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[54] CODING OF ORIGINALS AND SENSITIVE PAPER IN A MULTI-COLOR ELECTROPHOTOGRAPHIC PROCESS

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[21] Appl. No.: **26,348**

[30] **Foreign Application Priority Data**

Apr. 8, 1969 Japan.....44/27048

[52] **U.S. Cl.**.....**96/1.2,** 355/4

[51] **Int. Cl.**.....**G03g 13/00**

[58] **Field of Search**.....96/1.2; 355/4

[56] **References Cited**

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[57] **ABSTRACT**

The provision of corresponding codes on originals and sensitive paper employed in the production of multi-colored copies by an electrophotographic process. The codes enable multiple copies of one color to be prepared before incorporation of further colors, by excluding any possibility of a mismatch between original and sensitive paper during subsequent exposures.

4 Claims, 10 Drawing Figures

FIG. 1

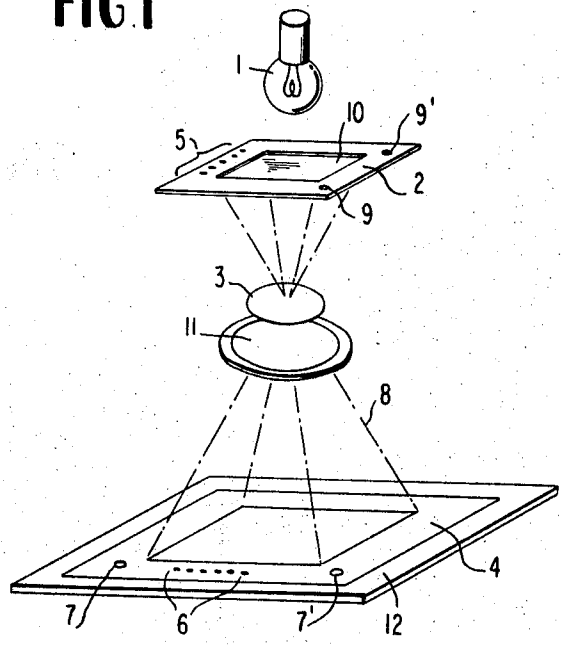


FIG. 2

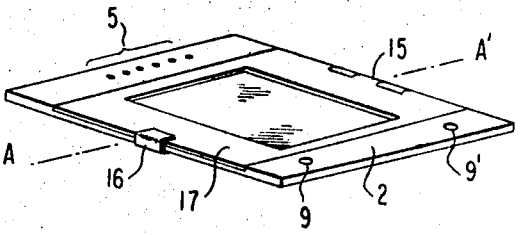


FIG. 3

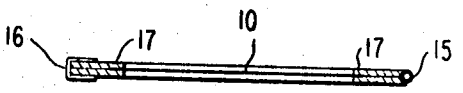


FIG. 4

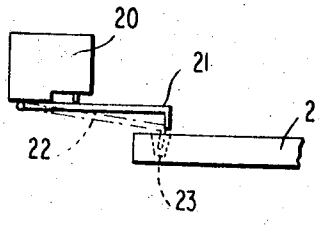
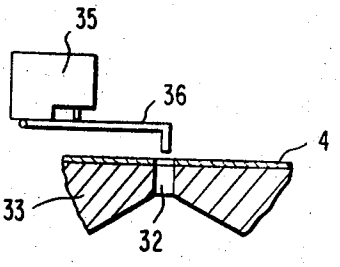


