

[54] **PHOTOCONDUCTOR DISCHARGE SHUTTER ASSEMBLY**

[75] Inventors: **David K. Gibson; Frederick W. Johnson**, both of Lexington, Ky.

[73] Assignee: **International Business Machines Corporation**, Armonk, N.Y.

[22] Filed: **Apr. 12, 1972**

[21] Appl. No.: **243,137**

[52] U.S. Cl.355/3, 355/8, 355/11, 355/71

[51] Int. Cl.G03g 15/00

[58] Field of Search.....355/3, 8, 11, 14, 67, 71, 84, 355/101, 81, 121

[56] **References Cited**

UNITED STATES PATENTS

3,540,806	11/1970	Starkweather.....	355/8 X
3,671,121	6/1972	Albert	355/3 X
3,375,806	4/1968	Nost	355/3 X
3,556,655	1/1971	Lux et al.	355/55

Primary Examiner—Robert P. Greiner
Attorney—Laurence R. Letson et al.

[57] **ABSTRACT**

A shutter arrangement is disclosed which at pre-selected intervals opens and closes to either permit light to illuminate a document plane or reflect light to the photoconductor of an electrostatic copying machine having the capability of half tone development, thus preventing the toning of unexposed areas of the photoconductor which bear no relation to the document being copied. The control arrangement opens the shutter during the normal scanning portion when a document is exposed to the illumination light and closes the shutter at a point corresponding approximately to the end of the document scan thus reflecting light to the photoconductor as if the photoconductor was receiving light from a white document, to discharge the unused portion of the photoconductor. This prevents excessive toning and the associated cleaning problems since this portion of the photoconductor will not have the toner transferred from it to a copy sheet.

