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[54] **WIDE SPAN PATTERN GENERATOR**
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[50] Field of Search 178/15, 90,
6.7; 340/324.1, 172.5; 315/21; 346/110

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ABSTRACT: A method and apparatus for positioning at least one terminal point of the scan of a medium by a beam is disclosed. The beam is moved in the direction of the scan from one point past a fiducial point having a known position with respect to the medium. There is registered a quantity related to the distance the beam moved from one point to the fiducial point. Thereafter, during scans of the medium, the one terminal point is shifted along the direction of the scan by a distance related to the registered quantity.

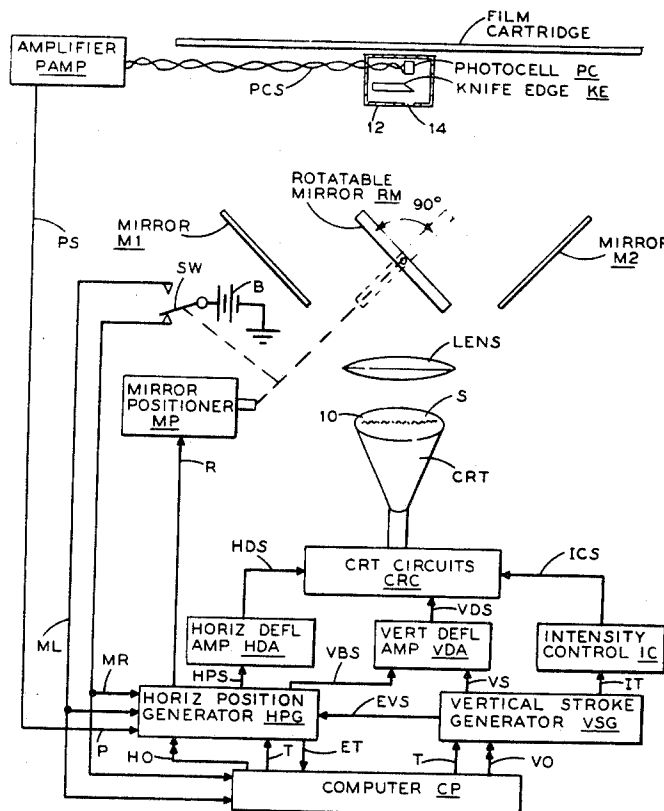


FIG. 1

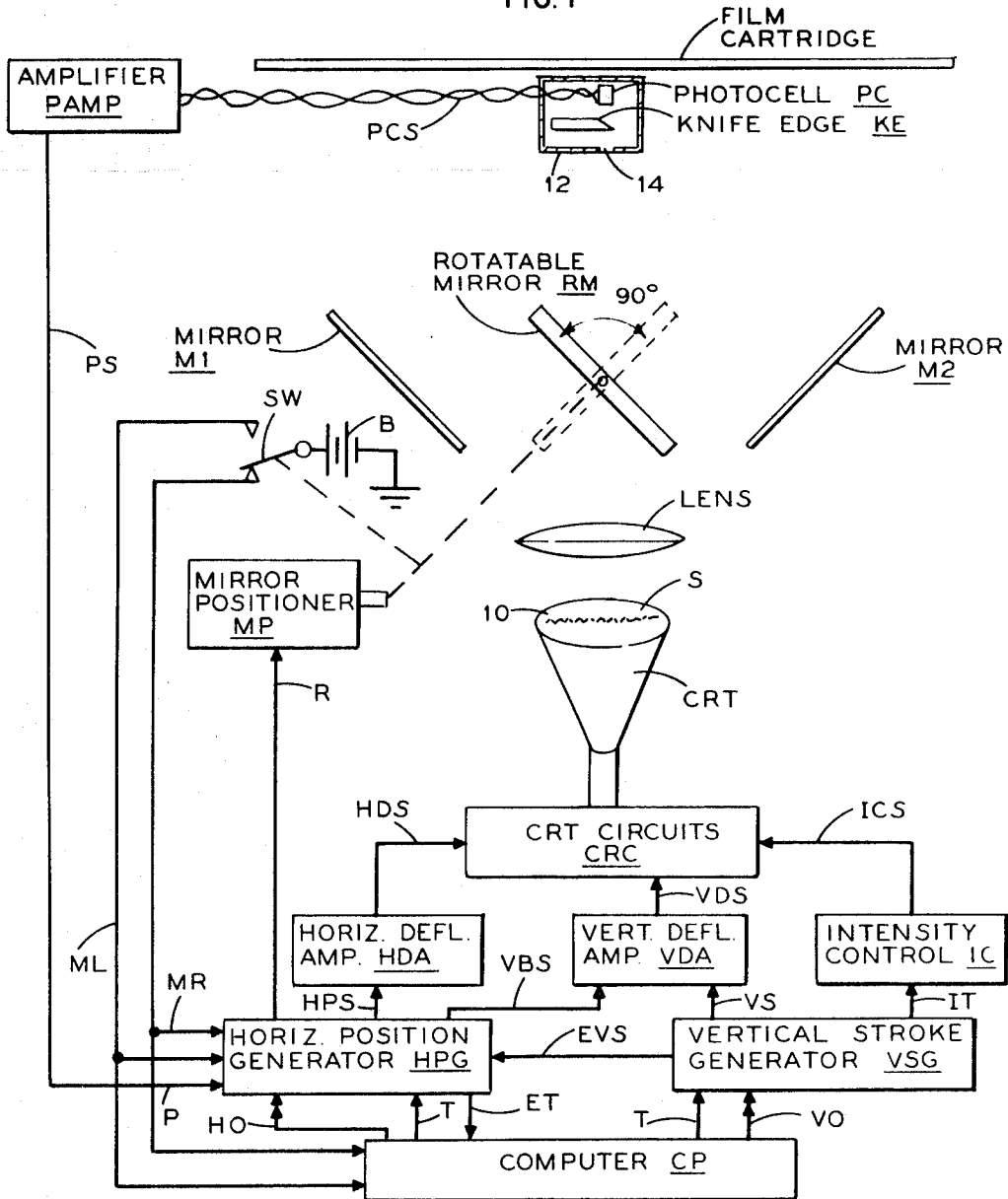
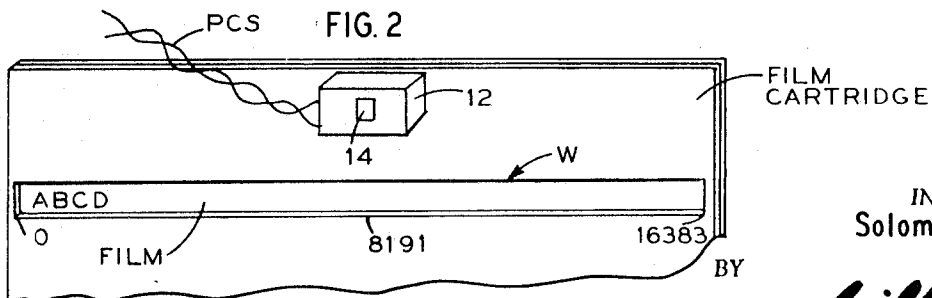


