

United States Patent

[11] 3,580,671

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3,313,623 4/1967 Bixby 355/17X
 3,488,118 1/1970 Parrent, Jr. et al. 355/71

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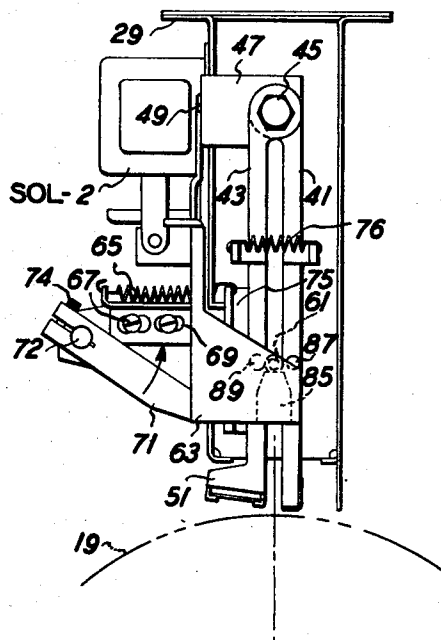
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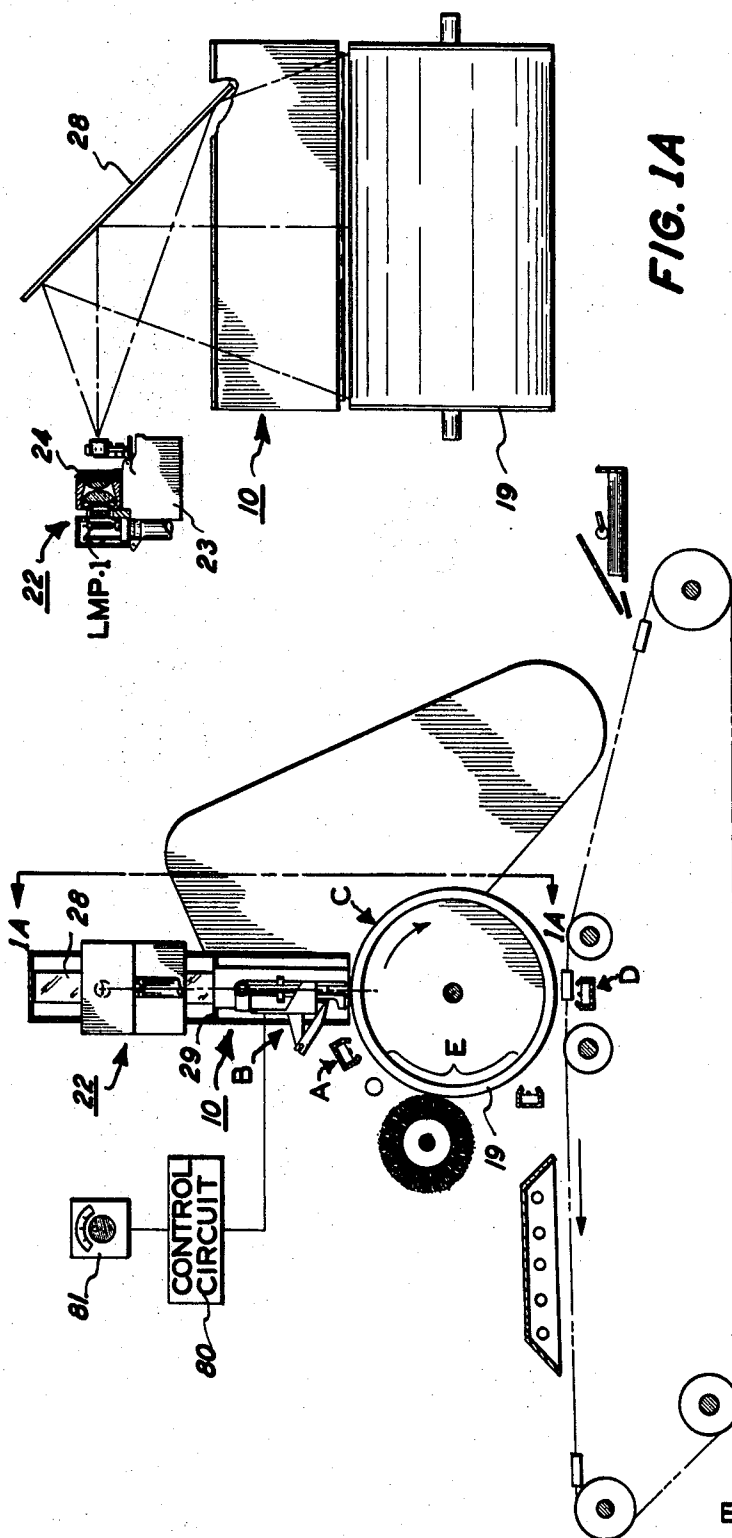
[54] **EXPOSURE APPARATUS**
5 Claims, 7 Drawing Figs.