7 Claims, 4 Drawing Figures

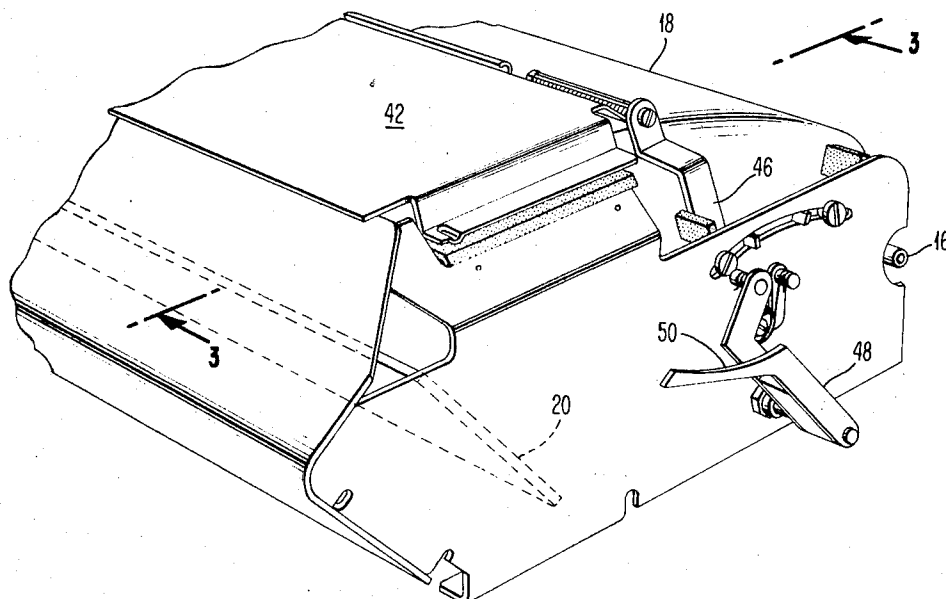


FIG. 1

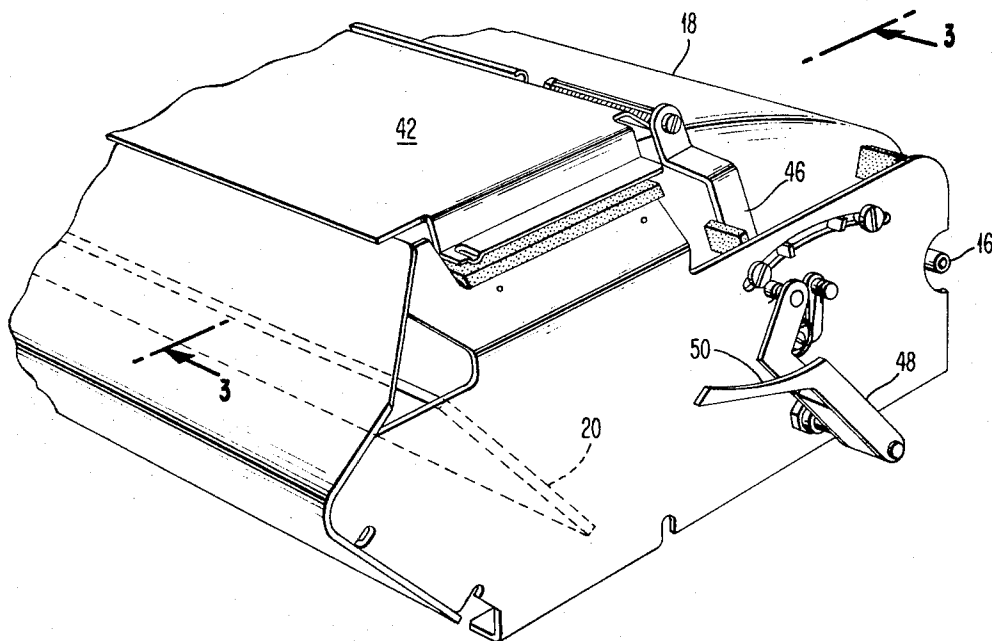


FIG. 2

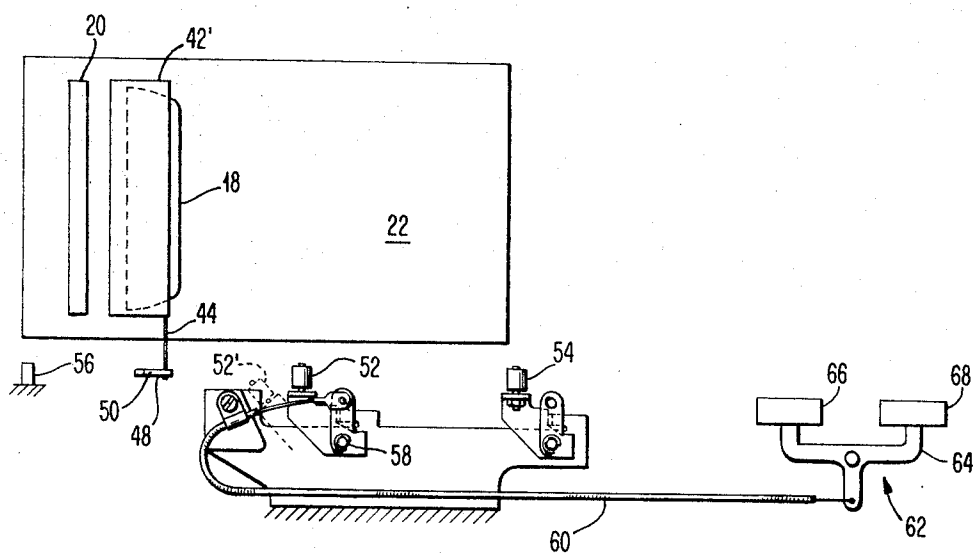


FIG. 3

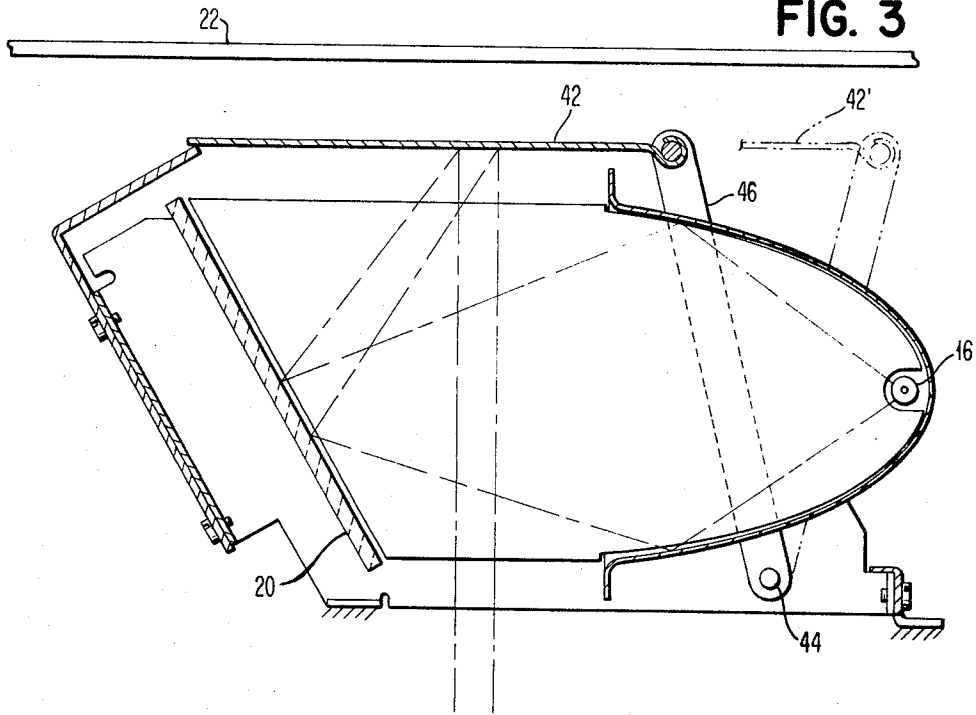
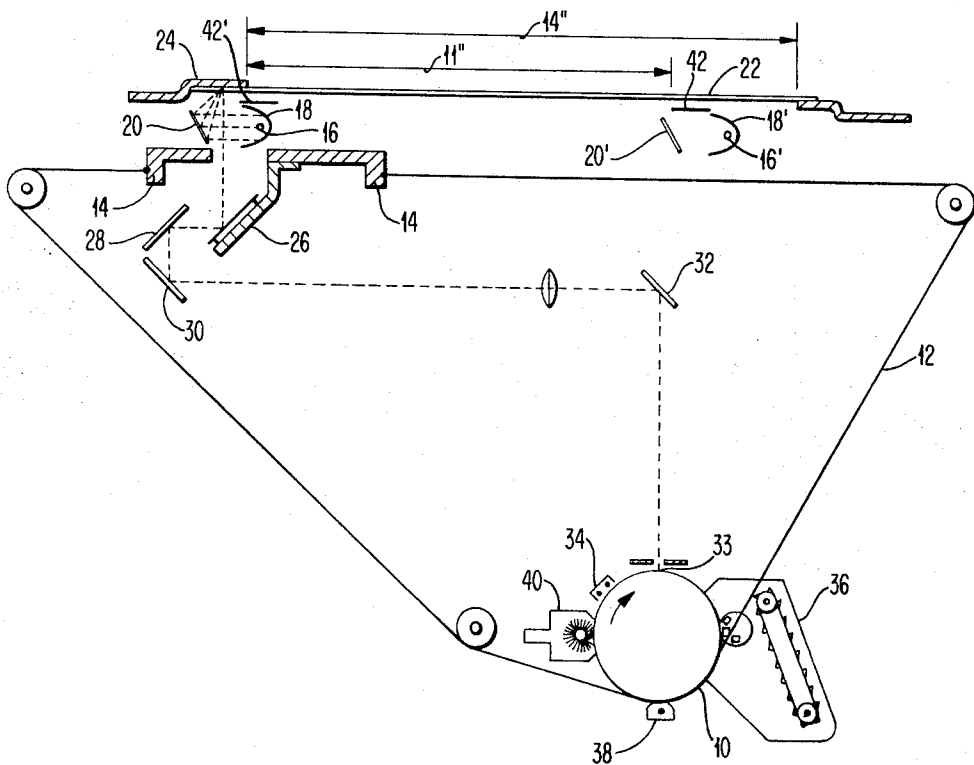


