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(54) Refurbishing of image carrying members of an image reproduction system

(57) The image reproduction system contains an endless member having an outer surface for carrying toner images in a printing mode. A control arrangement is provided for switching the image reproduction system between a printing mode and a refurbishing mode. In the refurbishing mode, the surface of the endless member is cleaned using a cleaning solution comprising at least one organic solvent. In an embodiment, the endless member is subsequently polished to remove the liquid present on the surface of the endless member.

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Description

Related Application

[0001] This application claims the benefit under 35 U.S.C. §119(e) to provisional application number 60/314,681, filed August 24, 2001, the disclosure of which is incorporated herein by reference in its entirety.

Background of the Invention

Field of the Invention

[0002] The present invention is related to image reproduction systems, such as, e.g., printing and copying systems, and particularly to the refurbishing of the developed-image carrying members of such systems.

Description of the Related Technology

[0003] In a typical printing or copying process, a charged latent image is formed on an image-forming member by image-wise exposure. The image-forming member can be an endless member such as a drum or a belt. Typical graphical processes include amongst others magnetography, ionography and electrography, particularly electrophotography. In the latter process for instance, the charged latent image is formed on a precharged photosensitive member by image-wise exposure to light. The latent image is subsequently made visible on the image-forming member with developer at a development zone, the developer comprising, or consisting of, charged toner. After the development of the latent image, the developed image is transferred to a recording medium, directly or via one or more intermediate image transfer members, where it may be permanently fixed. Examples of intermediate image transfer members are endless belts or drums. In practice the transfer from an image-delivering member being either an image-forming member or an intermediate image transfer member to an image-receiving member being either an intermediate image transfer member or a recording medium may be incomplete. Multiple subsequent transfers are possible. In normal operating conditions, typical transfer efficiencies range from 95% to 100%. The residual image on the image-delivering member has to be removed because otherwise the image quality of subsequently formed or transferred images can be seriously disturbed.

[0004] This residual image has to be removed within each cycle of the image-delivering member, being before re-entering into the development zone in case of an image forming member or before re-entering into the transfer zone in case of an intermediate image transfer member. Otherwise this could lead to serious image defects because of mixing up of the new developed or transferred image with the residual image.

[0005] This cleaning action is executed by a cleaning station positioned downstream the transfer zone. A cleaning station usually comprises a revolving brush and/or a scraper blade and/or other cleaning means, which can be engaged against the image-delivering member for removing residual toner therefrom. It is known that any cleaning means relying at least partly on mechanical forces to perform the cleaning, may result in filming on the image-delivering member due to smeared out toner particles. In case of an image-delivering member such as, e.g., a photosensitive belt or drum, this filming may influence the level of chargeability amongst others resulting in a decreased image density of the final printed image. In case the image delivering member is an intermediate image transfer member this filming may negatively influence the surface properties of the image transfer member which directly affect the transfer properties leading to transfer efficiency degradation and deterioration of the overall image quality. Filming may be one of the failure mechanisms limiting the life-time of such an image-delivering members. Another failure mechanism may be the formation of defects such as micro-cracks and/or scratches on the surface of the image delivering member during handling, introduction in the reproduction system, or during extended use. Compressed toner particles and other extraneous matter may accumulate on these defects. The matter accumulated on the surface of the image delivering member can usually not be removed by the cleaning brush or blade. To the contrary, during subsequent cycles more and more toner tends to adhere to this already accumulated matter leading to clearly visible marks in the final image.

[0006] US Patent No. 5,671,475 (assigned to Xeikon), which is hereby incorporated by reference in its entirety, discloses a web-fed electrostatographic printer wherein the image delivering member, in this case a photosensitive drum, is refurbished by contacting the photosensitive surface with an abrasive web.

[0007] US Patent No. 5,464,555 (assigned to Dotolo Research Corporation) discloses a liquid, non-aqueous, one-step graphic ink remover cleaner comprising ethyl lactate, while the Japanese patent abstract JP58209773A2 (assigned to Ricoh Co.) discloses the use of cleaning sheet impregnated with a solvent to remove contaminants from a paper conveyance path.

Summary of Certain Inventive Aspects

[0008] The present invention is related to an image reproduction system, which enables the refurbishing of image-delivering members in the image reproduction system itself. By obviating the need for removal of these members from the system for refurbishing purposes, these members are no longer subjected to any further handling which is beneficial with respect to life-time and reliability as such handling could introduce new defects on their outer surface. This is particularly so in case of image delivering members in the form of belts as han-

dling of belts is far more difficult compared to for instance drums. Therefore, in a first aspect of the invention, an image reproduction system is disclosed, comprising an endless member having an outer surface for carrying toner images in a printing mode; and a control arrangement for switching said image reproduction system between a printing mode and a refurbishing mode, wherein in said refurbishing mode said image reproduction system further comprises a cleaning member for contacting said outer surface of said endless member to apply a layer of a cleaning solution comprising at least one organic solvent thereon to release toner based and extraneous matter built up on said surface of said endless member. Examples of endless members having an outer surface for carrying toner images in a printing mode are image-forming members such as drums or belts with a seamed or seamless photosensitive outer layer, such as an organic photoconductor (OPC), for use in electrophotographic image reproduction systems, or a magneto-sensitive outer layer for use in magnetographic image reproduction systems. Examples of other image-carrying members are seamed or seamless intermediate transfer or transfuse drums or belts. Some recent printers and copiers are, to enable printing on a wide variety of receptor materials, provided with at least one intermediate transfer member to transfer a developed toner image from an image forming member to a receptor material. Multiple intermediate transfer members may be provided. In case the developed toner image is not only transferred but also simultaneously fused, usually by means of heat and pressure, to the receptor material, then the intermediate transfer member contacting the receptor material constitutes the transfuse member referred to herein.

[0009] Drive means may be provided for rotating the endless member in the refurbishment mode, optionally at a different peripheral speed and in a different direction compared to the printing mode. Means may also be provided to disengage, at least in the refurbishment mode, the endless member to be cleaned from other image delivering or image receiving members.

[0010] At least the part of the cleaning member for contacting the outer surface of the image delivering member is preferably composed of a material selected from the group including polyether, crosslinked polyesters, polyurethanes, derivated cellulose, and melamine. The cleaning member may be of arbitrary shape, provided a continuous and uniform contact can be established with the outer surface of the image delivering member at least in the transverse direction. The cleaning member is retractable and/or removable. The cleaning member can be a roller or a belt. In the latter case, when not kept stationary, drive means may also be provided for cycling the cleaning member at a predetermined speed. The cleaning member may be driven such as to result in a continuous movement. Alternatively, the cleaning member may be driven by a stepping motor resulting in a discontinuous movement. Preferably, the cleaning member is a roller with a foamy outer layer optionally covered with an impurity-absorbing material, which releases the cleaning solution on the endless member.

[0011] In an embodiment of the invention, the cleaning solution comprises a mixture on a molecular level of at least one high solubility solvent with at least one low or non-solubility solvent. Both the high solubility solvent (s) as well as the low or non-solubility solvent(s) have —O- present in their structure. Preferably, in the high solubility solvent molecule this —O- is related to C=O structures, such as found in ketones and esters, while the -O- —group present in the low or non-solubility solvent molecules is e.g. —OH based such as in alcohols, water, and ether groups.

