

[54] ELECTROPHOTOGRAPHIC APPARATUS

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[56]

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[57]

ABSTRACT

Electrophotographic printing apparatus wherein a photo-sensitive member is maintained in stationary tilted position throughout multi-color image-forming and development. Ejector and receptor elements are selectively rotated into operative position relative to the photo-sensitive member respectively for cascading treating solutions thereover and for collecting dispensed treating solutions.

11 Claims, 3 Drawing Figures

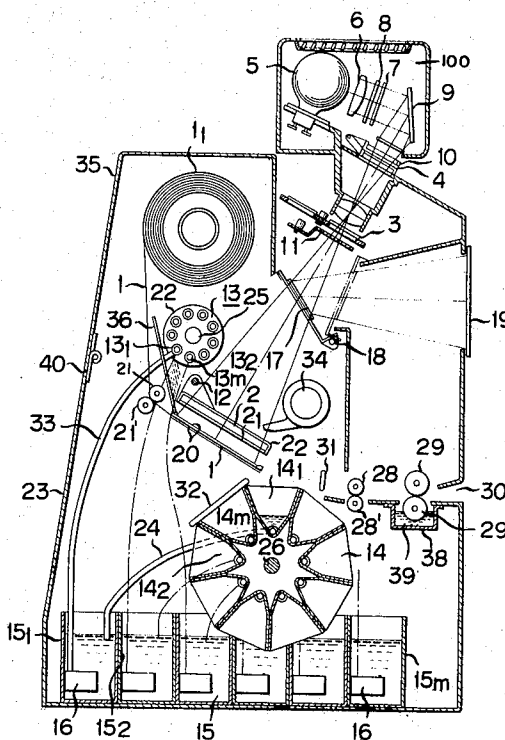


FIG. 1

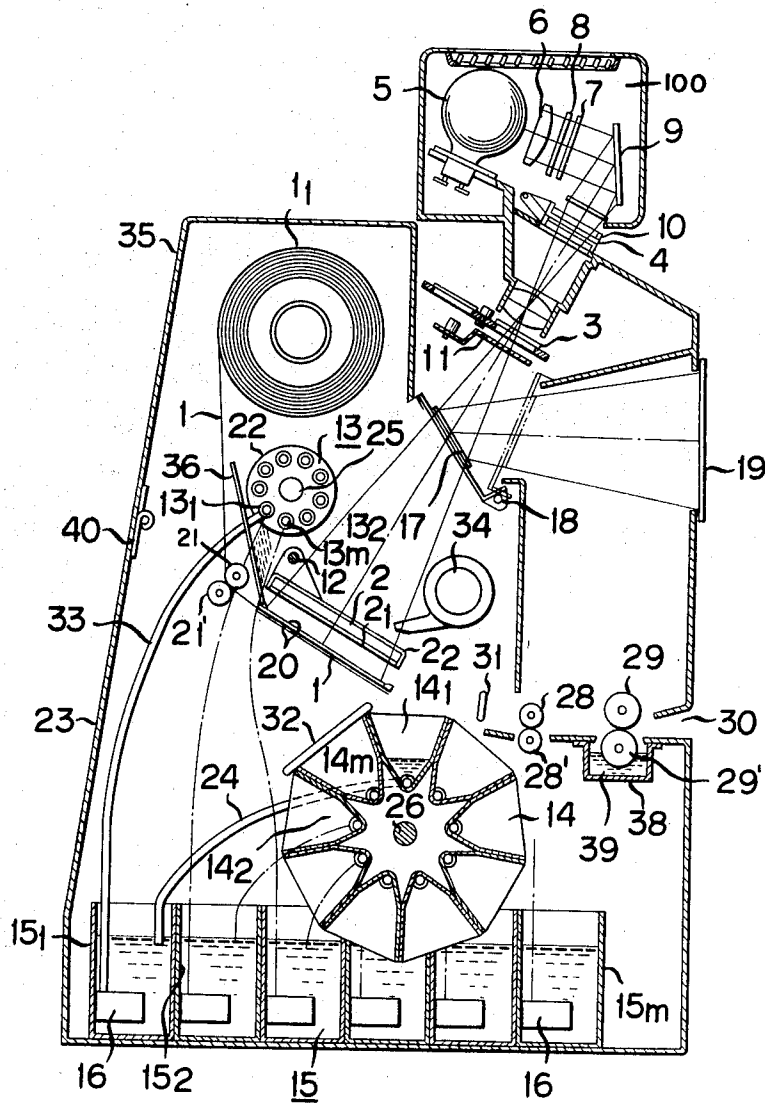


FIG. 2

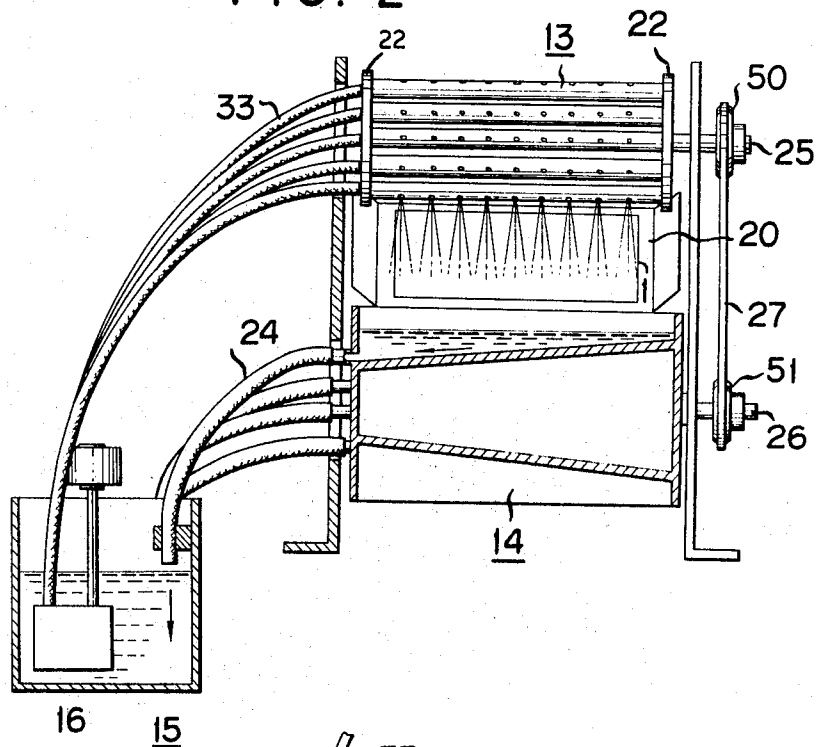
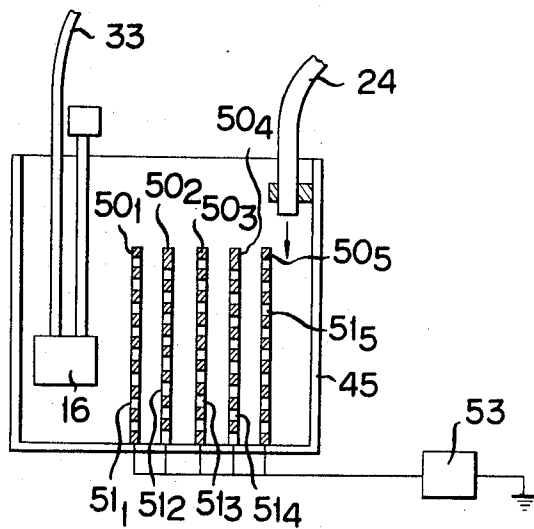


FIG. 3



ELECTROPHOTOGRAPHIC APPARATUS

The present invention relates generally to electrophotographic apparatus and more particularly to an improved wet type electrophotographic color printing apparatus. In conventional color printing processes, an electrophotographic photo-sensitive member is first uniformly charged with electrostatic charge, exposed to light through a color filter, pretreated with a pre-wetting solution and developed with a corresponding color developing solution. Thereafter, the developed photo-sensitive member is cleaned with a cleaning solution so as to remove blurring and then is dried. In accordance with the number of exposures through color filters, such developing process is repeated with different color developing solutions, thereby providing an electrophotographic color print.

