained sheet as just described.

The reactants used in pressure sensitive copying material for feint or unobtrusive imaging by the present method may be conventional, for example the colour formers may be fluorans, phthalides or spirobipyrans and the colour developers may be, for example, acidic clays, phenolic resins or salts of certain aromatic acids. Alternatively, one reactant may be an aromatic solvent solution of N,N'-di-benzyl-di-thio-oxamide and the other reactant may be a nickel rosinate derivative. Since the nature of pressure sensitive copying material is now very well known and is described very extensively in the patent literature, further details will not be given herein.

Care must of course be taken to see that the ink or other marking material used for the feint or unobtrusive image in a pressure-sensitive copying system does not de-sensitize the reactants or otherwise impair the functional performance of the copying system. Similar considerations of course apply to other sheet materials carrying functional coatings.

Although the application of the invention to pressure-sensitive copying materials has been stressed, it will be appreciated that the invention finds application in other fields where it is desirable for the origin or brand of a particular material to be apparent not only to the manufacturer's immediate customer but also to a subsequent purchaser (for example in order to increase the effectiveness of the manufacturer's advertising or to capitalise on good-will achieved by the previous satisfactory use of the same manufacturer's product). It should be understood in this respect that because paper and similar products frequently reach the end user through the intermediary of a printer or other converter, rather than direct from the manufacturer, the end user may receive the product in the converter's packaging and labels rather than that of the manufacturer.

Examples of other products to which the present invention is applicable are heat-sensitive recording material and numerous printing and writing papers; photographic print base; automotive air and oil filter base papers; and compressible gasket and jointing material.

The invention will now be illustrated by the following Examples:-

EXAMPLE 1

This illustrates the use of a static experimental ink-jet printing rig (shown in diagrammatic side view in Fig. 1) to produce unobtrusively-imaged sheets for use in a pressure-sensitive copying system.

The rig incorporated an ink gun 1 having a single nozzle 2 adapted to emit a stream of ink droplets 5 in conventional manner. The nozzle 2 was positioned generally above a paper support platform 3 which was movable in two directions x, y at right angles to one another, and to the direction Z of ink droplet emission. Movement of the paper support platform 3 was controlled by punched tape such that ink droplets impinging on the paper could be made to form a desired image. The nozzle had a diameter of about 75 microns and was arranged to be pulsed so as to effect ink droplet formation. Deflector plates 4 were positioned near the nozzle so as to deflect certain of the ink droplets 5 on to the paper (only one deflected drop 7 is shown). A gutter 6 was positioned beneath the nozzle for collecting undeflected ink droplets.

A sheet of clay-coated colour developing paper ("Idem"* CF57 supplied by Wiggins Teape) was positioned (clay-coated side uppermost) on the paper support platform and the rig was operated to produce an unobtrusive image on the sheet. The ink used was a conventional ink jet printing ink except that it was of very much lighter intensity than is used for standard printing operations. The pulse frequency was 64 KHz, which gave ink droplets of approximately 140 microns diameter, and the deflecting voltage was adjusted until the desired angle of deflection was achieved. The deflection voltage was maintained constant so that each deflected droplet was deflected to the same extent. The arrangement was such that only about one droplet per thousand emitted droplets were actually deflected. The distance of travel before each deflected droplet impinged on the paper was about 70mm. It was found that the resultant dot diameter on the imaged paper was about 400 microns.

The procedure was then repeated first with two microcapsule coated sheets ("Idem"* CB56 supplied by Wiggins Teape), in one case with the uncoated surface uppermost and in the other with the coated surface uppermost and then with two sheets each coated on one surface with colour developing clay and on the other surface with microcapsules ("Idem"* CFB53 supplied by Wiggins Teape). In one case the clay-coated surface was uppermost and in the other case the microcapsule coated surface was uppermost. The desired unobtrusively image was obtained on each occasion.

On assembling the sheets so as to form a pressure-sensitive copying set, and subjecting the set to normal use, the unobtrusive image was found not to impede the formation of good legible copies.

EXAMPLE 2

This illustrates the use of an ink-jet printer on a paper-coating machine. The ink-jet printer described in Example 1 was mounted adjacent to the web path downstream of the drying station of the coater and close to a steam jet decurling station. The support platform 3 was of course omitted. A variable deflection voltage was used, so as to deflect the ink droplets to varying extents in order to form the desired image. The voltage variations were controlled by means of a punched tape. A range of coated and uncoated papers were run through the machine at speeds of up to 750 $m.min^{-1}$, and an unobtrusive image was successfully obtained in each case. It was found that even at web speeds of 750 $m.min^{-1}$, air entrained by the web did not affect the flight path of the droplets and so lead to distortion of the image, and that on reel-up, there was no set-off of ink on to the adjacent sheet. The presence of ambient steam was found not to affect the image, despite the ink being water based.