[0012] The ratio between the amount of high solubility solvent(s) and low or non-solubility solvent(s) in said solvent mixture is preferably between 0.3 and 3, more preferably between 0.6 and 1.5.

[0013] In another embodiment of the invention, in the refurbishing mode, the image reproduction system further comprises a wiping member positioned downstream of said cleaning member for contacting said outer surface of said rotatable endless member to thereby remove the liquid therefrom. In this case, the cleaning solution applied comprises at least one organic solvent showing at least an OH-functionality and which also comprise, within the same molecule, another polar group such as a ketone group, an ether group or an ester group. Examples of such solvents are alkyl lactates, alcohols, alkoxyalcohols, furfuryalcohol, isopropanol and methoxypropanol. The solvent(s) may be mixed with water to thereby form the cleaning solution.

[0014] In another aspect of the invention a method is disclosed for refurbishing the outer surface of an endless member of an image reproduction system, said outer surface carrying toner images when operating said image reproduction system in a printing mode, wherein, in the refurbishment mode, wetting said outer surface with a cleaning solution comprising at least one organic solvent to thereby release toner based and extraneous matter built up on said surface; and removing any residual matter from said outer surface. Although not preferred it is clear that the refurbishing may also be executed offline.

[0015] In an embodiment of the invention, when operating the reproduction system in the refurbishing mode, the outer surface of the endless member to be cleaned is wetted by contacting with an endless member having at least an outer layer being impregnated with cleaning solution. One may opt to remove the liquid on the outer surface of the endless member by contacting with a wiping member, preferably having an outer layer composed of a lint-free material.

[0016] In a further embodiment according to the present invention, in the refurbishing mode, a contact is established between the outer surface of the endless member to be cleaned and a cleaning member impreg-

nated with a predetermined amount of cleaning solution. The cleaning member may comprise an outer layer of an impurity-absorbing material which enables the efficient removal of the solubilized accumulated toner-based contaminants. Doing so enables the use of a single cleaning member both for the solvent application as well the removal the solubilized accumulated toner-based contaminants.

[0017] Another aspect is a system for an image reproduction system which operates in a print mode and in a refurbishment mode comprising an endless member having an outer surface for carrying a toner image during the printing mode, a dry cleaning unit configured to contact the endless member during the printing mode to remove undesirable matter therefrom, a refurbishing member configured to contact the endless member during the refurbishment mode and apply a cleaning solution thereto, and a controller configured to select the print mode and the refurbishment mode.

[0018] Another aspect is a method for cleaning an outer surface of an endless member in an image reproduction system, the outer surface carrying a toner image when the image reproduction system is operating in a printing mode. The method comprising applying the toner image to the outer surface during the printing mode, contacting the outer surface with a dry cleaning member, disengaging the dry cleaning member from the outer surface, wetting the outer surface with a refurbishing solution, and removing undesirable matter from the wetted outer surface.

[0019] Still another aspect is a method for refurbishing an endless member in an image reproduction system. The method comprising applying the toner image to an outer surface of the endless member during a printing mode, contacting the outer surface with a cleaning member during the printing mode, wetting the outer surface with a cleaning solution when the cleaning member is not contacting the outer surface, and removing undesirable matter from the outer surface with the cleaning solution.

[0020] Yet another aspect is a system for an image reproduction system which operates in a print mode and in a refurbishment mode which comprises an endless member having an outer surface for carrying a toner image during the print mode, dry means for removing undesirable matter from the outer surface during the printing mode, wet means for removing undesirable matter from the outer surface during the refurbishment mode, and means for selecting between the print mode and the refurbishment mode.

[0021] A further aspect is a method of refurbishing an endless member in an image reproduction system which comprises removing the endless member from the image reproduction system, wetting an outer surface of the endless member with a mixture of a high solubility organic solvent and a low solubility organic solvent, both relative to the toner, dislodging toner from the outer surface with the at least one organic solvent, and replacing the endless member in the image reproduction system.

Brief Description of the Drawings

[0022] Figure 1 depicts a printing system, which can be operated in a refurbishment mode according to an embodiment of the invention.

[0023] Figure 2 depicts a printing system, which can be operated in a refurbishment mode according to an embodiment of the invention.

[0024] Figure 3 depicts an image-forming station according to an embodiment of the invention.

[0025] Figure 4 depicts a printing system, which can be operated in a refurbishment mode according to an embodiment of the invention.

Detailed Description of Certain Inventive Embodiments

[0026] In relation to the appended drawings, the present invention is described in detail as follows. It is apparent, however, that a person skilled in the art can imagine several other equivalent embodiments or other ways of executing the present invention. The spirit and scope of the present invention is limited only by the terms of the appended claims.

[0027] The present invention is directed to a system and method for refurbishing an outer surface of endless members of an image reproduction system. Examples of image reproduction systems include digital printing or copying systems which carry toner images when operating in a printing mode. This is enabled by the provision of a control arrangement which allows the image reproduction system to switch between the printing mode and a refurbishment mode. For example, an operator provides a command to a computer or controller which controls the image reproduction apparatus. The computer may use one or more processors, microprocessors, or microcontrollers. Software, used in connection with the processor, then deactivates certain functions and activates other functions.

[0028] The refurbishment system and method can be employed offline, i.e., outside the image reproduction system, or online. However, the online implementation within the image reproduction system is clearly advantageous compared to the offline refurbishment system as it reduces the chance of damaging the surface of the endless member during its removal from the reproduction system, handling, and replacement of the endless member into the system. Moreover, such a configuration reduces the downtime of the image reproduction system, i.e., the time that the system is not operative in the printing mode. Therefore, the image reproduction system according to one aspect of the present invention comprises at least an endless member having an outer surface for carrying toner images in a printing mode; and a control arrangement for switching the image reproduction system between a printing mode and a refurbishing mode, wherein in the refurbishing mode the surface of

the endless member is cleaned using a cleaning solution comprising at least one organic solvent, optionally, dependent on the selected cleaning solution, followed by a wiping step wherein the liquid present on the surface of the endless member is removed.

[0029] The receptor material for carrying the printed images can be in web form or in sheet form. In the latter case, the receptor material is preferably transported on a conveyor. Typical receptor materials are paper, films, label stock, cardboard, etc.

[0030] The marking particles used to develop the images with the image reproduction system in the printing mode are toner particles. The toner particles may constitute dry particulate matter. Alternatively, a wet liquid type developer may be used wherein the toner particles are dispersed in a solvent. The development technique for electrophotographic printing systems applied in the examples further described herein uses a two-component dry developer material of toner particles adhering tribo-electrically to larger carrier beads. When the developer material, contained in a developer unit, is placed in an appropriate magnetic field, the carrier beads with the toner thereon form a magnetic brush. As the carrier beads and the toner particles are oppositely charged, in the development zone the toner particles are attracted to the carrier beads and develop the latent image on the image-forming member. In case of a two-component developer it is clear that both the developed image and the residual image are primarily composed of toner particles. It should be clear however that the present invention is in no way limited to the refurbishing of endless members of electrophotographic image reproduction systems carrying dry toner images in the printing mode. To the contrary, the present invention is equally applicable when using a liquid type developer and/or image reproduction systems employing other image forming processes including but not limited to magnetography, ionography, direct electrostatic printing (DEP) and electography.