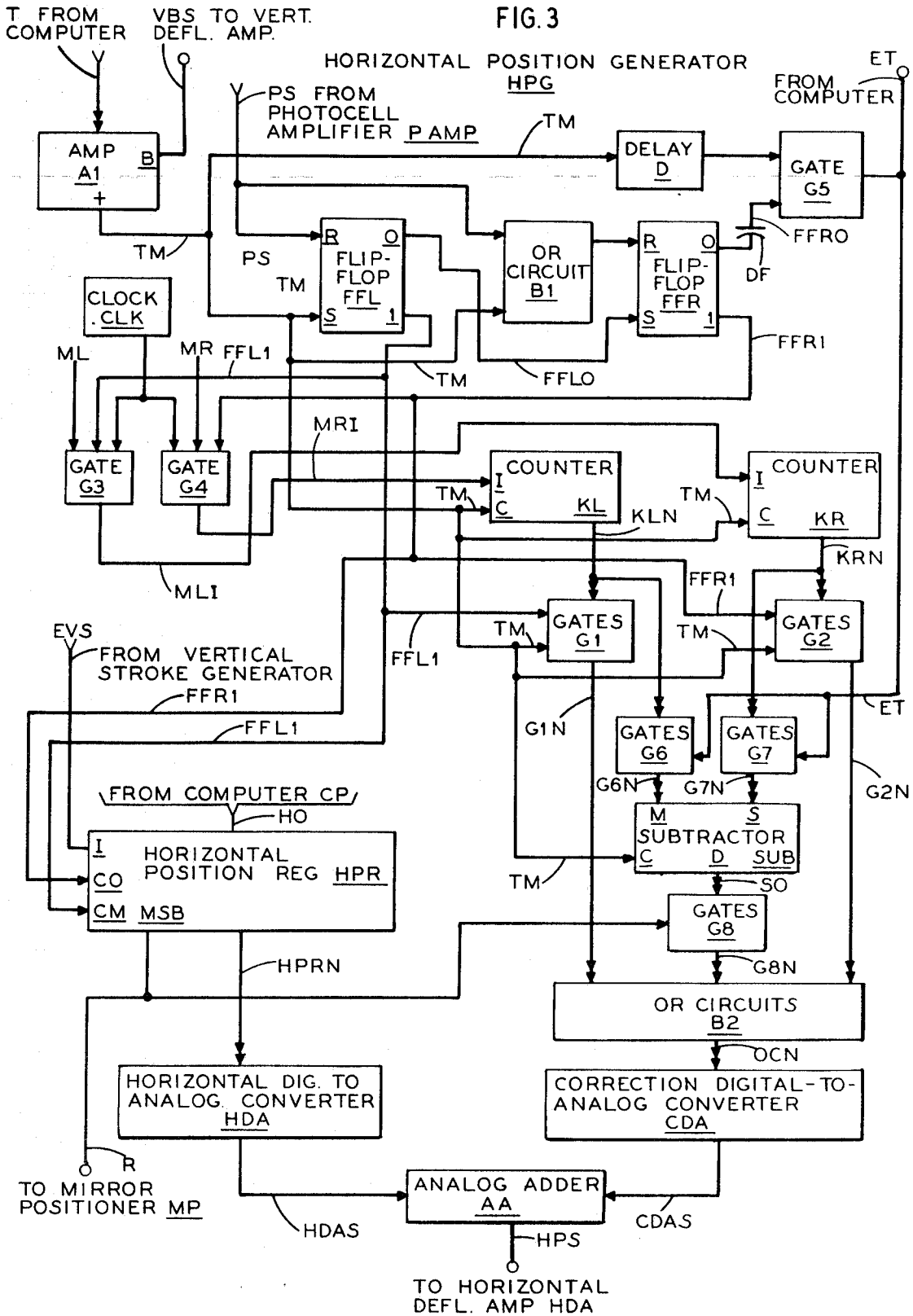
FIG. 2



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FIG. 3



WIDE SPAN PATTERN GENERATOR

This invention pertains to pattern generators and more particularly to pattern generators for recording symbols on a wide span record medium.

