This invention relates to symbol display apparatus and, more particularly, to apparatus for accepting digitally coded input signals representing various symbols and producing those symbols on a display device. Most people are familiar with outdoor signs in which a variety of symbols are presented by illuminating different combinations of electric light bulbs arranged in a matrix. Such signs are found in advertising displays, in scoreboards on athletic fields, in time and temperature displays, and in a variety of other applications. A similar technique for generating symbols of illuminating predetermined combinations of points arranged in a matrix has now been applied to high-speed displaying of information derived from a computer.

In the art of high-speed data display, symbols are usually generated on a phosphor-coated face of a cathode ray tube by an electron beam within the tube. Voltages are provided to sequentially position the beam at the various locations on the face of the tube where it is desired to display symbols. This action is analogous to typing a page of symbols on a typewriter. While the beam is at each of the locations at which it is desired to display a symbol, additional voltages are provided to cause the beam to scan a matrix of points and to cause predetermined combinations of those points on the phosphor-coated face of the tube to glow to provide visible symbols. That portion of the display apparatus which causes the electron beam to scan the matrix of points and to turn the beam on and off to cause only predetermined combinations of points to emit visible light is known as a symbol generator.

The input to a symbol generator is usually in the form of six bit digitally coded signals, which must be converted to signals of the proper type for generating the symbol display on the face of the cathode ray tube. If a six bit input code is used, it may involve up to sixty-four different combinations, each of which represents a different symbol. If it is desired to create each symbol on, for example, a 5 x 7 matrix of points on the cathode ray tube face, it is necessary that each of the sixty-four different input signals be converted to a different thirty-five bit output signal, with each bit of the output signal representing a different one of the thirty-five points on the 5 x 7 matrix. This involves the provision of six bit to thirty-five bit binary conversion circuitry in the symbol generator.

One type of conversion apparatus that has been utilized for this purpose includes a memory device having stored within it the various possible output signals or words. Receipt of a digitally coded input signal initiates a search of the memory device to find the desired output word. Examples of such memory devices are rotating magnetic drums or discs with bits permanently recorded on a track and sensed by a magnetic read head. Another example of such a device is a rotating drum or disc with bits marked on it so that they can be sensed optically by a photodetector.

A disadvantage of such rotating memory devices, as heretofore used, is that all of the bits of an output word are recorded sequentially and adjacent each other on the recorded track of the device. The output words are sequentially recorded around the track. This means that each output word is recorded on the memory device at a different distance from a given reference point on the recorded track. Because of this, there is a variable time delay introduced into the apparatus that must be removed before the output signal can be utilized to actuate a display device. Furthermore, the bits of each desired output word all become available within a short period of time and there is then a relatively long, and variable, period of time before the bits of the next output word are available. The display device which uses these bits is less expensive if it is designed to accept the bits in the output words in a smooth sequence rather than in bursts. For these reasons, it has been necessary to provide storage apparatus such as a buffer register to receive the desired output word from the memory device and store it until it is read out at the proper time and at a suitable speed for the display device to accept the word. The present invention provides symbol display apparatus which does not involve the use of a buffer between its memory device and display device, which provides symbol positioning signals to the display device at a rate of speed at which the device can accept them, and which synchronizes those signals with symbol positioning signals also provided to the display device.

Broadly speaking, the present invention is based on the concept that all of the bits of a multibit output word to be supplied to a display device do not need to be recorded sequentially on a moving memory medium without gaps between the bits. In fact, numerous advantages are attained if the bits comprising each output word are so spaced apart on the memory medium that they may be supplied to the display device at a rate at which it can accept them. The present invention contemplates dividing the memory medium into a plurality of sectors at least equal in number to the number of bits in each output word. Each sector is of such size that it is capable of storing a number of bits at least equal in number to the number of output words. One bit from each of the output words is stored in each sector with those bits forming each output word being stored in like places in all of the sectors. For example, if there are thirty-five bits in each output word, the storage medium may be divided into thirty-five sectors and, if there are sixty-four possible combinations of those output bits, each sector would be capable of storing sixty-four bits. The first sector would contain the first bits of each of the sixty-four words, the second sector would contain the second bits of the sixty-four words in the same sequence as in the first sector, and so on until the thirty-fifth sector contains the thirty-fifth bits of the sixty-four words. Thus, it is seen that every sixty-fourth bit recorded on the memory medium is part of the same thirty-five bit output word. Readout means are provided which are selectively responsive to the sixty-four different input signals for sequentially reading out from the sectors of the storage medium all bits stored in like places in the sectors.