[0031] Examples of endless members having an outer surface for carrying toner images in a printing mode are image-forming members such as drums or belts with a seamed or seamless photosensitive outer layer. Depending on the type of image reproduction system, the photosensitive outer layer can be an organic photoconductor (OPC), for use in electrophotographic image reproduction systems, or a magneto-sensitive outer layer for use in magnetographic image reproduction systems. Examples of other image-carrying members are seamed or seamless intermediate transfer or transfuse drums or belts. Such an intermediate transfer member may be composed of an electrically semi-insulating or insulating material with a low surface energy, or comprise at least a top coating of such a material. Examples of such a material are polyesters such as e.g. Hytrel 7246, polyimides, polycarbonates or dissipative polymer blends. Examples of transfuse members are members having at least an outermost layer of a material selected from the group of polyorganosiloxanes, fluorosilicones, phenylsilicones and fluoro-elastomers.

[0032] In a preferred embodiment, the cleaning member is a roller. When not kept stationary, drive means may also be provided for cycling the cleaning member at a predetermined speed either continuously or discontinuously by means of a stepping motor. Preferably, the cleaning member is a roller with a solid core covered with a, preferably open-celled, foamy layer. The cell size is preferably smaller than lmm, more preferably even smaller than 300 μm. The foamy layer is preferably composed of a material selected from the group including polyether, crosslinked polyesters, polyurethanes, derivated cellulose, and melamine. Optionally this foamy layer is covered with an impurity-absorbing material. The thickness of the impurity-absorbing material is typically from 100 μm to 300 μm. This impurity-absorbing material is preferably a lint-free material. Typical examples thereof are cootan or polyestercellulose. This foamy outer layer, and optionally the impurity absorbing layer, are impregnated with a predetermined amount of the cleaning solution. Alternatively, the cleaning member is a roller having a permeable, e.g., perforated, hollow core with a cleaning solution held therein and a foamy outer layer. Optionally an intermediate layer impregnated with said cleaning solution may be positioned around said hollow core, example by being wound around the core, and is covered with the foamy outer layer which will contact the endless member. The intermediate layer is typically formed of paper or felt. This optional layer may allow for a better control of the application rate of the cleaning solution. The application rate can be determined by the composition and thickness of the cleaning solution impregnated intermediate layer, the size and the distribution of the perforations in the core, the thickness and porosity of the foamy layer, the contact pressure between the cleaning roller and the endless member, the propagation speed of both cleaning roller and endless member, the temperature, and the chemical and physical properties of the cleaning solution.

[0033] The removal of accumulated toner-based contaminants from the outer surface of an image delivering member by means of solvents is a highly complex process. This is particular the case when the image delivering member has a photoconductive outer layer. Essentially this complexity relates to the fact that the basic component in an organic photoconductor (OPC) is polycarbonate whereas toners, especially color toners, comprise polyester resins. Polyester resins are close in chemical composition and in solubility characteristics to the polycarbonates used in OPC layers. By consequence, a cleaning solution, effective in wetting, solvating and solubilising the accumulated toner-based contaminants, will very likely also induce a similar effect on the OPC layer. In the latter case, the OPC layer will degenerate, especially in repetitive cleaning cycles. Both electro-optical defects may occur due to the distortion

of the charge transport, as well as mechanical defects due to the partial removal and/or dissolution of compounds from the top layer. This may further result in other defects such as shrinking, cracking, etc.

[0034] In a first approach, the range of available solvents was intensively screened in order to find a solvent showing solubilising power towards the accumulated toner-based contaminants and substantially no solubilising power towards the OPC. Solvents showing at least an OH-functionality and which also comprise, within the same molecule, another polar group such as a ketone group, an ether group or and ester group show high solubilising power to the accumulated toner-based contaminants, and limited interaction with OPC. Examples of such solvents are alkyl lactates, alkoxyalcohols, ethyllactate, furfuryalcohol, and methoxypropanol.

[0035] It was experimentally observed that by optimizing the resident time of a cleaning solution which comprises at least one of such solvents onto the OPC, a workable window can be created where the accumulated toner-based contaminants can be removed and at the same time no appreciable defects are induced in the OPC. The resident time of the cleaning solution can be carefully controlled by providing a wiping member in the system according to the present invention. The wiping member is positioned downstream of the cleaning member for contacting the outer surface of the image delivering member to thereby remove the liquid therefrom. The resident time of the cleaning solution on the outer surface of the image delivering member is determined by both the speed at which the image delivering member is cycled as well as the distance between contact zone of the cleaning member and the contact zone of the wiping member, and can be carefully controlled dependent on the properties of the cleaning solution.

[0036] The wiping member may be of arbitrary shape, provided a continuous and uniform contact can be established with the outer surface of the image delivering member at least in the transverse direction. The wiping member is retractable and/or removable.

[0037] This wiping member may be a roller or a web, endless or not, preferably having an outer layer composed of a lint-free material. Drive means may be provided to drive the wiping member at a predetermined speed.

[0038] In a second approach at least one solvent having a high solubility toward toner was mixed on a molecular level with at least one solvent having low or no solubility towards toner. It was expected that such molecular mixtures of solvents would not yield a useful cleaning solution because the solvents with high solubilising power would also interact with the OPC. Furthermore, even differentiation in the solubilising process towards toner and OPC by controlling the resident time of the solution on the OPC was expected to be very difficult due to the expected high process kinetics involved. It has been surprisingly found that a mixture of at least one high solubility solvent with at least one low or non-solubility solvent, results in a cleaning solution which allows the very effective removal of the accumulated toner-based contaminants while leaving the OPC unaffected. The underlying process is not well understood. It is guessed that this very unexpected behavior might be due to the interaction of the high solubility solvent(s) and low or non-solubility solvent(s) on molecular level, resulting in a kind of "temporary" cluster molecule, showing these very peculiar solubilising properties. It has been found that preferentially both molecules have polar groups, so that this assumed "molecular" interaction can be operational. It has been found that preferentially both molecules have —O- present in their structure. Whereas in the case of the high solubility solvent molecule this —O- is related to C=O structures, such as found in ketones, esters, ..., the -O- —group present in the low or non-solubility solvent molecules is e.g. —OH based such as in alcohols, even water, and e.g. ether groups,.... It has been observed also that one of the major advantages of cleaning solutions comprising such high/low solubility solvent mixtures is that the evaporation rate is high, particularly compared to cleaning solutions comprising at least one organic solvent showing at least an OH-functionality and which also comprises, within the same molecule, another polar group such as a ketone group, an ether group or an ester group.

