Feb. 3, 1959 R. B. JOHNSON ET AL 2,872,669

CATHODE RAY CHARACTER TRACER

Filed April 15, 1954 2 Sheets-Sheet 1

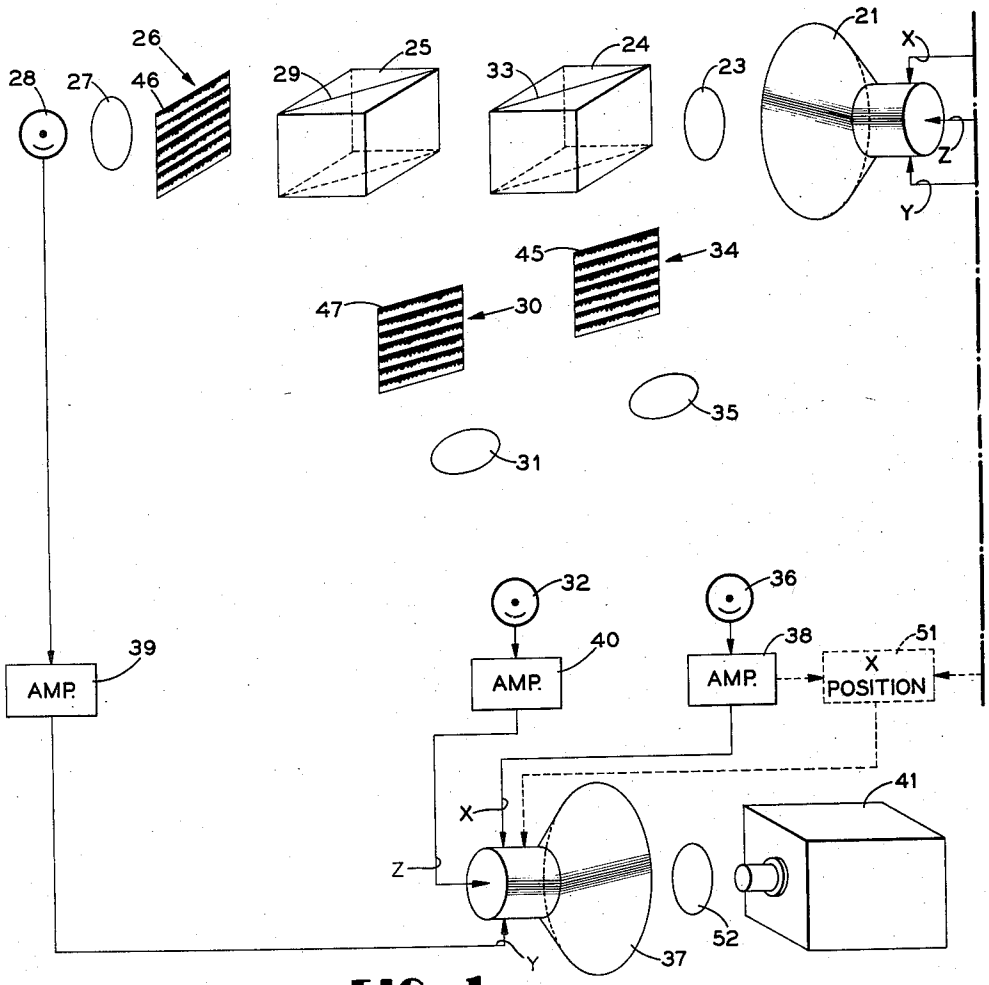


FIG. 1a

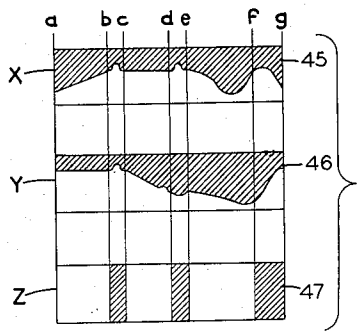


FIG. 2

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CATHODE RAY CHARACTER TRACER