Various synchronizing and clock pulses are also stored on the recording medium. When the display device utilized is, for example, a cathode ray tube, the synchronizing pulses control its electron beam sweep, and the symbol generating output words control blanking and unblanking of the electron beam to generate symbols on the tube face.

The invention, together with further features and advantages, will be better understood from the following description, taken in conjunction with the accompanying drawings, in which:

FIGS. 1 and 2 are diagrams useful in understanding the generation of symbols from a matrix arrangement of electric light bulbs;

FIGS. 3a, 3b, 4a and 4b are diagrams useful in understanding the generation of symbols on the face of a cathode ray tube on a matrix of points;
FIG. 5 is a block diagram of symbol display apparatus embodying the invention; and FIG. 6 is a block diagram of the system of FIG. 5, but showing a symbol generator in greater detail and also showing a memory device in diagrammatic perspective view.

FIGS. 1 and 2 are useful in understanding the generation of various symbols on, for example, a 5 x 7 matrix arrangement of electric light bulbs. If the bulbs are arranged substantially as shown in the figures and are numbered from 1 through 35, it is readily seen that if bulbs numbered 1, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 21, 22, 28, 30, 31, 32, 33 and 34 are illuminated and all others remain dark, a symbol "Y" is formed (FIG. 1). Similarly, as seen in FIG. 2, if bulbs numbered 1, 2, 3, 4, 5, 6, 7, 11, 17, 18, 19, 23, 27, 29 and 35 are illuminated, a letter "K" is formed. Thus, it is apparent that by illuminating different ones of the thirty-five electric light bulbs, both alphabetical and numerical symbols may be formed from a matrix of only thirty-five bulbs. Although the generation of symbols by illuminating various combinations of light bulbs arranged on a matrix is quite useful for outdoor displays and signs, it is obviously unsuitable for displaying text in a format similar to typewritten or printed pages. However, analogous techniques can be used. For example, the matrix in FIGS. 1 and 2 may be replaced by a cathode ray tube having a phosphor-coated face over which an electron beam is caused to move. If the intensity of the beam is made sufficiently great at predetermined points, which is known as unblanking the beam, the phosphor on the face of the tube may be caused to glow at those points and form visible symbols. FIGS. 3 and 4 illustrate this analogous technique.

If an electron beam on a cathode ray tube can be made to scan over a matrix of points on the phosphor-coated face of the cathode ray tube and can be unblanked at certain of those points, visible symbols can be generated on the face of the tube. A possible scanning pattern is shown in FIG. 3(a) where an electron beam scans in zigzag fashion over a 5 x 7 matrix of points and is unblanked at certain of the points. As shown, if the beam is unblanked at points numbered 1, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 21, 22, 28, 30, 31, 33, 34 and 35, a letter "D" is developed. FIG. 3(b) illustrates as a function of time the unblanking pulses that are applied to the cathode ray tube to cause the phosphor to emit light in the pattern shown in FIG 3(a). Obviously, the sweep of the electron beam across the face of the tube and the unblanking pulses applied to the tube must be synchronized in order to generate a meaningful symbol.

FIGS. 4(a) and 4(b) are similar to FIGS. 3(a) and 3(b), respectively, but illustrate the unblanking pattern necessary to form a letter "K". As can be seen from a comparison of FIGS. 3(b) and 4(b), the time sequence of unblanking pulses is quite different for generating the two letters. Each symbol to be generated has a unique sequence of unblanking pulses which is like that of no other symbol.

Having looked at a fundamental method of generating symbols on the face of a cathode ray tube, let us now consider apparatus embodying the invention for performing that function. Throughout the following description and for purposes of illustration only, it is assumed that the apparatus is of the invention requiring a 5 x 7 matrix of points. It is pointed out, however, that the invention is in no way limited to the use of an input signal having a particular number of bits or to the production of symbols on any particular size matrix of points. Apparatus embodying the invention may be easily modified to operate on various types of input signals and to produce symbols on any desired form of matrix. It is understood that as used herein the term "bit" is used to describe a single, which may be in one of two states, in the usual computer sense.