[52] U.S. Cl. 355/3,
 355/71
 [51] Int. Cl. G03g 15/04
 [50] Field of Search 355/3, 7,
 16, 17, 71

[56] **References Cited**
UNITED STATES PATENTS
 3,120,790 2/1964 Carlson et al. 355/3

ABSTRACT: Improved exposure apparatus for use in electrostatic recording machines in which continuous tone and solid area images or line images are produced automatically at the option of the machine operator. The exposure apparatus comprises two exposure slits, each of which is adapted for movement into and out of the optical path in response to discrete electrical signals. One slit is open and used for line images. The other slit is provided with transparent and opaque lines and is used for producing tonal and solid area images.





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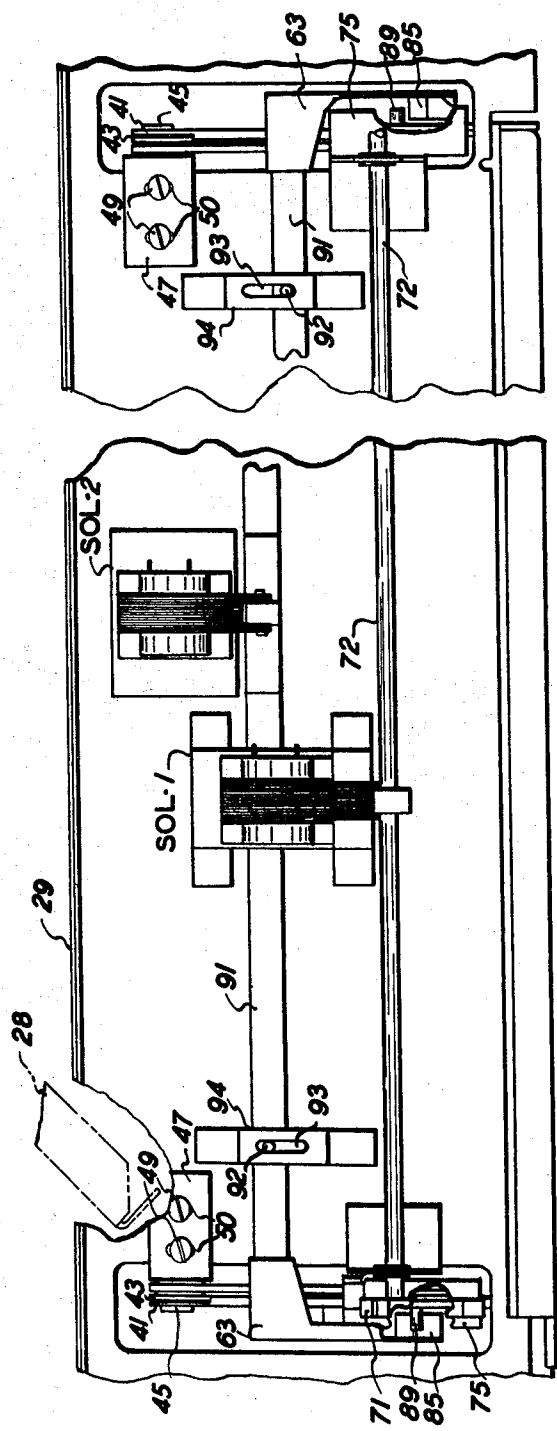


