

July 7, 1964

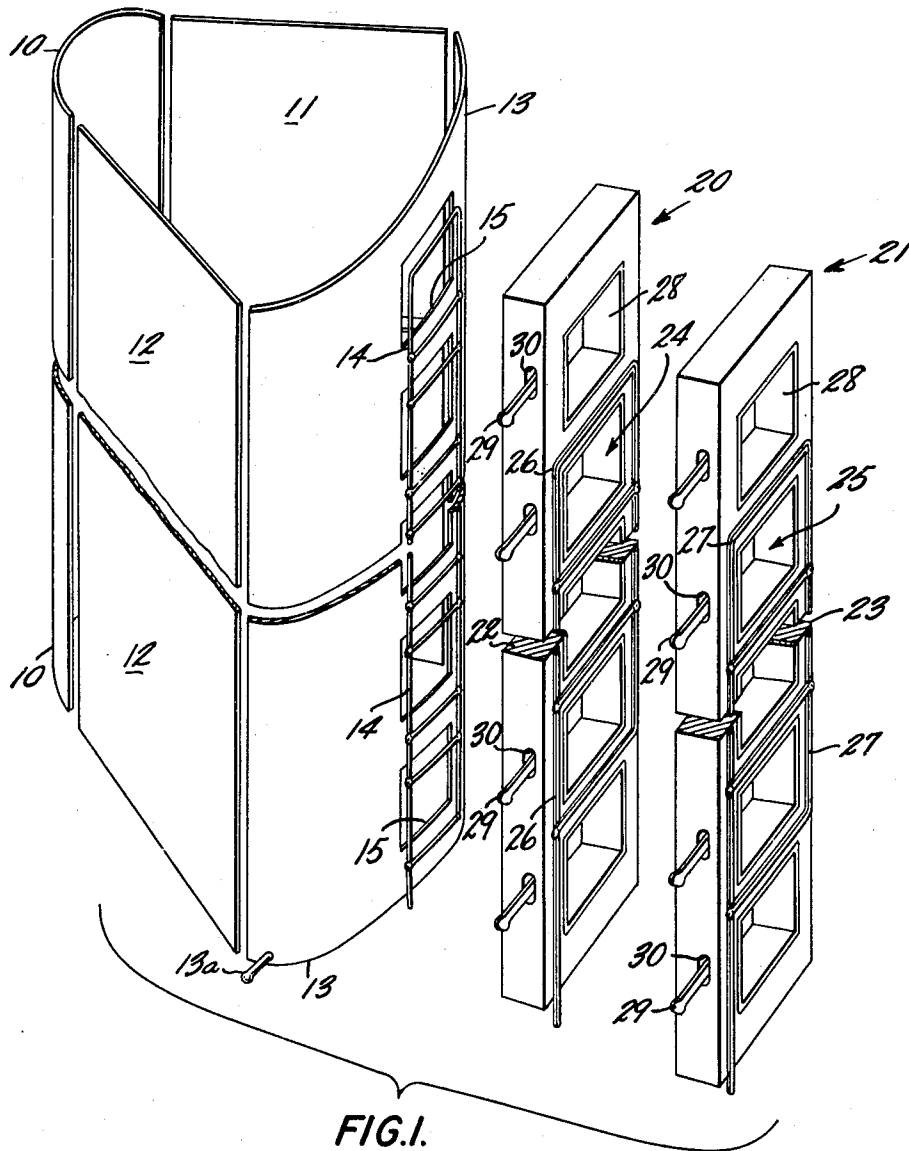
J. E. GAFFNEY, JR

3,140,473

INFORMATION STORAGE SYSTEM

Original Filed Dec. 24, 1956

5 Sheets-Sheet 1



INVENTOR
JOHN E. GAFFNEY, JR.
BY *Baumgardner, Free
Groves + Donahue*
his ATTORNEYS