FIG. 6



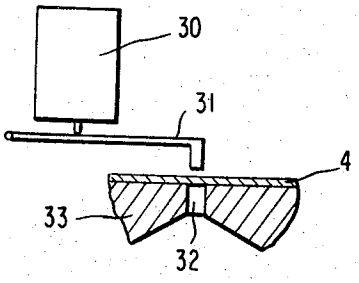


FIG. 5

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FIG.7

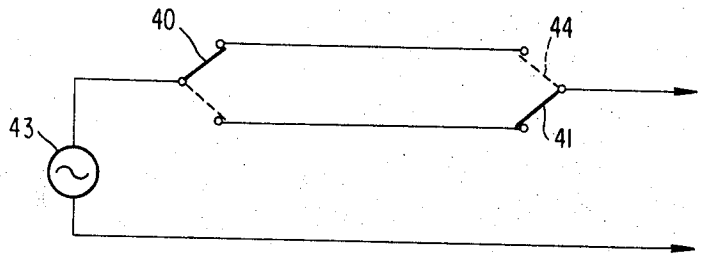


FIG.8

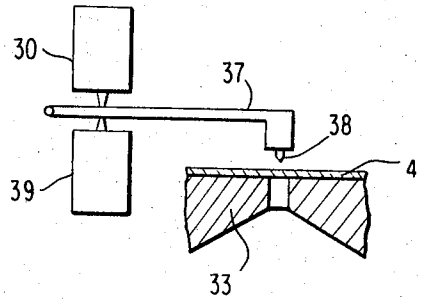


FIG.9

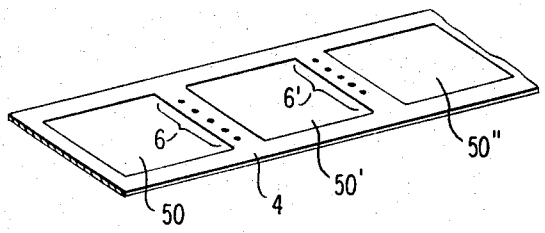
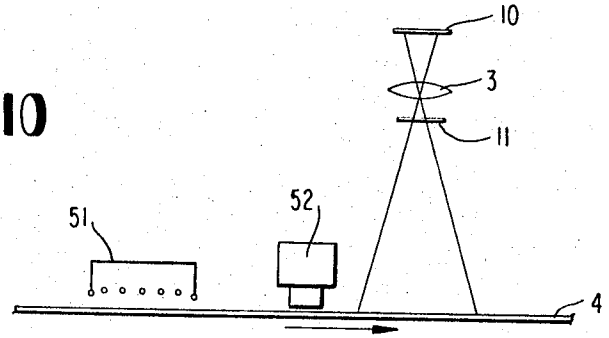


FIG.10



CODING OF ORIGINALS AND SENSITIVE PAPER IN A MULTI-COLOR ELECTROPHOTOGRAPHIC PROCESS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an electrophotographic process. More particularly, it relates to a multi-color electrophotographic process involving two or more colors.

2. Description of the Prior Art

There is known in the art an electrophotographic process which comprises the steps of electrically charging an electrophotographic sensitive paper having a photo-conductive insulative layer by means of the well-known corona discharge or other similar method, exposing the paper to light through an image, forming thereon an electrostatic pattern (hereinafter referred to as "electrostatic image") and depositing toner powder on the sensitive paper in conformity to the electrostatic image, either by bringing the paper into close proximity with electrically charged, colored fine powder (hereinafter referred to as "toner") or bringing it into contact with an insulative liquid having toner dispersed therein (hereinafter referred to as "liquid developing agent"). Two or more toners of different colors are adhered to the sensitive paper by repeating the steps of electric charging, exposure to light, and development as many times as required.

In such electrophotographic processes, proper registration of the various colored images constitutes an important problem. In exposing a sensitive paper to light through a colored original image involving the use of cyan and magenta yellow pigments, for example, the electrophotographic sensitive paper is electrically charged with respect to the first color, exposed to light through the image via a filter for the first color, and subjected to a first development. The sensitive paper is then electrically charged with respect to the second color and subjected to a second development through a filter for the second color. Similarly, an image composed of a number of toners having different colors can be obtained by repetition of this procedure. In such a process, after the sensitive paper is exposed to light projected through the original for the purpose of exposing it to the image, a first development is carried out and completed for the first color prior to further processing. Thus, the light projector cannot be used again until the development is completed. Since, therefore, the light projector is made to stand unused during the interval between the completion of the first development and the second exposure to light which follows the step of electrically charging the sensitive paper, the operating ratio of the machine (the proportion of time it is actually in use during the process) is very low.