[0039] Cleaning solutions comprising such high/low solubility solvent mixtures can be further optimized with respect to their evaporation behavior. It has been found experimentally advantageous to combine solvents characterized by the fact that the high solubility solvent is more volatile than the low or non-solubility solvent. In this case the system is self-protective as in case a change in the solvent composition would occur, the relative amount of low or non-solubility solvent in the solution will increase and thus avoid a situation where at the end a high solubility solvent mixture remains and attacks the OPC.

[0040] The ratio between the amount of high solubility solvent(s) and low or non-solubility solvent(s) in said solvent mixture is preferably between 0.3 and 3, more preferably between 0.6 and 1.5. The absolute value of the evaporation rate is preferably larger than 1, especially when using a single cleaning and wiping member. (The evaporation rate is defined relative to the evaporation rate of butylacetate.) Examples of such high/low solubility solvent mixtures are acetone/ methanol 50/50, MEK / ethanol: 40/60, ethylacetate / isopropanol: 50/50.

[0041] It has been found surprisingly that a cleaning solution comprising such a mixture of solvents enables the use of a single cleaning member for both the solvent application and the removal of the solubilised accumulated toner-based contaminants. In the latter case, optionally an air blower or a heating device may be provided downstream of said cleaning member to stimulate the evaporation of the cleaning solution from the outer surface of the image delivering member.

[0042] It has further been observed that it might be

advantageous to include viscosity increasing substances in the cleaning solution. Examples thereof are *inter alia* colloidal silica, alumina, both hyrophobized or not, and other fine materials. These materials also improve the adsorbing capability with respect to the toner-based contaminants. Also, a release agent may be incorporated as well as additives for rejuvenating the surface layer of the image delivering member.

EXAMPLES

[0043] In a first example, see Figure 1, a schematic representation of an electrophotographic duplex color printer is depicted. The printer comprises a light-tight housing 11, which has at its inside a stack 12 of sheets to be printed. At its output the printer has a platform 14 onto which the printed sheets are received. When operating in the printing mode, a sheet to be printed is removed from stack 12 and is fed through an alignment station 16. As the sheet leaves the alignment station, it follows a straight horizontal path 17 up to output section 18 of the printer. The speed of the sheet, upon entering said path, is determined by driven pressure roller pair 47. A number of processing stations are located along the path 17. A first image-forming unit 20 indicated in a dash-and-dot line is provided for applying a multi-color image to the obverse side of the sheet and is followed by a second station 21 for applying a multi-color image to the reverse sheet side. A buffer station 23 then follows, with an endless transport belt 24 for transporting the sheet to a fuser station 25. As both image forming units are similar to each other, only unit 20 will be described in more detail hereinafter.

[0044] An endless photoconductor belt 26 is guided over a plurality of rollers 27 to follow a path in the direction of arrow 22 to advance successive portions of the photoconductive surface sequentially through the various processing stations disposed along the path of movement thereof. The photoconductive belt may comprise a base layer of polyethylene terephthalate of 100 μm thickness covered with a thin layer of aluminum as a back electrode (less than 0.5 μm thickness). The organic photoconductor (OPC) layer is on top of the aluminum layer and is from 15 μm in thickness. The belt is arranged such that the photoconductive layer is positioned on the outside of the belt loop.

[0045] In the printing mode, initially, a portion of the photoconductive belt 26 passes through the charging station 28. At the charging station, a charge-generating device electrostatically charges the belt to a relatively high, substantially uniform potential, i.e., the dark potential. Next, the belt passes to an exposure station 29. The exposure station 29 exposes the photoconductive belt to successively record four latent color separation images by image-wise discharging the belt. Thereafter, the belt advances these images to the development unit. This unit includes four individual developer stations 35, 36, 37 and 38 with, for example, cyan, yellow, magenta and black developer. During development of each electrostatic latent image only one developer station is in the operative position (developer station 35 in Figure 1). The developer used is two-component developer consisting of non-permanently magnetized magnetic carrier beads having toner particles adhering triboelectrically thereto. A magnetic brush of developer particles is formed in the operative developer station adjacent the photoconductive member. The negatively charged toner particles are attracted by an electrical field from the magnetic brush to thereby develop the corresponding latent image on the photoconductive belt. Each latent image is developed subsequently using the developer station of the corresponding color to thereby form four spaced-apart subsequently developed images on the photoconductive belt.

[0046] After their development, the toner images are moved to toner image transfer stations 40, 41, 42 and 43 where they are transferred on a sheet of receptor material. At the transfer stations, the sheet follows the rectilinear path 17 into contact with the photoconductive belt 26. The sheet is advanced in synchronism with the movement of the belt such that at each transfer station an image is transferred to the paper in perfect register one onto the other to thereby form a registered multicolor image on the sheet. After transfer of the four images, the belt, which acts both as an image-delivering and an image-forming member, is directed towards a cleaning unit 45, which is positioned downstream from the transfer stations. In the cleaning unit, a rotating fibrous-like brush contacts the photoconductive belt 26 to remove residual toner particles remaining after the transfer operation. The cleaning brush rotates preferably in a direction opposite to the propagation direction of the image-delivering member. A collecting roller contacts the cleaning brush and rotates in a direction, preferably opposite to the rotation direction of the cleaning brush. The collecting roller may be a freely rotating roller or may be driven. The cleaning brush and the collecting roller may be independently driven and their rotation speed may be independently controlled. The collecting roller is incompressible and electrically conductive. Bias means are provided to apply a voltage to the collecting roller in order to create an electrical field which is attractive for the toner gathered on the cleaning brush. The cleaning unit may further comprise an auger positioned below the collecting roller. The auger removes the waste toner which is scraped off the collecting roller by a cleaning blade. Airflow may be provided to assist in the removal of the waste developer. Alternatively, instead of an auger, only airflow may be provided to remove the waste. Thereafter, a lamp 46 illuminates the belt to remove any residual charge remaining thereon prior to the start of a next cycle.

[0047] Although the cleaning unit 45 effectively cleans the outer surface of the photoconductive belt, it is believed that over time by the mechanical action of the cleaning brush on the surface filming may occur. More-

over, as micro-cracks, scratches and other defects, in the printing mode, compressed toner particles and other extraneous matter may accumulate on these defects. The matter accumulated on the surface of the image delivering member can usually not be removed by the cleaning brush or blade. To the contrary, during subsequent cycles more and more toner tends to adhere to this already accumulated matter leading to clearly visible marks in the final image. Removing this accumulated matter and/ or filming clearly enhances reliability and lifetime of the OPC.

