

PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) ALPHANUMERIC CHARACTER DISPLAY APPARATUS AND METHOD

(71) We, HEWLETT - PACKARD COMPANY, a corporation organised and existing under the laws of the State of California, United States of America, of 1501, Page Mill Road, Palo Alto, State of California, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an alphanumeric character display apparatus and method. The term "display" in this specification is intended to include the case where the characters are directly displayed as well as where they are indirectly displayed as by recording on paper.

According to the invention an alphanumeric character display apparatus comprises a set of a plural number of output indicators disposed at selected interstices of M number of column axes and N number of intersecting row axes where M and N are integers not less than 4 and 5, respectively, and each of the output indicators provides an output manifestation in response to electrical row and column signals applied thereto; first and second electrical connections to each of said output indicators for applying electrical signal thereto, the first electrical connections for the plurality of output indicators being grouped into P number of column connections and the second connections for the plurality of output indicators being grouped into Q number of row connections, where P is an integer less than M but not less than 2 and Q is an integer greater than N; the character being formed in response to electrical signals applied to the output indicators along P column and Q row connections to provide output manifestations in combinations along M and N axes.

The invention will now be more particularly described with reference to the accompanying drawings, which is a schematic diagram of a preferred embodiment of display

apparatus showing the layout of light sources and associated scanning circuitry.

Referring to the drawing, there is shown a counter 10 including a plurality of cascaded decade counting units (DCU) 9 arranged to receive an input frequency through gate 11 for counting the same during a gate period determined by timer 13. The binary coded decimal outputs of the decade counting units 9 are disposed to be transferred through transfer gates 15 at the end of a gate period (controlled by timer 13) to the digit data storage units 21, 22, 23 and 24 each providing four lines of binary information for use in a multiple-place output presentation. Counters of this type are described in the literature (see, for example, Hewlett-Packard Journal; May, 1961; Vol. 12, No. 9).

In accordance with the present invention, sources of digit data such as the data storage units 21—24 of a counter 10 are all scanned sequentially by common circuitry and are displayed sequentially in rapid succession in a matrix array of light sources or other output indicators per digit place. Thus, the output lines 25—28 of the data storage units are all connected in common to character generator 17 and the units are actuated sequentially by the column scanner 19 to apply their outputs in turn to the character generator 17. The column scanner 19 may be a shift register which operates at a scanning rate determined by the timing pulses which are received from the display clock 36 and which recur at a sufficiently fast rate to prevent perceivable flicker in the displayed characters.

In its operation, column scanner 19 sequentially actuates each of the data storage units 21—24 for a selected display period by applying signals in sequence to control inputs 31—34. The character generator 17 thus receives the digit data from unit 21 during the first display period, the digit data from unit 22 during the second display period, and so on through the sequence for all units to the start of the next sequence. Also, during each

[Price 25p]

Price 33p

display cycle, column scanner 19 first energizes the left-side electrode, say 41A, of the associated display digit 51 and then energizes the right-side electrode 41B. Thereafter, the scanner 19 actuates the next storage unit 22 in response to a signal on line 32 and, during the display period for the digit stored in unit 22, first energizes the left-side electrode 42A and then the right-side electrode 42B, and so on through repetitive sequences. In addition, the scanner 19 also applies signals to the character generator 17 via line 35 during the display period for each digit to indicate whether the A-electrode or the B-electrode is being energized.

