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(54) Printing process.

(57) There is provided a printing process comprising liquefying an ink which is solid at room temperature, applying the liquefying ink onto a plate having a pattern, and transferring the ink from the plate to a transfer-receiving medium to form thereon an ink pattern. The above-mentioned solid ink is easy to handle and the resumption of the printing process is easy even after the printing machine supplied with the ink is left standing for a long time.

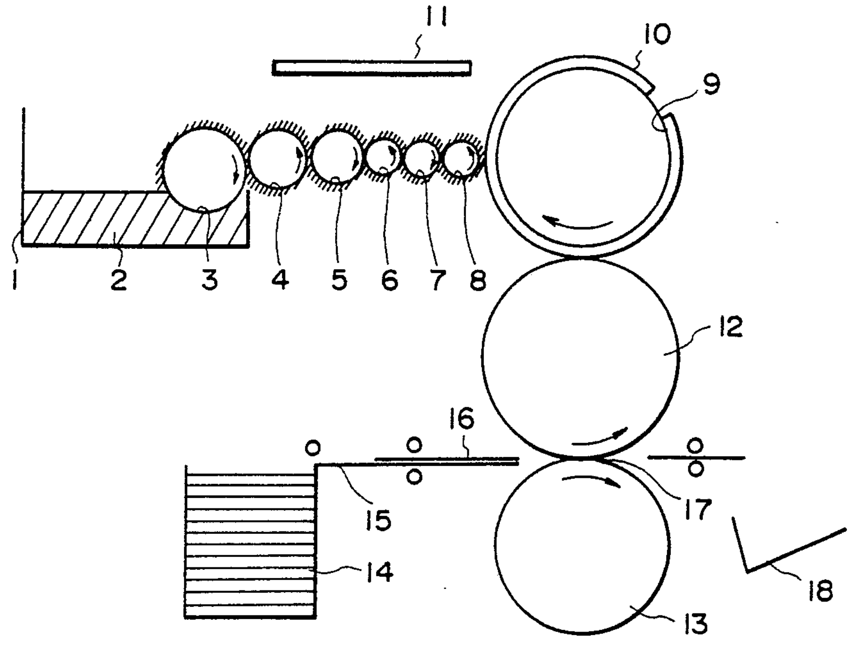

FIG. 1

PRINTING PROCESS

FIELD OF THE INVENTION AND RELATED ART

The present invention relates to a printing process.

Hitherto, planographic offset printing, letterpress printing, etc., have been used as printing processes. In these conventional printing processes, there have been used liquid high-viscosity printing inks comprising vehicles therefor which comprise drying oils, semidrying oils, high-boiling point solvents, resins, etc. Accordingly, in the conventional printing processes, it is very inconvenient to handle the printing ink when it is supplied to a printing press or machine, or the printing ink tends to stain clothes or hands very often.

Further, in the conventional printing process, when the printing machine supplied with the printing ink is as such left standing for a long time, the printing ink is dried whereby it is impossible to resume the printing. As a result, in the conventional printing process, the maintenance of the printing machine is very troublesome.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a printing process wherein the printing ink to be used is easy to handle, and the resumption thereof is easy even after the printing machine supplied with the printing ink is as such left standing for a long time.

According to the present invention, there is provided a printing process comprising: liquefying an ink which is solid at room temperature; applying the liquefied ink onto a plate having a pattern; and transferring the ink from the plate to a transfer-receiving medium thereby to form thereon an ink pattern corresponding to the pattern of the plate.

These and other objects, features and advantages of the present invention will become more apparent upon a consideration of the following description of the preferred embodiments of the present invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic side sectional view showing an embodiment of the apparatus for practicing the printing process according to the present invention; and

Figure 2 is a schematic side sectional view showing another embodiment of the apparatus for practicing the printing process according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In the printing process according to the present invention, as specifically described hereinafter, there is used a solid ink which is solid at room temperature (generally, 20 - 30 °C). The solid ink used in the present invention may include an ink in the form of powder.

