

[54] **METHOD FOR GENERATING INFORMATION TO CONTROL THE SCANNING BEAM OF A DISPLAY DEVICE**

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[51] Int. Cl. .... H01j 29/70

[58] Field of Search ..... 315/18; 178/6.8, 178/7.6, 7.1 E, DIG. 27; 250/219 DD

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Assistant Examiner—J. M. Potenza

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[57] **ABSTRACT**

An enlarged photographic transparency of a print character to be displayed on a cathode ray tube is placed between a directional light source and a directional light detector aligned with the light source. Relative motion is introduced between the transparency and the aligned source and detector to form a vertical rectilinear scanning pattern across the transparency. Each subject print character is placed on the transparency between two reference characters that are in predetermined spatial relationship to the boundaries of the em square of the subject character. A series of binary indications corresponding to the elemental areas of the scanning pattern is produced from the response of the detector and stored on a first storage medium. Then, the indications representing the reference characters are sensed. From the indications representing the reference characters, the indications that represent the boundaries of the em squares of the subject characters are determined. Finally, the indications within the boundaries of the em squares of the subject characters are selectively transferred to a second storage medium. The subject characters are retrieved from the second storage medium as required to control the electron beam of the cathode ray tube.

10 Claims, 5 Drawing Figures

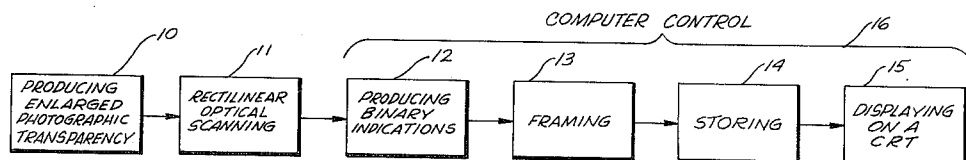


FIG. 2

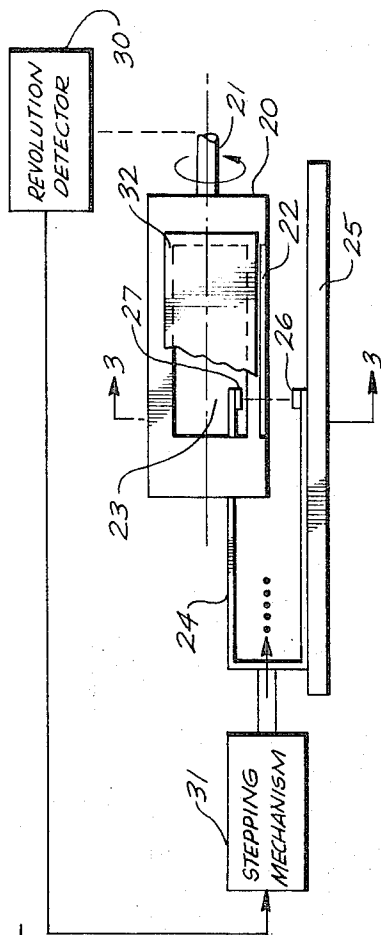


FIG. 3

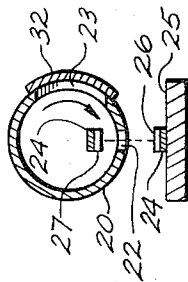


FIG. 1

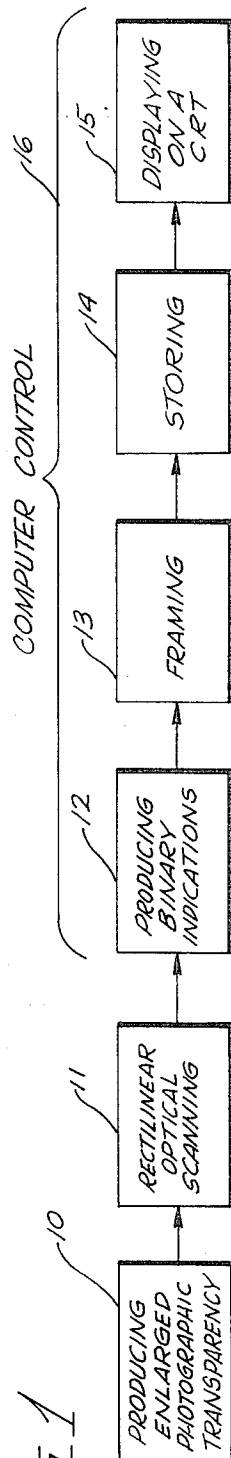
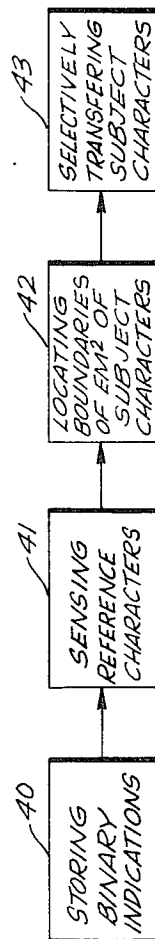