The output display devices 51—54 are each comprised of a plurality of output indicators physically arranged symmetrically in two left and two right columns and along upper, lower and intermediate transverse rows of a 4-by-7 matrix array where the output indicators may be spot heaters for thermographic recording paper or light sources such as gas-discharge glow lamps or incandescent lamps. In a preferred embodiment of the present invention the output indicators are solid-state injection electro-luminescent diodes which are arranged in substantially symmetrical left-side and right-side portions with each side portion disposed to be selectively illuminated in response to a column electrode A or B being energized by the column scanner 19. The additional electrode for each light source per digit 51—54 is provided by the rows of electrodes 57 that are energized by the character generator 17. This generator 17 may be a conventional diode matrix which translates four-line coded signals received from the storage units 21—24 into signals (or conditions of conductivity) appearing at selected ones of the row electrodes 57. It should be noted that the light sources which are physically arranged in upper, lower and intermediate transverse rows per digit are energized from the character generator 17 through electrodes 57 along with the light sources that are arranged in the generally vertical columns. The effect of this is that the physical arrangement of light sources at selected interstices of a matrix array of M columns and N rows (e.g. 4-by-7) is scanned electrically as a matrix array of P columns and Q rows (e.g. 2-by-10). P must be an integer less than M but not less than 2 and Q must be an integer greater than N. For relatively clear and legible characters the physical matrix array of indicators should have an odd number of rows to provide acceptable upper-half and lower-half symmetry and 5 rows is the minimum acceptable number. However, in order to provide adequate control over the indicators in the matrix to form acceptably legible characters, the N number of physical rows (which include the upper and lower and intermediate lateral "bars" of the digit 8) are transformed into a larger

number of electrical rows by making the three lateral "bars" of the digit 8 separate electrical rows.

This arrangement has the advantage that the average light intensity from each digit is increased over conventional column-by-column scanning of a digit for a given drive current per light source and display period since each column may remain illuminated for a larger fraction of the total digit display period. In the described embodiment the average light intensity is double the intensity obtained by scanning the 4-by-7 matrix array column by column during the same display period. Also, for multiple-place digit displays, the number of drive lines required to energize the light sources in a digit matrix is greatly reduced. Further, the present invention permits substantial simplifications of the scanning circuitry due to the reduction in the number of possible signal combinations involved (i.e. number of rows $\times$ number of columns $\times$ number of digit places) with concomitant reduction in complexity and expense. Additional simplifications may be accomplished in the illustrated embodiment of a two-column electrical driving system since display characters such as 0, 8, A etc. having right-left symmetry may be formed using only one set of signals on the Q number of row electrodes 57 while scanning both half sections of the display character. For unsymmetrical display characters such as 2, 3, E, etc., which have no left-right symmetry, the set of signals on the Q number of row electrodes 57 must be changed in response to signal on line 35 simultaneously with the change in energization of one of the P number of column electrodes (say, A) to another of the P number of column electrodes (i.e. B).

In a multiple-place digit display according to the present invention, the average light intensity per digit decreases for a given drive current to each light source in the digits as the number of digit places operated in the same scanning cycle increases. This is due to the reduction per extra digit in the period of time that a column electrode is energized compared with the total period of time required to complete a scanning cycle. This reduction in light intensity may be compensated for by increasing the drive current to the light sources as the number of display digit places increases. However, for a large number of display digits of the order of 8—12 digits, drive current levels may have to be increased above safe limits for the light sources and, in that case, it is convenient to separate the total digit display into two or more groups of display digits, each group operating through its own scan cycle of a few digits, as previously described.

WHAT WE CLAIM IS:—

1. Alphanumeric character display

display cycle, column scanner 19 first energizes the left-side electrode, say 41A, of the associated display digit 51 and then energizes the right-side electrode 41B. Thereafter, the scanner 19 actuates the next storage unit 22 in response to a signal on line 32 and, during the display period for the digit stored in unit 22, first energizes the left-side electrode 42A and then the right-side electrode 42B, and so on through repetitive sequences. In addition, the scanner 19 also applies signals to the character generator 17 via line 35 during the display period for each digit to indicate whether the A-electrode or the B-electrode is being energized.

The output display devices 51—54 are each comprised of a plurality of output indicators physically arranged symmetrically in two left and two right columns and along upper, lower and intermediate transverse rows of a 4-by-7 matrix array where the output indicators may be spot heaters for thermographic recording paper or light sources such as gas-discharge glow lamps or incandescent lamps. In a preferred embodiment of the present invention the output indicators are solid-state injection electro-luminescent diodes which are arranged in substantially symmetrical left-side and right-side portions with each side portion disposed to be selectively illuminated in response to a column electrode A or B being energized by the column scanner 19. The additional electrode for each light source per digit 51—54 is provided by the rows of electrodes 57 that are energized by the character generator 17. This generator 17 may be a conventional diode matrix which translates four-line coded signals received from the storage units 21—24 into signals (or conditions of conductivity) appearing at selected ones of the row electrodes 57. It should be noted that the light sources which are physically arranged in upper, lower and intermediate transverse rows per digit are energized from the character generator 17 through electrodes 57 along with the light sources that are arranged in the generally vertical columns. The effect of this is that the physical arrangement of light sources at selected interstices of a matrix array of M columns and N rows (e.g. 4-by-7) is scanned electrically as a matrix array of P columns and Q rows (e.g. 2-by-10). P must be an integer less than M but not less than 2 and Q must be an integer greater than N. For relatively clear and legible characters the physical matrix array of indicators should have an odd number of rows to provide acceptable upper-half and lower-half symmetry and 5 rows is the minimum acceptable number. However, in order to provide adequate control over the indicators in the matrix to form acceptably legible characters, the N number of physical rows (which include the upper and lower and intermediate lateral "bars" of the digit 8) are transformed into a larger

number of electrical rows by making the three lateral "bars" of the digit 8 separate electrical rows.

This arrangement has the advantage that the average light intensity from each digit is increased over conventional column-by-column scanning of a digit for a given drive current per light source and display period since each column may remain illuminated for a larger fraction of the total digit display period. In the described embodiment the average light intensity is double the intensity obtained by scanning the 4-by-7 matrix array column by column during the same display period. Also, for multiple-place digit displays, the number of drive lines required to energize the light sources in a digit matrix is greatly reduced. Further, the present invention permits substantial simplifications of the scanning circuitry due to the reduction in the number of possible signal combinations involved (i.e. number of rows $\times$ number of columns $\times$ number of digit places) with concomitant reduction in complexity and expense. Additional simplifications may be accomplished in the illustrated embodiment of a two-column electrical driving system since display characters such as 0, 8, A etc. having right-left symmetry may be formed using only one set of signals on the Q number of row electrodes 57 while scanning both half sections of the display character. For unsymmetrical display characters such as 2, 3, E, etc., which have no left-right symmetry, the set of signals on the Q number of row electrodes 57 must be changed in response to signal on line 35 simultaneously with the change in energization of one of the P number of column electrodes (say, A) to another of the P number of column electrodes (i.e. B).

In a multiple-place digit display according to the present invention, the average light intensity per digit decreases for a given drive current to each light source in the digits as the number of digit places operated in the same scanning cycle increases. This is due to the reduction per extra digit in the period of time that a column electrode is energized compared with the total period of time required to complete a scanning cycle. This reduction in light intensity may be compensated for by increasing the drive current to the light sources as the number of display digit places increases. However, for a large number of display digits of the order of 8—12 digits, drive current levels may have to be increased above safe limits for the light sources and, in that case, it is convenient to separate the total digit display into two or more groups of display digits, each group operating through its own scan cycle of a few digits, as previously described.

WHAT WE CLAIM IS:—

1. Alphanumeric character display



apparatus comprising: a set of a plural number of output indicators disposed at selected interstices of M number of column axes and N number of intersecting row axes where M and N are integers not less than 4 and 5, respectively, and each of the output indicators provides an output manifestation in response to electrical row and column signals applied thereto;

first and second electrical connections to each of said output indicators for applying electrical signals thereto, the first electrical connections for the plurality of output indicators being grouped into P number of column connections and the second connections for the plurality of output indicators being grouped into Q number of row connections where P is an integer less than M but not less than 2 and Q is an integer greater than N;

the character being formed in response to electrical signals applied to the output indicators along P column and Q row connections to provide output manifestations in combination along M and N axes.

2. Apparatus as in Claim 1 wherein the output indicators are disposed at each intersection of successive row axes with a pair of spaced column axes and at each intersection of adjacent column axes with a pair of spaced row axes and also at each intersection of adjacent column axes with another row axis intermediate said pair of spaced row axes, the output indicators being disposed in substantially lineal arrays at contiguous intersections along the selected column and row axes.

3. Apparatus as in Claim 1 wherein said output indicators are discrete light sources disposed at said selected interstices.

4. Apparatus as in claim 2 wherein:

said first electrical connections for all the output indicators disposed along one of said pair of spaced column axes and for selected ones of said output indicators which are disposed along said row axes and which are contiguous said one of the pair of spaced column axes being connected to form a first column connection for said set; and

said first electrical connections for all the output indicators disposed along the other of said pair of spaced column axes and for selected remaining ones of said output indicators which are disposed along said row axes and which are contiguous said other of the pair of spaced column axes being connected to form a second column connection for said set.

5. Apparatus as in claim 4 wherein:

M is an even number; and

the first and second column connections for said set are connected to the first electrical connections for said output indicators disposed in substantially symmetrical left-half and right-half sections of said set.

6. Apparatus as in claim 5 wherein:

M is 4;

N is 7;

P is 2; and

Q is 10.

7. The method of producing output manifestations of signals from a source of logic information on an array of electrically-activated output indicators disposed at selected interstices of M number of column axes and N number of intersection row axes, where M and N are integers not less than 4 and 5, respectively, the method comprising the steps of:

applying actuating electrical signals to selected output indicators through first and second electrical connections to each such output indicator where the first electrical connections for all output indicators are grouped into P number of column connections and the second electrical connections for all output indicators are grouped into Q number of row connections and P is an integer less than M but not less than 2 and Q is an integer greater than N, the application of actuating electrical signals being performed sequentially along one of the P number of column connections and Q number of row connections.

8. Alphanumeric character display apparatus as in claim 1 including for each place character to be displayed a plurality of discrete output indicators arranged at selected interstices in a matrix array, a character being formed and display by activating the output indicators in symmetrical left-side and right-side halves of the matrix array.

9. Alphanumeric character display apparatus as in claim 1 including:

translator means having Q number of output terminals connected to said Q number of row connections and being responsive to logic information supplied thereto from a source of logic information for producing electrical signal conditions on selected ones of the Q number of row connections indicative of said logic information; and

scanning means having P number of output terminals connected to said P number of column connections and producing electrical signal conditions on each of said P number of output terminals in sequence, where said translator means and the scanning means supply electrical signals to set up a selected signal condition.

10. Apparatus as in claim 9 comprising:

a plurality S of sets of said plural number of output indicators, each set including output indicators disposed at selected interstices of M number of column axes and N number of intersecting row axes;

first and second electrical connections to each of said output indicators in each of said sets, the first electrical connections for the plurality of output indicators in each of said sets being grouped into P number of column



- connections for each set and the second connections for the plurality of output indicators in all sets being grouped into a common Q number of row connections, where P for each set is an integer less than M for such set but not less than 2 and Q is an integer greater than N of any set; 25
- said translator means having the Q number of output terminals connected to the common Q number of row connections for all sets; and 30
- said scanning means having $P \times S$ number of output terminals connected to the column connections of all of said sets and producing electrical signal conditions on each of said $P \times S$ number of output terminals in sequence. 35
11. Apparatus as in claim 10 comprising:
- a source of logic information for each of said plurality of sets; and
- circuit means coupled to said sources, said translator means and said scanning means for applying logic information to said translator means from a source during the period of time said scanning means produces electrical signal conditions on the P number of output terminals for the set of output indicators corresponding to such source, said translator means producing electrical signal conditions on selected ones of said Q number of row connections during the period of time said scanning means produces an electrical signal condition on a column connection for such set.
12. Display apparatus substantially as hereinabove described with reference to and as illustrated in the accompanying drawing.
13. Display method substantially as hereinabove described.
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