FIG. 5 shows a simplified block diagram of apparatus embodying the invention for producing symbols on a cathode ray tube 110. The tube 110 is of conventional type having a phosphor-coated face and containing an electron gun for generating a beam of electrons. The beam of electrons is caused to impinge upon the phosphor-coated face of the tube at various points under the control of deflection circuitry and the beam is blanked and unblanked through a conventional unblanking circuit 112, such as a video amplifier, to effectively "write" symbols on the face of the tube.

The unblanking circuit 112 is controlled by a symbol generator 114 to cause symbols to appear on the face of the cathode ray tube in the manner previously described with reference to FIGS. 3 and 4. The symbol generator 114 is provided with input signals from a digital data source 116, such as a computer output register. In the present description, the input signal provided to the symbol generator 114 comprises six binary symbols which are fed in parallel to the symbol generator. However, it is again noted that the invention is not limited to the use of this particular input signal.

The symbol generator 114 serves not only to control the blanking of light bulbs shown in FIGS. 1 and 2, but also to control the unblanking of the electron beam of the cathode ray tube to generate symbols, but also to synchronize positioning of the electron beam with symbol generation. After each symbol is generated, a pulse called the origin synchronizing pulse is provided to an X symbol position generator 118. The X symbol position generator 118 provides voltages, which may be amplified by a deflection amplifier 120 and supplied to the deflection circuitry of the cathode ray tube 110 to position its beam in the X or horizontal direction. Each time that an origin synchronizing pulse is received from the symbol generator, the X symbol position generator 118 causes the electron beam of the cathode ray tube to move horizontally by one space to the proper position for the next symbol to be generated; these positions may be thought of as "primary" positions. After a predetermined number of pulses have been received, which number corresponds to the number of primary positions in a horizontal line at which it is desired to generate symbols, the X symbol position generator 118 sends a pulse to a Y symbol position generator 122. The Y symbol position generator 122 serves to position the cathode ray tube beam in the vertical direction. Each time that it receives a pulse from the X symbol position generator 118, indicating that a line of symbols has been generated, the Y symbol position generator provides voltages through a deflection amplifier 124 to the cathode ray tube 110 to cause its beam to move downwardly to another position where another line of symbols may be generated.

In accord with the usual practice in the art, "carrier return" pulses and "start page" pulses are supplied to the symbol position generators from the digital data source. The former pulses are provided to the X symbol position generator 118 at the end of each line of symbols and cause the generator to reset itself to start a new line. Similarly, start page pulses are supplied to both X and Y symbol position generators 118 and 122 to cause them to reset themselves to start a new page.

Each of the X and Y symbol position generators 118 and 122 receives as its input a digital counter and a digital-to-analog converter to provide voltages for the cathode ray tube. Both the counters and the converters may be of conventional types as well known in the art. If, for example, it is desired to provide thirty-two symbols in each horizontal line and thirty-two lines in one raster, the digital counters may each comprise five flip-flop circuits whose outputs are provided to the digital-to-analog converters. In the present embodiment, the outputs of both the X and Y symbol position generators are not smoothly rising sawtooth voltages, but rather are
of the staircase type. This permits a symbol to be generated in one position and, after it is generated, the electron beam of the cathode ray tube is quickly moved to the next position. Alternatively, smoothly rising saw tooth voltages may be used. This will cause the symbols to be tilted slightly, which may be desirable in some applications.

As will later be explained in more detail, the symbol generator 114 also provides deflection voltages to the amplifiers 120 and 124. Those voltages are utilized to cause the symbol beam in the cathode ray tube to scan in the manner shown by FIGS. 3(a) and 4(a) in generating the various symbols.