Referring to Fig. 1, a solid ink 2 contained in an ink container (or tank) 2 is moved toward a plate cylinder 9 by means of rollers 3 - 8 respectively rotating in the direction of arrows shown in Fig. 1, and supplied to a plate 10 disposed on the plate cylinder 10. As the solid ink 2 is conveyed from the roller 4 to the roller 8, the solid ink 2 disposed on the roller is gradually converted into a thin layer form. Accordingly, the amount of the ink supplied to the plate 10 may suitably be controlled by regulating the number of such rollers 4 - 8. Examples of the material constituting the rollers 3 - 8 may include metal, resin, elastomer such as rubber, etc. Among these, elastomer is particularly preferred.

Above the rollers 3 - 8, a heating device 11 is disposed as desired. In the process of conveying the solid ink 2 from the ink container 1 to the plate 10, the solid ink 2 is converted into a liquid form (i.e., supplied with an adhesiveness to the plate 10), e.g., by heating it up to a temperature of the softening point thereof or higher. As a result, the liquefied ink is supplied to the plate 10.

More specifically, the thus liquefied ink may preferably have an adhesiveness as follows.

On the surface of the liquefied ink, a 0.1 mm - thick aluminum foil of 5 cm x 5 cm in size is, after being accurately weighed, placed gently and is left standing as it is for 1 min. in an environment of a moisture of 60 %. Then, the aluminum foil is gently peeled off from the surface of the ink and then quickly weighed accurately to measure the increase in weight of the aluminum foil. Through the measurement, the liquefied ink used in the present invention should preferably show a weight increase of the aluminum foil of 20 mg or more, more preferably 50 mg or more.

Referring to Fig. 1, the heating device 10 may be known one such as an infrared lamp, a resistor capable of generating heat due to current conduction therethrough. Instead of the heating device 11 disposed above the rollers 3 - 8, heating devices (not shown) may be disposed inside the rollers 3 - 8.

The liquefied ink is applied onto the plate 10 by means of the roller 8, and the thus applied ink is then transferred to a blanket cylinder 12 to form an ink pattern corresponding to the pattern of the plate 10, as the plate cylinder 9 rotates. the plate 10 may be known one. Example thereof may include, e.g., a plate for offset printing, a plate for gravure printing, a relief, etc.

Below the blanket 12; an impression cylinder 13 is disposed opposite thereto. A transfer-receiving paper 16, (i.e., medium to be recorded) 16 is supplied to the nip portion 17 between the impression cylinders 13 and the blanket 12 in synchronism with the ink pattern formed on the blanket 12. A large number of sheets of the transfer-receiving paper are stored in a reservoir 14 and they are sequentially sent out to a conveying path 15.

The transfer-receiving paper 16 is moved by the rotation of the blanket 12 and the impression cylinder 13, and contacts the ink pattern formed on the blanket 12 at the nip portion 17, whereby the ink pattern is transferred to the transfer-receiving paper 16. The transfer-receiving paper 16 onto which the ink pattern is transferred is discharged from the nip portion 17, and falls into a tray 18.

In the present invention, the blanket 12 is omissible in some cases. In such case, an ink pattern formed on the plate 10 may be transferred to the transfer-receiving paper 16 directly. However, the blanket 12 may preferably be disposed, because the abrasion of the plate 10 due to the transfer-receiving paper 16 can be prevented, and an image having the same pattern as that of the plate 10 can be obtained on the transfer-receiving paper 16. The material constituting the plate cylinder 9, blanket 12 and impression cylinder 13 may be metal, resin, an elastomer such as rubber, etc.

Hereinbelow, the solid ink used in the present invention is described in more detail.

The solid ink used in the present invention may be either a material in the form of a block or mass having certain dimensions, or a material in the form of powder. More specifically, the solid ink may preferably be a powder material (i.e., a group of particles having a particle size of 1 mm or smaller), or a block material which has a shape-retaining property under ordinary conditions (i.e., 1 atmosphere, 25 °C, relative humidity of 60 %). It is further preferred that the solid ink does not have an adhesiveness.

In the present invention, the above-mentioned shape-retaining property may for example be evaluated in the following manner.