The papers unobtrusively printed were as follows :-

a) standard 49 gm^{-2} base paper of the kind used commercially in the manufacture of "Idem" pressure-sensitive copying paper.

b) clay-coated colour developing paper ("Idem"* CF 46 supplied by Wiggins Teape)- in some runs the coated surface was imaged and in others the uncoated surface.

c) "Idem"* CF 46 coated on its surface not carrying the clay coating with colour-former containing microcapsules and particulate stilt material (ground cellulose fibre floc) serving to protect the microcapsules from premature rupture during handling and storage of the paper (the microcapsule coating was applied by the coating machine on which the printer was mounted) - in some runs the clay-coated surface was imaged and in others the microcapsule coated surface.

d) standard 49gm^{-2} base paper as described in (a) but coated on one surface with a microcapsule coating as described in (c) - in some runs the coated surface was imaged and in others the uncoated surface

When the printed coated papers described above were assembled into a pressure-sensitive copying set, the set functioned satisfactorily.

*"Idem" is a Registered Trade Mark

CLAIMS

1. Sheet material carrying an unobtrusive image applied by charged droplet printing.

2. Sheet material as claimed in claim 1, wherein the unobtrusive image is applied by ink-jet printing.

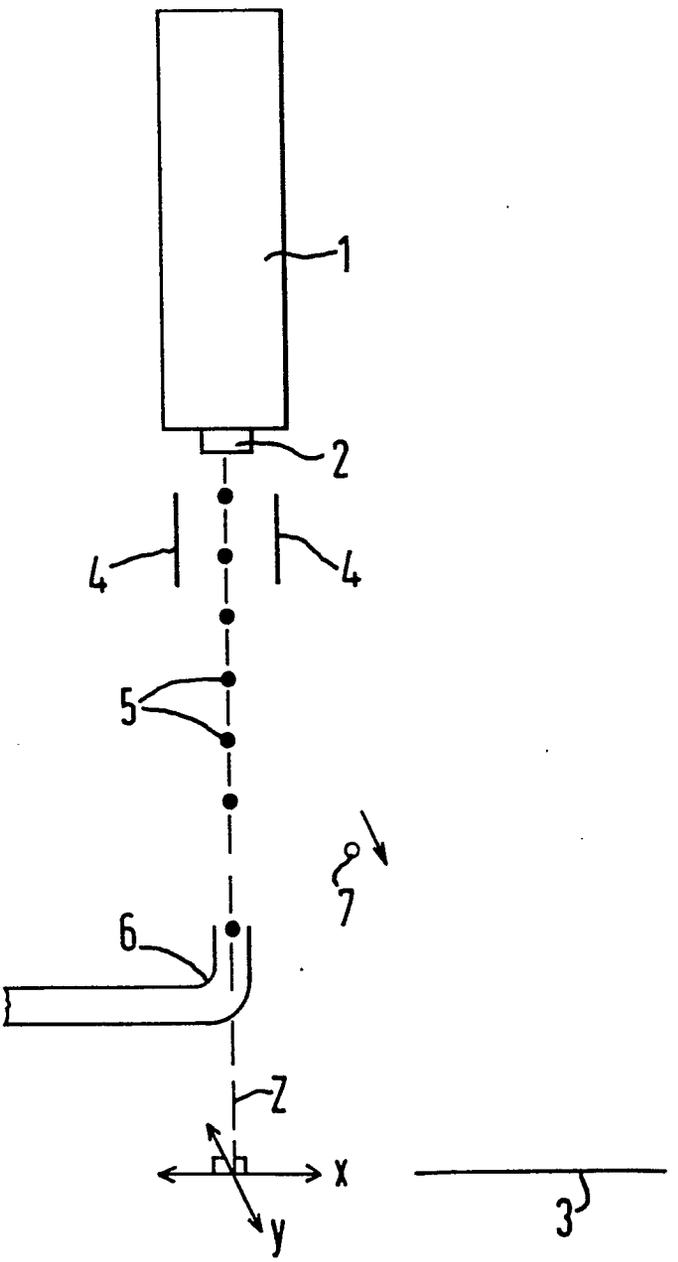
3. Sheet material as claimed in claim 1 or 2, wherein the sheet material is paper.

4. Sheet material as claimed in any preceding claim wherein the sheet material is pressure-sensitive copying material.

5. A method of producing sheet material carrying an unobtrusive image, comprising the step of applying the image to the sheet material by means of a charged droplet printer.

6. A method as claimed in claim 5, wherein the image is applied to the sheet material by means of an ink-jet printer.

7. A method as claimed in claim 5 or 6 wherein the sheet material is a web of paper or coated paper and the printer is mounted on the paper-making or paper-coating machine on which the web is produced, whereby the web speed through the printer is the same as the web speed through the machine.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