FIG. 4

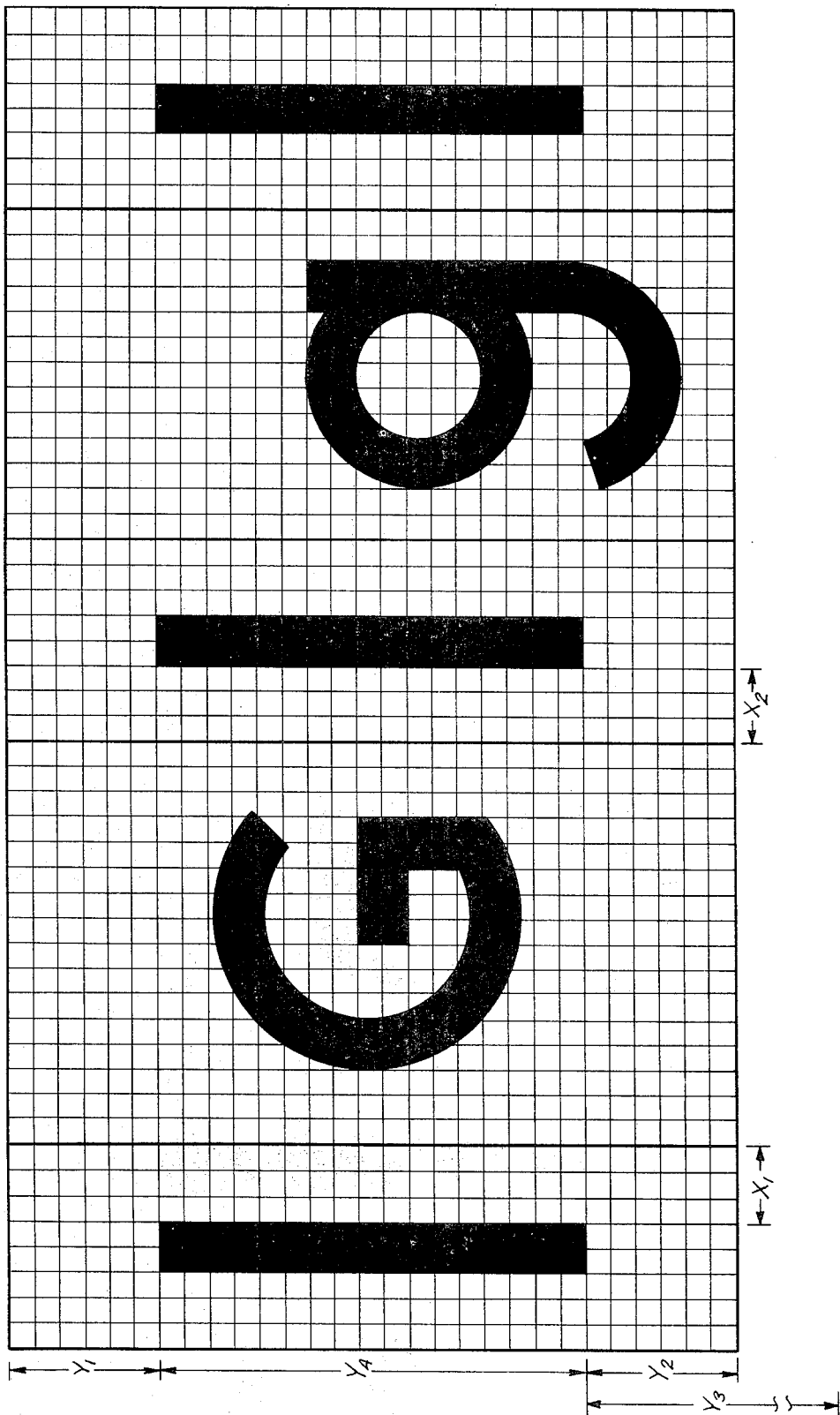


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FIG. 5



# METHOD FOR GENERATING INFORMATION TO CONTROL THE SCANNING BEAM OF A DISPLAY DEVICE

## BACKGROUND OF THE INVENTION

This invention relates to the printing art and, more particularly, to the generation of information to control the scanning beam of a display device in an electronic typesetting operation.

A recent development in the printing art is the use of a cathode ray tube to electronically set type for newspapers and other printed material. The page to be printed is displayed on the face of the cathode ray tube and photographically transferred therefrom to a plate coated with a photo-sensitive monomer. When the plate is developed, it is transformed into a printing plate, the areas exposed to light being raised relative to the unexposed areas. For a process to reproduce such printing plates for multiple press operation, reference is made to my copending U.S. Pat. application, Ser. No. 16,485, filed Mar. 4, 1970, and assigned to the assignee of the present application.

There are a number of commercially available cathode ray tubes specifically designed for electronic typesetting. For the most part, these are sophisticated display devices having high resolution and complex electronic control circuitry. The scanning pattern of such display devices is substantially rectilinear due to the high resolution and moves across the face of the cathode ray tube in successive vertical sweeps that correspond to the height of the line of type being reproduced on the face of the cathode ray tube. The character information for controlling the electron beam of the cathode ray tube is stored as binary indications in a memory and fed to the beam control apparatus of the cathode ray tube by a programmed digital computer.

Attempts to generate the character information for controlling the electron beam of the cathode ray tube by scanning techniques have proved unsuccessful. Presently, the character information is generated manually in the following way: A photographic transparency of the subject character is projected onto a screen to enlarge it. An artist draws the outline of the subject character from the projection. The subject character is segmented into elemental areas by placing a grid over the character outline. A human worker digitizes the character outline to conform to the lines of the grid. A key punch operator records the digitized character outline on a storage medium, grid area by grid area, thereby producing a series of binary indications that represent the character information in a form capable of reproducing the subject character on the face of a cathode ray tube.

It is also necessary to frame each character properly within its grid, i.e., to place the character in its proper location within the em square allotted to such character. Otherwise, the characters displayed on the face of the cathode ray tube will not be arranged properly with respect to each other and the aesthetic effect of the character font will be diminished.

A substantial amount of human time and effort is required to generate the binary beam control information representing even a single character and to frame such character information properly within its em square. Most printing operations require thousands of characters. For example, a typical newspaper printing operation might require about ninety different type fonts,

each in about three or four different sizes and each size having eighty or ninety characters. Thus, about thirty-thousand different characters are required in a typical newspaper printing operation.