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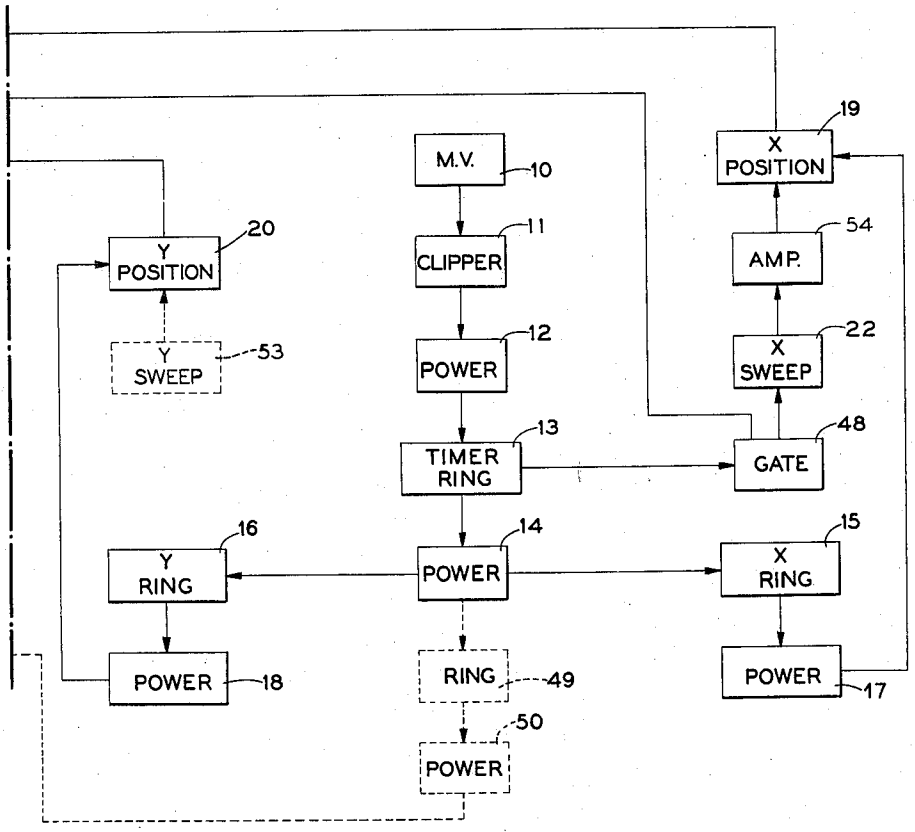


FIG. 1b

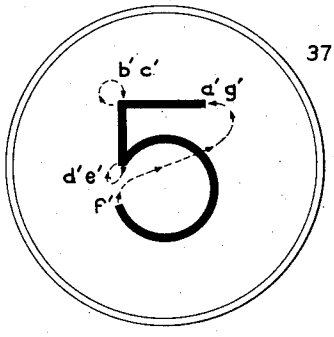


FIG. 3

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CATHODE RAY CHARACTER TRACER

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Application April 15, 1954, Serial No. 423,502

11 Claims. (Cl. 340—324)

This invention relates to electric apparatus and systems for character forming, and more particularly to high speed cathode ray character tracers.

One object of this invention is to provide an improved apparatus for tracing legible characters in accordance with code signals applied to the apparatus.

Heretofore, various character recorder systems for tracing characters have been known which utilized moving mechanical parts for light scanning either predetermined fiducial marks or pattern component emitters. This invention will eliminate all moving mechanical elements in the character recorder system, and will utilize the substantially inertialess movement of a cathode ray beam for effecting the sweep of a selected plurality of related character synthesizing patterns simultaneously.

