

June 27, 1972

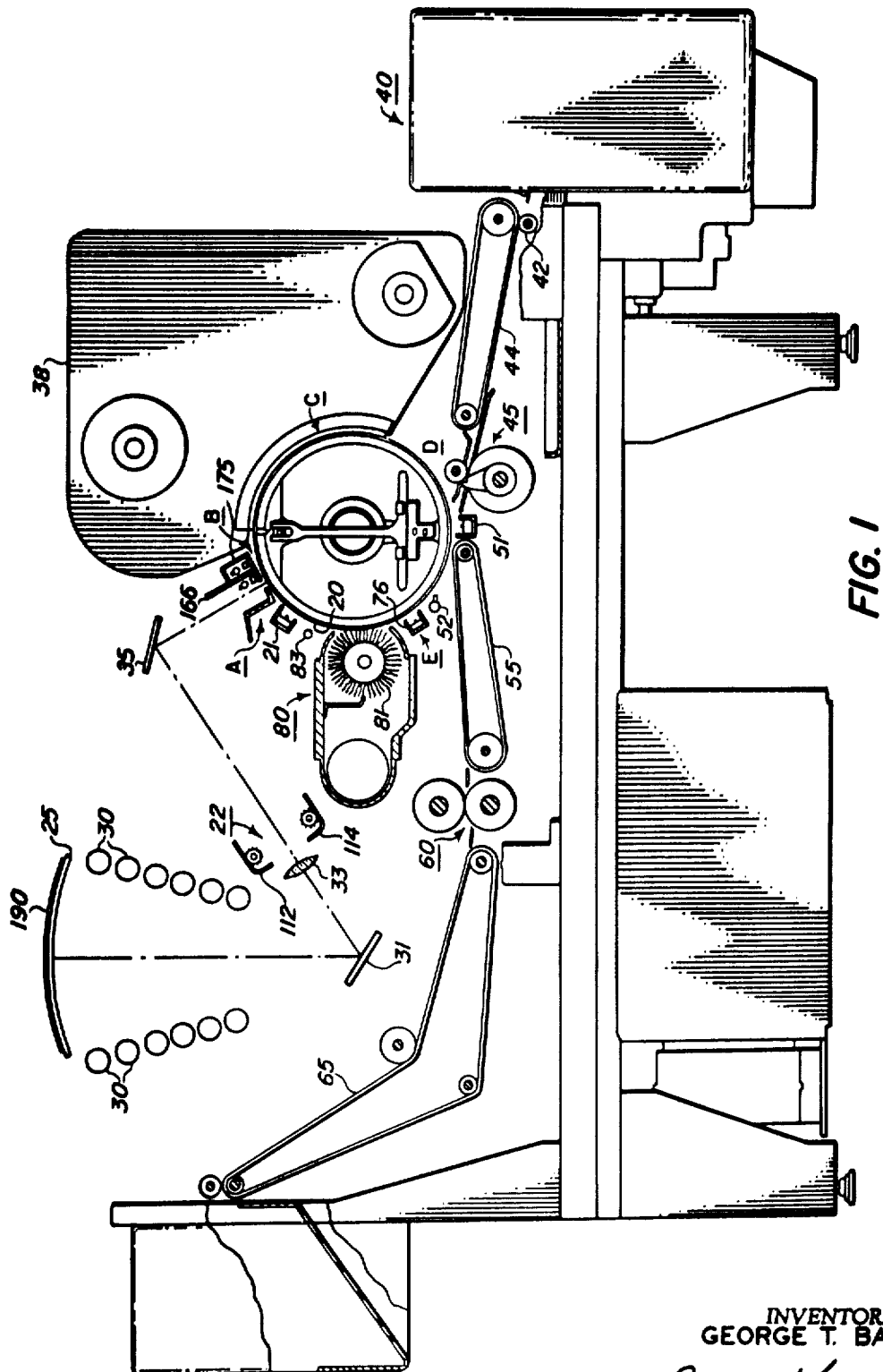
G. T. BAUER

3,672,759

ILLUMINATION CONTROL SYSTEM

Filed Nov. 17, 1970

4 Sheets-Sheet 1



INVENTOR
GEORGE T. BAUER

BY

Irving Keshner

ATTORNEY

June 27, 1972

G. T. BAUER

3,672,759

ILLUMINATION CONTROL SYSTEM

Filed Nov. 17, 1970

4 Sheets-Sheet 2

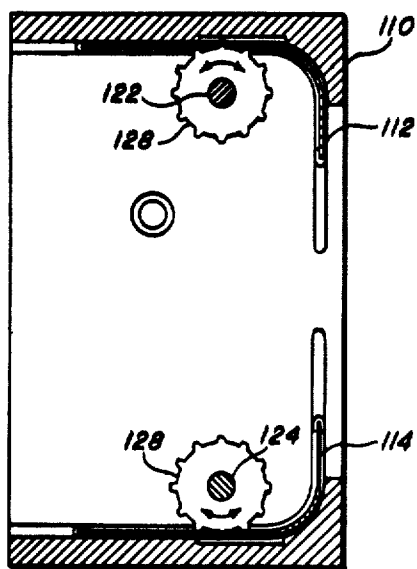


FIG. 4

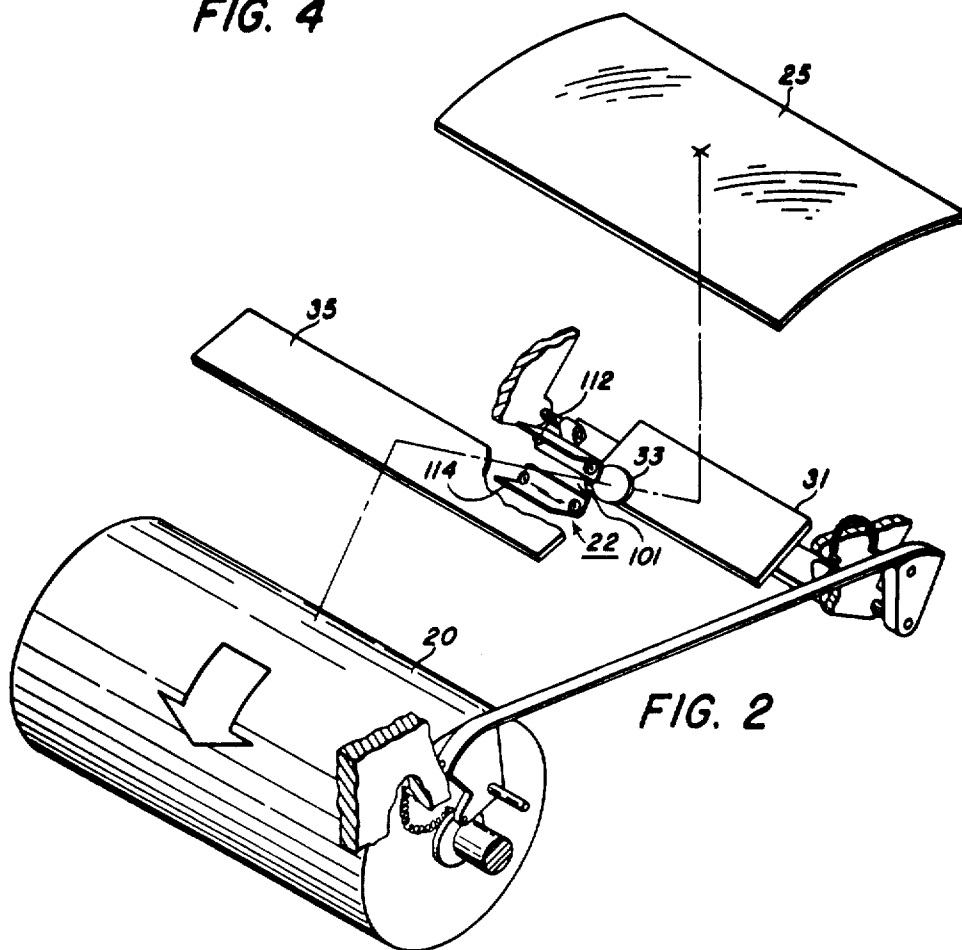


FIG. 2

June 27, 1972

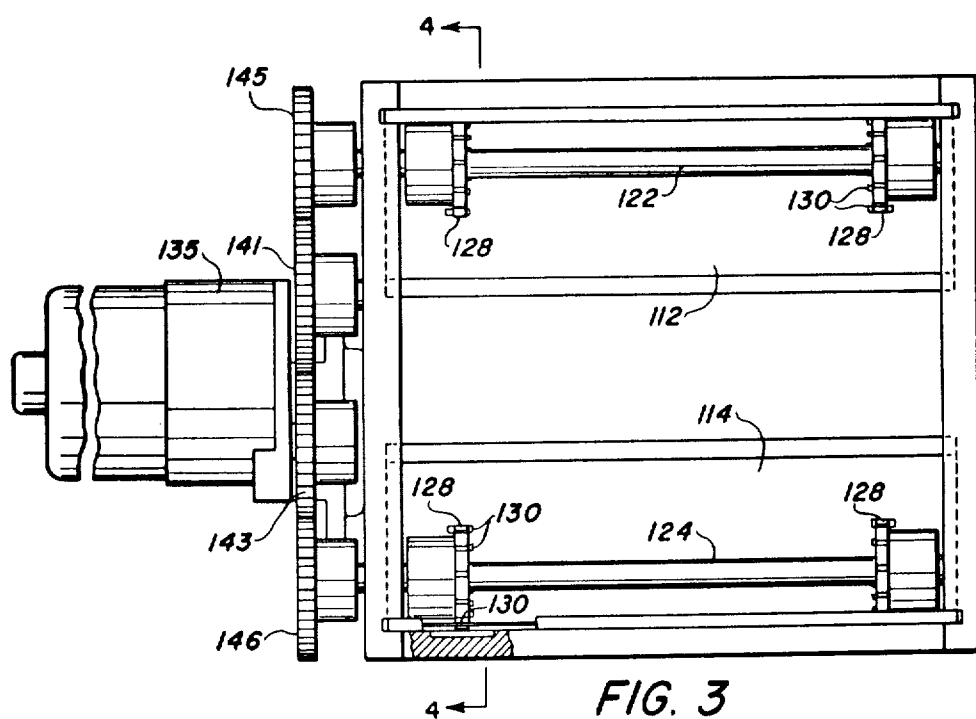
G. T. BAUER

3,672,759

ILLUMINATION CONTROL SYSTEM

Filed Nov 17, 1970

4 Sheets-Sheet 3



June 27, 1972

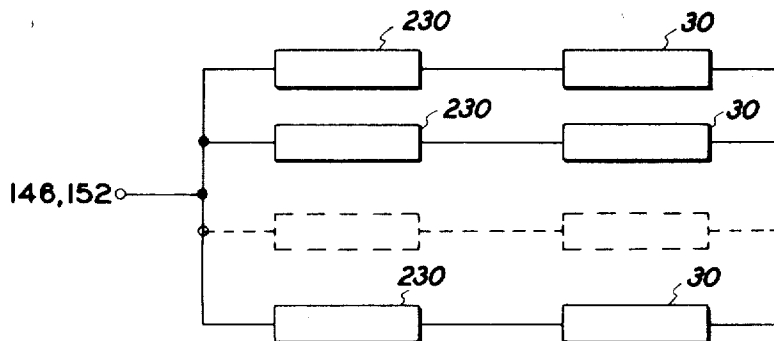
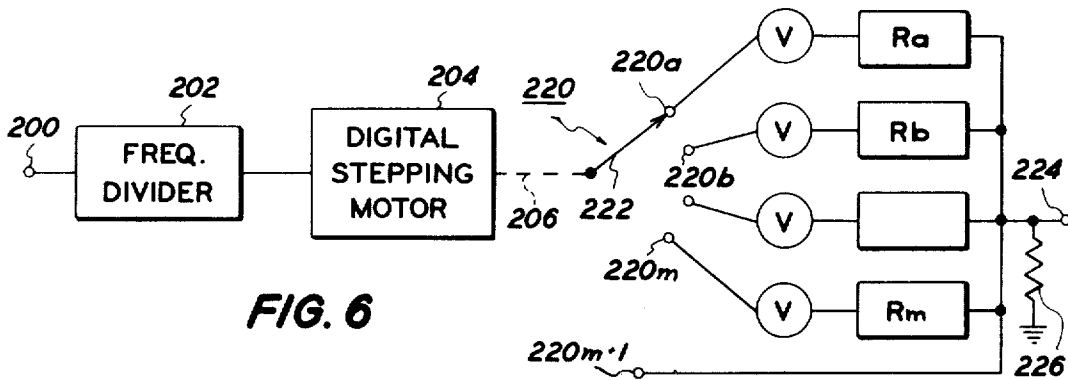
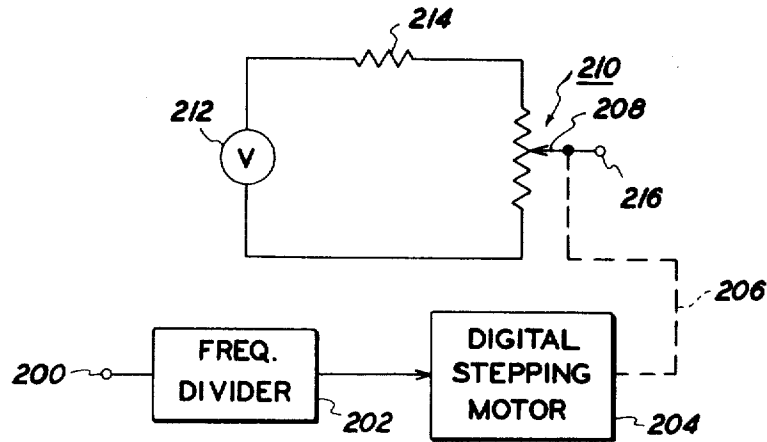
G. T. BAUER

3,672,759

ILLUMINATION CONTROL SYSTEM

Filed Nov. 17, 1970

4 Sheets-Sheet 4



1

3,672,759

ILLUMINATION CONTROL SYSTEM

