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(54) Method and device for regenerating an ink sheet.

(57) Described are a method and a device for regenerating an ink sheet or ribbon (12) having on an insulating layer (9) an ink layer (10). The ink sheet or ribbon comprises non-transferred portions (11a) where the ink layer (10) is still present and transferred portions (11b) where the ink layer (10) has been removed by a preceding image forming process. In order to fill up the transferred portions (11b) with ink again, charged electrically conductive ink (7) is made to adhere by an electrostatic force at an intermediate roller (3) having on an electrically conductive layer (1) a dielectric layer (2) or a photo-electrically conductive layer. The ink carrying circumferential surface of the intermediate roller (3) is brought into contact with the ink sheet or ribbon (12) to be regenerated. By supplying a charge to the side of the insulating layer (9) of the ink sheet or ribbon (12) an electrostatic force, larger than the first mentioned one, is established between the transferred portions (11b) of the ink sheet or ribbon (12) and the electrically conductive ink (7) on the intermediate roller (3). Thereby, the ink (7) is selectively transferred from the intermediate roller (3) to only the transferred portions (11b) of the ink sheet or ribbon (12).

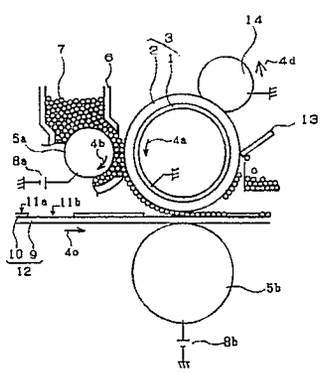

Fig. 5

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METHOD AND DEVICE FOR REGENERATING AN INK SHEET

The present invention relates to a method and device for regenerating an ink sheet or ribbon as it is used in a so-called thermal-transfer system wherein, by applying heat, ink is transferred from the ink sheet or ribbon to a recording medium or the like, as in a printer, facsimile machine or others. The ink normally is transferred from selective portions of the ink sheet so that after the transfer the ink sheet has portions where ink is still present (non-transferred portions) and other portions where due to the transfer ink is absent (transferred portions). The purpose of the regeneration of such an ink sheet or ribbon is to fill up with ink again those portions of the ink sheet or ribbon where ink is absent.

A method for regenerating an ink sheet is disclosed in SID 1985 DIGEST, pages 143 - 145. This known method makes use of a so-called direct ink layer regeneration by supplying heat-melted ink to the ink sheet to be regenerated. The known method involves some problems in that it requires a large apparatus and a complicated mechanism. It needs a warming-up time in order to melt the ink by a heat source and has a large electric power consumption in order to keep the ink in a melted state. Furthermore, ink cannot be supplied selectively to only those portions of an ink sheet from which the ink was transferred and became absent. An additional mechanism is needed in order to make the thickness of the regenerated ink layer constant and an additional mechanism in order to remove melted ink from the ink sheet after switching off a power source. Also, the maintenance of the apparatus used to perform the known method is complicated.

US-A-4,467,332 discloses another method for regenerating an ink sheet, using a powder ink. This known method is used for an ink sheet composed of an ink layer on an electrically conductive layer, and a voltage drop occurs corresponding to the residue of ink in portions where ink is still present. The powder ink also adheres to portions of the ink sheet where ink is still present (non-transferred portions), though the adhering amount of the powder ink can be varied at the transferred and non-transferred portions of the ink layer. Moreover, a potential distribution is generated at the interface between transferred and non-transferred portions of the ink layer (that is to say, an edge effect), so that the amount of ink adhering in the neighborhood of such interfaces increases. In other words, it is difficult to have the powder ink adhere to the transferred portions of the ink layer so that an unevenness of the adhesion of the powder ink occurs. Accordingly, there have been problems in that it is difficult to control the thickness of the ink layer of the regenerated ink sheet and an unevenness of the ink sheet is generated.

The JP-A-01-295876/1989 discloses an epochmaking regenerating method which allows to have electrically conductive ink selectively adhere at only the transferred portions of the ink layer of an ink sheet by using a simple mechanism.

The present invention is intended to solve the above stated problems of the prior art and to further develop the method disclosed in the Japanese Patent Application No. 36116/1988.

Accordingly, it is an object of the present invention to provide a method and a device for regenerating an ink sheet by which the utilization efficiency of the ink sheet is largely improved and the running cost decreased.

Another object of the present invention is to provide a method and a device for regenerating an ink sheet which allows to regenerate the ink layer of the ink sheet with a simple mechanism.

A further object of the present invention is to provide a method and a device for regenerating an ink sheet by which ink can be selectively supplied to adhere to only the transferred portions of the ink layer of the ink sheet and the amount of adhering ink can be controlled.

Still a further object of the present invention is to provide a method and a device for regenerating an ink sheet by which a high quality of regeneration is achieved such that by using the regenerated ink sheet, excellent images having no deterioration of the image quality are obtained.

The above objects are achieved with a method and a device as claimed.

With the invention as claimed an electric charge is applied to the electrically conductive ink by charge-injection so that the ink adheres to the intermediate roller by electrostatic force. The ink thus carried by the intermediate roller is brought into contact with the ink sheet having the non-transferred portions with the ink layer still being present and the transferred portions where the ink layer has been removed in a preceding image forming process. By supplying charge to the side of the insulating layer of the ink sheet, i.e. the back of the ink sheet, the electrically conductive ink is polarized and has a charge Q_1 at the side of the intermediate roller and a charge Q_2 at the side of the ink sheet. The polarized ink is subjected to a first electrostatic force F keeping it to the intermediate roller and a second electrostatic force f drawing it to the ink sheet. Provided the first electrostatic force F is smaller than the second electrostatic force f, the electrically conductive ink will adhere to the insulating transferred portions of the ink sheet so that these portions are replenished with the ink. In the non-transferred portions of the ink sheet the electrically

conductive ink is in contact with the electrically conductive ink layer of the ink sheet so that its charge Q_2 is released to the electrically conductive portion of the ink sheet and no second electrostatic force f is acting on the ink which, thus, keeps to adhere on the intermediate roller. In this way, it is possible that the electrically conductive ink is replenished selectively only in the transferred portions of the ink sheet.

The intermediate roller has an electrically conductive layer and a dielectric layer on the conductive layer. The dielectric layer may be composed of a photo-electrically conductive layer which, as long as it is not irradiated with light within its sensitivity range, behaves like a dielectric layer.

If powder ink is used as the electrically conductive ink, it is possible to supply the powder ink to only the transferred portions of the ink sheet in the state of almost a single particle layer, so that the replenishing amount of ink can be easily controlled.

It is advantageous to remove remaining ink from that portion of the intermediate roller that comes off the ink sheet and to remove the charge of the intermediate roller, in order to make the adhering amount of the electrically conductive ink more uniform when the electrically conductive ink is again supplied to the intermediate roller.