In carrying out the invention, means are provided to sweep a plurality of related character synthesizing patterns simultaneously whereupon a plurality of voltage wave forms, or voltage variations, corresponding to the configurations thereof are generated so as to control a character tracing device. The sweep effected by means of a fan-shaped, or band-shaped, cathode ray beam has a single basic scanning movement so that the plurality of related character synthesizing patterns are caused to be scanned only once for each character being traced. The cathode ray beam is further positioned in response to code signals in order to sweep selected related character synthesizing patterns.

In accordance with the foregoing, it is an object of this invention to provide an improved electronic means for tracing characters without using moving mechanical elements.

Another object of this invention is to provide apparatus for scanning in a selected order a plurality of related character patterns simultaneously.

Another object of this invention is to provide apparatus for tracing a character consequent upon a single sweep or deflecting movement of a cathode ray beam to thereby effect a single scan of a plurality of related character patterns.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of examples, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

Figs. 1*a* and 1*b*, taken together, are a block diagram of the preferred embodiment for character tracing.

Fig. 2 shows a plurality of related character representing synthesizing patterns which are scanned simultaneously, the particular one shown being thus used for deriving voltages for representing the digit "5."

Fig. 3 is a graph of the digit "5" with various plotting points indicated thereon.

Throughout the description of this invention, trigger circuits are referred to; and more particularly, triggers are described as being either "on" or "off." Due to the nature of the trigger which may comprise two reciprocally resistance coupled vacuum tubes, the trigger is maintained at one of two stable conditions, termed "on" and "off." When the left side of the trigger is conducting, the trigger is arbitrarily described as being "on." When the right side of the trigger is conducting, the trigger is arbitrarily described as being "off."

A plurality of sequentially coupled triggers form a ring wherein the said triggers are rendered "on" successively by suitable succeeding voltage pulses. When, in addition thereto, the last trigger is coupled to the first trigger so that the first trigger is rendered "on" as the last trigger is rendered "off," the ring is more accurately termed a closed ring.

As is well known in the electrical art, the point upon the screen of a cathode ray tube at which a cathode ray beam impinges, is controlled by voltages applied to deflection plates, or coils, associated with the said tube. By applying suitable tracing voltages to these deflection controls, the electron beam may be caused to trace an intelligible character.

It is also well known that the intensity of the electron beam in a cathode ray tube may be controlled by varying the bias voltage applied to its control grid. For the purposes of this description, the electron beam is referred to as being either "on" or "off." When the cathode ray tube electron beam strikes its related screen so that energy radiations are emitted therefrom, the electron beam is arbitrarily described as being "on." When the said electron beam fails to cause energy radiations to be emitted from its screen, the electron beam is arbitrarily described as being "off."

Inasmuch as the circuits represented by the blocks shown in Figs. 1*a* and 1*b* are well known to persons familiar with this art, these circuits are described only briefly in order to avoid undue prolixity. A more detailed description may be found in Palmer et al. Patent No. 2,658,681 which issued on November 10, 1953, and copending U. S. patent application Serial No. 263,122 filed by William C. Dersch, Jr., on December 24, 1951.

Referring to Figs. 1*a* and 1*b*, a multivibrator **10** generates timed parent voltage pulses which are changed to square wave voltage pulses by a clipper **11**, and amplified by a power vacuum tube circuit **12**. Output voltage pulses from circuit **12** render triggers included within closed primary timer ring **13**, "on," in a timed relation corresponding to the timed pulses generated by multivibrator **10**. The triggers within ring **13** are coupled sequentially to form a closed ring so that the said triggers are rendered "on" successively; i. e., for each voltage pulse applied to the said ring, a trigger is rendered "on" as its preceding trigger is turned "off."

Primary timer ring **13** in the embodiment of this invention comprises nine sequentially connected triggers. As the first one of these triggers is rendered "on" every ninth multivibrator voltage pulse, a correspondingly timed voltage impulse is transmitted to power vacuum tube circuit **14** so as to render the power amplifier tube therein conducting. A resulting amplified output voltage impulse from circuit **14** is transmitted simultaneously to character selector X and Y rings **15** and **16**, respectively.

