United States Patent

[11] 3,614,771

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[21] Appl. No. **859,087**
[22] Filed **Sept. 18, 1969**
[45] Patented **Oct. 19, 1971**
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[54] **DISPLAY APPARATUS**
8 Claims, 1 Drawing Fig.

[52] **U.S. Cl.** **340/336,** 178/30, 340/166, 340/324
[51] **Int. Cl.** **G09f 9/34**
[50] **Field of Search** 340/166, 324, 334, 336, 168; 178/15, 30

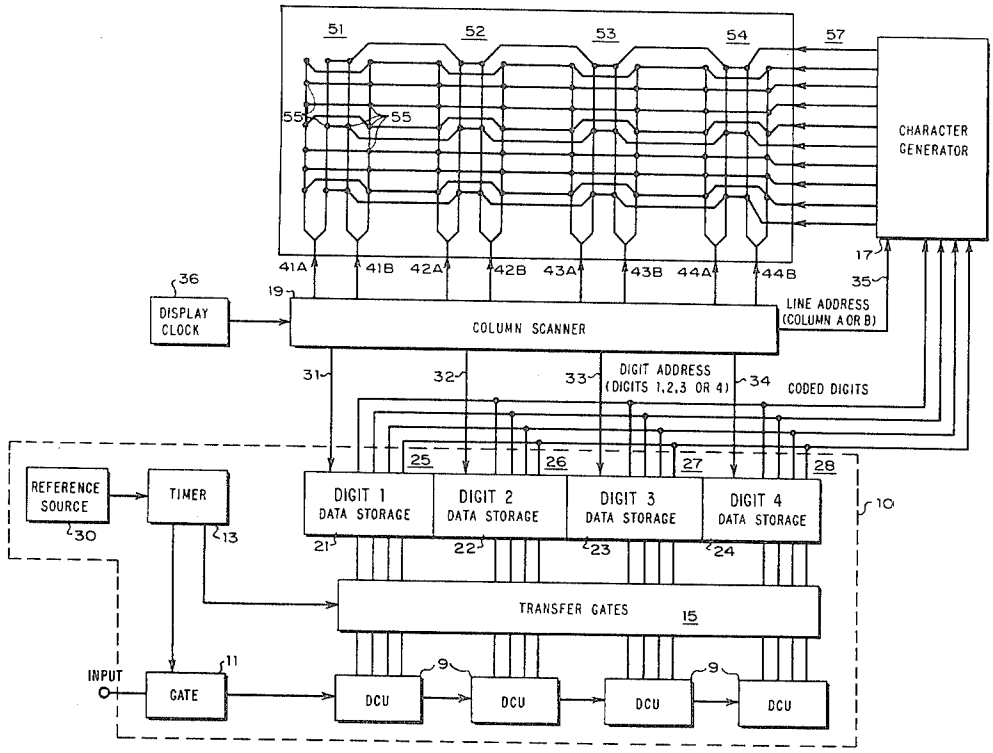
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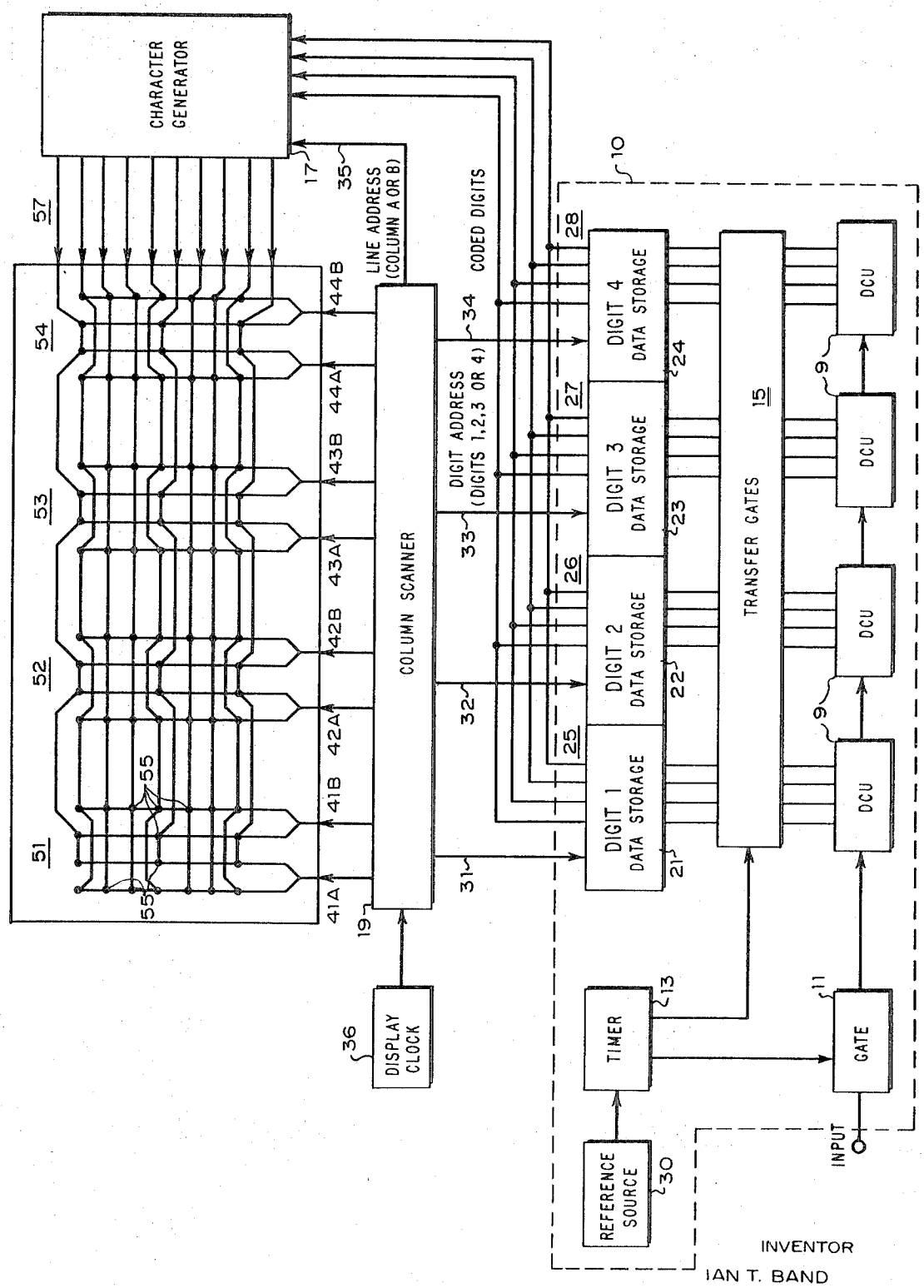
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ABSTRACT: A multiple-place alphanumeric character display includes for each place character to be displayed a plurality of discrete light sources arranged at selected interstices in a matrix array. The characters are formed and displayed more rapidly than in conventional techniques by sequentially scanning symmetrical halves of the digits that form the display.