Within the past few years there has become available graphic arts quality pattern generators of the type using a cathode-ray tube whose image is projected onto a record medium such as photographic film. The characters are built up of varying length parallel vertical strokes which abut each other in a horizontal direction. A typical pattern generator of this type is shown in U.S. Pat. No. 3,305,841. In order to obtain high-quality patterns, the cathode-ray tube should have a resolution of greater than 700 line pairs per inch and must have a minimum of distortion. These requirements limit the diameter of the cathode-ray tube and consequently the width dimension of record medium. Magnifying optical systems for increasing the width dimension of the cathode-ray tube image scan of the record medium can only double the width for all practical purposes. A mere doubling of the width cannot satisfy many of the present requirements of the printing industry. An example will make the point clear. Present high-quality and economically realistic cathode-ray tubes of the type herein required have only a practical scan width of about four inches. A practical and economically feasible magnification is 2-to-1. Thus the cathode-ray tube's scan is effectively about eight inches. Therefore, it is possible to print on record mediums having an eight inch width. Such a width is suitable for printing of many conventional size books and the like. However, many magazines, newspapers and other books have greater page widths.

A solution to the problem is to use one optical path to scan the left side of the record medium for writing the characters or symbols for that side and to use another optical path to scan and write on the right side of the record medium. It is possible to use two cathode-ray tubes with each focused at one half of the record medium. A more economic solution is to use one cathode-ray tube with a rotatable mirror or other optical means to alternately project the image of the cathode-ray tube first to left half of the record medium while the left half of a line of symbols is written, and, then, to the right half of the record medium while the right half of same line of symbols is written. With either scheme there is a change of the optical paths somewhere around the midpoint of the line of recorded symbols.

This transition of optical paths can create registration problems. There will be a misregistration of the right end of the scan via the left optical path with the left end of the scan via the right optical path, the adjacent terminal points of the scans. If this misregistration is slight and occurs in the space between symbols it may not be noticeable to the human eye. However, it is more likely that the transition will occur while a symbol is being written. Such misregistration will cause partial overlap of portions of the symbol or an intrasymbol gap. Both phenomena are noticeable upon visual inspection. In fact, since these misregistrations occur in each line, there is a subjective magnification of the misregistration. It should be noted that even slight misregistration will be apparent when it is realized the cathode-ray tube generates lines in the order of a thousandth of an inch in width.

Because of these very fine widths it is virtually impossible from a practical point of view to align precisely the two optical paths and to maintain this alignment over an extended period of time. Therefore, exact mechanical alignments are not a solution to the problem.

It is accordingly an object of the invention to provide a practical reliable and automatic solution to the above-stated problem.

Briefly, the invention is directed to registering the adjacent terminal points of at least two adjacent scans of a record medium by a recording beam which scans a first portion of the record medium via a first path and scans a second portion of the record medium via a second path. This is accomplished by having a fiducial point which is related to an intermediate point of the two adjacent partial scans, for example a point

where the transition from one scan to the other should occur when the record medium is scanned. A first partial scan, via the first path, is performed by the recording beam past the fiducial point and there is registered a first parameter related to the position of this scan when the recording beam is detected crossing the fiducial point. A second partial scan, via the second path, is performed by the recording beam past the fiducial point and there is registered a second parameter related to the position of this second scan when the recording beam is detected crossing the fiducial point. The terminal point of one of the adjacent scans is then displaced by a distance related to the difference of the two registered parameters.

Other objects, the features and advantageous of the invention will be apparent from the following detailed description when read with the accompanying drawings which show by way of example presently preferred apparatus for practicing the invention.

In the drawing:

FIG. 1 shows, primarily in block diagram form, a cathode-ray tube pattern generator system for recording symbols on a record medium;

FIG. 2 is a partial view of the record medium plane as seen by the cathode-ray tube; and

FIG. 3 is a block diagram of the horizontal position generator of the system of FIG. 1.

For the sake of simplicity, several conventions will be used. The signal lines which interconnect the units will bear the same reference numeral as the name of the signals and the signal name and signal line reference numeral may be used interchangeably. For example, the HPS signal is transmitted on the HPS signal line. Generally, only signal flow will be described. Therefore, a statement such as the HPS signal is transmitted from the horizontal position generator HPG to the horizontal deflection amplifier HDA means that there is transmitted a signal on the HPS signal line which connects horizontal position generator HPS to horizontally deflection amplifier HDA. Furthermore, some signal lines are actually cables of lines and these are designated by double arrowhead lines and generally carry coded combinations of signals representing binary numbers. See, for example, line HO which connects computer CP to horizontal position generator HPS. In this vein, statements such as "a number is transmitted from one unit to another unit" means that the coded combination of signals representing the number is transmitted.

The system of FIG. 1 records characters generated on the face of a cathode-ray tube CRT by projecting their images onto a photographic film FILM. During the generation of characters, the cathode-ray tube CRT is driven to form a raster of short-height vertical strokes which are centered on a horizontal diameter 10 on the face plate of the cathode-ray tube CRT. While this raster is generated, the electron beam of the cathode-ray tube CRT is turned on and off at particular times in the stroke in accordance with numbers represented by coded combinations of signals received by the vertical stroke generator VSG from the computer CP. At the end of each vertical stroke the electron beam is normally deflected one increment in the horizontal direction and a new stroke is initiated.

