United States Patent [19]

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[54] **ILLUMINATION SYSTEM**

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Related U.S. Application Data

[63] Continuation of Ser. No. 157,754, June 28, 1971, abandoned, which is a continuation of Ser. No. 813,201, April 3, 1969, abandoned.

[52] **U.S. Cl.**..... **240/41.35 R,** 240/41.1, 240/41.3, 240/103, 355/70

[51] **Int. Cl.**..... **F21v 7/00,** G03b 27/54

[58] **Field of Search**..... 240/41.1, 41.3, 41.35, 240/103; 355/67, 68, 69, 70

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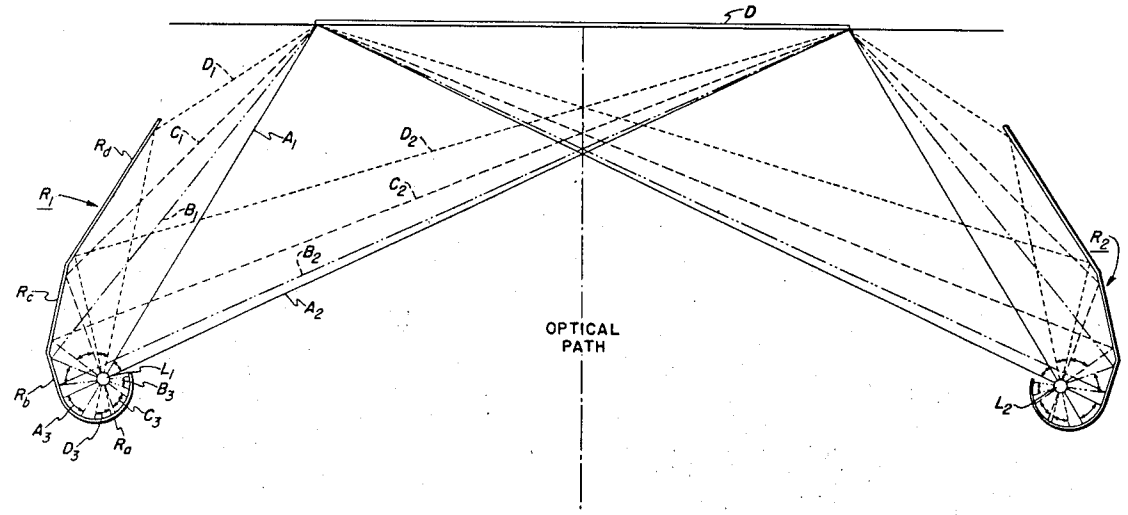
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[57] **ABSTRACT**

An illumination system having four lamps arranged orthogonally around a subject to be illuminated with each lamp positioned outside the corresponding adjacent edge of the subject. A reflector system having a cylindrical surface and a plurality of flat reflectors are associated with each of the lamps for directing light rays to the subject from the adjacent edge thereof to the edge opposite thereto.

