United States Patent

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[54] **GRAPHIC ARTS PRINTER**
3 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** ..... **95/4.5 R,** 178/6.7 R
[51] **Int. Cl.** **H04n 5/84,** H04l 15/34
[50] **Field of Search** ..... 95/4.5; 178/6.7 R, 15, 30

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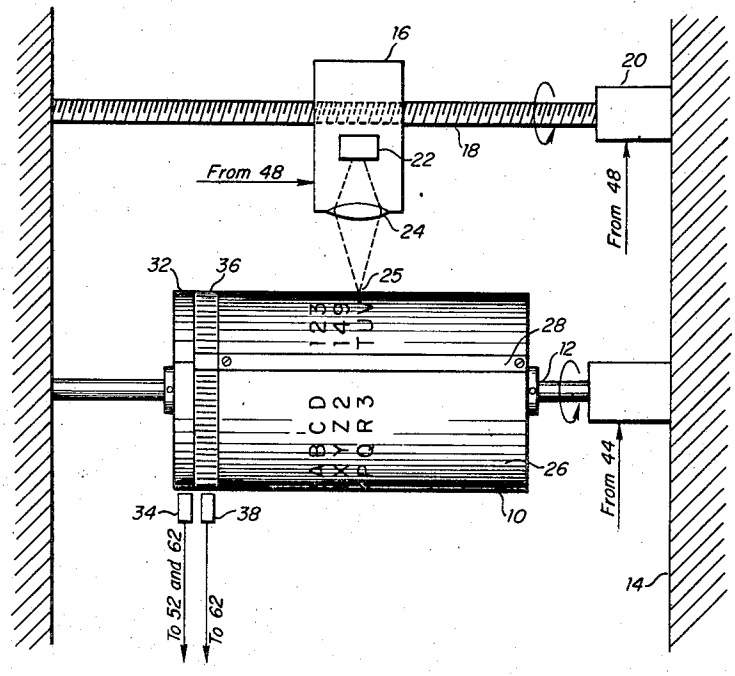
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ABSTRACT: A printer in which a continuously rotating drum carries an energy sensitive recording medium on which characters are formed by a modulated energy source such as light. Characters are formed by a plurality of line segments generated during successive revolutions of the drum. Electronic circuitry including a character generator, controls the modulation of the energy source.



