

[54] APPARATUS FOR OPTICAL COLOR SEPARATION IMAGING

[75] Inventors: William R. Hartman, Rochester;
Paul R. Lagonegro, Henrietta, both
of N.Y.

[73] Assignee: Xerox Corporation, Stamford,
Conn.

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Related U.S. Application Data

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1969, abandoned.

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350/15

[51] Int. Cl. G03g 15/04

[58] Field of Search 355/4, 32, 88;
95/12.2

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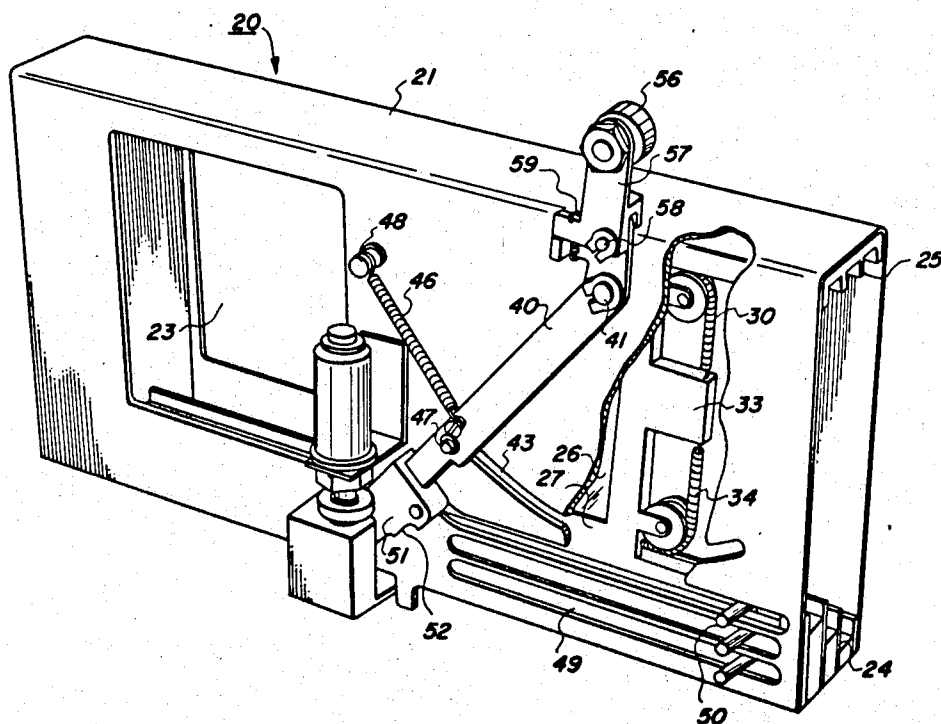
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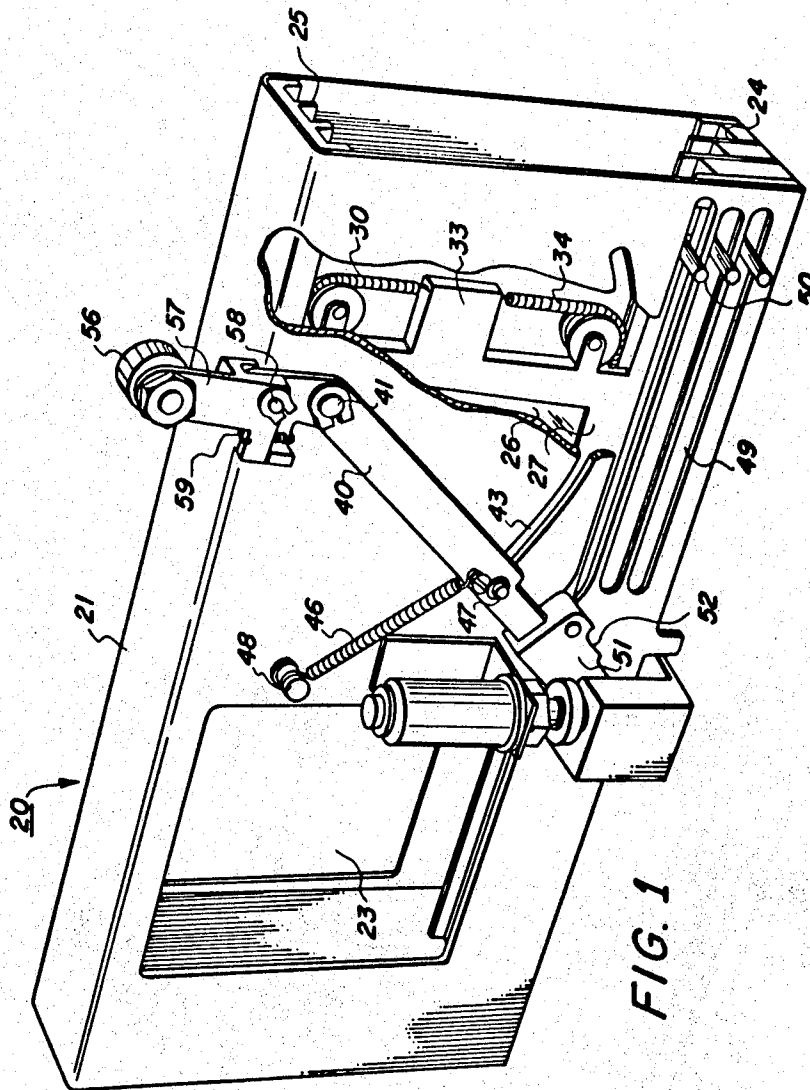
Primary Examiner—Samuel S. Matthews
Assistant Examiner—Kenneth C. Hutchinson
Attorney—James J. Ralabate et al.