13 Claims, 4 Drawing Figures



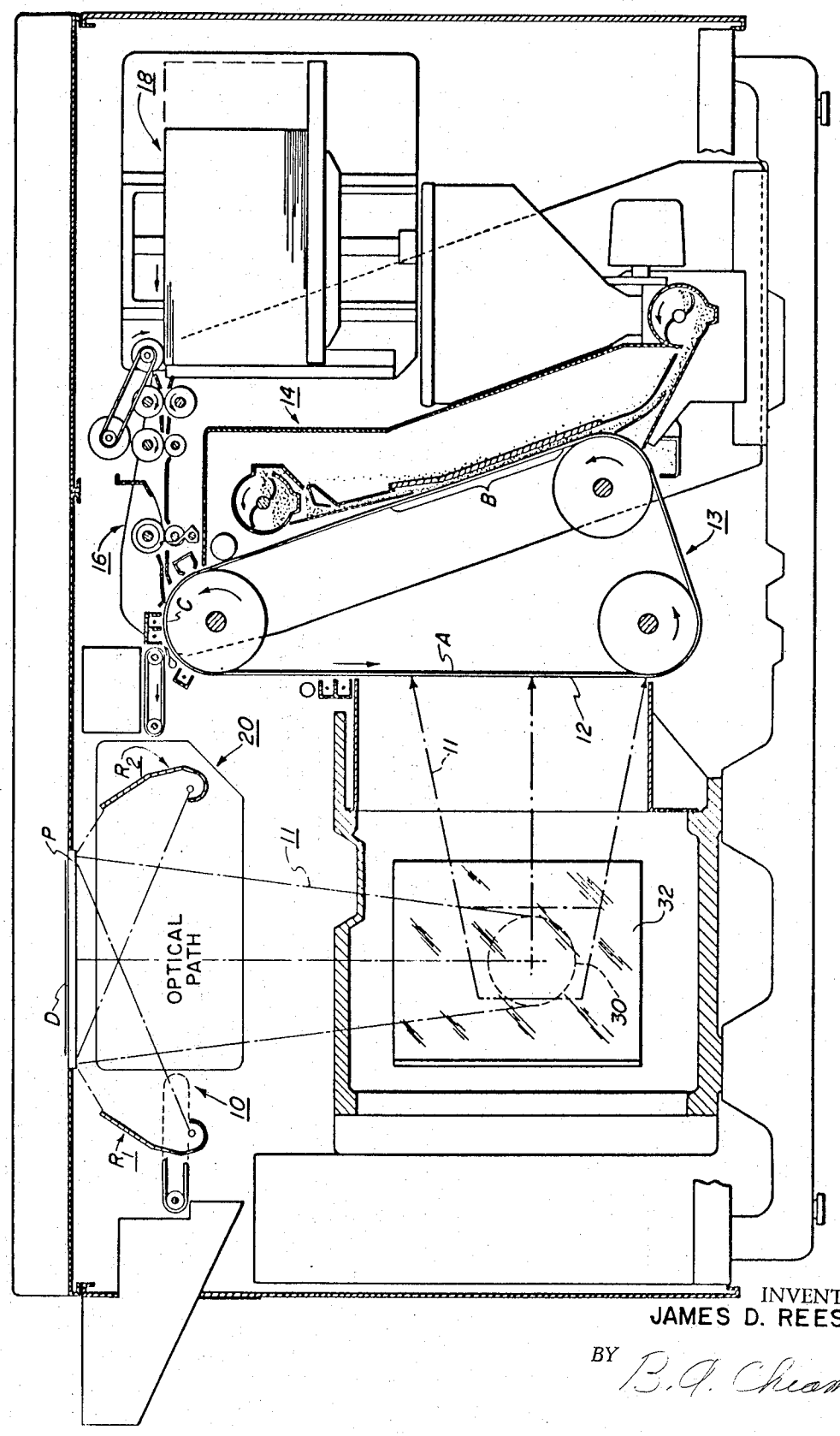


FIG. 1

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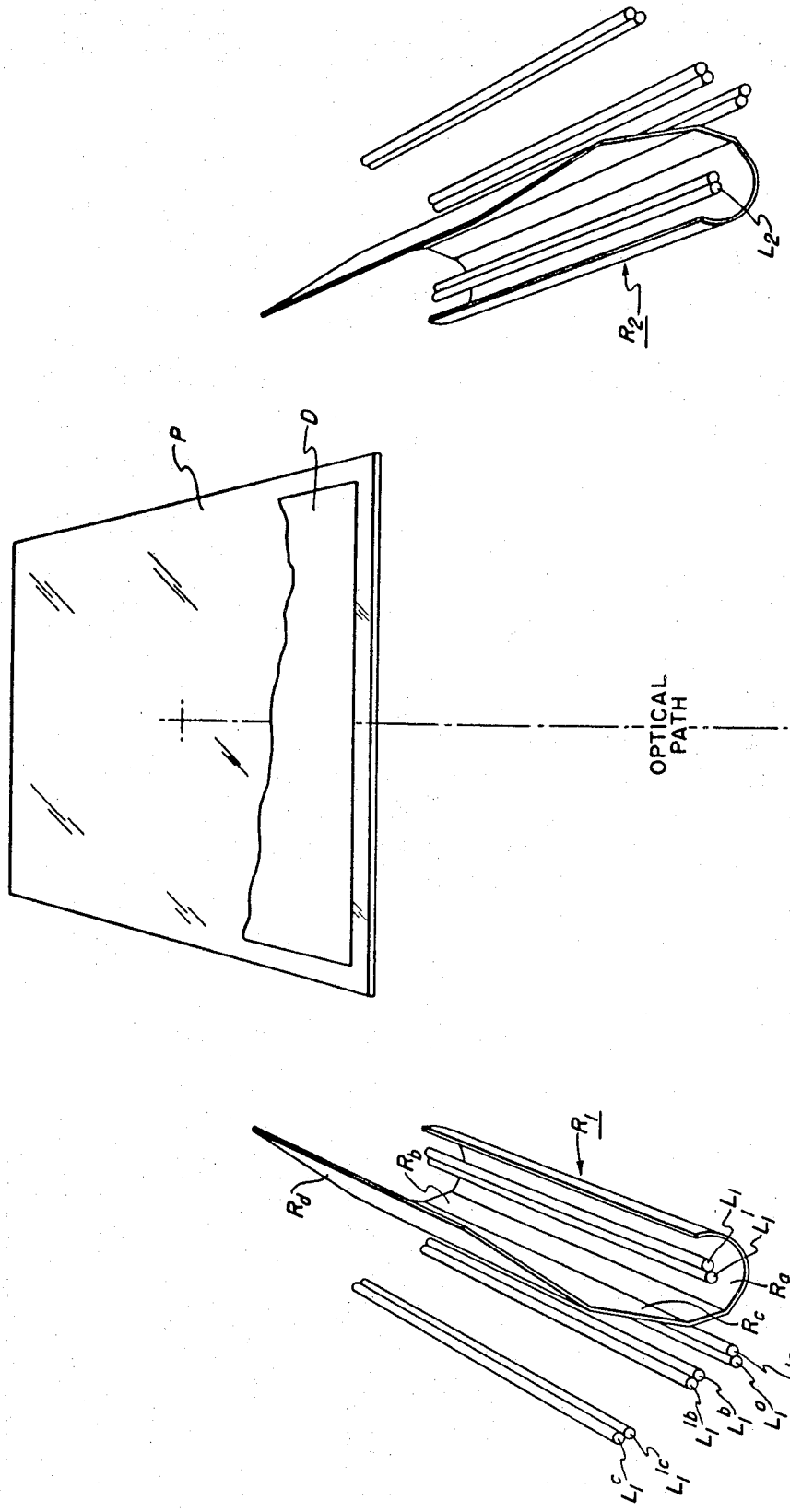