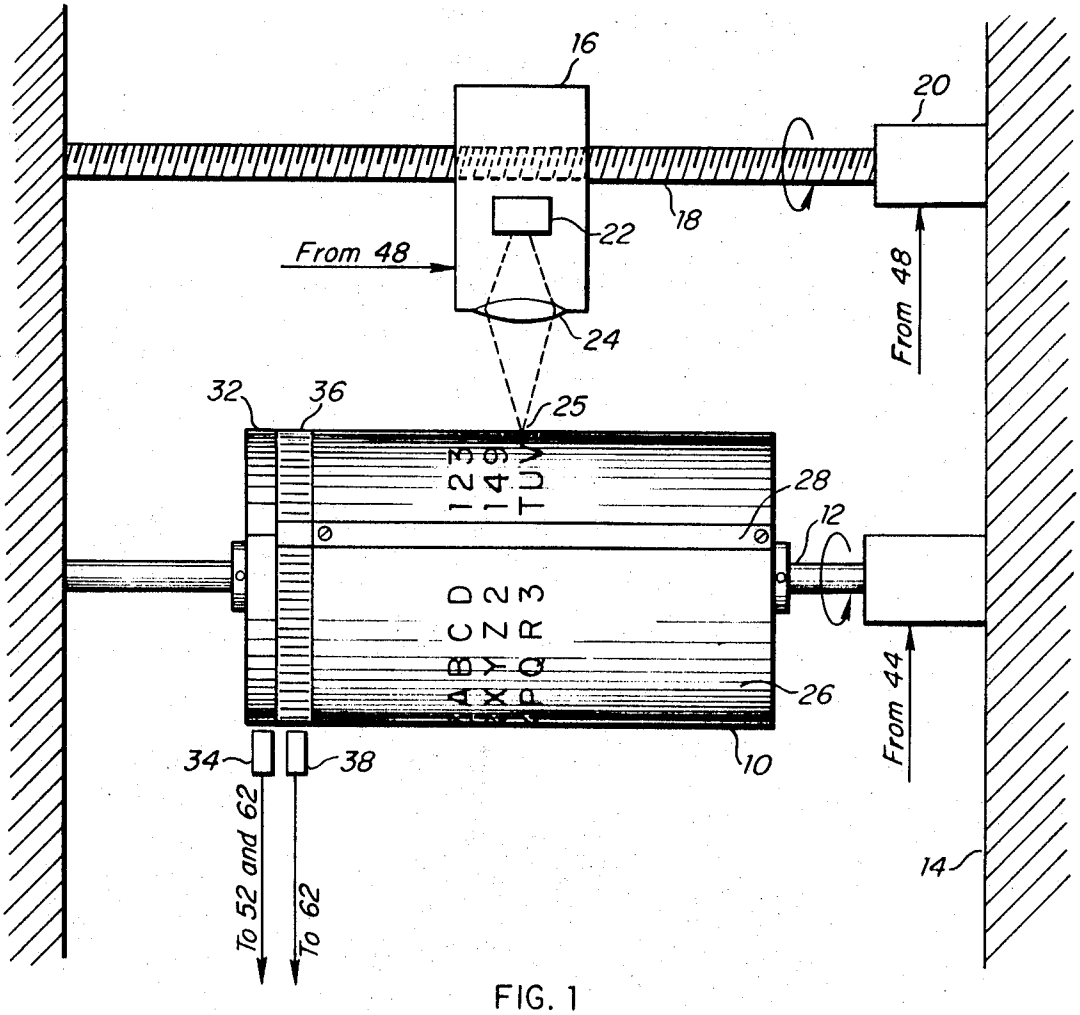


FIG. 1

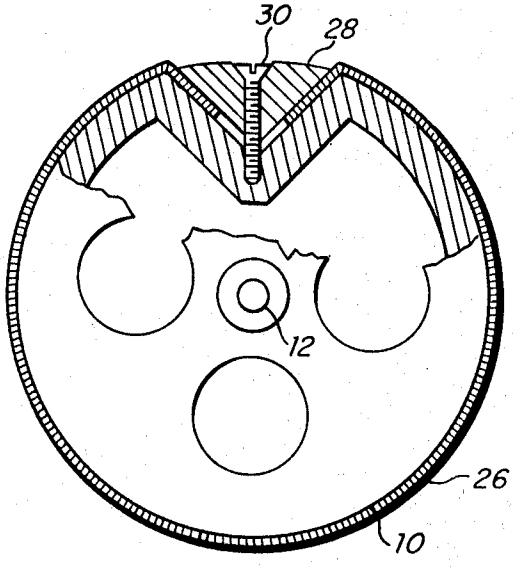


FIG. 2

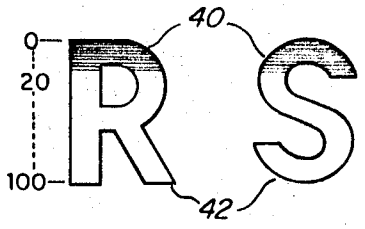
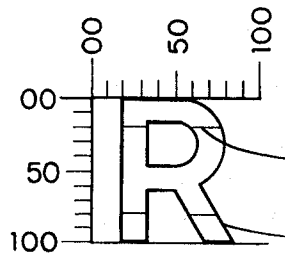


FIG. 4

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CHARACTER	ROW	START (ON)	STOP (OFF)
R	1	20	50
	20	20	30
	20	62	78
	80	20	30
	80	50	62
	100	20	30
	100	64	71
S	1	50	52

FIG. 3(b)