[57] ABSTRACT

A multiple optical filter apparatus for controlled exposure of a photosensitive surface to establish a selected appropriate exposure. A color or neutral density filter sequentially is interposed into operative position during exposure to establish an exposure level of the photosensitive surface to various desired colors. The filters are mounted in parallel relation in an inoperative position and are adapted to be selectively moved into operative position immediately prior to exposure.

6 Claims, 9 Drawing Figures





INVENTORS
WILLIAM R. HARTMAN
PAUL R. LAGONEGRO

BY

BY  ATTORNEY

ATTORNEY

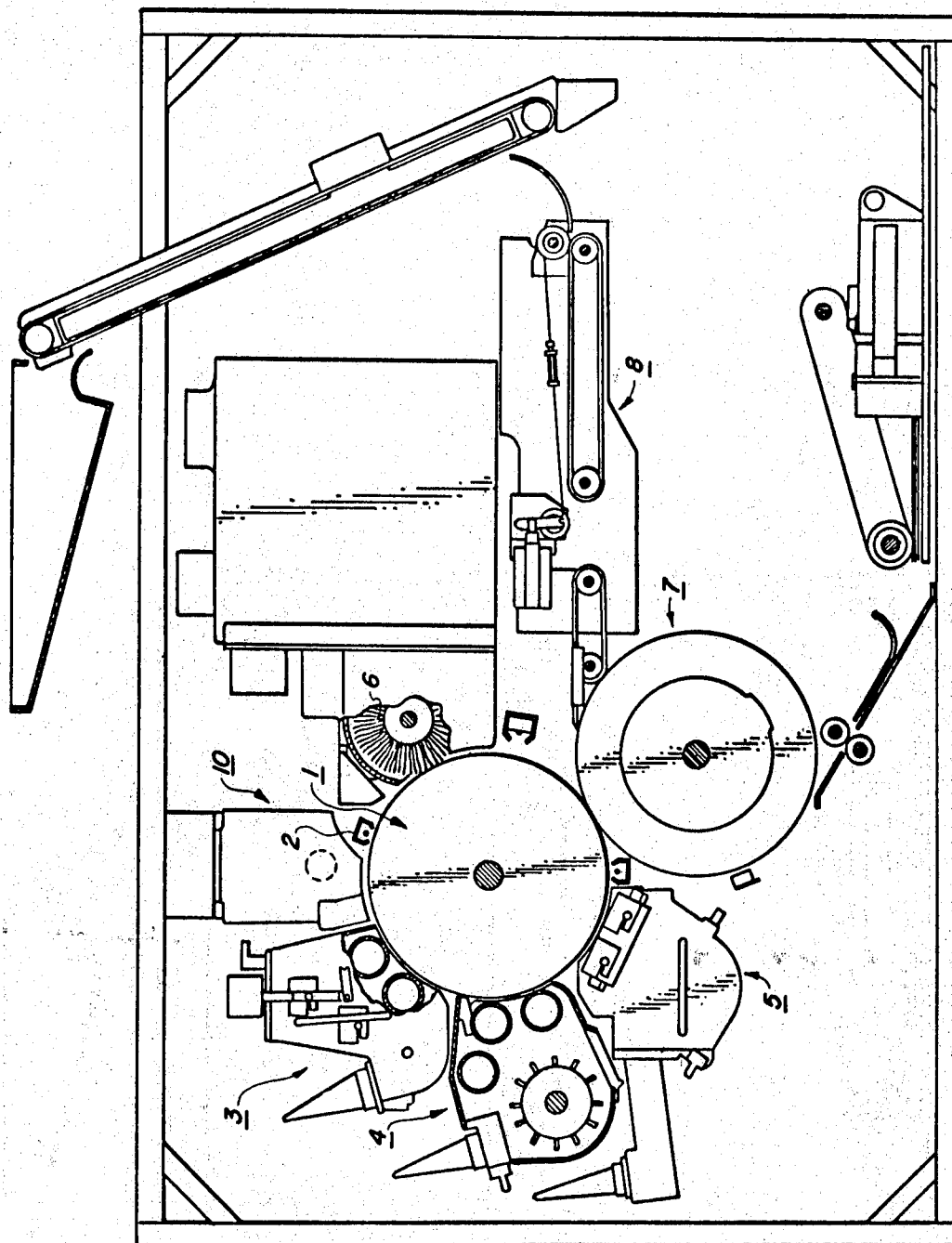


FIG. 2

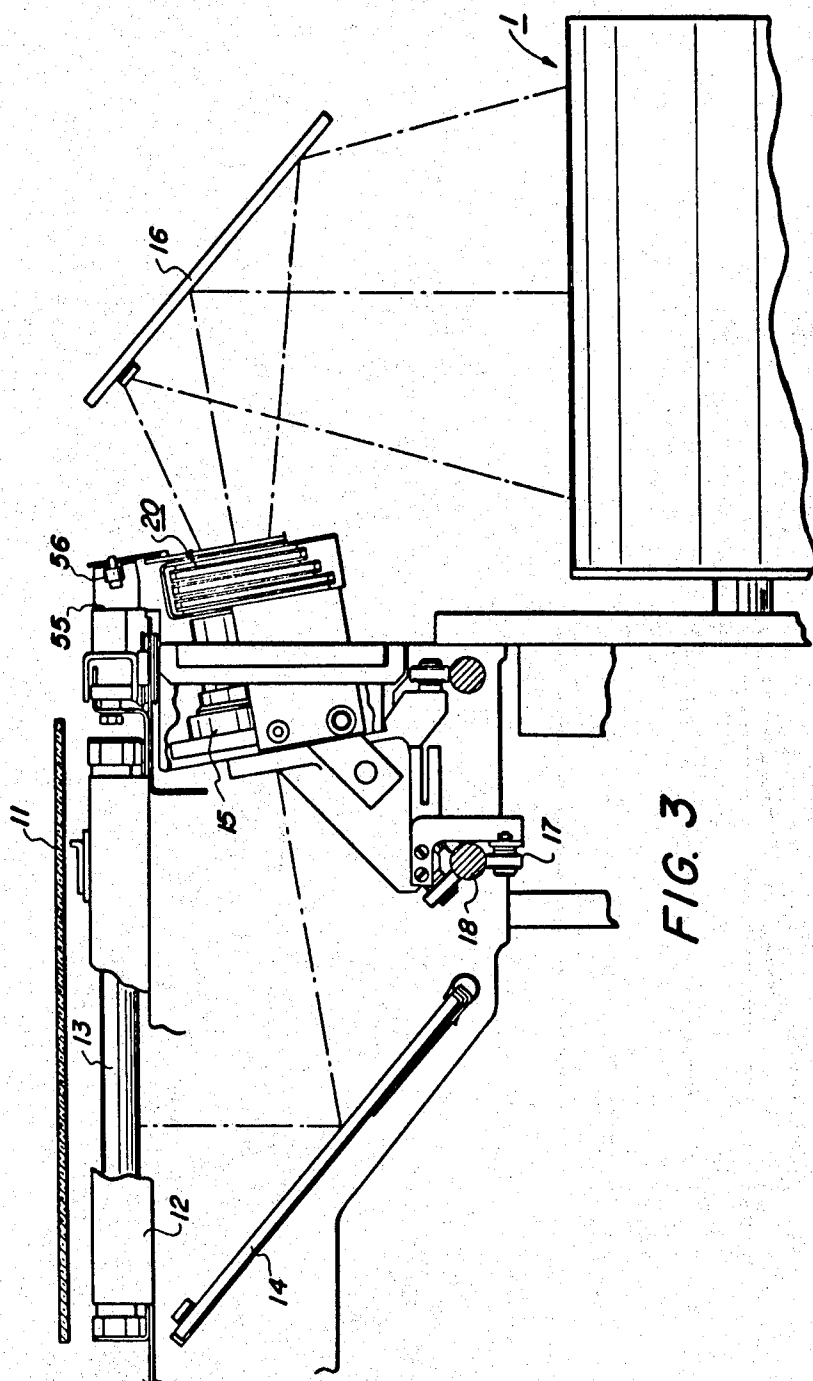


FIG. 3

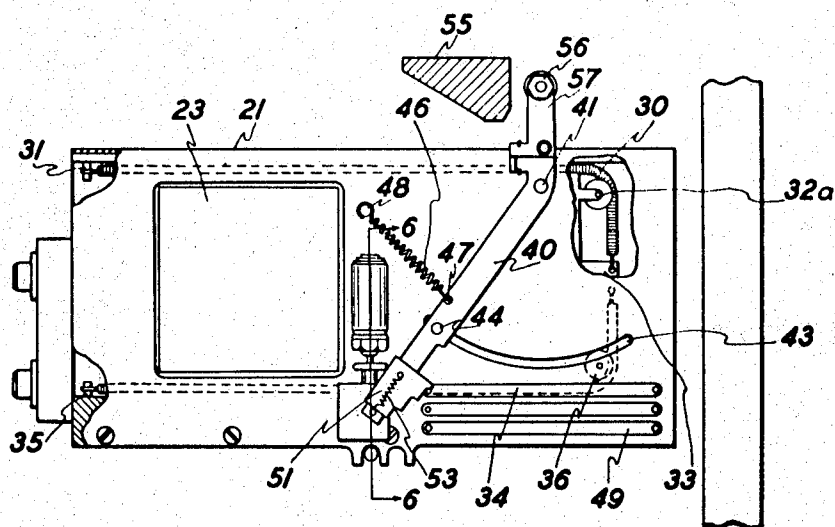


FIG. 4

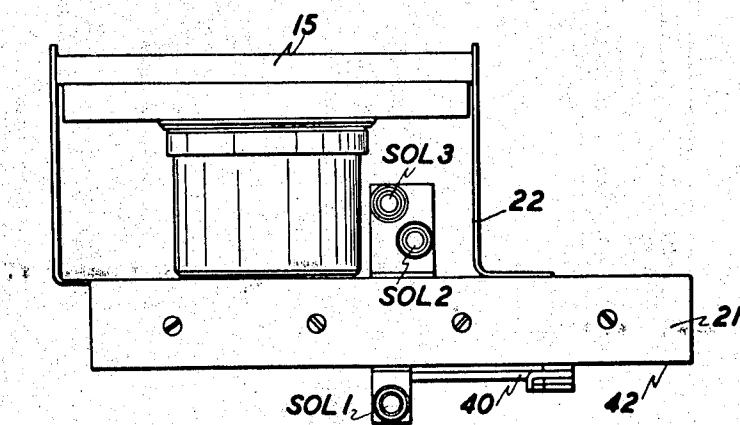


FIG. 5

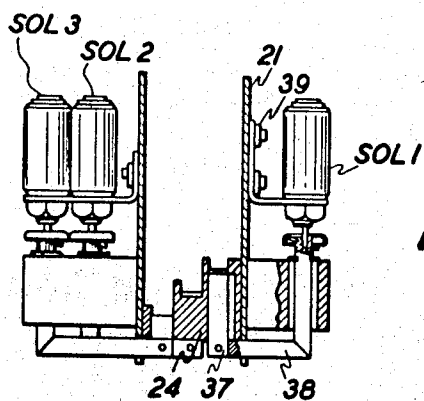


FIG. 6



FIG. 9

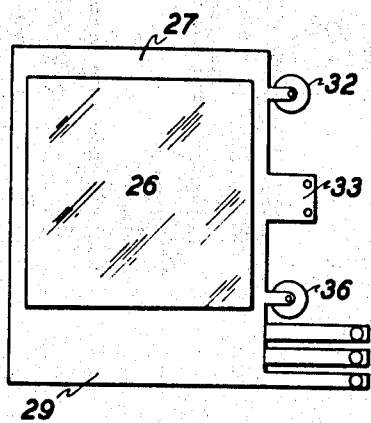


FIG. 8

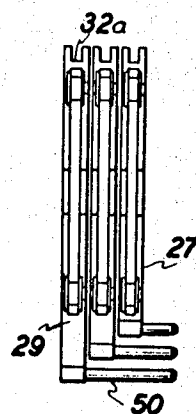


FIG. 7

APPARATUS FOR OPTICAL COLOR SEPARATION IMAGING

This application is a continuation-in-part of application Ser. No. 830,282, filed June 4, 1969, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates in general to optical projection systems and in particular to a multiple optical filter assembly.

More specifically this invention relates to a color multiple filter assembly wherein a plurality of optical filters comprising a selected number of color or neutral density filters are provided that are sequentially interposed in the light path of an exposure means in, for example, a xerographic