George T. Bauer, Fairport, N.Y., assignor to Xerox Corporation, Stamford, Conn.

Filed Nov. 17, 1970, Ser. No. 90,309

Int. Cl. G03g 15/00; G03b 27/78

U.S. Cl. 355—3

8 Claims

ABSTRACT OF THE DISCLOSURE

An illumination control system which compensates for gradual dimming or deterioration of exposure lamps in a photocopying machine. The accumulated number of reproductions made by the reproducing machine controls the current output of a variable current generator, which in turn controls the illumination projected onto the photoconductive surface in one of two ways. In the first embodiment, the current output controls an aperture slit mechanism positioned between the source of illumination and the photoconductive surface, widening the slit as the accumulated number of copies increases. In the second embodiment, the current output is coupled directly to the source of illumination, thereby controlling the amount of illumination it generates.

BACKGROUND OF THE INVENTION

In the practice of xerography, as described for example in U.S. Pat. No. 2,297,691 to Chester F. Carlson, a xerographic 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 xerographic plate is electrostatically charged uniformly over its surface 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 powder. The powder is held in image areas by the electrostatic charge on the layer. Where the charge is greatest, the greatest amount of material is deposited; and where the charge 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 thereto to form a permanent print.

It can be readily appreciated that the quality of the print is, in the large part, dependent on the exposure of the charged xerographic plate to the radiation image. The largest single factor effecting exposure latitude, i.e., range of illumination intensity, is the efficiency of the developer system. In other words if the developer system is highly sensitive so as to develop background or image portions as "grey" areas when in reality these are white, then illumination control must be commensurately sensitive to provide the proper exposure of the charged xerographic surface. With modern day improvements to xerographic developer systems, such as, an electrically biased backing electrode to enhance solid area development, the desirability of maintaining proper illumination becomes increasingly apparent.

A uniformly high level of illumination as required for exacting exposure is complicated by many factors. For example, variation in lamp output due to lamp aging or deterioration is sufficient to cause development of white

2

areas thereby detracting from the overall quality of the print.