FIG. 4



PHOTOCONDUCTOR DISCHARGE SHUTTER ASSEMBLY

BACKGROUND OF THE INVENTION

In cascade development electrostatic copying apparatus the toner is strongly attracted to the latent electrostatic image formed on a photoconductive surface when it has been charged and then exposed imagewise to an original document. The toning of the electrostatic image on the photoconductor is accomplished by the attraction of the toner particles to that portion of the latent image which remains charged to a high level after the exposure step. Where large areas remain charged such as those corresponding to large black areas on the original, the toning in a cascade developer unit is generally only effective in the edge portion of the large black area developed. This is due to the fact that the strongest attraction for the toner particle is in the fringes or edge areas where the electrostatic field is strongly developed and concentrated between charged and adjacent uncharged areas. In the center portion of a large charged area the electrostatic field is not strongly developed or concentrated in such a configuration that the toner particles are strongly attracted and thus the phenomenon known as washout occurs leaving only a development pattern known as edge development for large black areas.

With the advent of development electrodes and magnetic brush developer mechanisms, it has become increasingly possible to produce good continuous or half tone copies where large areas of gray and black are developed to substantially uniform density notwithstanding the phenomenon of washout experienced in the cascade form of development.

With the capability of heavily toning large black areas as a result of the large areas of highly charged photoconductor, the need for control of unused portions of the photoconductor have increased tremendously. The main reason for the increased need for control of the toning of these areas is because the cleaning of untransferred toner is difficult and the toner deposited on the unused areas of the photoconductor are not susceptible of transfer as there is no copy paper presented to those areas during the normal operation of the machine. Additionally, the cleaning system in electrophotographic copying machines is generally designed to clean only residual toner which is left on the photoconductor after the transfer of most of the toner to a copy sheet. When large quantities of untransferred toner remain on the photoconductor the cleaning system generally is not adequate to handle these quantities of residual toner and as a result the cleaning of the photoconductor is unsatisfactory. This cleaning failure manifests itself as toner deposits on the photoconductor which, in turn, block light during the succeeding exposure cycles thus permitting additional toner to be deposited in that spot and further compounding the problem.

The toner which is removed from the photoconductor in the large, heavily toned areas rapidly overloads the cleaning system and more specifically fills and overloads the vacuum bag of the cleaning system. This is a waste of toner and there is no beneficial effect derived from this toner.

PRIOR ART

The prior art has addressed the problem of exposing of unused portions of the photoconductor in the past by several techniques. These techniques are adapted to specific problems and although generally applicable, these applications do not solve the problem of excessive toning for all portions of the unused photoconductor.