FIG. 2

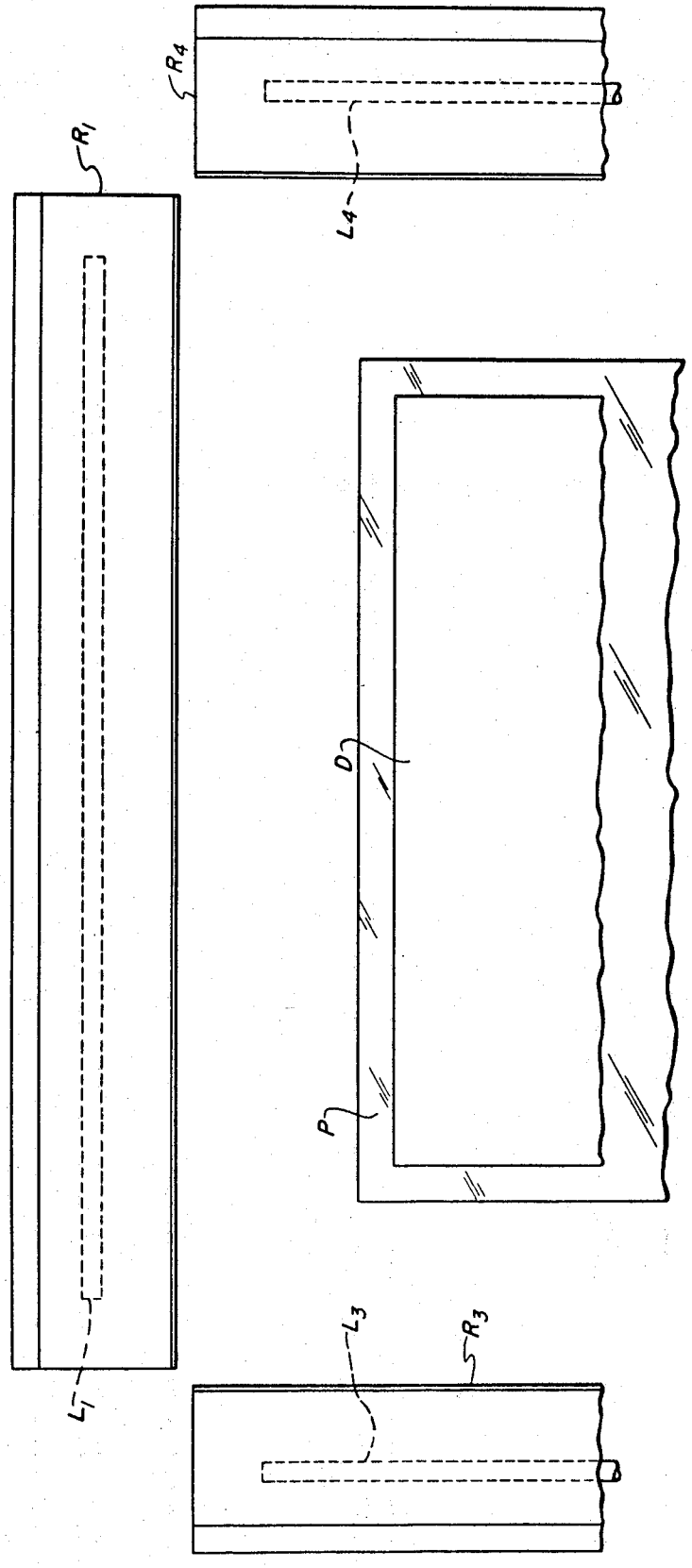


FIG. 3

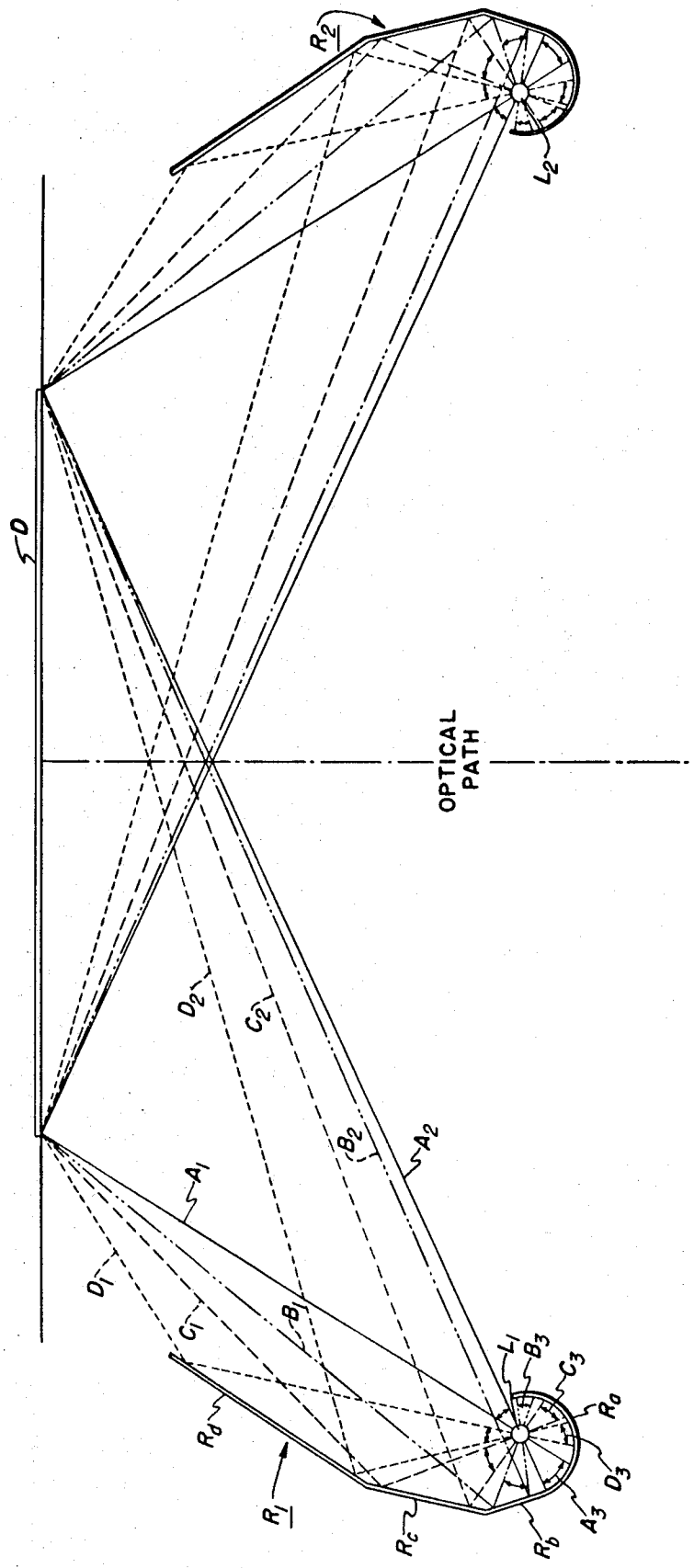

R2
L2
D
OPTICAL PATH
D2
C2
B2
A2
A1
D1
C1
B1
L1
B3
C3
Ro
D3
A3
Rb
Rc
R1
Rd

FIG. 4

ILLUMINATION SYSTEM

This is a continuation of application Ser. No. 157,754, filed June 28, 1971, which, in turn, is a continuation of application Ser. No. 813,201, filed Apr. 3, 1969, both now abandoned.

This invention relates to illumination systems, and particularly, to improvements in the arrangement of lamps and associated reflectors relative to a subject to be illuminated. The illumination system arranged in accordance with the present invention is particularly adapted for use with optical systems for illuminating originals to be reproduced in automatic copiers/duplicators that are adapted for high speed operation and capable of having its sequence timing varied thereby permitting variable speeds of output.

As is well known in recent years, the steadily increasing size of various industries has required an enormous increase in the amount of paper work that must be accomplished, maintained, and made available for wide interplant or department circulation. In the present day commercial automatic copier/reproduction machines, which are adapted to produce copies of between 5 and 60 8 × 11 inch sheets of copy per minute, the photoreceptor device is in the form of a drum which rotates in timed unison relative to a plurality of processing stations. The limiting feature in these present day machines is the use of the xerographic drum which seriously limits the positioning and action of each of the processing devices and, in particular, the requirement of presenting a flowing image upon the xerographic drum as a document is being scanned.

The mechanism which accomplishes the scan of a fixed document in the drum type copier/duplicator generally involves a slidable carriage for supporting illumination lamps in addition to drive mechanisms, levers, pulleys, switches, etc. for accomplishing scanning of the document. As the demands for faster copying or duplicating has come about, these conventional machines generally have been modified in their respective drive systems and electrical circuits in order to accomplish a faster scan for the scanning mechanisms already in the machine. The result of these modifications is to propel the structures that go to make up the scanning mechanisms at very great speeds and, as will be apparent, will place undue burden upon the structural supports of the machine and the scanning mechanism.

As a solution for overcoming the multitude of disadvantages for high speed copying, the latest machine concept for copiers utilizes flash exposure of a document and the arrangement of a moving photoconductor material in a flat condition at the instant of exposure. However, in order to overcome the loss of exposure time that these copiers usually demand the intensity of the illumination lamps, in order to accomplish adequate imaging, must be extremely high requiring specially designed lamps and overly large power sources.