A solid ink in the form of a block having a volume of 1 cm^3 (1 cm x 1 cm x 1 cm) is caused to stand still on a flat floor (e.g., the surface of a plate of stainless steel) under the condition of 1 atm. for one hour. Thereafter, the maximum height of the block counted from the floor surface (i.e., shape-retaining height) is measured. In the present invention, the above-mentioned shape-retaining height may preferably be 0.9 cm or larger, because such solid ink has a high shape-retaining property.

In the present invention, the above-mentioned adhesiveness may for example be evaluated in the following manner.

An aluminum foil having a thickness of 0.1 mm is caused to stand still on a solid ink to be evaluated for 5 sec. or more. Thereafter, the aluminum foil is peeled from the solid ink. In such measurement, the solid ink used in the present invention may preferably show a non-adhesiveness such that the solid ink is not substantially attached to the above-mentioned aluminum foil (i.e., substantial attachment thereof is not confirmed when observed with the naked eye).

More specifically, the solid ink at room temperature may preferably have a non-adhesiveness as follows.

On the surface of the solid ink, an 0.1 mm -thick aluminum foil of 5 cm x 5 cm in size is, after being accurately weighed, placed gently and is left standing as it is for 1 min. in an environment of a temperature of 25 °C and a moisture of 60 %. Then, the aluminum foil is gently peeled off from the surface of the ink and then quickly weighed accurately to measure the increase in weight of the aluminum foil. Through the measurement, the solid ink used in the present invention should preferably show a weight increase of the aluminum foil of 10 mg or less, more preferably 2 mg or less.

In an embodiment of the present invention wherein the solid ink is in the form of powder, particles constituting the solid ink may preferably have a volume-average particle size of 0.1 - 1,000 microns, more preferably 10 - 100 microns. If the volume-average particle size is smaller than 0.1 micron, the fluidity of the ink is undesirably too low. On the other hand, the volume-average particle size is larger than 1,000 microns, the resultant image quality undesirably decreases. In the present invention, the above volume-average particle size may be measured by means of a Coulter counter with a 100 microns -aperture.

The particles constituting the solid ink in the form of powder may be microcapsules comprising a core material and a shell material. In such case, the core of the microcapsule can also be a liquid material. Further, when a tacky solid material is converted into a microcapsule form by coating it with a shell material, the handling thereof becomes very easy.

In a case where a block having certain dimensions (i.e., a material other than powder) is used as the solid ink, it is preferred to keep the ink contained in the ink container 1 in a liquid state by heating the ink container 1.

Further, as shown in Fig. 2, the solid ink 2 may be shaped into a bar form and used by encasing it in a case 20. In the embodiment as shown in Fig. 2, the solid ink 2 in the bar form may continuously be pushed toward the roller 3 by means of a spring 21, etc., so that it may be applied onto the surface of the roller 3 along with the rotation of the roller 3. In such case, the ink container 1 may be omitted.

In an embodiment wherein the solid ink 2 comprises microcapsules comprising a liquid core material, the heating means 11 is omissible. In such case, the microcapsules may be ruptured by the pressure applied between the rollers 3 - 8, whereby the solid ink 2 is liquefied.

The solid ink (or the shell material in the case of the solid ink comprising microcapsules) may preferably have a softening point of 40 - 150 °C, more preferably 50 - 120 °C, according to the ring and ball method (JIS K 2531).

The solid ink (or the core material in a case where the solid ink comprises microcapsules) used in the present invention may preferably be a mixture comprising a wax and a colorant contained therein; or a gel, in a broad sense, comprising a liquid dispersion medium and a crosslinked substance impregnated therewith; etc.

Examples of the wax may include: natural waxes such as whale wax, beeswax, lanolin, carnauba wax, candelilla wax, montan wax, ceresin wax and the like; petroleum waxes such as paraffin wax and microcrystalline wax; synthetic waxes such as oxidized wax, ester wax, low-molecular weight polyethylene, Fischer-Tropsch wax and the like; etc.