July 7, 1964

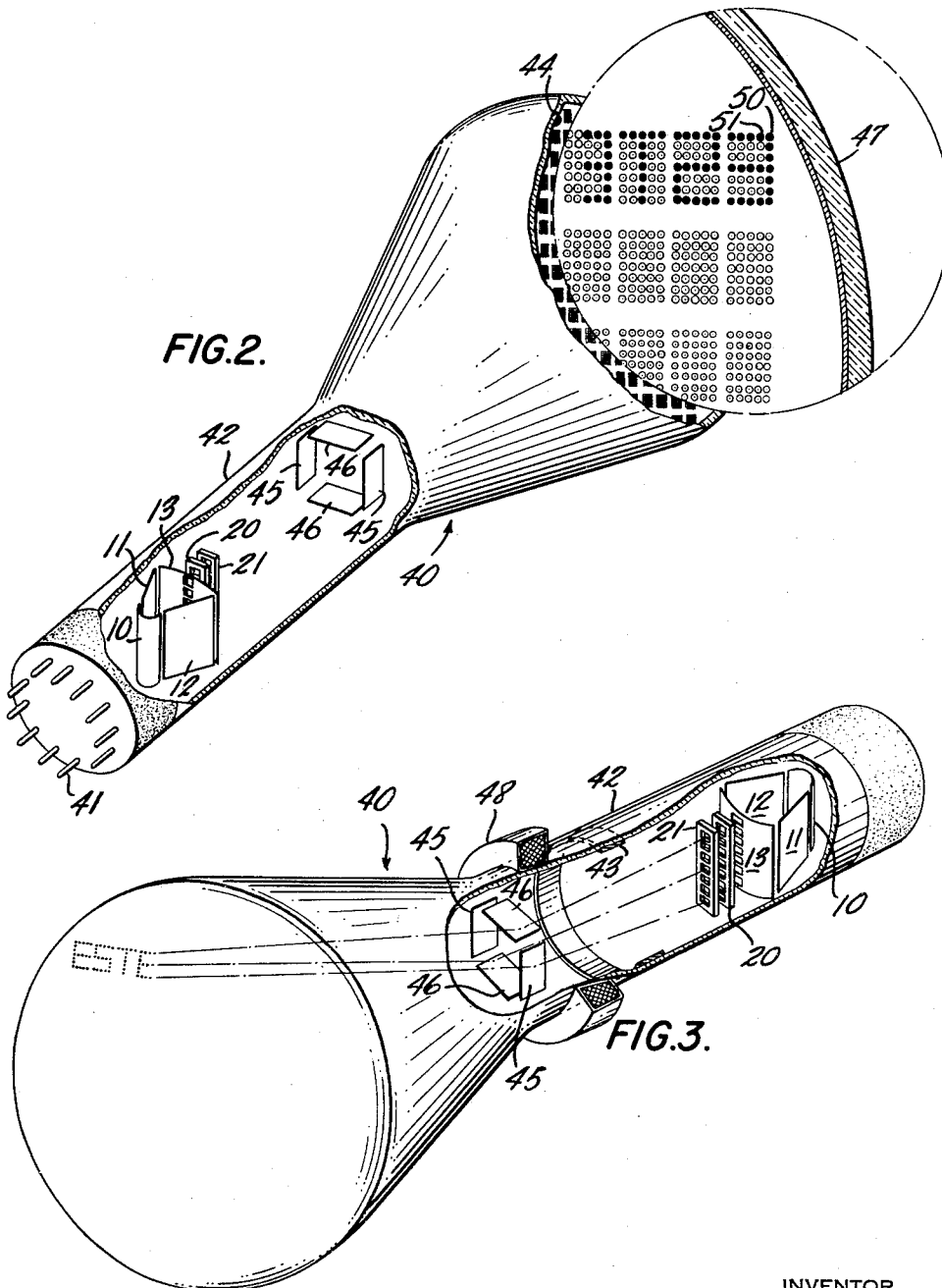
J. E. GAFFNEY, JR

3,140,473

INFORMATION STORAGE SYSTEM

Original Filed Dec. 24, 1956

5 Sheets-Sheet 2



INVENTOR
JOHN E. GAFFNEY, JR.
BY *Bumblough, free*
Shaw, & Dolan
his ATTORNEYS

July 7, 1964

J. E. GAFFNEY, JR

3,140,473

INFORMATION STORAGE SYSTEM

Original Filed Dec. 24, 1956

5 Sheets-Sheet 3

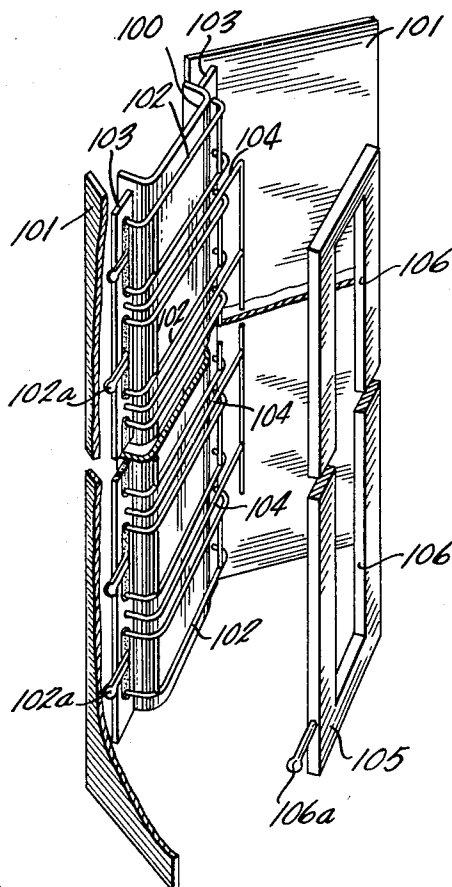


FIG. 4.

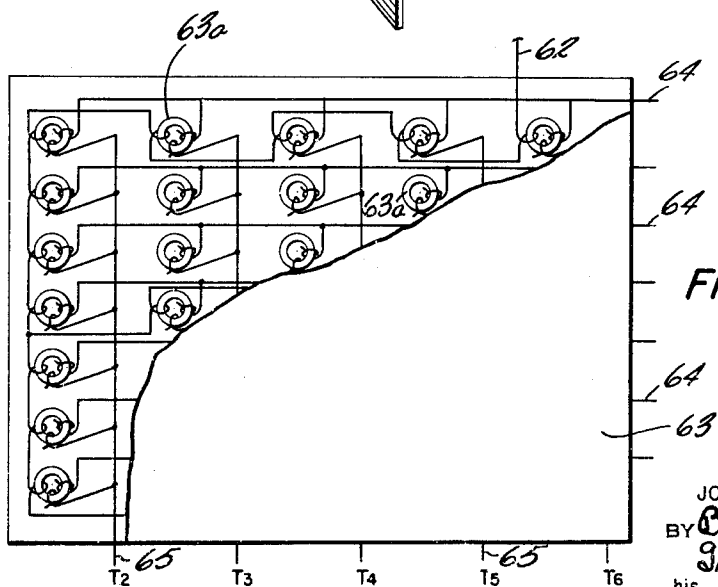


FIG. 5A.

INVENTOR
JOHN E. GAFFNEY, JR.
BY *Brundage, Free*
Graves + Rose
his ATTORNEYS.