It is therefore the principal object of this invention to improve illumination systems for effecting maximum capability of the lamps utilized therein, which system is capable for general copying applications and for making high speed copies in variable time sequences.

Another object of this invention is to improve illumination systems for flat objects wherein dark spots and light spots are substantially eliminated.

Another object of this invention is to improve illumination systems whereby light rays produced thereby when directed upon an object being illuminated is such as to effect homogeneous illumination at an image plane.

Another object of this invention is to improve illumination systems employing elongated lamps by arranging the same so as to achieve uniform illumination at maximum intensity and with a minimum of power requirements.

These and other objects of this invention are obtained by means of the orthogonal arrangement of a plurality of elongated light sources or lamps which are positioned outside the outer edges of a flat object being illuminated. The light rays from each of the lamps are directed on the adjacent edge of the object and extend across the object to the remote edge thereof thereby overlapping the light rays from the other lamps. In conjunction with each lamp there is provided a semicylindrical reflector and planar reflectors arranged edge to edge at different angles relative to each other and in position adjacent one edge of the semicylindrical reflector for directing different light rays therefrom for optimizing the projection of the light rays from each lamp to the object.

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 conjunction with the accompanying drawings, wherein:

FIG. **1** is a schematic sectional view of a typical reproduction machine showing the various electrostatic processing stations;

FIG. **2** is an isometric schematic view of a portion of the lamp assembly of an illumination system arranged in accordance with the present invention;

FIG. **3** is a partial top view of a portion of the lamp assembly and document platen; and

FIG. **4** is a sectional view of one side of the lamp assembly.

For a general understanding of the illustrated copier/reproduction machine, in which the invention may be incorporated, reference is had to FIG. **1** in which the various system components for the machine are schematically illustrated. As in all electrostatic systems such as a xerographic machine of the type illustrated, a light image of a document to be reproduced is projected onto the sensitized surface of a xerographic plate to form an electrostatic latent image thereon. Thereafter, the latent image is developed to form xerographic powder image, corresponding to the latent image on the plate surface. The powder image is then electrostatically transferred to a support surface to which it may be fused by a fushing device whereby the powder image is caused permanently to adhere to the support surface.