Generally, photoconductors are wider than the copy being made to ensure that all portions of the image focused on the photoconductor are received on a portion of photoconductive material which may respond to that image. Thus there are portions of the photoconductor which are not exposed to the image or which lie on either side of the document image. This portion of the photoconductor if not otherwise treated would be toned or developed and sent through the remaining process steps of the xerographic process. Since no copy sheet would be presented to that portion of the photoconductor, the toner particles attracted to and held on this highly charged portion of the photoconductive member will not be transferred and must be removed by the cleaning station of the electrostatic copying apparatus. To prevent excess toning of these areas, the prior art has used what are referred to as edge erase lamps where light is impinged from a lamp or light source through a control shielding arrangement onto the edge portions of the photoconductor which lie outside the image of the document being copied. This discharge usually occurs after the exposure and prior to the developing of the latent electrostatic image. As the discharge lamps effectively expose these edge areas the photoconductor becomes conductive and the charge level on those portions of the photoconductive surface drop to a residual voltage level which is generally insufficient to attract and retain significant quantities of toner particles.

The erase lamp technique is additionally used where a lamp is energized and caused to illuminate portions of the photoconductive surface between images when the electrostatic copying machine is conditioned for a smaller size copy thus leaving an unused portion of the photoconductor between images. This technique requires precise control of the period that the lamp is on.

A different type solution has been applied to those machines which use a flash illumination for illuminating the original document during the exposure step. In flash illumination systems it is possible to conduct light through a light conductor such as fiber-optical members and other similar type light conducting mechanisms and impinge this light onto the photoconductor at point where it is desired that the electrostatic charge be dissipated to prevent the toning of the charged but yet unused portions of the photoconductor, such as inter-image gaps.

This technique is not readily applicable in an environment which uses a scanning illumination exposure apparatus.

OBJECTS OF THE INVENTION

It is a primary object of this invention to control the discharge and toning of electrostatically charged photoconductive members in unused regions of the photoconductor.

It is another object of this invention to reduce the toning of unexposed portions of the photoconductor which bear no relationship to the image being produced.

It is a further object of this invention to improve the cleaning of the photoconductive member in an electrostatic copying apparatus having the capability of producing half tone copies.

It is still another object of this invention to improve copy quality of electrostatic copying apparatuses.

It is still a further object of this invention to reliably discharge the inter-image portion of a photoconductive surface.

It is still an additional object of this invention to reduce operator annoyance when operating the copying machine with a cover open.

Still further objects of this invention will become apparent and the solutions to the shortcomings of the prior art will be evident, from the more complete description of the invention to follow.

SUMMARY OF THE INVENTION

In order for the photoconductor to be discharged in that portion of its area which corresponds to the unused length of a 14 inch scan, commonly referred to as a legal size scan, when copying 11 inch or standard length paper, a shutter or other light reflective means is positioned in the light path from the illumination bulbs to reflect light in the same manner that a document would reflect light if that document were on the document plane. This light reflective surface or shutter is actuated to move into an intercepting position at a point which corresponds to the end of the scan of either an 11 or 14 inch document or for other sizes when the apparatus is adjusted or modified for non-standard paper lengths. The shutter closes and thus presents a white reflective surface to the light rays emanating from the illumination package or illumination assembly and effectively appears to the photoconductor the same as a white sheet of paper would appear if a white sheet occupied the document plane at that point. As the light illumination package re-scans or is repositioned to begin another scan, the shutter arrangement remains closed thus discharging all portions of the photoconductor which pass the exposure station during the period of re-scan and thereby prevent it from being toned in that region. Upon completion of the re-scan motion the shutter is opened at a point prior to the edge of the document so that as the illumination assembly begins its scanning motion the light from illumination source is impinged upon the original document and the reflected light from the document carrying the image of that document is being focused on the photoconductor surface to expose the photoconductor and thus form a latent electrostatic image which may be subsequently processed. As the illumination assembly reaches that point which corresponds to the end of scan for the size document selected, the shutter is closed and the scanning cycle is continued to the end of scanning movement. If there is no shutter arrangement such as herein disclosed or if the shutter is left open during the latter portion of the scan, there is insufficient light reflected to the photoconductor, because of the absence of a document on that portion of the document plane, to adequately discharge the photoconductor. This results in rather heavy toning of the photoconduc-

tor as the image projected onto the photoconductor is essentially the same as if there were a solid black area in that portion of the scan where there is no document. This is particularly true when the electrostatic copying machine is operated with its document cover in an open position such as when a single copy is being made of many documents, or when copying material in book form.

Due to the shutter closing and the light from underside of the shutter being reflected to the photoconductor and thus discharging it when the developer assembly has that segment of the photoconductor presented to it for developing, the residual voltage on the photoconductor is insufficient to attract and retain particles of toner and therefore the need for extensive cleaning is reduced.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings.

DRAWINGS

FIG. 1 illustrates a partial view of a scanning illumination assembly with a light intercepting and reflecting shutter positioned in its intercepting position.

FIG. 2 is a plan view of a document plane with the controls for operating the shutter on the illumination assembly of FIG. 1.

FIG. 3 is a sectional view along line 33 in FIG. 1.