Now, the screen S of the cathode-ray tube CRT is projected by an optical system LENS onto the photographic film in a film cartridge having an opening or window W (FIG. 2). A horizontal line of the film at the window can be visualized as being a series of equispaced points along one coordinate axis of a grid system wherein, say, the left-hand edge is coordinate 0, the midpoint 8,191 and the right-hand edge 16,383 for normal reader viewing. Therefore, any horizontal position on the film can be specified by a number. (It should be noted that these numbers are given by way of example and not limitation). The numbers from 0 to 8,191 encompass the left half of the film and the numbers 8,192 to 16,383 the right half of the film. In addition, during the generation of patterns, the horizontal diameter 10 of the cathode-ray tube screen S (ac-

usually only the central portion thereof, say, four inches of a five inch length), can also be visualized as a series of such points with one end having a value 0 and the other end the value 8,191. If it be assumed for the sake of simplicity that there is no left/right inversions through the optical system, then the point 0 is 2 inches to the left of the center of the screen and the point 8,191 is 20 inches to the right of the center of the screen. It should be noted that there is still some available deflection to the left of the point 0 and to the right of the point 8,191. This extra deflection will be used in a test mode which is hereinafter described. However, for the present, it should be ignored.

The image of the screen of the cathode-ray tube is controllably projected onto either the left half of the film or the right half of the film. Thus each point on the horizontal diameter of the cathode-ray tube's screen is related to one point on the right half of the film and one point on the left half of the film. For example, ideally, the point 0 on the cathode-ray tube screen should project to either the point 0 on the film or the point 8,192 on the film. It is therefore, possible to address where any vertical stroke will be written on the film. The horizontal position generator HPG stores the numbers, one at a time, representing the desired address and generates two signals, one representing the horizontal position of the beam of the cathode-ray tube CRT and the other representing which of two optical paths will be used to project the image of the screen onto the film.

With this in mind, the system comprises a computer CP which transmits serially the numbers representing the lengths of the vertical strokes via the signal lines VO to the vertical stroke generator VSG. It can also transmit numbers representing the horizontal position of a vertical stroke via the HO lines to the horizontal position generator HPG. In addition, it can transmit a calibrate test signal, via line T, to the horizontal position generator HPG and receive therefrom an end of test signal ET. The vertical stroke generator VSG can be considered to include means for generating the equivalent of a periodically recurring linear sawtooth signal which is transmitted via line VS to vertical deflection amplifier VDA, and means for emitting an EVS pulse at the end of each sawtooth signal. It also includes a counting register which unit increments to increase the count in synchronism with the amplitude of the sawtooth signal; and a comparator for comparing the accumulated count with a number received from the VO signal lines to generate IT signals fed to intensity control IC for changing the state of the electron beam of the cathode-ray tube CRT whenever an equality is detected. Further details may be found in the above cited U.S. Pat. No. 3,305,841. In addition, when it receives the test signal T from the comparator it generates a signal which insures that the electron beam is on and no sawtooth is generated.

The intensity control IC can be a one stage binary counter which changes state each time it receives an IT signal and transmits a signal via line ICS to a suitable amplifier in the cathode-ray tube circuits CRC for controlling the control grid (Z-axis) of the cathode-ray tube CRT. The vertical deflection amplifier VDA can be a suitable analog adder which can amplitude add the signal on line VS (the sawtooth wave form source) and the signal on line VBS (a signal of constant amplitude when present). As a practical matter, only one of the signals is present at any given time, so that the adder can be considered as an analog OR circuit. The output of the amplifier is fed via the VDS signal line to the vertical deflection circuits of the cathode-ray tube assemblage.

The horizontal position generator HPG is used to control the horizontal positioning of the image on the film. For the present, it can be considered to include a register which can be set to a given number and the number can be unit incremented. The signals representing the stored number are converted by a digital-to-analog converter to a signal whose amplitude is a function of the stored number. This signal is fed via the HPS signal line to the horizontal deflection amplifier HDA. In addition, when the number stored in the register is

greater than 8,191, the horizontal position generator transmits an R signal to the mirror positioner MP. The details of horizontal position generator HPG will be disclosed hereinafter with a description of FIG. 3.

The optical projection system LENS projects the image of the screen S of the cathode-ray tube CRT onto rotatable mirror RM. When mirror RM is in the position shown the image is deflected, via mirror M1, to the left half of the film. Mirror RM is rotated by mirror positioner MP, a suitable drive means which when it does not receive an R signal rotates the mirror to the position shown. In the presence of the R signal, mirror RM is in the alternate position. Ganged to the drive means is the moving contact of switch SW which follows the movement of the mirror RM. When the mirror RM is in a position to deflect to the right, a positive signal passes via the moving contact from battery B to line MR. In the alternate position a positive signal is on line ML. (Although a schematicized mechanical means is shown, it should be apparent that in practice suitable electronic switching and positioning circuits would be used.) The MR and ML signals are also fed to the computer CP to prevent transmission of stroke information when both signals are absent; i.e., when the mirror is rotating.

The image of the horizontal diameter 10 of the screen S projects on the film within the writing window W of FIG. 2. The film can move within a cartridge which has the window W that faces screen of the cathode-ray tube CRT.

