

[54] **SCANNING DEVICE FOR EXPOSING A PHOTSENSITIVE SURFACE**

[72] Inventor: **Heinz Joseph Gerber**, West Hartford, Conn.

[73] Assignee: **The Gerber Scientific Instrument Company**, South Windsor, Conn.

[22] Filed: **May 25, 1970**

[21] Appl. No.: **40,413**

Related U.S. Application Data

[62] Division of Ser. No. 692,981, Dec. 22, 1967.

[52] U.S. Cl.**346/29, 95/12, 346/110, 178/6.7 R**

[51] Int. Cl.**G01d 9/40**

[58] Field of Search**346/1, 110, 29, 108; 95/1, 95/12; 350/96; 178/6.7 R, DIG. 2**

[56] **References Cited**

UNITED STATES PATENTS

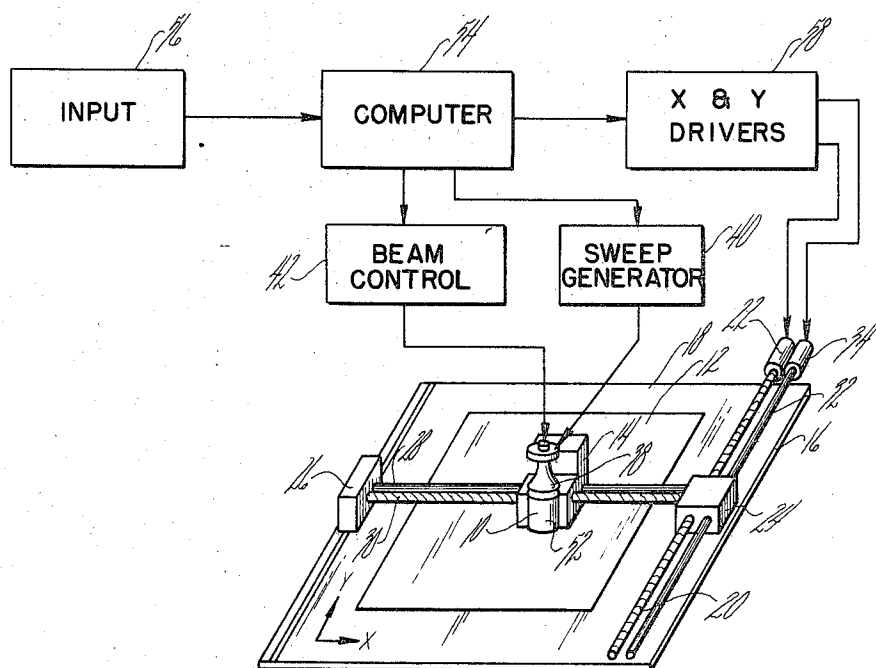
1,597,487	8/1926	St. Clair.....	346/108
1,751,584	3/1930	Hansell.....	178/6.7
3,403,263	9/1968	Hargens.....	250/202