FIG. 4 is a schematic representation of an illumination system incorporating the shutter arrangement of FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

To provide an electrostatic copying or reproduction apparatus, with the capability of forming copies of originals to be reproduced, an electrophotographic photoconductive member or photoconductor 10 is provided. The photoconductor 10 is preferably formed in the shape of a revolving drum. To provide synchronous motion between the drum surface and the optical system of the electrophotographic copying or reproduction machine, a drive means or cable 12 is driven in synchronism with the rotation of the drum. This may be accomplished by any conventional means such that a desired length of cable 12 is driven past any preselected point in relation to a pre-determined peripheral length of the photoconductor 10. An example of the type drive arrangement which may be implemented in this arrangement, refer to U.S. Pat. No. 3,554,640 to Thomas A. Hoskins. Slight modification may be necessary to adapt scan direction and to move the illumination assembly. As the cable 12 is moved, support carriage 14 to which cable 12 is attached is translated from left to right in FIG. 4. To provide illumination for the document an illumination source 16 is supported in generally parallel relationship to a document plane 22. To direct and focus the light rays from illumination source 16, a generally parabolic reflective mirror 18 is provided. The mirror surrounds the lamp 16 or illumination source 16 and is positioned such that the light emanating from the illumination lamp 16 and reflecting off of parabolic reflector 18 is focused partially onto mirror 20 which reflects partially focused

light onto the document plane 22. The positioning of reflector 18 around lamp 16 is such that the light which reaches document plane 22 is focused to a relatively narrow footprint of light or band of light which illuminates the entire width of the document and an incremental length of the document. Reflector 18, lamp 16, and mirror 20 are all fixedly attached to carriage 14 such that the translational movement of carriage 14 in response to the timed rotation of photoconductive drum 10, causes a scanning of document plane 22. The position of reflector 18', lamp 16', and mirror 20' illustrate a position which these elements will occupy part way through a completed scanning movement.

To direct the light rays which will be reflected from the illuminated portion of the document plane 22 and any document placed thereon, a mirror 26 is mounted below the point at which the footprint of light from mirror 20 illuminates document plane 22. Mirror 26 is positioned to direct the light to other reflecting surfaces in the optical path. These other reflecting surfaces are mirrors 28, 30, and 32. Mirrors 28 and 30 are fixedly attached to a translatable carriage. As carriage 14 is translated in response to the movement of cable 12, mirrors 28 and 30 likewise scan due to the movement of the carriage to which they are attached. The velocity of the mirrors 28 and 30 in a horizontal direction is one half of the velocity of carriage 14, in order to provide a constant length optical path from any point on document plane 22 through mirrors 26, 28, 30, and 32 to the photoconductive drum surface 10.

FIG. 1 illustrates the entire illumination assembly which is in turn mounted on carriage 14. The parabolic reflector 18 has mounted within it a light source 16 such that the light reflected from the reflector 18 partially focuses on mirror 20 and illuminates a footprint of light on the document plane 22. As illustrated in FIG. 3 the light rays emanating from lamp 16 and reflected from mirror 20 are intercepted by the shutter 42 in as much as shutter 42 is closed. When the light is reflected from shutter 42, which is generally a white or light colored finish, the image transmitted through the remainder of the optical system does not have any history of the document or any object on the document plane 22. The effect will be to expose the photoconductive surface of drum 10 with a light which is uniformly transmitted and thus present to the photoconductive surface 10 the same type of exposure as would be encountered with light which is reflected from a totally white blank document. The light rays reflected from shutter 42 in its closed position then cause discharge of any electrostatic charge placed on the photoconductive surface by charging corona 34 as shown in FIG. 4.

The photoconductive drum 10 continues to rotate in a clockwise position and the surface of the photoconductor which has been imaged due to the reflected light from shutter 42 is presented to a magnetic brush developer apparatus. In this preferred embodiment description the explanation is with respect to a magnetic brush developer, however, this apparatus is equally applicable to cascade developers having development electrodes. Additionally this shutter arrangement could be implemented into a cascade developer system, if desired.

FIG. 2 also illustrates the shutter in its open position or copying position at 42'. The movement of shutter 42 from its closed position to its open position 42' is effected through the use of a bail 44 which in turn causes arm 46 to rotate about the pivot point defined by bail 44. The rotation of bail 46 is controlled by a knockoff cam lever 48 as illustrated in FIG. 1. Knockoff cam lever 48 has a camming surface 50 designed to engage a cooperating engaging member 52, or knockoff stop 52, if the length of scan desired is less than the complete scan capability of the overall reproduction apparatus, or alternatively cam stop 54 to close the shutter at the end of the longest permissible scan.

In order to control the opening of shutter 42 at the desired point prior to the beginning of any scan, a limit stop 56 or shutter opening means 56 is provided. Actuator arm 48 engages limit stop 56 at the point that is just prior to the carriage 14, reflector 18, mirror 20, and shutter 42 reaching the end of a re-scan movement prior to the initiation of the scanning movement.