FIG. 6 also shows the apparatus of FIG. 5, but shows the symbol generator 114 in considerably greater detail. As was previously stated, it is assumed for purposes of illustration that each symbol is to be generated on a 5 X 7 matrix of points ("secondary" positions) on the cathode ray tube face. Thus, the unblanking circuit 112 requires that thirty-five binary bits of information be provided to it serially from the symbol generator 114 for each symbol to be generated. With a six bit input word to the symbol generator, the six bit input word having up to sixty-four different possible combinations, the symbol generator must be capable of providing up to sixty-four different combinations of thirty-five bit output words. Each of the thirty-five different output word combinations is pre-determined in accordance with the various symbols to be generated, in a manner similar to that described with reference to FIGS. 3 and 4.

The symbol generator 114 includes memory or storage means such as a rotatable magnetic drum 130. As previously mentioned, however, numerous other memory devices are also suitable, such as rotating discs or tape loops. Furthermore, the invention is not limited to the use of magnetic recording, and other techniques, such as optical recording, may be utilized. It is necessary only that there be a capability for relative motion between the recording medium and the means for reading the recorded data.

The drum 130 has four recording tracks 130a, 130b, 130c, and 130d thereon with conventional magnetic pickup heads 131a, 131b, 131c, and 131d, respectively, located to read information previously recorded on the tracks. It is pointed out that the memory drum 130 need not be utilized only for the symbol generator. It is one of the advantages of the invention that the symbol generator requires only four recording tracks on a memory device which can also be used for other purposes in equipment with which the apparatus of the invention may be operating.

The recording track 130a on the drum is divided into a number M of sectors equal to the number of bits in the output words from the symbol generator, in this case, thirty-five. Each of the thirty-five sectors must be capable of storing a number of bits at least equal to the number N of different input and output words, in this case, sixty-four. One bit from each of the sixty-four different output words is stored in each sector, with those bits forming each output word stored in like places in all of the sectors with sequential bits of each output word separated from each other by (N-1) other bits. More specifically, the first bit of the first output word is stored in a first position in the first sector, the second bit of the second word is stored in a second position, the first bit of the third word is stored in a third position, and so on, until the first sector contains the first bit information of each of the possible sixty-four output words. In a similar manner, the second sector stores the second bit information for each of the sixty-four output words in the same order as they are stored in the first sector. One bit from each of the sixty-four output words is stored in each of the thirty-five sectors with the bits forming each word stored in like places in all of the sectors. Thus, by reading the information stored at the same position in each of the thirty-five sectors, a thirty-five bit output word may be obtained which corresponds to one of the sixty-four input words.

In order to synchronize the reading of the output words with the deflection of the electron beam, various other pulses are provided in tracks 130b, 130c, and 130d. Track 130b has recorded thereon thirty-five sector synchronizing pulses (SSP), each of which corresponds in position to the beginning of one of the sectors on track 130a. The track 130c contains a single pulse, called the origin synchronizing pulse (OSP), which corresponds in position to the beginning of the first sector on track 130a. The track 130d contains clock pulses (CP), which correspond in position to the information pulses recorded on track 130a. The track 130e could be eliminated by coding the information on one of the other tracks. For example, a pair of adjacent tracks at track 130a, one location can be decoded by digital logic to produce the origin synchronizing pulse.

The selection of a particular thirty-five bit output word to be read from the track 130a is made with a six bit counter 134 which counts in binary fashion from 63 to 0. This counter receives the sixty-four bit input signal from the data source 116. When actuated by the origin synchronizing pulse from the track 130c, whose position corresponds in time to the beginning of the first sector on the track 130a, the counter starts to count down from the number set into it by the six bit input word. Clock pulses from the track 130d actuate the counter 134, which counts down a number for each clock pulse received. When the count has reached 0, all of the counter's output signals are 0's and the next count takes the counter to 63 from which it continues to count down. The 0's may be changed to 1's by means of inverters (not shown) or complementary signals from the counter 134 may be used and passed to an AND gate 138. When all of the input signals to the AND gate are 1's, a 1 is produced by the AND gate, which indicates that the desired bit to be read from track 130a is now under the read head 132a.