When many originals are reproduced simultaneously so as to eliminate the above shortcoming, the first original is mounted on the projector to effect the necessary exposure and the sensitive paper subjected to this exposure (to be called "first sensitive paper") is forwarded to development. The first original is then removed from the projector and the second original is immediately mounted thereon to effect exposure on the second sensitive paper, which is then immediately forwarded to development. This procedure is repeated until the *n*th original is mounted on the projector and the *n*th sensitive paper is subjected to exposure and forwarded to development. In this manner, the electrophotographic process for one color can be efficiently effected on many originals, maintaining the operating ratio of the machine high.

Subsequently, the same electrophotographic process can be efficiently effected for the second color at a high operating ratio of the machine by, repeating the above process, combining the sensitive papers which have already undergone development for the first color with their corresponding originals. Thus, images of the second color can be laid over those of the first color on these sensitive papers.

The above process enjoys the following advantages:

I. The operating ratio of the machine is heightened.

II. Once an electrophotographic sensitive layer is exposed to light, it has a tendency to retain residual photoconductive effects, even after exposure. However, when many sensitive papers are developed continuously for one color, they are maintained in a dark place for a sufficient time to achieve complete recovery from such residual effects. Consequently, such papers are very stable in this regard.

When sensitive papers which have undergone the development with the first color are subsequently exposed to light with the second color, however, the originals used must correspond exactly to those used in the development with the first color. Otherwise, up to several hundreds of useless copies may be obtained by the possible mismatching of originals and papers.

SUMMARY OF THE INVENTION

With a view to preventing such confusion, the present invention proposes to provide an identifying code, corresponding to the original, struck or written on the sensitive paper at the time of exposure using the first color, so that, at the time of exposure using the second and subsequent colors, agreement between the sensitive papers and the originals may be sensed by virtue of such codes. Upon detection of a lack of agreement, there will be issued an alarm signal or, alternatively, the machine will be brought to a stop. This same principle can be applied to the use of a roll of sensitive paper by regarding the first exposure frame as the first sensitive paper and the *n*th exposure frame as the *n*th sensitive paper, etc.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** represents a perspective view illustrating the manner in which the present invention is executed.

FIG. **2** is a perspective view of the mount for the original to be used in the present invention.

FIG. **3** is a cross-sectional view along line A–A′ of FIG. **2**.

FIG. **4** illustrates a mechanism for reading the code of the original mount.

FIGS. **5** and **6** illustrate a device for transferring the original mount onto the sensitive paper.

FIG. **7** illustrates one example of circuitry for setting the code.

FIG. **8** illustrates mechanism usable concurrently for reading and writing the code.

FIG. **9** is a perspective view illustrating one example of a roll of sensitive paper having the code thereon.

FIG. **10** is a side elevation illustrating such a roll of sensitive paper on which the present invention is being executed.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the accompanying drawings in more detail, FIG. **1** represents a manner of exposing to light an electrically charged sensitive paper. In the Figure, **1** denotes a light source for exposure, **2** is a frame for mounting an original, and **10** is an original composed of a plurality of colors. By means of projecting lens **3**, the image on the original is projected through a color-resolving filter **11**, as shown by **8**, onto a sensitive paper **4**, with a result that there is formed an image of one color resolution. Denoted by **9** and **9′** are the holes which serve to enable the original to be held at a fixed position. By virtue of these holes, originals can be laid in a fixed position. The numerals **7** and **7′** denote the pins provided on the base **12** for the purpose of obtaining proper register. Holes are punched in the sensitive paper corresponding to these pins so that the sensitive paper can be laid in the same fixed position at all times.

The numeral **5** denotes a code applied to the mount of the original. To permit discrimination of one mount from another, each has a different code. This code may be in the form of punched holes which may be sensed by means of pins, or it may be in the form of prints to be read out by means of photoelectric tubes. The numeral **6** denotes a code formed on the sensitive paper corresponding to that of mount **5**. The code is placed in an area of the sensitive paper other than that

used for the formation of an image. The code may be punched holes or colored marks. The code may also be formed by imparting an electrostatic image on the sensitive paper at the time of exposure with the first color and converting it into a colored mark by utilizing the development of the first color.