In the present invention, various known dyes or pigments may be used as the colorant. Specific examples of such colorant may include known dyes or pigments such as carbon black, Nigrosin dyes, lamp black, Sudan Black SM, Fast Yellow G, Benzidine Yellow, Pigment Yellow, Indo Fast Orange, Irgadine Red, Paranitroaniline Red, Toluidine Red, Carmine FB, Permanent Bordeaux FRR, Pigment Orange R, Lithol Red 20, Lake Red C, Rhodamine FB, Rhodamine B Lake, Methyl Violet B Lake, Phthalocyanine Blue, Pigment Blue, Brilliant Green B, Phthalocyanine Green and Oil Yellow GG. These dyes or pigments may be used singly or a combination of two or more species as desired. The colorant may preferably be used in an amount of 0.1 -40 wt. %, more preferably 1 - 20 wt. %, based on the total weight of the ink.

In a case where the solid ink comprises a wax and a colorant contained therein, an organic solvent may also be contained in the non-microcapsular solid ink. In such case, the organic solvent content may preferably be 50 wt. % or less, more preferably 30 wt. % or less, in view of the storability of the ink.

As described above, the solid ink may also be a gel, in a broad sense, comprising a liquid dispersion medium and a crosslinked substance impregnated therewith.

Herein, the "crosslinked substance" refers to a single substance which per se can assume a crosslinked structure, such as those generally known as a thickness or a telling agent, or a mixture of a substance capable of assuming a crosslinked structure with the aid of an additive such as a crosslinking agent for providing a crosslinking ion such as borate ion, and the additive. Further, the term "crosslinked structure" refers to a three-dimensional structure having a crosslinkage or crosslinking bond. The crosslinkage may be composed of any one or more of covalent bond, ionic bond, hydrogen bond and van der Waal's bond, but may preferably be composed of ionic bond and/or hydrogen bond in order to satisfy the above-mentioned fluidity and liquid dispersion medium-retaining property of the ink in combination. More specifically, the crosslinked structure may be any one of a network, a honeycomb, a helix, etc., or may be an irregular one.

Examples of the crosslinked substance for providing the above-mentioned gel may include: natural polymers including plant polymers such as guar gum, locust bean gum, gum arabic, tragacanth, carrageenah, pectin, mannan, and starch; microorganism polymers such as xanthane gum, dextrin, succinoglucan, and curdran; animal polymers such as gelatin, casein, albumin, and collagen; semi-synthetic polymers including cellulose polymers such as methyl cellulose, ethyl cellulose, and hydroxyethyl cellulose, starch polymers such as soluble starch, carboxymethyl starch, methyl starch; alginic acid polymers such as propylene glycol alginate, and alginic acid salts; and other semi-synthetic polymers such as derivatives of polysaccharides; synthetic polymers including vinyl polymers such as polyvinyl alcohol, polyvinylpyrrolidone, polyvinyl methyl ether, carboxyvinyl polymer, and polysodium acrylate; and other synthetic polymers such as polyethylene glycol, and ethylene oxide-propylene oxide block copolymer. These polymers may be used singly or in mixture of two or more species, as desired.

In the present invention, the above-mentioned crosslinking agent may be a compound containing aluminum, titanium, boron, etc. The crosslinking agent may preferably be used in an amount of 20 wt. % or less based on the weight of the crosslinked substance.

The liquid dispersion medium constituting the gel composition in combination with the above-mentioned crosslinked substance may preferably be a less vaporizable liquid, in view of the ink storability and environmental sanitation. More specifically, there may preferably used a liquid having a (saturation) vapor pressure of 15 mm Hg or below, more preferably 1 mm Hg or below, particularly preferably 0.1 mm Hg or below at 20 °C, in view of less vaporization.

Examples of such liquid dispersion medium may include: polyhydric alcohols such as ethylene glycol, propylene glycol, sorbitol, mannitol, diethylene glycol, triethylene glycol, tetraethylene glycol, polyethylene glycol and glycerin; glycol ethers such as ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, and ethylene glycol monobutyl ether; nitrogen-containing compounds such as triethanolamine, formamide, dimethylformamide, dimethyl sulfoxide, N-methyl-2-pyrrolidone, and 1,3-dimethylimidazolidinone. the content of the liquid dispersion medium may preferably be 90 wt. % or less, more preferably 60 wt. % or less, based on the total weight of the solid ink.

