

March 6, 1962

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3,024,454

GENERATION AND DISPLAY OF ALPHA-NUMERIC AND OTHER SYMBOLS

Filed Aug. 7, 1958

4 Sheets-Sheet 1

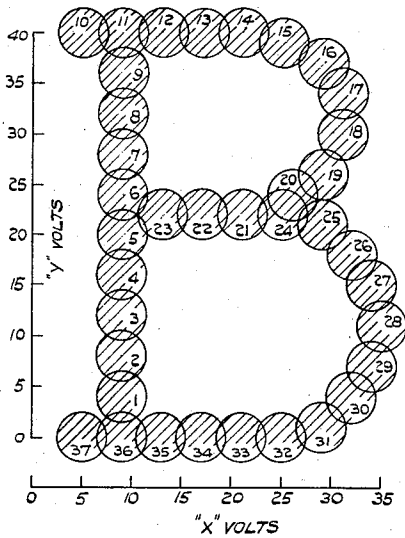


Fig. 2.

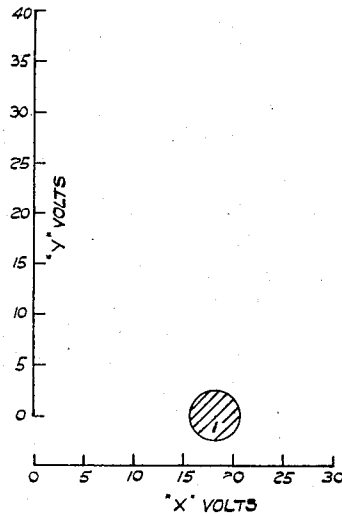


Fig. 3.

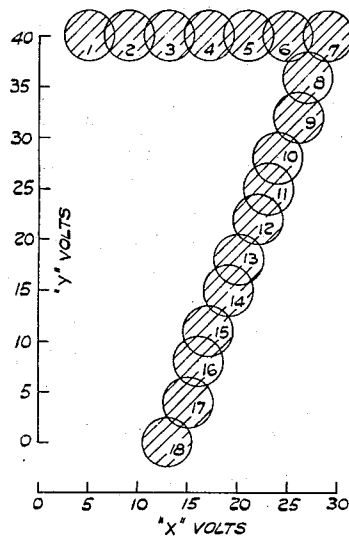


Fig. 1.

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4 Sheets-Sheet 2

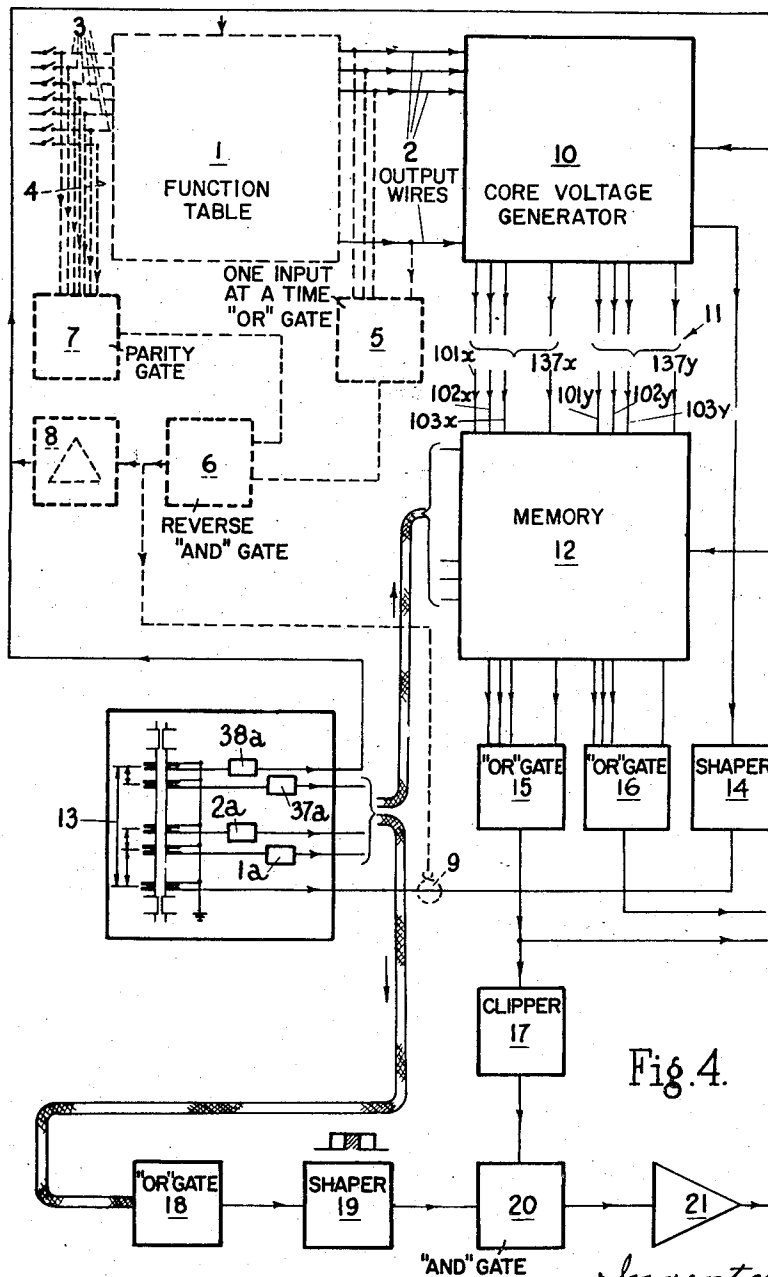


Fig. 4.

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4 Sheets-Sheet 3

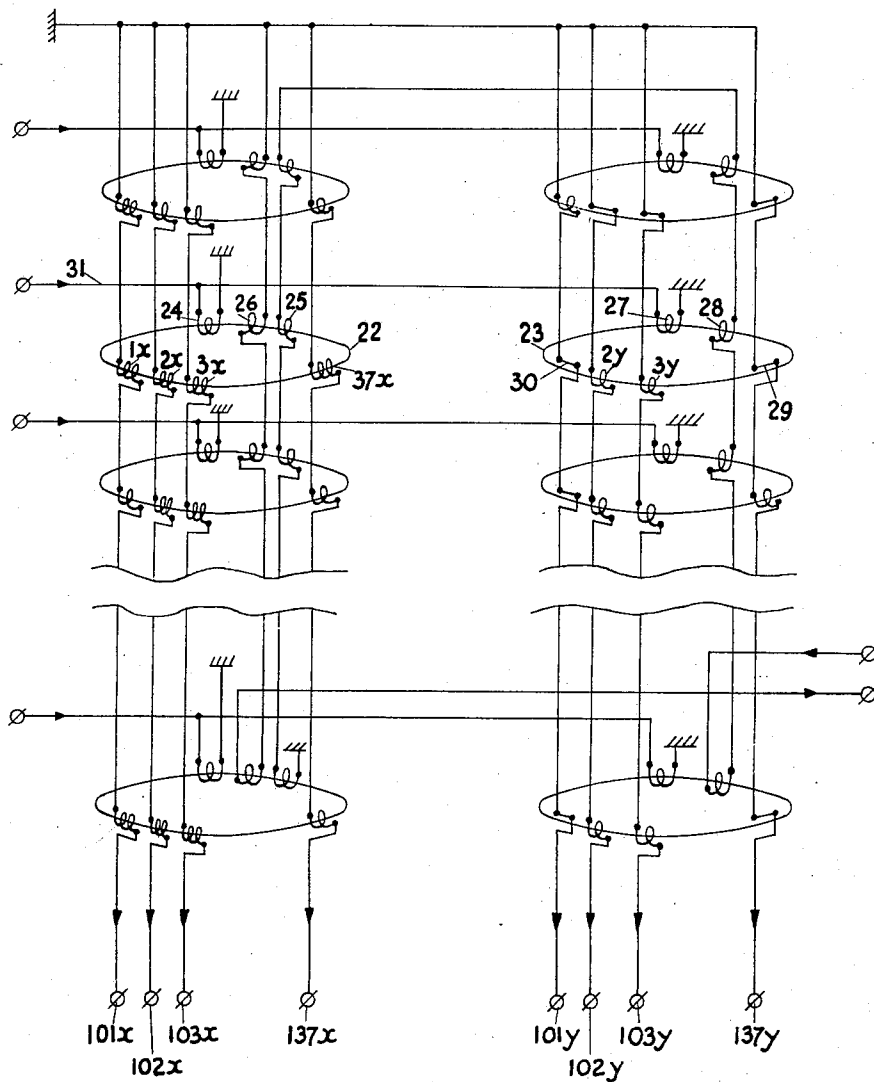


Fig. 5.

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4 Sheets-Sheet 4

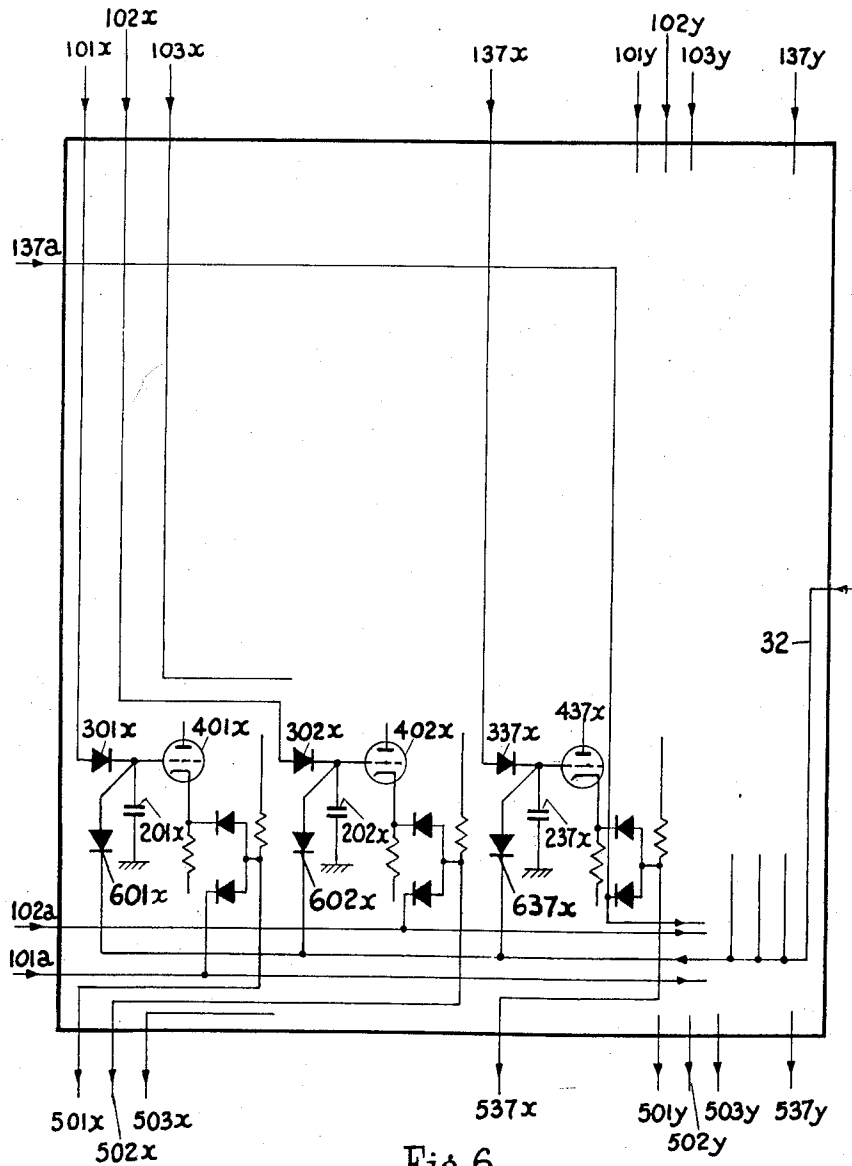


Fig. 6.

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3,024,454

GENERATION AND DISPLAY OF ALPHA-NUMERIC AND OTHER SYMBOLS

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8 Claims. (Cl. 340—324)

This invention relates to the display upon the face of a cathode ray tube of alpha-numeric and other symbols formed as a sequence of discrete light dots and in particular to means for generating the waveforms controlling the electron beam.

The expression characters will hereinafter be intended to include in addition to alpha-numeric characters, other predetermined symbols, such as punctuation marks and any patterns generally.

In the dot-sequential display of characters, the ultimate end of the circuitry involved is the generation of coincident X and Y waveforms for deflecting the beam of the cathode ray tube to the predetermined dot positions defining a given character in conjunction with timed beam-switching Z pulses applied to the beam-current control means of said tube. In other words, the cathode ray tube deflecting system requires an analogue form of input.

Where said waveforms are determined by digital means, a digital-to-analogue converter must be resorted to in providing said form of input. Generation of characters by coding and decoding, as required by the digital approach to the problem, introduces certain complexities of circuitry and design which adversely reflect upon capital outlay, maintenance costs, and reliability generally, while aiming at relative freedom from components drift, at least in the purely digital section of the arrangement. It would obviously be an advantage to generate the deflecting signals in the form in which they are ultimately required. Analogue arrangements, on the other hand, place a heavy demand on constancy of at least certain parameters depending on stability of components.

A primary object of the present invention is in fact to provide a method of, and apparatus for, displaying characters in dot-sequential manner on the face of a cathode ray tube, wherein the deflecting signals are generated in the analogue form required at the cathode ray tube while maintaining relative freedom from components drift, thus obviating the need for coding and decoding.

A further object is to provide for easy changeability of the range and style of characters displayable.

The invention consists of an apparatus and method for selectively displaying any one of a predetermined range of characters upon the face of a cathode ray tube as a sequence of discrete light dots in positions defined by sequential pair of X and Y beam-deflecting voltages, wherein upon selection of a character the voltage pairs defining said character are generated simultaneously in analogue form and stored for sequential interrogation and gating to the cathode ray tube deflection means.

Each voltage pair corresponds and is proportional to the Cartesian coordinates with respect to a chosen pair of axes of the several dots constituting the character being generated and consists of an analogue voltage applied to the X deflection means, hereinafter called the "X voltage," and an analogue voltage coincidentally applied to the Y deflection means, hereinafter called the "Y voltage."

Coincidentally with each voltage pair there is applied to the means controlling the beam current of the tube a beam switching or bright-up pulse, hereinafter referred to as the "Z voltage," it being understood that upon application of the Z voltage the beam of the cathode ray tube

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is switched on or intensified, this leading to a bright dot appearing upon the face of the cathode ray tube in the position at the same instant defined by said voltage pair.

The generation of the coincident X and Y voltage pairs is effected by feeding an electrical signal, for example, in response to the output of a computer device, via a function table or selection matrix, to an analogue voltage generator capable of generating simultaneously all the voltage pairs required for defining the character selected by said function table.

Preferably, selection causes switchable magnetic core means exclusively associated with the character selected to be switched from reset to activated state, said core means being provided with windings in which the deflecting voltages are generated simultaneously upon switching.

Preferably, the analogue voltage generator is a core voltage generator consisting of an array of as many pairs of switchable magnetic cores as there are characters to be displayed, each pair consisting of an X core and a Y core, each core causing, upon switching from a reset condition, the generation of as many deflection voltages, respectively X and Y voltages, as there are dots defining the particular character selected, said deflection voltages being generated each in a separate core winding having an integer number of turns and thus causing said voltages to occur in quantized values. In both the X and Y set of cores thus defined, windings associated with dots in the same sequential order—say, all the windings respectively generating the X co-ordinate from number one dot—are connected in series. This means that in the X set of cores there will be established the number one dot series, the number two dot series and so on. Similarly for the Y set of cores.

The voltages thus generated are stored in a voltage memory from which they are interrogated by means including a succession of sequentially interrogating pulses of equal amplitude initiated by a starting pulse and converted into sequential pairs of X and Y voltages for gating to the cathode ray tube deflection means.

Preferably, the voltage memory includes storage condensers which are read out by interrogating pulses derived in response to a starting pulse originating from the analogue voltage generator, said starting pulse activating a unit comprising basically a delay line and a group of pulse shapers.

Said interrogating pulses are further employed in conjunction with at least a portion of the analogue output read out from the voltage memory to provide a train of bright-up pulses always equal in number to the number of dots defining the selected character.

Preferably, at least a portion of the interrogating pulses output is adapted to be gated towards the beam-current controlling means of the cathode ray tube upon coincidence with the co-operating portion of said analogue output read out from the voltage memory.

The X, Y, and Z voltages thus generated and defined may be used to control any number of additional cathode ray tubes for the purpose of producing one or more duplicate displays.

The invention will now be described by way of example only with reference to the accompanying drawings, wherein:

FIG. 1 illustrates the generation of the numeral 7;

FIG. 2, that of the letter B;

FIG. 3, that of a full stop;

FIG. 4 is a functional diagram of a preferred embodiment of the invention;

FIG. 5 illustrates the core voltage generator;

FIG. 6 illustrates the voltage memory.

With reference to the drawings, it will be seen that the numeral 7 (FIG. 1) is formed by partial overlapping of

18 dots, the letter B (FIG. 2) similarly by the overlapping of 37 dots, and that the full stop (FIG. 3) consists of a single dot. The position of each dot is defined by an X voltage and a Y voltage. When the required pairs of X and Y voltages are sequentially applied to the deflection system of a normal type cathode ray tube, the electron beam will be shifted sequentially to the positions defined by the successive X and Y pairs, in the order shown by the numbering of the dots in FIGS. 1, 2, and 3, thus forming the selected character.

The beam switching Z voltage hereinafter referred to is adapted to switch on the electron beam when the first dot position has been selected, extinguish the electron beam after a predetermined time interval, and switch on the beam again when the second dot position has been selected, the sequence being continued until after the exhibition of the final dot, when the beam is extinguished until it is required for the formation of the next character.

With reference to FIG. 4, character code in the form of a combination of electrical pulses is fed from any computer device source to a function table 1 which converts the coded pulses into switching pulses to initiate the generation of the character represented by the input pulses.

This function table or selection matrix is constructed according to known principles, and is of the type "some out of m into one out of n ," where m is the number of digits or pulses per character in the code used in the input to the invention, and n is the total number of characters available in a given embodiment. Thus if the embodiment being considered is to be fed with 6-digit code, and has to generate any of 64 predetermined characters, the function table will be of the type "some out of 6 into one out of 64." It will therefore be supplied with 64 output wires 2 each one corresponding to a character, and with 6 code-input wires 3. Each of 64 out of all the possible modes of activating the input wires will be significant, and will signify a character, and will cause the output wire corresponding to that character to become activated, i.e. to carry an electrical pulse. There is provided an additional input wire 4 carrying a "parity" signal, which in conjunction with samples of the signals carried by the output wires 2 and of signals carried by the input wires 3, by means of known logical devices 5, 6, 7, and 8 shown dotted in FIG. 1, will cause that part of the apparatus subsequent to the inhibitor 9 to become inoperative if there should be present at its input a non-significant, incomplete or otherwise erroneous signal, or unless one and only one of the output wires 2 should be activated in response to a single input code-group.

In actual fact, unit 5 is adapted to produce an output pulse when one and only one of its inputs originating from wires 2 is activated, and in FIG. 4 has been captioned "one input at a time OR gate." Similarly unit 7 is adapted to produce an output pulse when and only when the binary pulse combination on wires 3 extended thereto produces parity in conjunction with the parity signal fed on wire 4. In FIG. 4 has been captioned "Parity gate." In normal circumstances, unit 6, which in FIG. 4 is captioned "Reverse AND gate," would receive an input pulse from unit 7 coincidentally with an input pulse from unit 5, and as long as this condition is maintained it is arranged that no output pulse shall issue from unit 6. An output pulse is however produced when coincidence of inputs fails. The output pulse from unit 6 upon a failure having occurred is adapted to activate inhibitor unit 9 disabling unit 13, and to send out a reset signal after a time delay governed by unit 8, said signal resetting both the core voltage generator and the voltage memory.

The function table output wires 2 are fed to a core voltage generator 10 which is shown in detail in FIG. 5. This generator consists of a number of ring shaped cores composed of rectangular B-H loop material such as ferrite material, each wound with a specified number

of windings, each winding having a specified number of turns. Two cores are provided for each character, one to supply voltages corresponding to the X voltages, and one to supply voltages corresponding to the Y voltages of that character. In addition, each core carries a winding for the input pulses and a winding to enable its magnetic state to be re-set after the generation of a character is completed. Further, one set of cores, either that corresponding to the X voltages or that corresponding to the Y voltages, carries on each member an additional winding to provide a voltage hereinafter referred to as the "starting pulse" whose function is described later.

Referring to FIG. 5, four pairs of cores are shown out of the 64 pairs actually used in the embodiment being considered and corresponding to 64 different displayable characters. The action of the core voltage generator will be described with reference to the pair of cores marked 22 and 23. For simplicity, not all of the windings are shown. Those illustrated are: 24 the input winding of core 22; 25 the reset winding of core 22; 26 the starting pulse winding; 1x, 2x, 3x and 37x some of the X voltage windings; 27 the input coil of core 23; 28 the reset coil of core 23; 27 and 35 some of the Y voltage windings; 29 and 30 shorting links taking the place of windings where zero voltages are required. If now the character corresponding to cores 22 and 23 is presented in code at the input wires 3 (FIG. 4) it will so activate the function table 1, that the wire 31 (FIG. 5) will carry a pulse. This pulse, passing through coils 24 and 27 will alter the magnetic state of cores 22 and 23 thereby generating pulses in the other windings on these cores. The pulses generated in the reset windings 25 and 28 are not used, the starting pulse in winding 26 is used as described hereinafter and the pulses in the remaining windings are given magnitudes corresponding and proportional to the required X voltages and Y voltages by suitably arranging an integer number of turns in each coil, the integer number leading to quantizing of voltages. The maximum number of dots in any character in the present embodiment will be taken to be 37 so that each core carries not more than 40 windings of which not more than 37 are used for the generation of X and Y voltages.

In both the X set of cores and Y set of cores, windings having the same order number, i.e. corresponding to character elements occupying the same numerical position in the scanning sequence, are connected in series, thereby providing a single output wire for the impulse defining one or other co-ordinate of the element occupying that numerical position in any required character. This is possible since the nature of the cores used is such that a coil on an unswitched core possesses an extremely low impedance in comparison with either the impedance of a coil on a switched core, or with that of the subsequent unit, which is the voltage memory.

Referring again to FIG. 4, the X and Y voltage pulses are transmitted via 2x37 core voltage generator output wires 11 to the voltage memory 12, which is shown in detail in FIG. 6.

Referring to FIG. 6 in respect of the X coordinates and in conjunction with a similar assumed layout for the Y coordinates, some or all of the wires 101x, 102x, 103x . . . 137x, and 101y, 102y, 103y . . . 137y, which are the same wires as the wires 11 in FIG. 4, will carry pulses consequent upon the action of the core voltage generator 10 (FIG. 4) already described. As a result, some or all of the condensers 201x . . . 237x, and corresponding Y condensers will become charged, each via one of the reading-in diodes 301x, 302x . . . 337x and corresponding Y diodes, to a voltage adapted to be virtually equal to the peak voltage of the pulse applied to that diode.

The condensers 201x, 202x . . . 237x, and corresponding Y condensers are connected in the grid circuits of cathode-followers 401x, 402x . . . 437x, and corresponding Y cathode-followers. Thus voltages to which the

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condensers are charged become effective in the cathode output of these valves. Since the pulses from the core voltage generator 10 (FIG. 4) are simultaneous, all the condensers in the voltage memory charge to their various voltages simultaneously, said voltages being each simultaneously duplicated in the output of associated cathode-follower.

For the spot-sequential presentation of the character on a cathode ray tube screen, the voltages are required in sequential pairs, first, that from 201x together with that from corresponding Y condensers forming an X and a Y voltage respectively; next, that from 202x together with that from corresponding Y condensers; and so on until the number of pairs necessary to form the required character have been supplied to the cathode ray tube. In this embodiment of the invention this is achieved by supplying to the voltage memory via the set of wires 101a, 102a . . . 137a a train of sequentially interrogating pulses of the constant amplitude. The first of these pulses appears on wire 101a and is followed at short equal intervals by pulses on wires 102a . . . 137a, until the interrogation of the voltage memory is completed. These sequentially interrogating pulses are applied each to one input wire of each of two "AND" gates, said gates comprising an X "AND" gate and a Y "AND" gate, the other input wire of each such gate being connected to the cathode of the appropriate valve of the said 401x, 402x . . . 437x, and corresponding Y valves in such a way that 201x and corresponding Y condenser are interrogated by the first pulse, 202x and corresponding Y condenser by the second, and so on. When an interrogating pulse arrives at the "AND" gate connected to a valve having a charge on its associated condenser, and therefore a corresponding voltage across its cathode resistance, there will be an output from that "AND" gate corresponding to and virtually equal to the peak value of the pulse which originally charged that condenser.

Normally the branch of the "AND" gate connected to the cathode resistance as shown in FIG. 6 has its diode biased in the forward direction, so that in the absence of a charge on the associated memory condenser said diode is conducting. The other branch at this stage is not activated and consequently there is no output from the gate.

Upon reading-in of a deflection voltage from the core generator, a P.D. (i.e., potential difference) appears across the cathode resistance which tends to make the appertaining diode non-conducting to an extent proportional to the value of said P.D. Until the diode of the other branch is left in the conducting state, its internal resistance is so low that it acts as a shunt across the output of the gate. When, however, it is made non-conducting on being pulsed in the reverse direction by the interrogating pulse, the output of the gate is made available for extending it to the cathode ray tube deflection means.

The output of the voltage memory will therefore consist of voltage pairs in rapid sequence, one member of each pair being an X voltage and the other a Y voltage, each pair being suitably proportioned and scaled to define the position of one element of the required character on the face of the cathode ray tube. These outputs appear on some or all of the wires 501x, 502x, 503x . . . 537x and 501y, 502y, 503y . . . 537y.

Referring again to FIG. 4, the sequentially interrogating pulses above mentioned are seen to be derived from the unit numbered 13. This unit consists of a delay line and a group of 38 pulse shapers 1a, 2a, 37a . . . 38a, shaper 38a producing the reset pulse, said shapers being of the same general functional type as for instance described at page 481 of "Radio and Radar Technique" by A. T. Starr, published by the Pitman Publishing Company. Said unit is fed, via a further shaper 14, with the starting pulse mentioned above derived from core voltage generator 10. The starting pulse is a voltage pulse

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and shaper 14 converts it into a current pulse, which as it proceeds down the delay line initiates a pulse output from each of the shapers 1a . . . 37a in turn, these pulses forming the sequential interrogating pulse train. Unit 13 further provides a pulse from 38a which is used to reset both the core voltage generator 10, by causing a reset pulse to reset the core which originally sent out the start pulse at the beginning of generation of one character, and the voltage memory 12, by causing the individual memory condensers to discharge, for instance, through a constant-current discharge device including discharge diodes 601x, 602x, 637x through wire 32 (FIG. 6) and corresponding Y discharge diodes. This is effected at the end of the generation of the one character selected in readiness for the generation of the next character to be selected.

The pulses resulting in the output of the voltage memory 12 from the application of the sequentially interrogating pulses are taken in two groups, all of the X voltages going to an "OR" gate 15 and all of the Y voltages to another "OR" gate 16 (FIG. 4). The output of these gates are the sequential pairs of X and Y voltages which are fed to the deflection system of a cathode ray tube or tubes.

It should be observed that for effective gating the amplitude of the sequential interrogating pulses must be greater than the highest possible voltage read-in in any one memory condenser.

The method used in this invention for forming the brighten-up pulses or Z voltages will now be described. In the core voltage generator 10, the X cores, for example are provided with a sufficient number of winding turns in respect of each co-ordinate to generate a voltage of the order of 5 volts in excess of that required for co-ordinate determination. This has no effect on the shape of the character, but ensures that there is an output voltage for every dot of the total defining the character selected from "OR" gate 15. The output from this gate is extended to a clipper 17, of the general type as shown for instance at page 467 of the above reference, which produces a train of equally spaced pulses of equal amplitude. A portion of the train of pulses from the shapers 1a, 2a, 3a . . . 37a is fed to an "OR" gate 18 producing at its output a pulse train on a single wire. This train is fed to a shaper 19, of the same general type as that shown at page 481 of the above reference, which produces in its output a sequence of 37 deferred pulses. This train and the output from the clipper 17 are each fed to one of the two inputs of the "AND" gate 20. The output from the shaper 19 will consist, for every character, of 37 consecutive pulses. If, however, the character under consideration has only 18 elements as in the example of the numeral 7 quoted above, the output from the clipper 17 will consist of 18 pulses. Thus the output from the "AND" gate 20 in this case would consist of 18 pulses only, and in general will always consist of a number of pulses equal to the number of dots in the character being generated. These pulses are fed to an amplifier 21 where they are sufficiently raised in level to enable them to switch on the beam of a cathode ray tube. The output of this amplifier is the pulse train previously referred to as the Z volts. The shaper 19 is so arranged that each pulse in the Z volts train commences later and finishes earlier than the corresponding pulse in the sequence of X and Y voltage pairs. Hence the beam of the cathode ray tube will not be switched on while it is moving towards or leaving a position defined by one of the X and Y voltage pairs.

The logics associated with the generation and timing of the Z pulses ensures, therefore, that these bright-up pulses are made available at the cathode ray tube only coincidentally with one dot and for a duration slightly less than that, say, of the X co-ordinate of said dot.

The operation of the invention from selection of a given character to display thereof in dot-sequential form

upon the face of a cathode ray tube will now be traced with reference to the drawings.

It is assumed that the binary code combination assigned to the letter A has appeared upon wires 3 of FIG. 4, the letter A forming the output of a computer device at one particular instant of time. Function table 1, being thus activated, instantly selects one of its 2^n unique output lines, n being the number of lines on which the binary input code is formed. Assuming that the first of the output lines bearing the general reference 2 corresponds to the letter A, activation of said line results in a pulse being available thereon. The line is connected to the input winding of the X core and the Y core generating character A. Thus the A cores are switched simultaneously from reset to activated state in response to selection of the A line.

Upon simultaneous switching of the A cores, X and Y voltage pairs are simultaneously generated and stored each in a pair of memory condensers. At the same time either the X or the Y core causes the regeneration of a start pulse from which a sequential pulse generator is activated for the purpose of interrogating sequentially the pairs of memory condensers and producing step by step simultaneous X and Y waveforms in the time sequence required at the cathode ray tube for defining the letter A.

As the co-ordinates are being generated, say, the X co-ordinate voltages, a portion thereof is utilized to condition a gate for allowing a portion of the sequential pulse output to be gated to the cathode ray tube for the purpose of intensifying the beam of said tube only when a dot occurs.

At the end of its interrogating cycle, the sequential pulse generator produces a reset pulse which causes the cores and the memory condensers associated with the letter A to be reset. The operation described takes only a few microseconds and the device is ready to respond to the selection of another character.

One of the aims in the conception of the method disclosed has been to prevent drift in components affecting the shape of any character. To this end it has been arranged for all the co-ordinates to be generated simultaneously so that any drift involves all co-ordinates in a nearly uniform manner and safeguards the shape of the character. The generating means actually preferred is a core voltage generator in which, by suitable switching arrangement, the output pulse may be closely defined in level and made independent of temperature changes affecting the physical constants of the core. Said arrangement is also adapted to ensure that the output voltage pulses have a waveform with a substantially flat top portion. This feature in conjunction with judicious choice of output pulse duration in relation to the time constant of the associated memory condenser ensures that each condenser charges up to a substantially constant predetermined level despite a small drift in the time constant of the charging circuit.

Thus the analogue approach to the problem of character generation, inherently simpler, has been pursued while safeguarding stability of operation. Another notable advantage achieved by the invention is the ease with which any one character may be replaced by simple substitution of the X and Y core pair defining said character without the need for painstaking adjustments. The X core and the Y core may in fact be arranged in the form of separate plug-in units or even in a combined plug-in unit. The importance of this facility is obvious when outputs in various languages and symbols have to be accommodated.

This in combination with the ease with which the maximum number of dots defining any given character may be increased—either to improve definition of display or to generate unusually complex patterns—leads to extreme versatility allied with simplicity in the presentation of predetermined visual information upon a cathode ray tube.

It will be appreciated by those skilled in the art that the functions of this invention as described herein and illustrated in the accompanying drawings have been treated in a simplified fashion, in the manner customary with apparatus of this nature. Thus, while all of the essential components have been described and illustrated it may be desirable or necessary in practice to include known devices such as amplifiers, transformers and the like in the inter-connection links between the several units in order to modify power levels and to match impedances; and/or to modify the transient responses of certain components by the use of damping resistors; and/or to use more than one valve, or a transistor or transistors instead of a valve, where one valve is shown. Furthermore, the number of cores per character may be other than two; for example, one core may carry all the windings required for the formation of a single character, or as many cores might be provided as the number of windings required, or any intermediate number of cores might be employed.

I claim:

1. A waveform generator comprising switchable magnetic means, a plurality of windings upon said magnetic means, means for switching the magnetic state of said magnetic means to induce analogue voltages in said windings proportional to the number of turns in each winding, analogue storage means for storing each individual voltage, interrogating means for sequentially sampling said storage means and means for sequentially gating the storage contents to a circuit for the utilization of the step-by-step wave form thus generated, whereby each instantaneous element of the waveform is represented by an analogue quantity throughout the generator.

2. A waveform generator for producing simultaneously X and Y deflection waveforms and Z bright up pulses for dot sequential cathode ray tube display of graphical symbols comprising an X set of switchable magnetic cores, a Y set of switchable magnetic cores, one core of the one set and one core of the other set forming an X—Y pair for defining one symbol, a plurality of windings on each core, means for switching any one core pair to induce analogue voltages in the windings associated therewith proportional to the number of turns in each winding, an analogue store for each induced voltage, each voltage representing one coordinate of one dot, interrogating means for sampling said stores in sequential manner and for causing Z pulses, and means for sequentially gating the contents of said stores whereby step-by-step X and Y wave forms are made available to the X and Y deflection means of a cathode ray tube and Z bright up pulses are made available to the beam controlling means of the tube, said X and Y waveforms in conjunction with said Z bright up pulses enabling the symbol corresponding to the switched core pair to be displayed upon the face of the cathode ray tube.

3. A waveform generator as claimed in claim 2, wherein the interrogating means includes a sequential pulse generator and a Z pulse is produced whenever a pulse from the sequential pulse generator coincides with the gating of the contents of a store.

4. A system for selectively displaying any one of a predetermined range of graphical symbols in response to coded electrical input combination representative of the symbol selected comprising decoding means yielding a unique electrical output in response to said combination, generating means for simultaneously generating a set of analogue voltage pairs in response to said unique output, analogue storage means for storing said voltage pairs, interrogating means for sampling sequentially the contents of said storage means, and means whereby one member of each voltage pair stored is sequentially gated from said storage means to the X deflection means of a cathode ray tube and the other member to the Y deflection means of said cathode ray tube and whereby the symbol selected is displayed as a succession of light dots on the face of said tube, the beam of the cathode ray tube

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being swept only to the positions corresponding to the coordinates of said dots.

5. A system for selectively displaying any one of a predetermined range of graphical symbols in response to coded electrical input combination representative of the symbol selected comprising decoding means yielding a unique electrical output in response to said combination, generating means including switchable magnetic core means provided with windings for simultaneously generating therein a set of analogue voltage pairs upon switching of said core means in response to said unique output, analogue storage means for storing said voltage pairs, interrogating means for sampling sequentially the contents of said storage means, and means whereby one member of each voltage pair stored is sequentially gated from said storage means to the X deflection means of a cathode ray tube and the other member to the Y deflection means of said cathode ray tube and whereby the symbol selected is displayed as a succession of light dots on the face of said tube, the beam of the cathode ray tube being swept only to the positions corresponding to the coordinates of said dots.

6. A system for selectively displaying any one of a predetermined range of graphical symbols in response to coded electrical input combination representative of the symbol selected comprising decoding means yielding a unique electrical output in response to said combination, generating means including two switchable magnetic cores provided with windings for simultaneously generating therein a set of analogue voltage pairs upon simultaneous switching of said two cores in response to said unique output, analogue storage means for storing said voltage pairs, interrogating means for sampling sequentially the contents of said storage means, and means whereby one member of each voltage pair stored is sequentially gated from said storage means to the X deflection means of a cathode ray tube and the other member to the Y deflection means of said cathode ray tube and whereby the symbol selected is displayed as a succession of light dots on the face of said tube, the beam of the cathode ray tube being swept only to the positions corresponding to the coordinates of said dots.

7. A system as claimed in claim 4, wherein windings producing a voltage corresponding to identical dot positions throughout said range of graphical symbols are connected in series, the impedance of the windings upon unswitched cores in any series being negligible.

8. A system for selectively displaying any one of a predetermined range of graphical symbols in response to coded electrical input combination representative of the symbol selected comprising decoding means yielding a unique electrical output in response to said combination, generating means including two switchable magnetic cores provided with windings for simultaneously generating therein a set of analogue voltage pairs upon simultaneous switching of said two cores in response to said unique output, analogue storage means including pairs of capacitors for storing said voltage pairs, interrogating means including a sequential pulse generator for sampling sequentially the contents of said storage means, means whereby one member of each voltage pair stored is sequentially gated from said storage means to the X deflection means of a cathode ray tube and the other member to the Y deflection means of said cathode ray tube, and means whereby a beam bright up pulse is produced whenever coincidence occurs between a pulse from the sequential pulse generator and a voltage gated from said storage means and whereby the symbol selected is displayed as a succession of light dots on the face of said tube, the beam of the cathode ray tube being swept only to the positions corresponding to the coordinates of said dots.

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