FIG. 2

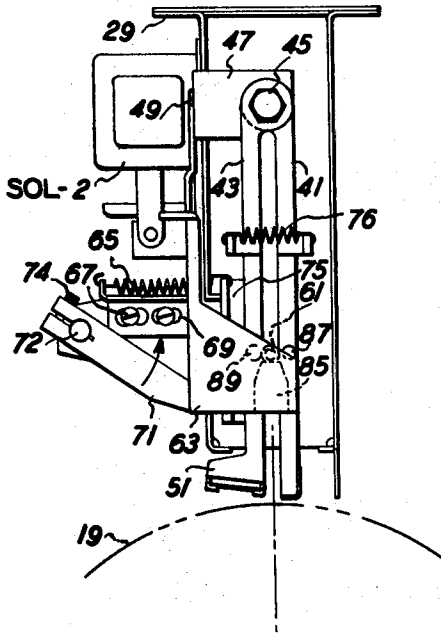


FIG. 3

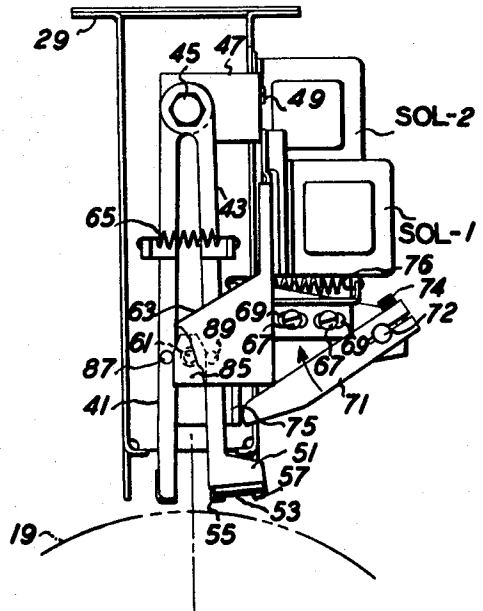


FIG. 5

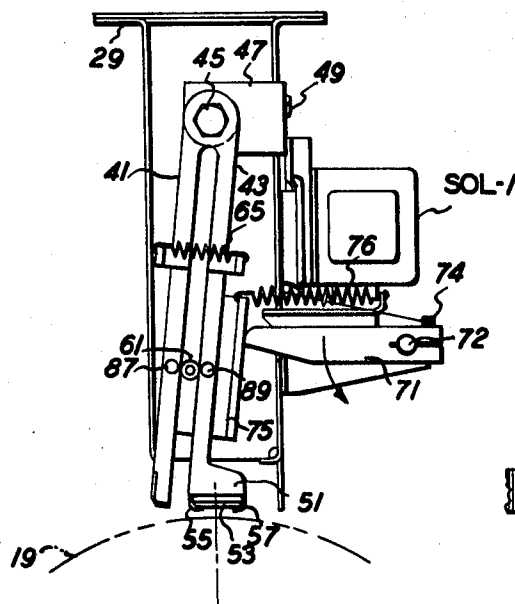


FIG. 4

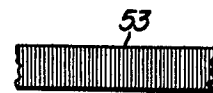


FIG. 6

EXPOSURE APPARATUS

This invention relates in general to automatic electrostatic recording machines and in particular to exposure apparatus for reproducing solid area and tonal images or line image at the option of the machine operator.

In electrostatic recording as described for example in U.S. Pat. No. 2,297,691 to Chester F. Carlson, a recording surface comprising a layer of photoconductive insulating material affixed to a conductive backing is used to support electrostatic images. In the usual method of carrying out the process, the surface is electrostatically charged uniformly and then exposed to a light pattern of the image being reproduced to thereby discharge the charge in the areas where light strikes the layer. The undischarged areas of the layer thus form an electrostatic charge pattern in conformity with the configuration of the original light pattern.

The latent electrostatic image can then be developed by contacting it with a finely divided electrostatically attractable material such as a resinous powder. The powder is held in image areas by the electrostatic charge fields on the layer. Where the charge field is greatest, the greatest amount of material is deposited; and where the charge field is least, little or no material is deposited. Thus, a powder image is produced in conformity with the light image of the copy being reproduced. The powder is subsequently transferred to a sheet of paper or other surface and suitably affixed to thereby form a permanent print.