[0048] Therefore, according to the present invention, a control arrangement is provided to switch the printer between the printing mode and the refurbishing mode. In the refurbishing mode, a drive motor (not shown) is provided to drive the photoconductive belt independently at a controlled speed typically in the range from 1 to 20 cm/s, while all other components are disabled. A cleaning roller having a 1.5-cm thick outer layer of melamine is presoaked in a cleaning solution comprising a 50/50 mixture of acetone and methanol. This presoaked cleaning roller is placed in the system. For instance, the cleaning unit may be temporarily replaced by the cleaning roller. In the refurbishment mode pressure contact is established between the driven cleaning roller and a backing roller while the photoconductive belt is guided in between. The cleaning roller is driven by means of a stepping motor. The length (the longitudinal dimension) of the contact zone is typically about 1 cm. By doing so, a thin layer of the cleaning solution is applied on the outer surface of the photoconductive belt. This may be done at a controlled temperature, usually a fixed temperature in the range from 15 to 35 Centigrade degrees or about room temperature. No other means are engaged against the outer surface of the photoconductive belt. Particularly in case of a dry toner, the development stations 35, 36, 37, 38 may be temporarily removed from the system or sealed from the environment to prevent any undesirable interaction between the toner and the (volatile components) of the cleaning solution leading to, for example, toner clustering. However the vapors are normally removed by the airflow present in the cleaning unit. Extra vapor evacuating means may be provided. By cycling the photoconductive belt while in rolling contact with the cleaning roller, the cleaning roller gradually releases its predetermined amount of cleaning solution. The cleaning solution, which is already applied on the outer surface of the photoconductive belt, gradually evaporates after interaction with the contaminants present on the surface. When the cleaning roller has released all of its cleaning solution, which is after at least one complete cycle of the photoconductive belt, the dried cleaning roller removes any remaining residual contamination from the belt surface.

[0049] The cleaning solution is preferably chemically inert towards the belt's surface material. A photoconductive member usually comprises a conductive backing layer with thereon a photosensitive layer comprising a charge generating material and a charge transport material. Alternatively, instead of a single photosensitive layer, two photosensitive layers may be provided wherein the first layer is provided on the conductive support and comprises a charge generating material, while the second layer is formed on said first one and comprises a charge transport material. An outer protective layer may be provided on the photosensitive layer, e.g., to prevent contamination of the photosensitive layer or to improve release. While the solvent refurbishing method of the present invention is applicable regardless of the nature of the outermost layer, the abrasive refurbishment method may not be applicable when the outermost layer is a protective layer. The repeated abrasion removes a thin stratum of the outermost layer which may have an adverse effect on the life-time of the photoconductive member.

[0050] In a second example, see Figure 2, a schematic representation of another electrophotographic color printer is depicted. This printer has a supply station 113 in which a roll 114 of a web material 112 is housed. In the printing mode, the web of receptor material 112 is conveyed into a tower-like printer housing 144 in which a support column 146 is provided housing at least four printing stations A-D, e.g. black, yellow, magenta and cyan. (In the Figure an extra printing station E is provided, allowing to optionally add an additional color.) As shown in figure 3, each printing station comprises a cylindrical drum 124 having a photoconductive outer surface 126. The drum acts both as an image-delivering member and as an image-forming member. Circumferentially arranged around the drum 124 there is a main charge generating device 128 capable of charging the drum surface to a high potential of about —600 V, i.e. the dark potential, an exposure device 130 will imagewise discharge (e.g. to a potential of about -250 V) the surface 126 to thereby form a latent image. This latent image is developed on the drum by the developer station 132 by contacting the drum with a magnet brush of a two-component developer of non-permanently magnetized magnetic carrier beads having toner particles adhering triboelectrically thereto formed on the surface of a magnet roller 133. Negatively charged toner particles are attracted to the exposed (discharged) areas of the photoconductor. After development, the toner image on the drum surface is transferred to the moving web 112 by a transfer corona device 134 which generates an attractive electrical field for the negatively charged toner particles. This transfer corona together with the guiding rollers 136 establishes also a strong adherent contact between the web and the drum over an angle of about 15 degrees which causes the latter to be rotated in synchronism with the movement of the web 112 and urges the toner particles into firm contact with the surface of the web 112. A web discharge corona 138 is provided to establish a controlled release of the web. Thereafter the drum surface is pre-charged by a charge generating device 140 to a potential between 0 and —600 V both

for facilitating the charging by the main charge generating device and to facilitate the removal of residual images on the drum surface by a cleaning unit 142. The cleaning unit 142 is similar to the cleaning unit 45 (Figure 1) as described above. The cleaning unit includes an adjustably mounted fibrous-like cleaning brush 143, the position of which can be adjusted towards or away from the drum surface to ensure optimum cleaning. The cleaning brush 143 is grounded or subject to a potential with respect to the drum so as to attract the residual developer particles away from the drum surface. The rest of cleaning unit 142 is similar to the cleaning unit 45 (Figure 1) as described above. The rotatable cleaning brush 143 which is driven to rotate in a sense the same as to that of the drum 124 and at a peripheral speed of, for example twice the peripheral speed of the drum surface. The developer station 132 includes a magnetic roller with a brush formed thereon 133 which rotates in a sense opposite to that of the drum 124. The resultant torque applied to the drum by the rotating developing brush 133 and the counter-rotating cleaning brush 143 is adjusted to be close to zero, thereby ensuring that the only torque applied to the drum is derived from the adherent force between the drum and the web.

[0051] Referring back to Figure 2, after a first image of a first color is formed and transferred to the web in a first print station, the web passes successively the other print stations where image of other colors are formed and transferred in register to thereby form a registered multi-color image on the web. After leaving the final print station E, the image on the web is fixed by means of the image fixing station 116 and fed to a cutting station 120 and a stacker 152 if desired.

[0052] A control arrangement is provided to switch the printer between the printing mode and a number of refurbishing modes, wherein in each refurbishment mode a particular photoconductive drum is refurbished. In the each refurbishing mode, a drive motor (not shown) is provided to drive the selected photoconductive drum independently at a controlled speed while all other components, including the web of recording material, are disengaged and/or disabled. A cleaning roller having a 1.5 cm thick outer layer of melamine is presoaked in a cleaning solution comprising a 50/50 mixture of acetone and methanol and replaces the cleaning unit 142. Contact is established between the cleaning roller and the selected photoconductive drum to initiate the refurbishment similarly as disclosed in the previous example.

[0053] In a third example, see Figure 4, a schematic representation of an electrophotographic color printer is depicted incorporating cleaning units according to the present invention. The printer comprises a primary transfer belt 212 formed of polyethylene terephthalate (PET) having a thickness of 100 μm and having spaced along one run thereof a plurality of toner image-forming stations A, B, C, D. Each of these stations is similar as described in Figure 3 and example 2. The charge generating devices 219, 221, 223, 225 are provided to subsequently electrostatically transfer a toner image of a particular color from each image-forming station to the PET belt 212 while the belt is advanced over a number of guide rollers 217 along the stations to thereby form a registered multi-color toner image. The primary transfer belt 212 acts as an image-delivering member.

[0054] At the intermediate transfer nip, the multi-color toner image is transferred to an intermediate transfer belt 250. The intermediate transfer nip 216 is formed between the guide roller 213 and an opposing guide roller 252 pressed towards each other to cause tangential contact between said primary transfer belt 212 and a heated intermediate transfer belt 250. The guide roller 213 comprises an electrically conductive core carrying a semi-insulating covering. A supply of electrical potential is provided for electrically biasing at least the first guide roller 213 to create an electrical field at the intermediate transfer nip 216 to assist in transferring an image 214 from the primary belt 212 to the intermediate transfer belt 250.