Positioned above the window W and facing the cathode-ray tube screen S is a light detector 12 with an opening 14 substantially aligned with the midpoint of the film (see FIG. 2). In FIG. 1, there is shown that light detector 12 includes a photocell PC behind a knife edge KE. It is equally possible to narrow the opening 14 down to a fine vertical slit and dispense with the knife edge. In either event, whenever the photocell PC is illuminated it emits a PCS signal to amplifier PAMP which transmits a pulse on the PS signal line.

A simple description of a writing mode for the recording of characters will now be briefly given. Generally, the computer CP will transmit a horizontal address number via the lines HO to the horizontal position generator HPG. If this number is less than 8,191, no R signal is generated and the rotatable mirror RM is in the position indicated. The screen of the cathode-ray tube images on the left half of the film in the window W and the beam of the cathode-ray tube is aimed at a point on the screen S which is related to the horizontal address number stored in the horizontal position generator HPG. (This number is converted to an analog signal HPS whose amplitude represents the number). The HPS signal is fed via the horizontal deflection amplifier HDA and the HDS signal line to the cathode-ray tube circuits CRC where it is used horizontally to deflect the electron beam. The computer now transmits vertical stroke length numbers to the vertical stroke generator VSG via the VO lines. Vertical stroke generator VSG now starts generating the vertical strokes by transmitting a recurring sawtooth signal via lines VS, vertical deflection amplifier VDA and line VDS to the CRT circuits CRC. At the same time, generator VSG intensity modulates the electron beam in accordance with the received stroke length numbers by transmitting the IT signal to intensity control IC which in turn transmits ICS signals to CRT circuits CRC.

At the end of each vertical stroke, vertical stroke generator VSG transmits an EVS pulse to the horizontal position generator HPG to increment the number stored therein by one. For example, if the computer CP initially loaded the horizontal address number 96 in the register, the first vertical stroke will be at coordinate point 96 on the screen S of the cathode-ray tube and recorded at coordinate point 96 OF THE FILM. After this first stroke, the EVS pulse increments the address to 97 and the second vertical stroke is at coordinate point 97 on the screen and recorded at coordinate point 97 of the film. This operation continues until the horizontal address stored in the register of the horizontal position generator HPG becomes 8,192. At that time the R signal is fed to the mirror positioner MP from the horizontal position generator HPG. Mirror RM is

rotated to the position shown in dotted outline and the screen image is projected onto the right half of the film. The digital-to-analog converter in the horizontal position generator HPG ignores the most significant binary bit position of the register storing the horizontal address number. Therefore, the HPS signal represents the number zero. Hence, the vertical stroke for the number 8,192 will be at the zero coordinate point on the screen S but will be recorded at the 8,192 coordinate point on the film. The recording routine then continues in the usual manner for numbers 8,193, ... When a line has been written, the film can be moved longitudinally one line up and a new line can be recorded.

There is an inherent source of registration error in the system as described. It was tactically assumed, that coordinate point 8,191 on the screen S was projected over the left mirror path to coordinate point 8,191 on the film. Misalignment of the optical path could cause screen coordinates point 8,191 to be projected to a different coordinate point either greater or less than 8,191. Similarly, coordinate point zero on the screen S could be projected via the right mirror path to a coordinate point on the film of greater or less than 8,192. Therefore some method and means must be provided to test and compensate for such possible misregistration.

Generally, a test mode is periodically called for the computer CP. In the test mode, the computer CP suspends the transmission of stroke information to the vertical stroke generator VSG which no longer generates the vertical strokes but leaves the electron beam in the on state. The horizontal position generator generates a VBS signal which is fed to the vertical deflection amplifier VDA. This signal deflects the electron beam up above the window W to a level where it will intersect the opening 14 of the light detector 12 during horizontal scans.

The horizontal position generator HPG is preset to horizontally locate the electron beam slightly to the left of the point 8,191 on the screen of the cathode-ray tube CRT with the left hand optical path operative (mirror RM projects light to mirror M1). The beam is then incrementally deflected to the right until it is sensed by light detector 12. A first number related to the number of increments the beam had moved is registered in the horizontal position generator HPG. The horizontal position generator HPG is then preset to again horizontally locate the electron beam slightly to the left of point zero on the screen but now the right-hand and optical path is operative because the R signal is forced to be present. The electron beam is again incrementally deflected to the right until it is sensed by light detector 12. A second number related to the number of increments the beam had now moved is also registered in the horizontal position generator HPG. The second number is subtracted from the first number and the difference, including the sign of the difference, is stored in the horizontal position generator HPG. This signed difference is a measure of the horizontal misregistration of the end of the left half horizontal scan and the start of the right half horizontal scan of the window.

If it is decided that the left half scan is to remain fixed wherever it occurs, then while the right half scan is being performed a signal correction voltage is superimposed on the normal horizontal deflection voltage. A negative correction voltage which is related to a negative difference number will shift the right half scan to the left by an amount proportional to the magnitude of the difference number. A positive difference number will result in the generation of a positive correction voltage which will shift the right half scan to the right by an amount proportional to the magnitude of the difference number. In this way all misregistrations at the center of the line are removed. Although it is true that the result may be that the whole line is shifted either right or left, such shifts within the normally occurring drift ranges are not noticeable since they are only detectable at the ends of the line. The major portion of the circuitry for performing the test and correction routine is in the horizontal position generator HPG as shown in FIG. 3.

