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(11) **EP 0 970 818 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
12.01.2000 Bulletin 2000/02

(51) Int. Cl.⁷: **B41L 13/18**

(21) Application number: **99113175.6**

(22) Date of filing: **07.07.1999**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE**
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **10.07.1998 JP 21198698**

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(54) **Stencil printing apparatus**

(57) Provided is a stencil printing apparatus which comprises a cylindrical drum (1) wound with a perforated stencil sheet (2) on its outer peripheral surface and rotated around its central axis, a squeezing means (3) disposed internally contacting with the inner peripheral surface of the drum and supplying a stencil printing ink (6) to the outer peripheral surface of the drum, and a pressing mechanism (4) pressing at least one of the drum and a printing paper (5), thereby to bring the drum and the printing paper into close contact with each other and to transfer the ink onto the printing paper through the perforated stencil sheet, in which the peripheral wall of the cylindrical drum comprises an ink-permeable porous member which generates heat upon passing an electric current therethrough. The peripheral wall may comprise a cylindrical porous material (1a) and a porous layer (1b) of a heat generating resistance element, which are laminated on each other. According to the present stencil printing, the ink may be one that reversibly changes in phase from solid state to liquid state at a specific temperature, and thus warm-up time before starting the printing can be shortened and besides heat energy can be efficiently utilized.

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Description

[0001] The present invention relates to an apparatus for stencil printing, and more particularly relates to an apparatus for stencil printing which employs an ink that changes in phase from solid state to liquid state to improve drying of ink and inhibit occurrence of offset or seep through on prints, and in which a time required for warm-up before starting of printing is shortened and heat energy efficiency is improved.

[0002] Stencil printing is utilized in a wide range of fields since it is easy to make masters. However, a considerable time is needed for drying of ink after stencil printing, and thus there are problems that when a printed paper is taken in hands just after printing, the ink transfers to hands or when papers printed by continuous printing are superposed, seep through of ink occurs and this phenomenon is especially conspicuous on papers inferior in permeability to ink, such as postal cards. This is because drying of conventional stencil printing inks depends on only penetration of oil phase components and evaporation of water phase, and, therefore, drying properties of ink are considerably deteriorated on papers of the type inferior in ink permeability.

[0003] In order to improve these defects, there have been proposed to add a thermosetting component to an oil phase and/or a water phase (JP-A-6-128516, JP-A-6-172691) and to add solid fine particles to an emulsion ink (JP-A-6-116525), but satisfactory results have not yet been obtained.

[0004] Furthermore, in the case of conventional emulsion inks, viscosity of ink varies depending on the environmental temperature, and, for example, ink becomes soft at high temperatures to cause seep through of ink or side or end leakage of ink, which is a phenomenon of leakage of ink from an end portion of a stencil sheet wound round a printing drum.

[0005] The object of the present invention is to provide an apparatus for stencil printing, which employs an ink that changes in phase from solid state to liquid state to improve drying of the ink and inhibit occurrence of offset or seep through on prints as well as the side or end leakage of ink and which can shorten the time required for warm-up before starting of printing and can efficiently utilize heat energy.

[0006] According to the present invention, the object can be attained by a stencil printing apparatus comprising a cylindrical printing drum which is rotatable about its central axis with a perforated stencil sheet wound around its outer peripheral surface, a squeezing means which is disposed in internal contact with an inner peripheral surface of the drum so that a stencil printing ink capable of reversibly changing in phase from solid state to liquid state is supplied to the outer peripheral surface of the drum, and a pressing mechanism which presses at least one of the drum and a printing paper so that while the printing paper is being moved synchro-

nously with rotation of the drum, the drum and the printing paper are brought into close contact with each other and the ink in liquid state is transferred from the inner surface of the drum to the printing paper through the stencil sheet, in which the drum comprises a peripheral wall made of an ink-permeable porous member which generates heat upon passing an electric current there-through.