Ways of carrying out the invention are described in detail below with reference to drawings which illustrate only specific embodiments and in which:

Fig. 1 is a schematic illustration of one embodiment of a device used for regenerating an ink sheet according to the present invention,

Fig. 2 is an equivalent circuit of the device shown in Fig. 1,

Fig. 3 is a diagram showing the relation between a voltage v and a thickness d necessary for having the electrically conductive ink adhere to the ink sheet in the method according to Fig. 1,

Fig. 4 is an illustration, similar to Fig. 1, of a device according to a second embodiment of the present invention,

Fig. 5 is an illustration, similar to Fig. 1, of a device according to a third embodiment of the present invention,

Fig. 6 is an illustration, similar to Fig. 1, of a device according to a fourth embodiment of the present invention,

Fig. 7 is a schematic illustration of an image forming apparatus having built-in the ink sheet regenerating device of Fig. 1, and

Fig. 8 is a schematic illustration of another image forming apparatus having built-in an ink sheet regenerating device according to the invention.

Example 1

Fig. 1 schematically illustrates a device for regenerating an ink sheet according to a first embodiment of the present invention. A multi-layer intermediate roller 3 comprises a dielectric layer 2 on an electrically conductive layer 1. The roller 3 is rotated in the direction of an arrow 4a by operating means not shown. A first electrode 5a is arranged at a fixed distance from the intermediate roller 3 and is rotated in the direction of an arrow 4b by operating means not shown. Electrically conductive ink 7 filled in a hopper 6 is supplied to an aperture between the intermediate roller 3 and the first electrode 5a. A voltage V is applied between the layer 1 of the intermediate roller 3 and the first electrode 5a by means of a power source 8a. Due to the applied voltage V an electric field is established in the aperture between the intermediate roller 3 and the first electrode 5a. An electric charge q is induced in the electrically conductive ink exposed to the said electric field. The ink which is in contact with the dielectric layer 2 of the intermediate roller 3 can hold the charge and, thereby, adhere to the intermediate roller 3 by an electrostatic force.

An ink sheet or ribbon 12 is conveyed in the direction of an arrow 4o by operating means not shown. The ink sheet 12 is a multi-layer sheet or ribbon, having an ink layer 10 on an insulating layer 9. The ink sheet 12 has portions 11a where the ink layer is still present (non-transferred portions) and which are thus electrically conductive, and portions 11b where the ink layer 10 is not present (transferred portions) and where the insulating layer 9 is exposed. As explained before, the transferred portions 11b are the result of the ink sheet having been used in an image forming process. The ink sheet 12 is arranged to be moved between the intermediate roller 3 and a second electrode 5b so that the intermediate roller 3 with the ink 7 adhering to it contacts the ink layer 10, whereas the second electrode 5b contacts the insulating layer 9. By applying a voltage v between the electrically conductive layer 1 of the intermediate roller 3 and the second electrode 5b, an electric field is established due to which the electrically conductive ink which comes into contact with the insulating layer 9 in the transferred portions 11b of the ink sheet 12 has a charge

$Qtotal = Q_1 - Q_2$.

This charge is determined by the voltage V, the voltage v, the electrostatic capacity C of the dielectric layer 2 of the intermediate roller 3 and the electrostatic capacity c of the insulating layer 9 ($-Q_1$ is the charge induced in the electrically conductive layer 1 of the intermediate roller 3 and Q_2 is the charge induced in the second electrode 5b). The Coulomb force F holding the ink 7 to the intermediate roller 3 and the Coulomb force f acting on the ink 7 toward the ink sheet 12 can be expressed as

$F = k_1 Q_1^2/D^2$ and $f = k_2 Q_2^2/d^2$,

wherein k_1 and k_2 are constants, D is the thickness of the dielectric layer 2 and d is membrane thickness of the insulating layer 9.

Under the condition (1)

$F < f$ (1)

the ink 7 can be transferred from the intermediate roller 3 to the transferred portions 11b of the ink sheet 12. That is, by an appropriate selection of the voltage V, the voltage v, the capacity C and the capacity c, the transferred portions (insulated portions) 11b of the ink sheet 12 can be replenished with the electrically conductive ink 7. However, where the electrically conductive ink 7 contacts the electrically conducting non-transferred portions 11a of the ink sheet 12, it retains the charge Q_1 and keeps to adhere to the intermediate roller by the electrostatic force (the electrically conductive portions 11a of the ink sheet 12 have the charge Q_2). Therefore, the ink 7 does not adhere to the non-transferred portions 11a of the ink sheet 12 and, thus, the ink 7 can be selectively supplied to only the transferred portions 11b of the ink sheet 12.

The ink sheet 12 having thus been selectively replenished in its transferred portions 11b, in case of necessity, can be subjected to a fixing procedure by fixing means, not shown, to fix the supplied electrically conductive ink 7 and to complete the regeneration of the ink sheet.

In order to estimate the voltage V, the voltage v, the capacity C and the capacity c so as to have the condition $F < f$ fulfilled, use can be made of the CR equivalent circuit, shown in Fig. 2 of the device of Fig. 1.

In Fig. 2, C corresponds to the capacity C, c to the capacity c, $-Q_1$ to the charge induced in the electrically conductive layer 1 of the intermediate roller 3, Q_2 to the charge induced in the second electrode 5b, V to the voltage V, v to the voltage v, and R to the resistance of the electricity passage formed by the electrically conductive ink 7 to the first electrode 5a. SW is a switch closing when the electrically conductive ink 7 is in contact with the ink sheet 12. The time when SW closes is supposed to be $t = 0$. Qtotal possessed by the electrically conductive ink 7 is

$Qtotal = Q_1 - Q_2$.

At the time $t = 0$, $Qtotal\ (t = 0) = CV$.

When $t \geqq 0$ and $(C+c)R \ll 1$, Q_1 and Q_2 are

$Q_1 = CV$, $Q_2 = c(v-V)$.

As mentioned before, in order to transfer ink 7 from the intermediate roller 3 onto the ink sheet 12, the above condition (1) has to be fulfilled.

With D and d defined as mentioned above and assuming that the dielectric constants of the dielectric layer 2 and the insulating layer 9 are the same, to simplify the matter, in order to satisfy the condition (1) v and d should be within the shaded portions of the graph shown in Fig. 3.

In Fig. 3 the ordinate shows the voltage v and the abscissa the thickness d of the insulating layer 9.

Actually, with v and d having been selected within the shaded portions of Fig. 3, the regeneration of an ink sheet was carried out and the result showed that the electrically conductive ink 7 supplied from the intermediate roller 3 selectively adhered to only the transferred portions 11b of the ink sheet 12.