It has been determined that deterioration of aperture lamps is dependent on properties of their phosphor coating. The deterioration characteristics of aperture lamps having the same type of phosphor coating do not differ significantly. The deterioration of certain types of aperture lamps can be as much as 40% after approximately 1000 hours of use. Such a large change in illumination level cannot be tolerated in most copying systems. The aperture lamps are generally replaced after a time period much earlier than the 1,000 hour deterioration period mentioned hereinabove.

Prior art techniques for compensating for variation in lamp output generally utilize photosensitive devices, such as photocells, which essentially measures lamp output and adjusts various machine parameters to compensate for the variation in lamp output. However, utilizing photocells for detecting lamp output has certain disadvantages associated therewith. For example the output of the photocells are not as accurate as desired and, in addition, the characteristics of one photocell may vary with age. Further, the characteristics of one photocells may vary considerably from another photocell.

SUMMARY OF THE INVENTION

The present invention provides a technique for automatically maintaining the illumination output of an exposure aperture lamp in a reproducing machine at a desired level. In particular, the reproducing machine generates pulses which correspond to the number of reproductions being made. The pulses are coupled to a variable current generating means which generates a current output which is proportional to the number of generated pulses. The current output is coupled to a slit aperture mechanism in one embodiment, the slit aperture width being adjusted in accordance with the current input thereto. In the second embodiment, the current output is coupled directly to the exposure aperture lamps, the lamp current increasing in proportion to the number of reproductions being made.

It is an object of the invention to maintain the illumination level in reproducing machines substantially constant.

It is a further object of the present invention to automatically maintain the illumination level in reproducing machines substantially constant.

It is still a further object of the present invention to automatically maintain the illumination level in reproducing machines substantially constant without a significant increase in cost or modification of the reproducing machines.

It is a further object of the present invention to maintain the illumination level in reproducing machines substantially constant wherein the reproducing machine produces pulses corresponding to the number of reproductions being made. A current is produced which is proportional to the number of pulses produced, the current, in one embodiment, controlling a slit aperture mechanism, and in the other embodiment, being directly coupled to the exposure lamps.

DESCRIPTION OF THE DRAWING

For a better understanding of the invention reference is now had to the following detailed description to the invention to be read in connection with the accompanying drawings; wherein:

FIG. 1 illustrates schematically a xerographic recording apparatus having a line scan type optical system with illumination control according to one embodiment of the present invention;

3

4

FIG. 2 is an isometric view of the optical system;
FIG. 3 is a side elevational view of the slit aperture mechanism;

FIG. 4 is a cross-sectional view of the slit aperture mechanism taken along lines 4—4 of FIG. 3;

FIG. 5 and FIG. 6 are two circuits for producing a current output which is proportional to the number of reproductions being made; and

FIG. 7 is a schematic diagram of the second embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1 there is shown schematically a high speed automatic xerographic reproduction machine incorporating optical scanning apparatus which includes automatic illumination control according to one embodiment of the present invention whereby high quality reproduction is accomplished.

The automatic xerographic reproducing apparatus comprises a xerographic plate 20 including a photoconductive layer on a conductive backing and formed in the shape of a drum, which is mounted on a shaft journaled in a frame to rotate in the direction indicated by the arrow to cause the drum surface sequentially to pass a plurality of xerographic processing stations.

For the purpose of the present disclosure, the several xerographic processing stations in the path of movement of the drum surface may be described functionally, as follows:

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

An exposure station which a light or radiation pattern of copy to be reproduced is projected onto the drum surface to dissipate the drum charge in the exposed areas thereof and thereby form a latent electrostatic image of the copy to be reproduced;

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

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

A drum cleaning and discharge station 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 charging station is preferably located as indicated by reference character A. As shown, the charging arrangement includes a corona charging device 21 which includes a corona discharge array of one or more corona discharge electrodes that extend transversely across the drum surface and are energized from a high potential source and are substantially closed within a shielding member.

Next subsequent thereto in the path of motion of the xerographic drum is an exposure station B. In accordance with one embodiment of the present invention, illumination control, to be described more fully hereinafter, is accomplished by selectively opening and closing an aperture slit mechanism 22 positioned in the path of a flowing image projected from a stationary original onto the surface of drum 20.