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DISPLAY APPARATUS

SUMMARY OF THE INVENTION

Alphanumeric display characters are formed using electroluminescent diode light sources or other suitable output indicators disposed in a 4by 7matrix array. The light sources are selectively activated by energizing the electrodes to selected light sources arranged in symmetrical left-side and right-side groups Multiple-place arrangements of such display characters are formed by sequentially scanning the light sources in the two symmetrical groups per character at a sufficiently rapid rate that the resulting output indication appears to be continuous. The rate at which the display characters can be formed is increased by combining the light sources, or other output indicator, which are physically arranged in the 4by 7array per display character to form an electrical matrix per display character having only two matrix electrodes which need by scanned.

DESCRIPTION OF THE DRAWING AND PREFERRED EMBODIMENT

The drawing is a schematic diagram of the 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 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 for providing a multiple-place digital output presentation. Counters of this type are described in the literature (see, for example, Hewlett-Packard Journal; May, 1961; Vol. 12,No. 9). In counters of this type, the digit data in each of units 21–24 is typically decoded into 10-line decimal or other suitable code for convenient control of selected light sources that are required to produce the digits 0through 9per digit place.

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 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 in left and 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 electroluminescent 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 therefore 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 4-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 in 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). This has the advantage that the average light intensity from each digit is increased over conventional column-by-column scanning for a given drive current per light source 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 *x*number of columns *x*number of digit places) with concomitant reduction in complexity and expense Additional simplifications may be accomplished in the illustrated embodiment of a 2-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.

We claim:

1. Apparatus for producing visual output manifestations of signals from a source of logic information, the 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 in-

tegers not less than 4and 5,respectively, and each of the output indicators providing a visual output manifestation in response to electrical signal applied thereto, the set having:

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 where P is an integer less than M but not less than 2, and in one row of more than a pair of output indicators, the second connections for at least a selected pair of such output indicators which have first connections connected to different P column connections are connected to a common one of Q row connections, and the second connections for remaining ones of said plural number of output indicators are connected to other Q row connections where Q in an integer greater than N;

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 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 one of the translator means and scanning means supplies electrical signal as said signal condition;

whereby selected output indicators respond to electrical signals applied thereto along P column and Q row connections and provide visual output manifestations in combinations along M and N axes which are representative of logic information from a source.

2. Apparatus as in claim 1 comprising:

a plural number S of said sets disposed in spaced relationship:

means connecting the second connections for the plurality of output indicators in all sets into a common Q number of row connections

said translator means having the Q number of output terminals connected to the common Q number of row connections for all sets; and

said scanning means includes P × 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 × S number of output terminals in sequence.

3. Apparatus as claim 1 wherein:

said plural number of output indicators in the set are disposed only along a pair of spaced column axes and along first and second spaced row axes and along a third row axis spaced intermediate said first and second row axes, the output indicators being disposed in substantially contiguous and lineal arrays along said first, second and third row axes; and

said one row of more than a pair of output indicators comprises one of said first, second and third rows.

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

5. Apparatus as in claim 3 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 disposed along said first, second and third rows 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 disposed along said first, second and third rows being connected to form a second column connection for said set.

6. Apparatus as in claim 5 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.

7. Apparatus as in claim 6 wherein:

M is 4;

N is 7;

P is 2;and

Q is 10.

8. Apparatus as in claim 2 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 in sequence on each of 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.