In case of using a powder ink as the electrically conductive ink and making the circumferential speed of the intermediate roller 3 equal to the conveying speed of the ink sheet, the powder ink can be filled into the transferred portions of the ink sheet 12 almost in the state of a single particle layer, which is desirable because the se lectivity of the adhesion and the adhering amount can both be controlled.

The intermediate roller 3 contains at least the dielectric layer 2 at the surface and the electrically conductive layer 1 just beneath the dielectric layer 2. Instead of the electrically conductive layer an electrically conductive base roller or the like may be used. The dielectric layer 2 is desired to be composed of materials having a resistivity of 10^{12} Ωcm or more (for example fluororesin, polyester, polyaramide, SiO_2, SiC, Si_3N_4), and further materials having a poor wettability (for example fluororesin).

The first electrode 5a should have a slightly rough surface in order to convey the electrically conductive ink easily.

The electrically conductive ink 7 contains at least one kind of an electrically conductive agent such as carbon black (for example, furnace black, acetylene black), metal oxide (for example, ITO powder, SnO_2 powder), metal powder (for example Ag powder, Al powder), salt (for example, quaternary ammonium salt),

resin having electrical conductivity (for example, polyacetylene, polypyrol). Moreover, in case of necessity, the ink 7 contains substances selected from the following groups of substances:

1) single or complex substances selected from the following compounds: kinds of waxes such as candelilla wax, carnauba wax, rice wax, bees wax, lanolin, montana wax, ozokerite, paraffin wax, microcrystalline wax, perotolatam, polyethylene wax, Fischer Tropsch wax, montana wax derivatives, paraffin wax derivatives, hardened castor oil, synthesized wax, kinds of higher fatty acids such as stearic acid, palmitic acid, kinds of polyolefins such as low molecular polyethylene, polyethylene oxide, polypropylene, kinds of olefin copolymer such as ethylene, acrylic acid copolymer, ethylene acrylate copolymer, ethylene-vinyl acetate copolymer;

2) single body, copolymer or complex of resin selected from kinds of acrylic resins such as polyacrylate, polymethacrylate, kinds of styrene resins such as polystyrene, poly-1-methyl styrene, kinds of thermo plastic resins such as butyral resin, polyvinyl chloride, polyvinylidene chloride, polyvinyl-fluoride, polyvinylidene fluoride, polyester resin, polycarbonate resin, cellulose resin, polyallylate resin, polyethylene resin;

3) single, copolymer, or complex of resin selected from kinds of aqueous resins such as polyvinyl alcohol, polyallyl alcohol, polyvinyl pynolidone, polyvinyl amine, polyallyl amine, polyvinyl acrylic acid, polyvinyl methacrylic acid, polyvinyl sulfonic acid, polylatic acid, casein, hydroxypropylcellulose, starch, gum arabic, polyglutamic acid, polyaspartic acid, nylon resin;

4) resin selected from thermo-setting resins such as epoxy resin; silicone resin, urethane resin, melamine resin, alkyd resin;

5) coloring agents, black dyes (dyes or pigments) such as furnace black, lampblack, acetylene black, nigrosine, cyan dyes such as copper-phthalocyanine, magenta dyes such as carmine 6B, yellow dyes such as disazo yellow;

6) kinds of magnetic powder such as Fe_3O_4, Fe_2O_3, Fe, Cr, Ni;

7) surfactants or dispersing agents such as metal soap, polyethylene glycol;

8) static-controlling agents such as electron-accepting organic complex, polyester chloride, nitrophnic acid, quaternary ammonium salt, pyridiniium salt;

9) fillers such as talc; and

10) fluid-improving agents such as SiO_2, TiO_2.

Further, the resistivity of the electrically conductive ink 7, calculated from the so-called pressure-cell-resistance-value in the state of applying a voltage of 5V/mm under a pressure of $1N/mm^2$, is 10^8 Ωcm or less, preferably 10^5 Ωcm or less. The ink 7 can be powder ink, paste ink, melted and dissolved ink, half-melted and half-dissolved ink, but preferable is powder ink. If powder ink is used the volume-mean-particle size is preferably from 5 to 50 μm. In the drawings powder ink is shown although the invention is not limited to powder ink.

The ink sheet 12 contains as components at least an ink layer 10 having electrical conductivity and an insulating layer 9 just beneath the ink layer 10. The insulating layer may be composed of several layers and the insulating layer and the ink layer may be formed in a multi-layer structure on an electrically conductive support. A heat-resistant layer, an abrasion-resistant layer and so on can be formed at the side of the ink sheet 12 opposite to the ink layer. Further, the insulating layer 9 is preferred to be a film which can be easily formed (for example a poylester, polysulfon, polyimide or polyaramide film). The resistivity of the ink layer is preferably 10^{10} Ωcm or less, even more preferably 10^8 Ωcm or less.

In order to have the electrically conductive ink adhere to the intermediate roller, it has been explained above that charged ink is supplied to the intermediate roller to be kept on it by means of an electrostatic force. Alternatively, it is possible to supply the electrically conductive ink onto the intermediate roller and to charge it then for instance by means of a corotron (corona discharge device). Similarily, instead of using the second electrode 5b in order to supply charge to side of the insulating layer 9 of the ink sheet 12, a corotron or similar means could be used for supplying charge to the insulating layer.

A fixing means for fixing the electrically conductive ink 7 on the ink sheet 12 is needed especially if electrically conductive powder ink is used. In the case of paste ink, melted and dissolved ink, half-melted and half-dissolved ink, a fixing is not always necessary. The fixing may be performed by pressing a roller heated by a built-in lamp against the back of the ink sheet, by passing the ink sheet through the space between such a heated roller and a metal roller, by exposing the ink layer side of the ink sheet to the heat radiation from a lamp or by passing the ink sheet through the space of a couple of pressed-metal rollers.

Example 2

Fig. 4 schematically illustrates a device similar to that shown in Fig. 1, for explaining a second embodiment of the present invention. In Fig. 4 the same reference signs are used for elements same as or similar to those of Fig. 1, and only the differences between the two embodiments will be explained below.

In Fig. 4 the intermediate roller 23 has a photo-electrically conductive layer 22 instead of the dielectric layer 2 shown in Fig. 1. The intermediate roller 23 is not exposed to light within the sensitivity range of the photo-electrically conductive layer 22, at least not during the time during which the electrically conductive ink 7 adheres to the intermediate roller 23 until it has been transferred to the ink sheet 12. The photo-electrically conductive layer 22 may be either a single layer type or a multi-layer type. Photoconducting materials having a resistivity of 10^{12} Ωcm or more as long as they are not exposed to light within their sensitivity range are suitable.

As long as the intermediate roller 23 is not irradiated with light within the sensitivity range of the photo-electrically conductive layer 22, this layer acts as a dielectric layer so that the method for regenerating the ink sheet or ribbon 12 with this embodiment is practically the same as that with the first mentioned embodiment.

Example 3

Fig. 5 schematically illustrates a device for regenerating an ink sheet according to a third embodiment of the present invention.

In Fig. 5 the same reference signs are used to designate parts same as or similar to those in Fig. 1 and only the differences between the first and the third embodiment will be described in detail below.

Ink 7 remaining on the surface portion of the intermediate roller 3 coming off the ink sheet 12 is removed from the intermediate roller 3 by a blade 13 pressed against the intermediate roller 3. Further, the surface charge of the dielectric layer 2 is removed by an earthed charge-removing roller 14 contacting the intermediate roller 3 and rotating in the direction of an arrow 4d. The blade 13 is preferably made of a resin having a relatively low hardness, for example gum (urethane gum, silicon gum) or an elastomer (urethane-type, fluororesin-type). Alternative means for removing ink remaining on the intermediate roller are a tacky roller having a tacky substance at its surface so that the ink adheres to the roller, suction means and so on.

Instead of the charge removing roller 14 any other means can be used suitable for removing the surface charge of the dielectric layer 2. For instance, a charge-removing roller for applying a charge of a polarity opposite to the surface charge of the dielectric layer to compensate the latter could be pressed against the intermediate roller. Also, a charge of a polarity opposite to the surface charge of the dielectric layer to be removed could be applied by a DC corona discharge means.

The charge-removing roller may be an electrically conductive roller having a resistivity of 10^{8} Ωcm or less. A roller formed of an electrically conductive gum having a relatively low hardness at the surface (CR-type gum, NBR-type gum, Si-type gum) is preferred. Instead of an electrically conductive roller a conductive brush, a corotron etc. may be used.

The effect of the means for removing the electrically conductive ink remaining on the intermediate roller and the means for removing the surface charge of the intermediate roller have been investigated. More particularly, the state of adhesion to the intermediate roller 3 of the electrically conductive ink 7 supplied from the hopper 6 has been examined for each of the following conditions (0) to (4):

Condition (0) Prior to the first regenerating of the ink sheet 12;

Condition (1) after regenerating the ink sheet 12 but neither removing the ink 7 remaining on the intermediate roller 3 nor removing the surface charge of the intermediate roller 3;

Condition (2) after regenerating the ink sheet and removing the ink 7 remaining on the intermediate roller 3 but not removing the surface charge of the intermediate roller;

Condition (3) after regenerating the ink sheet and removing the surface charge of the intermediate roller 3 but not removing the ink 7 remaining on the intermediate roller; and

Condition (4) after regenerating the ink sheet, removing the ink 7 remaining on the intermediate roller 3 and removing the surface charge of the intermediate roller.

The results of the experiments are shown in Table 1 below. The results for each of the conditions (1) to (4) are given relative to the condition (0) as reference.

Table 1

Condition	State of adhesion
(1)	Worse than (0), non-uniform adhesion
(2)	Worse than (0), decreased amount of adhering ink
(3)	Experiment could not be carried out
(4)	Same as (0), i.e. good

Note:

Electrically current flows from the first electrode 5a to the electrically conductive gum roller through the electrically conductive ink onto the intermediate roller in case of carrying out charge-removing by a contact system of the electrically conductive gum roller etc. Further, in case of carrying out charge-removing under the state of the electrically conductive ink still remaining on the intermediate roller, charge of the electrically conductive ink losing the adhering force to the intermediate roller, is eliminated at the same time because the conductive ink is dispersed.

Despite the results of the experiment, even under the conditions (1) to (3), a detrimental influence on an image produced by a thus regenerated ink sheet could not be observed and the ink sheet could be repeatedly used. However, in case of condition (4) the adhesion of the ink to the intermediate roller could be effected more accurately with good reproducibility, and the number of times the ink sheet could be regenerated and used again was increased.

Example 4

Fig. 6 schematically illustrates a device for regenerating an ink sheet according to a fourth embodiment of the present invention.

In Fig. 6 the same reference signs are used to designate parts same as or similar to those in Figs. 1 and 5, and only the differences between the third and the fourth embodiment will be described in detail below.

In this embodiment, for removing the surface charge of the intermediate roller 23 after the regenerating of the ink sheet 12, a charge-removing lamp 24 is used instead of the charge-removing roller 14 shown in Fig. 5. As with the second embodiment, a photo-electrically conductive layer 22 is used instead of the dielectric layer 2 of the first and the third embodiment. The charge-removing lamp is composed of a light source whose wavelength is within the sensitivity range of the photo-electrically conductive layer 22 of the intermediate roller 23. As to the effect of the charge-removal by means of the charge-removing lamp 24, reference is made to the description of the third embodiment of the invention.

Example 5

Fig. 7 schematically illustrates an image forming apparatus making use of a device according to Fig. 1 for regenerating an ink ribbon.

The ink ribbon 101 is comprised of a heat-resistant layer 100, the ink layer 10 and the insulating layer 9 between both. The ink ribbon is conveyed in the direction of arrow 4o from a supply roller 102a.

By means of a thermal head 103 selective portions of the ink ribbon 101 are heated corresponding to an image signal and the ink of the heated portions is transferred to a recording medium 104 to form an image corresponding to the image signal. The recording medium 104 is moved in the direction of an arrow 4e at the same rate as the ink ribbon 101. Because of this image forming process, the transferred portions 11b and the non-transferred portions 11a of the ink layer 10 are formed on the ink ribbon 101. By the method according to the invention described in detail with respect to Figs. 1, a thin layer of electrically conductive powder ink 7 is formed on the circumferential surface of the intermediate roller 3 in order to

regenerate the used ink ribbon passing between the intermediate roller 3 and the second electrode 5b.

The ink ribbon 101, after having been replenished with ink again, passes over an electrically heated body 106 contacting the heat-resistant layer 100 of the ink ribbon. Thereby, the electrically conductive powder ink 7 is fixed onto the ink ribbon 101. The thus regenerated ink ribbon is then wound onto to a take-up roller 102b.

When all the ink ribbon has been drawn off the supply roller, the supply roller 102a and the take-up roller 102b can be exchanged for a repeated use of the ink ribbon. Experiments revealed that by the repeated use of the ink ribbon, no change of the image quality could be observed.

Instead of using the supply roller 102a and the take-up roller 102b and exchanging these rollers from time to time, an arrangement wherein the regenerated ink ribbon is directly fed back to the starting point (position of supply roller 102a) in a closed loop might be possible under certain circumstances.

In the above described apparatus the image forming process is carried out by using a thermal head. Alternatively, however, the image forming process can also be carried out by a heat-resistance head, when a heat-resistance layer is provided at the back of the ink ribbon 101 to generate Joule heat in selected portions of the heat-resistance layer by means of the head.

