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(54) **Photogravure printing method using water based ink and a printing machine for carrying out the method**

Tiefdruckverfahren mit wässrige Druckfarbe und Vorrichtung unter Verwendung des Verfahrens

Procédé d'impression en creux avec une encre à base d'eau et machine faisant usage de ce procédé

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- **PATENT ABSTRACTS OF JAPAN vol. 7, no. 237 (M-250) [1382], 21 October 1983 (1983-10-21) & JP 58 126159 A (KOMORI), 27 July 1983 (1983-07-27)**

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Description

[0001] This invention relates to a gravure (photogravure) printing method carried out using water based ink and using a printing drum in association with an ink reservoir, a inking roll, and a doctor blade unit.

[0002] Conventionally an organic solvent type of (oil based) ink has been used in gravure printing, and for colour matching, printing is performed once or repeatedly in the overlaid state using coloured ink in which colouring materials for indigo blue, red, yellow, black and white colours are included. When a specific colour is required by a customer, toning is performed to satisfy the customer's request, and if a large quantity of ink with any specific colour is required, a printing firm purchases the ink already toned by a manufacturer from the supplier. Because of the characteristics of the organic solvent type of ink, to satisfy customer's requests for colouring performance and gradation, generally a low-mesh (with about 175 lines) and deep (with the depth of 18 to 30 μ) printing plate is used.

[0003] For the reasons described above, the following problems occur in the gravure printing method using the organic solvent type of ink.

[0004] As the ink is of an organic solvent type, there is a problem concerning the working environment in printing works, accident prevention, contamination of environment due to emission of the vapours and the problem of residual solvent when the material printed with the ink is used as a film for food packaging.

[0005] When the organic solvent type of ink is used, as the ink dries fast and the gradation in printing is narrow, a deep and low-mesh printing plate is used as described above, and a large quantity of ink is consumed, which is a main cause for a cost increase in printing.

[0006] In the conventional gravure printing, printing with the process colour ink as described above is performed once or repeatedly, and further as ink with a specific colour (required by a customer) is used in many cases, the number of colours and the number of printing plates increase, which results in time loss in preparatory steps before the start of printing and toning loss. Further in the case of ink with a specific colour, as the ink can not be used for other purposes, a quantity of remains unused, which adds to the printing cost. Sometimes the remaining ink is discarded, which wastes resources.

[0007] Customers now require various types of printed matter but in small lots and in addition within a short period of time, thus cost management is more stringent. Further environmental pollution and hygiene management in food industries are important when the organic solvent type of ink is used. These needs can not always be satisfied.

[0008] For the reasons described above, a printing method using water based gravure ink in place of the organic solvent type of ink is advantageous. Further, in contrast to oil based gravure ink conventionally used in the art, a water based gravure ink insures substantial improvement in the working environment and it may be expected that the water based gravure ink will be used more and more in gravure printing

[0009] When the water based gravure ink is used there are problems such as difficulties in drying, dissolving or dispersing or resolving in the water solvent, and wetting the printing plate surface due to surface tension, when the type board is set by the same technique as that used with the organic solvent type of ink currently available, the printing speed becomes lower, and in addition such problems as fogging or gradation faults occur on the printing plate, which makes it impossible to obtain high quality printed matter.

[0010] As shown in Fig. 5 of the drawings, in the conventional type of gravure printing machine, the size of the ink reservoir 1 is very large and a large quantity of ink is left in the ink reservoir 1 (about 20 kg per printing plate). When the ink is a standard colour, the ink can be used again, but if the ink is a specific colour based on the customer's request, it is required to re-stock the ink until the ink is used next time, which results in substantial cost increase.

[0011] With a structure of printing machine using water based gravure ink as described above and due to fogging on the type plate caused by difficulty of the ink in resolving in a water solvent, the remaining ink can not be used again.

[0012] Referring to Fig. 5 the reference numeral 2 is an inking roll, 3 is a printing drum, 3a is a printing plate surface, 5 is a doctor blade unit arrangement, 6 a pressure roller, and 7 a film being printed.

[0013] In the conventional type of gravure printing machine, the inking roll 2 is provided in the side opposite to the doctor blade unit as shown in Fig. 6. Because of this configuration, when gravure printing is carried out with water based gravure ink, wetting failure as an intrinsic defect of the water based gravure ink occurs due to the surface tension on a surface of the printing plate, so that, as the printing speed becomes faster, ink on the printing plate drops into the ink reservoir 1, which causes blurring on printed matters or fogging on the printing plate surface and makes it difficult to produce good printing under all conditions.

[0014] Further in the conventional doctor blade unit arrangement of the gravure printing machine, the length L of a back plate 5b projecting from a bracket 5a of the doctor blade unit 5 is set to 30 mm as shown in Fig. 7 and Fig. 8, and the length L1 of a blade tip of a doctor blade unit 5c is set to 4 mm, because of the dimensions, the excellent colouring performance and gradation on a base film are insured when the printing ink is oil based.

[0015] However, when printing is performed with water based gravure ink under the same conditions as those employed when printing is performed with oil based gravure ink, fogging occurs on a surface of the printing plate due to the doctor blade unit in association with the difficulty of the ink in resolving in a water solvent, and there occurs the

problem that printing can not be carried out without changing the doctor blade unit.

[0016] In the gravure printing machine using oil based ink, as shown in Fig. 11, the inking roll 2 is provided against the printing drum 3 in the side opposite to the doctor blade unit 5, and ink 4 in the ink reservoir 1 is drawn up by the single inking roll 2 and fed onto the printing plate surface 3a. In Fig. 11, 6 is a pressure roller, and at 7 is a printed film.

[0017] When gravure printing is performed using the water based gravure ink, if the conventional structure is unchanged, wetting failure of the ink 4 occurs on the printing plate surface 3a due to the surface tension as an intrinsic defect of the water based ink, and as the printing speed becomes faster, the ink 4 supplied onto the printing plate surface 3a drops into the ink reservoir 1, and as the result, blurring on printed matters and fogging on the printing plate occur, which makes it impossible to perform printing under good conditions.

[0018] When gravure printing is performed using the oil based gravure ink, the problem described above does not occur, but such problems as blocking occur when the printing plate surface 3a is dried after the ink is transferred onto the film 7, and to prevent this phenomenon, it is necessary to pick up the ink 4 from the ink reservoir 1 as fast as possible, and to satisfy this the inking roll 2 is provided in the opposite side from the knife edge 5. When the printing drum 3 is rotated at a faster speed, the ink 4 falls or scatters from the surface 3a of the printing drum 3 due to the centrifugal force and weight of the ink 4, so that there is a limit in increasing a rotating speed of the printing drum 3 even when the oil based gravure ink is used.

[0019] In the gravure printing machine using oil based ink, ink 4 in the ink reservoir 1 is taken up by the inking roll 2, and surplus ink transferred onto the printing drum 3 is scraped off by the single doctor blade unit 5 to form a good printing plate surface 3a as shown in Fig. 14, thus good printed matter can be obtained on the base film 7 via the pressure roller 6.

[0020] The blade tip 5c of the doctor blade unit 5 is generally supported by the back plate 5b and clamped or fixed with the bracket 5a as shown in Fig 15.

[0021] When gravure printing is carried out using water based gravure ink and with the conventional type of doctor blade unit 5 having the structure as described above, the wetting failure of the printing plate surface 3a caused by high surface tension and the doctor blade unit fault due to precipitation of non-resolved materials onto the printing plate surface 3a generates blurring of the printed matter or fogging on the printing plate is generated This makes it difficult to produce good quality printing.

[0022] Especially when black ink (with carbon contained therein) or white ink (containing titanium white) is used in printing, the defect of precipitation of non-resolved materials is a particular problem.