At the time of first exposure, code **6** is recorded in conformity to code **5** which is placed on the original mount. At the time of the second and subsequent exposures, code **5**, on the original mount, and code **6**, on the sensitive paper, are compared. When they are in agreement, the sensitive paper is subjected to exposure and then forwarded to the development step.

However, should the two codes not be in agreement, the process is stopped and an alarm is issued.

In this manner, duplicates can be produced from numerous originals efficiently and safely, with heightened machine operating ratios.

FIG. **2** illustrates an original mount as one embodiment of the present invention. In this figure, a multi-color original **10** is mounted and fixed on mount **2**. Numeral **15** denotes a hinge which may be utilized for removing the original from the mount. **17** is a holder for the original, and **16** is a clip which holds holder **17** and mount **2** together. Of course, one original is held in the same mount throughout the entire procedure. In other words, one mount is prepared for each original and the original held in one mount is handled as one original. Therefore, discrimination between originals is accomplished by means of codes in these mounts. Numeral **5** denotes a code comprised of holes formed on the illustrated mount. One example of a coding system which may be employed is one wherein a hole may be punched or unpunched at each of a total of eight places. Using such a system, there may be prepared 2^8 mounts which can be discriminated from one another.

FIG. **4** illustrates a device for sensing code **5** on mount **2**. The drawing is intended to show the working of the device sensing the presence or absence of a coded hole at a given position. In this device, **20** denotes a microswitch and **21** an actuator thereof which is raised or lowered depending upon the presence or absence of a coded hole in a given position. Where a hole is present, the actuator falls, as indicated by dotted lines **22**, turning the microswitch, for example, from OFF to ON.

FIG. **5** illustrates a device for transferring the sensed code onto the sensitive paper. Solenoid **30** pushes up punch **31** so as to punch a hole in sensitive paper **4** which is laid on the base **33**. Denoted by **32** is a hole in the base provided for insertion of the point of the punch.

The devices shown in FIG. **4** and **5** are combined as a pair, and any required number of such pairs may be arranged in a row to form a system usable for transferring code **5** from the mount onto the sensitive paper.

FIG. **6** illustrates a device, similar to that of FIG. **4**, adapted to read the code from the sensitive paper during the course of second and subsequent processing. This device is so constructed that the sensing punch is situated at the same position as the punch of FIG. **5**. In the drawing, **35** denotes a microswitch and **36** the actuator thereof. The actuator senses the presence or absence of a hole and turns the microswitch ON or OFF accordingly.

FIG. **7** illustrates one example of circuitry which may be employed for the sensing of codes. In this figure, there is shown a circuit including a microswitch contact arm **40** connected to the code **5** sensing means (e.g. **20** of FIG. **4**) and a microswitch contact arm **41** connected to the code **6** sensing means (e.g. **30** of FIG. **5**) connected by two lead wires.

Assuming a sensitive paper in which is punched holes in the same pattern as that of the code holes on the mount and, assuming further that the position of arm **40** represents the presence of a hole punched in the mount and that the position of arm **41** represents the presence of a code hole in the sensitive paper. In this case, since the code holes correspond, the circuit is not connected. If no hole is present on the sensitive paper, arm **41** will be positioned as shown by dotted line **44**. The circuit would then be connected to permit electric current to flow from source **43** to the device for stopping the process or to the alarm system and actuate such device. By arranging any required number of such pairs, erroneous combinations of mounts with sensitive papers can be quickly detected and possible loss of materials can be prevented. It will be obvious to the skilled practitioner in this art, of course, that alternative designs could be employed. For example the operation of the microswitches could be arranged so as to permit the flow of power to the exposing device only a proper combination of original and sensitive paper is present.