The image forming apparatus has been described as using the device of Fig. 1 for regenerating the ink ribbon. Needless to say that any of the devices of Figs. 4 and especially Fig. 5 or Fig. 6 could be used instead. The advantages of the removal of remaining ink and of the charge removal from the intermediate roller 3, 23 have been explained before and need not be repeated here.

Example 6

Fig. 8 schematically illustrates another image forming apparatus using any of the above described devices and methods for regenerating an ink ribbon.

The ink ribbon 201 is conveyed in the direction of arrow 4o and comprises ink layers 200y, 200c, 200m and 200b. The letters y, c, m and b refer to the colors yellow, cyan, magenta and black of the respective ink layers. The ink layers are formed one after the other on the insulating layer 9 in a repeated pattern.

By moving the ink ribbon back and forth in the direction of double arrow 4e, an image corresponding to the image signals of the respective colors is formed on a recording me dium 203 by an image forming means 202. Thereby, the transferred portions and the non-transferred portions of each of the differently colored ink layers are formed on the ink ribbon.

Devices 204y, 204c, 204m and 204b for regenerating the ink ribbon 201 with the respective colors of y, c, m and b are arranged one after the other. The devices are provided with a built-in color sensor to ensure that each of the devices supplies its ink to only those portions of the ink ribbon having the same color. The principle or method of regenerating the ink ribbon by each of the devices 204y, 204c, 204m and 204b is, however, the same as it has been described in detail before.

In this way, electrically conductive ink of the respectively correct color is supplied to the transferred portions of the ink layer on the ink ribbon 201.

In this way, image forming and regenerating of a multicolor ink sheet or ink ribbon can be repeatedly carried out.

Experiments showed that with an image forming apparatus according to Fig. 8 a deterioration of the image quality by a repeated use of the multicolor ink ribbon did not occur.

Claims

1. A method for regenerating an ink sheet or ribbon having on an insulating layer (9) an ink layer (10) with portions of the latter being removed, said method comprising the steps of

making electrically conductive ink (7) which is charge-injected or charge-induced adhere at an intermediate roller (3, 23) containing at least an electrically conductive layer (1) and a dielectric layer (2, 22) formed on said electrically conductive layer,

supplying charge to the side of the insulating layer (9) of the ink sheet or ribbon (12), and

transferring by electrostatic force the electrically conductive ink (7) from the intermediate roller (3, 23) to those portions of the ink sheet or ribbon (12) where the ink layer (10) has been removed.

2. The method according to claim 1, wherein the dielectric layer (22) of the intermediate roller (23) is a photo-electrically conductive layer.

3. The method according to claim 1 or 2, wherein the electrically conductive ink (7) is a powder having a

volume-mean-particle size of 5 to 50 µm.

4. The method according to any of the preceding claims, wherein the following steps are performed after the portions of the ink sheet or ribbon (12) with the ink layer removed have been replenished with the electrically conductive ink (7) from the intermediate roller (3, 23),

removing the electrically conductive ink (7) remaining on the intermediate roller (3, 23), and

removing the electric charge from the intermediate roller.

5. A device for regenerating an ink sheet or ribbon comprising on an insulating layer (9) and ink layer (10), portions of which have been removed, comprising

an intermediate roller (3, 23) having an electrically conductive layer (1) or an electrically conductive base roller and a dielectric layer (2, 22) on the electrically conductive layer (1) or the electrically conductive base roller,

means (6) for supplying electrically conductive ink (7) onto the circumferential surface of the intermediate roller (3, 23),

means (5a, 8a) for establishing a first electrostatic force (F) holding the ink (7) at the intermediate roller (3, 23),

means for bringing the circumferential surface of the intermediate roller (3, 23) into contact with the ink sheet or ribbon (12), and

means (5b, 8b) for establishing a second electrostatic force (f) between the ink (7) on the intermediate roller and those portions (11b) of the ink sheet or ribbon (12) where the ink layer (10) has been removed,

said second electrostatic force (f) being larger than said first electrostatic force in order to transfer the ink (7) from the intermediate roller to those portions (11b) of the ink sheet or ribbon (12) where the ink layer (10) has been removed.

6. The device according to claim 5, wherein the intermediate roller (23) comprises as said dielectric layer a photo-electrically conductive layer (22) having a dielectric property as long as it is not exposed to light within its sensitivity range.

7. The device according to claim 5 or 6, further comprising means (13) for removing the electrically conductive ink (7) remaining on the intermediate roller (3, 23) after ink was transferred to the ink sheet or ribbon (12) and prior to supplying again electrically conductive ink (7) to the intermediate roller.

8. The device according to any of claims 5 to 7, further comprising means (14, 24) for removing electrical charges from the intermediate roller (3, 23) after ink (7) was transferred to the ink sheet or ribbon (12) and prior to supplying again electrically conductive ink (7) to the intermediate roller.

9. The device according to claim 6 and 8, wherein the charge-removing means (24) comprises a lamp emitting light of a wavelength within the sensitivity range of the photo-electrically conductive layer (22).

10. The device according to any of claims 5 to 9, wherein the electrically conductive ink (7) is a powder having a volume-mean-particle size of 5 to 50 µm.