FIG. 3

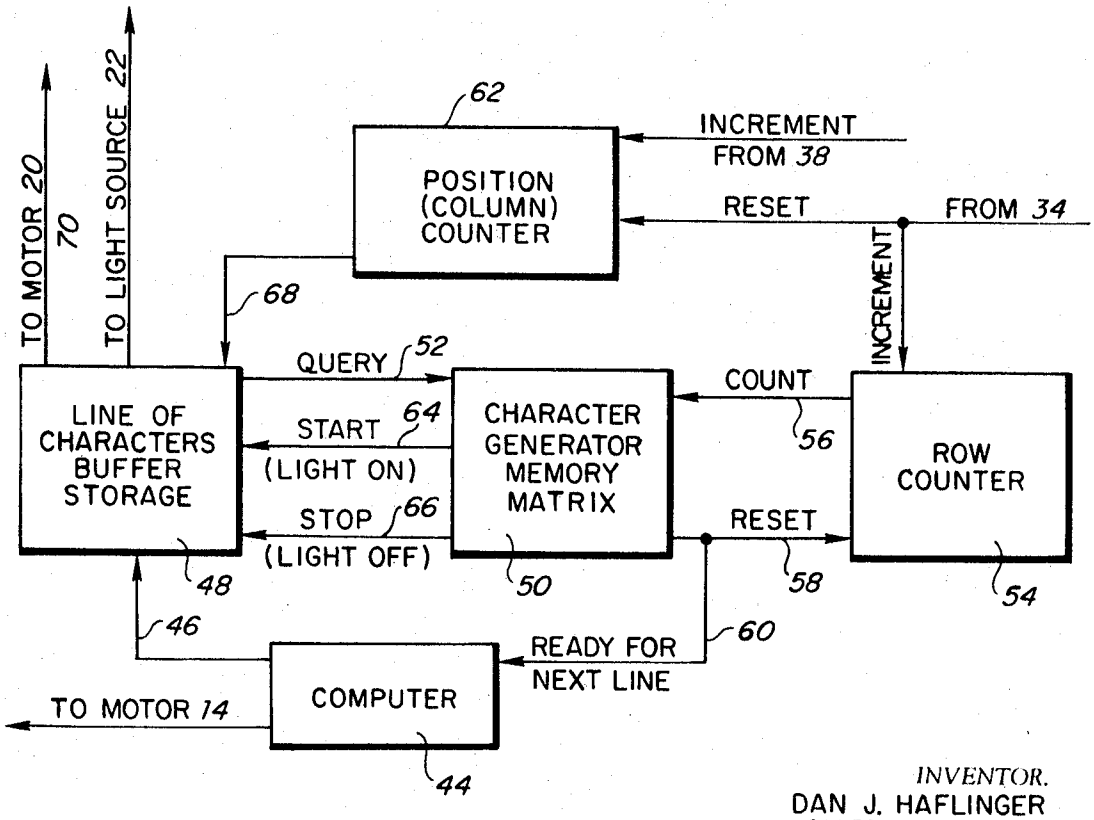


FIG. 5

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GRAPHIC ARTS PRINTER

BACKGROUND OF THE INVENTION

This invention relates to computer output graphic arts printers, and, more specifically, to a novel method and to improved apparatus for forming printed information at relatively high speed when compared with conventional methods currently in use.

Some form of electronic or electromechanical character generation is used in all high speed printers currently in use. In some machines a single character is formed on a cathode ray tube face plate by electronic means. This character is optically imaged on a photosensitive media. This method has been successful in giving good quality since the entire tube face is used to form a single character. Other methods which use more than one character on a tube face suffer in quality since the CRT is limited in the number of resolvable picture elements per tube face diameter.

Still another method uses photographic images of characters on a disc or drum which is rotated at a constant speed. Such systems give good quality and are limited in speed by the number of characters on the disc or drum. The larger the number of characters in a font the slower the printing speed since on the average the printing speed corresponds to the disc r.p.m.

The art progressed to the use of a cathode ray tube with a stencil bearing an array of characters. The electron beam was directed at the location on the stencil having the desired character thereby shaping the beam to the desired shape. Finally, deflection circuits deflected the shaped beam to the desired position on the face of the tube. Although the quality of the output character was improved, only a limited character font was available in each cathode ray tube.

An alternate approach included video scanning of a stencil and using the video signal to intensity modulate the beam of a cathode ray tube. However, none of the prior art devices have been able to provide the desired quality of characters.