## SUMMARY OF THE INVENTION

One aspect of the invention involves the use of a directional light source and a directional light detector aligned with the source to generate the information for controlling the electron beam of a cathode ray tube designed for electronic typesetting. First, the graphic item to be displayed on the face of a cathode ray tube is produced in enlarged form on a photographic transparency. The transparency is placed between the light source and the detector. Relative movement between the transparency and the aligned source and detector is introduced to scan the transparency. Preferably, a rectilinear vertical scanning pattern is employed. The indications of the detector responsive to the scanning of the transparency are stored on a storage medium as a source of information to control the electron beam of a cathode ray tube. Preferably, these indications are in binary form if the graphic item to be displayed on the face of the cathode ray tube comprises a print character.

Another aspect of the invention involves framing the character information generated in the manner described above properly within the em square of the character. A subject character is placed adjacent to a reference character that is in predetermined spatial relationship to the boundaries of the em square of the subject character. The subject and reference characters are scanned together in the course of the same scanning pattern to produce a series of indications corresponding to the elemental areas of the scanning pattern. The indications representing the reference character are sensed. From the indications representing the reference character, the indications which represent the boundaries of the em square of the subject character are determined. The indications representing the subject character are stored on a storage medium for use to control the beam of a display device. Preferably, a reference character is placed on both sides of each subject character so the reference characters also define the width of the em square of the subject character.

A feature of the framing aspect of the invention is the manner in which the series of indications corresponding to the elemental areas of the scan pattern is processed. First, the series of indications is stored on a first storage medium. After the boundaries of the em square of the subject characters are determined, only the indications within the boundaries of the em squares of the subject characters are selectively transferred from the first medium to a second storage medium, thereby eliminating the reference characters. The second storage medium comprises the source of character information for controlling the beam of the display device.

## BRIEF DESCRIPTION OF THE DRAWINGS

The features of a specific embodiment of the best mode contemplated of carrying out the invention are illustrated in the drawings, in which:

FIG. 1 is a block diagram depicting a method of generating character information for controlling the electron beam of a cathode ray tube to electronically type-set a page to be printed.

FIGS. 2 and 3 are a side elevation view and a section view, respectively, of apparatus for carrying out a rectilinear optical scan in accordance with the method depicted in FIG. 1.

FIG. 4 is a block diagram of the individual steps of the framing operation depicted in the method of FIG. 1.

FIG. 5 is a diagram depicting several subject and reference characters placed in a predetermined spatial relationship to each other.

#### DETAILED DESCRIPTION OF THE SPECIFIC EMBODIMENT

The blocks in FIG. 1 represent the steps involved in generating character information for controlling the electron beam of a cathode ray tube to display on its face print characters. Block 10 represents the step of producing an enlargement of one or more print characters on a photographic transparency. Block 11 represents the step of optically scanning the transparency in a rectilinear, preferably vertical, scanning pattern. This scanning step is discussed in more detail below in connection with FIGS. 2 and 3. Block 12 represents the step of producing a series of binary indications corresponding to the successive elemental areas of the scanning pattern. Typically, these binary indications would be produced by periodically sampling the output of a light detector that is part of the optical scanning equipment. If the output of the light detector falls below a threshold level, one binary value is indicated, and if it lies above the threshold level, the other binary value is indicated. Block 13 represents the step of framing each character within its em square, i.e., determining which binary indications represent the boundaries of the em square of each character. The framing step is described in detail below in connection with FIGS. 4 and 5. Block 14 represents the step of storing the binary indications corresponding to the framed characters. Block 15 represents the step of displaying characters on a cathode ray tube, the electron beam of which is controlled by the stored binary indications. As represented by a bracket 16, the steps represented by blocks 12 through 15 can be carried out under the control of a programmed digital computer. Steps 12 through 15 are per se old to the art. The invention involves the production of the binary indications by optically scanning an enlarged photographic transparency of the characters and the particular manner of framing the characters within their em squares.