In one of the various proposed apparatus of the type described, the photo-sensitive member is advanced through units consisting of a pre-wetting section, a developing section and a cleaning section, the units being equal, in number, to the number of exposures.

In the apparatus of the type described above, in order to prevent color shears caused in the courses of several exposures, the photo-sensitive member must be moved into a predetermined correct position and the control of such operation is extremely difficult.

In other types of the apparatus, in order to prevent color shears, the position at which the photo-sensitive member is treated remains unchanged until the completion of the whole color printing process while the containers for the developing solutions, cleaning solutions, drying solutions and the like for respective colors are vertically or horizontally moved together with an easel retaining thereupon the photo-sensitive member in such manner that the photo-sensitive member is either immersed in the treating solutions in predetermined order or the treating solutions are spread upon the photo-sensitive member in predetermined order.

However, in order to vertically or horizontally move the treating solution containers and/or the easel, very complicated mechanism and tedious operations are inevitably required so that the apparatus is large in size and expensive to manufacture. Furthermore, fully automatic color printing apparatus of this type for automatically carrying out all of the steps from charging to finishing has not been proposed.

The present invention solves all of the problems encountered in the conventional color printing apparatus by the provision of an improved electrophotographic color printing apparatus in which an electrophotographic photo-sensitive member, while in a stationary position, is uniformly charged by a corona discharging device exposed through a color filter, cascaded with a developing solution corresponding to the color filter to form a visual image and if required, cleaned with a cleaning solution to remove blurring. The above steps are repeated for each color filter used.

An object of the present invention is therefore to provide an improved electrophotographic color printing apparatus.

Another object of the present invention is to provide a wet type electrophotographic color printing apparatus of the type in which the photo-sensitive member is held in fixed position throughout the whole color printing process.

A further object of the present invention is to provide a compact electrophotographic color printing apparatus.

A still further object of the present invention is to provide an electrophotographic color printing apparatus capable of completely eliminating any color shears.

The above and other objects, features and advantages of the present invention will become more apparent from the following description in conjunction with the accompanying drawings in which:

FIG. 1 is a longitudinal sectional view of one embodiment of an electrophotographic color printing apparatus according to the present invention;

FIG. 2 is a front view in section on an enlarged scale of one portion of FIG. 1; and

FIG. 3 is a sectional view of a modified cleaning tank of the present invention.

Referring to FIG. 1, a housing designated generally by reference numeral 23 accommodates therein various devices and means for effecting color printing. Reference numeral 1 designates an electrophotographic photo-sensitive member, for example a photo-sensitive member comprising an electrically conductive sheet upon which is applied a coating of a photoconductive material. Reference numeral 1₁ denotes a roll of such photo-sensitive member from which the photo-sensitive member is continuously supplied for color printing. The invention will be described with reference to the rolled photo-sensitive member, but it will be understood that the present invention can be applied to a stack of photo-sensitive members which may be separated one by one by a suitable sorting machine. The photo-sensitive member 1 supplied from the roll 1₁ is guided by a pair of guide rollers 21 and 21' and is held in stationary position in an easel 20 which can be opened or closed. In this case, the photo-sensitive member is held perpendicular to the optical axis of the optical system within an exposure device. A corona discharging device 2 is disposed parallel to the easel 1 and spaced apart therefrom. The construction of the corona discharging device 2 is such that within a shield 2₂ are extended one or a plurality of wires 2₁ to which high voltage is applied from a high-voltage source (not shown) so that the corona discharge is generated, thereby imparting uniform electrostatic charge onto the surface of the photo-sensitive member 1. The corona discharging device is adapted to move along the rail 12 in such a manner that the corona discharge is applied over the whole surface of the photo-sensitive member at a right angle with respect to the plane of the figure. The corona discharging device is electrically controlled by a switch (not shown). It is to be understood that, while the corona discharging device described and shown in the accompanying drawings scans the photo-sensitive member, the corona discharging device may, alternatively, be held in stationary position to accomplish the same result.