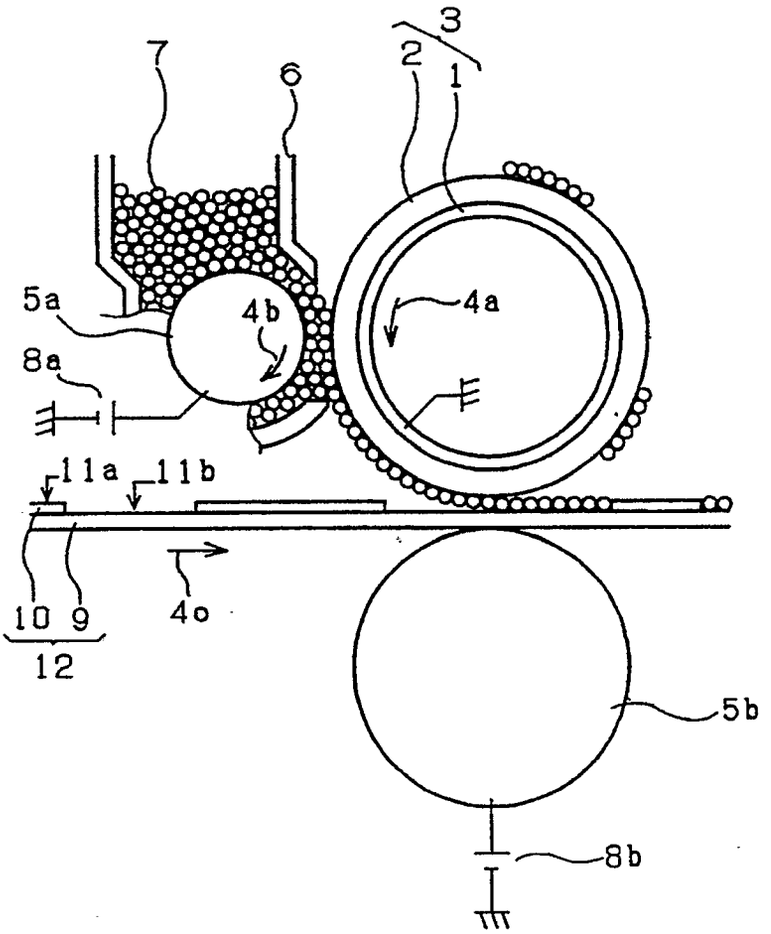

Fig. 1

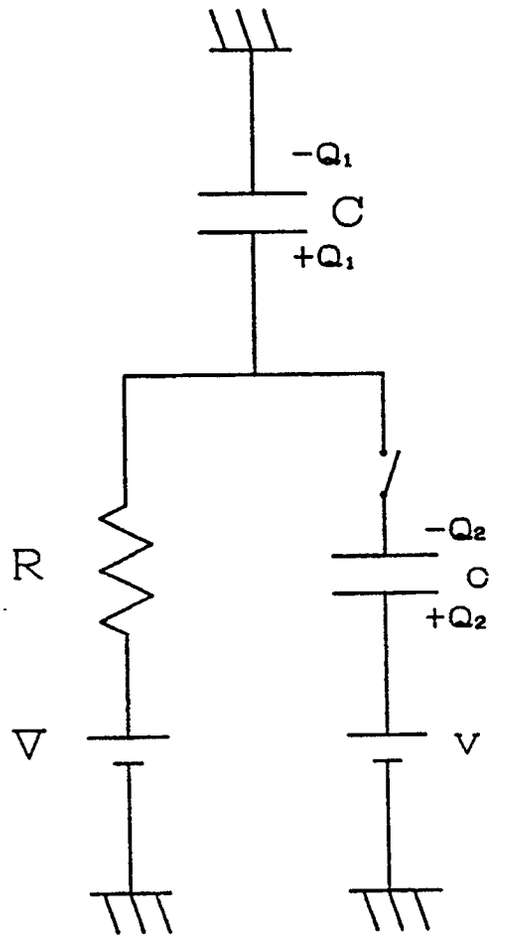

Fig. 2

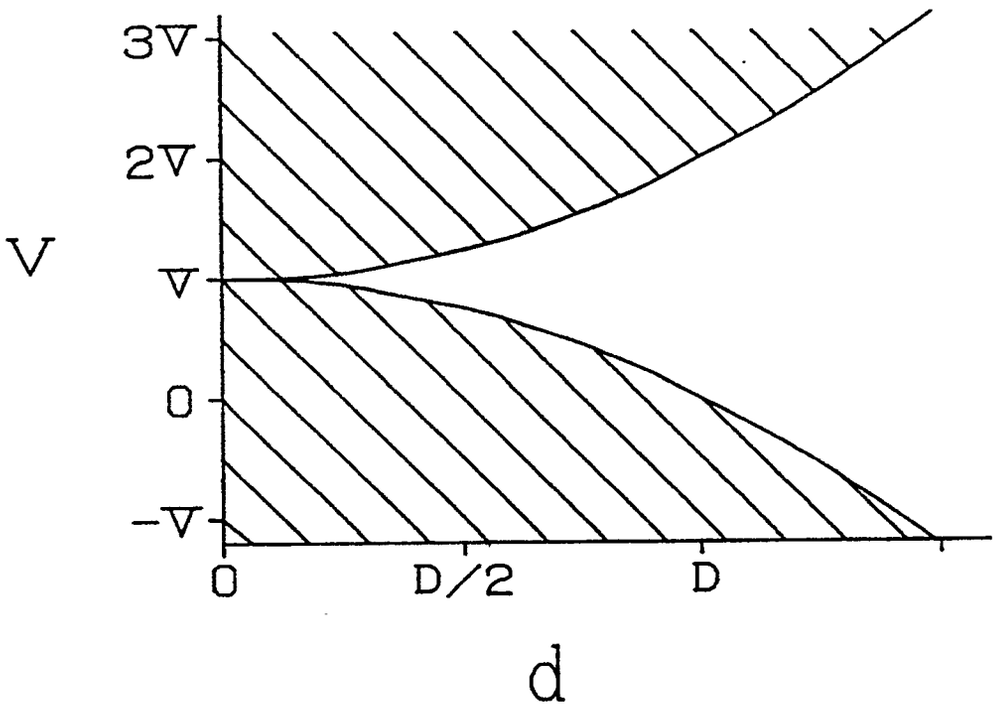

Fig. 3

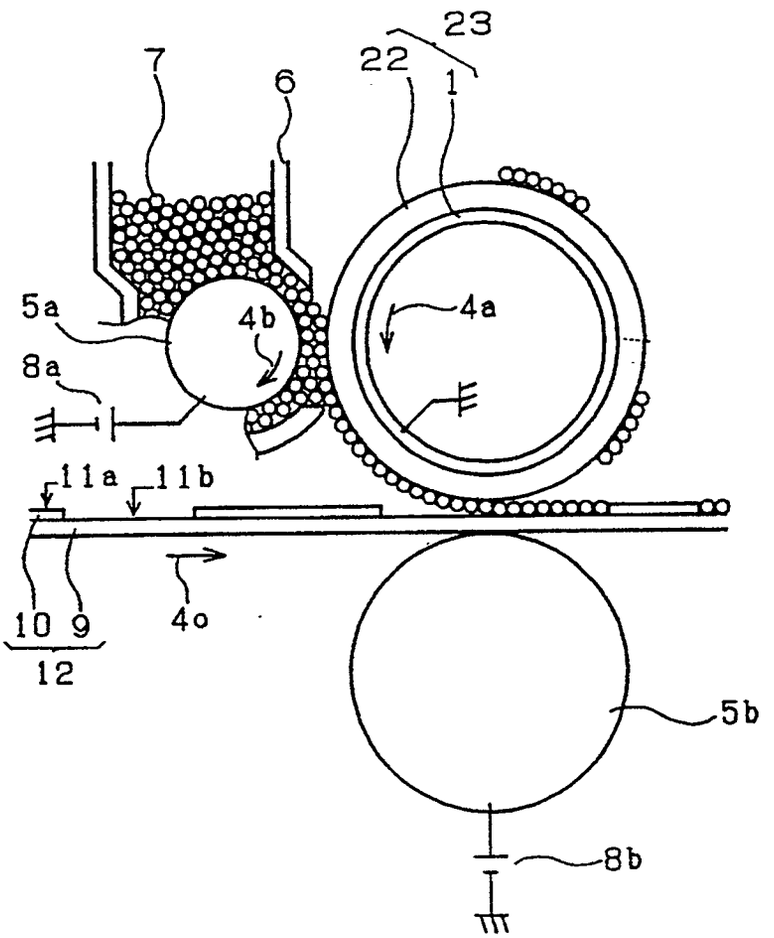

Fig. 4

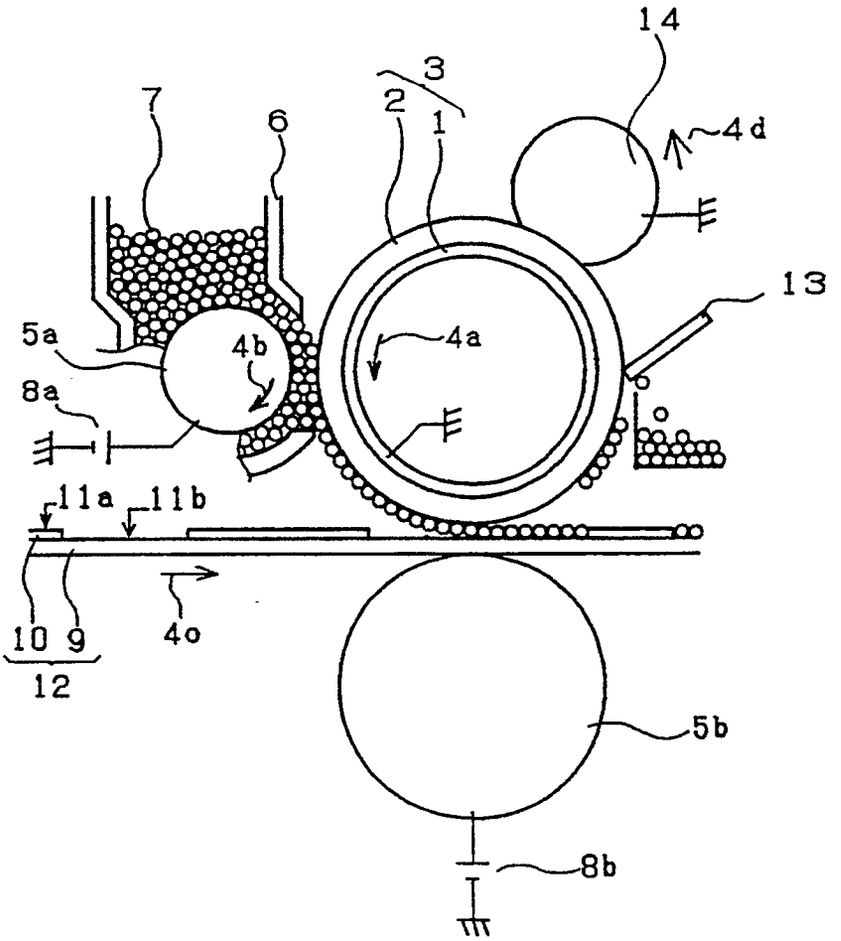

Fig. 5

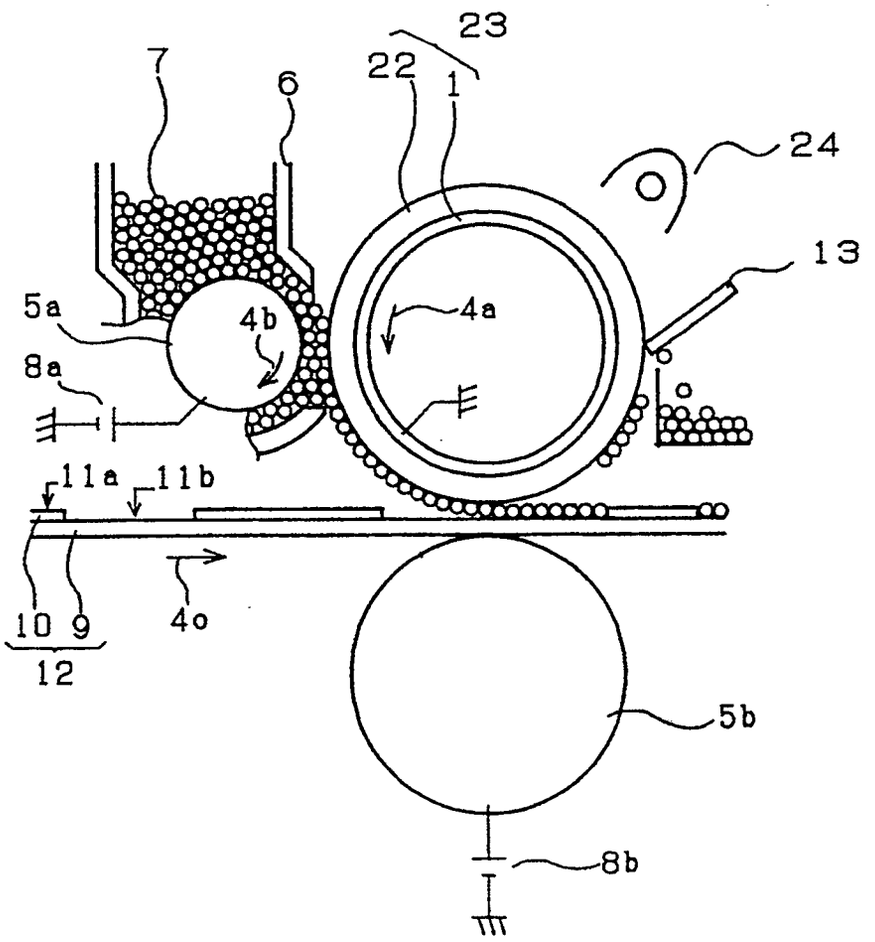

Fig. 6

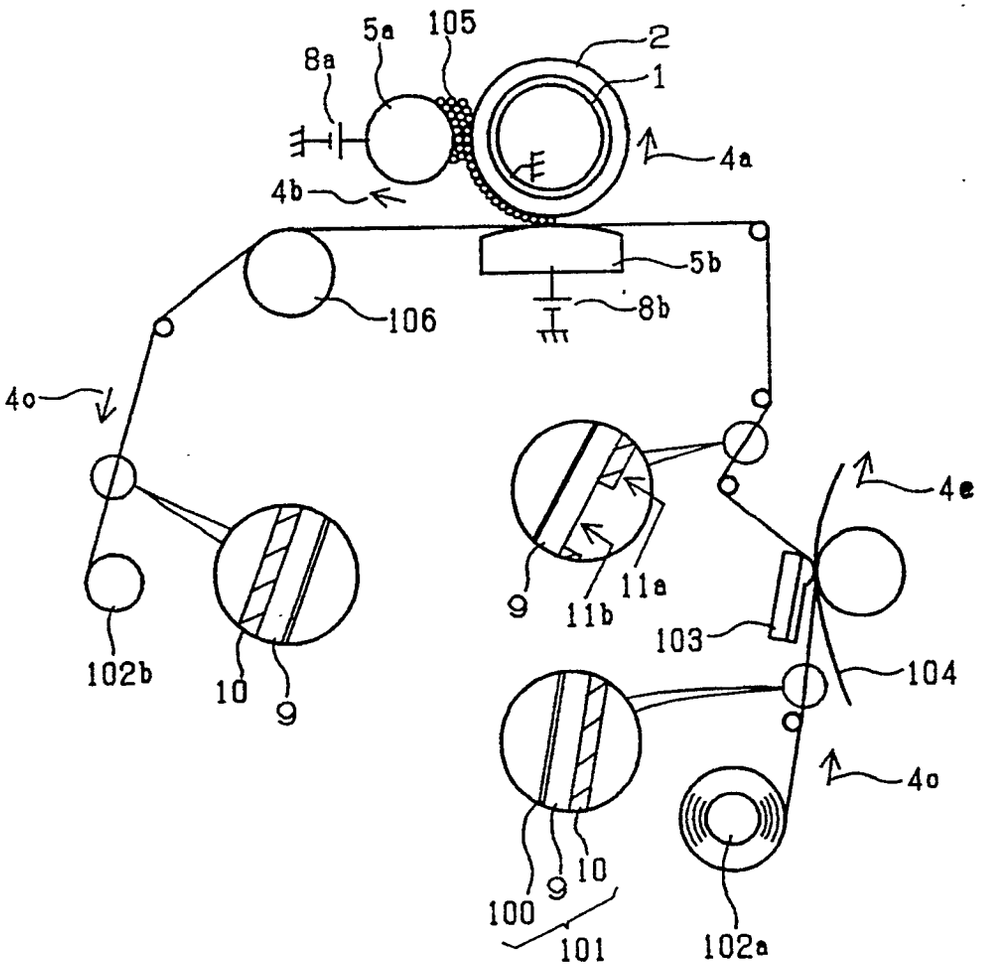
5a
105
2
8a
1
4a
4b
5b
106
8b
4o
4e
9
11b
11a
103
102b
10
9
104
4o
100
9
10
101
102a

Fig. 7

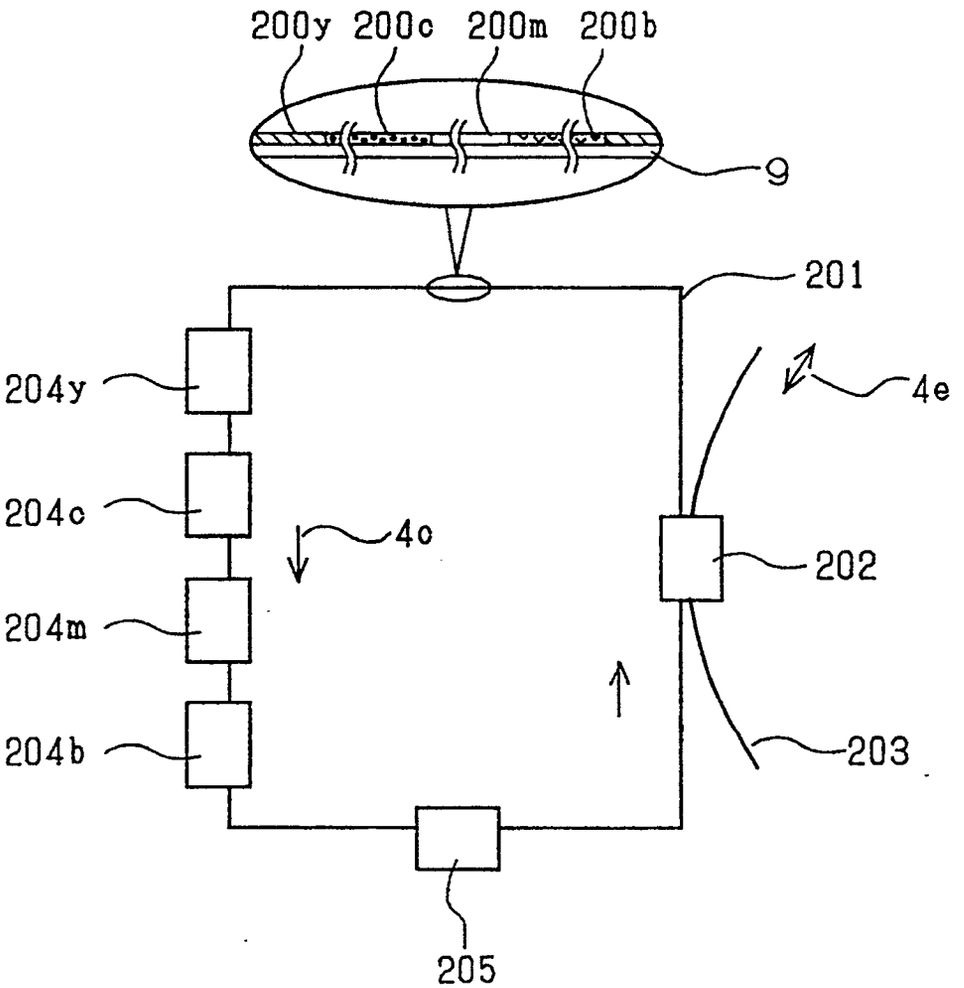

Fig. 8

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90116571.2

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	PATENT ABSTRACTS OF JAPAN, unexamined applications, M field, vol. 7, no. 279, December 13, 1983 THE PATENT OFFICE JAPANESE GOVERNMENT page 73 M 262 * Kokai-No. 58-155 971(A) (NIPPON) * --	1,3,4, 5,7,10	B 41 J 31/14
A	PATENT ABSTRACTS OF JAPAN, unexamined applications, M field, vol. 8, no. 57, March 15, 1984 THE PATENT OFFICE JAPANESE GOVERNMENT page 9 M 283 * Kokai-No. 58-208 073(A) (YOKOGAWA) * --	1,3,4, 5,7,10	
A	PATENT ABSTRACTS OF JAPAN, unexamined applications, M field, vol. 4, no. 179, December 11, 1980 THE PATENT OFFICE JAPANESE GOVERNMENT page 30 M 46 * Kokai-No. 55-126 475(A) (TOKYO SHIBAURA) * ----	1,3,4, 5,7,10	TECHNICAL FIELDS SEARCHED (Int. Cl.5) B 41 J G 01 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	20-11-1990	MEISTERLE

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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