Reference is now made to FIGS. 2 and 3 for a description of apparatus that scans the enlarged photographic transparency. The degree of enlargement depends upon the difference in size of the elemental scanning areas of the optical scanning pattern represented by block 11 and the electron beam scanning pattern represented by block 15 and further depends upon the size in which the character is to be displayed on the cathode ray tube. A hollow cylindrical drum 20 is supported by a rotatable shaft 21. During the scanning operation, shaft 21 is driven by a motor, not shown, at a constant angular velocity. Drum 20 has a narrow rectangular slot 22 and a wide rectangular slot 23. A carriage 24 is mounted on a frame 25 to translate in a direction parallel to the axis about which drum 20 rotates. A directional light source 26 is mounted on one arm of carriage 24, which lies outside drum 20, and a directional light detector 27, such as a photocell, is

mounted on the other arm of carriage 24, which is located inside drum 20. Source 26 and detector 27 are aligned with each other so light is coupled from source 26 to detector 27 in the absence of opacity in the path between them. A revolution detector 30 is coupled to shaft 21. Each time shaft 21 makes a revolution, detector 30 produces a pulse that actuates a stepping mechanism 31. Stepping mechanism 31 is coupled to carriage 24. Accordingly, after each revolution of drum 20, source 26 and detector 27 are advanced as a unit a discrete distance to the right, as viewed in FIG. 2. A photographic transparency 32 bearing the print character or characters to be scanned is mounted over slot 23. As drum 20 rotates, source 26 and detector 27 scan transparency 32 in successive parallel semicircular sweeps, each of which lies in a plane perpendicular to the axis of drum 20.

The characters are oriented on transparency 32 so that they are readable with drum 20 in the position shown in FIG. 2. Thus, the scan pattern traverses the characters in rectilinear, vertical sweeps displaced successively from each other, moving from left to right. The output of detector 27 varies, depending upon whether the area of transparency 32 in the path of source 26 at any given moment is opaque or translucent. A series of periodic sampling pulses are produced in synchronism with the rotation of drum 20. The output of detector 27 is sampled responsive to each pulse. If the sample of the output of detector 27 is above a particular threshold level, a first binary value is indicated, and if it is below the threshold level, a second binary value is indicated. Thus, for each rotation of drum 20, a series of binary indications are produced equal in number to the number of sampling pulses produced per revolution of drum 20. A first segment of this series of binary indications, corresponding to the rotation of slot 22 between source 26 and detector 27, are all of the first binary value. A second segment of this series, corresponding to the rotation of slot 23 between source 26 and detector 27, vary between the first binary value and the second binary value depending upon the nature of the characters on transparency 32. These are the binary indications of interest. A third segment of this series, corresponding to the rotation of the small portion of drum 20 separating slots 22 and 23 between source 26 and detector 27, are all of the second binary value. A fourth segment of this series, corresponding to the rotation of the remainder of drum 20 between source 26 and detector 27 are all of the second binary value. Revolution detector 30 is adjusted to actuate stepping mechanism 31 immediately prior to the passage of slot 22 between source 26 and detector 27. Thus, the first segment of each series of indications serves as a marker to designate the beginning of each vertical sweep. This marker can be used to set the electronic reading circuitry associated with detector 27 and to indicate the beginning of the second segment in the course of processing the binary indications produced from detector 27. Since the portion of drum 20 separating slots 22 and 23 has a known constant arc, a given number of sampling pulses always occur between the end of the first segment of binary indications and the beginning of the second segment of binary indications. The number of sampling pulses produced per revolution of drum 20 and the amount that carriage 24 is advanced each revolution determine the size of the elemental areas of the

scanning pattern. One binary indication represents each such elemental area.

Optical scanning of the characters in the manner shown in FIGS. 2 and 3 produces electron beam controlling character information of high quality without appreciable manual labor. Human intervention is only required to mount the transparencies on drum 20 and to start the drive motor for drum 20. A digital computer can be programmed to process the output of detector 27 via an analog-to-digital converter.