Each one of the closed X and Y rings includes seven sequentially connected triggers which are rendered "on" successively; i. e., for each voltage impulse transmitted

from circuit 14, one trigger within each of the rings 15 and 16 is turned "on" as its preceding trigger is turned "off," and the rings are referred to as having advanced one step.

There is associated with each of the X and Y rings 15 and 16, a respective power unit 17 and 18 each of which includes a power tube and associated circuit to correspond with each trigger in the aforementioned rings. A power tube within units 17 and 18 is caused to conduct when its corresponding trigger is turned "on." Thus, the tubes within each of the power units are rendered conducting successively in step with their corresponding triggers. Due to the fact that the component values of the aforementioned power unit power tube circuits differ for each power tube the potential output due to any one conducting power tube is of a correspondingly different magnitude.

These power tube output voltages from units 17 and 18 are applied to electron beam positioning circuits 19 and 20, respectively, associated with selector cathode ray tube 21. Positioning circuit 19 is, in effect, a voltage mixer circuit such that the output voltage from the positioning circuit 19 is due to the combinative voltages transmitted from a sweep circuit 22 and amplifier circuit 54 associated therewith, and power unit 17, also associated with the said positioning circuit. The component values of X sweep circuit 22 are such as to cause one saw-tooth voltage pulse during the time that each trigger in X ring 15 is "on." It is to be observed, however, that a character is traced during each saw-tooth voltage pulse. As the description advances, the over-all operation will become quite clear.

Positioning circuit 20 normally serves as an amplifier for the output signals from unit 18. The output voltages from positioning circuits 19 and 20 are applied to the horizontal, or X, and vertical, or Y, electron beam deflection plates within selector tube 21. As mentioned hereinbefore, the position of an electron cathode ray beam upon the screen of its cathode ray tube is controlled by the potentials applied to the deflection plates or coils associated with the tube. Hence, the position of the tracing pattern upon the screen of tube 21 is determined by the magnitude of the output voltages from positioning circuits 19 and 20. The magnitude of the output voltage from a positioning circuit, in turn, is determined by the magnitude of the output voltage from the aforementioned conducting power tube within the power units 17 and 18. By selecting suitable values for the electrical elements connected within the power tube circuits associated with each of power tubes corresponding to the triggers in rings 15 and 16, it is possible to shift successively formed tracing patterns selectively on the screen of cathode ray tube 21 as the said rings are advanced step by step.

The voltages applied to the electron gun of selector tube 21 are such as to cause a fan-shaped, or band-shaped, light beam to be emitted from the fluorescent screen of tube 21 when the said tube is turned "on." This light beam is directed along three paths towards a light sensitive phototube positioned in each path. One light beam path is defined by lens 23, light beam splitters 24 and 25, mask 26, collector lens 27, and phototube 28. Another path is defined by lens 23, beam splitter 24, half-silvered surface 29, mask 30, collector lens 31, and phototube 32. The third path is defined by lens 23, half-silvered surface 33, mask 34, lens 35, and phototube 36. Phototubes 36, 28 and 32 are associated via respective amplifier circuits 38, 39 and 40 with the X, Y and Z controls, respectively, of character viewing tube 37 as will be described shortly. The varying voltage outputs of amplifiers 38, 39 and 40 cause a character to be traced on the screen of viewing tube 37. Such a character may be recorded by any suitable means, such as camera 41.