[0023] When a doctor pressure on the printing drum 3 is made larger to solve the problems described above, the effect is maintained over a short period of time, but as the doctor blade unit 5 is worn out quickly the operation of the doctor blade unit becomes poor again with printing plate fogging easily generated. This makes it impossible to produce good quality printing. Type on the printing plate surface 3a is worn, making replacement of the gravure cylinder necessary.

[0024] Therefore, and as the final means for solving the problems as described above, when printing is performed with water based gravure ink and with the conventional type of doctor blade unit, there is no option but to continue the printing job by lowering the printing speed.

[0025] It is a first object of the present invention to provide an water based gravure printing method capable of providing high quality water based gravure printed materials by avoiding problems such as printing plate bleed and over inking and fogging or gradation problems generated when printing is performed with water based gravure ink. It is also an object to provide a printing drum used for carrying out the method, and printed material produced by the method.

[0026] It is a second object of the present invention to enable reduction of ink cost by reducing a quantity of residual ink as much as possible in an ink reservoir of a gravure printing machine using water based or oil based gravure ink.

[0027] It is a third object of the present invention to provide a inking roll which does not causing wetting failure even when rotated at a high speed in a gravure printing machine using water based ink.

[0028] It is a fourth object of the present invention to provide a doctor blade unit arrangement which does not causing fogging on a printing plate in a gravure printing machine using water based gravure ink.

[0029] It is a fifth object of the present invention to provide a inking roll to solve the problems of blurring or fogging on a printing plate due to wetting failure in gravure printing carried out using water based gravure ink.

[0030] It is a sixth object of the present invention to provide an inking roll to enable running of a oil based gravure printing machine at a higher speed as compared to that based on the conventional technology.

[0031] It is a seventh object of the present invention to provide a doctor blade unit which does not cause blurring on printed matters nor fogging on a printing plate due to wetting failure or difficulty in resolving.

[0032] According to this invention there is provided a gravure printing apparatus as defined in claim 1 using a water based gravure ink wherein the printing drum used has between 200 and 400 mesh lines with a depth between 10 and 17 μ.

[0033] This invention preferably provides also an ink reservoir for use in a gravure printing machine, the ink reservoir

having a deep ink containing trough located within a shallow tray, the trough being arranged to accommodate an inking roll which dips therein, the printing drum being located over the tray outside said ink pool.

[0034] This invention preferably provides further a gravure printing machine preferably using water based gravure ink wherein an inking roll associated with the machine is located on the same side of the printing drum as a doctor blade unit.

[0035] A doctor blade unit for the apparatus preferably has a back plate support which projects by a length of from 20 mm to 30 mm from a clamp, the doctor blade projecting from the back plate by between 3 mm and 4 mm.

[0036] A plurality of inking rolls may be provided.

[0037] An inking roll associated with the machine can be located on the same side of the printing drum as a doctor blade unit, with a further inking roll located on the side of the printing drum opposed to the doctor blade unit.

[0038] The gravure printing apparatus preferably has one or more inking rolls provided between the doctor blade unit and the inking roll positioned on the side opposite to the doctor blade unit.

[0039] The doctor blade unit for the apparatus can include a plurality of doctor blades, preferably two.

[0040] When two doctor blades are provided the pressure of one blade may be equal to or larger than the pressure of the other blade, and wherein the pressure of the leading blade is greater than that of the trailing blade.

[0041] When two doctor blades are provided, the material of the leading doctor blade unit may be different from the material of the trailing doctor blade.

[0042] This invention is further described and illustrated with reference to the drawings showing embodiments by way of example and explaining the method of this invention. In the drawings:

Fig. 1 is an explanatory side view showing a gravure printing machine using water based and oil based gravure inks according to a third embodiment of the present invention configured so that a quantity of remaining ink is substantially reduced by minimising an ink pool in an ink reservoir;

Fig. 2 is an explanatory view showing a gravure printing machine using water based gravure ink according to a fourth embodiment of the present invention configured so that generation of wetting failure is prevented by changing the position of the inking roll to the side of a doctor blade unit;

Fig. 3 is an explanatory view showing a gravure printing machine using water based gravure ink according to a fifth embodiment of the present invention configured so that generation of fogging on a surface of a printing plate due to an inappropriate contact pressure of the doctor blade unit is prevented;

Fig. 4 is an explanatory view showing details of structure of the doctor blade unit according to a fifth embodiment of the present invention;

Fig. 5 is an explanatory view for the known and conventional type of ink reservoir;

Fig. 6 is an explanatory view showing a position of the known and conventional type of inking roll;

Fig. 7 is an explanatory view showing a doctor blade unit in the conventional type of gravure printing machine;

Fig. 8 is an explanatory view showing details of structure of the conventional type of doctor blade unit;

Fig. 9 is an explanatory view showing sixth and seventh embodiments of the present invention using water based gravure ink in which the inking roll is positioned both in the side of the doctor blade unit and in the opposite side against the doctor blade unit,

Fig. 10 is an explanatory view showing an eighth embodiment in which inking rolls are provided at three positions;

Fig 11 is an explanatory view showing the position of the conventional type of inking roll;

Fig. 12 is an explanatory view showing two blade tips of a doctor blade unit according to a ninth embodiment of the present invention using water based gravure ink, configured so that generation of fogging on a surface of a printing plate due to doctor blade unit cutting fault is prevented;

Fig. 13 is an explanatory view showing the doctor blade unit according to the ninth embodiment of the present invention;

Fig. 14 is an explanatory view showing a key section of and a doctor blade unit in the conventional type of gravure printing machine using oil based gravure ink; and

Fig. 15 is an explanatory view showing the conventional type of doctor blade unit.

[0043] Water based gravure ink is generally process colour ink in which colouring materials for indigo blue, red, yellow, black, and white colours are included, and printing is basically performed with the process colour ink once or repeatedly in the overlaid state to obtain desired colours and tone The process colour ink in which colouring materials for these five colours are mixed contain resins for water based ink as main components, and is adjusted by adding pigments and necessary additive(s) and dissolving or suspending the mixture in water or in a solvent comprising water, alcohol, and the like.

[0044] The technique for making a gravure cylinder is important in the gravure printing method using water based gravure ink. With the conventional type of printing plate (a low-mesh and deep one with about 175 lines and the depth in the range from 18 to 30 μ), such failures as blocking on the printing plate, fouling of the printing drum, appearance of the doctor blade unit line, fogging on a surface of the printing plate, and gradation faults frequently occur during printing even if water based gravure ink is used, so that the industrial needs are not satisfied. It has now been found that when a printing plate with 200 to 400 lines, preferably 350 lines and the depth in the range from 17 to 10 μ, and preferably in the range from 12 to 13 μ is used, all of the problems which occur when the conventional printing plate as described above is used are solved. This is found to be true for any type of printing plate.

[0045] With the low-mesh printing plate with 200 lines or below, as the water based ink does not dry fast, blurring occurs in the dots on film, which makes it impossible to obtain high quality printed matter.

[0046] When the number of lines is 400 or more, a bank surrounding a cell on a gravure printing plate (intaglio plate) is not formed or is broken and a dot of water based ink film is thus not present. In addition, dots on the film become smaller, so that the tone becomes less, which also makes it impossible to obtain high quality printed matter.

[0047] When the depth is 17 μ or more, blocking occurs on the printing plate because of the difficulty of water based ink in resolving in an aqueous solution. In addition, due to the difficulty of water based ink in drying, characters or colour tones are not clear, so that printed matters with desired quality can not be obtained. Further, the quantity of used ink increases, so that cost increases.

[0048] When the depth of engraving on a printing plate is 10 μ or less, unevenness is generated on a surface of the printing plate, so that printed tones are not even and printed matter with desired quality can not be obtained. Further the ink film is thin, so that problems such as difficulty in obtaining desired colour density occur.