July 7, 1964

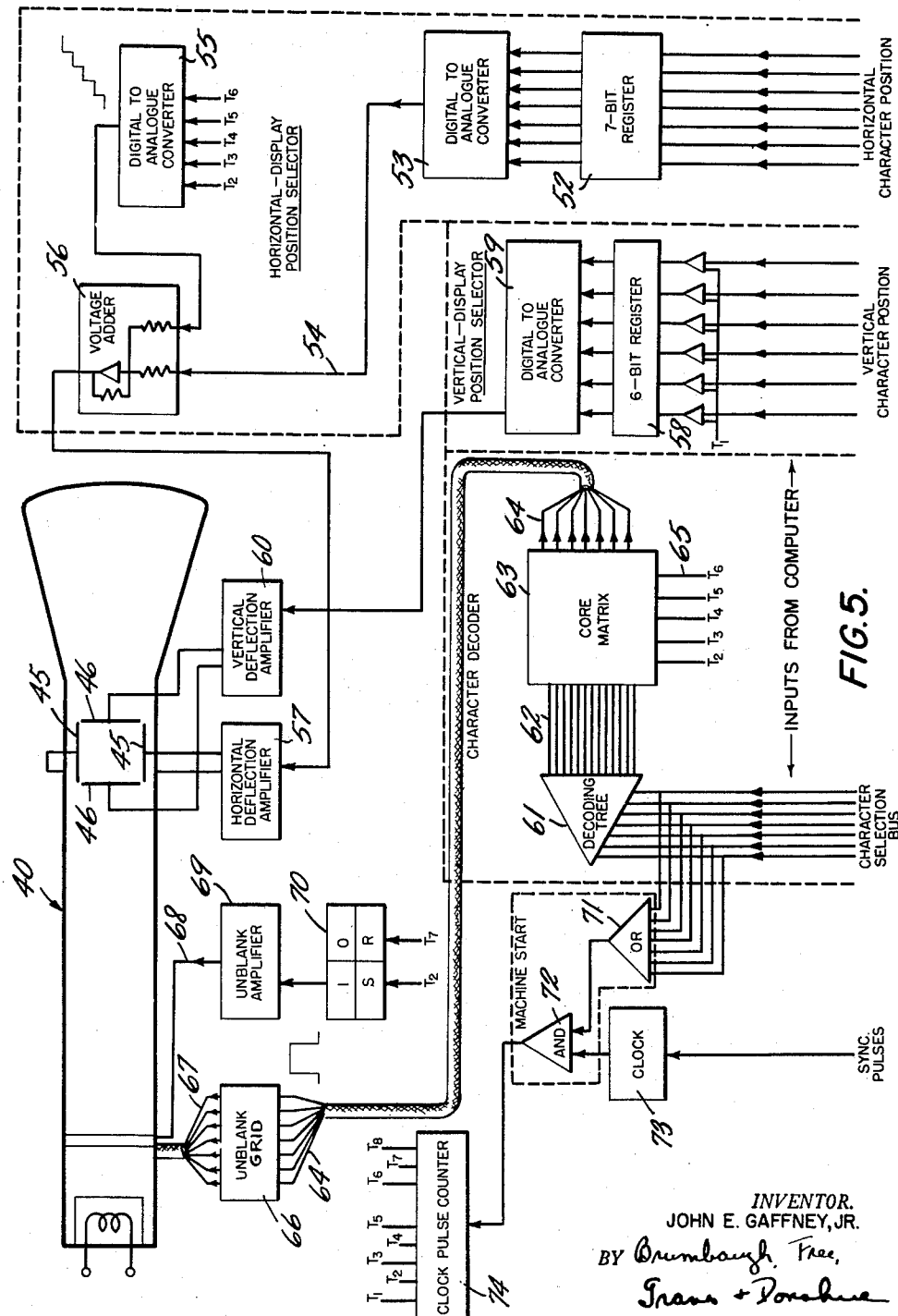
J. E. GAFFNEY, JR

3,140,473

INFORMATION STORAGE SYSTEM

Original Filed Dec. 24, 1956

5 Sheets-Sheet 4



July 7, 1964

J. E. GAFFNEY, JR
INFORMATION STORAGE SYSTEM

3,140,473

Original Filed Dec. 24, 1956

5 Sheets-Sheet 5

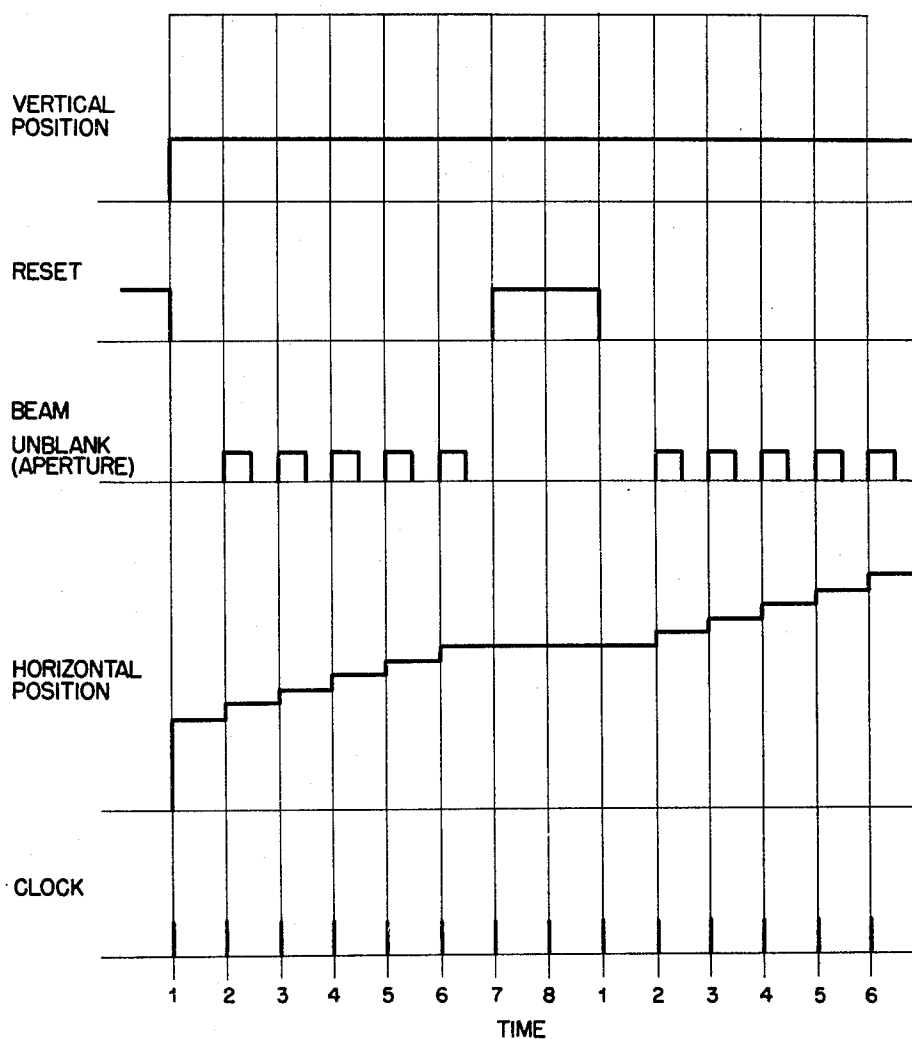


FIG.6.

INVENTOR
JOHN E. GAFFNEY, JR.
BY *Brennbaum, Inc.,*
Graves + Donahue
his ATTORNEYS

1

3,140,473

INFORMATION STORAGE SYSTEM

John E. Gaffney, Jr., Poughkeepsie, N.Y., assignor to International Business Machines Corporation, New York, N.Y., a corporation of New York

Application Oct. 2, 1959, Ser. No. 844,144, now Patent No. 2,978,608, dated Apr. 4, 1961, which is a continuation of Ser. No. 630,386, Dec. 24, 1956. Divided and this application May 12, 1960, Ser. No. 28,586
8 Claims. (Cl. 340-174)

This invention generally relates to information storage systems, more particularly, to systems of this sort of which one practical application is for providing information to operate a cathode ray tube for synthesizing characters on a display screen.

This application is a division of Serial No. 844,144, filed October 2, 1959 (now Patent 2,978,608, dated April 4, 1961) which, in turn, is a continuation of now abandoned application Serial No. 630,386, filed December 24, 1956.

In one prior indicator of the cathode ray tube type, one of a whole roster of selectable characters must be chosen by a set of selecting deflection coils. All but one of these possible characters forming beams are off the axis of the tube, thereby necessitating the application of specialized focusing fields to counteract the radial non-uniformity of the electric accelerating field produced between the cathode and the anode of the tube due to the use of a plurality of divergent beams. Both the focusing and the selecting deflection fields present technical difficulties.

Another disadvantage of the cathode ray character indicators of the prior art is the effect of the non-homogeneity of the electric or magnetic deflection fields acting upon the character representing beam of the cathode ray tube. In such prior art devices, the various beams emanate from different geographical locations on the cathode and, therefore, the effect of the electric or magnetic deflection fields on all possible characters is not uniform.

I have found that the abovementioned difficulties may be overcome by providing a cathode ray tube with a plurality of independent electron beams capable of being focused upon an incremental area on the tube screen. Obviously, the electron beams may be obtained by using separate electron guns but, for practical purposes, a single electron gun is preferred.

To obtain the desired separate electron beams from a single electron gun, the emitter or cathode is constructed to present a relatively small lateral dimension and any desired length. In other words, the cathode is much longer than it is wide. Such a cathode ray beam generator provides a single beam which is then subdivided into a plurality of vertically spaced-apart smaller independent beams in a line array acted upon separately by an electron lens.

The control of each electron beam is provided by suitable circuitry external to the tube. By sweeping the beam array across the screen area allotted to each character, and at the same time cutting predetermined electron beams "on" and "off," a desired character may be produced on the screen. Although the inventive character synthesizing tube is unique in its ability to scan the screen in line sequence, discrete positions on the screen may be selected by the application of suitable control voltages or, indeed, any desired sequence and any desired speed may be selected. The character synthesizing tube is useful, therefore, in selecting any one of many memory elements in which information is stored and retained. In such an application the conventional luminescent screen may be replaced by a memory screen made up of many memory

2

elements from which information may be selected at random due to the fact that the beams are "off" until a selected time on the sweep cycle, or the beams may be left "on" to pass in turn from one to the other of the memory elements in a predetermined order.

In connection with the operation of the tube which has just been described, there are applications in which it is desirable that the characters or other visual symbols displayed by the tube be derived from permanently stored representations thereof.

An object of this invention is, accordingly, to provide a system for permanently storing one or more of such representations and for reading out such representations in a manner whereby the read-out signals are conveniently adapted to control the character display of the mentioned tube.

Another object of the invention is to provide an information storage system of the mentioned sort which is adapted for uses other than to control the character display of the described tube.

These and other objects are realized according to the invention by providing a plurality of information storage means electrically arranged in rows and columns to form a network or matrix. For each column of storage means there is provided an input means coupled to all the storage means of such column, and, similarly, for each row of storage means there is provided an output means corresponding to all the storage means of such row. The matrix as a whole is interrogated by means which applies successive input signals to the plurality of input means in such manner that the matrix is interrogated column by column in a predetermined order of columns.

At least one permanently stored representation of a character or other symbol is provided by means which defines for the matrix at least one preselected pattern of information storage means. The several information storage means of the matrix which belong to such preselected pattern are, of course, essential elements although the same would not be true of those information storage means not belonging to any preselected pattern.

The mentioned pattern-defining means is adapted to make its corresponding pattern manifest by operably rendering only each of the ones of the storage means which are in that pattern responsive to interrogation to produce an output signal on the output means coupled to such storage means. Thus as each entire column of the matrix is interrogated, there appear simultaneous output signals on only those of the plurality of output means which are coupled to storage means satisfying both of the conditions of being located in that column and of belonging to the preselected pattern. Those output signals may be used to control the electron beams of the described multi-electron-beam tube or they may be used for other purposes.

In one practical form of the invention the several information storage means of the matrix are furnished by magnetic cores of reversible magnetic state, the several input means are provided by input conductors of which each magnetically links each of all the cores of the corresponding column to operably exert upon each such core a magnetic coercive force of itself insufficient to reverse the state of cores in the column not belonging to a pattern to be read-out, and the several output means are provided by output conductors of which each is magnetically linked with each of all the cores of the corresponding row to have an output signal included in such output conductor each time a core of such row reverses state. In such form of the invention it is convenient, although not necessary, that the one or more pattern-defining means each be a single conductor which is magnetically linked in each column with all the one or more cores therein belonging to the pattern corresponding to such means, and which may

also run in the row direction of the matrix to interconnect magnetic cores disposed in separate columns in the instance where the pattern includes magnetic cores in separate columns. Whether or not a given pattern-defining means is in the form of such single conductor, its function is related to the column by column interrogation of the matrix, in that, as each column of cores is interrogated, the pattern defining means causes the one or more cores of the column which belong to the corresponding pattern to respond to the applied interrogatory coercive force by reversing in magnetic state to produce an output signal. Such response may be produced by applying to the cores of the pattern a coercive force which supplements that produced by the interrogatory coercive force, and which, together with the interrogatory force results in the reversal of the magnetic state of each core to which both coercive forces are applied in overlapping time relation. This overlapping time relation may conveniently, although not necessarily, be obtained by applying the supplemental coercive force to all cores of the pattern throughout the entire duration of the different times at which the pattern-contained cores in different columns are subjected to the interrogatory coercive force.

For a better understanding of the invention, reference is made to the following disclosure and to the accompanying drawings in which:

FIGURE 1 is a perspective view, greatly enlarged, illustrating one embodiment of a cathode ray beam generator in accordance with the present invention;

FIGURE 2 is a perspective view, partially in section, of a cathode ray tube incorporating the invention and illustrating the position of the beam generator, and partially in magnified section to illustrate the illumination of selected spots on the inner face of the cathode ray tube screen to represent selected characters;

FIGURE 3 is a perspective view partially in section of the cathode ray tube of FIGURE 2 taken from another angle;

FIGURE 4 is a view in perspective, greatly enlarged, of another cathode ray beam generator;

FIGURE 5 is a circuit diagram illustrating one arrangement of components to operate the character synthesizing tube of the present invention;

FIGURE 5A is a partial schematic diagram of a magnetic core matrix illustrated in FIGURE 5; and

FIGURE 6 is a timing chart illustrating the relative timing of control pulses and voltages in the operation of the present invention.

Referring to the perspective view of FIGURE 1, a typical embodiment of the present invention provides a cathode ray beam generator for developing any desired number of vertically spaced-apart electron beams to be focused in a vertical array on an incremental area of a cathode ray tube screen. Included in the generator is a long narrow cathode 10 emitting electrons in a fan-shaped beam as determined by side-deflecting plates 11 and 12. A conventional arrangement for indirectly heating the cathode 10 may be utilized. It has been found that for optimum beam density the plates 11 and 12 should be at an angle of approximately 135° with each other.

To subdivide the single electron beam, a curved anode plate 13 provided with a terminal 13a is positioned between the flared ends of the deflecting plates 11 and 12. Since one embodiment of the cathode ray beam generator utilizes seven separate electron beams, seven vertically spaced-apart apertures 15, rectangular in shape, for example, are provided along the central axis of the anode plate 13. Of course, the apertures may be circular or of any other desired configuration. The electron beam passing through each aperture in the anode plate 13 is shielded from interacting field effects of the electron beams passing through adjacent apertures by interconnected electrical conductors 14 adjacent to the apertures, such conductors preferably being maintained at ground potential. In this manner, seven separate and distinct electron beams are

provided which may be controlled independently of each other. Of course, seven separate electron emitters may be substituted for the above arrangement although such a system would be more complex and expensive than the above-described structure.

Considering next the control of the seven electron beams, each beam is either "on" or "off." That is, any predetermined electron beam either passes through a grid structure or electron lens to a screen, described hereinafter, or it is cut off entirely. To achieve the latter effect, the electron beam may be defocused by suitable elements. Another arrangement to cut off the beam involves the provision of an electron mirror effect to reflect the electrons entirely. An electron mirror acts identically upon an electron beam as does its optical counterpart on light. This is accomplished by providing a potential distribution which decelerates and reverses the direction of flow of the impinging beam of electrons.

The beam defocusing type of control, on the other hand, achieves the desired control by defocusing the beam sufficiently with an electron lens along the axis of the beam path. This simply causes the beam to be imaged at some spot beyond the aperture plane, causing an apparent disappearance of the spot from the display screen. For the purposes of the present invention, however, the electron mirror type of beam control is preferred although it is understood that other systems may be used.

The primary prerequisite to successful electron beam control is to provide isolation of each beam from the others in order that it may be turned "on" or "off" without interfering with the other beams. That is, the field effect of one set of beam control electrodes as well as the space charge effect produced by the electron beam upon which it acts must be minimized. To this end, elongated grids 20 and 21, forming an electron lens, utilize supporting dielectric material, indicated generally by the numerals 22 and 23, to provide a plurality of rectangular apertures 24 and 25, respectively, preferably equal in number to the cathode apertures 15. Permanently interconnected electrical conductors 26 and 27 on the grids 20 and 21, respectively, form closed loops about each of the apertures 24 and 25 to isolate the electron beams passing therethrough from any appreciable interacting field effects, their effect being identical with that of the electrodes 14.

The grid control elements comprise electrically conductive facings 28 supported by the dielectric material in the apertures 24 and 25. Each of the facings 28 receives a control voltage from a terminal 29 extending through an opening 30, separate electrical conductors (not shown) connecting each terminal 29 to separate pins 41 (FIGURE 2) extending from the base of a cathode ray tube 40. Thus, only seven connections for each of the two grids are required. Through these simplified connections, a control voltage may be maintained independently at each of the grid apertures. In certain instances, all of the terminals of one of the grids may be tied to a common potential.

If desired, each of the apertures may contain a fine wire mesh at the potential of the conductive facings 28. It will be understood that such wire mesh may be used with or without the facing 28. In addition, the grid control elements may be self-supporting in which event the dielectric structure may be eliminated.

Under normal operation of the tube, the control elements 28 at the apertures 24 and 25 are maintained at such potentials that the beam formed by the related cathode aperture 15 is in an "off" condition. When an appropriate signal is received at related terminals 41, predetermined apertures are unblanked and that beam is focused on the tube screen at a point determined by a separate beam deflection circuit to be described hereinafter. More particularly, if the electron mirror effect is used, the facings 28 in the grid 21 may be maintained

5

6

at a fixed positive potential of, for example, 200 volts, and the facings 28 in the grid 20 may be held normally at a negative 200 volt potential. By applying a positive 150 volt potential to selected facings 28 on the grid 20, selected beams may be turned "on." This demonstrates the electron mirror effect, the surface of the mirror being between the grids 20 and 21.

With the provision of seven vertically spaced-apart electron beams, each being capable of separate and independent control, the next requirement for the operation of the present character synthesizing tube is that the seven beams, as a unit, be deflected horizontally and vertically to a predetermined position on the tube screen.

Referring now to FIGURE 2 of the drawings, the cathode 10, the beam forming plate 13 and the grids 20 and 21 are shown in operating position within an evacuated container 42 of the cathode ray tube 40. It should be understood that the size of the cathode, anode and grid structures has been greatly exaggerated in FIGURES 2 and 3 in the interests of clarity. In practice, the apertures 24 and 25 in the grids 20 and 21 may be on the order of .010 to .030 inch square, for example. Electrical connections (not shown) are provided between each of the separate components within the evacuated container 42 and the pins 41, only a representative number of which are shown for simplicity. As such connections are well known in the art, a detailed description thereof is deemed unnecessary here.

A second anode 43 (FIGURE 3) may be provided in the envelope 42 in accordance with conventional cathode ray tube construction in order to accelerate the electron beams, a final accelerating aquadag coating 44 on the tube interior also being useful.

The deflection of the electron beams is controlled by horizontal deflection plates 45 and by vertical deflection plates 46, such beams thereby impinging on desired areas of a screen 47. A conventional phosphorescent coating may be provided on the screen. If desired, a storage type screen may also be utilized in which event the information may be read from the screen by scanning it.

A magnetic field may be provided by a coil 48 (FIGURE 3) to reduce the beam column height by converging the beams, as shown in FIGURE 3, to reduce the character size. In other instances such a magnetic field may be employed to increase the column height by diverging the electron beams, if desired.

Another arrangement to provide a plurality of independent electron beams spaced apart in a lineal array is shown in FIGURE 4. In this structure, a cathode 100, indirectly heated in a conventional manner, is flanked by a pair of side baffles 101. Grids 102 spaced from and extending in front of the cathode 100 are supported by strips 103, separate grids being energized through terminals 102a to control electrons emitted from separate areas of the cathode. A fine wire mesh may be provided across the opening defined by the wires of each individual grid, if desired. It will be understood that the grid-cathode structure has been greatly enlarged, the distance between horizontal grid wires being on the order of .015 to .030 inch, for example.

To isolate the electron beams and minimize interacting field effects, grounded conductors 104 extend in front of the cathode 100 between each pair of grids 102.

A first anode 105 also includes a longitudinal aperture 106 to limit the width of the electron beam array provided by the cathode-grid structure. The entire cathode ray tube may be controlled by suitably varying the potential of this anode by a connection to a terminal 106a thereon.

The theory of operation of this beam forming structure will be understood when it is compared to a conventional three element vacuum tube. Thus, each of the grids 102 forms with an area of the cathode and the anode 105 a triode controlled by appropriately vary-

ing the cathode-grid potential gradient. Furthermore, by setting the potential on the anode 105 sufficiently low, the generation of an electron beam is prevented regardless of the grid-cathode potential.

To illustrate the manner in which the single column electron beam array is deflected, a suitable voltage applied between the horizontal deflection plates 45 and between the vertical deflection plates 46 directs the array, for example, to a column 50 on the screen 47, as shown by the magnified section of FIGURE 2. Solid dots indicate an "on" beam and blank circles indicate the spot where that electron beam would have been focused had it not been blanked "off".

In column 50, all seven of the vertically spaced-apart electron beams are "on" as indicated by the seven solid dots on the screen 47. By changing the voltage between the horizontal deflection plates 45 while holding the voltage constant between the vertical deflection plates 46, the single column of seven electron beams is deflected to the next column position 51. Coincident with the change in horizontal position of the beams, the second, third, fifth and sixth electron beams, counting downwardly from the top, are cut "off," as indicated by the small blank circles in the column 51. Thus, only the top, middle and bottom beams impinge upon the screen. The seven beams are continuously stepped across the screen 47 as predetermined beams are cut "on" and "off" at a rapid rate to form the selected characters. In the example shown in FIGURE 2 of the drawings, the letter E is printed at the first character position with the letters S, T, and a partially formed E, following the T. In FIGURE 3, the letters formed on the screen 47 appear from the front with the electron beam array shown in a position to complete the second letter E.

The timing of the beam array shift is shown in the timing chart of FIGURE 6 which will be explained in greater detail hereinafter. As the voltage on the vertical deflection plates 46 is held constant, the horizontal position voltage is varied in a sequential step fashion to move the single-column electron beam array across the selected character position.

For the purpose of further illustrating the invention, it will be assumed that the cathode ray tube 40 has sufficient area on its display screen 47 for an array of 128 characters across by 64 characters down. Such an array has been chosen arbitrarily for use in the proposed character synthesizing tube although the invention is not limited to any particular array or number of characters. Since each character position on this tube screen is composed of five vertical columns of seven spots (spaces at which each beam may be focused), a total display is divided into 1024 (8×128) vertical column spaces of 64 horizontal arrays of 7 rows. Each character will physically occupy five of the eight lines of its character space. These lines correspond in the time chart to T_2 - T_6 of a given machine cycle while the other three of the eight lines correspond to T_1 , T_7 and T_8 of the machine cycle, which increments are reserved for a reset operation.

One circuit arrangement for operating the character synthesizing tube 40 is illustrated in FIGURE 5 of the drawings. Considering first the operation of that portion of the block diagram enclosed by broken lines and labeled horizontal display position selector, during the time intervals T_7 and T_8 of the machine cycle preceding the generation and display of the next character, a computer (not shown) sends into a register 52 a binary coded positioning signal which corresponds to one position out of the 128 horizontal positions on the tube face on which it is desired that the next character appear. The binary coded positioning signal is transformed by a digital-to-analog converter 53 to provide a voltage on a line 54 that will index the selected character at column 2 of a given character space, column 1 actually comprising space between adjacent characters.

Another digital-to-analog converter 55 produces a horizontal position step voltage, indicated in the time sequence chart of FIGURE 6, to step the electron beam array across the tube face 47. The converter 55 does this incrementally since it steps the output voltage when pulses are fed to it at times T_2 to T_6 . The stepped voltage is added to the horizontal positioning voltage from the line 54 by an analog voltage adder 56, the composite voltage being fed into a horizontal deflection amplifier 57 which, in turn, energizes the plates 45 to move the beam array horizontally, step by step, across the selected character position.

To determine on which line the characters are to be formed, a predetermined vertical deflection of the electron beam array must be obtained. In response to suitable binary code signals from the computer, a register 58 positioned in a unit termed a vertical-display position selector produces output signals if such coded signals are received coincidentally with time T_1 pulses. A digital-to-analog converter 59 receives the binary signals from the register 58 and generates a voltage providing the desired vertical deflection for one of the 64 selectable rows of characters. The vertical deflection voltage is amplified by a suitable amplifier 60 and applied to the vertical deflection plates 46 of the tube.

At the same time that horizontal and vertical positioning signals are being applied to the deflection plates, predetermined ones of the seven electron beam are unblanked (turned "on") at selected intervals. The control of the unblanking is initiated by a binary coded character signal from a character selection bus leading from the computer. This coded signal is applied to an appropriate decoding tree 61, which is composed of magnetic cores or diodes, in a unit labeled character decoder. The decoding tree 61 selects and applies a voltage pulse to one of sixty four, for example, character selection output wires 62 corresponding to the coded character from the computer.

The wires 62 selectively couple energizing potentials to a core matrix 63 which generates coded output signals on seven output conductors 64 corresponding to the seven vertical electron beam positions. For example, the core matrix 63 may take the form of the circuit shown in FIGURE 5A. Five columns of seven high remanence magnetic cores 63a form the matrix, the output conductors 64 being connected to individual windings on the cores in corresponding rows. A second connection to the core windings has been omitted since it merely leads to a suitable potential. Five input conductors 65 receiving pulses at times T_2 to T_6 , as shown in FIGURE 5, energize windings on corresponding columns of the magnetic cores 63a.

The manner of connecting a single character selection output conductor 62, representing the letter "E," has been illustrated in FIGURE 5A. Thus, the conductor 62 leads to windings on the cores 63a corresponding to the dots that must be illuminated to form an "E," namely the top, middle and bottom rows and the left column.

In operation, a potential is maintained on the "E" conductor 62 while that character position is scanned. However, the cores 63a will not be switched by such potential alone since corresponding windings will not furnish the required switching magnetomotive force. Energization of the T_2 conductor 65 by a pulse at time T_2 adds an additional coercive force to the left column of cores, this being sufficient to switch them and provide output voltages on all the conductors 64 at this instant.

The circuit designated unblank grid 66 is a simple diode circuit normally maintaining the beam control electrodes at such potential that the several beams are blanked out. At this time, suitable output lines 67 will be energized to unblank the beams required to illuminate a portion of the selected character. More specifically, the output lines will supply potentials to the grid facings 28 in FIGURE 1 or the grids 102 in FIGURE 4.

While the electron beam array is being moved from

one character position to another, or to a new row, a suitable blanking potential is applied to a control electrode by a conductor 68. For example, the control electrode may be the plate 13 in FIGURE 1 or the anode 105 in FIGURE 4. This potential is normally furnished by an unblank amplifier 69. A set-reset circuit 70, which may comprise a trigger circuit stable in two conditions, supplies a continuous D.-C. voltage at level "1" to the amplifier 69 in response to a pulse at time T_2 to unblank the tube 40. A further pulse received by the trigger 70 at time T_7 turns off the D.-C. voltage and restores the circuit to its "0" condition so that a blanking signal is carried on the line 68. The interval during which the tube is blanked in this manner for reset is indicated in FIGURE 6 by the legend "reset."

At the same time that a signal representing a particular character to be printed on the screen is fed into the decoding tree 61, the same signal is fed into an "OR" circuit 71 in a machine start unit, as shown in FIGURE 5. The "OR" circuit 71 is of the type which provides an output signal if there is a pulse on any one of the input leads. The output of the "OR" circuit is fed into an "AND" circuit 72 also receiving pulses from a clock 73 synchronized with the computer. The "AND" circuit 72 provides an output pulse at each instant that pulses from the clock 73 and from the "OR" circuit 71 coincide. Each output pulse from the "AND" circuit 72 causes a clock pulse counter 74, which may comprise a ring counter, to advance one step and supply pulses on the outputs T_1 to T_8 at the corresponding times. These pulses are supplied to various units in the systems, as described above, so that the indicator circuits are synchronized with the computer.

It will be evident from the foregoing that the indicator circuits incorporating the inventive cathode ray tube 40 may be substituted for a conventional printer to display the output of a computer. A high speed camera may be synchronized with the computer to obtain information from the tube screen 47. If a storage type screen 47 is used, it may be scanned to provide signals representative of the output information.

While there has been shown and described and pointed out the fundamental novel features of the invention as applied to the preferred embodiment, it will be understood that various omissions, 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.

I claim:

1. Apparatus comprising a plurality of information storage means electrically arranged in rows and columns to form a matrix, a plurality of input means each corresponding to one of said columns and coupled to all of the storage means therein, means adapted by applying successive input signals to said plurality of input means to interrogate all of the storage means of said matrix column by column in a predetermined order of columns, means defining in said matrix a preselected pattern of storage means, said pattern defining means being adapted during said column by column interrogation to make said pattern manifest by operably rendering only each of the ones of said storage means which are in such pattern responsive to interrogation to produce an output signal, and a plurality of output means for said matrix, each output means corresponding to one of said rows and being coupled to all of the storage means therein to transmit from said matrix each output signal produced by a storage means in such row, said pattern occupying at least portions of both of ones of said rows and of ones of said columns.

2. Apparatus comprising a plurality of information storage means electrically arranged in rows and columns to form a matrix, a plurality of input means each corresponding to one of said columns and coupled to all of the storage means therein, means adapted by apply-

9

ing successive input signals to said plurality of input means to interrogate all of the storage means of said matrix column by column in a predetermined order of columns, means defining in said matrix a preselected pattern of storage means, said pattern defining means being adapted during said column by column interrogation to make said pattern manifest by operably rendering only each of the ones of said storage means which are in such pattern responsive to interrogation to produce an output signal, and a plurality of output means for said matrix, each output means corresponding to one of said rows and being coupled to all of the storage means therein to transmit from said matrix each output signal produced by a storage means in such row, said matrix being a fully filled matrix having an information storage means at the intersection of each row and each column.

3. Apparatus comprising, a plurality of information storage means electrically arranged in rows and columns to form a matrix, a plurality of input means each corresponding to one of said columns and coupled to all of the storage means therein, means adapted by applying successive input signals to said plurality of input means to interrogate all of the storage means of said matrix column by column in a predetermined order of columns, means defining in said matrix a preselected pattern of storage means, said pattern-defining means being electrically coupled with all the storage means in said pattern, and being adapted by applying an electric signal to the pattern contained storage means during said column by column interrogation to render only each of the pattern contained storage means responsive to interrogation to produce an output signal, and a plurality of output means for said matrix, each output means corresponding to one of said rows and being coupled to all of the storage means therein to transmit from said matrix each output signal produced by a storage means in such row.

4. Apparatus as in claim 3 further comprising, a plurality of means defining in said matrix a corresponding plurality of electrically separate, preselected patterns of storage means, each of said pattern defining means being electrically coupled with all the storage means of only the corresponding pattern, and means to apply a control signal selectively among said plurality of pattern defining means to thereby obtain selective production of output signals from only one selected pattern among said patterns.

5. Apparatus as in claim 3 in which said pattern occupies at least portions of more than one of said columns, and in which said electric signal is simultaneously applied to all the storage means in each column portion of said pattern at a time which overlaps with that of the interrogation by an input signal of such columnar portion.

10

6. Apparatus as in claim 3 in which said electric signal is of continuous duration throughout the column by column interrogation of said matrix.

7. Apparatus comprising, a plurality of magnetic storage elements of reversible magnetic state and electrically arranged in rows and columns to form a matrix, a plurality of input conductor means each corresponding to one of said columns and coupled in coercive relation with all of the elements therein, means adapted by applying successive electric pulses to said plurality of conductor means to produce magnetic interrogation of said elements column by column in a predetermined order of columns, control conductor means coupled in coercive relation with all of a preselected pattern of elements in said matrix and being adapted by applying a control signal to the pattern-contained elements during said column by column interrogation to render only each of the pattern-contained elements responsive to interrogation to reverse in magnetic state, and a plurality of output conductor means for said matrix, each output conductor means corresponding to one of said rows and being inductively coupled to all the elements therein to have an output signal induced in such output conductor means in response to a reversing in magnetic state of each of the elements in such row.

8. Apparatus comprising, a plurality of magnetic cores electrically arranged in rows and columns to form a matrix, a respective input conductor means for each row, a respective output conductor for each column, said input and output conductors each being magnetically linked with all the cores of the rows and columns respectively corresponding thereto, a control conductor magnetically linked in said matrix with each core in a preselected pattern of said cores, a source of successive electric pulses, means to apply said pulses to said input conductors serially to produce column by column interrogation of all the cores in said matrix, and means to apply to said control conductor an electric signal which is continuous in duration throughout said column by column interrogation, only the cores in said pattern being each responsive to time-overlapping application thereto of said signal and a pulse by which such core is interrogated to produce an output signal on the output conductor corresponding to such core.

References Cited in the file of this patent

UNITED STATES PATENTS

2,820,956	Rueger	Jan. 21, 1958
2,844,812	Auerbach	July 22, 1958
2,912,677	Ashenhurst et al.	Nov. 10, 1959