Each of the masks 26, 30 and 34 includes a plurality of character representing patterns, such as are shown in Fig. 2. Each character representing synthesizing pattern in a mask consists of transparent and opaque configurations arranged so as to vary the amount, or intensity, of light energy impinging upon a related phototube. Each of these patterns is disposed within an area of the mask which is proportional to an area of the screen on tube 21 covered by the aforementioned tracing pattern. As a result, it is possible to sweep only one of the character representing synthesizing patterns included within the masks simply by applying suitable biasing, or cathode ray positioning, voltages to the deflection plates of tube 21. The embodiment of this invention is capable of handling forty-nine characters; namely, twenty-six alphabetic characters, ten numeric characters and thirteen special characters. Hence, each of the aforesaid masks is divided into forty-nine areas so as to form seven rows by seven columns of character representing synthesizing patterns. Each of the forty-nine patterns in mask 26 is used to control the Y deflection plates of tube 37, whereas each of the patterns in mask 34 is used to control the X deflection plates of this tube. The patterns in mask 30 are used to govern the Z control of tube 37. Furthermore, each of the elements in the aforedescribed three optical paths are arranged so that at any given time the light beam from the screen of tube 21 impinges upon a corresponding region of masks 26, 30 and 34. Hence, if the light beam impinges upon the extreme left-hand region of area 45 (see Fig. 1*a*) which is situated in the first row of the first column in mask 34, the light beams of approximately equal intensity will impinge concurrently upon the extreme left-hand portions of corresponding areas 46 and 47 in masks 26 and 30, respectively.

The mask areas 45, 46 and 47 may be formed in any suitable manner. For example, as shown and described in Patent No. 2,406,880, issued to N. H. Young, Jr., on September 3, 1946, apertures may be formed in a plate with each aperture having a configuration which corresponds to a predetermined voltage wave form. The individual voltage wave forms for controlling the horizontal and vertical deflection of the cathode ray beam may be plotted beforehand in accordance with the particular style of character desired. The matrix of apertures may then be photographed to produce masks 26, 30 and 34, wherein the apertures themselves will be transparent while the rest of the mask will be opaque.

During the time that a phototube is energized by light rays, a voltage impulse is directed to an associated amplifier circuit. However, the magnitude of this voltage impulse is determined by the intensity of light energy impinging upon the phototube. Hence, a varying voltage output may be had by varying the light input to the phototube.

As is shown in Fig. 1*a*, mask areas 45, 46 and 47 (see also Fig. 2) are situated in the first row of the first column in masks 34, 26 and 30, respectively. Referring specifically to Fig. 2, the shaded parts in each of the areas 45, 46 and 47 is the opaque pattern, whereas the remaining parts are transparent. Since the width of the light beam generated by tube 21 is caused to equal the height of each of the patterns, by referring to Figs. 2 and 3, it may readily be seen that by causing such a fan-shaped light beam to sweep across the patterns in areas 45, 46 and 47, simultaneously, the digit "5" may be traced.

During the period that the light beam sweeps from *a* to *b*, the electron beam in viewing tube 37 is caused to move from *a'* to *b'*. It may be seen that between the limits *a* and *b*, the Y control character synthesizing pattern does not change the amount of light impinging upon its associated phototube. Hence, the voltage output from phototube 28 (see also Fig. 1*a*) does not vary and the electron beam in tube 37 is not caused to move vertically between the period of time defined by limits *a'* and *b'*. On the other hand, the X control pattern in area 45 causes the amount of light energy impinging upon its