The solid ink may preferably be a gelatin gel containing gelatin in an amount of 5 - 50 wt. %, as the above-mentioned crosslinked substance, in view of printability; supercooling property, etc., because such gel may shown in temperature at a relatively low a large change in adhesiveness corresponding to a small difference temperature. In a case where the above-mentioned gelatin gel is used, the solid ink may preferably contain water in view of solubility and stability thereof. More preferably, the solid ink may contain a liquid dispersion medium comprising a mixture of water and a polyhydric alcohol, in view of the stability.

In a case where the solid ink comprises microcapsules, the shell material constituting them may preferably be polyamide such as nylon, gelatin, urea-formalin resin, melamine-formalin resin, polyurethane, etc. When the core material comprises a liquid, the liquid may preferably be alkylnaphthalene, biphenyl derivatives, linseed oil, chlorinated paraffin, etc.

The amount of a colorant contained the ink may preferably be 0.5 - 40 wt. %, more preferably 1 - 20 wt. %, based on the total weight of the ink (or the core material in the case of the microcapsular ink).

In order to form microcapsules, there may be used known microencapsulation techniques such as the in-situ polymerization method, the interfacial polymerization method, and the orifice method.

As described hereinabove, according to the present invention, there is provided a printing process wherein a solid ink which is solid at room temperature is liquefied to effect printing. According to the printing process of the present invention, it is very easy to handle the ink and the frequency of staining of clothes or hands is very low. Further, the printing machine can be operated immediately, even after it is left standing for a long time. As a result, the operability of the printing machine may be enhanced and the maintenance thereof becomes easier.

Hereinbelow, the present invention will be explained in further detail with reference to Examples.

Example 1

Liquid A

Diisopropylbiphenyl	20 wt. parts
Coronate L[*1] (mfd. by Nihon Polyurethane K.K.)	3 wt. parts
Ethyl acetate	6 wt. parts
Macrolex Red 5B (mfd. by Bayer)	0.2 wt. parts

[*1]: Tri-functional isocyanate obtained by reacting 1 mole of trimethylolpropane with 3 moles of tolylene diisocyanate.

The above components were sufficiently mixed to prepare a liquid A.

Liquid B

Colloidal Silica RA200-5 [*2]	0.6 wt. parts
Water	120 wt. parts

*2: Product obtained by treating 100 wt. parts of Aerosil 200 (mfd. by Nihon Aerosil K.K.) with 5 wt. parts of aminopropyltriethoxysilane.

The above components were sufficiently mixed to prepare a liquidB.

The liquid B was mixed with the above liquid A, and subjected to mixing by means of a homomixer at 7,000 rpm for 30 min. Then, the mixture was heated up to 60 °C, subject to mixing at 200 rpm for three hours and subjected to filtration and drying, thereby to prepare a solid ink in a powder form comprising microcapsules having a volume-average particle size of 11 microns.

By using the thus prepared solid ink, printing was effected by means of a printing machine as shown in Fig. 1.

Referring to Fig. 1, a plate 10 was prepared in the following manner. A paint comprising a fluorine-containing polymer (trade name: FC-721, Sumitomo Three-Emu K.K.) as an ink-adherent liquid was applied onto a 50 micron-thick polyimide film to form an about 3 microns-thick paint layer. Then, a desired pattern was formed on the fluorine-containing polymer paint layer by electrophotography by using toner particles which had a volume-average particle size of 4.4 microns and predominantly comprised a styrene-acrylic resin and carbon black. The above prepared plate 10 was wound about an aluminum plate cylinder 9 having a diameter of 20 cm.

Referring again to Fig. 1, the above-mentioned solid ink 2 was charged in an ink tank 1 and printing was effected by rotating rollers 3 - 8 so as to rotate the above-mentioned plate cylinder 9 at 10 rpm. The solid ink was crushed by the rollers 3 - 8 and liquefied, and was applied onto the plate 10. Then, the ink applied onto the plate 10 was transferred to a transfer-receiving paper 16 by the medium of a blanket cylinder 12 having a diameter of 20 cm. As a result, the liquefied ink penetrated into the transfer-receiving paper 16 thereby to provide a good image which was faithful to the original pattern formed on the plate 10.

After the printing, the ink disposed on the rollers 3 - 8 was removed, and the printing machine was left standing for 10 days while retaining the ink 2 in the ink tank 1 as such. Thereafter, printing was again effected whereby the same images as described above were obtained.