[0055] The primary transfer belt 212, with the residual image thereon passes thereafter through a cooling station 268, where the belt is forcibly cooled by directing cooled air onto the primary transfer belt 212. Alternatively, instead of blowing cooled air a cooling liquid such as water may be directed through roller 215 to cool the primary transfer belt. The primary transfer belt 212 is thereby cooled to a temperature of about 35 C. This cooling assists in establishing the required temperature gradient at the intermediate transfer nip 216. The residual toner image on the primary transfer belt 212 is removed by the cleaning unit 246 before the deposition of further developed toner images thereon.

[0056] The intermediate transfer belt, i.e., the transfuse belt, 250 with the transferred multi-color image is advanced over a heated roller 266 to a final transfer station 226. The final transfer station 226 comprises a nip formed between a guide roller 254 of the intermediate transfer belt 250 and a counter roller 270, through which the intermediate transfer belt 250 and a substrate in the form of a paper web 258 pass in intimate contact with each other. Drive rollers 262, driven by a motor 230, drive the web 258 in the direction of the arrow X from a supply roll 260 continuously through the final transfer station 226 where it is pressed against the intermediate transfer belt 250 by the counter roller 270. At this final transfer zone, the multi-color image is transferred from the intermediate transfer belt to the web of receptor material.

[0057] Downstream of the final transfer station 226, the intermediate transfer belt 250 passes through a cleaning station comprising a tacky cleaning roller 229 opposed to a counter roller 227, and thereafter over a steering and tensioning roller 232, before returning to the intermediate transfer nip 216.

[0058] A control arrangement is provided to switch the printer between the printing mode and a number of refurbishing modes, wherein in each refurbishment mode

a particular image delivering member is refurbished, e. g. one of the photoconductive drums, or the primary transfer member, or the intermediate transfer. For instance, when refurbishing the intermediate transfer belt, this belt is separately driven at a controlled speed while all other components, including the primary transfer member and the web of recording material, are disengaged and/or disabled. A cleaning roller having a 1.5 cm thick outer layer of melamine is presoaked in a cleaning solution comprising a 50/50 mixture of acetone and methanol and replaces the tacky cleaning roller 229. A rolling contact is established between the cleaning roller and the intermediate transfer belt to initiate the refurbishment.

[0059] The foregoing description details certain embodiments of the present invention and describes the best mode contemplated. It will be appreciated, however, that no matter how detailed the foregoing appears in text, the invention can be practiced in many ways. It should be noted that the use of particular terminology when describing certain features or aspects of the present invention should not be taken to imply that the terminology is being re-defined herein to be restricted to including any specific characteristics of the features or aspects of the invention with which that terminology is associated. The scope of the present invention should therefore be construed in accordance with the appended claims and any equivalents thereof.

Claims

1. An image reproduction system which operates in a print mode and in a refurbishment mode, the image reproduction system comprising:

an endless member having an outer surface for carrying a toner image during the printing mode;
a dry cleaning unit configured to contact the endless member during the printing mode to remove undesirable matter therefrom;
a refurbishing member configured to contact the endless member during the refurbishment mode and apply a cleaning solution thereto; and
a controller configured to select either the print mode or the refurbishment mode.

2. The system of Claim 1, wherein the refurbishing member is substantially cylindrical in shape and wherein the cleaning solution is located around a circumference of the refurbishing member.

3. The system of Claim 1 or 2, wherein the cleaning solution comprises at least one organic solvent that releases toner and extraneous matter from the surface of the endless member.

4. The system according to anyone of claims 1 to 3, further comprising a wiping member positioned downstream of the refurbishing member and configured to contact the outer surface of the endless member to remove residual matter therefrom.

5. The system to any of claims 1 to 4, wherein the at least one organic solvent is selected from the group consisting of alkyl lactates, alcohols and alkoxyalcohols.

6. The system according to any of claims 1 to 5, wherein the cleaning solution comprises a mixture of at least one organic solvent with high solubilising power and at least one organic solvent with low solubilising power, both relative to toner material.

7. The system according to claim 6, wherein a ratio of high solubilising solvent to low solubilising solvent ranges from 0.3 to 3.0.

8. The system according to claim 6 or 7, wherein an evaporation rate for the high solubilising solvent is higher than an evaporation rate for the low solubilising solvent.

9. The system according to anyone of claims 6 to 8, wherein the mixture is selected from the group consisting of acetone/methanol, MEK/ethanol, and ethylacetate/isopropanol.

10. A method for refurbishing an endless member in an image reproduction system, the method comprising:

applying the toner image to an outer surface of the endless member during a printing mode;
contacting the outer surface of the endless member with a cleaning member during the printing mode;
wetting the outer surface of the endless member with a cleaning solution when the cleaning member is not contacting the outer surface; and
removing undesirable matter from the outer surface of the endless member with the cleaning solution.

11. A method according to claim 10 for cleaning or refurbishing an outer surface of an endless member in an image reproduction system, the outer surface carrying a toner image when the image reproduction system is operating in a printing mode, the method comprising:

applying the toner image to the outer surface of the endless member during the printing mode;
contacting the outer surface of the endless

member with a cleaning member;
disengaging the cleaning member from the outer surface of the endless member;
wetting the outer surface of the endless member with a cleaning or refurbishing solution; and
removing undesirable matter from the wetted outer surface of the endless member.

12. The method according to claim 10 or 11, wherein the said solution comprises at least one organic solvent.

13. The method according to anyone of claims 10 to 12, wherein the wetting of the outer surface comprises contacting the outer surface with a revolving endless member having an outer layer impregnated with the refurbishing solution.

14. The method according to anyone of claims 10 to 13, wherein the at least one organic solvent is selected from the group consisting of alkyl lactates, alcohols and alkoxyalcohols.

15. The method according to anyone of claims 10 to 14, wherein said solution comprises at least one organic solvent with high solubilising power and at least one organic solvent with low solubilising power, both relative to toner material.

16. The method according to anyone of claims 10 to 15, wherein said solution contains a rejuvenating agent for the outer surface.

17. An image reproduction system which operates in a print mode and in a refurbishment mode, the image reproduction system comprising:

an endless member having an outer surface for carrying a toner image during the print mode;
dry means for removing undesirable matter from the outer surface of the endless member during the printing mode;
wet means for removing undesirable matter from the outer surface of the endless member during the refurbishment mode; and
means for selecting between the print mode and the refurbishment mode.