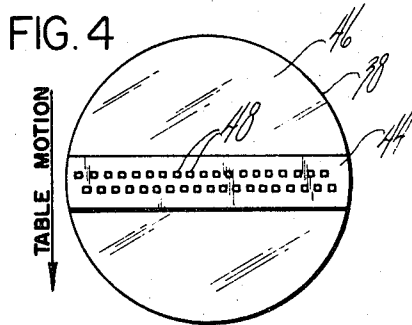
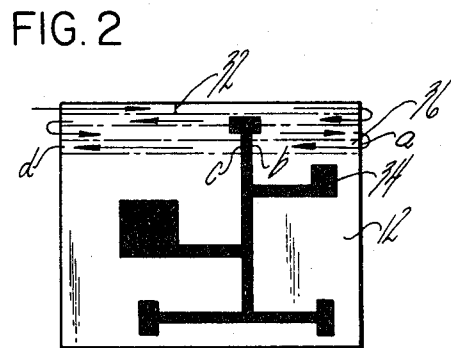
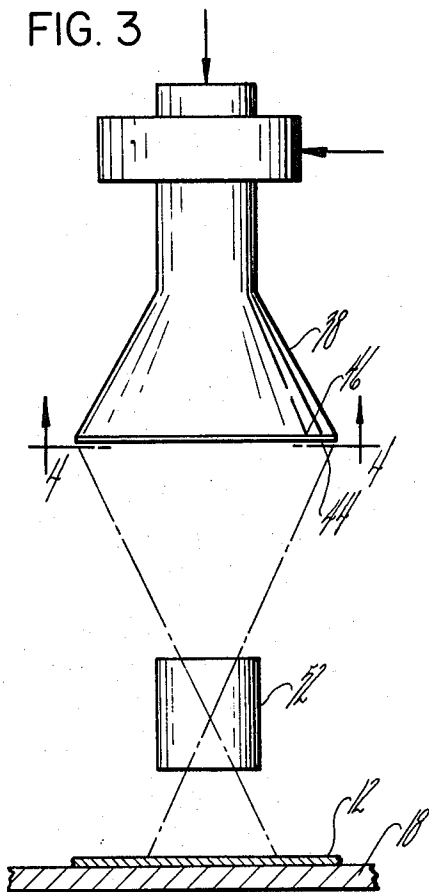
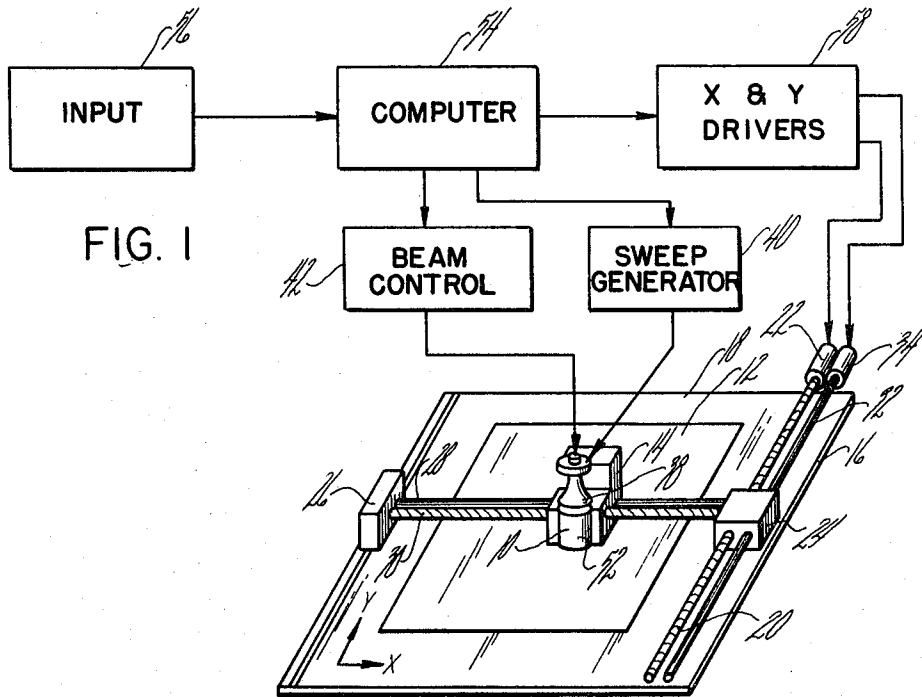
Primary Examiner—Joseph W. Hartary

[57] **ABSTRACT**

A device for producing graphic art work by exposing a photosensitive surface consists of a device having a working surface for supporting a sheet of photosensitive material and a carriage movable in both directions over such working surface. The carriage carries a device for projecting light onto the photosensitive surface along a given line. The light projecting device is such that the light projected therefrom passes through a large number of discrete spots located along the given line, and means are provided for controlling the amount of light passing through each such outlet area and onto the photosensitive surface. The carriage is moved in a scanning fashion over the surface of the photosensitive material in a direction generally perpendicular to the projected line, and as such movement occurs the amount of light energy projected through each of the outlet areas is varied as necessary to produce the desired graphic. A computer receiving input information as to the desired graphic is used to control the scanning movement of the carriage and the variation of the light energy projected through each outlet area. The source of light energy may be either a cathode ray tube having a mask with a large number of openings, or a fiber-optic bundle having a separate light source for each fiber. A lens may be used between the surface from which the light is emitted and the photosensitive surface to effect a reduction in size.