As used in this specification, the term "em square" means the space allotted to a particular character. The vertical height of the em squares of the characters in any one font and size are identical but the horizontal width of such em squares vary from character to character. For example, a "W" has a wider em square than an "I." A difficulty associated with scanning the characters is the framing of the characters within their respective em squares, in other words, determining which binary indications in the series of vertical sweeps represent the boundaries of the em square of each character. It is essential to the display of the characters in their proper spatial relationship to each other on the cathode ray tube that the characters be properly framed within their respective em squares.

The invention accomplishes framing by placing on either side of each character to be scanned, hereafter called "a subject character," a reference character that is in predetermined spatial relationship to the boundaries of the em square of the subject character. Specimens of all the characters of a type font in their proper relative spatial relationship are readily available from designers of printing type. In ordering these specimens, it is simply necessary to specify that some selected reference character be placed on either side of each subject character in the font in its proper relative spatial relationship.

Reference is made to FIG. 5, in which an upper case "G," a lower case "g," and three reference characters are shown. A simplified "I" is selected as the reference character for ease of detection. In principle, any other unique, detectable symbol could be selected as the reference character. As depicted in FIG. 5, one reference character that lies between two subject characters can help to frame both of these subject characters. In other words, it is not necessary to have four reference characters to frame two adjacent subject characters; three reference characters will suffice, one being shared by both subject characters. The grid superimposed upon the characters in FIG. 5 represents the elemental areas of the scanning pattern. In other words, the areas of the grids correspond to the binary representations, a black area being one binary value and a white area being the other binary value. In practice, many more elemental areas would be employed than are actually shown in FIG. 5. The heavy lines surrounding each character represent the boundaries of the em square of such character. Only the elemental areas inside the boundaries of the em squares are represented. For the purpose of illustration, it is assumed that the optical scanning beam starts from the lower lefthand corner in FIG. 5, and moves upward from elemental area to elemental area in successive vertical sweeps that progress from left to right. The number of elemental areas from the edges of a reference character to the boundaries of its em square are known. As represented in FIG. 5, the number of elemental areas from the top edge of the ref-

erence character to the top boundary of its em square is " $Y_1$ ," the number of elemental areas from the bottom edge of the reference character to the bottom boundary of its em square is " $Y_2$ ," the number of elemental areas from the right edge of the reference character to the right side boundary of its em square is " $X_1$ ," and the number of elemental areas from the left edge of the reference character to its left side boundary is " $X_2$ ." It can be seen from FIG. 5 that the top boundary of the em squares of the reference characters is also the top boundary of the em squares of the subject characters, e.g. the upper case "G" and the lower case "g," the lower boundary of the em squares of the reference characters is also the lower boundary of the em squares of the subject characters, the righthand boundary of the em square of each reference character is the lefthand boundary of the em squares of the adjacent subject character, and the lefthand boundary of the em square of each reference character is also the righthand boundary of the em square of the adjacent subject character. In short, the boundaries of the em square of each subject character are defined by the em square boundaries of the adjacent reference characters which are known from the position of such reference characters.

One way in which the boundaries of the em squares of the subject characters can be determined from the position of the adjacent reference characters is as follows: Count the number of elemental areas,  $Y_3$ , from the beginning of the second segment to the lower edge of the reference character. Subtract  $Y_2$  from  $Y_3$  to find the number of elemental areas from the beginning of the second segment to the lower boundary of the em square of the subject character on each vertical sweep. Add  $Y_3$ ,  $Y_4$  (the number of elemental areas in the length of the reference character), and  $Y_1$  to find the number of elemental areas from the beginning of the second segment to the upper boundary of the em square of the subject character on each vertical sweep. Count a number of vertical sweeps  $X_1$ , from the right edge of the lefthand adjacent reference character to find which vertical sweep is the lefthand boundary of the em square of the subject character. Count a number of vertical sweeps  $X_2$  from the left edge of the righthand adjacent reference character to find which vertical sweep is the righthand boundary of the em square of the subject character. Only the series of binary indications for those vertical sweeps between the vertical boundaries of the em square of the subject character thus determined are used as the character information. Further, within such series, only those binary indications between the horizontal boundaries of the em square of the subject character thus determined are used as the character information.