[0007] In the present stencil printing apparatus, a hot-melt ink is used, which reversibly changes in phase from solid state to liquid state at a given temperature. This hot-melt ink becomes liquid having a certain viscosity by a heating device at the time of stencil printing, and, hence, it can be transferred onto a material to be printed through the perforations of the stencil sheet. Moreover, the liquid ink transferred onto the material instantaneously changes in phase to solid state while the material is conveyed, and thus can be fixed on the material in a short time. Therefore, even when a print obtained by the present stencil printing apparatus is touched with hand, the hand is not soiled with the ink, and, besides, no seep through occurs when continuous printing is carried out.

[0008] Furthermore, in the present stencil printing apparatus, the peripheral wall of the printing drum is made of an ink-permeable porous member which generates heat upon passing an electric current there-through. In this way, the peripheral wall of the drum through which the ink passes comprises a porous member which generates heat upon passing an electric current therethrough, and the porous member is connected to a suitable electric source and generates heat upon passing an electric current. Therefore, the hot-melt ink present inside or in the vicinity of the peripheral wall can be heated in a short time. As a result, the hot-melt ink in the vicinity of the stencil sheet first changes in phase from solid to liquid, and, thus, printing can be started immediately. Moreover, the temperature of not only the hot-melt ink but also the members contacting with the drum preferentially rises due to the heating energy of the porous member through which an electric current has been passed. Therefore, the temperature gradient of the present stencil printing apparatus is such that the temperature of the drum is the highest and the temperature lowers with increase of the distance from the drum, resulting in a smaller loss of energy due to heat conduction and heat radiation.

[0009] Furthermore, since the hot-melt ink used in the present invention instantaneously changes in phase from liquid to solid, it does not penetrate into the material to be printed and no seep through of ink occurs. Therefore, according to the present invention, printing can be performed not only on usual printing papers and postal cards inferior in ink permeability, but also on films or metals.

[0010] The hot-melt ink is preferably one which reversibly changes in phase from solid state to liquid state at 30-150°C, preferably 40-120°C. Hereupon, the solid

state means a state of ink losing fluidity to such an extent that the ink does not adhere to a finger when the ink is touched with the finger, and the liquid state means a state of ink higher in fluidity than in the solid state, preferably, a state of ink having a viscosity to such an extent that the ink can flow out through the perforations of the stencil sheet. The phase changing temperature means the maximum temperature at which the ink keeps the solid state. If the phase changing temperature is lower than 30°C, the ink is fluidized when the inside temperature of the stencil printing apparatus or the environmental temperature reaches 30°C, and this often causes stain of the printing apparatus and side or end leakage of the ink. If the phase changing temperature is higher than 150°C, the heating device for ink must be made larger, which needs a great energy, and, besides, longer time is required for changing the phase of ink to liquid state, and, thus, the waiting time before starting the printing becomes longer.

[0011] The hot-melt ink can be prepared by mixing a necessary amount of a colorant with the component reversibly changing in phase from solid state to liquid state at a specific temperature.

[0012] As the above reversibly phase-changing component, waxes, fatty acid amides, fatty acid esters, resins and the like are used, and examples thereof include carnauba wax, microcrystalline wax, polyethylene wax, montan wax, paraffin wax, candelilla wax, shellac wax, oxidized wax, ester wax, bees wax, Japan wax, spermaceti, stearic acid amide, lauric acid amide, behenic acid amide, caproic acid amide, palmitic acid amide, low molecular weight polyethylene, polystyrene, α -methylstyrene polymer, vinyltoluene, indene, polyamide, polypropylene, acrylic resin, alkyd resin, polyvinyl acetate, ethylene-vinyl acetate copolymer, and vinyl chloride-vinyl acetate copolymer. Melting point or softening point of the reversibly phase-changing component is preferably 30-150°C, especially preferably 40-120°C.