associated phototube 36 to vary, and accordingly, causes the voltage output from phototube 36 to vary and the electron beam in tube 37 to move horizontally from *a'* to *b'*. Since light energy is permitted to impinge upon phototube 32 between the limits *a* and *b*, the viewing cathode ray tube 37 is turned "on" and the path of the cathode ray beam within tube 37 between *a'* and *b'* is rendered visible. However, during the period between *b* and *c* (see Fig. 2), the viewing tube beam is turned "off" while the voltages applied to the deflection plates associated therewith cause the beam to move in a clockwise direction, as is indicated by the broken line, to prepare for the sweep between pattern limits *c* and *d*. The Z blanking control is provided to improve the sharpness and quality of the character being traced, and to prevent an over-trace. It may be seen that at limit *c* the electron beam in tube 37 is turned "on." In view of the fact that the amount of light impinging upon phototube 36 between limits *c* and *d* is a constant, the voltage applied from this phototube to the X deflection plates viewing tube 37 is also constant between limits *c'* and *d'* (see Fig. 3). However, the light energy variation applied to phototube 28 is such to cause the lower Y deflection plate to become more positive. Accordingly, the cathode rays in tube 37 are moved downwardly from *c'* to *d'*. During the time interval *d* to *e*, the electron beam is once again turned "off" as is indicated by the broken line. During the time interval *e* to *f*, the electron beam is turned "on" and the voltages applied to the X and Y deflection plates are such as to cause the electron beam in tube 37 to trace a substantially circular path. At limit *f'*, the electron beam is turned "off" so that the beam may be moved to *g'* which is the starting point, *a'*. It may be seen that if the patterns in areas 45, 46 and 47 are scanned again, the digit "5" will be retraced.

A blanking voltage is applied to character selector cathode ray tube 21 (Figs. 1*a* and 1*b*) in order to render its electron beam "off" during the time that the electron beam is shifted from the end of one character representing synthesizing pattern to the start of another pattern.

Gate circuit 48 includes a trigger which is connected to timer ring 13 so that the trigger in gate circuit 48 is turned "off" when the last trigger in ring 13 is turned "off," and is turned "on" when the second trigger in ring 13 is turned "on." It is to be recalled that primary timer ring 13 includes nine sequentially connected triggers. Hence, the trigger in gate circuit 48 is rendered "on" for eight multivibrator pulses, and "off" for one pulse. As ring 13 is a closed ring, these nine multivibrator pulses advance said ring once around.

When the trigger of gate circuit 48 is reset "off," a suitable voltage is caused to be applied to X sweep circuit 22. This voltage biases the sweet circuit sufficiently to prevent an output sweep voltage therefrom. This voltage is also applied to the Z control of tube 21 in order to render its electron beam "off."

The impulse from the first trigger in ring 13 that turns the second trigger therein "on," also turns the trigger in gate circuit 48 "on." This results in a voltage being applied to X sweep circuit 22 and the Z control of tube 21. This voltage biases sweep circuit 22 so as to render the same operative, whereby one sawtooth wave is generated during the period that trigger 2 through 9 in ring 13 are "on." During the period that trigger 1 in ring 13 is "on," the electron beam of tube 21 is being moved under control of position units 19 and 20. Hence, one-ninth of timer ring 13 time is utilized to position the beam, and eight-ninths of timer ring 13 time is used to trace a character.

Means for positioning a cathode ray beam in response to received coded signals to thereby select a related symbol arranged on a mask, is described and shown in McNaney Patent No. 2,283,383 which issued on May 19, 1942. Hence, by connecting converters 25 (refer to Fig. 1 of aforementioned McNaney patent) and 27 to the X and Y positioning circuits 19 and 20 (Fig. 1*b*) of cathode ray tube 21 (see also Fig. 1*a*), the electron beam within tube 21 can be deflected in accordance with received coded signals. The connection of power unit 17 to circuit 19, and unit 18 to circuit 20 would not be necessary in view of the aforementioned connections.

It will be recognized by persons familiar with this art that the fan-shaped light beam emitted from the screen of tube 21 (Fig. 1*a*) may be caused by focusing the cathode ray beam therein to a fan-shape. The focusing controls are, of course, included within the electron gun of this cathode ray tube. This fan-shaped light beam may also be generated by moving a spot type cathode ray beam rapidly along the Y axis of a rectangular, or plane, coordinate system. This generator is indicated by Y sweep 53 (Fig. 1*b*). Due to the persistency of the fluorescent screen, a single fan-shaped light beam will appear.

It will also be recognized by persons familiar with this art that electron cathode ray beam positioning controls may be applied to viewing tube 37 so that successively formed tracings on the screen thereof may be positioned in a sequential order across this screen. Referring to Figs. 1*a* and 1*b*, a closed ring 49, similar to rings 15 and 16, is advanced one step for each impulse from circuit 14. Hence, rings 15, 16 and 49 are advanced one step in unison. Power unit 50 includes a power tube and associated circuit to correspond with each trigger in ring 49. Since the electrical component values of these power tube circuits differ for each power tube, the potential output from unit 50 is different for each power tube therein which is conducting. The components selected are such as to cause successive tracings to appear in sequential order across the face of tube 37. As ring 49 is a closed ring, and since it includes seven triggers, seven tracings appear in sequential order. The voltage output from unit 50 is applied to a mixer circuit 51 wherein the output from amplifier 38 and unit 49 are combined to cause a representative voltage to be applied to the X deflection controls of tube 37. Lens 52 is used to direct each of the seven tracings on the screen of tube 37 towards recording camera 41.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a single modification, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. In a data recording device, a first cathode ray tube comprising means for producing first cathode rays and a screen having the property of emitting light rays under the influence of said cathode rays, a plurality of masks each having a plurality of character synthesizing patterns defined by areas of transparent and opaque configurations positioned in optical relationship to said screen so that said light rays impinge upon corresponding ones of said patterns in different ones of said masks concurrently, a plurality of light ray sensing means for producing voltages associated with said masks and positioned so that each one of said sensing means is influenced by said light rays passing through a mask associated therewith, cathode ray deflecting means associated with said first cathode ray tube for causing said first cathode rays to sweep a region of said screen proportional to one of said pattern areas whereby said light rays sweep corresponding pattern areas in said masks simultaneously, a second cathode ray tube comprising means for producing second cathode rays and a recording screen responsive thereto, cathode ray control means associated with said second cathode ray tube, and electrical means for connecting

said control means to said sensing means whereby voltages derived from said sensing means as a result of said light rays impinging thereon during the simultaneous sweep of corresponding pattern areas in different ones of said masks effect a tracing upon said recording screen.

2. A device according to claim 1 wherein said cathode ray deflecting means associated with said first cathode ray tube includes positioning means for causing said first cathode rays to sweep in a selected order a plurality of regions of said first cathode ray tube screen corresponding to a plurality of mask areas representing tracings to be recorded.

3. A device according to claim 2 additionally comprising cathode ray positioning means associated with said second cathode ray tube for selectively positioning successive tracings in a sequential order across said recording screen.

4. A device according to claim 2 additionally comprising means for applying a predetermined blanking voltage to said first cathode ray tube and said deflecting means associated therewith.

5. A data recording device comprising an electron discharge device including means for producing cathode rays and a screen having the property of emitting energy radiations under the influence of said cathode rays, radiant energy sensing means for producing voltages positioned so as to be influenced by said energy radiations, a plurality of character representing patterns disposed in rows and columns relative to said screen for controlling the intensity of said energy radiations impinging upon said sensing means in accordance with the configurations of said patterns, means for causing a relative movement between said energy radiations and select ones of said patterns simultaneously whereby said energy radiations impinge upon said sensing means simultaneously in accordance with configurations of said select ones of said patterns, a cathode ray tube comprising means for producing cathode rays and a screen, cathode ray control means associated with said cathode ray tube, and electrical means for connecting said control means to said sensing means whereby voltages derived from said sensing means cause the character represented by the configurations of said patterns to be reproduced on said cathode ray tube screen.

6. A device according to claim 5 wherein said means for causing a relative movement between said energy radiations and said patterns comprises cathode ray deflecting means associated with said electron discharge device for causing said cathode rays to sweep said screen.

7. A character tracer system having, in combination, an electron discharge device comprising means for producing an electron beam and a screen having the property of emitting a beam of radiant energy under the influence of said electron beam, a plurality of radiant energy sensing means for producing voltages positioned so as to be influenced by said radiant energy beam, a plurality of character synthesis patterns each of which is associated with one of said sensing means and each of which is positioned and arranged so that said energy radiations impinge on said patterns concurrently to thereby cause said energy radiations to impinge upon said sensing means in accordance with the configuration of the patterns associated therewith, electron beam sweep means associated with said electron discharge device for causing said electron beam to move past a region of said screen proportional to one of said patterns whereby said beam of radiant energy sweeps said patterns simultaneously, and recording means responsive to voltage variations derived from said sensing means for effecting a tracing of a character represented by said patterns.

8. A device of the class described having a plural-voltage generator comprising an electron discharge device including means for producing cathode rays and a screen for emitting light energy radiations under the influence of said cathode rays, a plurality of masks having transparent and opaque configurations, optical elements so constructed and arranged as to cause said radiations to impinge upon said masks concurrently, cathode ray deflecting means for causing said cathode rays to sweep a region of said screen proportional to one of said masks whereby said radiations sweep said masks simultaneously, and generator output voltage means including a phototube for each of said masks, said phototube being positioned so as to be influenced by said radiations passing through an associated mask.

9. In a device of the class described having a multi-signal voltage generator for generating plural voltages, the combination of an electron discharge device including means for producing cathode rays and a screen for emitting light energy radiations under the influence of said cathode rays, a plurality of masks having areas of transparent and opaque configurations, optical elements so constructed and arranged as to cause said radiations to impinge upon related areas in each of said masks concurrently, cathode ray deflecting means including sweep means for causing said cathode rays to move past a region of said screen proportional to one of said areas and positioning means for causing said cathode rays to sweep in a selected order a plurality of regions of said screen corresponding to a plurality of mask areas, generator output voltage means including a phototube for each of said masks, said phototube being positioned so as to be influenced by said radiations passing through an associated mask, and timing means for applying a predetermined blanking voltage to said electron discharge device during every period said cathode rays are caused to move from one screen region to another screen region.

10. A character tracer system having, in combination, an electron discharge device comprising means for producing an electron beam and a screen having the property of emitting a radiant energy beam under the influence of said electron beam; a plurality of radiant energy sensing means for producing voltages, positioned so as to be influenced by said radiant energy beam; a plurality of character synthesis patterns each of which is associated with one of said sensing means, each of which is positioned so that said radiant energy beam impinges said patterns concurrently, and each of which is arranged so that said radiant energy beam impinges said sensing means in accordance with the configuration of said patterns associated therewith; electron beam sweep means associated with said electron discharge device for causing said electron beam to move past a region of said screen proportional to one of said patterns whereby said radiant energy beam sweeps said patterns simultaneously, said electron beam sweep means including first means for causing said electron beam to vibrate in a single plane and with an amplitude of vibration substantially equal to the height of one of said patterns and second means for moving said electron beam an amount equal to the distance across one of said patterns; and recording means responsive to voltage variations derived from said sensing means for effecting a tracing of a character represented by said patterns swept by said beam of radiant energy.

11. A device of the class described having a plural-voltage generator comprising an electron discharge device including means for producing cathode rays and a screen for emitting light energy radiations under the influence of said cathode rays, a plurality of masks having character synthesizing patterns defined by transparent and opaque configurations, optical elements so constructed and arranged as to cause said light energy radiations to impinge upon said masks concurrently, cathode ray deflecting means for causing said cathode rays to sweep a region of said screen proportional to one of said masks whereby said light energy radiations sweep said masks simultaneously, said deflecting means including first means for causing said cathode rays to vibrate in a single plane and with an amplitude of vibration substantially equal to

the height of one of said patterns and second means for moving said cathode rays an amount equal to the distance across one of said patterns, and generator output voltage means including a phototube for each of said masks, each said phototube positioned so as to be influenced by said light energy radiations passing through an associated mask.

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