device. Each filter is sequentially moved into operative position to create a color exposure on a photosensitive surface whereupon, for example, as a color filter is moved in place, certain selected wave length colors are transmitted through the filter while selected wave length colors are blocked or as a neutral filter is utilized, a desired exposure level may be established. Each filter element is slidably mounted in parallel relationship in a casing and is movable into a position to be interposed in the path of the exposure light to a photoreceptor just prior to exposure thereof.

Although not intended to be so limited, for convenience of illustration the multiple filter assembly of this invention is described for use in an automatic xerographic reproducing machine. In the process of xerography, the xerographic surface comprising a layer of photoconductive material on a conductive backing is given a uniform electrostatic charge on its surface and then is exposed to the subject matter to be reproduced by various projection techniques. The exposure discharges the photoreceptor in accordance with the light intensity reaching it thereby creating a latent electrostatic image on and in the photoreceptor. Development of the image is effected by developers which may comprise, in general, a mixture of suitable pigmented or dyed resin base powder, hereinafter referred to as toner, which is brought into contact with the photoreceptor by various well known development techniques. During such development of the image the toner powder is brought into surface contact with the photoconductive coating and is held there electrostatically in a pattern corresponding to the latent electrostatic image. Thereafter, the developed xerographic image may be transferred to a support material to which it may be fixed by any suitable means such as heat fusing.

This basic process of xerography may be utilized to produce color to color xerographic reproduction by slightly altering the aforementioned basic steps according to one mode of color xerography. Such color to color reproduction by xerography is accomplished by repeating the usual techniques of charging the photoconductive material, exposing it to the subject matter to be reproduced, developing the photoconductive surface, and transferring the developed image onto a support material in selected repeated cycles of operation. The number of times that the basic sequence for color reproduction is repeated depends on the number of colors utilized to develop the image and during each cycle a different color separation filter is utilized to selectively absorb and transmit the passage light to the photoconductive surface of selected wave lengths whereupon the photoconductive surface is discharged

to proper levels. After the first exposure using a first separation filter, the latent electrostatic image on the drum then is developed by a selected color toner and the developed image of the first particular color is transferred to a support material. The support material retaining the developed image of the first selected color is brought into position to receive subsequent developed images.