With the above-mentioned problems and deficiencies of the prior art in mind, the invention contemplates the provision of improved apparatus for generating characters and for printing these characters as part of a computer output.

The invention further contemplates the provision of an improved character generator which forms characters having high quality.

The invention also contemplates the provision of a high speed character generator which is adaptable to be used as a display device or as the output of a computer.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of the invention will be apparent from the following detailed description of the invention when read in conjunction with the following drawings wherein like numerals represent similar elements and wherein:

FIG. 1 is an illustration of the light source, power and timing components for forming and printing characters on a rotating drum according to the principles of the invention;

FIG. 2 is an end view of the drum and printing medium of FIG. 1 and illustrates a manner of attaching the light sensitive paper to the rotating drum;

FIG. 3, comprising FIGS. 3*a* and 3*b*, shows an individual character and the equivalent information stored in the memory for forming that character;

FIG. 4 illustrates portions of characters as they are being formed; and

FIG. 5 illustrates schematically the electronic circuitry for controlling the operation of the printer.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. 1, the apparatus for forming and printing the individual characters will now be explained. Drum 10, mounted on shaft 12, is rotatably driven by motor 14 in a counterclockwise direction as seen from the right end in FIG. 1. Optical system 16 is mounted on shaft 18 which is rotated by motor 20 in synchronism with the rotation of the drum. The optical system 16 includes a point light source 22 and a lens 24. The shaft 18 has threads thereon and rotation of the shaft causes the optical system to scan a helical path across the surface of the drum. The lens focuses the light at a point 25 on the surface of the rotation drum.

In order to provide exact timing, there are two timing tracks on the drum. A first timing track 32 has a single timing mark which is sensed by transducer 34. The transducer generates a pulse for each complete revolution of the drum. The second timing track 36 has a series of marks which are sensed by the transducer 38. Transducer 38 generates a pulse for each mark sensed on timing track 36. Various types of timing tracks and transducers could be used. For example, the marks on the timing tracks could be made of magnetic material and the transducer could respond to a change in reluctance as each mark passes the transducer. Similarly, the marks could be dark lines on a light background and a photoelectric transducer could respond to the changes in reflected light. The operation of these timing tracks and the associated electronic circuitry will be more fully described hereinafter.

FIG. 2 shows a portion of the drum 10 with a light sensitive recording media 26, such as paper, or film, attached thereto by a fastener 28 and a screw 30. The screw may be removed to replace the recording media. Other energy sensitive recording media and an appropriate energy source could be used instead of the light source and light sensitive media.

FIG. 3 illustrates the principles of character generation according to the present invention. The letter R is taken as being illustrative although any character, number or symbol can be generated. Hence the term character should be interpreted as referring to any graphical symbol. An individual character occupies a character block which is the frame of reference for the generation of the individual characters and, as shown in FIG. 3*a*, may be considered as having 100 vertical columns and 100 horizontal rows thereby forming a matrix. It will be noted that character R in FIG. 3*a* does not need any of the columns prior to column 20 nor does it use any of the columns after column 80. Narrower characters, such as the letter I would use less space and, of course, wider letters such as the M or the W would use more space. However, the first few columns and last few columns of each character block will always be blank to provide spacing between the characters. It will be appreciated that the number of columns and number of rows in a character block can be modified to increase or decrease the desired resolution of the printed character.

FIG. 3*b* illustrates that portion of the character generator or memory matrix which stores information for the formation of the character R. The information in the character generator determines when the light source is turned on an when the light source is turned off for each character. For example, in the illustrated character R, at the first row the light will be turned on at column 20 remain on until column 50, and then be turned off. Similarly, in the 20th row the light source will be turned on at column 20, remain on until column 30, be turned off, and then turned on again from column 62 to column 78. For row 80 of the light source is turned on from column 20 to 30, turned off and then on again from column 50 to 62. Finally in the last row, row 100, the light source is turned on at column 20 and off at column 30, and then turned on from column 64 to column 79.

It will be appreciated that the above information for character R is merely illustrative Various configurations or symbols and various fonts of numerals and letters may be stored in the character generator memory and it is merely the size and economy limitation of the character generator which restrict the number of characters and different style fonts which may be printed.