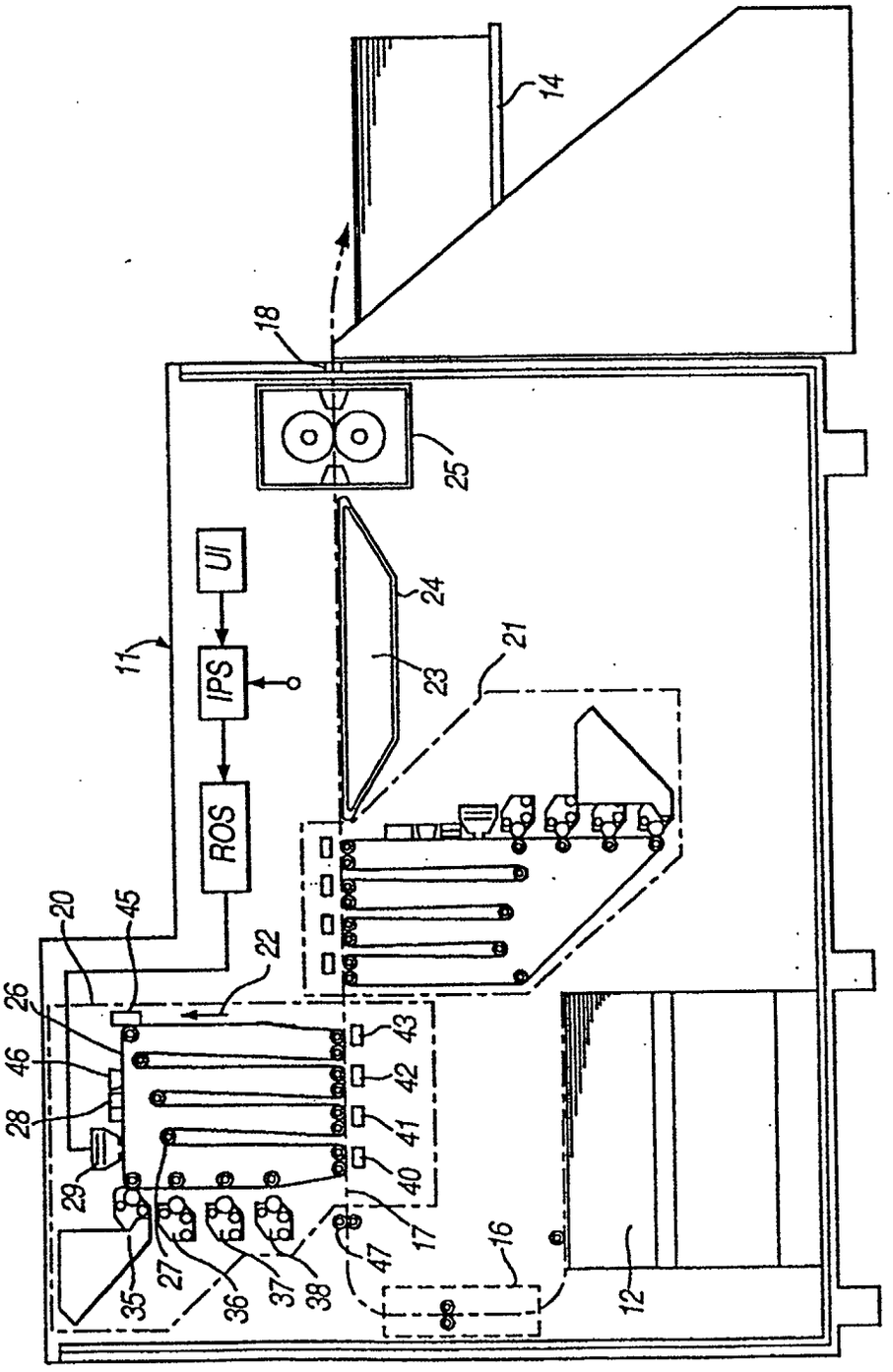

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Fig.1

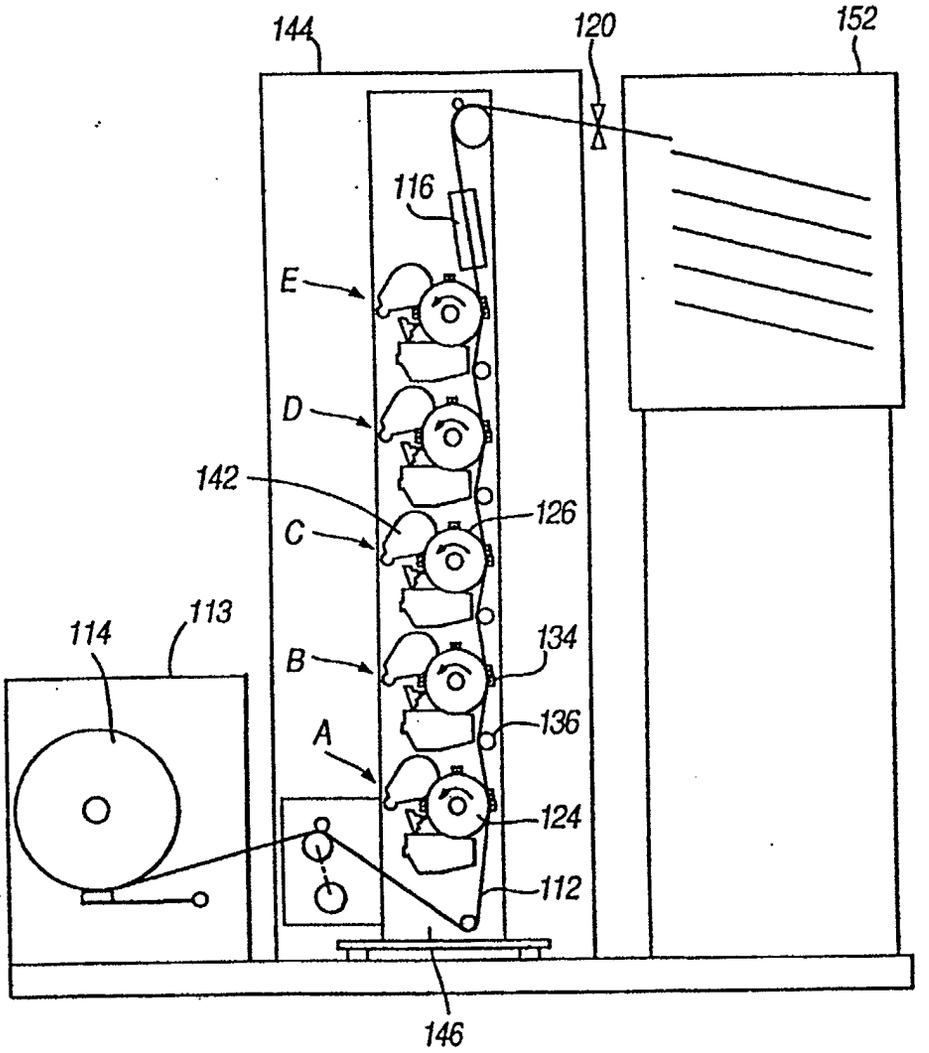


Fig. 2