The optical scanning or projection assembly comprises a stationary copyboard which consists of a transparent curved platen member 25 such as for example, a glass plate or the like, positioned on the exterior of the cabinet, which is adapted to support a document to be repro-

duced, the document being uniformly illuminated and arranged in light projecting relation to the moving light-receiving surface of the xerographic drum. Uniform lighting is provided by a plurality of aperture lamps 30 arranged on opposite sides of the copyboard. Scanning of the document on the stationary copyboard is accomplished by means of a mirror assembly which is relative to the copyboard in timed relation to the movement of the xerographic drum.

The mirror assembly, which includes an object mirror 31, is mounted below the copyholder to reflect an image of the document through a spherical lens 33 onto an image mirror 35 which, in turn, reflects the image onto the xerographic drum.

Adjacent to the exposure station is a development station C in which there is positioned a developer apparatus 38 including a casing or housing having a lower or sump portion for accumulating developer material. A bucket conveyor (not shown) is used to carry the developing material to the upper part of the developer housing where it is cascaded over a hopper chute onto the xerographic drum to effect development.

Positioned next and adjacent to the developing station is the image transfer station D which includes a sheet feeding arrangement adapted to feed sheets of support material, such as paper or the like, successively to the xerographic drum in coordination with the presentation of the developed image on the drum surface at the transfer station.

The sheet feeding mechanism includes a sheet feed device 40 adapted by means of vacuum feeders to feed the top sheet, of a stack of sheets to roller 42 cooperating with the belts of paper transport 44 for advancing the sheet sufficiently to be held by paper transport 44 which in turn, conveys the sheet to a sheet registration device 45 positioned adjacent to the xerographic drum. The sheet registration device arrests and aligns each individual sheet of material and then in timed relation to the movement of the xerographic drum, advances the sheet material into contact with the xerographic drum in registration with a previously formed xerographic powder image on the drum.

The transfer of the xerographic powder image from the drum surface to the sheets of support material is effected by means of a corona transfer device 51 that is located at or immediately after the line of contact between the support material and the rotating drum. In operation, the electrostatic field created by the corona transfer device is effective to tack the support material electrostatically to the drum surface, whereby the support material move synchronously with the drum while in contact therewith. Simultaneously with the tacking action, the electrostatic field is effective to attract the toner particles comprising the xerographic powder image from the drum surface and cause them to adhere electrostatically to the surface of the support material.

Immediately subsequent to the image transfer station, there is positioned a stripping apparatus to paper pick-off mechanism 52 for removing the sheets of support material from the drum surface. This device, which is of the type disclosed in Rutkus et al. U.S. Pat. 3,062,536, includes a plurality of small diameter orifices supplied with pressurized aeriform fluid by a suitable pulsator or other device. The pulsator is adapted to force jets of pressurized aeriform fluid through the outlet orifices into contact with the surface of the xerographic drum slightly in advance of the sheet of support material to strip the leading edge of the sheet from the drum surface and to direct it onto an endless conveyor 55 whereby the sheet material is carried to a fixing device 60. At the fixing device, the transferred xerographic powder image on the sheet of support material is permanently fixed or fused thereto as by heat. After fusing, the reproduction is discharged from the apparatus at a suitable point for collection externally of the apparatus by means of the conveyor 65.

5

The next and final station in the device is a drum cleaning station E, having positioned therein a corona preclean device 76, a drum cleaning device 80 adapted to remove any powder remaining on the xerographic drum after transfer by means of a rotating brush 81, and a discharge lamp 83 adapted to flood the xerographic drum with light to cause dissipation of any residual electrical charge remaining on the xerographic drum.

It is believed that the foregoing description is sufficient for purpose of the present invention to show the general operation of a xerographic reproducing apparatus.

Referring now to FIGS. 2-4, there is illustrated in greater detail the automatic illumination control system according to one embodiment of the present invention. The intensity of illumination is regulated by the opening in slit aperture mechanism 22 interposed in the optical path adjacent the lens as best shown in FIG. 2. The illumination level at the surface of the drum is estimated by detecting the number of reproductions being made, which is proportional to the aging or deterioration of aperture lamps 30, generating an electrical signal which is proportional to the number of reproductions being made and feeding back the signal to the slit aperture mechanism to compensate for lamp deterioration.