FIG. 4 represents the steps involved in framing the subject characters in their respective em squares. As represented by a block 40, the series of binary indications derived from the output of detector 27 are stored on a first storage medium, such as magnetic tape. These binary indications represent both the subject characters and the reference characters. As represented by a block 41, the reference characters stored on the first storage medium are sensed. As represented by a block 42, the boundaries of the em square of each subject character are then located by means of the reference characters in the manner described in the preceding paragraph or in some other manner. As represented by

a block 43, the subject characters are selectively transferred to a second storage medium; in other words, only the binary indications lying between the boundaries of the em squares of the subject characters are transferred to the second storage medium. The second medium serves as a source of beam controlling character information for the cathode ray tube. The framing operation could be carried out with a programmed digital computer or by hand. In the latter case, the first storage medium could be a paper printout on which the series of binary indications derived from the output of detector 27 are visible to a human being. The reference characters are sensed by visually observing where its edges are located in the series of binary indications and the boundaries of the em square of each subject character are located by manually counting the binary indications in the manner described in the preceding paragraph. The binary indications within the boundaries of the em square of each character could then be put into an electronic memory by a key punch operator.

The described embodiment of the invention is only considered to be preferred and illustrative of the inventive concept; the scope of the invention is not to be restricted to such embodiment. Various and numerous other arrangements may be devised by one skilled in the art without departing from the spirit and scope of this invention. For example, the optical scan could also be employed to generate electron beam control information concerning pictorial material, in which case the output of detector 27 would be converted into a multiple digit code instead of binary indications. Further, it would be possible to use one reference character to frame a subject character, instead of two, if the widths of the em squares were for some reason either known or constant.

What is claimed is:

1. A method for displaying graphic information on the face of a cathode ray tube having an electron beam, the method comprising the steps of:

producing the information to be displayed on a photographic transparency by placing a subject print character adjacent to a reference character that is in predetermined spatial relationship to the boundaries of the em square of the subject character; placing the transparency between a point source of light and a point detector of light aligned with each other; introducing relative movement between the transparency and the aligned point source and detector to scan the subject and reference characters on the transparency together; storing the indications of the detector responsive to the scanning of the transparency; and controlling the electron beam of the cathode ray tube responsive to the stored indications so as to reproduce on the face of the cathode ray tube the subject print character on the transparency.

2. The method of claim 1, in which the step of introducing relative movement between the transparency and the aligned point source and detector comprises the steps of:

mounting the transparency over a slot on a rotating drum; placing the light source and light detector on opposite sides of the drum; and

translating the light source and detector as a unit parallel to the axis of rotation of the drum a discrete distance after each revolution of the drum.

3. A method of generating character information for controlling the electron beam of a cathode ray tube to display on its face print characters, the method comprising the steps of:

producing an enlarged photographic transparency of the character to be displayed and reference marks in predetermined spatial relationship to the boundaries of the em square of the character to be displayed;

aligning a directional light source and a directional light detector so as to couple light to the detector in the absence of opacity between the source and the detector;

introducing relative motion between the transparency and the aligned source and detector so as to scan together the character to be displayed and the reference marks on the transparency;

producing binary indications representative of the character and the reference marks responsive to the detector while the transparency is being scanned; and

storing the binary indications for the control of the electron beam.

4. A method for generating character information to control the scanning beam of a print character display device, the method comprising the steps of:

placing a subject character adjacent to a reference character that is in predetermined spatial relationship to the boundaries of the em square of the subject character;

scanning the subject and reference characters together to produce a series of indications corresponding to the elements of scanning pattern;

sensing the indications representing the reference character;

determining which indications represent the boundaries of the em square of the subject character from the indications representing the reference character; and

storing the indications representing the subject character.