In the illustrated machine, an original D to be copied is placed upon a transparent support platen P fixedly arranged in an illumination lamp assembly **10** arranged at the left end of the machine as viewed in FIG. **1**. While upon the platen, an illumination system, to be described herein, flashes light rays upon the original thereby producing image rays corresponding to the informational areas on the original. The image rays, indicated by lines **11** are projected by means of an optical system for exposing the photosensitive surface of a xerographic plate at the exposure station A, the plate being in the form of a flexible photoconductive belt **12** arranged on a belt assembly generally indicated by the reference numeral **13**.

The photoconductive belt assembly **13** is slidably mounted upon a support bracket secured to the frame of the machine and is adapted to drive the selenium belt **12** in the direction of the arrow as shown in FIG. **1** at a constant rate. During this movement of the belt, the light imaging rays of an original are flashed upon the xerographic surface of the belt. The belt surface that intercepts the light rays comprises a layer of photoconductive material such as selenium on a conductive backing that is sensitized prior to exposure by means of a suitable charging corona generator device.

The flash exposure of the belt surface to the light image discharges the photoconductive layer in the areas struck by light, whereby there remains on the belt a latent electrostatic image in image configuration corresponding to the light image projected from the original on the supporting platen. As the belt surface continues its movement, the electrostatic image passes through a developing station B in which there is positioned a developer assembly generally indicated by the reference numeral **14** and where the belt is maintained in a flat condition. The developer assembly **14** comprises a vertical conveying mechanism which carries developing material to the upper part of the belt assembly **13** whereat the material is dispensed and directed to cascade down over the upwardly moving inclined selenium belt **12** in order to provide development of the electrostatic image. As the developing material is cascaded over the xerographic plate, toner particles in the development material are deposited on the belt surface to form powder images.

The developed electrostatic image is transported by the belt to a transfer station C whereat a sheet of copy paper is moved at a speed approximately in synchronism with the moving belt in order to accomplish transfer of the developed image. There is provided at this station a sheet transport mechanism generally indicated at **16** adapted to transport sheets of paper from a paper handling mechanism generally indicated by the reference numberal **18** to the developed powder image on the belt at the station C. The transfer of the developed image from the selenium belt surface to sheet material is effected by means of a suitable corona transfer device that is located within the sheet transport mechanism to the point of contact between the sheet and selenium belt as the sheet passes the transfer station C.

After the sheet is stripped from the belt **12** it is conveyed into a fuser assembly generally indicated by the reference numeral **20** wherein the developed and transferred xerographic powder image on the sheet material is permanently affixed thereto. After fusing the finished copy is discharged from the apparatus at a suitable point for collection externally of the apparatus.

Suitable drive means may be arranged to drive the selenium belt **12** in conjunction with timed flash exposure of an original to be copied to effect conveying and cascade of toner material, to separate and feed sheets of paper and to transport the same across the transfer station C and to convey the sheet of paper through the fuser assembly in timed sequence to produce copies of the original.

It is believed that the foregoing description is sufficient for the purposes of this application to show the general operation of an electrostatic copier using an illumina-tion system constructed in accordance with the invention. For further details concerning the specific construction of the electrostatic copier, reference is made to U.S. Pat. No. 3,661,452, issued May 9, 1972 in the name of Hewes et al.

The illumination system of the present invention is illustrated in detail in FIGS. **2–4** and is designed for irradiating the diffusely reflecting original D such that the image of the original produced by a lens has irradiance uniformity to a maximum of ±5 percent. This uniform image irradiance is obtained by the use of four linear light sources L_1, L_2, L_3 and L_4 and their associated reflectors R_1, R_2, R_3 and R_4 arranged orthogonally relative to the original. The arrangement is such as to compensate for the relative illumination functions of the lens, for example, the illumination falloff due to vignetting of the optical aperture for the system and to the cosine to the fourth power law.

Each of the four linear light sources, which may be in the form of a xenon flash lamp or other gaseous discharge tube having a small diameter, is provided with a semi-cylindrical reflector and at least one plano reflector. The radio-metric equations for the reflectors are utilized to project reflected light from a platen supporting an original onto an image plane where the irradiated image has nearly uniform irradiance.

As shown in FIGS. **2** and **3**, the lamps L_1, L_2, L_3 and L_4 are arranged along the sides of a rectangle somewhat larger than the rectangle defined by the original D. The inner edges of the reflectors R_1, R_2, R_3 and R_4 being parallel to the respective lamps are also arranged as the sides of a rectangle having its inner edges spaced slightly outwardly from the edges which define the original. With this arrangement, the light rays which emanate from each of the lamps, are directed toward the original, to impinge thereon at various angles other than directly or at 90°. This arrangement, then, eliminates direct perpendicular impingement of the light rays upon the document thereby preventing excessively high intensity illumination of the edges of the document if such were extended over the light sources.

In order to provide homogeneous illumination wherein there will be a minimum amount of variation in the image irradiance from an original and, to increase the amount of light that can be directed toward the original D to near perfect efficiency, the illumination system is provided with a semi-cylindrical shape reflective surface in combination with at least one plano reflective surface for each of the linear lamps. These reflective surfaces are designed to direct light upon the original being illuminated and are so arranged that the impinging rays of one lamp and its corresponding reflective surfaces overlap with the impinging rays of the opposing lamp and its corresponding reflective surfaces. These reflected rays coupled with the rays emanating directly from each of the lamps upon the original and result in a more uniform, homogeneous illumination of the photoconductive surface.