The electrostatically attractable developing material commonly used in xerography consists of a pigmented resinous powder referred to here as "toner" and a "carrier" of larger granular beads formed with glass, sand or steel cores coated with a material removed in the triboelectric series from the toner so that a triboelectric charge is generated between the toner powder and the granular carrier. Such charge causes the toner to adhere to the carrier. The carrier also provides mechanical control so that the toner can readily be handled and brought into contact with the exposed xerographic surface. The toner is then attracted to the electrostatic image to produce a visible powder image on the xerographic surface. Thereafter the developed xerographic image is usually transferred to a support or transfer material to which it may be fixed by any suitable means such as heat.

Good results have been obtained with this process especially with cascade development using toner-carrier mixtures. This is especially true in automatic and continuous recording machines for line copy such as letters or lines on a white background.

Due to the electric field conditions in the region of the electrostatic images, however, large solid areas do not develop uniformly. Development of such areas delineate their outline in charge gradient areas, only, the centers of the areas not being developed or filled in with powder, unless a closely-spaced development electrode is used in the development zone, as described in U.S. Pat. No. 2,952,241 to H. E. Clark et al. Continuous tone images suffer in like manner, the tonal rendition being poor unless a development electrode is used. However, with continuous automatic equipment it is not usually feasible to provide a development electrode closely-spaced enough to the xerographic drum surface for this purpose without somewhat interfering with the flow of developer and hence slowing down the speed of the machine, and also producing undesirable developer jamming at times.

U.S. Pat. No. 2,598,732 to Walkup discloses a method of overcoming these difficulties in stationary flat-plate recording equipment by exposing the recording plate to a screen pattern in addition to the image pattern to be recorded, thereby breaking up the image into a halftone pattern. However, Walkup has not disclosed means which are suitable for application to automatic continuous machines where the surface carrying the electrostatic image is moving, such as in the case with a rotating drum.

Another technique for reproducing continuous tone and solid area images is disclosed in U.S. Pat. No. 3,120,790 to Carlson et al. This technique employs a screen formed of

transparent and opaque lines to dissipate the original charge on a xerographic drum in a pattern of lines parallel to the direction of drum rotation. According to this latter technique the screen is positioned either to extend over the entire exposure slit so that various portions of the image are always blocked by the opaque lines of the screen and thus line copies are not successfully reproduced or in a location as to require an additional source of illumination which detracts from the overall quality of the print.

The present invention is an improved exposure apparatus for making reproductions of continuous tone and solid area images or, alternatively, reproducing line copy of very high quality and constitutes an improvement over the aforementioned techniques.

It is, therefore, an object of this invention to improve automatic electrostatic recording apparatus for reproducing graphic information having variations in tonal value throughout all or part of the area or instead having lines or letters.

Another object of this invention is to improve exposure apparatus for use in a recording machine reproducing continuous tone and solid area images or line images on a moving recording surface.

Another object of the instant invention is to produce positive prints from microfilm negatives containing alphanumeric information or tonal information with improved and simplified apparatus.

Another object of this invention is to enable different exposure times and different exposure patterns characteristic of line or tonal patterns in a single unitary exposure mechanism.

These and other objects of the instant invention are achieved by an exposure mechanism having different optical slits selectively positioned in the optical path of a moving recording surface. One slit is open while the other is provided with transparent and opaque lines which are used for reproducing tonal or solid area images. Information is continually projected as a flowing image through one or the other of the slits onto a moving recording surface during the exposure process. Latent electrostatic images developed after such a selective imaging process produce prints with both improved solid area and line portions.

For a better understanding of the invention as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in connection with the accompanying drawings, wherein:

FIG. 1 is a schematic representative of an automatic electrostatic recording machine incorporating an exposure apparatus according to the present invention;

FIG. 1A is an end view taken along line 1A-1A of FIG. 1 illustrating details of the optical system;

FIG. 2 is a side view of the exposure apparatus of the invention with parts in section to illustrate various details of the invention;

FIG. 3 is an end view of the exposure apparatus illustrating in optical position a slit defining portion of the apparatus used for producing line images;

FIG. 4 is an end view as shown in FIG. 3 illustrating in optical position another slit defining portion of the apparatus used for producing tonal images; and

FIG. 5 is another end view similar to that of FIG. 3 but showing the slit defining portion in a variable slit width position;

and FIG. 6 is a partial plan view of screen for producing tonal patterns.