[0049] The description above assumes a case where printing with process colour inks is executed once or repeatedly in the overlaid state, but water based gravure ink with adjusted tone and specified colour may be used in combination with the process colours in a part of the printed matter or over the entire printed matter, and the making of a gravure cylinder is performed in the same way also when the water based gravure ink with adjusted tone or specified colour is used.

Embodiment 1

[0050] By using a biaxial oriented polypropylene film 20 μ as a base material, with a commercially available water based ink and a diluted solvent in which water, ethanol, and isopropyl alcohol are mixed at the ratio of 50/30/20%, printing ink with the viscosity of Zahn cup #3-16 sec in which colouring materials for indigo blue, red, yellow, black, white, and two other specific colours are mixed was prepared. A printing plate with 350 lines and a depth of 13 μ was set by means of a laser system, and gravure printing was carried out using seven colours and seven printing plates. As a result, defects caused by fogging on the printing plate or the like were not present on the printed matter obtained, which was of high quality.

Control 1

[0051] By using a biaxial oriented polyester film 12 μ as a base material, water based ink commercially available and a diluted solvent in which water, ethanol, and isopropyl alcohol are mixed at the ratio of 50/30/20%, printing ink with the viscosity of Zahn cup #3-16 sec in which colouring materials for indigo blue, red, yellow, black, white, and other two specific colours are mixed was prepared. A printing plate with 175 lines and the depth of 18 μ was set by means of a laser system, and printing was performed with the printing plate. In this case, as ink was water based and the depth of engraving was deep, the printing speed was low (70 m/min) because of the difficulty in drying, and further as the mesh of the printing plate was coarse, good colour gradation could not be obtained, and as water based ink is harder to resolve in a water solvent and has a higher surface tension as compared to oil based ink, as fogging on the printing plate occur, and printed matters with desired quality could not be obtained.

Embodiment 2

[0052] By using a biaxial oriented nylon film 15 μ as a base material, toned water based ink with a specified colour, and a diluted solvent in which water, ethanol, and isopropyl alcohol are mixed at the ratio of 50/30/20%, printing ink with the viscosity of Zahn cup #3-16 sec was prepared, and printing was performed with the printing ink described above using a printing plate with 350 lines and the depth of 13 μ set by a laser system. As a result fogging on the printing plate was not observed, and high quality printed matter with the specified colour were obtained. In addition the colour gradation and reproducibility of thin characters were excellent.

Control 2

[0053] By using the biaxial oriented nylon film 15 μ as a base material, toned water based ink with a specified colour, and a diluted solvent in which water, ethanol, and isopropyl alcohol are mixed at the ratio of 50/30/20%, printing ink with the viscosity of Zahn cup #3-16 sec was prepared, printing was performed with the printing ink using a printing plate with 175 lines and a depth of 18 μ set by a laser system. As a result fogging on the printing plate occurred, and printed matter with the desired quality could not be obtained.

[0054] From the Embodiments 1, 2 and Controls 1, 2 described in detail above, it is understood that practical gravure printing in which such failures as fogging on a printing plate do not occur can be performed by specifying particular conditions in the technology for making gravure cylinder.

Embodiment 3

[0055] This Embodiment relates to the structure of an ink tank or reservoir according to this invention and the Embodiment is described in detail below with reference to Fig. 1 which is a side view of a section of a gravure printing machine comprising a printing drum, an ink reservoir in which gravure ink for printing is held, an inking roll for transferring and applying the printing ink stored in the ink reservoir onto a surface of the printing drum, a doctor blade unit for scraping off surplus ink from the printing plate surface by contacting the blade tip thereto, and a pressure roller for pressing film to be printed onto the surface of the printing drum.

[0056] In Fig. 1, the reference numeral 1 indicates the ink reservoir, and the ink reservoir 1 in this Embodiment has an ink pool 4 formed with a deep bottom in a section where the inking roll 2 is positioned The section where the printing drum 3 is positioned is formed with a shallow bottom 1a having the depth enough to receive ink dropped from the printing drum 3, and this shallow bottom 1a is downwardly inclined toward the ink pool 4 so that the printing ink is not pooled on the shallow bottom 1a.

[0057] In the ink reservoir 1 in this Embodiment, the printing ink is always pooled only in the ink pool 4, and the ink is applied onto a surface 3a of the printing drum 3 via the inking roll 2, only surplus ink is scraped off by the doctor blade unit 5 from the printing plate surface, and the printing drum is used for printing.

Embodiment 4

[0058] This embodiment relates to the structure of a inking roll according to another feature of this invention. The inking roll is described in detail below with reference to Fig. 2 which is a side view of a section of the gravure printing machine comprising a printing drum, an ink reservoir in which printing ink is held, a inking roll for transferring and applying the printing ink from this ink reservoir onto a surface of the printing drum, a doctor blade unit for scraping off surplus ink from the printing plate surface by contacting with the blade tip and a pressure roller for pressing the film to be printed onto the printing plate surface.

[0059] In Fig. 2, the reference numeral 1 indicates an ink reservoir, and the ink reservoir 1 in this embodiment has the ink pool 4 formed in the side where the doctor blade unit 5 is positioned, and also the inking roll 2 for applying the printing ink from this ink pool 4 onto the surface 3a of the printing drum 3 is positioned in the side where the doctor blade unit 5 is positioned

[0060] As the inking roll 2 in this embodiment is provided in the side where the doctor blade unit 5 is positioned, an upward centrifugal force is imparted to the ink applied from the inking roll 2 onto the surface 3a of the printing drum 3, so that, when water based gravure ink with higher surface tension is used and printing is performed at a high speed, the printing ink does not drop into the side where the ink reservoir 1 is located and wetting failure does not occur.

Embodiment 5

[0061] This embodiment relates to the structure of a doctor blade unit according to a further feature of this invention which is described below with reference to Fig. 3 and Fig. 4. Fig. 3 is a side view of a section of a gravure printing

machine comprising an ink reservoir in which printing ink is stored, a inking roll for applying the printing ink from this ink reservoir onto a surface of a printing drum, a doctor blade unit for scraping off surplus ink from the printing plate surface by contacting the blade tip thereto, and a pressure roller for pressing film onto the printing plate surface.

[0062] In Fig. 3, the reference numeral 1 indicates an ink reservoir, and the ink reservoir 1 in this embodiment has the ink pool 4 with a depth formed in the section where the inking roll 2 is positioned, a shallow bottom 1a with enough depth to receive printing ink dropping from the printing drum 3 is formed in the side where the printing drum 3 is positioned, and this shallow bottom 1a is downwardly inclined toward the ink pool 4, so that the printing ink is not pooled in this shallow bottom section 1a.

[0063] The reference numeral 5 indicates a doctor blade unit, and in the doctor blade unit 5 in this embodiment, the length L of a back plate 5b projecting from a bracket 5a as shown in Fig. 4 is 25 mm, and the length L1 of a blade tip of a doctor blade unit 5c projecting from a tip of this back plate 5b is 3.5 mm.

[0064] In this doctor blade unit 5, when the length L of the back plate 5b is 27 mm or more, a blade tip of the doctor blade unit 5c does not work well for scraping off the printing ink, and on the contrary when the length L is 22 mm or below, a force loaded by the doctor blade unit 5 is excessive and has a bad effect as friction occurs on the print plate surface 3a, so that the length L of the back plate 5b should be set in the range from 22 mm to 27 mm, and the optimal length L is 25 mm.

[0065] When the length L1 of a blade tip of the doctor blade unit 5c is 3.7 mm or more, the doctor blade unit 5c can not scrape off the printing ink sufficiently, and when the length L1 is less than 3.2 mm, friction occurs on the printing plate surface 3a, so that the length L1 should be set in the range from 3.2 mm to 3.7 mm, and the optimal length L1 is 3.5 mm.