Slit aperture mechanism 22 is positioned so that elongated slit opening 101 has its longitudinal axis transverse to the direction of scan. By this arrangement tangential light rays pass parallel to the slit opening 101 while sagittal light rays pass normal to it. It should be noted that slit aperture mechanism 22 may be located on either the image side of lens 33 as illustrated or on the object side so long as the slit opening is closely spaced to the lens so as not to deleteriously affect the quality of the image.

Slit aperture mechanism 22 has a variable slit in a direction normal to the optical path to thereby increase or decrease the illumination received at the drum and comprises a housing 110 in which flexible wall members 112 and 114 are arranged so as to be movably slidable therein. Wall members 112 and 114 are impervious to light and made from any suitable material, such as Mylar dyed black. Rotatably journaled in the sides of housing 110 are a pair of shafts 122 and 124. On each end of shafts 122 and 124 are mounted sprocket members 128 which engage apertures 130 formed in wall members 112 and 114.

To move the flexible wall members in unison there is provided motor 135 which drivingly engages counter-rotating spur gears 141 and 143 which in turn drive gears 145 and 146 mounted on the ends of drive shafts 122 and 124, respectively. Motor 135 is caused to run in the forward direction when a positive signal is applied across its input terminals, thereby increasing the illumination projected on the surface of the drum.

Referring now to FIG. 5, there is shown a schematic diagram of a variable current generating means which may be utilized in the present invention. A switching device located within the reproducing machine produces output pulses corresponding to the number of reproductions being made. Such switching devices are disclosed, for example, in U.S. Pat. No. 3,301,126. The pulse output of the reproducing machine, corresponding to the number of reproductions being made, is applied to terminal 200 which is connected to the input of frequency divider 202. The stepdown ratio of frequency divider 202 may be adjusted to any value. As set forth hereinabove, the deterioration of aperture lamps is determined by the properties of their phosphor coating. The deterioration characteristics of lamps having the same type of phosphor coating do not differ significantly. The deterioration of the lamps can be as much as 40% after 1000 hours of use. For normal tolerance limits, the number of reproductions being made can be related to the number of hours the aperture lamps are being used, and consequently, with the deterioration of the lamps. The stepdown ratio of frequency divider 202 is chosen, for example, at 200 so that an output pulse is produced for every 200 input pulses. The output of

6

frequency divider 202 is applied to digital stepping motor 204, its output shaft 206 rotating a discrete angle. A model TS25 motor manufactured by the Superior Electric Company, Bristol, Conn., may be utilized as stepping motor 204. When the electrical pulses are removed from the input of digital stepping motor 204 and then reapplied, the output shaft 206 will rotate to a second discrete angle. The output shaft 206 drives tap 208 of potentiometer 210. A source of potential 212 is applied across the potentiometer terminals via resistor 214. The output potential appearing at terminal 216 is dependent on the position of tap 208 which in turn is positioned by output shaft 206. The output at terminal 216 is connected to the input of motor 135. As the output at terminal 212 increases, motor 135 runs forward driving wall members 112 and 114 further apart to increase the illumination to the drum.

Referring now to FIG. 6 there is shown a schematic diagram of another variable current generating means which may be utilized in the present invention. Elements 202 and 204 perform the same function as that described with reference to FIG. 5. However, output shaft 206 now drives rotary switch 220. Tap arm 222 of switch 220 is driven from switch terminal 220a through to switch terminal 220_{m+1} as shaft 206 is caused to rotate. The terminals 220a . . . 220_{m+1} are coupled to output terminal 224 via voltage sources V and resistors R_a, R_b, . . . R_m, the value of the resistors being chosen so that R_a, R_b, . . . R_m. The voltage appearing across terminal 224 is then coupled to motor 135. Since the value of the resistance in the path connecting tap arm 222 to terminal 224 decreases as tap 222 is driven from terminal 220a to terminal 220_{m+1}, it can be seen that the voltage appearing across output resistor 226 correspondingly increases in value. Therefore, motor 135 is caused to drive the wall members 112 and 114 further apart to increase the illumination on the drum.