The details of the horizontal position generator HPG will be explained for the following description of the test and correction routine. When the computer CP enters the test mode, it transmits a T signal to the vertical stroke generator VSG (FIG. 1) which stops generating the vertical strokes and causes the electron beam to remain on. In particular, no EVS signals are transmitted therefrom to the horizontal position register. The T signal is also transmitted to the horizontal position generator HPG where it is received by amplifier A1. The B output of amplifier A1 starts transmitting the VBS signal to the vertical deflection amplifier VDA for upwardly deflecting the electron beam to the level of the light detector 12 (see FIGS. 1 and 2). The positive output of amplifier A1 now transmits a signal on the TM signal line. The TM signal is used in several places to indicate the test mode and is used in other places to initialize certain logical elements. In particular, the TM signal is fed to the set terminal of flip-flop FFL and via OR circuit B1 to the reset terminal of flip-flop FFR. Each of the flip-flops is of the conventional set/reset type having capacitor inputs or the equivalent so that they switch on the leading edge of a received signal. The TM signal is fed to the preset input C of counters KL and KR to preset the counters to the number -200. (The presetting occurs on the leading edge of a received signal). Each of the counters is an up counter which adds 1 to the accumulated count each time it receives a pulse at its unit input I. The counters also store a sign bit which is negative for the first two hundred increments and becomes positive thereafter. The accumulated count, in binary representation, is continuously available on a plurality of parallel output lines. The TM signal alerts gates G1 and G2. These gates are parallel arrays of conventional three-input AND-circuits one per output signal line of the counters KL and KR, respectively. And the TM signal clears subtractor SUB to zero. Subtractor SUB can be a parallel binary subtractor register which subtracts a number represented by signals received at subtrahend inputs S from a number represented by signals received at minuend inputs M and stores the difference for transmission from difference outputs D. The subtractor is algebraic in the sense that the subtraction process takes into account the sign of the minuend and subtrahend numbers and transmits a signed difference.

When flip-flop FFL was set it started transmitting an FFL1 signal from its "1" output. The leading edge of the FFL1 signal is fed to CM preset input of horizontal position register HPR. This register can be a 14-stage binary up counter which can be forced set to given values by signals received in parallel on the HO signal lines. In addition, it can be set to the specific value of 8,191 by a signal received at the CM input or to the specific value 8,192 by a signal received at the CO input. The counter is unit incremented by pulses received at the I input. The signals representing the binary count accumulated in the first 13 stages are transmitted to the HPRN signal lines. The signal representing the state of the 14th stage (the most significant bit) is transmitted from the MSB output to the line R.

The FFL1 signal opens gates G1 which has been altered by the TM signal. Finally, the FFL1 signal alerts gate G3, a three-input AND-circuit.

Now, it should be recalled that horizontal position register HPR is preset to the number 8,191. This number in binary form is a zero in the most-significant bit position and ones in the 13 following positions. Thus, this number fed, via the HPRN signal lines, to the horizontal digital-to-analog converter HDA which never receives the most significant bit (it is only connected to the 13 lower counter states) is the greatest number which it can possibly receive. Converter HDA transmits an analog signal, of maximum amplitude, say, 8,191 units of amplitude, via the HDAS signal line to the analog adder AA. The amplitude of this signal is sufficient to position the electron beam to the horizontal point 8,191 on the screen of the cathode-ray tube. Since the most significant bit is zero, there is no R signal at this time and the rotating mirror RM (FIG. 1) deflects the image to mirror M1 and the left optical path is operative. However, the electron beam is to the left of point 8,191 on the screen because of the following action.

It will be recalled test counter KL had been preset to -200, the signals representing this number are transmitted via the KLN signal lines, the gates G1, the GIN signal lines, the OR circuits B2 (a parallel array of three-input OR-circuits) and the lines OCN to the correction digital-to-analog converter CDA. This converter is a signed converter which transmits a signal having an amplitude related to the magnitude of the received binary number and a polarity which corresponds to the sign of the binary number. Accordingly, the signal on line CDAS is negative and has an amplitude of 200 units. The signals on lines HDAS and CDAS are algebraically added by analog adder AA which now transmits a signal on line HPS of +7,991 units to the horizontal deflection amplifier HDA (FIG. 1). In this manner the electron beam is positioned to the left of the opening 14 of the detector 12.

When the rotating mirror RM reaches the left position, switch SW (FIG. 1) starts generating the ML signal which opens gate G3. Pulses from clock CLK which can be a free-running pulse generator, pass via gate G3 and line ML1 to the increment input I of counter KL. For each pulse received the accumulated count increases by one from the initial value of -200. Thus, the CDAS signal becomes less negative and the HPS signal more positive. The net effect is that the electron beam starts moving toward the right. This continues until the detector 12 senses the electron beam. The amplifier RAMP connected to the photocell PC (FIG. 1) via the PCS signal line transmits a PS pulse signal to the reset input of flip-flop FF1 which resets terminating the FFL1 signal and initiating the FFLO signal.

The FFLO signal, fed to the set input of flip-flop FFR triggers the flip-flop to the set state causing the generating of the FFR1 signal. The FFR1 signal alerts gate G4, a three-input AND-circuit and opens gates G2, previously alerted by the TM signal. In addition, the FFR1 signal is fed to the CO input of horizontal position register HPR to reset the register to the number 8,192. This number, in binary representation, has a one in the most-significant-bit position and zeros in the 13 lower bit positions. Therefore, a signal is present on the line R and no signals present on the HPRN signals lines. Accordingly, horizontal digital to analog converter HDA transmits a zero amplitude signal on the line HDAS. This would normally position the electron beam to the zero point on the screen of the cathode-ray tube. However, just as previously described with respect to the counter KL, the counter KR was also preset to -200, and, since the gates G2 are now open, the signals representing this number are fed via the KRN lines, gate G2, the G2N lines, the OR-circuits B2 and the OCN lines to the correction digital-to-analog converter CBA. The converter CDA transmits a negative signal having an amplitude 200 units on the CDAS line to analog adder AA. The result is that analog adder AA transmits, via the HPS line to the horizontal deflection amplifier HDA a negative signal of 200 units amplitude and the electron beam is at a point 200 units to the left of the zero point.

At the same time, the R signal causes the repositioning of the rotatable mirror RM to deflect the image of the screen to mirror M2 (FIG. 1) and the right optical path is operative with the electron beam to the left of the opening 14 of detector 12. When mirror RM reaches the right position, switch SW starts transmitting the MR signal.

The MR signal opens the three-input AND-circuit G4 causing clock pulses to pass from clock source CLK via the MR1 line to the increment input I of counter KR which starts unit incrementing up from -200. Just as described for counter KL, the electron beam starts moving toward the right until it is sensed by detector 12 (FIG. 1) and another PS pulse is generated. The PS pulse passes through OR circuit B1 to the reset input of flip-flop FFR. Flip-flop FFR resets, terminating the FFR1 signal and initiating the FFRO signal. With the end of the FFR1 signal, gate G4 closes ending the incrementing of counter KR which now contains a signed number related to the electron beams crossing of the detector 12 via the right optical path.

The leading edge of the FFRO signal passes via differentiator DF through gate G5, a two-input AND-circuit, to become the ET signal. Note the second input to gate G5 is the TM signal via delay D. The purpose of delay D and differentiator DF is to insure that an ET pulse is only generated after the occurrence of the second PS pulse and not at the start of the test mode. The ET signal is fed back to the computer CP to end the test mode by terminating the T signal. The ET pulse signal also strobes gates G6 and G7, pluralities of two-input AND-circuits.

The signals representing the signed number in counter KL pass, via lines KLN, gates G6 and line G6N to the minuend input M of subtractor SUB while the signals representing the signed number in counter KR pass, via lines KRN, gates G7 and line G7N, to the subtrahend inputs S of subtractor SUB. Subtractor SUB algebraically subtracts the two numbers and stores the signed difference. This stored signed difference number will be used during the generate mode to horizontally shift the right scan. To illustrate its operation, several examples will be given.

Example 1.

Assume that the test mode, counter KL ends up storing the count zero; i.e., $NKL=0$. This means the left scan would end exactly at point 8191 on the film. Assume also that counter KR ending up storing the count zero; i.e., $NKR=0$, then the right scan would start exactly at point 8,192 on the film. The difference between the numbers NKL and NKR is also zero and there would be no horizontal shifting of the right scan. Note whenever $NKL=NKR$ there is no shifting to the right scan.

EXAMPLE 2.

Assume NKL a negative number. This means that the left scan would end to the left of point 8,191 on the film. Say $NKL=-100$, then the left scan would end at point 8,091. Now several cases can arise. If $NKR < -100$, then the right scan would start to the left of point 8,092 on the film and there would be an overlap of scans. (Say, $NKR=-150$, then the right scan would start at point 8,042. In these cases, the right scan must be shifted to the right. For example, if $NKL=-100$ and $NKR=-150$, then $NKL-NKR=+50$ and the right scan is shifted 50 points to the right. Again if NKL is negative and $NKR > -100$, then the right scan would start to the right of point 8,092 and there would be a gap in the scans. In this case, the right scan must be shifted to the left. Assume $NKL=-100$ and $NKR=-50$, then $NKL-NKR=-50$ and the right scan is shifted 50 point to the left.

EXAMPLE 3.

If NKL is positive, then the left scan would end to the right of point 8,191. Assume $NKL=+100$, then the left scan would end at point 8,291 on the film. If $NKR > NKL=+100$, then the right scan would start to the right of point 8,292 and there would be a gap in the scan. Say $NKR=+150$, then the right scan would start at point 8,342 on the film. Note: $NKL-NKR=+100-(+150)=-50$ and the right scan would be shifted 50 points to the left. If $NKR < NKL=+100$, then there would be an overlap of the scans. Assume $NKR=-50$, then $NKL-NKR=+100-(-50)=+150$ and the right scan would be shifted 150 points to the right.

There will now be described how the correction stored in subtractor SUB is used during the generate mode.

During the generate mode, computer CP transmits the starting point of the horizontal scan by transmitting the initial position register HPR and the stroke length information via the VO signal lines, to the vertical stroke generator VSG (FIG. 1). Note: at this time it will be assumed that the number in register HPR is less than 8,192. Therefore, the left optical path is operative because no R signal is generated. At the end of each vertical stroke, generator VSG emits an EVS pulse which is

fed to the increment input 1 of horizontal position register HPR. The contents of this register are continuously converted to a horizontal deflection signal by converter HDA and fed via lines HDAS and analog adder AA to line HPS to deflect the beam one point to the right for each unit increment. When the count reaches 8,192, the R signal is generated and the right optical path becomes operative. It is now necessary to add a correction if necessary. The R signal in addition to going to the mirror positioner MP is also fed to gates G8, a parallel array of two-input AND-circuits. The signals representing the signed correction value pass from the difference outputs D of subtractor SUB, via the SO lines, the gates G8, lines G8N, OR-circuits B2 and lines OCN to correction digital-to-analog converter CDA. The proper polarity correction signal is fed via lines CDAS to analog adder AA where it is algebraically added to signal HDAS and the resulting signal transmitted via the HPS line to the horizontal deflection amplifier HDA.

It should be noted that although the correction has been performed only for the right scan, the system could be modified to perform corrections on the left scan or on both scans with respect to a fiducial point. All of these variations come within the scope of the invention.

In addition, although only two optical paths were disclosed wherein each path recorded images on a different half of the record medium, the invention contemplates a plurality of optical paths each of which records images on a different fraction of the record medium.

Furthermore, although only a method of insuring horizontal registration has been described, a similar technique can be used for vertical registration

What is claimed is:

1. The method of registering the adjacent terminal points of at least two longitudinally adjacent scans along the same line of an energy-absorbing medium by a beam of energy by periodically measuring the degree of longitudinal misregistration of the adjacent end points of said longitudinally adjacent scans, recording a quantity related to the measured degree of longitudinal misregistration, and shifting the start or end of at least one of said longitudinally adjacent scans by an amount related to the recorded quantity each time the said longitudinally adjacent scans are sequentially performed.

2. The method of recording a line of patterns on recording medium comprising the steps of generating the patterns from a single source, projecting a first portion of the line of patterns, via a first optical path, to a first half of the record medium, projecting a second portion of the line of patterns, via a second optical path, to a second half of the record medium, and displacing along the direction of said line the images of the patterns projected via at least one of said optical paths by a distance related to any possible misregistration, at the demarcation of the halves of the record medium, of the images projected thereon via the different optical paths.

3. The method of registering the adjacent terminal points of at least two adjacent scans of a record medium by a recording beam which scans a first portion of the record medium via a first path and scans a second portion of the record medium via a second path comprising the steps providing a fiducial point related to an intermediate point of said two adjacent partial scans, performing at least a first partial scan with said recording beam via said first path, registering a first parameter related to the position of said first partial scan when said recording beam is detected crossing said fiducial point, performing at least a second partial scan with said recording beam, registering a second parameter related to the position of said second partial scan when said recording beam is detected crossing said fiducial point, and displacing the adjacent terminal of at least one of the two adjacent scans in accordance with the difference of said parameters.

4. Apparatus for recording lines of patterns on a photosensitive medium comprising means for generating successive lines of patterns of radiation, image projection means for sequentially projecting the first half of each line onto one half of the photosensitive medium and the second half of each line onto

the other half of the photosensitive medium, means for sensing for possible misregistration of the patterns projected on one half of the photosensitive medium with respect to the patterns projected on the other half of the photosensitive medium, and means responsive to said sensing means for shifting in the direction of said line the lines of patterns projected onto at least one-half of the photosensitive medium.

5. The method of claim 2 wherein the image displacement is performed by displacing the position where the patterns are generated.

6. The apparatus of claim 4 wherein said generating means includes a cathode-ray tube assemblage with a screen and electron beam deflection means responsive to signals with the patterns being traced on the screen by the electron beam and said shifting means includes means for superimposing on the signals which deflect the electron beam in a given direction related to the direction of the line of characters a constant-amplitude signal during the generation of the lines of patterns which are projected onto said one-half of the photosensitive medium.

7. The apparatus of claim 4 wherein said generating means is a cathode-ray tube assemblage and said image projection means includes a rotatable mirror.

8. The apparatus of claim 4 wherein said sensing means includes an image-sensing means having a given position with respect to said photosensitive medium, means for scanning an image from a starting position past said image sensing means and means responsive to said image sensing means for registering a quantity related to the distance from said starting position to said given position.

9. Apparatus for recording a line of patterns on a photosensitive medium comprising a cathode ray tube assemblage having a screen and an electron beam and including at least means for deflecting the electron beam in at least one direction across the screen of the cathode-ray tube and means for intensity modulating the electron beam, optical projection means for alternately projecting the image of the screen of the cathode-ray tube via a first optical path onto the first half of the photosensitive medium, or via a second optical path onto the second half of the photosensitive medium, a photosensitive detector having a given position with respect to the width dimension of the photosensitive medium, test control means operative on said deflecting means and said optical projection means for causing said deflecting means to deflect the electron beam to scan at least once in said one direction starting from a given point on said screen and for causing said optical projection means to project, via the first optical path, the image of the scan to move past said photosensitive detector, means for registering a first representation of the distance between the starting point of the scan and the point where the scan is detected by said photosensitive detector, means for generating a correction deflection signal having a value related to said first representation registered by said registering means, and means for applying said correction deflection signal to said deflecting means when the image of said screen is projected onto the photosensitive medium via a particular one of the optical paths.

10. The apparatus of claim 10 wherein said test control means causes the deflecting means to deflect the electron beam to scan at least a second time in said one direction starting from a given point and for causing said optical projecting means to project, via the second optical path, the image of the second scan to move past said photosensitive detector, said registering means further registering a second representation of the distance between the starting point of the second scan and the point where the second scan is detected by said photosensitive detector, and said correction deflection signal generation means generates the correction deflection signal in accordance with the relative values of said first and second representations.

11. The apparatus of claim 10 wherein the correction deflection signal has an amplitude related to the difference between the values of the first and second representations.