After transferring the developed image of the first color, the photoconductor is then cleaned and uniformly charged to be exposed a second time. A second filter which selectively absorbs and transmits color from the light passing through it is imposed in the optical projection path after the first utilized filter has been removed and the photoconductor is again discharged to proper levels to form a latent electrostatic image. The latent electrostatic image then moves to a second development station which develops the second image with a second desired color and the developed image is moved to the transfer station where it is transferred to the support material on top of the developed image of the first color already adhering thereto. By repeating this process a desired number of times, a color reproduction lies on the support material whereupon the support material then moves to a fusing area where the color reproduction may be permanently affixed. Although not so limited, three cycles of the process may be utilized whereupon the image is developed with yellow, magenta, and cyan color developer toner. In such a three color system, different color separation filters are normally provided to subtractively produce the color reproduction and these filters may be red, green and blue and, if desired, a neutral density filter for exposure control. Other developer colors and filters as well as numbers thereof could be utilized in this subtractive color process if so desired.

In order to accomplish the aforementioned technique of color xerography, it is necessary to provide a multiple color filter assembly which effectively inserts the different filters required in the process into position to be interposed in the optical path of the exposure means in the proper sequence of operation. Each filter must be stored in a position to not interfere with the projection system when not in use, but which is readily inserted into the exposure system when in operation. The filter assembly must further be simple and compact and readily adaptable to cooperate with the various stations necessary in the xerographic process. Also, it is desirable that the filters of the multiple color filter assembly be readily adapted to be inserted into an operative exposure position in any desired order of sequence rather than be limited to only one predetermined order. Therefore, it is advantageous in color to color xerographic reproduction to provide a sequentially operated multiple filter system which effectively inserts a series of color separation filters into the projection system of a xerographic reproduction apparatus.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to improve the apparatus for selectively inserting one of a plurality of optical filters into an optical projection system.

Another object of this invention is to improve a multiple color filter assembly for use in a color to color xerographic reproduction system.

A further object of this invention is to improve the selective insertion of a plurality of color separation fil-

ters into the projection system of a color to color xerographic reproduction apparatus.

Still another object of this invention is to improve the effectiveness and speed that a color filter is inserted into operative position in an optical projection system.

These and other objects are obtained in accordance with the present invention wherein there is provided a multiple color filter assembly that sequentially inserts a selected separation filter into a moving optical projection system in an effective and efficient manner. A plurality of color separation filters in the form of slide members are mounted on tracks in a casing according to the present invention and are adapted to be moved into the direction of an operative color filtering position. Retention means retain each of the filter slide members out of the light path of the projection system whereas when a particular filter is desired to be in an operative position, control means act to immediately insert it into a light filtering capacity. The filter assembly is adapted to be incorporated, for example, in a well known scan system of a xerographic apparatus and the desired filter is moved into operative position prior to the scan cycle of the exposure device and is returned to an inoperative position upon return of the scan system for recycling of the process. The filter slide members can be inserted in any sequence until the system has exposed the photoreceptor a sufficient number of times to allow the selected filters to be interposed during exposure to effect the aforementioned mode of color xerography.

The multiple color filter assembly according to the present invention is an economical and non-complicated system to provide effective adaptation to the well known optical scan systems now utilized in the prior art. The filter assembly further requires little input power and effectively cooperates to provide the desired filtering of the exposure of a subject matter in the manner intended for color to color reproduction. Further, as previously mentioned, the filters may be inserted in any sequence of operation and are removed from an operative filtering position in an efficient manner.

DESCRIPTION OF THE DRAWINGS

Further objects of the invention together with additional features contributing thereto and advantages accruing therefrom will be apparent from the following description of one embodiment of the invention when read in conjunction with the accompanying drawings wherein:

FIG. 1 is a front perspective view of the multiple color filter assembly of the present invention.

FIG. 2 is a schematic illustration of a color xerographic reproduction device utilizing the multiple color filter assembly of the present invention.

FIG. 3 is a side schematic illustration of the exposure means utilized in the device of FIG. 2.

FIG. 4 is a front schematic view of the filter assembly of the present invention.

FIG. 5 is a top schematic view of the filter assembly of the present invention.

FIG. 6 is a schematic side view of the solenoid operated filter retention means taken along line 6—6 of FIG. 4.

FIG. 7 is a schematic end view of the filter and filter frame of the multiple filter assembly of the present invention.

FIG. 8 is a front view of the filter and frame assembly utilized in the multiple filter assembly of the present invention.

FIG. 9 is an enlarged schematic view of the bottom filter frame tracks utilized in the multiple filter assembly of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring in particular to FIG. 2, there is illustrated a schematic illustration of an example of a color to color reproduction xerographic apparatus utilizing the optical filter assembly of the present invention. The central element of the apparatus is a drum 1 mounted for rotation and drivable in a conventional direction by a motor (not shown). The drum 1 comprises an outer surface with a layer of a panchromatic photoconductive photoconductive insulating material and a uniform electrostatic charge is placed on the moveable photoconductive surface of the drum by means of a conventional corona charging device 2. The uniformly charged surface of the drum is then moved to an exposure means 10 which includes the optical filter assembly of the present invention (to be hereinafter described in detail) where the charged surface is exposed to the copy to be reproduced thereby forming a latent electrostatic image of the copy on the photoconductive surface. During this exposure a selected filter is interposed by filter assembly of the present invention into the projection system of the exposure means to properly discharge the electrostatic charge from the drum wherein the filter prevents the transmission to the photoreceptor of a particular color light. For convenience of illustration a blue filter is interposed during the first exposure of the drum although the other color filters of the system could be utilized in the first cycle of operation of the machine.

Following the formation of the latent electrostatic image of the copy to be reproduced, the image on the drum will move to the first development device 3 which comprises a magnetic brush development device. The magnetic brush development device brings the charged image into contact with a selected color development material. If, for example, the first exposure of the drum included the use of a blue filter, then the color of the developer material used to develop the image would be of a yellow color toner. After development by the color developer material, the visible image moves to a transfer means and is transferred from the drum to a sheet of paper or other support material which is positioned adjacent the drum by an electrically biased conductive transfer roller 7. After transfer of the color toner image of the first cycle of operation, the biased roller is programmed to keep the support material bearing the first developed image adjacent the drum to receive thereon other developed images produced in subsequent cycles of operation. For further details of the transfer means utilized in the machine, reference is made to the co-pending application Ser. No. 830,426 filed by Michael J. Langdon on June 4, 1969, now abandoned. After the photoreceptor surface has transferred the first developed image to the support material, the drum moves to a brush cleaning device 6 to clean the surface thereof. Accordingly, it should be clear that the machine has gone through the first cycle of the sequence of steps to form a tone image of a first selected color on the support material.

Still referring to FIG. 2, the apparatus thereupon moves to be charged a second time by the corona device 2 to begin a second cycle of the sequence of operation to create a color reproduction. During the second cycle the photoconductor drum 1 is then exposed to the subject matter to be reproduced whereupon a second selected filter is interposed in the light projection path of the exposure means 10. By so doing, a second color light is blocked from transmission through the filter to again discharge the photoconductive surface to proper levels. The exposed photoconductive surface thereby has another electrostatic image formed thereupon which moves past the first development device 3, which in this cycle of operation is inoperative, to move to a second identical development device 4 which develops the electrostatic image with developer material of a second selected color. If, for example, the second cycle of operation in the machine utilized a green filter in the projection path, the latent electrostatic image on the drum is developed by magenta developer. The developed image on the drum thereupon moves to the transfer roller 7 to transfer the developed image to the support material where the second developed image is placed on top of the previously developed image of the prior cycle of operation of the machine.

Again, the transfer roll drum 7 is programmed so as to receive a third developed image from the drum 1 after the machine effects a third cycle of operation. During the third cycle of operation of the machine a third color filter is interposed in the projection of the exposure means to selectively block a third color from being exposed to the photoconductive drum. Thereupon, the drum may be moved to the third development device 6 to effect development of the latent electrostatic imaging on thereon. The third development device contains still a third color and if, for example, the third filter utilized in the machine was a red filter, then the third development device develops the electrostatic image with cyan color developer. The third developed electrostatic image is then moved to the bias roll transfer means 7 whereupon the developed image is transferred to the support material on top of the other two developed color images to thereby form a color to color xerographic reproduction of six colors plus a three color black.

After completing these three cycles of operation the machine is programmed thereupon to move the support member carrying the color reproduction to a fusing means 8 to affix the colored reproduction thereto to form a permanent copy. The three cycles of operation of the machine may be performed in any desired order. Further, the machine may utilize other number of cycles of operation, other than three as disclosed herein, to effect other desired color reproduction. This may include the use of fewer filters and developer colors or a greater number if desired. Also, the filter and developer colors disclosed herein are only intended to be examples and other color filters and developer materials may be utilized in connection with this process.

Referring now to FIG. 3, there is illustrated the exposure means 10 including the optical filter assembly 20 of the present invention utilized in the xerographic machine of FIG. 2. Generally, the exposure means 10 of FIG. 3 includes a platen 11 for supporting the subject matter to be reproduced, a carriage 12 for carrying a lamp means 13 for illuminating the subject matter and, a mirror 14 for reflecting the light therefrom through

a lens assembly 15. After passing through the lens assembly 15, the light passes through the optical filter assembly 20 of the present invention where a selected color separation filter is inserted in the path of the light. Thereupon, after passing the color filter assembly, the light is reflected off a second mirror 16 onto the photoconductor drum 1 for forming a latent electrostatic image thereon.

The light assembly comprises a carriage 12 which is moveable in a direction to traverse the stationary mounted platen 11 supporting the subject matter to be reproduced. The lamp carriage is mounted by suitable means and is driven by a cable pulley means from the motor (not shown) driving the photoconductive drum. As the light carriage traverses the platen supporting the subject matter to be reproduced, another cable pulley acts to also move the lens assembly 15 at a correlated speed therewith on suitable rollers 17 surrounding a shaft 18. The optical filter assembly 20 is mounted by a suitable bracket means (to be described later) on the lens assembly 15 so as to move therewith. The lens assembly and optical filter assembly of the present invention as well as the light carriage scan the subject matter to be reproduced in a normal direction with respect to the illustration of FIG. 3.

Upon reaching the end of the scan path of the platen, the lamp carriage, the lens and optical filter assembly are spring biased to return to their original position to again scan the support platen for a new cycle of operation. It should be clear that the movement of the lens assembly and the lamp is correlated with the speed of the drum for exposure thereof. For greater details regarding the exposure means described in FIG. 3 and its cooperation with the movement of the photoconductor drum, reference is made to the U.S. Pat. to Mayo et al., No. 3,062,109.