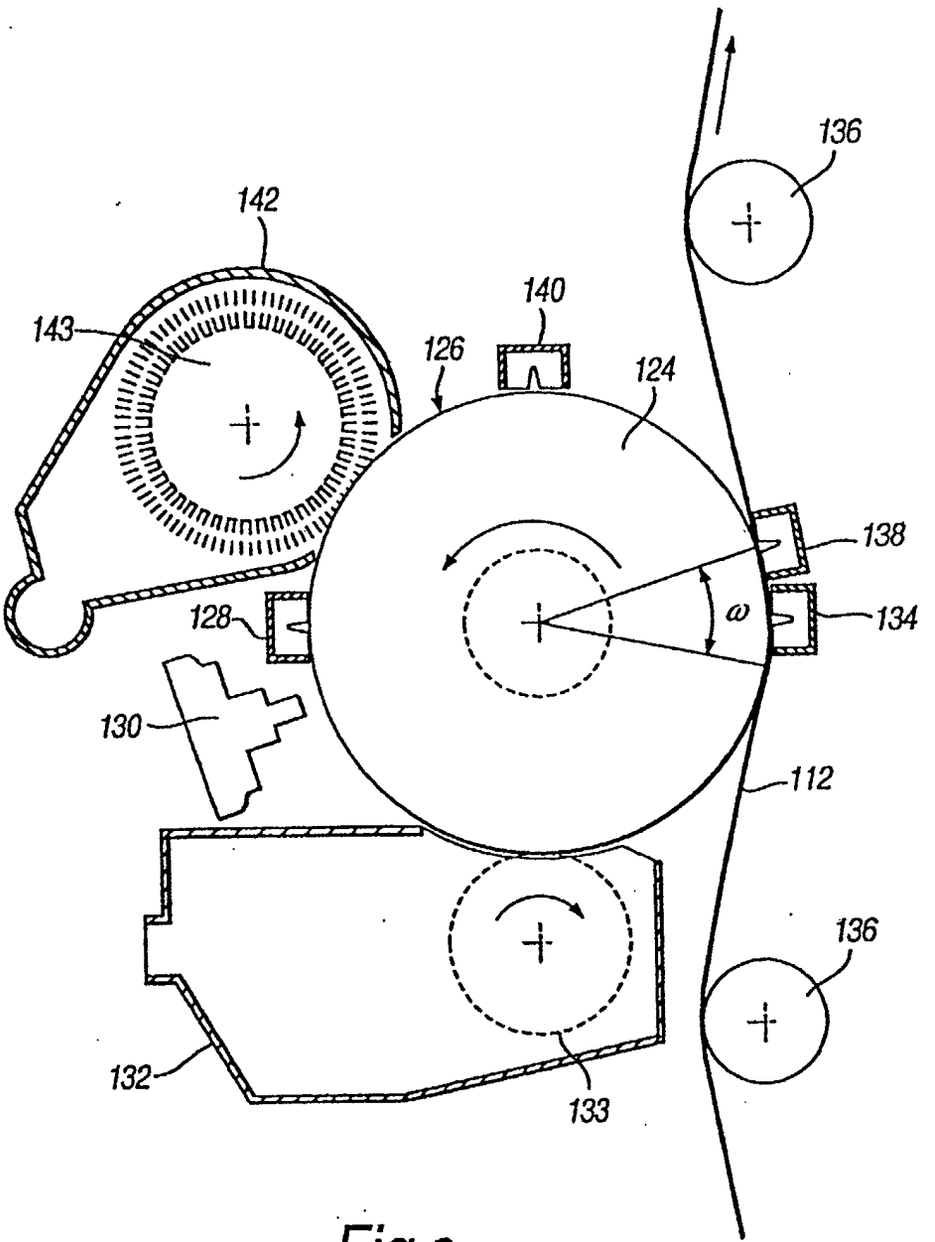


Fig.3

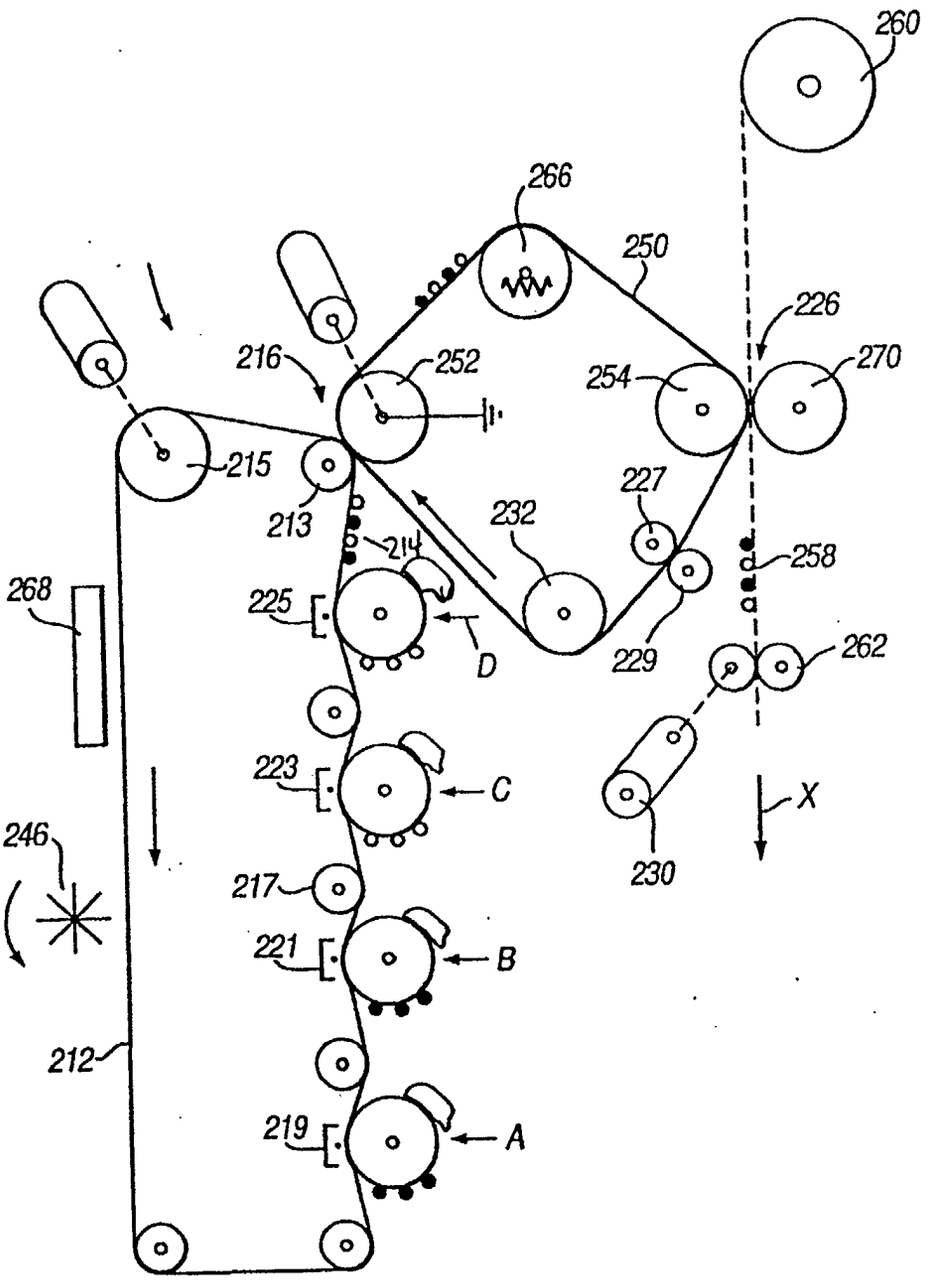

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Fig. 4