Shown in FIG. 1 is an automatic continuous recording machine adapted for use with an exposure apparatus generally designated 10 and constructed in accordance with the present invention. The recording machine comprises an electrostatic recording member including a photoconductive layer or light-receiving surface on a conductive backing formed in the shape of a drum, generally designated by numeral 19. As is normal in machines of this type, the drum is journaled in a frame to rotate in the direction indicated by the arrow to cause the

drum surface sequentially to pass a plurality of processing stations. For the purpose of the present disclosure, the several processing stations in the path of movement of the recording surface may be briefly described as follows:

A charging station A, at which a uniform electrostatic charge is deposited on the photoconductive layer of the drum;

An exposure station B, at which a light or radiation pattern of information to be reproduced is projected onto the drum surface to dissipate the drum charge in the exposed areas to thereby leave a latent electrostatic image;

A developing station C, at which a developing material, including toner particles having an electrostatic charge opposite to that of the electrostatic latent image, are cascaded across the drum surface, whereby the toner particles adhere to the electrostatic latent image to form a powdered image in the configuration of the information being reproduced;

A transfer station D, at which the powdered image is electrostatically transferred from the drum surface to a transfer material or a support surface; and

A drum cleaning and discharge station E, at which the drum surface is brushed to remove residual toner particles remaining thereon after image transfer, and at which the drum surface is exposed to a relatively bright light source to effect substantially complete discharge of any residual electrostatic charge remaining thereon.

The above processing stations with the exception of the exposure station are already known and are described more fully, for example, in U.S. Pat. No. 3,078,770 to Hunt et al.

The exposure apparatus of the instant invention is adapted for incorporation in any suitable projecting system. Typically a scanning or projection system designed to project a flowing image onto the surface of the moving recording member from microfilm as individual frames mounted in suitable apertured cards is disclosed in copending application Ser. No. 730,459 filed on May 20, 1968 in the names of Balbierer and Hynes. Specifically the optical scanning or projection system includes a projector 22 having a movable carriage 23 for transporting a microfilm card 24 in light projecting relation to the moving light sensitive recording surface. Uniform lighting of microfilm card 24 is provided by means of a projection lamp LMP-1. The optical system includes an image mirror 28 mounted in a light shield frame 29. The microfilm card supported by a movable carriage of the projector is arranged for movement in a path to transverse the optical path in reverse direction whereby the film is scanned in timed relation to the movement of a recording surface to project a light image corresponding to the film onto the surface.

Referring now to FIGS. 2-5 and the instant invention, exposure of the drum surface to a radiation image is controlled by exposure apparatus 10 which provides two kinds of slit openings each having exposure characteristics compatible with the type of image to be reproduced as will become more apparent. In accordance with the present invention, the exposure apparatus is capable of introducing two kinds of slit openings one of which is for producing line copies and another which is for tonal patterns. Exposure apparatus 10 comprises a pair of slit control arms 41, 43 extending across the width of the drum and are each secured at the ends thereof by support pin 45 which is received in a support bracket 47 mounted on frame 29. It will be appreciated that the spacing between slit control arms 41 and 43 define an exposure slit within the light shield frame which slit is vertically adjustable relative to the frame by means of adjusting screws 49 which are received in support brackets 47 through elongated slots 50. Slit control arm 43 is formed with an extension 51 at the lower portion thereof which serves to support a plate 53 made of glass or the like which is provided with parallel opaque lines preferably about 50 lines to about 300 lines per inch thereby forming a screen. The opaque lines and the spacings between the opaque lines preferably being of equal width to provide a 50-50 ratio of clear and opaque areas. The opaque lines may be formed by ruling or photographically. Screen 53 is secured firmly to the extension 51 by means of guides 55, 57 the spacing between

which forms still another slit opening in addition to the slit opening defined between control arms 41 and 43.

To enable precise optical alignment of the slits defined by the control arms 41, 43 with the center line of the optical path, a space control and centering pin 61 mounted on a bracket 75 pivotable on support pin 45 is positioned between the control arms which are restrained against the pin 61 by means of a spring 65 connected to the arms. To enable adjustments of the space control and centering pins 61 relative to the optical path, bracket 63 is secured to the frame by means of adjusting screws 67 through elongated slots 69 formed in the bracket. In this manner, precise alignment of the optical center line is maintained at all times for the slit formed by control arms 41, 43.

When the slit control arms 41, 43 are in the optical position, as shown in FIG. 3, a line image will be formed and a developing material or toner will develop narrow lines and printed or typed characters, since this is where the electric fields are the highest and the lines of force most concentrated. On the other hand, large solid areas will not be produced as solid areas of toner but rather the toner will deposit heavily along the edges of these areas and very little or none will deposit in the centers which would be desirable in the solid area images or continuous tone images. In order to overcome this problem, a second slit containing screen 53 is moved into the optical path and the slit formed by arms 41, 43 is removed therefrom. This results in electrostatic images after exposure being subdivided into a line half tone pattern which can now be adequately developed by the development material to form solid area and continuous tone images since the screen breaks up the exposed areas into alternate lines of charge and no charge.

To accomplish this alternate mode of operation, a cam 71 which is pivotally mounted onto a cam shaft 72 by means of a clamping screw 74 is pivoted into abutting contact with a mounting bracket 75 thereby urging the mounting bracket and space control and centering pin 61 out of the optical path against the action of a spring 76 which tends to hold the bracket in a fixed optical position. By this arrangement slit control arms 41, 43 are pivoted about their support pins 45 and a slit containing screen 53 is moved into optical position. Cam shaft 72 is turned a predetermined arc by means of an actuating solenoid SOL-1 which receives an actuating signal from a control circuit 80 (see FIG. 1) as by turning a dial 81 which would indicate a position corresponding to that of the exposure slit. By rotating dial 81, the position of the slit can be varied from line copy to half tone and solid area images by the machine operator from the front of the machine. When the solenoid SOL-1 is deenergized as by movement of the dial, the actuating magnet of the solenoid will drop to its lower position thereby turning cam shaft 72 and hence cam 71 out of the path of the mounting bracket 75 allowing slit control arms 41, 43 to return to their original position due to the action of spring 76.

It is often desirable that the exposure time be selectively controlled in electrostatic recording machines. This is particularly desirable in the production of line copy prints where high speed recording machines are greatly in demand. As a consequence of this, it is possible with the present invention to change the exposure slit opening of the slit formed by control arms 41, 43 to obtain still a second exposure time. This is accomplished by camming members 85 mounted on brackets 63 which members are moved upward and downward into contact with pins 87 and 89 formed on slit control arms 41, 43 respectively. To move the camming member 85 in an upward direction mounting brackets 63 are connected to a rod 91 which in turn is secured to an actuator solenoid SOL-2 which receives discrete electrical signals from control circuit 80 in any suitable manner as by movement of the dial 81 to a set position. Rod 91 extends along the length of the slit opening and has pins 92 which are received in elongated slots 93 of bracket 94 secured to the frame 29. Upon receipt of a signal, SOL-2 is actuated pulling rod 91 upwardly with pins 92 riding in slots 93. As a result camming members 85 urge pins 87 and

89 outwardly against the action of spring 65 thereby widening the slit opening. When the solenoid SOL-2 is deenergized, rod 91 and hence pins 92 drop to their lowermost position as determined by the lowest portion of the slots 93 thereby moving camming members 85 out of contact with pins 87 and 89 on the slit control arms 41 and 43 thereby allowing the control arms to be drawn into their normal close position determined by the space control and centering pins 61 due to the action of spring 65.

Above is described an invention which enables reproducing line copy of very high quality or alternatively continuous tone and solid area images in a fully automatic continuous recording machine. In the past, this dual mode of operation could only be carried out by opening a light tight machine to insert or withdraw a screen member from the optical path which was unduly burdensome and awkward, or, alternatively, by a complicated optical system with a plurality of imaging stations which detracted from the overall quality of print produced. In accordance with the present invention, high quality copies of these different image types are produced simply and automatically by the simple turning of a knob by the machine operator. Moreover, it is also possible to vary the opening of the exposure slit to obtain different exposure time on a moving recording member in the same unitary exposure mechanism. Hence, various exposure conditions may be obtained in a single machine at the option of a machine operator. It can readily be appreciated that a machine using an exposure mechanism such as this is greatly desirable in the high speed automatic copying field.