[0013] Examples of the colorant include organic and inorganic pigments such as furnace carbon black, lamp black, cyanine blue, lake red, cyanine green, titanium oxide, and calcium carbonate, and dyes such as azo, anthraquinone and quinacridone dyes.

[0014] If necessary, the hot-melt ink may contain anionic, cationic and nonionic dispersants such as sorbitan fatty acid esters, fatty acid monoglyceride and quaternary ammonium salts.

[0015] The hot-melt ink may be in the form of an oil ink and a W/O emulsion ink. The oil ink is prepared by mixing and dissolving the reversibly phase-changing component, the colorant, the dispersant, etc. The emulsion ink capable of changing in phase is prepared by dissolving and mixing the reversibly phase-changing component, the colorant, the dispersant and the like, and then adding thereto water phase components with stirring to emulsify the above components. The colorant may be contained in the water phase.

[0016] When stencil printing is carried out using the

hot-melt ink, viscosity of the ink is usually 10-1,000,000 cps, preferably 100-100,000 cps. If the viscosity of the ink in printing is lower than 10 cps, side or end leakage of ink, which is a phenomenon of ink leaking from the end or edge portion of a stencil sheet wound round a drum) occurs and furthermore the ink rapidly penetrates into the inside of a printed paper from the surface thereof to cause seep through. If the viscosity of the ink in printing is higher than 1,000,000 cps, the ink can hardly pass through the perforations of the stencil sheet, sometimes resulting in low printing density and unevenness in printing.

[0017] In carrying out printing by allowing the ink in liquid state to pass through the perforations of the perforated stencil sheet and transfer the ink onto a printing paper in the printing apparatus of the present invention, it is preferred that the stencil sheet and the printing paper are pressed together under a pressure of 0.01-10 kg/cm², preferably 0.05-5 kg/cm² and the printing is carried out for 0.001-10 seconds, preferably 0.005-5 seconds. If the pressure is lower and the time is shorter, the ink in liquid state hardly passes through the perforated stencil sheet and, as a result, amount of the ink transferred onto the printing paper is small to cause low printing density and unevenness in prints. On the other hand, if the pressure is higher and the time is longer, amount of the ink passing through the stencil sheet is great and amount of the ink transferred onto the printing paper is great, sometimes resulting in unclear prints with blurring or blotting and, besides, causing seep-through or setoff. Therefore, good prints can be obtained when the printing time is prolonged in the case of low pressure, and the printing time is shortened in the case of high pressure.

[0018] Any stencil sheets of pressure-sensitive stencil sheets, heat-sensitive stencil sheets and soluble-type stencil sheets can be used for the stencil printing apparatus of the present invention. The pressure-sensitive stencil sheets can be perforated directly by a stencil pen, dot printer, and the like to form an image. The heat-sensitive stencil sheets can be perforated by superposing a light-absorbing original image and a stencil sheet one upon another and exposing them to flash light or by melting a stencil sheet by a thermal head to reproduce an image. The soluble-type stencil sheet can be perforated by transferring a solvent onto the stencil sheet by means of a solvent ejecting device to reproduce an image and dissolve the stencil sheet at the image portions.

[0019] The peripheral wall of the drum of the present stencil printing apparatus comprises an ink-permeable porous member which generates heat upon passing an electric current therethrough. That is, the peripheral wall comprises a porous member which has many pores pierced so as to pass the ink from the inner surface to the outer surface of the drum and which generates heat upon passing an electric current by connecting with a suitable electric source. Such heat generating porous

members can be prepared by using heat generating resistance elements such as reticulate heaters comprising a reticulate fabric such as a woven fabric, a nonwoven fabric or a gauze which is impregnated or coated with an electroconductive resin such as carbon black graft polymer, porous ceramics mainly composed of barium titanate or the like and having PTC (positive temperature coefficient) characteristics, and glass-like (amorphous) carbon porous body. Preferred are those which are of self-temperature-controlling type. This heat generating resistance element alone may be molded into a porous molded article and this may be used as the peripheral wall of a cylindrical drum, but in order to maintain mechanical strength, a porous layer of said heat generating resistance element may be laminated on a cylindrical porous structure such as a punching metal, a metal sintered body having communicating pores, a polymer porous body having communicating pores, or the like. Furthermore, if necessary, ink-permeable materials used for drums of conventional stencil printing apparatuses, such as metal fibers, synthetic fibers, screen meshes, and polymeric porous sheets are wound round said porous members to make a peripheral wall of multi-layer structure.