12 Claims, 12 Drawing Figures





INVENTOR.
HEINZ JOSEPH GERBER

BY

McCormick Paulding & Huber
ATTORNEYS

FIG. II

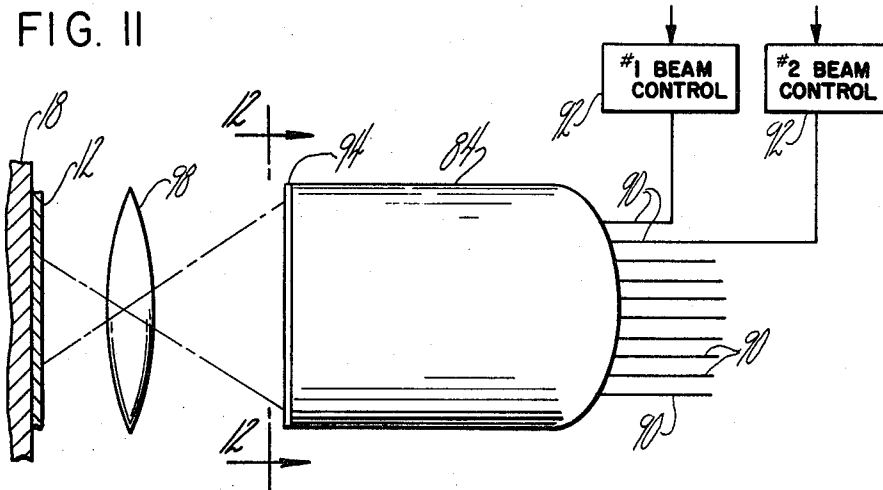


FIG. 12

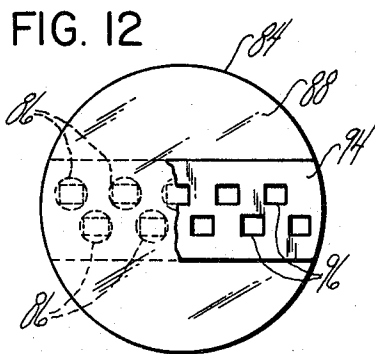


FIG. 10

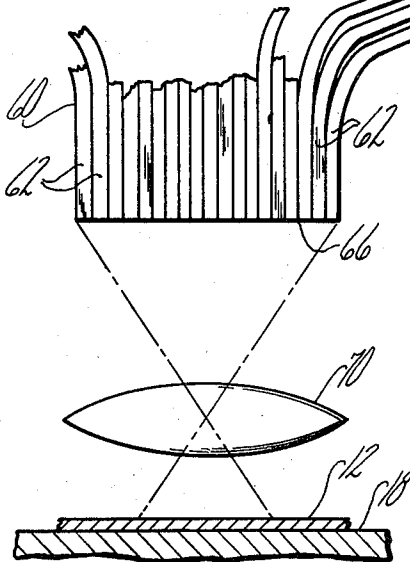
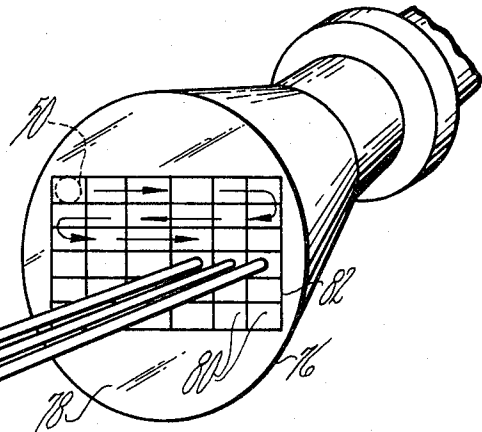


FIG. 6

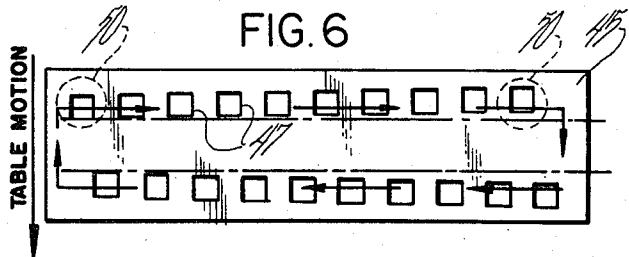
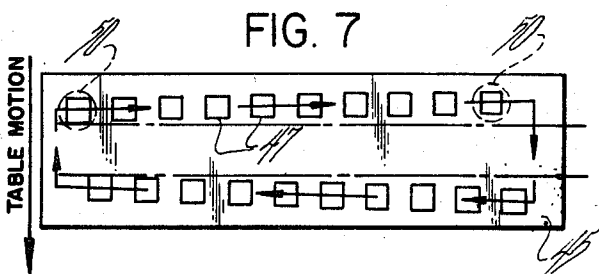


FIG. 7



SCANNING DEVICE FOR EXPOSING A PHOTSENSITIVE SURFACE

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation of application Ser. No. 692,981, filed Dec. 22, 1967 for Scanning Device For Exposing A Photosensitive Surface.

BACKGROUND OF THE INVENTION

This invention relates to a device for accurately exposing a photosensitive surface to produce a graphic art work, and deals more particularly with such a device wherein a line of light is moved in a scanning fashion over the photosensitive surface and the light intensity of various points therealong varied as required to effect different degrees of exposure at different points on the photosensitive surface.

The device of this invention may be used for many different purposes and is particularly of benefit in the production of photographic transparencies used as masters in the making of masks used in turn for making circuit boards or integrated circuit elements. For example, in the production of masks used for making large scale integrated circuits, it has been conventional in the past to use, as masters, drawings prepared by hand and requiring a large amount of skill, accuracy and time. The device of this invention eliminates this hand work and additionally allows the drawing to be made from input information which itself may be derived from a tape or other record prepared on a large computer, with the result that no human intervention is required for either the design or the drawing of the master.

SUMMARY OF THE INVENTION

The general object of this invention is to provide a device for rapidly and accurately exposing a photosensitive surface to produce a graphic on the photosensitive surface.

The invention resides primarily in a device for projecting radiant energy through a plurality of outlet areas superimposed on the photosensitive surface and arranged generally in end to end fashion along a given line. This line is then moved by associated means in a scanning fashion over the photosensitive surface, in a direction generally perpendicular to the given line, to expose successive adjacent bands of the photosensitive surface. As the outlet areas are so moved the amount of light energy projected through each outlet area is varied by an associated means so that different spots on the photosensitive surface receive different amounts of light energy. By properly selecting the correct amount of light energy for each spot of the photosensitive surface, the desired graphic is accordingly produced.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram, partly in block form and partly schematic, showing a system embodying this invention.