Referring now to FIG. 1 and 4, there is illustrated an embodiment of the optical filter assembly 20 according to the present invention. The optical filter assembly comprises a housing member 21 which is mounted on the lens assembly 15 by bracket 22 (as shown in FIG. 5) to move with the lens 15 during scanning as a single unit. The housing of the filter assembly 20 includes a window 23 in the two parallel side walls which is correspondingly positioned with respect to the lens to allow the light emanating from the subject matter on the platen 11 to pass therethrough to the photoconductive drum 1 for forming a latent electrostatic image thereon. The bottom and top walls of the housing 21 include a plurality of tracks 24 and 25 which extend the entire width thereof. The tracks 24 on the bottom wall of the housing are formed in a step fashion, as shown in FIG. 9, so that each track is elevated from the preceding track for reasons to be explained in detail later. Each track is adapted to carry a filter 26 and filter frame 27 in a manner to allow movement of the filter from an inoperative position at the right-hand side of the housing to an operative position to be interposed in the window of the housing to allow light to pass there-through.

The individual filters 26 are mounted in frames 27 as illustrated in FIGS. 7 and 8 and the filters are made of any suitable filter material, such as for example, a coated glass. The bottoms 29 of the filter frames each extend a varying vertical distance to correspondingly be inserted into the different elevated step tracks 27 at the bottom of the housing and still maintain each filter

at the same elevation. The number of filters of the embodiment described herein is shown to be three; however, other number of filters could be utilized in the filter assembly of the invention if so desired.

Referring now to FIG. 4, the filters 26 are biased into a position to be inserted into the optical window 23 of the housing by individual extension springs 30 which extend from a pin member 31 mounted in each individual track 25 and extending through grooves 32A shown in FIG. 7 on the top of the frame member 27 of the filter. The spring 30 is mounted around a filter frame roller 32 and is retained at its end in a hole in projection 33 of the frame. Each frame includes such a biasing spring and a bottom spring 34 also is similarly retained from a pin 35 on the bottom track and extends around a roller 36 into the second hole on projection 33. Therefore, the filter frame includes a spring means wrapped around it on both edges.

When not in operation the three filters of the filter assembly of the present invention are retained in the tracks 24 and 25 in an inoperative position. The three parallel frames and filters are locked into position out of line with the window by means of a stop pin 37 which extends up through an opening in the bottom of the housing into the respective track 24 of each filter. The stop pins 37 are supported, as best shown in FIG. 6, on an arm 38 which includes a 90° elbow thereby extending horizontally beyond the side of the housing and up to respective solenoids mounted by suitable brackets 39 thereon. The solenoid arm 38 supporting the longest stop pin which extends up from the bottom of the housing to retain the filter in the top track extends to one side of the filter assembly housing and the two respective arms for the two lower tracks for retaining the two filters therein extend in the opposite direction to the other side of the filter assembly housing.

The selected filter is inserted into the optical path of the housing window 23 by the activation of a selected solenoid, SOL-1, SOL-2, or SOL-3. By activating the selected solenoid, the respective stop pin 37 is moved downward from the track 24 out of abutment with the filter frame 27 thereby allowing the springs around the filter in that track to pull it into the optical path of the window. The solenoids may be operated by being connected to a suitable electrical potential (not shown) applied thereto in correlation to the operation of the xerographic machine. The potential may be applied to the operated solenoid for a short duration just prior to scanning by the exposure means and thereafter the released filter frame will maintain the pin 37 out of an abutment position in the track.

When a filter is activated into an operable position in the window, the filter will remain there through the entire scanning of the subject matter to be reproduced. As previously stated, the lens 15 and lamp carriage 12 is adapted to be returned to the starting position by a spring means (not shown) upon completion of the scanning of the subject matter during exposure. During the return of the lens and carriage, the inserted filter is removed from the operative position to allow a second or subsequent filter to be inserted. A return pivot arm 40 is pivotally mounted on a pin 41 on the exterior of the housing wall 42 to return each filter to its inoperative position after being inserted in the window 23. An arcuate slot 43 is formed on the wall of the housing to receive a pin 44 mounted on the return pivot arm 40 which guides the pivot arm through an arcuate path

and limits the extent of movement of the arm. A pivot arm extension spring 46 is attached to a hole 47 on the arm and extends to a pin 48 on the housing to bias the pivot arm in a clockwise direction as viewing FIG. 4, which illustrates the normal position of the pivot arm.

Three parallel horizontal slots 49 are included in the wall 42 of the housing and are of sufficient length to allow a filter to move from an inoperative to an operative position. Each of the slots 49 in the wall correspond to the height of the individual tracks 24 carrying the filter frames as previously discussed. As best illustrated in FIG. 7, an arm 50 is mounted on the bottom of each of the filter frames and extends therefrom to the exterior of the housing through one of the parallel slots 49 corresponding to the respective tracks. Therefore, each arm 50 is in the far right position of the slot as shown in FIG. 4 when its respective filter is in a storage position, but when the filter is released to an operative position, the arm moves with the filter to a far left position in a slot 49.

An abutment member 51 is suitably mounted on the end of the return pivot arm 40 to engage the arm 50 of whichever filter frame is in the operative position. The side 52 of the abutment member contacting the filter frame arm is in a stepped shape to more efficiently abut the filter frame arm in a filtering position wherein the member 51 is slideably mounted on the return pivot arm and is biased by a small spring 53 against the filter arm in contact therewith. Therefore, it should be apparent that a filter in an operative position may be returned to its inoperative storage position by the counterclockwise movement of the return pivot arm 40 pushing the filter arm 50 carrying the filter along its respective parallel slot to a far right position therein as viewing FIG. 4. Thereupon, when the arm is moved the entire length of the slot, the stop pin 37 connected to the solenoid is biased by solenoid spring 54 to move back into a blocking position in the track 25 and lock the filter and frame in the inoperative position. As soon as the filter and frame have been returned and locked, the pivot arm spring 46 causes the pivot arm 40 to return to its normal position as shown in FIG. 4.

Referring now to FIG. 1 and FIG. 4, there is illustrated the means to cause movement of the return pivot arm 40 for returning a filter to the storage position after being inserted in operation. The pivot arm 40 is moved by means of a ramp 55 which engages a roller 56 rotatably mounted on a second arm 57 attached to the top of the pivot 40. The second arm 56 is pivotally mounted on a pin 58 which connects the second arm 57 to the return pivot arm 40 and is positioned to allow only a clockwise movement of the second arm relative to the pivot arm. A tension spring 59 extends between the two arms 40 and 57 to bias the two arms together.

As viewed in FIG. 4, the filter assembly 20 is illustrated in a position prior to scanning and is adapted to be carried with the lens assembly in a leftward direction during exposure. The ramp 55, shown in FIG. 3 and FIG. 4, is positioned to abut the roller 56 mounted on the second arm. As the roller strikes the ramp when the exposure means begins scanning, the second arm 57 pivots around the pin 58 out of the way of the ramp 55 allowing the filter assembly to pass thereby. After passing the ramp, the second arm 57 and pivot arm 40 are biased back together by the spring 59. However, following the completion of the scan cycle and as the filter assembly is moving in the opposite direction back to its

initial position, the roller 56 mounted on the second arm 57 comes into rolling contact with the ramp 55 wherein the ramp acts to pivot the return pivot arm 40 in a counterclockwise direction to abuttingly push the filter in an operative position back into the storage position in a manner previously described. Therefore, it should be clear that the cooperative effect of the ramp and the return pivot arm act to return the filter previously in use back to an inoperative position to allow the next filter to be inserted into operation.

In operation the activation of the selected solenoids removes the pin carrying the selected filter in its track to allow a filter to be inserted into an operative filtering position. Thereupon, at the end of the scan cycle of exposing the subject matter to be reproduced to the photoconductor, the return of the lens and filter assembly to its initial position causes the pivot arm to be rotated in a counterclockwise position to return the previously utilized filter. Thereafter, a second filter may be inserted in a second cycle of operation. The solenoids may be activated in any order thereby achieving any desired order to develop the image with color toner.

In the above description there has been disclosed an improved multiple filter assembly for use with a xerographic photoconductive surface for producing color to color reproductions. The surface to be exposed was described for convenience of illustration as that of a xerographic drum, but the invention may be used to expose other well known photoconductive members in the form of plates, belts, webs, or coated papers. It is further within the scope of the present invention to use the instant multiple filter assembly for use in any optical system where sequentially operated filters are required. Further, the filter assembly may be utilized in connection with other xerographic exposure means other than the particular scanning type herein disclosed.

While the invention has been described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the true spirit and scope of the invention. In addition, many modifications may be made to adapt a particular situation and material to the teachings of the invention without departing from its essential teachings.

What is claimed is:

1. Apparatus for recording a light image of a stationary original upon a moving photosensitive element including

a moving lens element arranged to scan across the stationary original to focus a flowing light image of the original upon the moving photosensitive ele-

ment,

filtering means containing a plurality of filters mounted in a stack array adjacent to said lens, said stack array being arranged to move in synchronization therewith as the lens scans across the original, and

means operatively associated with said filtering means to place a pre-selected one of said filters from the stack array into the light image focused upon said photosensitive element as the lens scans across the original.

2. The apparatus of claim 1 further including a means to illuminate the viewing domain of said lens upon the original as said lens scans thereacross.

3. The apparatus of claim 1 further including program means to sequentially position each of the stored filters in the housing within the optical light path of the lens during successive scanning passes.

4. The apparatus of claim 1 further including a filter housing for storing the filter adjacent said moving lens, said housing having a clear aperture through which the light image from said lens passes and slide means to guide the pre-selected filter between a stored position within the housing and an operative position within the clear aperture.

5. The apparatus of claim 4 further including means to restore the filter positioned within the clear aperture in said housing upon the completion of the scanning pass.

6. A filtering apparatus for creating a series of light images from a stationary original including

means to move a lens element from a first start of scan position to a second end of scan position so as to create a flowing light image of said stationary original and then restoring said element to the start of scan position,

a filtering means including a housing having a clear aperture therein being arranged to move in synchronization with said lens element whereby the flowing light image created by said lens passes through said aperture as the lens scans said original, said housing containing a plurality of light filters in a stored position adjacent said clear aperture,

actuating means operatively associated with said filter means for placing one of said stored filters into the clear aperture whereby the flowing light image produced by the lens is optically filtered as the original is scanned, and

means for returning the actuated filter to a stored position as the lens element is being restored to the start of scan position.

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