While the instant invention has been described with reference to the structures disclosed herein, it is not confined to the specific details set forth, and this application is intended to cover such modifications or changes as may come within the scope of the following claims.

I claim:

1. In an automatic continuous electrostatic recording apparatus of the type wherein a photoreceptor member is mounted for movement past a plurality of processing stations including a charging station at which a uniform electrostatic charge is placed onto the surface of the photoreceptor member, an exposure station at which an image of graphic information is optically projected in flowing sequence onto the charged surface to form a latent electrostatic image thereon, and a development station at which the latent electrostatic image is developed by electroscopic toner material, an improved exposure mechanism for reproducing either line or varying tone images comprising:

optical scanning means for projecting a flowing image of graphic information along an optical path onto the surface of a photoreceptor member adapted for movement in timed relation therewith;

slit means disposed in the optical path including a first slit defining portion and a second slit defining portion, said first slit defining portion being open and said second slit defining portion having a semitransparent plate containing substantially parallel opaque lines thereon and substantially parallel transparent lines between said opaque lines with the spacing between said opaque lines being substantially equal;

said slit defining portions being movably mounted in close proximity to said photoreceptor surface to move from a first position with said first slit defining portion in the optical path to a second position with said second slit defining portion in the optical path whereby each slit defining portion can be moved into and out of said optical path in response to discrete electrical signals; and

circuit means to emit discrete electrical signals to position one of said slit defining portions in the optical path according to whether line or varying tone type images are to be reproduced.

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2. Apparatus according to claim 1 wherein said slit means includes means to move said slit defining portions along in parallel relation and at right angles to the optical path.

3. In an automatic continuous electrostatic recording apparatus of the type wherein a photoreceptor member is mounted for movement past a plurality of processing stations including a charging station at which a uniform electrostatic charge is placed onto the surface of the photoreceptor member, an exposure station at which an image of graphic information is optically projected in flowing sequence onto the charged surface to form a latent electrostatic image thereon, and a development station at which the latent electrostatic image is developed by electroscopic toner material, an improved exposure mechanism for reproducing either line or varying tone images comprising:

optical scanning means for projecting a flowing image of graphic information along an optical path onto the surface of a photoreceptor member adapted for movement in timed relation therewith;

slit means disposed in the optical path including a first slit defining portion and a second slit defining portion, said first slit defining portion being open and said second slit defining portion having a semitransparent plate containing substantially parallel opaque lines thereon and substantially parallel transparent lines between said opaque lines with the spacing between said opaque lines being substantially equal;

said slit defining portions being movably mounted in close proximity to said photoreceptor surface whereby each slit defining portion can be moved into and out of said optical path in response to discrete electrical signals; and

circuit means to emit discrete electrical signals to position one of said slit defining portions in the optical path according to whether line or varying tone type images are to be reproduced, wherein said first slit defining portion is formed with a pair of gates movable toward and away from the optical centerline to form a variable width exposure slit, and means to move said gates toward and away from the optical centerline to render different time exposures of said photoreceptor member.

4. Apparatus according to claim 3 wherein said slit means includes optical space control and centering means to maintain a uniform spacing between said gates and a predetermined relationship between said gates and the optical centerline.

5. Exposure apparatus comprising:

optical scanning means for projecting a flowing image of graphic information along an optical path onto the surface of a photoreceptor member adapted for movement in timed relation therewith;

slit means disposed in the optical path including a first slit defining portion and a second slit defining portion, said first slit defining portion being open and said second slit defining portion having a semitransparent plate containing substantially parallel opaque lines thereon and substantially parallel transparent lines between said opaque lines with the spacing between said opaque lines being substantially equal;

said slit defining portions being movably mounted in closed proximity to said photoreceptor surface to move from a first position with said first slit defining portion in the optical path to a second position with said second slit defining portion in the optical path whereby each slit defining portion can be moved into and out of said optical path in response to discrete electrical signals; and

circuit means to emit discrete electrical signals to position one of said slit defining portions in the optical path according to whether line or varying tone type images are to be reproduced.