FIG. 2 is an example of a graphic which may be produced by the device of this invention and indicates the manner in which the projected line of light is moved relative to the receiving surface.

FIG. 3 is an enlarged schematic view of a portion of the device of FIG. 1.

FIG. 4 is a still further enlarged view taken on the line of 4—4 of FIG. 3.

FIG. 5 is a still further enlarged view of the mask shown in FIG. 4.

FIG. 6 is a plan view illustrating generally another mask which may be used in place of the one shown in FIGS. 4 and 5.

FIG. 7 is a plan view illustrating the same mask as in FIG. 6 but with a slightly different beam sweep path.

FIG. 8 is a generally schematic diagram illustrating a system comprising another embodiment of this invention.

FIG. 9 is an enlarged view taken on the line 7—7 of FIG. 6.

FIG. 10 is a generally schematic diagram illustrating part of a system comprising still another embodiment of the invention.

FIG. 11 is a generally schematic diagram illustrating part of a system comprising still another embodiment of the invention.

FIG. 12 is a view taken on the line 12—12 of FIG. 11, the mask used with the cathode ray tube being shown partly broken away to reveal the locations of the beam target areas.

DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. 1 shows a complete system embodying this invention. Referring to this figure, the system there shown includes an exposure device 10 which is arranged for movement over a sheet of photosensitive material 12 to be exposed by being mounted on the main carriage 14 of an X-Y plotter 16. The plotter 16 is or may be of generally conventional construction and includes a working surface or table 18 for receiving and holding the photosensitive sheet 12, and a means for moving the carriage 14 in two directions in a plane spaced above and parallel to the working surface 18. The means for moving the carriage 14 in the Y direction, as indicated by the arrow in FIG. 1, consists of a lead screw 20 driven by a motor 22, which may be a stepping motor. As the lead screw 20 is rotated by the motor 22 it drives an associated sub-carriage consisting of two housings 24 and 26 and a guide bar 28 and a second lead screw 30 spanning the distance between the two housings, the housings being guided for movement relative to the working surface 18 in the Y direction.

The means for driving the carriage 14 in the X direction, as indicated by the arrow in FIG. 1, consists of a spline shaft 32 driven by an associated motor 34, which may also be a stepping motor. Gears in the housing 24 rotate the lead screw 30 in response to rotation of the spline shaft 32, the lead screw 30 in turn driving the carriage 14 in the X direction along the guide bar 28 as it is rotated.

The exposure device 10 is designed to project onto the surface of the photosensitive material 12 a large number of discrete spots of light arranged along a given line, with the amount of light projected onto each of such spots being controllable independently of that projected onto any other spot. For the purpose of clearer explanation, each of these discrete spots of light may be considered to be formed by light transmitted through an associated one of a plurality of outlet areas superimposed on the photosensitive surface and fixed relative to the exposure device so to be moved in unison relative to said photosensitive surface as a result

of movement of said exposure device relative to said photosensitive surface. In producing a design or graphic on the photosensitive sheet 12, the exposure device 10 may be moved in a scanning fashion over the sheet by the carriage 14, with the scanning motion being generally perpendicular to the line along which the outlet areas are located, and the amount of light energy projected through each outlet area varied as required to properly expose each incremental area of the sheet as the line of light passes thereover. As will be evident from the detailed description which follows the outlet areas need not be located exactly on the given line, perpendicularly to which the scanning movement is effected, but may be laterally displaced different distances therefrom, the important consideration being that when geometrically projected in the plane of the photosensitive surface perpendicularly onto said given line the projections thereof are located end to end along the line so that as said plurality of outlet areas is swept over said photosensitive surface the entire area of said photosensitive surface between the paths of the end ones of said outlet areas is transversely by said outlet areas.

FIG. 2, for example, shows an exemplary graphic which may be produced by the device of FIG. 1. In this figure, the line 32 is intended to represent the line and the arrows indicate the manner in which the line is moved or scanned relative to the sheet 12. The blackened design 34 is the graphic which it is desired to have exposed on the sheet. The line 32 represents a large number of outlet areas and if each is considered to be "on" when light energy is projected therethrough and to be "off" when no light energy is projected therethrough, it will be obvious from FIG. 2 that the design or graphic 34 may be exposed on the sheet 12 by moving the line 32 in the indicated scanning fashion and by selectively turning "on" and "off" at the proper time the various outlet areas located along the line. For example, in FIG. 2, several bands of scanning are illustrated, and in considering the bottom most illustrated band 36, the exposure device 10 in scanning this band is operated so that while moving from the point *a* to the point *b* all outlet areas along the line are turned "off", while moving from the point *b* to the point *c* all the outlet areas are turned "on", and while moving from the point *c* to the point *d* all outlet areas are turned "off".

The degree of accuracy of exposure may be readily controlled by varying the length of the line 32 to vary the width of the band scanned by each pass of the line, by varying the number of outlet areas making up the line 32, by varying the speed at which the line is moved relative to the sheet and by varying the speed at which the outlet areas are turned "on" and "off". It should also be understood that, although in FIG. 2 the illustrated graphic is one made up solely of black and white or black and transparent areas produced by switching the light projected through each outlet area between fully "on" and fully "off" conditions, graphics with grey or shaded areas may be produced by modulating the intensity of the light projected through each outlet area through a range of values.

The projecting means for forming the plurality of outlet areas may take various forms without departing from the broader aspects of this invention, and in FIG. 1, 3, 4 and 5 is shown to consist of a cathode ray tube

38. Associated with the cathode ray tube is a sweep generator which is connected with the deflection plates or coils of the tube and which supplies a signal thereto to move the beam of the tube in a desired sweep pattern across the face of the tube. Also connected with the tube 38 is a beam control which turns the beam on and off as it moves through its sweep. The sweep path of the beam carries it across a large number of discrete portions of the face of the tube each corresponding to a respective one of the projected outlet areas or spots. Therefore, by turning the beam of the tube on or off as it reaches each such discrete portion, the desired amount of light to be projected through each outlet area may be obtained.

Preferably, each sweep cycle of the beam consists of two straight line sweeps of the beam across the tube face with the beam first moving in one direction and then in the opposite direction with the two line sweeps being parallel to and spaced slightly from one another. As shown in FIGS. 3, 4 and 5, a mask 44 is also preferably placed immediately in front of the output surface or face 46 of the tube 38 and contains two rows of openings 48, 48. The two rows are parallel to one another and spaced a slight distance laterally from one another, and the openings of one row are laterally aligned with the spaces of the other row.

In FIG. 5, the arrows indicate generally the path of movement of the beam, indicated at 50. From this figure, it will be noted that the two rows of mask openings 48, 48 are so located, and the sweep path so controlled, that the beam moves along one row when moving in one direction of its sweep and along the other row when moving in the other direction of its sweep. Each opening 48 is of a generally square shape and of such a size as to be enclosed within the bounds of the beam 50 when the beam is registered therewith. The spaces between adjacent openings of each row are equal to the length of each opening. It will be obvious from FIGS. 4 and 5 that if the rows of openings are taken to make up a single line, the line is accordingly divided into a large number of adjacent spots or segments and is devoid of any lengthwise spaces or gaps between such spots. Therefore, if all of the openings 48, 48 are simultaneously illuminated and the line produced by such illuminated openings projected onto the photosensitive surface and moved in a direction perpendicular the line, the result will be the exposure of a solid band having a width corresponding to the length of the line.

It should, of course, be understood that in the embodiment of FIGS. 1 to 5, the beam 50, as it moves through its sweep path, actually registers with only one mask opening 48 at a time. However, all of the openings, or any selected group of openings, may be effectively illuminated simultaneously by moving the beam along its sweep path at a very rapid rate in comparison to the rate of movement of the projected line relative to the photosensitive surface. For example, the beam sweep speed is preferably selected so that between 5 and 10 complete cycles of sweep will occur for each movement of the mask relative to the photosensitive surface a distance equal to the lateral dimension of each opening 48. That is, as the mask in FIG. 5, for example, is moved a sufficient distance to bring each trailing edge of each opening to the position

formerly occupied by its leading edge the beam 50 makes five to ten sweeps of each opening. This insures very sharp edges on the exposed graphic and good integration of exposure over the exposed area as the carriage moves.

The photosensitive sheet 12 may be located very close to the output surface 46 of the cathode ray tube so that the light energy emitted from the openings 48, 48 of the mask pass directly to the photosensitive surface and expose it with a one-to-one reduction ratio. Preferably, however, a lens means, indicated generally at 52 in FIGS. 1 and 3, is interposed between the output surface 46 of the tube and the photosensitive sheet 12 to effect a change in size. That is, the lens means 52 is arranged so as to project a real image of the mask openings onto the surface of the sheet 12, and preferably a size reduction is made so that the real image projected onto the sheet is smaller than the actual image, thereby achieving a greater accuracy in the resulting graphic.

Referring again to FIG. 1, the illustrated system further includes means for simultaneously controlling the sweep generator 40, the beam control 42 and the X and Y motors 34 and 22 so that the carriage 14 is driven in the desired scanning movement, the beam of the cathode ray tube moved in the desired sweep path and the intensity of the beam controlled so as to properly expose each spot of the photosensitive sheet as one of the outlet areas moves thereover. This control means may take various different forms, and as illustrated comprises a computer 54 which receives input information from an associated input device 56 such as punched paper or magnetic tape reader. The computer 54 is programmed to accept information from the input device 60 concerning the desired graphic to be produced and to convert this input information into proper commands for the sweep generator 40, the beam control 42 and the X and Y motors 34 and 22, the latter motors being driven through suitable X and Y drivers indicated at 58. It should be noted that the fact that the two rows of openings 48, 48 in the mask 44 are offset from one another as shown in FIGS. 4 and 5 is of no disadvantage insofar as the computer 54 may be readily programmed to account for this offset.

Although FIGS. 4 and 5 show the mask 44 as including two parallel rows of openings 48, 48 it should be understood that, if desired, a larger number of rows could be used together with different sweep paths for moving the beam across the rows, without departing from the broader aspects of this invention. Also, the rows need not be, as in FIGS. 4 and 5, perfectly perpendicular to the table motion, as indicated by the arrows in FIGS. 4 and 5. Instead, particularly in cases where the projected line is moved at a high rate of speed over the photosensitive surface in comparison with the scanning speed of the beam, it may be desirable to slightly slant or incline each row relative to a line perpendicular to direction of table motion to compensate for the amount that the mask moves relative to the photosensitive surface as the beam moves from one mask opening to the other. Such a mask is shown at 45 in FIGS. 6 and 7. In both of these figures, the arrows at the left of the masks indicate the direction of table motion and the arrows in the mask indicate the path of the beam 50.

Considering first FIG. 6, it will be noted from this figure that the illustrated mask 45 includes two rows of openings 47, 47, with each row inclined slightly relative to a line perpendicular to the direction of table motion.

The beam 50 is of a substantially larger size than each opening 47 so that as it is moved in a straight line path, perpendicular to the direction of table motion, from one side to the other of each row, it will fully encompass each opening as it moves therepast. For example, in the two different illustrated positions of the beam 50 indicated in FIG. 6, it will be noted that when the beam is registered with the left-hand most opening in the upper row, it fully covers such opening with the opening being located in the lower portion of the circle defined by the beam. When the beam reaches the right-most opening, it still completely covers this opening but due to the inclination of the row of openings, this opening is located in the upper portion of the circle defined by the beam. During the time the beam moves from the right to the left hand side of the upper row of openings, the mask moves a small distance relative to the photosensitive surface and by properly selecting the inclination of the row, with respect to the speed of table motion and the speed of the beam sweep, a line drawn through the centers of all the spots exposed by the illumination of all of its openings of a row may be made to be exactly perpendicular to the direction of table motion. Also, it will be noted that due to the fact that the beam is swept first in one direction along the upper openings and then in the opposite direction along the bottom row of openings, the two rows of openings are slanted in opposite directions. It also should be understood that the mask 45 shown in the FIG. 6 is intended to be a general illustration only and that an actual mask would most likely include a very much larger number of openings in each row.

The mask 45 in FIG. 7 is the same as the one in FIG. 6, but this figure shows that instead of using a beam 50 of substantially larger size than each opening and moved in a sweep path perpendicular to the direction of table motion, the beam size may be decreased so as to be of a size only slightly greater than needed to encompass each opening and moved in a sweep path slanted in accordance with the slant of the opening. That is, in this figure, the arrows in the mask indicate the path of movement of the beam and from these arrows it will be noted that as the beam 50 is moved along each row of openings it traverses a line slanted by the same degree as the row of openings.

FIGS. 8 and 9 show an alternate embodiment of this invention. This embodiment is generally similar to that of FIGS. 1 through 5 except that the part used as a source of the light energy projected onto the photosensitive surface, instead of being a cathode ray tube, is a fiber-optic bundle. This fiber-optic bundle may be moved relative to the photosensitive surface by any means such as the carriage 14 of FIG. 1 and for convenience such moving means have been omitted from FIG. 6 for clarity.

In FIG. 8, the fiber-optic bundle is indicated at 60 and consists of a large number of optical light transmitting segments 62, 62 arranged, as shown in FIG. 9, such that each segment 62 has one end surface 64 located in and forming a part of a common output surface 66. Each segment 62 may consist of a single light

transmitting fiber or a small group of such fibers. The end surfaces 64, 64 are preferably square or rectangular in shape and are located adjacent to one another so as to form a line made up of a large number of discrete outlet areas with each outlet area being the end surface 64 of a respective one of the segments 62, 62. Each segment 62 has its other end surface illuminated by a separate light source 68 exclusively associated with such segment. Accordingly, by selectively energizing the various light sources 68, 68 light may be emitted simultaneously from any desired group of outlet areas 64, 64 on the output surface 66. By turning the light sources 68, 68 on and off as the fiber-optic bundle is moved relative to the photosensitive sheet 12, a graphic may therefore be exposed on the sheet 12 in the same manner as described above in connection with FIG. 1.

As indicated in FIG. 9, a lens 70 may be used between the output surface 66 of the fiber-optic bundle 60 and the photosensitive sheet 12 to effect a size reduction. Also, as indicated in FIG. 9, the various light sources 68, 68 are controlled by a light control device 72 responsive to commands from a computer 54 supplied with input information from the input device 56, the computer also supplying commands to the X and Y motor drivers 58 for the X and Y motors used to drive the fiber-optic bundle relative to the photosensitive surface.

FIG. 10 illustrates a system using a fiber-optic bundle 60 similar to that of FIGS. 8 and 9. In this system, however, the individual segments 62, 62 of the fiber-optic bundle 60 are, instead of being illuminated by individual light sources, illuminated by a common cathode ray tube 76 having an output face or surface 78 divided into a plurality of discrete areas 80, 80. Each segment 62 of the fiber-optic bundle 60 is directed to the face of the cathode ray tube 76 and positioned so as to have its receiving end surface registered with a respective one of the discrete areas 80, 80 of the tube face. The tube 76 is energized so that its beam 50 is swept across the grid 82 as indicated by the arrows and so that as the beam registers with each discrete area 80 it is turned either "on" or "off" as required to produce the desired output from the output surface 66 of the fiber-optic bundle.

In FIG. 10, each segment 62 is shown as having its receiving end face positioned directly in front of the surface 78 of the tube so as to receive light energy directly from the tube without any intervening lens means. If desired, however, a suitable lens system may be used between the surface 78 of the tube and the associated ends of the segment 62, 62 so that as the beam 50 passes a particular discrete area 80 of the tube, the light from that area is concentrated onto the receiving end of the associated segment 62 so as to obtain a greater output from the emitting end of the fiber.

In connection with the embodiments of the invention shown in FIGS. 1 to 5 and 10, the cathode ray tubes 38 and 76 have been described as single beam tubes wherein a single beam is swept across the output surface of the tube to illuminate the discrete areas of such tube used as sources of radiation for, in turn, providing the discrete spots of light projected onto the photosensitive surface. The use of a single beam tube is not, however, necessary to the broader aspects of this invention and, if desired, a multiple beam tube, some-

times referred to as a multiple gun tube, may be used in place of a single beam tube. By way of example, such a multiple beam tube is shown at 84 in FIGS. 11 and 12, in a system otherwise generally similar to that of FIGS. 1 to 5.

The cathode ray tube 84 is one capable of producing a large number of beams, such as indicated at 86, 86 in FIG. 12, each permanently directed toward and exclusively associated with a discrete target area on the face 88 of the tube. For controlling the beams 86, 86, the tube 84 includes a number of input terminals or lines 90, 90, each of which controls a respective one of the beams and each of which receives a control signal from an exclusively associated beam control 92 in turn responsive to commands from an associated computer or other controller, not shown, similar to the computer 54 of FIG. 1. That is, in response to the presence or absence of a signal on one of the lines 90, 90, the associated beam 86 is either turned "on" or "off." Therefore, by properly energizing the lines 90, 90, any selected group of beams 86, 86 may be turned "on" simultaneously.

In the system of FIGS. 11 and 12, the multiple beam tube 84 further includes a mask 94, generally similar to the mask 44 of FIG. 4, positioned in front of its output surface 88 and including a plurality of rectangular openings 96, 96. The target areas of the various beams 86, 86 and their diameters are in turn so adjusted that each beam 86 registers with and completely encompasses a respective one of the openings 96, 96. As indicated in FIG. 11, a lens 98 may be used between the mask 94 and the sheet 12 of photosensitive material so as to project a real, and preferably reduced, image of the mask openings onto the photosensitive surface, these images constituting the previously referred to outlet areas. Suitable means, such as the plotter 16 of FIG. 1, is, of course, employed for moving the outlet areas spots in a scanning fashion over the photosensitive material.

It should, of course, also be understood that, if desired, the photosensitive material 12 could be placed close to the output face of the cathode ray tube 84 so that the light from the mask openings is emitted directly onto the photosensitive material. Also, the multiple beam cathode ray tube 84 may be used with a fiber-optic bundle, as in the system of FIG. 10, for transmitting the light emitted from the tube to the photosensitive material or to a suitable projecting lens system.

I claim:

1. A device for exposing a photosensitive surface to produce a graphic art work thereon, said device comprising a cathode ray tube having an output face with two mutually perpendicular axes and a plurality of discrete portions, said discrete portions each having a maximum dimension at least several times smaller than the maximum dimension of said face and said discrete portions being distributed over said face in such a manner that at least some of them are spaced from other of them in the direction parallel to one of said mutually perpendicular axes and some of them are spaced from other of them in the direction parallel to the other of said mutually perpendicular axes, said cathode ray tube including beam means for energizing said discrete portions to cause the emission of radiant

energy therefrom, means for transmitting the radiant energy emitted from said discrete portions through a plurality of discrete outlet areas, each associated with a respective one of said discrete portions, onto said photosensitive surface, means for scanning said plurality of discrete outlet areas over said photosensitive surface by moving them as a group relative to said photosensitive surface along side-by-side parallel scan bands extending across said photosensitive surface, and means for controlling the flow of radiant energy transmitted through each of said outlet areas independently of the flow transmitted through all other of said outlet areas so that said flow may during said scanning movement be switched between an ON condition and an OFF condition, said means for controlling the flow of radiant energy transmitted through each of said outlet areas comprising means for controlling said beam means as to each individual one of said discrete portions to selectively cause each of said discrete portions to either emit or not emit radiant energy independently of the state of emission of any other of said discrete portions, said plurality of outlet areas being so located that when projected parallel to said scan bands and onto a given line perpendicular to said scan bands the projections thereof are located end-to-end along such given line whereby said photosensitive surface across the width of each of said scan bands may be selectively exposed either across the entire width of the band or along smaller portions of the width of the band.

2. A device as defined in claim 1 further characterized by said beam means comprising means for producing only a single beam, said discrete portions being arranged to form at least two rows extending along one of said axes and spaced from one another along the other of said axes, and said beam control means including means for repetitively sweeping said beam in sequence along said rows of discrete portions and means for selectively causing said beam to be in either an ON or an OFF condition as it passes each of said discrete portions.

3. A device as defined in claim 1 further characterized by said beam means comprising means for producing a plurality of beams each directed toward a respective one of said discrete portions, and means for selectively causing each of said beams to be in either an ON or an OFF condition independently of the condition of the other of said beams.

4. A device for exposing a photosensitive surface as defined in claim 1 further characterized by said means for transmitting radiant energy through each of said outlet areas onto said photosensitive surface further including a lens means between said output face and said photosensitive surface for projecting real images of said discrete portions of said output face onto said photosensitive surface, said real images of said discrete portions of said output face defining said outlet areas.

5. A device for exposing a photosensitive surface as defined in claim 4 further characterized by said means for transmitting radiant energy through each of said outlet areas onto said photosensitive surface further including a mask positioned adjacent said output face and having a plurality of openings each of which is superimposed on and delineates a respective one of said discrete areas of said output face.

6. A device for exposing a photosensitive surface as defined in claim 5 further characterized by said mask including at least two rows of openings with the openings of each row being spaced from one another and laterally aligned with the spaces between the openings of the other row.

7. A device for exposing a photosensitive surface as defined in claim 6 further characterized by said mask openings being rectangular in shape.

8. A device for exposing a photosensitive surface as defined in claim 1 further characterized by said means for transmitting radiant energy through each of said outlet areas onto said photosensitive surface comprising a plurality of light conducting members each having a receiving end located adjacent a respective one of said discrete portions of said output face of said cathode ray tube and having an emitting end located in a plane common to all of such emitting ends.

9. A device for exposing a photosensitive surface as defined in claim 8 further characterized by a lens means between said common plane and said photosensitive surface for projecting real images of said emitting ends of said light conducting members onto said photosensitive surface, said real images of said light emitting ends defining said outlet areas.

10. A device for exposing a photosensitive surface as defined in claim 9 further characterized by said emitting ends of said light conducting members being arranged in a side by side arrangement to one another along a single line.

11. A device for exposing a photosensitive surface to produce a graphic art work thereon, said device comprising means providing a plurality of discrete radiant energy outlet areas superimposed on said photosensitive surface and arranged so that when geometrically projected in the plane of said photosensitive surface perpendicularly onto a given line fixed relative thereto such geometric projections thereof are located end to end along said line and each associated with a respective one of an equivalent plurality of discrete end to end segments of said line, means for scanning said plurality of discrete outlet areas over said photosensitive surface by moving them as a group relative to said photosensitive surface in a direction perpendicular to said given line, means for directing radiant energy through each of said outlet areas onto said photosensitive surface, means for controlling said flow of radiant energy directed through each of said outlet areas individually of the flow directed through the other of said outlet areas so that said flow may at any desired time during said scanning movement be switched between an ON condition and an OFF condition, said means for directing radiant energy through each of said outlet areas being such that when said flow is in an ON condition said flow is sufficiently continuous as to cause the areas of said photosensitive surface swept by the associated outlet areas during such ON condition of said flow to be exposed in its entirety to radiant energy from said outlet area, said means for directing radiant energy through each of said outlet areas including a single source of radiant energy in the form of a cathode ray tube having an output face with a plurality of discrete portions each associated with a respective one of said outlet areas, said cathode ray tube including means for producing a beam, means for sweeping said beam in

11

sequence across said discrete portions of said output face, and said means for controlling said flow of radiant energy comprising means for selectively causing said beam to be in either an ON or an OFF condition as it passes each of said discrete portions of said output face, said means for sweeping said beam being such as to cause said beam to be moved at such a speed relative to the speed at which said scanning means moves said outlet areas over said photosensitive surface that during the time required for any given one of said outlet areas to move relative to said photosensitive surface a distance equal to its dimension perpendicular to said given line said beam is swept past the associated discrete portion of said output face a plurality of times, said means for directing radiant energy through each of said outlet areas onto said photosensitive surface further including a lens means between said output face and said photosensitive surface for projecting real

12

images of said discrete portions of said output face onto said photosensitive surface, said real images of said discrete portions of said output face defining said outlet areas, said means for directing radiant energy through each of said outlet areas onto said photosensitive surface further including a mask positioned adjacent said output face and having a plurality of openings each of which is superimposed on and delineates a respective one of said discrete areas of said output face, said mask including at least two rows of openings with the openings of each row being spaced from one another and laterally aligned with the spaces between the openings of the other row.

12. A device for exposing a photosensitive surface as defined in claim 11 further characterized by said mask openings being rectangular in shape.

* * * * *

20

25

30

35

40

45

50

55

60

65