The exposure device generally indicated by reference numeral 100 includes an optical system, exposure filters, a shutter and other elements. Reference numeral 5 designates a light source; 6, a condenser lens; 7, a scattering glass; 8, a heat-resisting filter; 9, a reflecting mirror; and 10, an original retaining plate for holding in position an original 4 such as a micro-film. Any desired number of exposure filters 3 may be selected and changeably disposed in the optical path. A shutter 11 is disposed within the exposure device in such a manner that the light image may be projected upon the photo-sensitive member when it is opened. A mirror 17 is disposed between the exposure device 100 and the photo-sensitive member 1 located in position, and is tiltable about the pivot 18. When the mirror is in the solid line position shown in FIG. 1, the image of the original is focused upon a focusing or ground glass 19 so that the original may be read or the position thereof may be suitably adjusted. When the mirror 17 is in the dash line position, the image of the original is projected upon the photo-sensitive member. Such operation of the mirror 17 is performed by an electromagnetic switch (not shown).

A treating solution ejection pipe assembly 13 is rotatably disposed upwardly of the photo-sensitive member 1 in such a manner that one of the treating solutions may be cascaded over the photo-sensitive member 1 slantly disposed upon the easel 20. Where exposures are carried out by using different colors, for example, red, green and blue (or yellow), pipes for ejecting pre-wetting solution, developing solution and cleaning solution for each color are disposed, as many as required, between a pair of disks 22, 22' in equiangularly spaced apart relation.

A treating solution container assembly generally designated by 14 is disposed downwardly of the photo-sensitive member 1 so as to receive the treating solution flowed over the photo-sensitive member and dropped from the lower edge thereof. The number of treating solution receptors or containers which are radially disposed about the axis of shaft 26 of the treating solution container assembly 14 is equal to that of the pipes in treating solution pipe assembly 13. The treating solution

received in each container 14 is returned to a sectioned tank 15 through a conduit 24. The treating solution is pumped up by a pump 16 to corresponding ejection pipe in the pipe assembly 13 through a conduit pipe 33 and is ejected therefrom. In such manner, each of the treating solutions is circulated.

Such treating solution circulation system is shown in FIG. 2 in more detail. The bottom of the container 14 is inclined transversely as shown in FIG. 2 and at the lowermost portion thereof is formed an outlet to which the conduit is connected so that the treating solution in the container 14 may be returned to its corresponding tank 15. Thereafter, the treating solution is pumped up through the conduit 33 to its corresponding pipe 13 so that each treating solution is circulated in the manner described above. The container assembly 14 is rotated by a rotary shaft 25. Shafts 25 and 26 are respectively provided with pulleys 50 and 51 or sprocket wheels and a belt or chain is lapped around them so that the pipe assembly 13 and the container assembly 14 are rotated in synchronism with each other. After the photo-sensitive member 1 has been charged, exposed and pre-wetted, it is subjected to cascade development by the developing solution ejected from one of the pipes 13, and the developing solution flows down to the lowermost edge of the photo-sensitive member 1 and drops into its corresponding container of the container assembly 14. It is then returned to the corresponding developing solution tank 15, in the manner as described above and not to other treating solution tanks 15₂ to 15_m. That is, the rotations of the pipe and container assemblies 13 and 14 and the actuation of each of the pumps 16 are mechanically and electrically controlled by a predetermined program of sequential steps of the color printing process, such as exposures and after-treatments. Each of the ejection pipes 13 and each of the containers 14 will be rotated clockwise or counterclockwise within an angle of rotation of less than 360°. The conduit pipes 24 and 33 are made of a flexible material such as synthetic resin so that they are not twisted with one another as they are arranged as described above with reference to the accompanying drawings.

Referring back to FIG. 1, it is preferable to provide a photo-sensitive member guide 32 upon the opening of the last treating solution container 14_m for facilitating the discharge of the developed photo-sensitive member out of the apparatus. A pair of guide rollers 28 and 28' serve to guide the photo-sensitive member from which fog or blur has been removed by a suitable treating solution such as cleaning solution ejected through the pipe 13_m. The photo-sensitive member is discharged from the easel 20 by an automatic discharge mechanism (not shown). A pair of squeeze rollers 29 and 29' serve to squeeze the treating solution remaining upon the photo-sensitive member 1 and the squeezed solution drops into a reservoir 39. The completely treated photo-sensitive member is discharged out of the apparatus through an outlet 30. If required, means for drying and fixing the photo-sensitive member may be interposed between the pair of squeeze rollers 29 and 29' and the outlet 30.