Control 3

[0066] A control against the doctor blade unit 5 in Embodiment 5 is described below. In the doctor blade unit as an object for comparison, the length L of the back plate 5b shown in Fig. 8 is 35 mm, the blade length L1 of the doctor blade unit 5c is 6.5 mm, and this doctor blade unit is for oil based ink.

[0067] By using bi-axial oriented nylon film 15 μ as a base material, a printing plate with 350 lines and the depth of 13 μ was prepared by a laser system. Printing for six colours was performed with five printing plates and water based gravure inks for indigo blues, red, yellow, black, and white colours which were commercially available. This embodiment was compared with the embodiment of conventional technology shown in Fig. 8 in terms of dimensions of the doctor blade unit 5. In the latter case, fogging on the printing plate occurred due to the doctor blade for all colours, and high quality printing film could not be obtained, but in the former case, namely in the case of the doctor blade unit 5 according to the present invention, the doctor blade unit functioned well in scraping off inks for all of the colours with no fogging generated on the printing plate at all, and high quality printing film could be obtained.

Embodiment 6

[0068] A further embodiment of this invention is described in detail below with reference to Fig. 9.

[0069] In Fig. 9, the reference numeral 1 indicates an ink reservoir filled with water based ink 4, and the ink 4 is picked up and applied onto the surface 3a of the printing drum 3 by the inking roll 2 positioned in the opposite side to the doctor blade unit 5 and the inking roll 2a positioned on the side where the doctor blade unit 5 is provided. In the figure, the reference numeral 6 indicates a pressure roller, and the reference numeral 7 indicates film to be printed.

[0070] When the two inking rolls 2, 2a are positioned as shown in Fig. 9, at first the ink 4 is supplied by the inking roll 2 in the side opposite to the knife edge 5 to the printing drum 3, and then the ink 4 is supplied thereto by the inking roll 2a, so that the ink 4 is sufficiently applied onto the surface 3a, and the ink does not drop (scatter) even when printing is performed at a high speed.

Experiment 1

[0071] In this Experiment 1, the inking roll unit shown in Fig. 9 was used. Printing was performed with a printing drum (with the depth of 13 μ and 350 lines) prepared by applying the water based gravure ink (supplied by Toyo Ink Kabushiki Kaisha; product name: Aquaecol S; surface tension: 24 dyne/cm) onto bi-axial oriented PP film (with the thickness of 20 μ), and the printing speed could be raised up to 300 m/min without losing good printing conditions.

[0072] In this experiment, the two inking rolls 2, 2a were provided in the side where the doctor blade unit 5 was positioned and also in the opposite side, and because of this configuration, the printing ink 4 did not drop into the ink reservoir 1 even when the printing drum was rotated at a high speed, and wetting failure on the printing plate surface 3a as an intrinsic defect of water based gravure ink did not occur.

Control 4

[0073] The inking roll (based on the conventional technology) shown in Fig. 11 was used. Printing was performed under the same conditions as those in Experiment 1 above. The printing speed could be raised only up to 70 m/min without losing the good printing conditions.

[0074] The limited printing performance in this case is based on the fact that wetting failure occurs due to large surface tension of the water based gravure ink 4 itself and the ink 4 applied on the printing plate surface 3a drops into the ink reservoir 1 when the printing drum 3 is rotated at a higher speed.

Embodiment 7

[0075] An embodiment according to the invention as described in Claim 13 is described in detail below.

Experiment 2

[0076] Printing was performed under the same conditions as those in Experiment 1 excluding the fact that oil based gravure ink (supplied by Toyo Ink Kabushiki Kaisha; product name: NEW LP Super; surface tension: 17 dyne/cm) was used for the printing ink. As the result, even when the printing speed was raised up to 350 m/min, printing could be performed under good conditions.

Control 5

[0077] Printing was performed under the same conditions as those employed in Experiment 2 by using a printing machine in which the inking roll 2 was provided only on the opposite side to the knife edge 5 as shown in Fig 11. In this case, the printing ink dropped with uneven printing generated when the printing speed was over 200 m/min, and printing could not be performed under good conditions.

Embodiment 8

[0078] An embodiment of the present invention is shown in Fig. 10. In this embodiment, a third inking roll 2b is provided between the inking roll 2 and inking roll 2a. With this configuration, printing was performed under the same conditions as those employed in Experiment 1 and printing could be performed under good conditions. Further, even when the printing speed was raised up to 320 m/min, the printing ink did not drop, and printing was performed under good conditions.

Embodiment 9

[0079] An embodiment of the invention is described in detail below with reference to Fig. 12 and Fig. 13. This embodiment relates to the structure of a doctor blade unit according to the invention, and Fig. 12 is a side view of a key section of a gravure printing machine consisting of the printing drum 3, an ink reservoir 1 in which water based ink 4 is pooled, a inking roll 2 positioned in the side where a doctor blade unit 5 is provided for transferring and applying the water based ink 4 from the ink reservoir 1 onto the printing plate surface 3a, the doctor blade unit 5 for scraping off surplus ink from the printing plate surface 3a by contacting the two blade tips thereto, and a pressure roller 6 for pressing film 7 onto the printing plate surface 3a.

[0080] By providing the inking roll 2 in the side where the doctor blade unit 5 is positioned, there is provided the advantage that wetting failure can be prevented by reducing the quantity of ink dropping having been applied onto the printing plate surface 3a and also printing can be performed at a high speed.

[0081] The double-bladed doctor blade unit 5 has blade tips $5c_1$ and $5c_2$ supported by back plates $5b_1$ and $5b_2$ and fixed with the bracket 5a as shown in Fig. 13, but the structure is not limited to this one. For instance, a plurality of doctor blade units 5 each set with a discrete bracket may be provided.

[0082] A space between the blade tips $5c_1$ and $5c_2$ may be set to any value according to necessity.

[0083] Further the length of each of the back plates $5b_1$, $5b_2$ projecting from the bracket 5a and blade tips $5c_1$, $5c_2$ may be set to any value according to necessity.

[0084] The doctor blade unit 5 used in this embodiment is a double-bladed one as shown in Fig. 12, and the lengths of the back plates $5b_1$, $5b_2$ projecting from the bracket 5a as shown in Fig. 13 are 26 mm and 25 mm respectively, while the length of both the blade tips $5c_1$, $5c_2$ projecting from the back plates $5b_1$, $5b_2$ is 3.5 mm, and a space between the blade tips $5c_1$, $5c_2$ is 0.8 mm By using the bi-axial oriented polypropylene film 20p as a base material, a printing plate with 350 lines and the depth of 13 μ was prepared by a laser system, and printing with six colours was performed

by using water based gravure ink available from the market and five printing plates for indigo blue, red, yellow, black, and white colours.

[0085] In this case, the printing ink on the printing plate surface 3a was scraped off by the first blade tip $5c_2$ first and then by the second blade tip $5c_1$ from the printing plate surface 3a, and printing could be performed under good conditions without doctor blade unit cutting faults.

[0086] The number of doctor blade units 5 is practical up to three. The two or three blades may be provided at one position or at different positions. The conventional type of doctor blade unit 5 is generally made from stainless steel, and the configuration is allowable in which the first blade is made from stainless steel and the second one is made from another material.

[0087] The pressures loaded by the first and second knifes may be identical, or the pressure loaded by the first knife may be set to a higher pressure with that loaded by the second knife set to a lower pressure so that the second blade performs more of a wiping action.

Control 6

[0088] A control in which printing was performed with the doctor blade unit 5 shown in Fig. 14 and Fig. 15 using water based gravure ink is described below.

[0089] This doctor blade unit 5 in this case has one blade as in the conventional type of doctor blade unit as shown in Fig. 14, and in Fig. 15, the length of the back plate 5b projecting from the bracket 5a is 25 mm, and the length of the blade tip 5c projecting from the back plate 5b is 3.5 mm.

[0090] Dimensions and construction of this doctor blade unit 5 are the same as those of the first doctor blade unit in Embodiment 9. With this doctor blade unit 5, printing was performed by using the same base film, printing plates, and water based gravure ink as those in the Embodiment.

[0091] The results of comparison are as shown in Table 1which follows:

Table 1

	Embodiments	Controls
Fogging on a printing plate	Fogging was not generated for any colour even when printing was performed up to 20,000 m Printing could be continued for double or more the period of time as compared to that in the control	Fogging occurred when printing was performed up to 10,000 m Especially fogging occurred frequently in the cases of black ink (including carbon therein) and white ink (including titanium white)
Abrasion of doctor blade unit	As the doctor pressure was reduced to 1.5 kg, printing could be performed even up to 24,000 m continuously,	As the doctor blade unit had only one blade, the doctor pressure was set to 2 kg, and printing came to the limit at the length of 12,000 m
Wearing of a printing plate	For the reason as described above, printing could be performed up to 100,000 m or more continuously	Printing limit was at the length of 70,000 m due to the same cause.
Printing speed	Printing could be performed even at the printing speed of 150 m/min.	Printing came to the limit at the printing speed of 120 m/min.

[0092] As described above, by taking necessary measures in the gravure cylinder production process to allow use of gravure printing technology using water based gravure ink, it is possible to obtain printed matter with the same quality as that realised by using conventional oil based ink. Namely, by using a printing plate with a number of lines and small engraving depth, it is possible to solve the problems concerning quality of printed matter and productivity as well as that concerning gradation in printing caused in association with drying failure being an intrinsic defect of water based ink along with fogging of a printing plate due to the difficulty of water based ink in resolving in a water solvent or wetting failure of a surface of the printing plate

[0093] Further by using water based gravure ink, it is possible to solve labour problems, accident prevention and to prevent of environmental pollution due to emission of organic solvent vapour to the atmosphere. The present invention provides advantages, for instance, in the food packaging industries using plastic films as base materials.

[0094] As the quantity of ink pooled in the ink reservoir can be minimised, a quantity of ink remaining on an ink reservoir can be reduced from about 20 kg/reservoir in the conventional technology to about 5 kg/reservoir. As a result,

it is possible to reduce the ink cost and the cost of stocking left-over ink, and thus save resources.

[0095] Printing ink is applied from a inking roll at a position where the printing plate surface is moving (rotating) upward, so that the printing ink does not scatter during high speed printing and further the problem of wetting failure does not occur, even if water based gravure ink with high surface tension is used.

[0096] The contact pressure of a doctor blade unit tip on a printing plate surface is optimised in gravure printing performed using water based ink, and fogging does not occur on the printing plate surface.

[0097] Inking rolls are provided both in the side opposite to the knife edge and in the side where the knife edge is positioned, and in addition, when required, between the two sides, printing ink is sufficiently applied to a surface of a printing plate, and wetting failure does not occur even when water based gravure ink with high surface tension is used, so that high quality printed matter can be obtained without causing blurring or fogging

[0098] For the reasons described above, with the present invention, printing can be performed with water based gravure ink to avoid environmental pollution. Further when oil based gravure ink is used, the printing speed can be increased.

[0099] A plurality of doctor blade knives for water based gravure printing machines are provided, so that the doctor blade knives function to scrape off surplus ink from the printing plate surface, so that high-quality printed matter can be obtained, even when water based printing ink having high surface tension and low resolving power in a water solvent is present.

[0100] Further, as the doctor blade unit pressure can be set to a low level, abrasion of the doctor blade unit and wearing of the printing plate can be reduced, so that not only the printing speed can be raised but also the productivity can be improved.

[0101] This invention thus provides a photogravure printing method and machine for printing films (7) uses a water based ink and avoids customary problems associated with wetting of the plate, bleed, fogging and drying by using a printing drum (3) having between 200 and 400 mesh lines with a depth between 10 and 17 μ. Left-over ink may be reduced by having an ink reservoir formed with a trough (4) into which the inking roller (2) dips the trough (4) being associated with a drip tray (1a) located beneath the printing drum (3). Printing may be improved further by using a doctor blade assembly (5) having two blades of differing resilience. In a modification two inking rollers are used in spaced relationship at the lower part of the printing drum.

Claims

1. A gravure printing apparatus for carrying out a gravure printing method using a water based gravure ink, **characterised in that** the apparatus includes a printing drum having between 200 and 400 mesh lines with a depth between 10 and 17 μ.

2. A gravure printing apparatus in accordance with claim 1, including an ink reservoir, **characterised in that** the ink reservoir has a deep ink containing trough located within a shallow tray, the trough being arranged to accommodate an inking roll which dips therein, the printing drum being located over the tray outside said ink pool.

3. A gravure printing apparatus in accordance with claim 1 or 2,, **characterised in that** an inking roll associated with the apparatus is located on the same side of the printing drum as a doctor blade unit.

4. A gravure printing apparatus in accordance with any preceding claim,, **characterised in that** a doctor blade unit for the apparatus has a back plate support which projects by a length of from 20 mm to 30 mm from a clamp, the doctor blade projecting from the back plate by between 3 mm and 4 mm.

5. A gravure printing apparatus in accordance with any preceding claim, **characterised in that** a plurality of inking rolls are provided.

6. A gravure printing apparatus in accordance with any preceding claim, **characterised in that** an inking roll associated with the apparatus is located on the same side of the printing drum as a doctor blade unit, with a further inking roll located on the side of the printing drum opposed to the doctor blade unit.

7. A gravure printing apparatus in accordance with claim 6, **characterised in that** one or more inking rolls are provided between the doctor blade unit and the inking roll positioned on the side opposite to the doctor blade unit.

8. A gravure printing apparatus in accordance with any preceding claim, **characterised in that** a doctor blade unit for the apparatus includes a plurality of doctor blades.

9. A gravure printing apparatus in accordance with claim 8, **characterised in that** two doctor blades are provided.

10. A gravure printing apparatus in accordance with claim 9, **characterised in that** two doctor blades are provided the pressure of one blade being equal to or larger than the pressure of the other blade, and wherein the pressure of the leading blade is greater than that of the trailing blade.

11. A gravure printing apparatus in accordance with claim 9, **characterised in that** two doctor blades are provided, the material of the leading doctor blade unit being different from the material of the trailing doctor blade.

Patentansprüche

1. Tiefdruckvorrichtung zur Durchführung eines Tiefdruckverfahrens unter Verwendung von Tiefdruckfarben auf Wasserbasis, **dadurch gekennzeichnet, dass** die Vorrichtung eine Druckwalze mit 200 bis 400 Gitternetzlinien mit einer Tiefe zwischen 10 µ und 17 µ aufweist.

2. Tiefdruckvorrichtung nach Anspruch 1 mit einem Druckfarbenbehälter, **dadurch gekennzeichnet, dass** der Druckfarbenbehälter eine in einer seichten Schale angeordnete tiefe Wanne mit Druckfarbe aufweist, wobei die Wanne zur Aufnahme einer in ihr eintauchenden Farbauftragswalze ausgelegt ist, wobei die Druckwalze außerhalb des Druckfarbenbassins über der Schale angeordnet ist.

3. Tiefdruckvorrichtung nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** eine mit der Vorrichtung verbundene Farbauftragswalze auf der selben Seite der Druckwalze wie eine Rakeleinheit angeordnet ist.

4. Tiefdruckvorrichtung nach einem der voranstehenden Ansprüche, **dadurch gekennzeichnet, dass** eine Rakeleinheit für die Vorrichtung eine abstützende Hinterplatte aufweist, die um eine Länge von 20 mm bis 30 mm über eine Klemme hinausragt, wobei die Rakel um 3 mm bis 4 mm über die Hinterplatte hinausragt.

5. Tiefdruckvorrichtung nach einem der voranstehenden Ansprüche, **dadurch gekennzeichnet, dass** mehrere Farbauftragswalzen vorgesehen sind.

6. Tiefdruckvorrichtung nach einem der voranstehenden Ansprüche, **dadurch gekennzeichnet, dass** eine mit der Vorrichtung verbundene Farbauftragswalze auf der selben Seite der Druckwalze angeordnet ist wie eine Rakeleinheit, wobei sich eine weitere Farbauftragswalze auf der der Rakeleinheit gegenüberliegenden Seite der Druckwalze befindet.

7. Tiefdruckvorrichtung nach Anspruch 6, **dadurch gekennzeichnet, dass** eine oder mehrere Farbauftragswalzen zwischen der Rakeleinheit und der Farbauftragswalze, welche auf der der Rakeleinheit gegenüberliegenden Seite angeordnet ist, vorgesehen sind.

8. Tiefdruckvorrichtung nach einem der voranstehenden Ansprüche, **dadurch gekennzeichnet, dass** eine Rakeleinheit für die Vorrichtung mehrere Rakel aufweist.

9. Tiefdruckvorrichtung nach Anspruch 8, **dadurch gekennzeichnet, dass** zwei Rakel vorgesehen sind.

10. Tiefdruckvorrichtung nach Anspruch 9, **dadurch gekennzeichnet, dass** zwei Rakel vorgesehen sind, wobei der Druck der einen Rakel größer oder gleich dem Druck der anderen Rakel ist, und wobei der Druck der vorderen Rakel höher als der Druck der hinteren Rakel ist.

11. Tiefdruckvorrichtung nach Anspruch 9, **dadurch gekennzeichnet, dass** zwei Rakel vorgesehen sind, wobei das Material der vorderen Rakeleinheit ein anderes als das Material der hinteren Rakel ist.

Revendications

1. Appareil d'impression en creux destiné à exécuter un procédé d'impression en creux utilisant une encre hélio à base d'eau, **caractérisé en ce que** l'appareil comprend un cylindre d'impression ayant entre 200 et 400 lignes de maillage avec une profondeur comprise entre 10 et 17 µ.

2. Appareil d'impression en creux selon la revendication 1, comprenant un réservoir d'encre, **caractérisé en ce que** le réservoir d'encre a un bac profond contenant de l'encre situé à l'intérieur d'un plateau peu profond, le bac étant agencé afin de lever un rouleau encreur qui trempe dans celui-ci, le cylindre d'impression étant situé au-dessus du plateau à l'extérieur dudit bassin d'encre.

3. Appareil d'impression en creux selon la revendication 1 ou 2, **caractérisé en ce qu'**un rouleau encreur associé à l'appareil est situé sur le même côté du cylindre d'impression que l'unité de racle.

4. Appareil d'impression en creux selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**une unité de racle pour l'appareil a un support de plaque arrière qui fait saillie sur une longueur de 20 mm à 30 mm depuis un pressoir, la racle faisant saillie depuis la plaque arrière sur une longueur comprise entre 3 mm et 4 mm.

5. Appareil d'impression en creux selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**une pluralité de rouleaux encreurs sont mis à disposition.

6. Appareil d'impression en creux selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**un rouleau encreur associé à l'appareil est situé sur le même côté du cylindre d'impression que l'unité de racle, avec un rouleau encreur supplémentaire situé sur le côté du cylindre d'impression opposé à l'unité de racle.

7. Appareil d'impression en creux selon la revendication 6, **caractérisé en ce qu'**un ou plusieurs rouleaux encreurs sont mis à disposition entre l'unité de racle et le rouleau encreur positionné sur le côté opposé à l'unité de racle.

8. Appareil d'impression en creux selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**une unité de racle pour l'appareil comprend une pluralité de racles.

9. Appareil d'impression en creux selon la revendication 8, **caractérisé en ce que** deux racles sont mises à disposition.

10. Appareil d'impression en creux selon la revendication 9, **caractérisé en ce que** deux racles sont mises à disposition, la pression d'une racle étant égale à ou supérieure à la pression de l'autre racle, et dans lequel la pression de la racle principale est supérieure à celle de la racle secondaire.

11. Appareil d'impression en creux selon la revendication 9, **caractérisé en ce que** deux racles sont mises à disposition, le matériau de l'unité de racle principale étant différent du matériau de la racle secondaire.

Fig.1

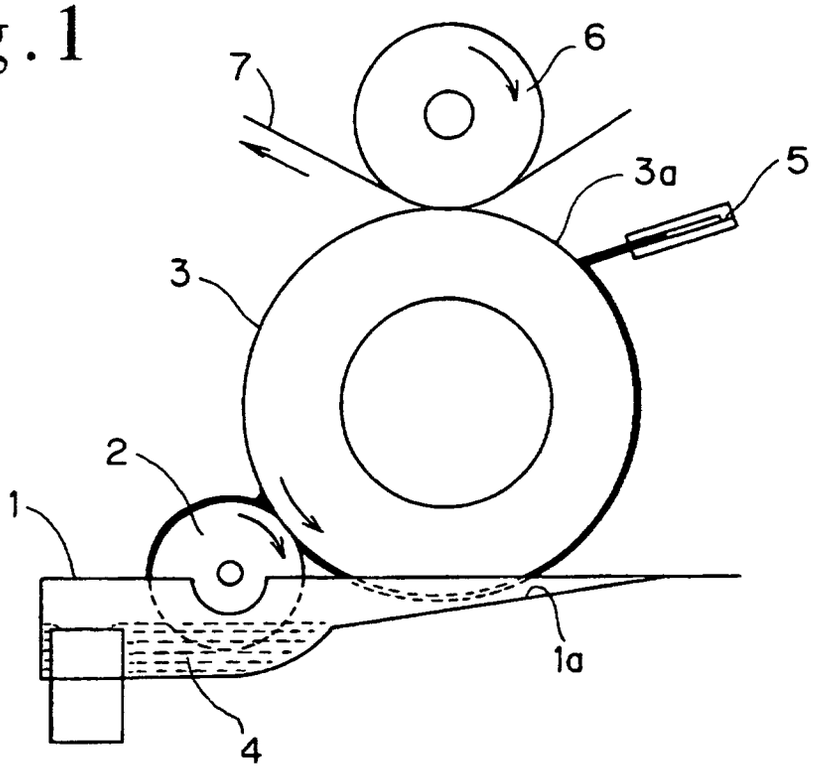


Fig.2

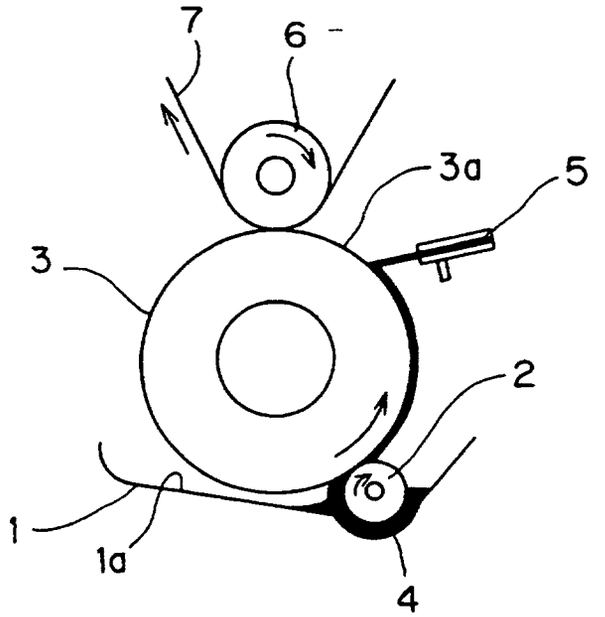


Fig.3

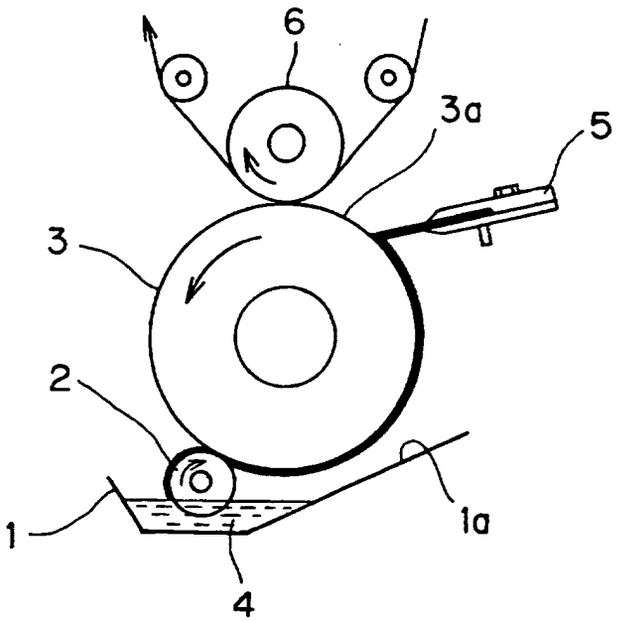


Fig.4

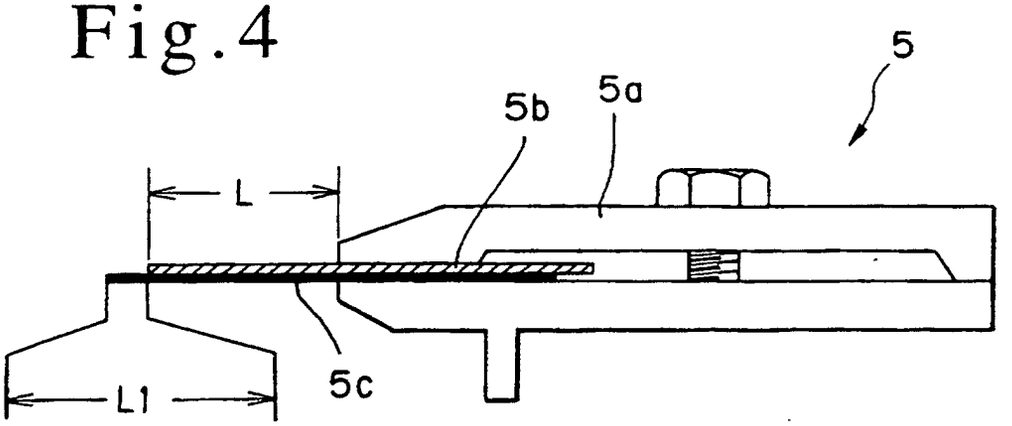


Fig.5

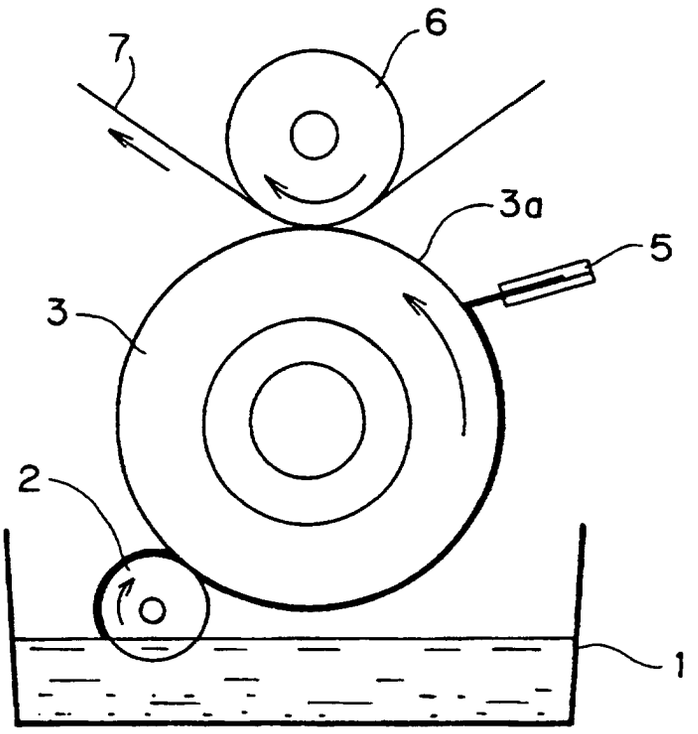


Fig.6

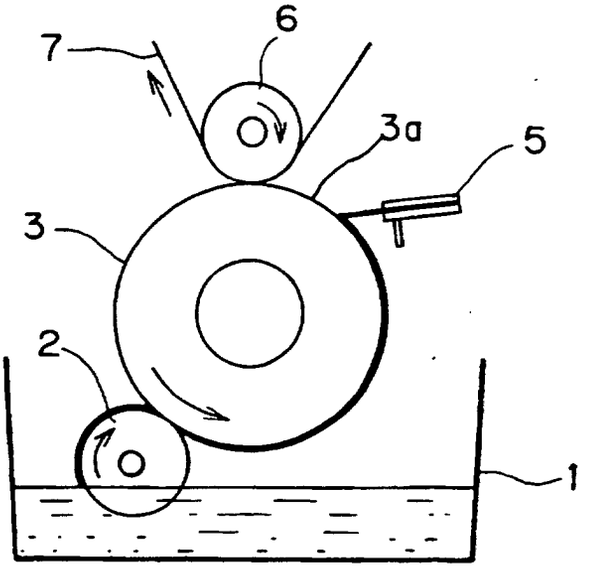


Fig.7

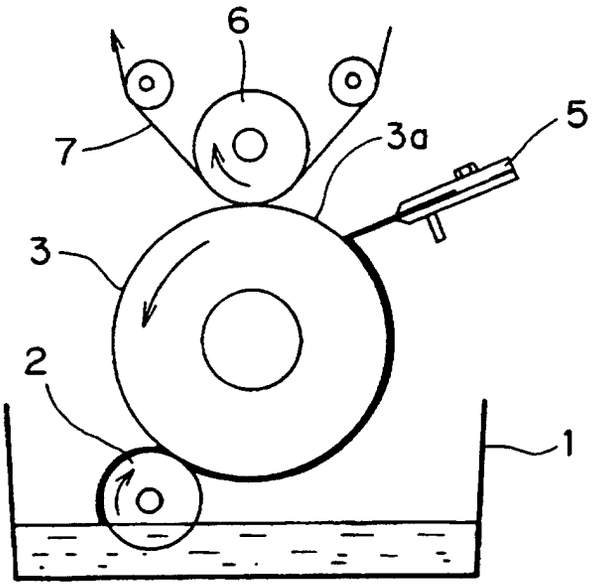


Fig.8

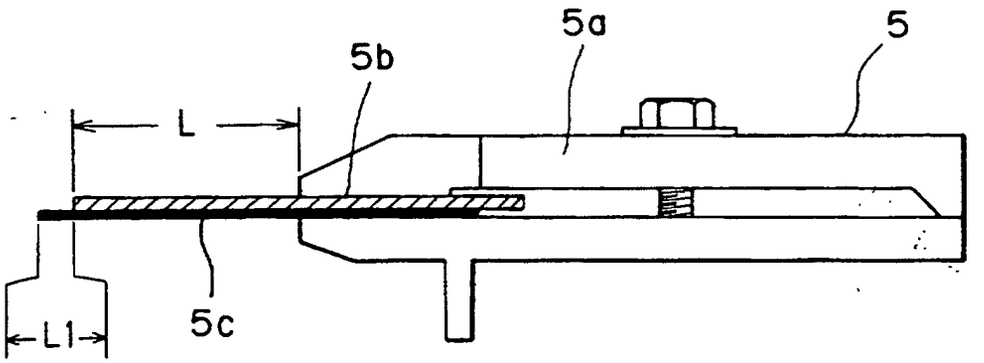


Fig.9

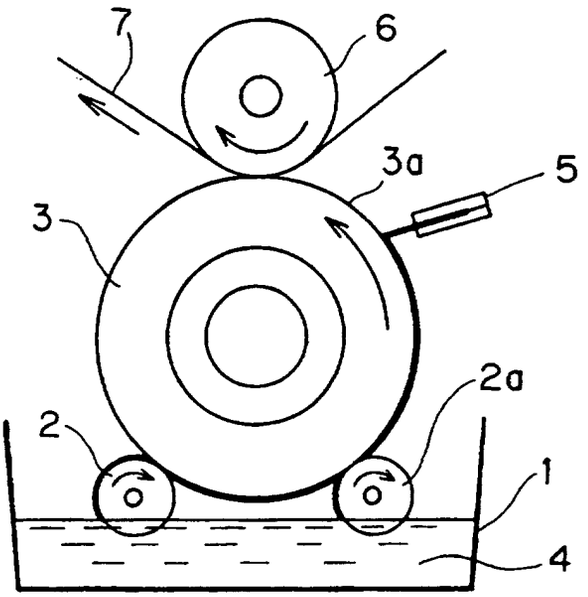


Fig.10

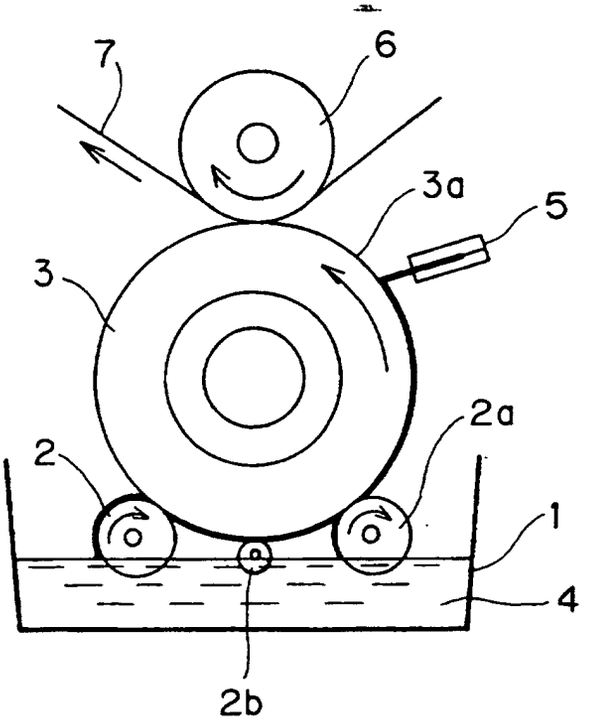


Fig. 11

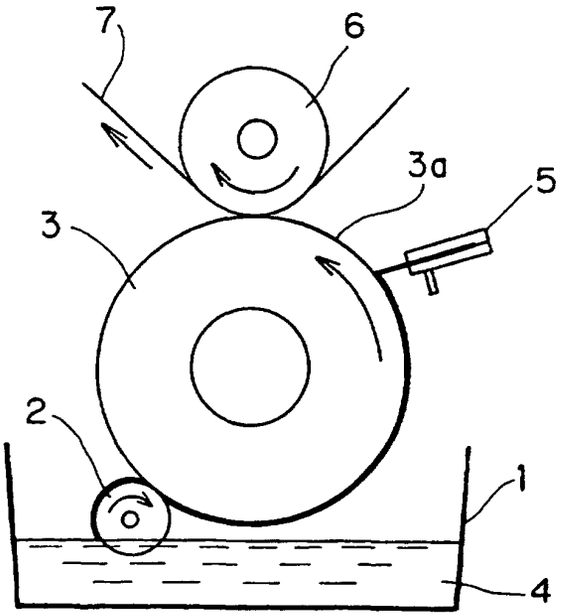


Fig. 12

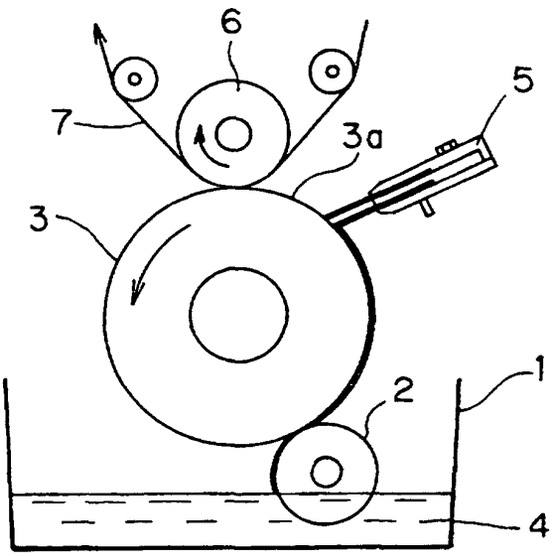


Fig. 13

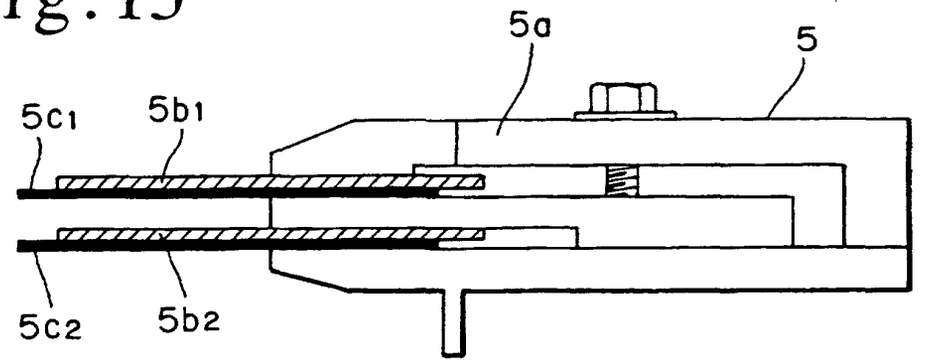


Fig. 14

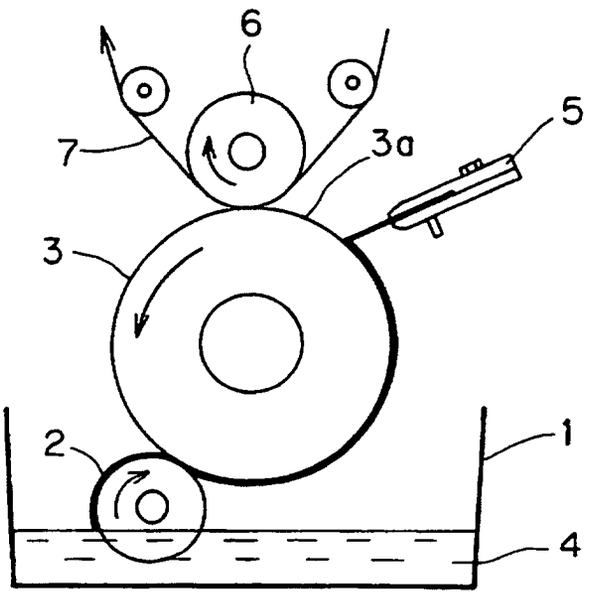


Fig. 15