Each of the reflectors, and for simplicity the reflector R_1 will be the only one described in detail, comprises a first reflector surface R_a having the form of a right circular cylinder with the axis of the surface of revolution parallel to and offset relative the axis of the linear lamp L_1 by an amount approximately equal to the radius of the lamp. The reflector surfaces R_a, one for each of the reflectors in the illumination system, define the inner limits of the four assembled reflectors. When assembled, the surfaces define an opening through which the light rays emanating from an illuminated original are directed therethrough to a projection lens

for the document illumination system. Light rays, as illustrated in FIG. 4 by lines A_1 and A_2 emanate from the lamp L_1 and from the cone A_3 of light directly in back of the lamp and reflected by the surface R_a through the lamp. The lines A_1 and A_2 extend to the adjacent and furthermost edges, respectively, of the document D and define the outer limits of the light reaching the document from lamp L_1 and cone A_3. In addition, with the axis of the lamp L_1 being located adjacent the axis of the cylindrical surface R_a, light is also reflected from this surface and directed upon the original.

Joined along the outer edge of the reflector surface R_a is a second reflector surface R_b in the form of an elongated plane surface having its inner longitudinal edge connected to the edge of the surface R_a and arranged to redirect some of the light rays from the lamp L_1 between the lines B_1 and B_2 that extend to the adjacent and furthermost edges, respectively of the document. The light falling upon the surface R_b that is redirected upon the document would otherwise be lost for illumination purposes if this surface was not provided. The ray B_2 may be made to fall very near to the ray A_2 in order to minimize the light that may be lost at the juncture of the surfaces R_a and R_b. The line B_2 and its originating direct light line that extends between the lamp and the surface has been illustrated relative to a point away from the R_a–R_b junction point for clarity reasons. The only light that is lost by operation of the surfaces R_a, R_b would be at this junction and then only for a very narrow cone of light rays, too small to be illustrated.

In order to enhance the illumination uniformity by the illumination system at the image plane, which for the machine of FIG. 1 is the same as the exposure station A, a second elongated plano reflective surface R_c is provided and has one of its longitudinal edges joined to the outer longitudinal edge of the plano surface R_b. The surface R_c redirects still more of the light emanating from the lamp L_1 that would be otherwise lost, along light rays extending away from the document and the other surfaces R_a, R_b. The plane of the surface R_c is at an angle relative to the plane of the surface R_b such that the light rays falling thereon from the lamp L_1 and from the cone C_3 immediately behind the lamp from the surface R_c is reflected and directed along the light lines C_1 and C_2. These lines define the limits of the light reaching the document from the surface R_c. As was the case for the R_a–R_b junction, the light line C_2 is illustrated in FIG. 4 slightly away from the R_b–R_c junction in order to permit better visualization. In actual practice, the line C_2 would be effectively closer to the R_b–R_c junction thereby minimizing light losses due to this reflector junction.

Additional effeciency is possible with the illumination system by the provision of a third elongated plano reflective surface R_d having its inner longitudinal edge connected to the outer edge of the surface R_c and at an angle relative thereto for redirecting additional light from the lamp L_1 upon the document. The surface R_d is arranged so as to redirect light reaching the same from the lamp and from the cone D_3 immediately behind the lamp from the surface R_d upon the document between light lines D_1 and D_2. These lines define the limits of the light reaching the document from the reflective surface R_d. As in the previous cases, the line D_2 has been shown slightly displaced relative to the R_c–R_d junction in order to permit better illustration thereof. The angles between the planes of the surfaces R_b, R_c and R_d are less than 180 degrees relative to one another.

In actual practice, there is negligible light losses from the linear junction R_a–R_b, R_b–R_c, R_c–R_d of the reflective surfaces. The cones A_3, B_3, C_3 and D_3 having been drawn in FIG. 4 to correspond with their respective light lines reaching the document being illuminated. As shown, there are appreciable gaps between the cones signifying light losses in the gaps. Actually, with light lines impinging upon points closer to the above referred to junctions, the cone angles would be larger and the gaps therebetween smaller and negligible. The dimension for the width of each of the surfaces R_b, R_c and R_2 is chosen so that the portions of the surfaces nearest the edges will effect reflection to the edges of the document,no more, no less. In this manner, there is a minimum of loss of light directed upon the reflecting surfaces.

From an analysis of FIG. 2, in conjunction with the description above, it will be seen that each lamp L_1, L_2, L_3 and L_4 generates seven images, some real and some virtual, which serves as light sources. Again, using lamp L_1 as typical of the operation of the other lamps in the illumination system, the seven images are disposed approximately in the portions illustrated in FIG. 2. With the lamp L_1 being slightly displaced relative to the longitudinal axis of the cylindrical reflector R_a, the first read image thereof is illustrated at L_1^1 being produced by the internal reflection of the reflective surface R_a. Both the lamp L_1 and its image L_1^1, serving as light sources for the reflector R_b in turn generate the virtual images L_1^a and $L_1^{a'}$ respectively. By reflecting from the reflective surface R_c, the lamp L_1 and its image L_1^1 also effect the virtual images at L_1^b and $L_1^{b'}$. Similarly, the reflective surface, R_d will effect the virtual images L_1^c and $L_1^{c'}$ from the lamp L_1 and its image L_1^1, respectively. Each of the seven images will serve as light sources for illuminating the document D, thereby optimizing the efficiency of the illumination system.