A cutter 31 is provided so that the photo-sensitive member is cut into a predetermined length before the developed photo-sensitive member is discharged out of the apparatus. The operation of the cutter 31 is synchronized with the displacement of the photo-sensitive member 1. A fan 34 is disposed so as to blow heated air upon the photo-sensitive member 1 after each application of the treating solution in order to reduce the time period required for each step. To facilitate the setting of the photo-sensitive member 1, a cover 35 is attached to one side of the housing by a hinge 40 to enable it to open.

Referring to FIG. 3 showing one modification of a cleaning device used in the electrophotographic color printing apparatus according to the present invention, a cleaning or purifying tank for cleaning or purifying the cleaning solution directed thereto through a pipe 24 is generally designated by reference numeral 45. A plurality of electrode plates 50, to 50₅, is disposed in parallel with and spaced apart from one

another in the tank 45. It is preferable that the holes formed in one of the electrodes 51₁ to 51₅ are misaligned vertically or transversely with those formed in the adjacent electrode plates so that the cleaning solution flows in zig-zag courses. From a power supply 53, the electrode plates 51₁ to 51₅ receive voltage ranging from a few to tens of volts so that the toner included in the cleaning solution directed into the tank 45 is attracted to the electrode plates 51₁ to 51₅, as the cleaning solution flows in zig-zag paths through the tank. Thus the cleaning solution is cleaned or purified. Then cleaned or purified solution may be pumped up by a pump 16 through a pipe 33 for the next cleaning step. The configuration of the electrode 50 is not limited to a plate, and other electrodes having different configurations such as cylindrical electrodes may be also used in the present invention. Furthermore, it is not required to provide cleaning solutions equal in number to the different colors, and a common cleaning solution may be used in the development of each color.

While the construction of one embodiment of the electrophotographic color printing apparatus according to the present invention has been described, for the purpose of facilitating an understanding of the present invention, the mode of operation thereof will now be described. Upon the sequential control of a plurality of switches in a control circuit (not shown), the light source 5 is turned on and the original inserted into original holder 10 is subjected to the light. First, for example, a red filter is interposed in the light path. When the shutter 11 is opened the image is viewed upon the ground or focusing glass 19 through the reflecting mirror 17 so that the image can be sharply focused and correctly positioned. Upon the next operation of the switches, the light is turned off, the shutter 11 is closed and the photo-sensitive member 1 is set. Thereafter, the photo-sensitive member is scanned by the corona discharging device 2 to uniformly charge the member and then the shutter 11 is opened for exposure. Next, the pre-wetting solution for the photo-sensitive member exposed through the red filter is pumped up to the ejection pipe and the solution is ejected upon a chute 36 so as to be cascaded over the photo-sensitive member 1. The pre-wetting solution will be returned to its reservoir tank in the manner as described hereinbefore to circulate it. After a predetermined period, in similar manner as the pre-wetting solution was applied, the developing solution for the image formed through the red filter is automatically applied upon the photo-sensitive member 1. After a predetermined period, the cleaning solution is applied and thereafter the fan 34 is actuated so as to dry the photo-sensitive member. Thus, the charging, exposure, pre-wetting, development, cleaning, drying, and fixing steps of the photo-sensitive member for the red color are accomplished.

While the photo-sensitive member remains in the same position in the easel, the first filter 3, in this case, the red filter, is substituted by the second color filter. In similar manner as in the case of the red color printing process described above, the color printing cycle for the second color is carried out. In similar manner, the color printing cycles for other colors are performed to complete the color print.

After completion of the color development, the developed photo-sensitive member is cut off by the cutter 31 from the rolled member 1.

It will be seen that all of the color printing processes described above are mechanically and electrically carried out on an automatic basis in accordance with the program.

The color separation method is not limited to three colors, but two color filtering or four color filtering including black color may be performed with the present invention. Furthermore, lacquer finishing may be added if required.