Referring now to FIG. 4, a portion of a line of print on the rotating drum 10 is illustrated. The characters R and S are shown as part of the same line of print. The shaded portion 40 of each character indicates that portion which has already been printed while the outlined portion 42 of each character

represents that part still to be printed. It is noted that the characters are made up as indicated previously by a series of vertically disposed horizontal line segments. As seen in FIGS. 1 and 3 a row is printed completely around the drum before the next row is started. It will be appreciated that the instant graphic arts printer prints the first row of each character and then the second row of each character, etc., and on the final sweep of the light prints the last row of each character for a particular line of print.

Referring now to FIG. 1, the threaded shaft 18, which is driven by motor 20 in synchronism with the rotation of the drum 10, moves optical system 16 in a transverse direction at a speed such that each row of the characters is printed in succession. The pitch of the helical screw 18 may be adjusted depending upon the particular resolution desired.

The series of marks on timing track 36 correspond to the columns for each character. If 75 characters are printed on one line and each character has 100 columns, then track 36 has 7500 timing marks. Transducer 38, which senses the marks on track 36, generates a pulse for each of the various columns of each character. The output of the transducer or read-head 38 is a series of clock pulses which provide the start and stop timing pulses required by the memory illustrated in FIG. 3*b*. In a preferred embodiment of the invention, the drum 10 rotates at a speed of 500 revolutions per second. One row, or one revolution would take 0.002 seconds, and, since each character block is 100 rows (100 revolutions), a complete row of characters would be printed in 0.2 seconds. On the assumption of 75 characters per line, the printing speed is 375 characters per second. Different operating speeds can be obtained by modifying any of the four basic parameters; drum speed, number of characters per line, number of columns per character, and number of rows per character.

FIG. 5 illustrates the preferred embodiment of the control means for coordinating the rotation of drum 10, the transverse scanning motion of the optical system 16 and the modulation of the light source 22. At the start of a line of print the computer 44 sends a signal which starts the motor 14 and supplies information for a single line of print via lead 46 to line buffer 48. Line buffer 48 controls the motor 20 which regulates the transverse scanning of the optical system. Line buffer 48 also controls the modulation of the light source as will be more completely described hereinafter.

A character generator or memory matrix 50 has the various characters or symbols stored therein, in a manner similar to that shown in FIG. 3*b* for each symbol. Character generator 50 receives a signal from line buffer 48 via line 52 to indicate which character is to be printed. Row counter 54 is a conventional counter which, in the preferred embodiment, counts from 1 to 100. This corresponds to the number of rows for each line of print. The counter is incremented or advanced each time the drum rotation mark 32 is sensed by the transducer or read-head 34. Row counter 54 sends a count signal via line 56 to the character generator 50 indicative of the particular segment to be printed. The specific logic circuitry for accomplishing this is well known in the art. Since the information regarding the start and stop positions is stored in memory 50 in matrix form, similar to that seen in FIG. 3*b*, when a given row is reached on row counter 54 (e.g. row 4) that row (4) is activated for all characters in memory 50. This could be thought of as one input to each of a series of AND gates or the X input to the memory matrix. Then, as line buffer 48 sequentially goes from character to character along a given line, this would be the other input to the appropriate AND gates or the appropriate Y inputs to the memory matrix. The start and stop signals are then "read" from the matrix 50 as each AND gate goes on or as each position in the matrix has its X and Y inputs occur simultaneously. The "reading" of the start and stop signals from the matrix will be more fully explained hereinafter.

When the last row is printed for a particular line of print, character matrix 50 sends a reset signal via line 58 to the row counter 54 setting the counter back to zero and similarly sends a signal to the computer 44 via lead 60 to indicate that a new line of print should be introduced to the line buffer 48.

Position counter 62 receives signals from the timing track 36, via read-head 38, to indicate the position along the periphery of the drum and the corresponding position on the recording medium. It will be noted that there are 100 positions corresponding to the 100 columns for each character in a particular line of print. The position counter is reset by a signal generated by the timing track 32. That is, each revolution of the drum resets the position counter to 0 corresponding to the first column of the first character for that line of print. This the same signal which increments the row counter up to 100. Synchronization between the various line segments of each character and the various columns of each character is afforded by the two timing tracks on the drum and each line segment of each character will be printed at the appropriate location on the light sensitive recording media.

In operation, when a line of characters is to be printed, the position counter 62 is set at 0 by the reset pulse from timing track 32 (sensed by transducer 34) and the row counter 54 is set at 0 by the reset pulse from the character generator 50. Computer 44 send the line of characters to be printed to the line of characters buffer 48. In response to the query for the light modulation information for each character in the line (the query being sent along line 52), the start and stop signals from the character matrix 50 are sent along lines 64 and 66, respectively, to the line-of-characters buffer. The line-of-characters buffer then controls the rotation of the motor 20 which controls the transverse scanning motion of the optical system and also the modulation of the light source. With the row counter set at the first row of the character, the position counter 62, in response to the pulses generated by timing track 36, sends the necessary position information (column count) to the line buffer 48, via lead 68, to control the printing. In the illustration shown in FIGS. 3 and 4, with the row counter set at the first row of the character, when the position (column) counter reaches position 20, the light source will be turned on and remain on until position 50 is reached. This corresponds to the top line of the character R as seen in FIGS. 3*a* and 3*b*. When the next position 50 is reached, the light source will turned on and when position 52 is reached the light source will be turned off. This corresponds to the top of the character S as seen in FIGS. 3*b* and 4. Similarly, the first row for each character of the line of print will be formed. Note that position counter 62 could be internally wired to reset itself to zero each time it reaches 100 (corresponding to the 100 columns per character). Character selection may be accomplished in a conventional manner, such as by stepping shift register or including a character position counter in the system. At the completion of the first revolution of the drum, timing track 32 generates a signal which is picked up by read-head 34. This signal resets position counter 62, increments row counter 54 from 1 to 2, and the process is then ready to be repeated. Row counter 54 now indicates to the character generator that information for the second row of characters in the line is required. Character generator 50 sends the information for the second line of the queried characters via lines 64 and 66 to the character buffer 48 and the modulation of the light is performed according to the information in storage. This forms the second row of segments for the characters on this particular line of print. In a similar fashion, each of the 100 rows for each of the characters on one line of print will be printed on the recording media. At the conclusion of the 100th row, it is apparent that a larger space will be desired such that vertical spacing can be maintained between lines of print. A signal is generated via lead 70 causing motor 20 to speed up. Therefore, the optical system will be moved more quickly along the shaft 18. This signal via lead 70 may be generated by the computer 44 or by the line of characters buffer 48.

While a representative embodiment has been shown and described for the purpose of illustration, changes, substitutions and modifications may be made without departing from this invention in its broader aspects. Therefore, the invention

is not to be construed as limited to the specific embodiment described, but is intended to encompass those changes to the specification and drawings which are envisioned by those skilled in the art.

We claim:

1. Apparatus for printing characters in the form of a plurality of line segments, each character being defined by M columns and N rows, comprising:

a rotatable drum having an energy sensitive recording medium placed thereon,

an energy system including an energy source,

means for scanning said energy system parallel to the axis of said drum,

means for modulating said energy source to record line segments on said recording media,

each of said line segments having discrete beginning and end points,

means for controlling said modulating means, said scanning means, and the rotation of said drum in synchronism,

said controlling means including:

a. information storage means storing a unique representation of each symbol to be printed;

b. buffer storage means storing symbols to be printed in one line on said drum;

c. a row counter for counting the N rows for each symbol; and,

d. a column counter for counting the M columns for each symbol; and

said drum including first and second timing tracks, said first timing track generating signals to increment said column counter and said second timing track generating signals to increment said row counters and to reset said column counter.

2. The apparatus of claim 1 wherein said energy system is optical system and said energy source is a light source.

3. The apparatus of claim 1 wherein said controlling means causes the (N–1)–th row to be printed for each character on one line of characters on the drum before the N–th row of any characters on said line of characters.

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