Example 2

Liquid A

Diisopropylnaphthalene	80 wt. parts
Adipic acid chloride	12 wt. parts
Terephthalic acid chloride	4 wt. parts
Kayaset Blue (mfd. by Nihon Kayaku K.K.)	2.2 wt. parts
Dioctyl phthalate	10 wt. parts

Liquid B

Colloidal silica RA 200-5 (the same as in Example 1)	1.2 wt. parts
Water	140 wt. parts

Liquid C

Diethylenetriamine	6 wt. parts
Tri (γ-aminopropyl) methane	10 wt. parts
Water	40 wt. parts

The above components were respectively sufficiently mixed to prepare a liquid A, a liquidB and a liquidC.

The liquid B was mixed with the above liquid A, and subjected to mixing by means of a homomixer at 8,500 rpm for 15 min. Then, the above liquid C was added to the resulted mixture and heated up to 40 °C, stirred for three hours at 100 rpm and subjected to filtration and drying, thereby to prepare a solid ink in a powder form comprising microcapsules, having a volume-average particle size of 16 microns.

By using the thus prepared solid ink, printing was effected in the same manner as in Example 1. As a result, good images were obtained similarly as in Example 1.

The printing machine was left standing for 10 days in the same manner as in Example 1, and thereafter printing was effected. As a result, there were obtained good images which were substantially the same as mentioned above (i.e., before the printing machine was left standing).

Example 3

A solid ink capable of liquefying under heating and pressure was prepared in the following manner.

Paraffin wax 130 °F (mfd. by Nihon Seiro K.K, softening point = 54 °C)	100 wt. parts
Carbon black (mfd. by Cabot Co.)	5 wt. parts

The above components were mixed at 60 °C for three hours by means of an attritor, thereby to prepare an ink which was solid at room temperature. when the thus prepared ink was subjected to the measurement of the shape-retaining height and the adhesion to an aluminum foil, in the above-described manner, it showed a shape-retaining height of 1.0 cm and substantially no adhesion.

The thus prepared ink was subjected to printing by means of the printing machine in the same manner as in Example 1 except that the ink 2 was heated up to 70 °C in the ink tank 1 and an infrared lamp 11 was disposed above the rollers 4 - 8 so that the roller surfaces were heated up to 65 °C to liquefy the ink disposed on the rollers.

In such state, the heating due to the infrared lamp was stopped and left standing for 10 days. Thereafter, the ink was again heated by the infrared lamp and the rollers of the printing machine was operated, whereby the same liquefied ink layer as described above was obtained. Further, such ink layer was applied onto a plate 10 and transferred to a transfer-receiving paper, whereby good images were obtained.

Example 4

Ethylene glycol (vapor pressure = 0.05 mmHg at 20 °C)	120 wt. parts
Water (vapor pressure = 17.5 mmHg at 20 °C)	40 wt. parts
Gelatin (trade name: S2088, mfd. by Nippi Gelatin Kogyo K.K.)	40 wt. parts
Carbon black (mfd. by Cabot. Co., USA)	6 wt. parts
Butyl para-hydroxybenzoate (antiseptic)	1 wt. parts

The above components were mixed at 70 °C to prepare an ink which showed a softening point of about 45 °C, a shape-retaining height of 1.0 cm and substantially no adhesion to an aluminum foil.

Referring to Fig., the thus prepared ink was heated at 70 °C in the ink tank 1 and subjected to printing in the same manner as in Example 3 except that the surfaces of rollers 3 - 8 were heated at 60 °C and a plate 10 corresponding to a solid image pattern was used. As a result, a uniform solid image was obtained on plain paper. This image was sufficiently fixed to the paper so that the offset thereof did not occur even when the recorded paper was superposed on another paper.

Then, the printing machine supplied with the ink was as such left standing at room temperature (23 -25 °C) for 10 days. Thereafter, printing was effected in the same manner as described above, whereby the same solid image as mentioned above was obtained.