[0020] In the present stencil printing apparatus, the peripheral wall of the cylindrical drum may be previously impregnated with a hot-melt ink. That is, during the drum being not heated, the hot-melt ink which is solid is in the state of being present on the surface of the porous member and filled in the pores of the porous member, but when an electric current is passed through the porous member, the inside of the porous member is heated to make the hot-melt ink liquid. At this time, if a perforated stencil sheet is mounted on the porous member, immediately, it becomes possible to carry out printing with the liquid ink.

[0021] In order to previously impregnate the porous member with a hot-melt ink, for example, the hot-melt ink is heated to make liquid, a cylindrical drum is immersed in this liquid ink to fill the pores of the porous member with the ink, and then the drum is taken out from the liquid ink. The liquid ink filled in the pores of the porous member becomes solid when cooled to lower than the phase changing temperature. Thus, a drum filled with a solid ink is obtained. Alternatively, it can also be obtained by heating the peripheral wall under rotating the drum, and coating the peripheral wall with solid or liquid hot-melt ink.

[0022] At the time of carrying out printing by the present stencil printing apparatus, the peripheral wall of the drum generates heat upon passing an electric current therethrough whereby the ink in the vicinity of the peripheral wall is heated to become liquid, and is squeezed out of the peripheral wall by a squeezing means disposed inside the rotating drum in contact with the inner peripheral surface of the drum and transferred onto the stencil sheet always in liquid state. However, the ink which is present in the vicinity of the squeezing

means in the drum and does not reach the peripheral wall need not be necessarily liquid. That is, when the ink previously filled in the peripheral wall of the drum is consumed for printing and becomes insufficient, hot-melt ink in solid state may be supplied into the drum to continue the printing. The supplied solid ink shortly becomes liquid with heating by the peripheral wall of the drum and is used for printing.

[0023] According to the present invention, a perforated stencil sheet is wound round the outer peripheral surface of the drum which rotates around its central axis as in the case of conventional rotary stencil printing apparatuses, and, in the state of a printing paper being moved synchronously with the rotation of the drum, at least one of the drum and the printing paper is pressed by a pressing mechanism to bring them into close contact with each other, whereby the hot-melt ink which has changed in phase from solid state to liquid state by heat inside the drum is allowed to pass through the perforations of the stencil sheet and transferred onto the printing paper. Thus, printing is performed.

[0024] The pressing mechanism is provided, for example, outside the drum in opposition thereto, and can be a pressing means comprising a rigid body or an elastic body which presses the outer peripheral surface of the drum, such as a metal roller, a rubber roller or the like, or can be a means which presses outwardly the squeezing means comprising a rigid body or an elastic body such as a metal roller, a plastic roller or the like to expand the peripheral wall of the drum.

[0025] Hereinafter, the preferred embodiments of the present invention will be explained with reference to the accompanying drawings, in which

FIG. 1 is a schematic sectional view of an embodiment of the stencil printing apparatus of the present invention, and

FIG. 2 is a schematic sectional view of another embodiment of the stencil printing apparatus of the present invention.