From the foregoing it will be apparent that the reflecting surfaces R_a, R_b, R_c and R_d serve to reflect the light rays emanating from the lamp L_1 upon the original D between both extreme edges thereof in overlapping fashion. This means the light reflected from the surface R_a will be directed upon the document starting from line ray A_1 coincident with the adjacent edges of the original, and sweeping across the document to the other edge thereof terminating in the line ray A_2. Light reflected from the plano reflectors R_b, R_c and R_d are directed upon the document between the line rays B_1, B_2; C_1, C_2; and D_1, D_2 respectively.

Similarly, as viewed in FIGS. 2 and 3, the reflector R_2 serves to reflect light from the lamp L_2 upon the original D. The light rays so reflected overlap those reflected from the reflecting surfaces of the reflector R_1. In similar fashion, light is directed from the reflectors R_3 and R_4 by reflection from the lamps L_3 and L_4 respectively, upon the original in overlapping ray-trace arrangement.

The effect then, of the use of four orthogonally arranged lamps arranged beyond the edges of an original being illuminated, and especially with the provision of the reflecting surfaces for each of the lamps and the relative positions thereof, an original is illuminated in such a manner that the object irradiance is $\cos.^{-4}$ or otherwise circularly symetrical for the center point of

the surface of the original. It will be apparent from this arrangement of reflecting surfaces that the illumination assembly **10** makes effective use of a large part of the light flux emitted from the light sources except for those areas wherein reflection losses are behind the lamps themselves. It will be appreciated from the foregoing that the arrangement of the lamps provides cos.$^{-4}$ illumination. By incorporating the illustrated plano reflectors R_b, R_c and R_d with each of the lamps, the resultant illumination profile for an object being illuminated is changed to be symmetrical. It will also be appreciated that the optimum illumination is available for an arrangement of light sources and reflectors which, in themselves, are of simple design, involving little manufacturing skill and expense and may be the result of relatively calculations. Each of the reflectors are made up of one cylindrical surface and one or more plane surfaces rather than some complex surfaces, such as ellipses, spirals, or combinations.

Each of the lamps L_1, L_2, L_3 and L_4 is connected to a suitable source electrical circuit for energizing these lamps. For the particular reproduction machine illustrated in FIG. **2**, the particular electrical circuit for energizing the lamps should be in the form of a flashing circuit which will energize the lamps for short periods of time, such as, for example, **100** microseconds. In this particular use, this short period of time will be suitable for flash exposing the original D upon a photoreceptor surface such, for example, as the selenium belt **12.**

The image forming light rays emanating from the original D during illumination thereof are directed to a suitable projection lens system **30.** Details of the lens system and mirrors **32** therefor and the housings for containing and supporting the illumination system as well as the lens system are not necessary for understanding the present invention. Further details of such matters may be derived from the U.S. Pat. application Ser. No. 731,960, filed May 24, 1968 in the name of Starkweather et al., the application being assigned to same assignee as the present application.

The illumination system is adapted to present light image representation of an original document upon the selenium belt **12** sequentially in timed relation to the movement of the belt which in the particular xerographic reproduction apparatus illustrated, continuously moves during the xerographic processing stations. The light image of the original being reproduced, is directed out of a housing for the illumination system and through a suitable rectangular opening on the side of the machine adjacent the selenium belt **12.** The housing may serve as a light shield for the selenium belt in order to present extraneous light from impinging upon a belt during use of the apparatus.

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

What is claimed is:

1. An illumination system for illuminating a planar object defined by a plurality of boundaries including

a plurality of illumination devices, one being arranged generally in parallel with one of at least two opposing boundaries of the object, and another of the devices being arranged generally in parallel with the other of the opposing boundaries,

each of said devices having an elongated light source and a reflecting surface of concave configuration disposed parallel to and adjacent the respective light source to reflect light rays from its respective light source and directly project the rays upon the object,

each of said devices having a reflecting surface of planar configuration for its respective light source and disposed parallel to and adjacent said light source to recieve some of the light rays emanating directly from its respective light source and to direct these rays upon the object,

each of said illumination devices having its light source and reflecting surfaces disposed relative to one another for directing light rays respectively from one of the opposing boundaries to the other with an intensity that varies decreasingly from the former to the latter.

2. An illumination system for illuminating a planar object defined by a plurality of boundaries including

a plurality of illumination devices, one being arranged generally in parallel with one of at least two opposing boundaries of the object, and another of the devices being arranged generally in parallel with the other of the opposing boundaries,

each of said devices having an elongated light source and reflecting surface of concave configuration disposed parallel to and adjacent the respective light source to reflect light rays from its respective light source and directly project the rays upon the object,

each of said devices having a reflecting surface of planar configuration for its respective light source and disposed parallel to and adjacent said light source to receive some of the light rays emanating directly from its respective light source and to direct these rays upon the object,

each of the illumination devices having its light source and reflecting surfaces disposed relative to one another for directing light rays respectively from one of the opposing boundaries to the other with an intensity that varies decreasingly from the former to the latter, said variation in intensity from one of the devices being substantially equal to the variation in intensity of another of the devices.

3. The illumination system of claim **1** for planar objects having a rectangular shape and the illumination system comprising four light sources, one parallel to each of the boundaries of the object, and said reflecting surfaces for each of the light sources.

4. The illumination system of claim **1** wherein each light source and its associated concave reflecting surface are positioned outside of the corresponding boundary of the object.

