Fig 1A

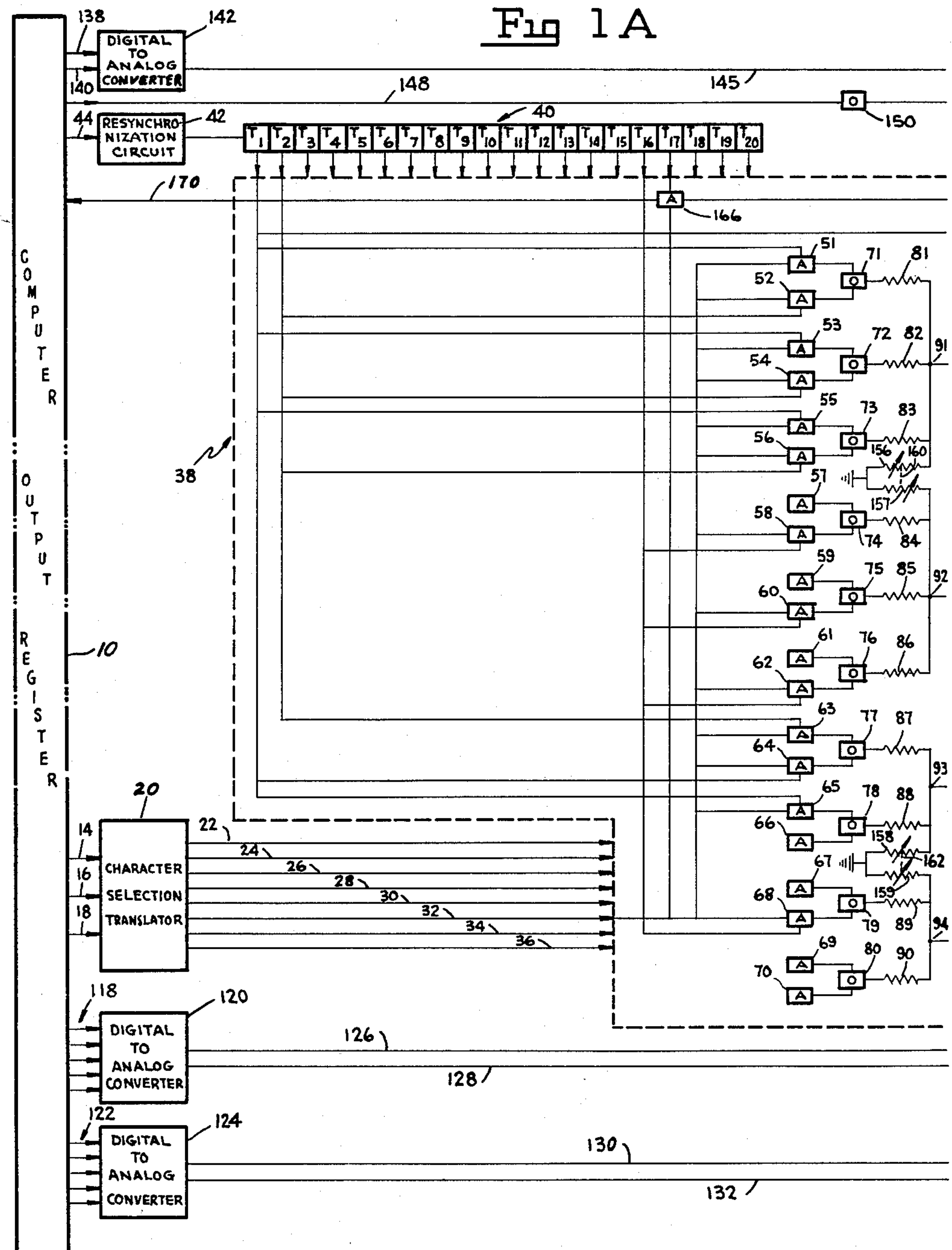

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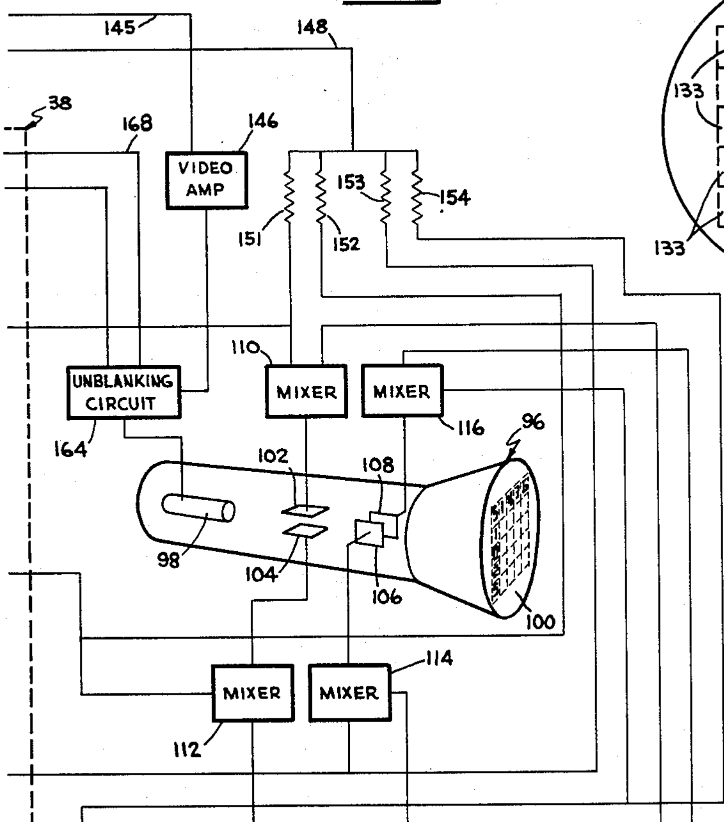
Fig 1B



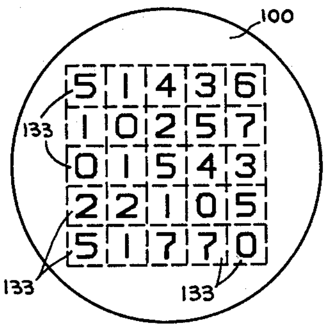
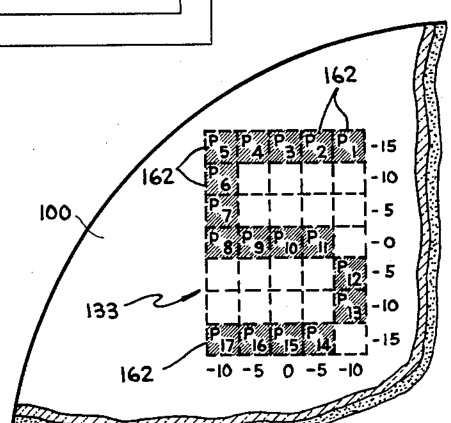


Fig 2

Fig 3



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CATHODE RAY TUBE SYMBOL DISPLAY SYSTEM HAVING EQUAL RESISTOR POSITION CONTROL

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This invention relates generally to high-speed data processing equipment, and pertains more particularly to a system for displaying coded information in the form of intelligible visual symbols.

The read-out and display of coded information in an easily understood form for ready viewing is not new. While a number of attempts have been made to produce a satisfactory symbol generator, such attempts still leave much to be desired in the way of greater simplicity, rapidity, cost and reliability. However, certain of the prior art devices will be referred to in order to emphasize to better advantages the attributes of the instant invention.

One prior art scheme, for instance, makes use of a metal mask or stencil mounted within a cathode ray tube, the mask containing openings corresponding to the character configuration to be displayed on the tube's screen. The mask is quite small, being on the order of one-half inch square, and might possess up to sixty-four separate and distinct openings if that many alpha-numeric symbols or characters are desired. In producing the desired character, the electron beam generated within the cathode ray tube is deflected electrostatically through the appropriate mask opening, and then deflected magnetically to the desired location on the tube's fluorescent screen. Due to the problems involved in re-focusing and converging the beam between deflections, this methods requires a cathode ray tube of considerable length. Furthermore, the electron gun and the magnetic deflecting yokes associated with this type of tube require a number of fine mechanical adjustments. Therefore, not only is a tube of this character expensive to manufacture, but it is also difficult to align for satisfactory operation.

The second method of symbol generation warranting comment at this time involves the scanning of a fluorescent screen with an eltcron beam to produce a fixed raster, similar to that of a television receiving set, and intensifying the beam upon its reaching certain positions on the screen. By properly selecting the positions, a series of bright dots can be made to appear having the desired character configuration. However, this system requires a raster scanning which is very high in relation to the character display rate. Also, an unblanking amplifier is needed having a frequency response considerably higher than the raster scanning rate.

The third method of symbol generation that will be mentioned untilizes a series of sine and ramp functions in various combinations in order to produce certain patterns on the face of a cathode ray tube. This particular system is usually limited to symbols which are combinations of circles, squares and triangles. It is rarely used to generate alpha-numeric characters. Furthermore, it is most adaptable to the displaying of very large symbols, for example, several inches in diameter.

One object of the present invention is to provide a system for displaying coded information in symbol form, alpha-numeric and otherwise, on the screen of a cathode ray tube with good accuracy so that the symbols can be quickly recognized.

Another object of the invention is to generate and display the various symbols in an extremely short period of time, for instance, on the order of one to three microseconds per symbol.

Another object is to provide for the display of symbols

having various desired sizes. More specifically, it is an aim of the invention to provide for the supervisory control of the symbol size by suitable signals, such as from the output register of a computer. It is also within the contemplation of the invention to adjust the ratio of width to height of the symbols.

Also, the invention has for an object the varying of the intensity of the indicated symbol. As with the preceding object, this may be done via computer programming.

A still further object is to provide a display system of the foregoing character that lends itself readily to use with a cathode ray tube equipped with either electrostatic or electromagnetic deflecting circuits.

Yet another object of the invention is to provide a highly versatile system for displaying encoded data in discernible form in which the symbols may be readily changed. In other words, if a different symbol or character configuration be desired for a given bit of coded information, the invention permits the interchanging of appropriately designed patch boards, or if desired individual plug boards might be employed in which potential values could easily be modified to suit specific conditions. The point to be understood in this regard is that the system is not inflexible, instead being susceptible to facile modification where circumstances so dictate.

A still additional object is to provide a display system of the contemplated type that will employ an array of simple digital logic elements that can be easily wired to provide the various discrete potentials used in the functioning of our invention.

Generally speaking, one embodiment of the invention comprises a conventional cathode ray tube in which the electron beam can be moved over the fluorescent face thereof through the application of different potentials to its deflection system. Discrete potential signals represenative of the coded data are produced by suitably connected logic elements and these voltages are applied to the deflection system in a successive fashion so as to cause the electron beam to be progressively shifted from one location to another until the desired alphabetical or numerical symbol has been "painted" on the screen of the cathode ray tube. Any alpha-numerical character can be quickly produced. To do this, a set of suitable voltages will be selected which when applied to the cathode ray tube will cause the beam to traverse the appropriate path for the particular symbol to be displayed. For a different symbol, a different set of voltages will be utilized, although certain of the voltages will of course be repeated in providing the second set.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth and the scope of the application which will be indicated in the appended claims.

In the drawings:

FIGURES 1A and 1B when placed side by side collectively depict a schematic representation of one embodiment the invention may assume, the diagram being largely in block form;

FIGURE 2 is an enlarged front view of the screen of the cathode ray tube with a typical numerical display pictured thereon; and

FIGURE 3 is a fragmentary view of a portion of the screen shown in FIGURE 2 on a still larger scale in order to illustrate to better advantage how a particular numeral is displayed.

Referring now in detail to FIGURE 1, the system there presented for exemplifying the invention includes a computer output register 10 of conventional design in which is stored certain coded information in binary form. For the sake of discussion, it will further be assumed that the stored binary data is representative of decimal system numbers 0 to 7. Hence, for our purposes the following abbreviated conversion table is all that is needed:

Decimal system:	Binary system
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111

In the selected situation, the binary signals from the computer register 10 are fed when called for over three lines 14, 16 and 18 to a character selection translator 20 typically composed of a number of logical elements wired together so as to produce a single output signal for each binary number. However, it is the responsibility of the translator to deliver such signal to one of eight channels 22–36. Thus, if the translator receives binary signals over lines 14 and 18, but not line 16, it knows that the number "5" is to be represented in the decimal system. Consequently, the output signal produced by the translator would be applied to channel 32.

In order to simplify the ensuing description as much as possible, and since the numeral "5" has been mentioned in the preceding paragraph, this particular number will serve as a satisfactory illustration. In this regard, each of the channels 22–36 is shown leading to what will be termed logic coincidence circuitry denoted in its entirety by the numeral 38.

Associated with the circuitry 38 is a timing chain device 40, such as a delay line or a string of flip-flops that successively trigger each other at prescribed intervals. An output signal is produced each time the device 40 changes state. For our purpose, twenty successive timing signals will be all that are needed, so the device has been divided into timing sections T1–T20. The device 40 is triggered into operation by a short pulse from a resynchronization circuit 42 at the proper moment. Initiation of this action occurs by virtue of a signal transmitted from the computer output register 10, or a control register associated therewith, over a "ready" line 44. As the name of the line 44 implies, the register 10 is at that time in readiness for the read-out of binary data by way of the lines 14, 16 and 18.

Included in the logic circuit 38 are twenty two-input AND gates 51–70 and ten two-input OR gates 71–80, all composed of simple digital logic elements. In order not to unduly complicate the description and also in order not to encumber the drawing with a multiplicity of lines, only channel 32 (the channel denoting the numeral "5" we have selected as a specific numerical example) has been shown connected to one input of certain of the AND gates 51–70, these particular AND gates being 51, 52, 53, 54, 55, 56, 58, 60, 62, 64, 65 and 68. Other connection patterns would be employed for other symbols to be displayed. The general principles involved will be understood, though, from a description of just a single pattern.

The section T1 of the timing device 40 is connected as illustrated to the second input of the AND gates 51, 53, 55, 64 and 65. Likewise, section T2 is shown connected to the second inputs of AND gates 52, 54, 56 and 63. The sequencing role played by the timing device and its connection to the various AND gates will become better understood as the description progresses.

At the moment it will suffice to explain that whenever there is an output from either AND gate paired with a given OR gate, there will be an output voltage signal from that particular OR gate. For instance, if either AND gate 51 or 52, these two gates being paired with the OR gate 71, emits a signal by reason of the simultaneous application of energizing signals to both of its inputs, then the OR gate 71 will produce an output voltage.

The outputs from the OR gates 71, 72 and 73, it will be noted, are connected together through three symbol forming resistors 81, 82 and 83; the outputs from the OR gates 74, 75 and 76 are similarly connected together through a trio of additional resistors 84, 85 and 86; the outputs from the OR gates 77 and 78 are in turn connected to each other by a pair of resistors 87 and 88, and the OR gates 79 and 80 are by the same token connected together by resistors 89 and 90. In this way, a plurality of junctions 91, 92, 93 and 94 are provided by which different potentials are produced. If the various OR gates 71, 72 and 73 are energized with, say, minus fifteen volts, the outputs of these digital elements can be either zero volts or minus fifteen volts. The zero volts level will be defined as the "off" state and the minus fifteen volt level will be defined as the "on" state. If, for example, all three OR gates 71, 72 and 73 are "off," it follows that the voltage at junction 91 will be zero volts. On the other hand, if all three elements 71, 72 and 73 are "on" the voltage will be minus fifteen volts. If any one element 71, 72 or 73 is "on" and the other two are "off," the voltage at point 91 will be five volts. When two elements are "on" and the third "off," the potential instead will be ten volts. Consequently, by turning the various elements on and off in various combinations, the potential at junction 91 can be changed to any four of the listed values, i.e. zero, five, ten or fifteen, for equal ohmic values of the resistors 81, 82 and 83. The same potentials can be developed at junction 92 as at junction 91, i.e. zero, minus five, minus ten and minus fifteen. By the same token, junction 92 can be readily modified as to its potential. Inasmuch as only three potential states are needed at junctions 93 and 94, as will be better understood as the description progresses, only two resistors 87, 88 and 89, 90 have been employed. With an applied voltage of minus ten volts, it can be readily seen, it is felt, that when both OR gates 77 and 78 are "on" the potential at 93 will be ten; if either element is "on" the voltage will be five, yet if both are "off" the voltage will be zero. The same is true for junction 94 in which the state of the OR gates 79 and 80 are involved.

The foregoing voltage magnitudes have been utilized in order to demonstrate the discrete voltage units that can be derived with the contemplated logic scheme made possible with the circuit 38. These values can readily be multiplied by whatever factor is necessary to provide the actual working potentials required at the junctions 91, 92, 93 and 94.

The junctions 91–94 supply discrete deflecting potentials for a cathode ray tube indicated generally by the reference numeral 96. As is convention, the tube 96 is equipped with an electron gun 98 at one end for generating an electron beam and a fluorescent screen 100 at the opposite end. Also included in the tube 96 is a pair of vertical deflecting plates 102, 104 and a pair of horizontal deflecting plates 106, 108. The description can be somewhat simplified by not showing the filament and high voltage supplies associated with the cathode ray tube 96, so the plate 102 is shown connected to the junction 91 only through a mixer 110; the plate 104 to the junction 92 via a mixer 112; the plate 106 to the junction 93 through a mixer 114, and the plate 108 to the junction 94 by way of a mixer 116. The office of the mixers 110–116 is to cause the electron beam to impinge on certain regions of the screen 100, whereas the smaller potentials developed at the junctions 91–94 will deflect the beam to designated areas within a particular region on the screen. It might be pointed out that there is a polarity inversion or reversal that takes place between the junctions 91–94 and the deflecting plates 102–108. We can assume for the sake of discussion that the inversion occurs within the mixers 110–116, the result being that the plates are energized with positive deflecting voltages in this instance.

To supply the deflection potentials to the mixers 110–116, appropriate information is contained in the computer output register 10. Since this control information is in binary form, as already mentioned, the binary signals controlling the "Y" or vertical deflection can be transmitted from the register **10** via a predetermined number of channels **118** to a digital-to-analog converter **120** which changes the binary information into usable discrete potentials much in the same manner as done by the coincidence circuitry **38**. By the same token, the "X" or horizontal deflection signals are transferred over channels **122** to a second digital to-analog converter **124**. The outputs from these two converters **120** and **124** are forward directly to the mixers **110–116** over lines **126**, **128**, **130** and **132**. What the mixers do, then, is to determine where the particular symbol to be displayed is to be located on the fluorescent face or screen **100**. These various regions have been assigned the reference numeral **133** and each has a numerical symbol appearing thereon as can be seen from FIGURE 2. Actually, each region **133** is subdivided into smaller areas but more will be said later on concerning this aspect of the situation.

In some instances, the intensity of the electron beam should be varied, for example, where particular emphasis or de-emphasis of a symbol is desired. Therefore, it is planned that the computer output register **10** contain information to this effect. Four levels of intensity can readily be achieved with two channels **138** and **140** leading from the register **10** to a digital-to-analog converter **142**. A conductor **145** leads from the converter **142** to a video amplifier **146** which in turn affects the biasing potential applied to the control grid of the electron gun **98** within the cathode ray tube **96** via an unblanking circuit yet to be referred to.

Another control that should be mentioned at this time is the control by which the size of the symbol being displayed may be changed. Signals for achieving this aim can also be stored within the register **10** and are fed out via single channel **148** to an OR gate **150**, the presence or absence of a signal causing an output or no output, respectively, from this gate. The output side of the OR gate **150** is impressed upon corresponding ends of a plurality of resistors **151**, **152**, **153** and **154**. The other ends of these resistors are connected to the junctions **91**, **92**, **93** and **94** so act to change the potential of these junctions whenever there is an output signal from the element **150**. In this way, two different sizes of symbols can be displayed, although further size changes can be effected, if desired.

Acting in conjunction with the control mentioned in the preceding paragraph is another control. This control involves the use of a plurality of potentiometers **156**, **157**, **158** and **159**. The potentiometers **156**, **157** are ganged together at **160** so that they are adjusted in unison; likewise, the potentiometers **158**, **159** are ganged together at **162** so that they, too, are operated together. Although concerted adjustment of the potentiometers **156–159** can be used to produce a manual change in the size of the symbols to be displayed on the cathode ray tube screen **100**, their primary purpose is to vary the aspect ratio. It is believed readily apparent that adjustment of the potentiometers **156**, **157** will change the potential at junctions **91** and **92**. If the setting of the potentiometers **158**, **159** remains unchanged, then only the height of the symbols will have been modified inasmuch as the junctions **91**, **92** are in circuit with the vertical deflecting plates **102**, **104**. However, both pairs of potentiometers can be readily adjusted to whatever ratio of symbol height to width is desired.

Reference has herein been made to FIGURE 2 and the various regions **133** which have been arbitrarily shown as being twenty-five in number. Attention is now drawn to FIGURE 3 where one of these regions, let us say the upper left hand one of FIGURE 2, has been subdivided into thirty-five different areas **162**. These areas **162** constitute a rectangle having seven areas on one side and five such areas along one end. Since the electron beam can be initially deflected into this general portion of the screen **100** via specific potentials applied to the deflecting plates **102** and **106** by way of the mixers **110** and **114**, we need only superimpose smaller discrete potentials on the plates **102** and **106**, as well as apply certain discrete potentials to the plates **104** and **108** in order to shift the impinging electron beam from location to location within this specific region. The beam, therefore, strikes certain of the areas within the region **133** in successive order, the particular areas impinged by the beam fluorescing and thus displaying the symbol which in the selected instance will be "5." To aid in understanding what relative potential values at the junctions **91–94** are needed to shift the beam from area to area in FIGURE 3, the coordinates have been assigned the potentials that would appear at these junctions. The actual potentials to be impressed on the deflecting plates **102–106** are of course derived from the junction voltages. More specifically, the negative potentials above the zero central horizontal row would be applied to the plate **102** and those negative magnitudes below this row would be applied to the plate **104**, relatively speaking. Similarly, the negative potentials to the right of the central zero column would be impressed on the plate **108**, whereas the negative potentials to the left would be applied to the plate **106**. It has already herein been explained that the potentials in the illustrative embodiment are inverted by the mixers **110–116**.

As a further aid in understanding the path taken by the electron beam in painting the number "5" the various successive positions required to form this numerical symbol have been labeled with a P and the numerical suffix indicates the time that the electron beam assumes a given position. More will be said concerning the shifting of the beam from spot to spot when the operation is described.

At this time attention is called to the provision of an unblanking circuit **164** associated with the electron gun **98**. As is customary with circuits of this type, the circuit **164** normally applies a sufficiently negative potential to the control grid of the gun **98** so as to bias the tube **96** to cut-off. However, the unblanking circuit **164** receives its triggering signal from the section T1 of the timing device **40** whereby the electron beam is "turned" on. Since, as will hereinafter be made clearer, we are desirous of seventeen positions when painting the number "5," when the seventeenth position is reached the electron beam should be turned off again. To effect this, a separate AND gate **166** is associated with the section T17 of the timing device **40**, this gate being anded with the section T17 and channel **32**. Its output is connected to the unblanking circuit **164** and restores it to its normal blanking state upon completion of a given symbol display.

When the last position has been reached for a particular symbol, a "resume" signal should, in some instances, be relayed back to the register **10**. Easy provision can be made for accomplishing this when found desirable or expedient to do so. For the situation at hand, the seventeenth position is the last so at the same time a blanking signal is delivered to the circuit **164**, the AND gate **166** can be connected so as to deliver a "resume" signal back to the computer register **10**. In other words, one line **168** connects the output of the gate **166** to the circuit **164** and a second line **170** conveys the same signal back to the register **10** so that no time is lost in conditioning the register for a suceeding character read-out.

It will be understood, though, that where a symbol is generated and displayed in a shorter period (or longer period) an AND gate corresponding to the gate **166** would be associated with the appropriate section of the timing device **40**. For example, in generating the most simple number, that is a "1," the gate supplying the dual function of the gate **166** would have one input connected to section T7 and its other input to channel **24**.

Having in mind the foregoing elements and their organization with respect to each other in the system, it is believed that the ensuing description involving the generation and display of the numeral "5," hereinbefore selected, will provide an adequate understanding of how other symbols can be formed. The particular symbol configuration, of course, is not important to a practicing of the invention.

To facilitate a comprehension of the following description, though, the various areas 162 to be traversed in stepwise fashion by the electron beam have been shaded and denoted by the letter P. Collectively, these areas 162 constitute one region 133. Each position P is followed by a numerical suffix corresponding with the sequencing provided by the timing device 40. In other words, when the section T1 is activated it puts out a signal which is applied to the hereinbefore referred to second inputs of the three AND gates 51, 53 and 55. Since the channel 32 is at this time supplying a sustained voltage signal to what has already been referred to as being first inputs of these three AND gates, the designated gates energize one input of the OR gates 71, 72 and 73. The output voltages, namely minus fifteen volts, applied to the symbol forming resistors 81, 82 and 83 are instrumental in bringing the junction 91 to this fifteen volt negative potential. With the previously mentioned inversion, it can be seen that the signal resulting from this potential is applied as a positive deflecting voltage to the plate 102 whereby the electron beam is deflected upwardly to the top horizontal row pictured in FIGURE 3.

Concomitantly with the foregoing deflection is the application of the signal from section T1 to the second inputs of the AND gates 64 and 65. Due to the fact that the sustained or continuing signal from channel 32 is simultaneously being impressed on the first inputs of these two gates 64 and 65, it can be appreciated that both the OR gates 77 and 78 each have one of their inputs energized with the consequence that a negative ten volts is applied to the symbol forming resistors 87 and 88. In other words, both OR gates 77 and 78 are turned on and the junction 93 is thereby brought to a minus ten volts. When inverted and applied to the deflecting plate 106, this causes a deflection of the electron beam to the right hand column appearing in FIGURE 3.

By reason of the combined vertical and horizontal deflection of the electron beam, the beam is positioned at P1, the upper right hand corner of the region 133 presented in FIGURE 3.

The pulse from the resynchronization circuit 42 which triggers the section T1 into action can be quite short, a pulse on the order of only 0.2 μsec. being contemplated. Likewise, it is planned that the successive triggering of the various sections of the timing chain 40 take place at comparable intervals. Thus, it can be seen that while the electron beam starts out at P1 it will remain there for only a very short interval of time.

Next, the beam of electrons is deflected to P2. This occurs when section T2 is energized. The signal from section T2 is applied to what has been termed the second input of certain AND gates. More specifically, the AND gates brought into operation at this moment are the gates 52, 54, 56 and 63. This is by reason of the sustained signal arriving via the channel 32 being applied to the first inputs of these AND gates.

It will be noted that the AND gates 52, 54 and 56 are paired with gates 51, 53 and 55, these latter gates being the ones activated in the reaching of P1. However, outputs from the gates 52, 54 and 56 serve the same function, that of energizing an input of each OR gate 71, 72 and 73. This results in the maintenance of the junction 91 at the same previously mentioned minus fifteen volts.

Although there is no change in the potential developed at junction 91, there is a change in the potential established at junction 93 under the instant circumstances. This stems from the fact that only the OR gate 77 is turned on. As can be discerned from the drawing, this is by virtue of the fact that the T2 signal is applied to the second input of just gate 63; the signal is not impressed on the gate 65 paired therewith. Hence, a potential of minus ten volts, this voltage having been selected as previously mentioned, is applied to only the symbol forming resistor 87, the absence of a potential to the resistor 88 causing the potential at junction 93 to be halved, i.e. reduced to minus five volts owing to the shunt relation of resistors 87 and 88.

The net result is that the beam of electrons is moved to position P2. At this time it can best be brought out that a capacitive effect is inherent in a deflection system of the type with which we are currently dealing. Stated somewhat differently, the particular deflection plate circuitry to which a deflecting voltage is applied via any one of the junctions 91–94 represents a capacitor which must be charged or discharged when any of the elements 71–78 switch state. The time constant of this charging path is determined by the value of the resistors 81–90. Advantage is made of this capacitive effect in the present instance to adjust the time constant so that the symbols displayed on the face 100 of the cathode ray tube 96 will be comprised of uniform lines rather than a series of spaced dots. While other circuit constants enter into the picture, it might be mentioned that resistors 81–90 having 2,000 ohm values have proved satisfactory. Accordingly, when the beam of electrons moves from P1 to P2, as it will do for the succeeding positions, the capacitive effect causes the beam to sweep from the first position to the second rather than make an abrupt jump. In this way the transition from position to position is smooth and a well defined symbol having excellent continuity is found, even though the deflecting voltages themselves are abruptly modified in discrete increments.

Having explained how the electron beam is moved to position P2, such explanation should be adequate to illustrate the manner in which the remaining positions P3–P17 are reached. Nonetheless, specific mention will be made of the next to last position P16. As shown in the drawing the section T16 is connected to the second inputs of AND gates 58, 60, 62 and 68. Inasmuch as channel 32 is connected to the first inputs of these gates, it follows that the electron beam is deflected to the lowermost row of the matrix pictured in FIGURE 3. This is because the above-mentioned AND gates turn the OR gates 74, 75 and 76 on, thereby applying the full minus fifteen volts to the junction 92.

It can be seen, though, that the second input of only AND gate 68 is energized, which together with the connection of the first input of this AND gate to the channel 32 results in just the OR gate 79 being energized. The OR gate 80 at this time remains in its off condition, as it receives no input from either AND gate 69 or 70. Therefore, only minus five volts are applied to the junction 94 to produce the desired horizontal deflection of the electron beam. The combined vertical and horizontal deflection causes the electron beam to be moved to the desired position P16.

The last position in the painting of the numeral "5" is P17. In addition to the moving of the electron beam to this position, provision is made for transmitting a signal back to the computer output register 10, which in some instances is desirable in order to inform the computer that it can proceed with the displaying of the next symbol or the handling of other matters. Of course in a number of situations the computer will not have the succeeding data ready and the resume signal will not be necessary, for when the succeeding information is ready the display system will have concluded the presentation procedure of the symbol at hand. Obviously, if a symbol is in the process of being painted, even though the total time is very short, one would not want the display procedure to be interrupted. In this regard, it should be remembered that the timing device is intended to operate at 0.2 microsecond intervals so the complete numeral

"5" will be displayed in only 3.4 microseconds and even quicker if the intervals are shorter. At any rate the point to be made is that through the agency of the AND gate **166**, which has one input tied to the section T17 and its other input to channel **32**, the line **170** will be energized so as to provide a resume signal if such is needed.

More importantly is the fact that the AND gate **166** supplies a signal to the unblanking circuit **164** signifying that the circuit **164** should be triggered back to its blanking state.

Assuming that the next symbol to be displayed is the numeral "1" and that this symbol is to appear immediately to the right of the numeral "5" as illustrated in FIGURE 2, the general location of this symbol will be determined by signals transmitted to the mixers **110–116** from the register **10** via the converters **118** and **122**. Other than the general deflection, it can be seen that no successive horizontal deflection is needed, for the electron beam only has to be moved in successive steps through a vertical path to produce the number "1."

Referring to FIGURE 3 to illustrate the sequence of events, although these steps need not be described in complete detail because of the information already presented, it can be pointed out that the electron beam would start at what has been labeled P3, then move to the position directly thereunder, then to the position directly above P10, then to P10, then to the position immediately under P10, then to the position immediately above P15 and finally to what has been denoted as P15. Therefore, no potentials are needed at junctions **93** and **94**.

However, minus fifteen volts will be needed to produce the first position in the painting of the symbol "1." To accomplish this, section T1 would be connected to the second inputs of AND gates **52**, **54** and **56**. Likewise, channel **24** would be connected to the first inputs of these particular gates. In this way when a signal is received from section T1, the OR gates **71**, **72** and **73** are switched on to apply a minus fifteen volt potential to junction **91**. Hence, the electron beam will initially impinge on the area **162** that has been labeled P3 in FIGURE 3, although it is of course the first position in the generation of the numeral "1."

The second position in forming numeral "1" would be produced by applying a negative potential of ten volts to junction **91**. This is done by connecting section T2 to the second inputs of two of the AND gates **51**, **53** and **55**, for instance gates **51** and **53**. With channel **24** connected to the first inputs of these gates, the OR gates **71** and **73** will be turned on to apply the desired potential to the junction **91**. Under these circumstances OR gate **73** is left in its off condition.

The third position in the production of the numeral "1" would be effected with zero bolts on the junction **91**, as well as no potential on the other junctions **92–94**.

The seventh position, which will complete the display of the numeral "1," will be produced by applying a negative fifteen volt potential to junction **92**. Such action will be inaugurated by the forwarding of a signal from section T7. While the production of this last deflection is deemed readily apparent from what has already been said, it should be explained that an AND gate corresponding to the AND gate **166** would have one input connected to section T7 and its other input to channel **24**. Not only does such an AND gate supply a resume signal, if desired, but it also transmits a signal to the unblanking circuit **164** signifying the end of the numeral "1" display. The electron beam is accordingly blanked until section T1 is again energized in the initiation of another symbol, say, the numeral "4" which is depicted at top center in FIGURE 2.

It will be understood, it is believed, that to supply all the elements and connections necessary to present just the number of different symbols displayed in FIGURE 2 would unduly encumber the drawings. In practice, even more symbols would be displayed. However, the needed wiring of elements is not at all objectionable because of the speed and reliability of operation that is realized.

Having presented the preceding information, the general manner of forming desired symbols and the way in which they are generally located on the screen **100** of the cathode ray tube **96** should be manifest. Obviously, the invention is not limited to any particular symbols, as others can be formed by using the appropriate number of components in the making up of the logic elements associated with each junction **91**, **92**, **93** and **94**.

Possibly further description will be helpful, though, in understanding how the size of symbols can be varied. Since it has been explained that the particular potential applied to any junction **91**, **92**, **93** or **94** governs the degree of deflection of the electron beam, any controlled change in the potential at these points will influence the extent of deflection. Hence, through the proper selection of values for the resistors **151**, **152**, **153** and **154** the connection of these resistors, if of low enough resistance, to ground by the OR gate **150** when it is on will reduce whatever potential that has been applied to the junctions **91**, **92**, **93** and **94**. A corresponding reduction will therefore ensue with respect to the deflection potentials applied to the electrostatic plates **102–108**. The end result is that the displayed symbols will be smaller, because the electron beam is not deflected as much. It will be recognized that the OR gate **150** may be turned on and off to produce a fluctuating symbol size. Such a situation would prove of benefit, as one illustration, where it is desired to attract the operator's attention to what is then taking place on the screen **100**.

By the same token, the actual potential at the junctions **91–94** can be altered by means of the potentiometers **156**, **157**, **158** and **159**. For example, with the resistance of the paired potentiometers reduced, the voltage values at junctions **91** and **92** will be less than they otherwise would be. The result is that the potentials applied to the vertical deflecting plates **102**, **104** will be lessened. The symbol then will not be as tall as before, although the symbol width will remain unchanged unless the setting of the paired potentiometers **158**, **159** is modified.

Sufficient information has probably already been given by which the role played by the converter **142** can be understood. All that any signal coming from the converter **142** does is to influence the biasing of the electron gun **98** by way of the conventional video amplifier **146**. Thus, whenever it is desired to paint a faint symbol this can be done, or if an extra heavy outline is desired such can be accomplished.

One point to be stressed is that a practising of the present invention is not dependent upon the design and manufacture of special components. All of the individual components comprising our system are currently available on the market. It is the manner in which these components are wired and employed that presents an unique and highly versatile system for rapidly displaying characters of various descriptions. The symbol form to be displayed can be that most easily grasped by those persons responsible for analyzing the encoded data. It might be explained, too, that reference to the computer output register **10** as the source of encoded data is only illustrative, although the invention does perhaps find its greatest utility where high-speed read-out is required. The point to be made, though is that the source of coded information does not have to be a computer register.

As many changes could be made in the above construction and many apparently widely different embodiments of the invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the language used in the following claims is intended to cover all of the generic and specific features of the invention herein described and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

What is claimed:

1. A system for displaying coded information in the form of visually recognizable symbols, the system including a source of digitally encoded data to be converted to symbol form, a cathode ray tube including a fluorescent screen at one end, an electron gun at the other end, means connected in circuit with said electron gun for directing an uninterrupted beam of electrons onto said screen, said beam being of substantially uniform intensity, means for deflecting said beam vertically and means for deflecting said beam horizontally, a first group of symbol forming resistors of equal ohmic value joined together at one end, means connecting said joined ends to said vertical deflecting means, a second group of symbol forming resistors of equal ohmic value joined together at one end, means connecting the joined ends of said second group of resistors to said horizontal deflecting means, and a plurality of digital logic elements responsive to discrete voltage signals derived from said source for successively and uninterruptedly applying a given potential to various of the other resistor ends of both groups to provide an uninterrupted trace in accordance with the symbol that is to be produced on said screen so that said symbol will be indicative of the encoded data.

2. A system for displaying coded information in the form of visually recognizable symbols, the system including a source of digitally encoded data to be converted to symbol form, a cathode ray tube including a fluorescent screen at one end, an electron gun at the other end, means connected in circuit with said electron gun for directing a beam of electrons onto said screen, said beam being of uniform intensity, means for deflecting said beam vertically and means for deflecting said beam horizontally, a first group of symbol forming resistors of equal ohmic value joined together at one end, means connecting said joined ends to said vertical deflecting means, a second group of symbol forming resistors of equal ohmic value joined together at one end, means connecting the joined ends of said second group of resistors to said horizontal deflecting means, a first group of OR gates having two inputs and and output for applying a given potential to any of the other resistor ends belonging to said one group, a pair of AND gates associated with each of said OR gates, each AND gate having first and second inputs and an output, the outputs of each pair of AND gates being connected to the inputs of the OR gate with which

said pair of AND gates is associated, a second group of OR gates having two inputs and an output for applying a given potential to any of the other resistor ends belonging to said second group, a pair of AND gates associated with each of the OR gates in said second group, each AND gate in this latter situation also having first and second inputs and an output, the outputs of each pair of AND gates in this latter situation being connected to the inputs of the OR gate with which said pair of AND gates in this latter situation is associated, timing means for applying a series of successive signals to certain of the first inputs of the AND gates associated with both groups of OR gates, and means controlled by said source for applying sustained signals to certain of the second inputs of the AND gates associated with both groups of OR gates, whereby coincidence of signals on predetermined AND gates associated with both groups of OR gates will deflect the electron beam smoothly and directly from position to position on the fluorescent screen to produce an uninterrupted trace forming symbol representative of the encoded data.

3. A system in accordance with claim 2 including means associated with said respective deflecting means for determining the region of said screen at which said symbol will be formed.

4. A system in accordance with claim 2 including additional means for modifying the respective potentials at the joined ends of said resistors so as to alter the size of said symbol.

5. A system in accordance with claim 2 including means associated with said electron beam for modifying the beam's intensity from one level of uniformity to another.

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