Limit stop 56, in engaging control arm 48 or lever 48, causes control arm 48 to rotate in a clockwise direction as viewed in FIG. 3, through a small segment of a circular movement around bail 44. This moves arm 46 in a clockwise movement retracting shutter 42 to position 42'. In this position the illumination assembly is ready for scanning and the light rays emanating from lamp source 16 and impinging on mirror 20 are focused into a footprint of light on the document plane 22. Either cooperative engaging member 52 or 54 acts to close the shutter 42 at the desired point of the subsequent scan. To allow the shutter 42 to either close at the end of a normal 11 inch document scan or to remain open for an extended scan of 14 inches or such other length as the basic scanning mechanism is capable of performing, engaging member 52 is pivotally mounted at 58 to allow it to pivot out of the path of control arm 48 and camming surface 50. This control is accomplished through a boden cable 60 or other equivalent mechanism interconnecting engaging member 52 with the copy size selection control 62. Copy selection control 62 may be comprised of a pivotally mounted toggle lever 64 as shown in FIG. 2 or other motion translating mechanism which moves in response to the depression of control buttons or other control members which are actuated in response to a desire for a particular copy size. Button 66 would be depressed to secure a 14 inch copy while button 68 would be depressed to secure an 11 inch copy. This copy size control mechanism is further connected into the paper transport system to ensure that the right size sheet is fed or the proper length of sheet is severed from a roll feed.

If button 66, representing a 14 inch copy length, is depressed the action of toggle link 64 is transmitted through boden cable 60 thus retracting engaging member 52 to the position indicated at 52'. By removing engaging member 52 from the path of control arm 48 and camming surface 50, the shutter is allowed to remain open through the entire scan of the illumination assembly.

In either event as the camming surface 50 engages either engaging member 52 or 54 and thus closes the shutter 42, the illumination assembly is then prepared for the re-scan portion of the optical system movement.

The shutter 42 being closed during re-scan likewise presents a solid white light to the photoconductor thus insuring that that unused portion of the photoconductor 10 is likewise discharged and not toned.

A more complete understanding of the operation and function of this invention will be possible from the following detailed description of the mode of operation.

For sake of convenience a point of the cyclic operation of the electrophotographic copying machine generally disclosed above and specifically disclosing the photoconductor discharge shutter arrangement, will start at a point where the scanning apparatus, specifically the illumination assembly, has completed a previous scan and is at rest at the end of the scan. In this position reflector 18, illumination source 16, mirror 20, and shutter 42 are at their right most limit of travel viewed as in FIG. 4.

A document to be copied, for example a standard letter size document, is placed on the document plane 22 with one edge positioned against edge guide 24. The machine operation is initiated through any conventional operator control to begin the copying operation. At this time the drum carrying the photoconductive surface 10 begins its clockwise rotation and carriage 14 is moved toward the left as viewed in FIG. 4. When the optical illumination system has reached its endmost point of travel in the previous cycle, engaging pin 54 insured that control arm 48 was rocked in a counterclockwise position insuring that shutter 42 was closed. As the next copying cycle is initiated, the lamp 16 is illuminated during the re-scan portion of the cyclic operation and light is reflected from reflector 18 and mirror 20 onto the underside of shutter 42. The light rays impinging on the underside of shutter 42 reflect from the shutter onto mirror 26, mirror 28, mirror 30, and mirror 32 and are focused at the exposing point 33 on photoconductive drum 10. During the re-scan portion the photoconductive surface of drum 10, in what may be characterized as an unused portion of the drum, is illuminated and thus discharged from its dark charge level deposited by charging corona 34.

As carriage 14 continues to move leftward as viewed in FIG. 4, the path of illumination from lamp 16 and reflector 18 onto mirror 20 moves under edge guide 24. When carriage 14 approaches the end point of the re-scan travel, limit stop 56 engages control arm 48 causing control arm 48 to rotate in a clockwise direction through a small portion of a circle. This causes arms 46 to likewise rotate around bail 44 in a clockwise direction thus retracting shutter 42 from the optical path between mirror 20 and document plane 22.

Carriage 14 then is driven in optically synchronized movement with the surface of drum 10, to scan the document previously placed on the document plane 22. The image of the document is transmitted through the same optical path described above and presented to the surface of photoconductive drum 10 where the light reflected from the original exposes the charged photoconductive surface 10 and allows the photoconductor to become conductive and dissipate the electrostatic charge in the areas corresponding to light areas of the original. Dark areas of the original do not reflect light and the lack of light impinging on the photoconductor does not allow the reduction of the charge level and thus the areas corresponding to black or dark por-

tions of the original retain the high level of electrostatic charge originally deposited on the photoconductive surface. As the photoconductive member 10 rotates it is presented to a magnetic brush developing apparatus 36 which deposits toner particles onto portions of the photoconductor retaining a high electrostatic charge level. Thus photoconductive areas having the high charge level corresponding to dark portions of the original document, are toned.

As the carriage 14 travels toward the right in FIG. 2 the illumination assembly moving with it, causes the control arm 48 and specifically cam surface 50 to engage engageable member 52. Engageable member 52 has been positioned into the path of movement of cam surface 50 by the depression of the copy size selector apparatus, specifically button 68 which acts through toggle link 64 and boden cable 60 to cause member 52 to pivot around pivot point 58 into the path of cam surface 50. As cam surface 50 of control arm 48 engages the extended portion of engageable member 52 the control arm 48 is rocked in a counterclockwise direction and as discussed earlier closes shutter 42 through the action of arms 46. The rotation of control arm 48 in a counterclockwise direction lowers cam surface 50 down below engageable member 52 such that on a re-scan motion there will be clearance between the upper portion of control arm 48 and engageable member 52.

As the illumination assembly continues its movement in the scanning direction the light which is produced by lamp 16 is reflected from the parabolic reflector 18 and partially focused on mirror 20 and then projected onto the underside of shutter 42. The light illuminating the underside of shutter 42 is reflected by the light colored highly reflective surface through the normal optical path and discharges the photoconductor during this portion of the cycle which when correlated to the photoconductive surface 10 corresponds to an unused photoconductor segment.

As the illumination assembly and optical carriage 14 reach the limit of the scan of the document plane 22, cam surface 50 of control arm 48 passes underneath engageable member 54. Engageable member 54 is positioned to close the shutter in the same fashion as engageable member 52 closes the shutter. However, it is positioned to effect the closing at a point corresponding to the trailing edge of a 14 inch document.

At this point the complete scanning cycle has been completed and the illumination package, carriage 14, and optical light directing system including mirrors 26, 28, 30, and 32 come to rest.

Assuming that the next copy to be made is that of an original 14 inches long, the document is placed face down on document plane 22 and the 14 inch copy selector button 66 is depressed. This rocks toggle member 64 around its pivot point and pulls boden cable 60 to retract engageable member 52 into its position 52'. When the electrophotographic apparatus is then started the carriage 14 together with the illumination assembly re-scans to the leading edge of the document plane 22 with the shutter closed since it has remained closed since cam surface 50 engaged in engageable member 52 in the last scanning sequence. Upon the completion of the re-scan motion, limit stop 56 engages control arm 48 thus opening the shutter and

allowing illumination of the document plane by the illumination source 16, parabolic reflector 18, and mirror 20. The scan portion of the operation is identical to that described above with respect to the 11 inch document, except that the shutter is allowed to remain open due to the retraction of engageable member 52, until the cam surface 50 of control arm 48 engages engageable member 54 to close the shutter at the end of the 14 inch document scan. Generally there is a small amount of over scan to insure that the illumination assembly and the entire optical package continues to move at its desired velocity and synchronism with the photoconductor 10 through the entire document scan and is allowed a little bit of over scan to slow down and stop.

Referring specifically to FIG. 4, during the time that the carriage 14 has been moving from left to right during the scanning operation it is moving in optical synchronization with the movement of the periphery of photoconductor drum 10, passed the exposure station 33. After the photoconductive member 10 has been illuminated by the light from the document, and has had impressed upon its surface by that light an image pattern corresponding to the light and dark areas of that document, the photoconductor 10 is then presented to a development station 36. In the preferred embodiment that developer station is a magnetic brush developer assembly 36. However, the magnetic brush developer assembly may be replaced with a development electrode developer station if desired. At the developer station, the carrier particles which are formed into the bristles of a brush by magnets within the magnetic brush housing 36, rub against the surface of the photoconductor 10 and deposit onto it small electroscopic particles of toner. The toner is attached and adhered to that portion of the photoconductor retaining a high electrostatic charge. These portions correspond to the dark portions of the original document. The photoconductive surface 10 carries the toner particles past the transfer corona 38. The transfer corona 38 is separated from the photoconductive surface 10 by a sheet or web of paper normally to receive the toner particles. The transfer corona 39 counteracts the tendency of the toner particles to adhere to the photoconductor 10 and causes them to adhere to the support sheet for subsequent fusing of the copy.

After transfer of the toner particles and the developed image from the photoconductive surface 10 to the copy sheet or copy support, the photoconductor 10 is then next presented to a cleaning station 40. At this point the photoconductor 10 is cleaned by a rapidly revolving brush of either natural or synthetic fibers or bristles, and the undesirable toner residue which inherently remains on the photoconductive surface is brushed from that surface and trapped into a vacuum cleaning system. Alternate techniques of cleaning such as web cleaning and wiper cleaning are known in the art and would be acceptable alternatives to the vacuum-brush arrangement. After cleaning, the photoconductor 10 is re-charged by charge corona 34 for subsequent exposure.

One characteristic of magnetic brush and developer electrode development stations, is that large dark areas on the original which are manifested as large areas of high charge level on the photoconductive surface 10 are developed to substantially uniform darkness by the

developing station. As the images on a photoconductive drum surface 10 are, of necessity, separated from each other by some increment of distance there are portions of the photoconductor which can best be characterized as unused.

Due to the operational limitations of most electrophotographic apparatus which have the capability of scanning either 11 or 14 inch copies, the scan is the same regardless of the length of the original document. Thus for a short document, that portion of the scan movement after the original is scanned, illuminates a region which is conveyed to the photoconductive drum surface 10, as a dark or at least darker surface than that of the original, even where the effort has been made to use a white backup material such as a rubber flap or rubber document backup sheet. This solution is not entirely satisfactory as it does not reflect the same amount of light as a white piece of paper and thus the charge on the photoconductor is not as fully dissipated by the exposure as if a white light were conveyed to the photoconductive surface.

One reason why the incomplete or only partial dissipation of the charge on the photoconductive drum surface 10 is detrimental to the continued operation of the system, is that if the charge level is allowed to remain at a substantial level above the normal residual voltage level for a white background, that portion of the photoconductor 10 will attract and hold toner when the surface passes the magnetic brush developer unit 36. As this portion of the photoconductor 10 then passes the transfer corona 38, there is no copy sheet or paper presented to the photoconductive surface 10, to which the toner particles can be transferred. Therefore, the toner particles are further carried past the transfer station 38 and carried to the cleaning station 40.

Cleaning stations for electrophotographic apparatuses are generally designed to satisfactorily clean small quantities of toner and residue from the photoconductor after most if not substantially all of the toner has been transferred to the copy sheet. The cleaning stations such as 40, are usually not capable of extensive cleaning of large quantities of residue toner. Even in the event that the cleaning station 40 is capable of this, the large quantity of toner which would be removed from the drum would represent a large waste of toner materials and further the depositing of this toner into a filtering bag or filtering arrangement would very quickly fill and clog the filter thus reducing its efficiency and further degrading operation of the electrophotographic copying apparatus.

By providing a selectively operable and timed apparatus for reflecting light onto the photoconductor 10 in those portions of the cycle which do not represent an image to be copied, the photoconductor is discharged prior to developing and prevents the excessive toning of these unused portions of the photoconductor and reduces the cleaning requirements placed upon the cleaning station 40.

Additionally, when the electrophotographic copying apparatus is being operated by an operator making a few copies of many documents, it is common to leave the copy cover open to ease in the transfer of originals to and from the document plane 22.

As a result there is no document or any light reflective surface presented to the light illuminating the

document plane during the unused portion of any particular scan and thus a very heavy deposit of toner will result in the trailing portion of the scan on the trailing portion of the photoconductive member after that segment representing an 11 inch copy. In such circumstances the toning of the unused portion is further compounded as the photoconductor sees this portion of the scan as a totally black document.

Additionally, when the document cover is left open to ease the changing of original, the high intensity of the illumination lamp 16 when concentrated in a small range of area as described above can be annoying to an operator. This would occur during any unused portion of the scan and during re-scan when the operator would be manually substituting a second document for a first document. By the implementation of the shutter arrangement disclosed herein and the sequential operation of that shutter, the undesirable exposure to the illumination source during unused portions of the scan and during the entire re-scan are substantially reduced if not completely eliminated.

As can be seen from the foregoing, the implementation of a selectively operable shutter arrangement for intercepting light prior to it being impinged upon a document plane, in relation to the scanning and re-scanning motion of an illumination assembly in an electrophotographic copier apparatus reduces the waste of toner and electroscopic developing materials, reduces operator annoyance by reducing or eliminating operator exposure to high intensity light and improves the cleaning by a cleaning station thus maintaining or improving copy quality in electrophotographic apparatus embodying development electrode and magnetic brush developer systems.

One skilled in the art can readily see that should it be desirable to implement this shutter light control concept in an electrophotographic apparatus where a document scans past a fixed illumination arrangement, it may be implemented quite simply by merely moving the engageable members together with the moving document and hold the illumination system and its associated shutter and shutter control members in a fixed position. Likewise alternate control members may be implemented to either electrically or electro-mechanically time the opening and closing of the shutters or alternate techniques may be used for intercepting the light prior to its impinging on the document plane 22 such as the use of mirrors or other apparatuses for redirecting the light and not allowing it to imprint onto the document and thus pick up a history of the document plane.

Also, a shutter arrangement may be implemented which compensates for the difference in document lengths where the scan direction is across the width of the document.

If desired, a continuously adjustable scan control to

close the shutter at any length of scan could be adapted to the electrostatic copying apparatus by mounting engageable member 52 on a slide arrangement.

While the invention has been particularly shown and described with reference to (a) preferred embodiment thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

We claim:

1. An illumination system for controlling the reflection of light and the image presented to a charged photoconductive member of an electrostatic copying apparatus to reduce excess toning of unused regions through exposure and discharge of said unused regions comprising;

an illumination source;

means for directing illumination from said source onto a document plane;

means for directing light reflected from said document plane to said photoconductive member and presenting an image of said document plane on the surface of said member;

selectively operable means for intercepting said illumination prior to said illumination being impinged onto said document plane and redirecting said intercepted illumination to present that illumination to the surface of said photoconductive member to expose and discharge said member.

2. The system of claim 1 wherein said selectively operable means for intercepting is operated in response to the relative displacement of said illumination source with respect to said document plane.

3. The system of claim 2 wherein said selectively operable means for intercepting source illumination comprise a shutter having an open and a closed position.

4. The system of claim 3 wherein said shutter is moveable into and out of the path of said illumination in a plane substantially parallel to and spaced apart from said document plane.

5. The system of claim 3 wherein said shutter has a surface which is highly reflective.

6. The system of claim 5 wherein said highly reflective surface is generally the same color as most original documents to be reproduced on said electrostatic copying apparatus.

7. The system of claim 2 wherein said selectively operable means further comprises an adjustable engaging means and a cooperating control means, said adjustable engaging means being positioned in the path of said control means and fixed with respect to said document plane to cause said selectively operable means to intercept said illumination during any time period after said engaging and control means contact each other during an exposure cycle.

* * * * *