5. The illumination system of claim **2** wherein each of said devices having a second reflecting surface of planar configuration disposed parallel to and adjacent each of said light sources to recive some of the light rays from its respective light source and to direct these rays upon the object.

6. The illumination system of claim **5** wherein each of said devices having a third reflecting surface of planar configuration disposed parallel to and adjacent each of said light sources to receive still other light rays from its respective light source and to direct these rays upon the object.

7. The illumination system in claim 5 wherein said planar reflecting surfaces are at angles less than 180° relative to one another.

8. In a utilization device wherein an object is arranged to be illuminated from one boundary to another boundary thereof, an illumination device comprising an elongated light source disposed to project light rays directly upon the object, an element having reflective surface of concave configuration disposed parallel to and adjacent the light source for receiving light rays therefrom and reflecting the same directly upon the object, an element having a reflecting surface of planar configuration extending along said concave surface and disposed parallel to and adjacent said light source to receive some of the light rays directly from said source and to reflect the same directly upon the object, said light source and reflecting surfaces disposed for directing light rays respectively from said one boundary of the object to said another boundary with an intensity that varies decreasingly from the former to the latter.

9. In a utilization device wherein an object is arranged to be illuminated from one boundary to another thereof, an illumination device comprising an elongated light source disposed to project light rays directly upon the object, an element having a reflective surface of concave configuration disposed parallel to and adjacent the light source for receiving light rays therefrom and reflecting the same directly upon the object, an element having a plurality of reflecting surfaces of planar configuration extending along with said concave surface with each planar surface disposed parallel to and adjacent said light source to receive some of the light rays directly from said source and to reflect the same directly upon the object in superimposed relation to the other rays directed to the object, said light source and reflecting surfaces disposed for directing light rays respectively from said boundary of the object to said another boundary with an intensity that varies decreasingly from the former to the latter.

10. In a projection apparatus for illuminating a planar object having at least two opposed sides and directing light rays emanating therefrom through a lens system and onto an image plane, the combination including

a plurality of illumination devices, one being disposed adjacent one of the sides of the object and another device disposed adjacent the other side, each of the devices having an elongated light source arranged generally parallel to the respective sides of the object, each of said light sources projecting light rays therefrom directly upon the object,

each of said devices having an element formed with a reflecting surface of right cylindrical configuration disposed parallel to and adjacent each of said light sources and reflecting light rays reaching said first surface from said source and directing the same upon the object in superimposed relation to the rays reaching the object directly from said source,

said element having a reflecting surface of planar configuration extending along each cylindrical surface to receive some of the light rays directly from each source and to reflect the same directly upon the object,

each of said devices having its light source and reflecting surfaces disposed relative to one another for directing light rays respectively from one of the opposed sides to the other with an intensity that varies decreasingly from the former to the latter.

11. In a projection apparatus for illuminating a planar object having at least two opposed sides and directing light rays emanating therefrom through a lens system and onto an image plane, the combination including

a plurality of illumination devices, one being disposed adjacent one of the sides of the object and another device disposed adjacent the other side, each of the devices having an elongated light source arrnged generally parallel to the respective sides of the object, each of said light sources projecting light rays therefrom directly upon the object,

each of said devices having an element formed with a reflecting surface of right cylindrical configuration disposed parallel to and adjacent each of said light sources and reflecting light rays reaching said first surface from said source and directing the same upon the object in superimposed relation to the rays reaching the object directly from said source,

said element having a reflecting surface of planar configuration extending along each cylindrical surface to receive some of the light rays directly from each source and to reflect the same directly upon the object,

each of said devices having its light source and reflecting surfaces disposed relative to one another for directing light rays respectively from one of the opposed sides to the other with an intensity that varies decreasingly from the former to the latter, said variation in intensity from one of the devices being substantially equal to the variation in intensity of another of the devices.

12. In a utilization device wherein a planar object is arranged to be illuminated and the light rays therefrom projected onto an image plane, an illumination system comprising at least two opposed elongated illumination devices each having a light source and reflecting means arranged along the object such that each of at least two opposite boundaries of the object has one of said illuminating devices adjacent thereto, each of said light sources having its longitudinal axis disposed outside the boundary of the object adjacent thereto and arranged to direct light rays from that light source directly upon the object, across the same and to an opposite boundary thereof at angles less than 90° relative to the plane of the object and with an intensity that varies decreasingly from said adjacent boundary to said opposite boundary, each of said reflecting means including a reflecting surface of planar configuration, each of said reflecting means together with its associated planar reflecting surface being arranged relative to its corresponding light source for reflecting light rays from that source and to direct these rays between said adjacent boundary and said opposite boundary with an intensity that varies decreasingly from the former to the latter, said variations in intensities from each of said illumination devices being substantially equal whereby the resultant illumination irradiance at the image plane is substantially homogeneous.

13. In a utilization device wherein a planar object is arranged to be illuminated and the light rays therefrom projected onto an image plane, an illumination system comprising at least two opposed elongated illumination devices each having a light source and a reflecting

means arranged along the object such that each of at least two opposite boundaries of the object has one of said illumination devices adjacent thereto, each of said reflecting means including a reflecting surface of planar configuration, each of said illumination devices having its longitudinal axis disposed outside the boundary of the object adjacent thereto and arranged for producing light rays which project upon the object with an intensity that varies decreasingly from said adjacent boundary to said opposite boundary, said variation in intensity of one of said illumination devices being substantially equal and from an opposite directional orientation relative to the variation of intensity of the other illumination device whereby the resultant irradiance illumination at the image plane is substantially homogeneous.

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