The photo-sensitive member is maintained in stationary position while the color printing cycle of charging, exposure through color filters, pre-treatment, development, cleaning, drying and fixing is repeated for each color in accordance with the number of exposures so that the color shear due to misaligned registration can be completely prevented. Further-

more, since the photo-sensitive member is held tilted as described above so that the treating solutions such as pre-wetting, developing and cleaning solutions are cascaded over the photo-sensitive member, it is not required to move the treating solution tanks vertically or horizontally. Thus, advantageously, the color printing apparatus of the present invention can be made simple and reasonable in construction, compact in size, light in weight and inexpensive to manufacture.

While the principle of the present invention has been described in conjunction with the illustrated embodiment, it is possible for those skilled in the art to make any modifications in structure, arrangement, proportions, elements, materials, components and the sequence of treating steps in realizing the present invention.

What is claimed is:

1. An electrophotographic color printing apparatus comprising

means for holding an electrophotographic photo-sensitive member in slanting stationary position,

means for uniformly imparting electrostatic charge upon the surface of said photo-sensitive member,

exposure means including color filters for exposing said photo-sensitive member,

means for pre-wetting said charged and exposed photo-sensitive member by cascading a pre-wetting solution over said photo-sensitive member,

means for cascading over said pre-wetted photo-sensitive member the developing solution corresponding to said color filters to develop an image formed thereon,

means for cleaning said developed photo-sensitive member by cascading a cleaning solution over said photo-sensitive member,

means for drying said photo-sensitive member every time said photo-sensitive member is developed by each developing solution and cleaned, and

means for drying and fixing said photo-sensitive member.

2. Electrophotographic color printing apparatus comprising means supporting an electrophotographic photo-sensitive member in slanting stationary position,

means for imparting charge to the surface of said photo-sensitive member,

exposure means including color filters for exposing said photo-sensitive member,

a plurality of treating solution ejectors each supported for movement into operative position relative to said photo-sensitive member surface for cascading a treating solution thereover,

a plurality of treating solution receptors each supported for movement into operative position relative to said photo-sensitive member surface for collecting treating solution cascaded thereover,

treating solution circulating means interconnecting each of said ejectors with a one of said receptors, and

means selectively moving each ejector and its interconnected receptor into said operative positions thereof.

3. The apparatus claimed in claim 2 wherein said selective moving means includes a first shaft supporting said ejectors, a second shaft supporting said receptors, means supporting said shafts for rotation and drive means connected to said shafts for synchronous rotation thereof.

4. The apparatus claimed in claim 3 further including a pair of plates secured in facing relation to said first shaft, said plates supporting therebetween tubular ejectors peripherally of said first shaft.

5. The electrophotographic color printing apparatus claimed in claim 2 wherein said treating solution circulating means comprises a plurality of tanks each having a pump incorporated therein for circulating treating solution between said ejectors and receptors.

6. The electrophotographic color printing apparatus claimed in claim 2 wherein said treating solutions comprise color developing solutions.

7. The electrophotographic color printing apparatus claimed in claim 2 wherein said treating solutions comprise pre-wetting solutions and color developing solutions.

8. The electrophotographic color printing apparatus claimed in claim 2 wherein said treating solutions comprise cleaning solutions and color developing solutions.

9. The electrophotographic color printing apparatus claimed in claim 2 wherein said treating solutions comprise pre-wetting solutions, color developing solutions and cleaning solutions.

10. The electrophotographic color printing apparatus claimed in claim 2 including treating solution tanks and a plurality of electrodes disposed therein for purifying contaminated solutions.

11. An electrophotographic color printing apparatus comprising

means for holding an electrophotographic photo-sensitive member in slanting stationary position,

means for uniformly imparting electrostatic charge upon the surface of said photo-sensitive member,

exposure means including color filters for exposing said photo-sensitive member,

treating solution ejection means for selectively cascading over said photo-sensitive member a plurality of kinds of treating solutions in a predetermined order,

treating solution receiving container means for receiving said treating solutions dropped from said photo-sensitive member, and

treating solution circulating means for circulating said treating solutions between said treating solution ejection means and said treating solution receiving means, both of said treating solution ejection means and said treating solution receiving means being rotatably carried by rotary shafts respectively in such a manner that they are rotated in synchronism with each other, thereby bringing each of the ejection pipes of said treating solution ejection means into operative position relative to said treating solution receiving means.

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