[0026] The stencil printing apparatus of FIG. 1 has an ink-permeable cylindrical printing drum 1, and the peripheral wall of the drum 1 is made of a porous member comprising a cylindrical punching metal 1a and a reticulate heat generating resistance element 1b wound round the outer surface of the peripheral wall. This reticulate heat generating resistance element 1b is an ink-permeable reticulate heater comprising a glass cloth coated and impregnated with an electroconductive resin, and is connected to an electric source (not shown) through an electrode (not shown) and generates heat upon passing an electric current therethrough. Furthermore, a perforated stencil sheet 2 is wound round the outer peripheral surface of the drum 1 comprising the porous member. Moreover, the stencil printing apparatus has as a squeezing means a

squeeze roller 3 disposed internally contacting with the inner surface of the cylindrical punching metal 1a. In addition, outside the drum 1, there is provided under the drum a press roller 4 as a pressing mechanism which presses a printing paper 5 to the stencil sheet 2 and simultaneously rotates synchronously with the rotation of the drum 1 to carry the printing paper 5.

[0027] In the construction mentioned above, upon passing an electric current through the reticulate heat generating resistance element 1b, the peripheral wall of the drum generates heat and the hot-melt ink present in the peripheral wall and in the vicinity of the wall is changed in phase from solid to a liquid ink 6. In this instance, when the drum 1 is rotated and simultaneously the printing paper 5 is carried synchronously with the rotation of the drum with pressing the printing paper against the outer peripheral surface of the drum 1 by the press roller 4, the liquid ink 6 is squeezed out of the drum 1 by the squeeze roller 3 and the liquid ink which passes through the stencil sheet 2 is transferred onto the printing paper 5, and, thus, printing is performed. When the transferred ink is exposed to room temperature during carrying of the printing paper 5, the ink instantaneously becomes solid ink 7 and is fixed.

[0028] The stencil printing apparatus of FIG. 2 is the same as that of FIG. 1, except that the peripheral wall of the drum 1 is made of an ink-permeable cylindrical porous member comprising a foamed and molded body of electroconductive carbon. The electrode and electric source for passing an electric current through the porous member are not shown. According to this construction, the drum of the present invention can be manufactured easily at a low cost.

Examples

[0029] The present invention will be explained in more detail by the following examples.

Example 1

[0030] Stencil printing was carried out in the following manner using the stencil printing apparatus of FIG. 1.

[0031] An ink-permeable reticulate heat generating resistance element 1b comprising a glass cloth coated and impregnated with an electroconductive resin of a carbon black graft polymer was wound round the outer peripheral surface of a cylindrical punching metal 1a of 10 cm in diameter having pores of 1 mm in pore diameter (opening ratio 25%), and slidable electrodes were provided at both ends of the heat generating resistance element to form a drum 1. A metal roller of 2 cm in diameter disposed so as to slidably contact with the inner peripheral surface of the drum 1 by a pressing mechanism not shown was used as the squeeze roller 3. Then, a perforated stencil sheet 2 was wound round the outer periphery of the drum 1. Thereafter, with rotating the drum 1, an electric current was passed through the heat

generating resistance element 1b to heat the inner peripheral surface of the punching metal at 70°C. Then, when a solid hot-melt ink consisting of 5 parts by weight of carbon black, 85 parts by weight of paraffin wax, and 10 parts by weight of ethylene-vinyl acetate copolymer was supplied to the inside of the drum 1 by an ink supplying means not shown, the ink becomes liquid. At this time, when a printing paper 5 was passed with being pressed to contact with the drum 1 by the press roller 4, the ink in liquid state passed through the perforations of the stencil sheet 2 and was transferred in liquid state onto the printing paper 5. The ink in liquid state transferred onto the printing paper 5 became instantaneously ink 7 in solid state on the printing paper 5, whereby clear images were printed on the printing paper.

[0032] Even if the print was rubbed with hands, the hands were not stained with ink. Moreover, when continuous printing of 100 copies was carried out, no set-off occurred on the prints that were superposed on each other.

[0033] When the stencil printing apparatus was cooled to room temperature after printing was once completed, the hot-melt ink became solid in the state of being filled in the punching metal 1a and the heat generating resistance element 1b. When an electric current was passed through the heat generating resistance element 1b so that the temperature of the drum 1 increased again to 70°C, printing was able to start immediately.

Example 2

[0034] Stencil printing was carried out using the stencil printing apparatus of FIG. 2 in the following manner.

[0035] Electrodes were provided at both ends of a cylindrical foamed body that was molded out of electroconductive carbon (average pore size: 10 μm, porosity: 60%) of 5 cm in inner diameter, 6 cm in outer diameter, and 20 cm in length, and this was employed as the drum 1. Then, an electric current was passed through the drum 1 to heat the drum while the same hot-melt ink as in Example 1 is supplied to the drum 1. When temperature of the squeeze roller 3 reached 70°C at its surface contacting the drum 1, the hot-melt ink changed in phase from solid state to liquid state, and upon carrying out stencil printing in the same manner as in Example 1, clear images were printed. Even if the print was rubbed with hands, the hands were not stained with ink. Moreover, when continuous printing of 100 copies was carried out, no set-off occurred on the prints that were superposed on each other.

[0036] When the stencil printing apparatus is cooled to room temperature after printing was once completed, the hot-melt ink became solid in the state of being filled in the carbon foamed body of the drum 1. When an electric current was passed so that the temperature of the drum 1 rose again to 70°C, printing was able to start immediately.

[0037] According to the present invention, since the

peripheral wall of the cylindrical printing drum of the stencil printing apparatus comprises an ink-permeable porous member which generates heat by passing an electric current, warm-up time before starting the printing can be shortened, and, furthermore, heat energy can be efficiently used for printing. Moreover, since a hot-melt ink is used, clear prints free from set-off or seep through can be obtained, and, besides, even if the prints just after printed are touched, the prints are not stained and printing can be efficiently performed. In addition, since the ink instantaneously changes in phase from liquid to solid on the printing paper, printing can be performed not only on normal printing papers or postal cards inferior in ink permeability, but also on films or metals.

Claims

1. A stencil printing apparatus comprising
 - a cylindrical printing drum which is rotatable about its central axis with a perforated stencil sheet wound round its outer peripheral surface, a squeezing means which is disposed in internal contact with an inner peripheral surface of said drum, whereby a stencil printing ink capable of reversibly changing in phase from solid state to liquid state is supplied to the outer peripheral surface of the drum, and
 - a pressing mechanism which presses at least one of said drum and a printing paper, whereby while said printing paper is being moved synchronously with rotation of said drum, said drum and said printing paper are brought into close contact with each other and said ink in liquid state is transferred from the inner surface of said drum to said printing paper through the stencil sheet,
 - in which said drum comprises a peripheral wall made of an ink-permeable porous member which generates heat upon passing an electric current therethrough.
2. A stencil printing apparatus according to claim 1, wherein said peripheral wall of the drum comprises a cylindrical porous material to which a porous layer of a heat generating resistance element is laminated.
3. A stencil printing apparatus according to claim 1, wherein said peripheral wall of the drum comprises a porous molded body of a heat generating resistance element.
4. A stencil printing apparatus according to claim 1, wherein said stencil printing ink reversibly changes in phase from solid state to liquid state at a temperature of 30-150°C.

FIG. 1

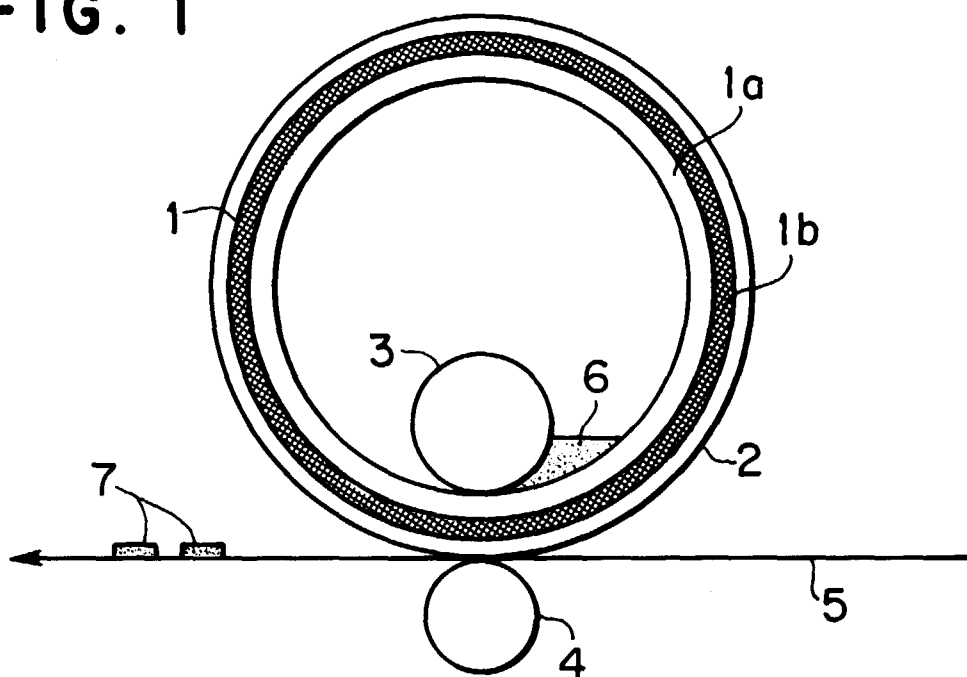
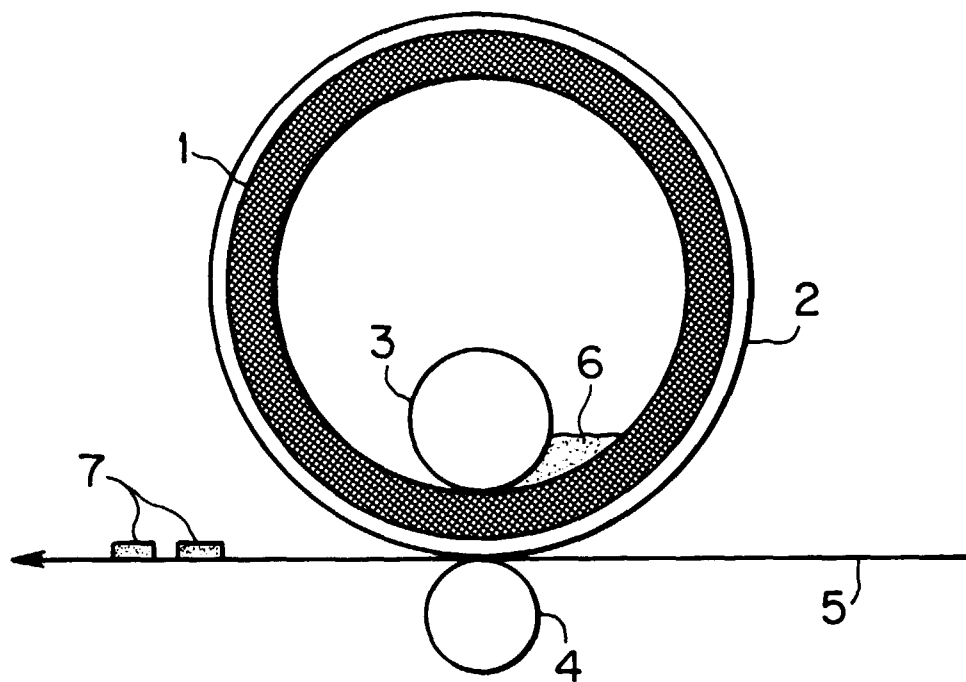


FIG. 2





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 99 11 3175

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION
A	EP 0 805 048 A (RISO KAGAKU CORP) 5 November 1997 (1997-11-05) * the whole document *	1	B41L13/18
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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		14 September 1999	Madsen, P
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 99 11 3175

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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14-09-1999

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