Example 5

Ethylene glycol	1440 wt. parts
Water	360 wt. parts
Butyl para-hydroxybenzoate (antiseptic)	8 wt. parts
Polyvinyl alcohol (trade name: Gohsenol GL-0.3, mfd. by Nihon Gosei Kagaku Kogyo K.K.)	360 wt. parts
Borax (decahydrate) (crosslinking agent)	14 wt. parts
0.1N NaOH	14 wt. parts
Carbon black (mfd. by Cabot Co., USA)	100 wt. parts

The above components were mixed at 70 °C to prepare an ink which showed a softening point of about 55 °C, a shape-retaining height of 0.98 cm and substantially no adhesion to an aluminum foil.

The thus prepared ink was subjected to printing in the same manner as in Example 4, whereby good printed matter the same as in Example 4 was obtained.

Then, the printing machine was left standing for 10 days in the same manner as in Example 4. Thereafter, printing was effected in the same manner as described above, whereby the same solid image as mentioned above was obtained.

Example 6

An ink was prepared in the same manner as in Example 4 except that 12 wt. parts of a reactive dye (trade name: Red E-S3B, mfd. by Nihon Kayaku K.K.) was used instead of the carbon black used in Example 4. This ink showed a shape-retaining height of 0.98 cm and substantially no adhesion to an aluminum foil.

The thus prepared ink was subjected to printing in the same manner as in Example 4, whereby good printed matter the same as in Example 4 was obtained.

Then, the printing machine was left standing for 10 days in the same manner as in Example 4. Thereafter, printing was effected in the same manner as described above, whereby the same solid image as mentioned above was obtained.

Claims

1. A printing process comprising:
a liquefying an ink which is solid at room temperature;
applying the liquefied ink onto a plate having a pattern; and
transferring the ink from the plate to a transfer-receiving medium thereby to form thereon an ink pattern corresponding to said pattern of the plate.

2. A printing process according to Claim 1, wherein the solid ink is liquefied by heating.

3. A printing process according to Claim 1, wherein the solid ink comprises powder

4. A printing process according to Claim 2, wherein the powder solid ink comprises microcapsules.

5. A printing process according to Claim 4, wherein the solid ink comprises microcapsules comprising a liquid core material, and the solid ink is liquefied by pressure.

6. A printing process according to Claim 1, wherein the solid ink is shaped into a bar form, the solid ink in the bar form is pressed to a rotating roller to be applied onto the roller, and then the solid ink applied onto the roller is liquefied.

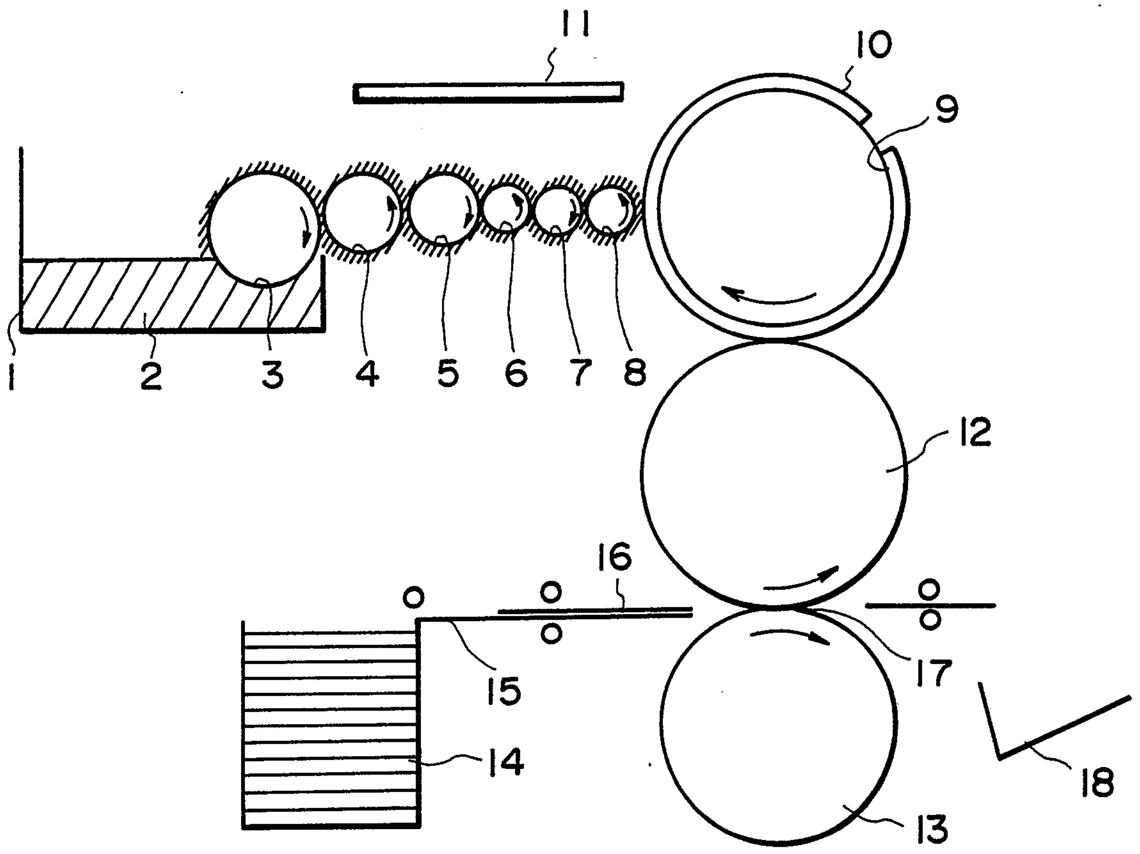
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FIG. 1