5. A method for generating print character information to control the beam of a print character display device, the method comprising the steps of:

placing a plurality of characters to be generated on a printing medium in their proper spatial relationship to each other;

placing on both sides of each character to be generated two reference characters that are in predetermined spatial relationship to the boundaries of the em square of such character to be generated;

scanning the reference characters and the characters to be generated together to produce a series of indications corresponding to the elemental areas covered by such scanning;

storing the series of indications on a first storage medium;

sensing those indications of the series stored on the first medium representing the reference characters;

determining from the indications representing the reference characters which indications represent the boundaries of the em square of each character to be generated; and

transferring from the first medium to a second storage medium only the indications within the boundaries of the em squares of the characters to be generated.

6. The method of claim 5, in which the printing medium comprises an enlarged photographic transparency of the characters to be generated and the reference characters, and the step of scanning the reference characters and the characters to be generated comprises the steps of:

mounting the transparency over a slot on a rotating drum;

placing the light source and light detector on opposite sides of the drum; and

translating the light source and detector as a unit parallel to the axis of rotation of the drum a discrete distance after each revolution of the drum.

7. A method for displaying graphic information on the face of a cathode ray tube having an electron beam, the method comprising the steps of:

producing an enlarged photographic transparency of the character to be displayed;

mounting the transparency over a slot on a rotating drum;

aligning a directional light source and a directional light detector on opposite sides of the drum so as to couple light to the detector in the absence of opacity between the source and the detector;

translating the light source and detector as a unit parallel to the axis of rotation of the drum a discrete distance after each revolution of the drum;

producing binary indications representative of the character responsive to the detector while the transparency is being scanned;

storing the binary indications; and

controlling the electron beam of the cathode ray tube responsive to the stored binary indications so as to reproduce on the face of the cathode ray tube the character to be displayed.

8. A method for generating character information to control the scanning beam of a print character display device, the method comprising the steps of:

placing a character to be generated on a printing medium;

placing on both sides of the character to be generated

two unique reference characters that are in predetermined spatial relationship to the boundaries of the em square of the character to be generated; scanning the character to be generated and the reference characters together to produce a series of indications corresponding to the elements of the scan;

sensing the indications representing the reference characters;

determining from the indications representing the reference characters which indications represent the boundaries of the em square of the character to be generated; and

storing the indications representing the character to be generated for the control of the scanning beam of the display device.

9. A method for displaying print characters on the face of a print character display device, the method comprising the steps of:

placing a plurality of subject characters and unique reference characters in a row in proper spatial relationship to one another, reference characters being located at both ends of the row and alternating with subject characters between the ends of the row;

scanning the subject and reference characters together to produce a series of binary indications corresponding to the elements of the scan;

sensing the binary indications representing the reference characters;

determining which indications represent the boundaries of the em squares of the subject characters from the binary indications representing the reference characters;

storing the binary indications representing the subject characters; and

controlling the scanning beam of the display device responsive to the stored binary indications so as to reproduce on the face of the display device the subject characters.

10. The method of claim 5, in which one reference character serves to determine in part the boundaries of the em squares of the characters to be generated on both sides of such reference character.

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UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTIONPatent No. 3,783,331 Dated January 1, 1974Inventor(s) JOHN C. DARNALL

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

Column 1, line 18, delete "For a process to reproduce such";  
lines 19 through 22, delete in their entirety.

Column 8, line 37, between "of" and "scanning" insert --a--.

Column 10, line 19, between "device" and the comma insert  
--having a controllable scanning beam--.

Signed and sealed this 29th day of October 1974.

(SEAL)  
Attest:

McCOY M. GIBSON JR.  
Attesting Officer

C. MARSHALL DANN  
Commissioner of Patents

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PO-1050  
(5/69)

UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

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