FIG. **8** illustrates a device by which the code holes may be punched in and read from the sensitive paper by one and same device. In the first color step, the solenoid is operated to open holes on the sensitive paper **4** in accordance with the code **5** on the original mount. In the second and subsequent process, the pressure exerted by the solenoid is adjusted downwards so that, where the hole is absent on the sensitive paper, arm **37** is stopped by the pin provided at the tip of punch arm **37**, whereas the arm is allowed to continue further down in the presence of a hole, with the consequence that the movement thereof will be detected by microswitch **39**. By means of this principle, one and same device can accomplish both the punching and reading of the code through adjustment of the strength of the solenoid.

Up to this point, the description has concerned only the use of codes composed of punched holes. However, besides using punched holes as codes, combinations of coded areas having different reflecting powers may be used as codes and sensed by photoelectric tubes as a matter of course.

FIG. **9** illustrates a case in which a plurality of coded areas are reproduced on a roll of sensitive paper **4**. In the figure, **50**, **50′** and **50″** denote a row of drawings and **6** and **6′** denote the codes which are placed on the boundaries thereof. These codes, **6** and **6′** may be combinations of punched holes or of colored elements. In the case of using colored elements, exposure may be regulated according to the codes and the codes may be obtained by development in the first process.

FIG. **10** illustrates a process involving the use of a roll of sensitive paper. By means of charging device **51**, sensitive paper **4** is electrically charged and in the first color step, the codes are recorded by device **52**. In the second and subsequent color steps, the codes are read out by device **52** and compared with the codes on the mounts.

As mentioned above, the method of the present invention provides a solution to problems intrinsic in the preparation of multi-color prints in electrophotography. Particularly, since electrophotography involves the processes of overlaying exposures and developments, precise registration of the sensitive paper with the original at the time of exposure is indispensable. Thus, the mechanism for exposure must incorporate means for positional registration. Incorporation of a sensing means with respect to individual frames in a roll of sensitive paper proves to be one advantageous embodiment of the present invention.

What is claimed is:

1. In an electrophotographic process for forming an image of two or more colors on the same sensitive paper comprising:

a. exposing a first sensitive paper to a first original, mounted on a projector, of a first color and developing said first color in said first sensitive paper;

b. immediately after said first sensitive paper is exposed in step (a), removing said first original of said first color from said projector, mounting thereon a second original of said first color, exposing a second sensitive paper to said second original of said first color and developing said first color in said second sensitive paper;

c. repeating steps (a) and (b) for n sensitive papers using n originals of said first color, wherein *n* can be zero or a positive integer;

d. exposing said first sensitive paper having an image of said first color thereon to said first original of a second color,

mounted on said projector, and developing said second color in said first sensitive paper;

e. immediately after said first sensitive paper is exposed in step (d), removing said first original of said second color from said projector, mounting thereon a second original of said second color, exposing said second sensitive paper having an image of said first color thereon to said second original of said second color and developing said second color in said second sensitive paper;

f. repeating steps (d) and (e) for said n sensitive papers using *n* originals of said second color, wherein n has the above meaning, to thereby obtain (2+*n*) sensitive papers each having an image of said first and second colors thereon; and

g. repeating steps (d), (e) and (f) for each additional color desired;

the improvement comprising, in the first exposing step of each original of said *N* originals of said first color, providing a code, corresponding to a code associated with each original of the image, on the sensitive paper whereon there is formed the image and, in subsequent exposing steps, collating the code associated with the original with the code provided on the sensitive paper, whereby subsequent exposure of the paper is allowed to occur only when the two codes are identical, thereby assuring that each of said sensitive papers, having a colored image thereon, is properly aligned for subsequent exposure to another original of the same image but of different color.

4. The process of claim **3** wherein said sensitive paper comprises a continuous roll, the first exposure frame thereof corresponding to the first sensitive paper and the nth exposure frame corresponding to the nth sensitive paper.

3. The process of claim **3** wherein the code is formed by imparting an electrostatic image onto the sensitive paper at the time of exposure with the first color and converting it into a colored mark by utilizing the development of the first color.

4. The process of claim **3** wherein a multiplicity of images are formed on a single sensitive paper and wherein the provided code is placed at a position of the sensitive paper corresponding to each individual image.

* * * * *