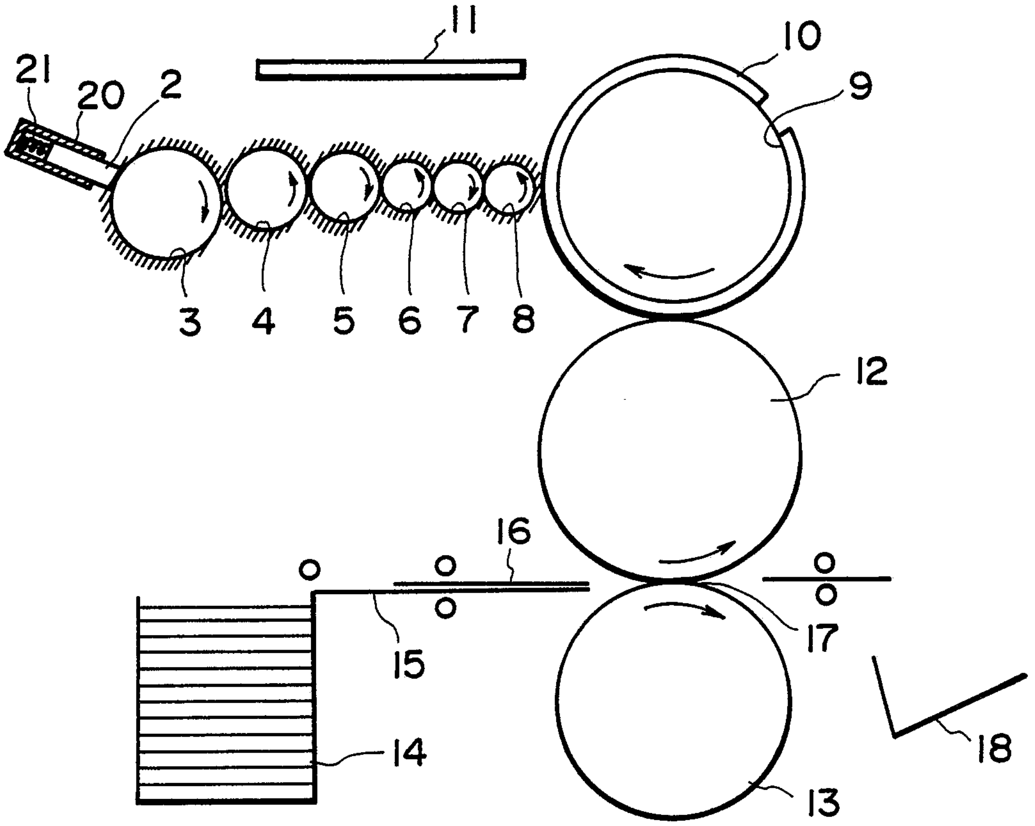
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FIG. 2