In a second embodiment, the output from the variable current generating means shown in FIGS. 5 and 6 is applied to aperture lamps 30 as shown in FIG. 7. The voltage appearing at the output terminals 212 (FIG. 5) or 224 (FIG. 6) is applied to the plurality of lamps 30 via ballast 230, the ballast 230 comprising a non-ohmic, energy retaining impedance to prevent large lamp currents. The illumination output of lamps 30 proportional to the current applied thereto, therefore corresponds to the number of reproductions being made. This follows since, as set forth hereinabove, the output of the variable current generating means corresponds to the number of reproductions being made.

While the invention has been described with reference to its preferred embodiments, 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 or material to the teachings of the invention without departing from its essential teachings. What is claimed is:

1. A reproducing machine wherein a document to be reproduced is projected onto a photoreceptor moved past an exposure station characterized by an illumination control system comprising in combination:

- support means located at the object plane to position a document to be reproduced,
- a source of illumination optically positioned to illuminate the document,
- a photoreceptor at the image plane to receive a pattern of light and shadow according to the document to be recorded,
- an optical system to project an image of the document onto said photoreceptor,
- light masking means interposed in the optical path between said source of illumination and said photoreceptor including a pair of spaced apart wall mem-

7

bers impervious to light adapted for movement transverse to the optical center line, drive means operative to position said wall members relative to said optical center line to control the intensity of illumination at the surface of said photoreceptor at a predetermined level in response to electrical signals, means responsive to the number of document reproductions for producing a mechanical motion corresponding to the number of said reproductions, and means operatively connected to the output of said producing means for generating an electrical signal of a magnitude directly proportional to said mechanical motion, said generating means being coupled to said drive means to actuate said drive means to move said wall members away from the optical center to maintain a predetermined level of illumination on the surface of said photoreceptor.

2. The reproducing machine as defined in claim 1 wherein said generating means comprises a plurality of impedance means each being coupled successively to a voltage source in accordance with the number of reproductions being made.

3. The reproducing machine as defined in claim 2 wherein the impedance value of each successively coupled impedance means is lower than the preceding coupled impedance means.

4. The reproducing machine as defined in claim 3 wherein said producing means comprises a digital stepping motor.

5. A reproducing machine wherein a document to be reproduced is projected in line scan fashion onto a photoreceptor moved past an exposure station characterized by an illumination control system comprising in combination:

support means located at the object plane to support a document to be reproduced, illumination means optically positioned to illuminate said document,

a photoreceptor at the image plane to receive a pattern

8

of light and shadow according to the document to be recorded,

means responsive to the number of document reproductions for producing a mechanical motion corresponding to the number of said reproductions,

means operatively coupled to the output of said producing means for generating an electrical signal of a magnitude proportional to said mechanical motion, and

means for coupling the output of said generating means to said illumination means to maintain a predetermined level of illumination on the surface of said photoreceptor.

6. The reproducing machine as defined in claim 5 wherein said generating means comprises a plurality of impedance means each being successively coupled to a voltage source in accordance with the number of reproductions being made.

7. The reproducing machine as defined in claim 6 wherein the impedance value of each successively coupled impedance means is lower than the preceding coupled impedance means.

8. The reproducing machine as defined in claim 7 wherein said producing means comprises a digital stepping motor.

References Cited

UNITED STATES PATENTS

2,078,080	4/1937	Kitroser	355—69
3,076,392	2/1963	Cerasani et al.	355—11
3,120,790	2/1964	Carlson et al.	355—3
3,438,704	4/1969	Schoen	355—8

JOHN M. HORAN, Primary Examiner

K. C. HUTCHISON, Assistant Examiner

U.S. Cl. X.R.

355—8, 69, 83

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,672,759 Dated June 27, 1972

Inventor(s) George T. Bauer

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 8, lines 11 and 12, delete "predetermined"
and insert --substantially constant--.

Signed and sealed this 17th day of October 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents