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April 14, 1970 E. F. BROWN ET AL 3,506,779

LASER BEAM TYPESETTER

Filed April 7, 1967 4 Sheets-Sheet 1

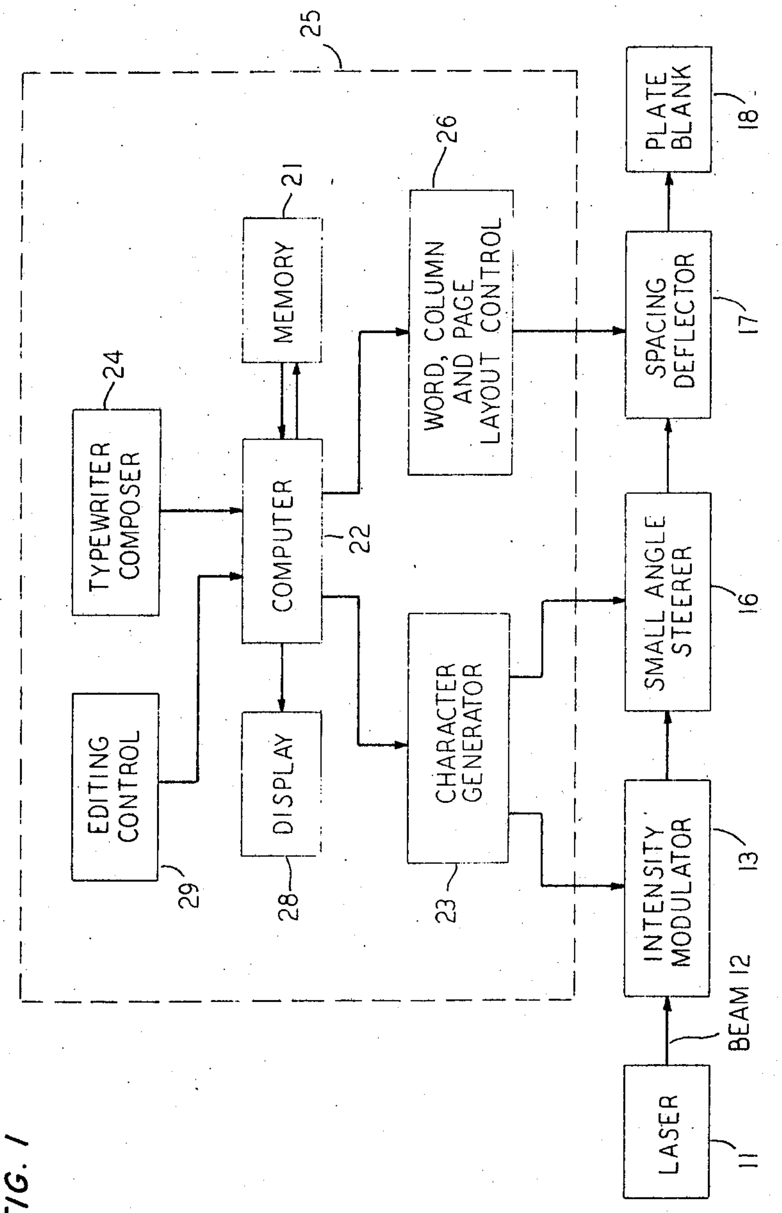

FIG. 1

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LASER BEAM TYPESETTER

Filed April 3, 1967 4 Sheets-Sheet 2

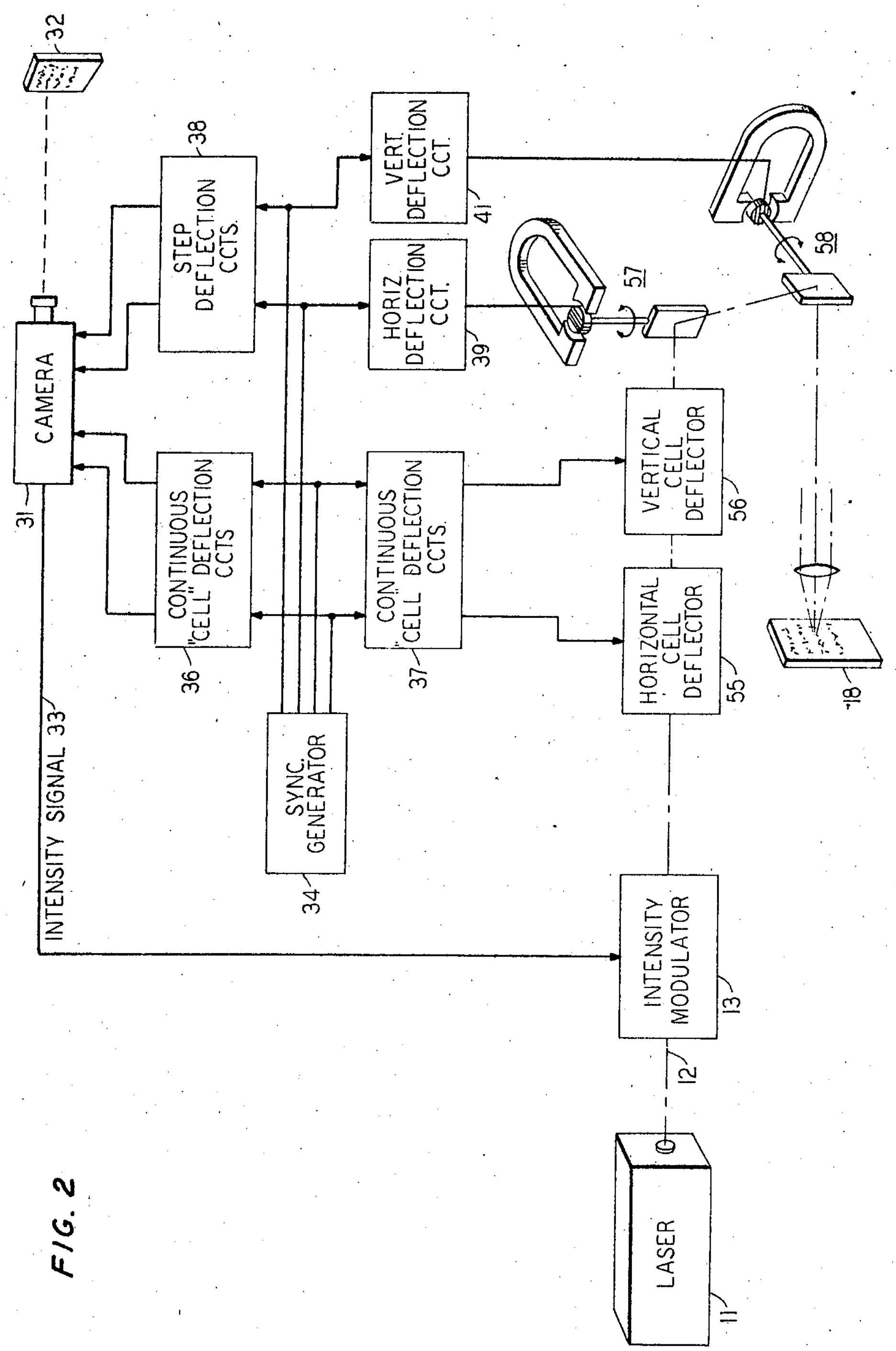

FIG. 2

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LASER BEAM TYPESETTER

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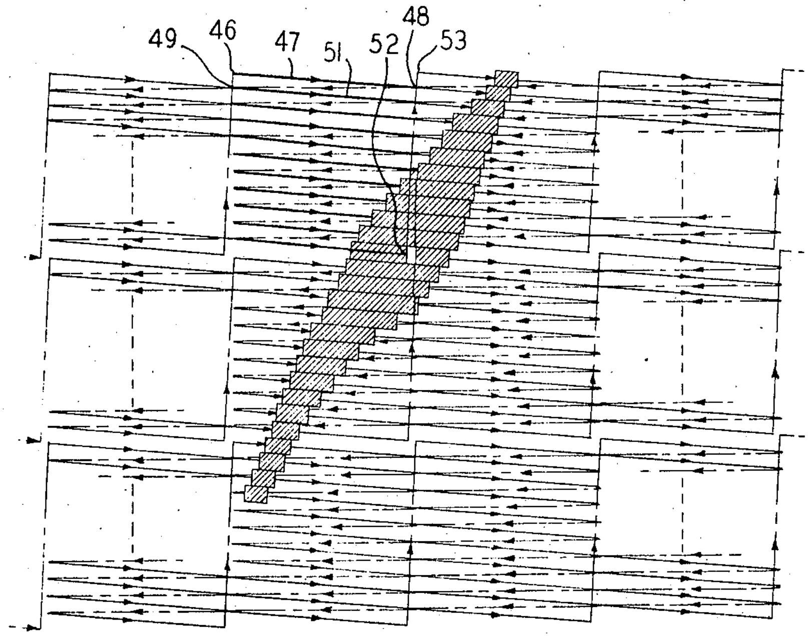
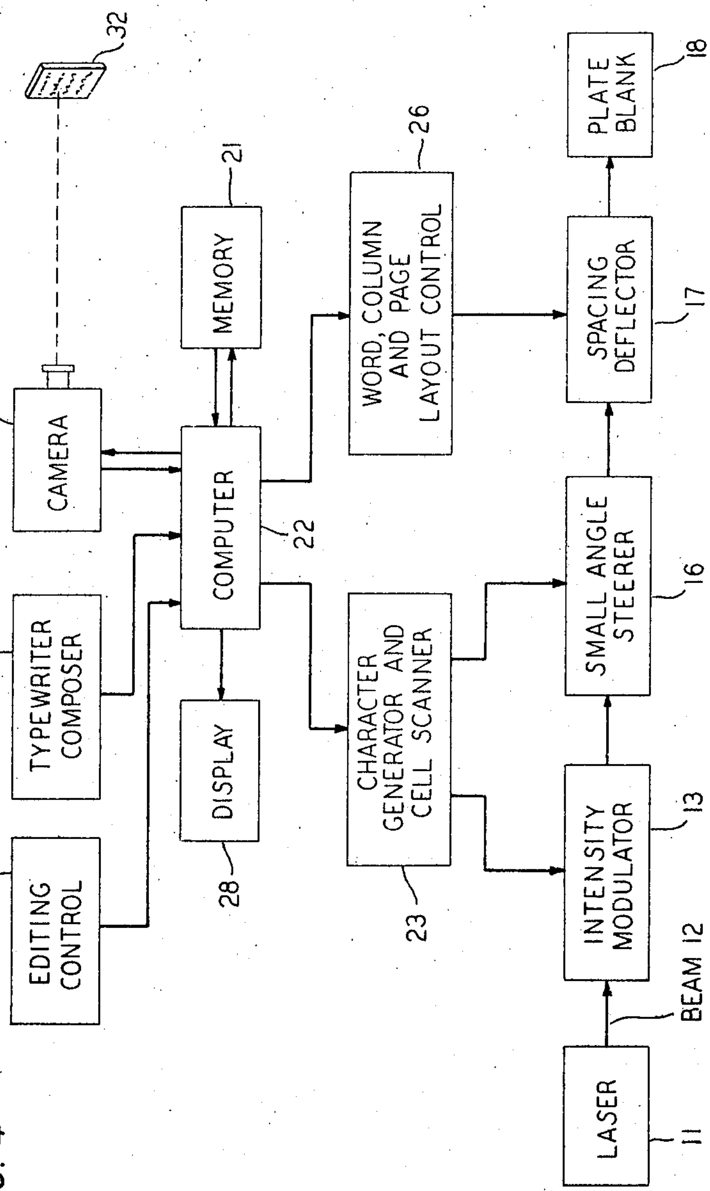
FIG. 3





32
CAMERA
31
MEMORY
21
COMPUTER
22
TYPEWRITER COMPOSER
24
DISPLAY
28
EDITING CONTROL
29
WORD, COLUMN AND PAGE LAYOUT CONTROL
26
CHARACTER GENERATOR AND CELL SCANNER
23
PLATE BLANK
18
SPACING DEFLECTOR
17
SMALL ANGLE STEERER
16
INTENSITY MODULATOR
13
BEAM 12
LASER
11

FIG. 4

United States Patent Office

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LASER BEAM TYPESETTER

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Int. Cl. H04n *1/10, 1/24*
U.S. Cl. 178—6.6 2 Claims

ABSTRACT OF THE DISCLOSURE

A printing plate, used for printing text and illustrations, is formed by a controlled laser beam writing directly upon a plate blank. A very high intensity beam of small cross section from a CO_2 laser removes material from the plate surface by vaporizing to form relief type plates for letter press or intaglio printing. The intensity and deflection of the beam are controlled to form the writing and may be programmed by a computer or driven by closed circuit television techniques. Photosensitive materials may be exposed at very high speed with excellent resolution by a controlled laser beam of shorter wavelength as a first step in forming plates by more conventional photographic methods.

BACKGROUND OF THE INVENTION

This invention relates to printing and the graphic arts, particularly to the preparation of plates for reproducing the same.

Typically in the printing art, the plates which transfer the ink to the paper are either of the relief type, such as letter press and intaglio, or of the planographic type, such as lithograph and offset. Relief type plates are used for high quality reproduction of large volume, and are made of a relatively hard and durable material, usually metal. Text may be composed with individual letters set up by hand or whole lines cast as a unit by the lintoype process. In both cases, the spacing between words should be adjusted to completely fill each column with proper hyphenation, a process called justification. For the purpose of editing, a whole page of type must be assembled and a proof sheet printed; then the page is disassembled and reset to make any changes.

Relief type plates to reproduce pictorial matter are normally produced by the more complicated process of photoengraving. This process entails photographing the pictorial matter, transferring the photograph to a sensitized metal surface, removing non-printing areas of the surface by etching, and perfecting the plate by hand engraving.

Planographic plates, on the other hand, are smooth surfaced, and, due to the immiscibility of grease and water, ink adheres only to the printing areas. Because the printing areas which form the image spread with use, the planographic printing processes are basically lower volume, but they are also lower cost. The image carrying plates may be plastic coated paper and are usually produced photographically or electrostatically. These processes, therefore, initially require a perfected original display to be photographically copied onto a plate.

According to a recent development shown in United States Patent No. 3,422,419, issued Jan. 14, 1969 to M. V. Mathews and H. S. McDonald, graphic images such as letters, numbers and symbols may be rapidly assembled from basic common segments and displayed on the face of a cathode ray tube. Information for generating letters and symbols to form text is stored in a memory and assembled by a computer which directs the deflection and modulation of the cathode ray beam. With this system,

text can be edited and printed out on the cathode ray tube in justified columns at the rate of hundreds of letters per second. To turn this cathode ray tube display into printing plates for graphic reproduction, conventional photoengraving and photographic methods are used. This latter step of transferring the information from the cathode ray tube to produce plates is, however, subject to two serious limitations: (1) the resolution attainable is limited because of the electron beam size and focus, the characteristics of the phosphor and the distortion of the glass face plate, and (2) the speed of photoengraving is limited because of the small amount of light generated by the tube phosphor.

An object of this invention is, therefore, to provide a new, fast and efficient technique for forming printing plates.

Another object is to produce printing plates from stored digital information with improved resolution and speed.

Another object is to produce relief type printing plates, properly edited, without proof printing.

Still another object is to produce relief type pictorial printing plates without chemical processing.

SUMMARY OF THE INVENTION

A laser beam is intensity modulated and deflected in accordance with control signals to strike areas on the surface of a printing plate blank in a pattern of information to be reproduced. The areas so struck are permanently altered to affect their ability to transfer ink; they may be vaporized, forming ink transferring recesses for intaglio printing or leaving raised ink transferring surfaces for letter press printing; or they may be chemically altered for further processing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a block diagram of a system embodiment for making plates according to the invention utilizing computer generated text;

FIG. 2 is a block diagram of an embodiment for producing plates for facsimile reproduction;

FIG. 3 illustrates a cell scanning technique which can be useful in the practice of the invention; and

FIG. 4 is a block diagram of a system embodiment which produces plates combining text and illustrations.

DETAILED DESCRIPTION

In the embodiment of the invention illustrated in block form in FIG. 1 a laser **11** produces a beam of intense coherent radiation **12**. The beam is passed through a modulator **13** which varies its intensity in accordance with a control signal from a character generator **23**. The modulated beam is then directed to a small angle steerer **16**, which, as discussed hereinafter, may employ conventional front surface mirror techniques to steer the beam through small angles so that it traces letters or symbols, again under the control of a signal from character generator **23**. The modulated and steered beam is now positioned or stepped either horizontally for letter spacing or vertically for line spacing by a spacing deflector **17**. As also discussed hereinafter, spacing deflector **17**, which may be a simple mirror system, is controlled by a word, column and page layout control **26**. The modulated, steered, and deflected laser beam then strikes and etches a plate blank **18** with the desired text as determined by the control signals from the character generator **23** and the word, column and page layout control **26**. It should be noted at this point that the plate blank **18** is prepared directly in accordance with the desired text thus eliminating the disadvantages of the prior art photographic and photoengraving methods discussed heretofore.

In the control network **25**, a typewriter composer **24** is connected to a computer **22**. Each key, space bar, shift, etc. of the typewriter keyboard feeds text in the form of electrical signals to computer **22**, which temporarily stores the data in digital form in a memory **21**. Also stored in memory **21** are instructions for deflecting a laser beam to trace characters and to space letters, words, lines and columns. Upon command, computer **22** assembles spacing instructions as well as character instructions in accordance with the temporarily stored data. An editing control **29** may also be connected to computer **22** along with a display device **28** to allow editing of the temporarily stored text. With this feature, the text may be displayed, read, corrected, and justified before any work is done on actual plates. Furthermore, since the editing is done electronically rather than by hand, the time saving can be immense. The outputs of the computer are fed to character generator **23** and word, column and page layout control **26**, both of which convert the computer instructions into analog voltage and current signals that control the intensity modulator **13**, the small angle steerer **16** and the spacing deflector **17**.

One such control system **25** is disclosed in the aforementioned Patent No. 3,422,419 by M. V. Mathews and H. S. McDonald. In that system, a digital memory unit such as unit **21** permanently stores instructions for deflecting a cathode ray tube beam to trace several individual elementary patterns and for varying their orientation. A computer upon command assembles and gates out of storage the correct sequence of such instructions to trace each character, and circuits similar to those which may be employed for character generator **23** transform the instructions into signals to drive a cathode ray tube display.

Since the laser beam does considerable work in etching away plate material, a high energy continuous wave laser operating in the infra-red region is most advantageous. The higher the beam energy, the faster the material can be vaporized and the faster the writing. One such laser which might be employed as the laser **11** of FIG. 1 is disclosed by C. K. N. Patel in copending application Ser. No. 495,884 filed Oct. 14, 1965. Patel's laser uses a mixture of gases including typically carbon dioxide, nitrogen and helium and has put out over 100 watts continuous at 10.6 microns wavelength.

With laser **11** operating at 10.6 microns wavelength, a gallium arsenide electro-optic modulator whose transmittance varies with applied voltage may be used as modulator **13**. The laser beam is directed through the modulator so that the intensity of the emerging beam varies in accordance with an intensity signal from character generator **23**. The beam may thereby be effectively shut off to prevent it from striking unwanted areas of the plate blank. A suitable modulator is described in the RCA Review, September 1966, volume XXVII, No. 3 at pages 323–335. According to author, T. E. Walsh, 70% modulation has been obtained at 10.6 microns wavelength.

At the present time, the function of small angle steerer **16** of deflecting the beam to trace out each character can be fulfilled using front surface mirror techniques which are old in the art. One mirror, with high reflectivity at the laser wavelength may be mounted on a vertical pivot and driven by a d'Arsonval meter movement which is in turn responsive to a horizontal deflection signal from character generator **23** to provide horizontal deflection. A similar mirror, mounted on a horizontal pivot and driven by a d'Arsonval movement responsive to a vertical deflection signal from character generator **23** will provide vertical deflection.

Spacing deflector **17**, since it performs a very similar function, may be a mirror device similar to small angle steerer **16**. Alternatively, however, since the stepping speeds required for thermal writing are relatively slow the spacing deflector may operate on the plate blank **18** rather than the laser beam. Any electro-mechanical system for stepping the plate blank horizontally for letter spacing and vertically for line spacing will suffice. Such systems are conventional in the electrical typewriter art to move the carriage and to advance the roll.

Plate blank **18** may be made in any shape or form convenient to the printing press in which it is to be used. Its surface, however, should be smooth and made of some material that is hard enough to stand the wear of printing, yet is easily vaporized locally. A fusible metal or thermoplastic high in infra-red absorption is particularly useful. If the surface material is of the thickness desired for type depth, and it is backed up with harder material of higher melting point, the laser beam can quickly etch away the areas of surface material it strikes right down to the backing material. The beam may be directed to etch away the areas which transfer ink, thereby recessing the letters into the plate for intaglio printing; alternatively, the beam may be directed to etch away the areas which do not transfer ink, thereby leaving the text raised for letter press printing.

The present invention may also be practiced to advantage making use of the photographic processes conventionally employed in making plates. The high energy of the laser beam allows extremely high writing rates and the ability to focus the beam to a small spot provides excellent resolution. In such a photographic process, the surface of plate blank **18** is treated by any of the well known conventional methods to be sensitive to light. Wherever laser beam **12** strikes, the surface is exposed. A physical or chemical change occurs which differentiates between exposed and unexposed areas and further processing causes the exposed areas alone to print. Such finish processing could include any of the known methods from photoengraving of metal plates to the electrostatic process of Xerox. In a particularly useful process, the plate blank **18** may be coated with a substantial thickness of a photo-polymer. Upon exposure to light, the coating polymerizes into a hard plastic. After laser beam **12** has written on the plate blank, therefore, the unexposed photo-polymer may be washed away, leaving the exposed areas in relief as letter press print. One such photo-polymer is Dycril, a registered trademark of the E. I. du Pont de Nemours Co.

Very little power is required to expose light sensitized surfaces for wavelengths below a threshold of about 1 micron. Consequently, almost any known continuous wave laser operative at a wavelength below 1 micron can be used to practice the invention by a photographic process, with wavelengths below .6 micron being most useful. The use of such a shorter wavelength, furthermore, can be very helpful in allowing alternative deflection and modulating techniques. In U.S. Patent No. 3,413,568 issued Nov. 26, 1968 to E. I. Gordon, E. F. Labuda and R. C. Miller, a technique is shown for providing high output from a typical argon ion laser which would be quite satisfactory.

For modulating and steering laser beams of wavelengths in the visible range, such as that produced by the aforenoted argon ion laser, devices employing electro-optic crystals may be used. These are, of course, controllable much faster than the mirror devices. In U.S. Patent No. 3,413,476 issued Nov. 26, 1968, E. I. Gordon teaches a technique for building intensity modulator **13** and small angle steerer **16**. According to Gordon's invention, a microwave modulating signal is propagated along a waveguide filled with an electro-optic material such as KTN (potassium-tantalate-niobate). The laser beam is formed by lenses or prisms into an elliptical cross section, the major axis of which lies parallel to the waveguide axis. The beam is then directed through the electro-optic material via elongated ports in the narrow faces of the waveguide. A portion of the beam energy is thereby deflected by an angle dependent upon the frequency of the modulating signal and the portion of energy so deflected depends upon the amplitude of the modulating signal. The emerging energy is therefore split into two beams, one deflected and one not.

For our small angle steerer two such waveguides may be used. After the beam has been deflected by one waveguide, it is reformed by lenses into a circular cross section, and then into an ellipse whose major axis is at right angles to that of the original ellipse and waveguide. The beam then passes through a second waveguide similar and at right angles to the first and the deflected portion is reformed to circular cross section. The microwave signal propagated along the first waveguide may be frequency modulated with a horizontal steering signal and its amplitude adjusted for maximum energy in the deflected beam. The microwave signal propagated along the second waveguide may be frequency modulated with a vertical steering signal and amplitude modulated with a beam intensity signal. The emerging deflected beam will then be deflected to accomplish both horizontal and vertical small angle steering and modulated in intensity.

As discussed heretofore, coil driven mirrors may be employed to accomplish spacing between letters, words, columns and lines, or plate blank **18** may be shifted as in the thermal systems.

The principles of the invention can also be used in making plates for reproducing pictorial matter or for copying previously printed matter according to the system diagrammed in FIG. 2. As in the previous embodiment, a laser **11** produces a beam of energy **12** which is varied in intensity by a modulator **13**, deflected both horizontally and vertically by a pair of cell deflectors **55** and **56** as discussed hereinafter, stepped through larger deflections by a pair of step deflectors **57** and **58**, and focused to write upon a plate blank **18**. Also as in the previous embodiment, either a high intensity thermal etching system or a photographic system may be employed.

In the embodiment of FIG. 2 a conventional television camera **31** scans a display to be copied **32** and produces a signal **33**, which corresponds to the brightness of the original **32** at the instantaneous scan point. Signal **33**, with any necessary amplification, is used to drive intensity modulator **13**. Of course, as in all television systems, the scan of the camera must be exactly synchronized with that of the display. Consequently, a sync generator **34** provides synchronizing signals for both the camera deflecting circuits and the laser beam deflecting circuits. While the invention may be practiced with single horizontal and vertical deflection circuits for both camera and laser beam, a dual deflection system, that is, one in which there are two horizontal deflectors and two vertical deflectors for the laser beam and a like number for the camera, can be advantageous. Mirror deflectors are relatively slow; electro-optic deflectors are very fast, but the angle through which they can deflect a laser beam is limited. The longer the path through the electro-optic crystal, the larger the deflection angle, but the greater the attenuation of the laser beam. A system, therefore, in which the beam is quickly deflected through small angles to cover an area, and then stepped more slowly to a new area can be fast and have lower losses. Thus, horizontal and vertical cell deflectors **55** and **56** respectively are driven by a pair of continuous cell deflection circuits **37** which quickly deflect the beam through small angles, and horizontal and vertical step deflectors **57** and **58** are driven by a pair of step deflection circuits **39** and **41** respectively, which step the beam through larger angles. Of course, the camera must have a pair of similar continuous deflection circuits **36** and a pair of step deflection circuits **38**. Sync generator **34** provides sync pulses which are fed simultaneously to camera continuous deflection circuits **36** and laser beam continuous deflection circuits **37** and additional sync pulses fed simultaneously to camera step deflection circuits **38** and beam step deflection circuits **39** and **41**.

One scan pattern for such a dual deflection system, a "cell block scan," is illustrated in FIG. 3. With this technique the beam is deflected both horizontally and vertically in a conventional scan pattern by cell deflectors **55** and **56** to completely scan a small area or cell; the beam is then stepped to an adjacent area by step deflectors **57** and **58**. Starting at point **46** in FIG. 3, for instance, the beam is deflected linearly along line **47** the width of the single cell block to point **48**. The beam is then quickly retraced to point **49** to linearly scan line **51**. The process continues until the whole cell has been covered. When the beam reaches the bottom of the cell at point **52**, it is quickly deflected to start scanning an adjacent cell at point **53**. When one line of cells has been scanned in this manner, the beam is quickly deflected to start another. With available deflection systems each cell could easily contain 100 scan lines and a matrix of 100 x 100 cells is not unreasonable.

Horizontal cell deflector **55** and vertical cell deflector **56** may therefore be either electro-optical crystals or driven mirrors, and their driving signals, derived from the continuous deflection circuits **37** are of a sawtooth shape just as in a television set. Step deflectors **57** and **58**, on the other hand may be driven by staircase type signals from deflection circuits **39** and **40** and may deflect the beam by mirrors or move the plate blank **18**.

Plates may be made using this facsimile embodiment with either a thermal or a photographic process. The thermal process is particularly suited to making intaglio plates, where the printing areas are recessed into the plates. The amount of ink available for any given spot is determined by the depth of the recess. Hence the blackness of a printed spot depends upon the intensity of the laser beam when it traced that spot in making the plate.

Letter press types of plates can also be readily made by this facsimile embodiment with a thermal process. The signal into intensity modulator **13** is merely inverted by a single stage of amplification; the laser beam in scanning the plate blank removes surface material by vaporization from all areas except those which are to transfer ink. If the intensity signal is amplified and clipped so that it has only two levels, the resulting printing areas will be raised a uniform amount above the etched out areas.

Finally, the control portion of the facsimile system of FIG. 2 may be added to the embodiment of FIG. 1 as shown in the block diagram of FIG. 4 to allow production of plates for printing illustrated text. The functions of each of the elements is as previously explained in connection with FIG. 1. In addition, character generator **23** performs the added duty of generating cell scanning signals, and word, column and page layout control **26** provides inter-cell stepping signals upon appropriate instructions from computer **22**. The camera deflection circuits, not separately shown, are included within the camera, and synchronizing signals are generated by computer **22**. Entire sheets of illustrated text may therefore be assembled by computer **22**, displayed on display **28** and edited and arranged by editing control **29**. Laser **11** may then be energized to quickly produce a plate capable of printing the sheet.

The above-described arrangement is illustrative of the principles of the invention. Other embodiments may be devised by those skilled in the art without departing from the spirit and scope of the invention.

We claim:

1. Apparatus for forming plates having an inking surface which reproduces print and the graphic arts by the transfer of ink from selected areas comprising a laser that produces a beam of coherent radiation, a plate blank having a smooth surface to be transformed into an inking surface, continuous deflection means positioned between said laser and said plate blank surface for deflecting said beam in a predetermined pattern to form a raster on said plate blank surface, step deflection means positioned be-

tween said continuous deflection means and said plate blank surface for deflecting said raster in steps equal in length to the dimensions of said raster to provide laser beam tracing over said plate blank surface, and modulating means positioned between said laser and said continuous deflection means for varying the intensity of said beam to permanently alter predetermined areas of said plate blank surface corresponding to the information which it is desired to reproduce.

2. Apparatus as in claim **1** wherein said continuous deflection means comprises an electro optic beam steerer and said step deflection means comprises coil driven mirrors.

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U.S. Cl. X.R.

101—1; 178—7.3, 15; 340—324; 346—77