The output of AND gate 138 is connected as one input to another AND gate 140 whose other input is from the read head 132a. AND gate 140 operates to pass information received from the read head 132a only when the counter 134 has counted down to 0. As previously pointed out, the length of time required for the counter 134 to reach 0 after the start of counting on track 130a depends on the six bit input signal from the data source 116 which sets the counter for each symbol to be generated. Although information is continuously supplied to the AND gate 140 from the read head 132a, it is passed by the gate only when the counter 134 has counted down to 0, which occurs thirty-five times for each rotation of the drum 130. Thus, it is apparent that if the input signal to the counter sets it at, for example, 5, the bits stored in the fifth positions of all sectors will be serially passed by the AND gate 140. In this manner, a thirty-five bit output word is constructed.

There is a variable time delay between the time the origin synchronizing pulse on track 132a passes under its read head and the time a selected bit from track 130a, as determined by the action of the counter 134, is read.

Also, there are similar time delays between the time the sector synchronizing pulses on track 132b and selected bits on track 132c pass under their respective read heads. Because the origin synchronizing pulse and the sector synchronizing pulses are utilized to control the deflection of the cathode ray tube beam, such variable time delays would cause jitter and other difficulties in the generated symbols. Therefore, a one bit memory 144, such as a flip-flop circuit, is provided to store the information from each sector of track 130a appearing at the output of AND gate 140 until that sector has completely passed under its read head. When a sector synchronizing pulse is applied to the one bit memory 144, the information contained in the memory is supplied as one input to an AND gate 146 and the memory 144 is reset. The sector synchronizing pulse is also supplied as a second input of the AND gate.
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The thirty-five bits comprising a one word output signal from AND gate 146, which actuate the unblanking circuit 112, must be synchronized with the position of the cathode ray tube beam on the thirty-five point matrix. Therefore, the original synchronizing pulses and the sector synchronizing pulses are provided to a Y bit position generator 148, which may be generally similar to the symbol position generators previously described. The Y bit position generator serves to provide stair-case voltages to the deflection amplifier 124 and hence to the deflection circuitry of the cathode ray tube 110 to position its beam in the Y or vertical direction on the desired points of the matrix. The Y bit position generator 148 may be initially actuated at the beginning of each symbol generation period by the origin synchronizing pulse received along with a sector synchronizing pulse, and thereafter each sector synchronizing pulse received causes the electron beam of the cathode ray tube to be moved vertically from point to point on the matrix until a predetermined number of pulses have been received. In the present case, when seven sector synchronizing pulses have been received, the digital counter contained in the generator resets itself and a pulse is sent to the X bit position generator 150. The X bit position generator is similar to the symbol position generators previously discussed, and is actuated at the beginning of each symbol generation period by the origin synchronizing pulse. Each time the X bit position generator 150 receives a pulse from the generator 148, it causes the electron beam of the cathode ray tube to be moved horizontally so that the Y bit position generator 148 can cause the electron beam to move along another column of points of the matrix. After five pulses have been received by the generator 150 from the generator 148, the drum 130 has made one complete revolution and another origin synchronizing pulse causes the generators 148 and 150 to be reset. The electron beam of the cathode ray tube is now repositioned to start generation of another symbol. Thus, the X and Y bit position generators 148 and 150 cause the beam of the cathode ray tube to move over the face of the tube in a manner very similar to that shown by FIGS. 3(a) and 4(a).

It will be apparent to one skilled in the art that the apparatus of the invention may easily be adapted to accept other than six bit input signals and to form symbols on other than a 5 x 7 matrix of points. For example, if it is desired to have five bit input signals, the counter 134 may be modified so that it counts from 31 to 0 rather than from 63 to 0. Similarly, if it is desired to generate symbols on a 6 x 8 matrix rather than on a 5 x 7 matrix, the recording track 130 would be divided into forty-eight sectors rather than thirty-five; the Y and X bit position generators 148 and 150 would be modified to provide eight-step and six-step output voltages, respectively, rather than seven-step and five-step.

It is now apparent that the invention provides a symbol display apparatus that eliminates the need for large buffers, and in which signals are provided to a display device at a rate at which it can accept them. It requires the use of only four memory tracks of a memory device that may have hundreds of other tracks being used for other storage and retrieval purposes. The electronic circuitry embodied in the system is relatively simple and it is believed that all elements are well known to one skilled in the art.

Although an embodiment of the invention has been shown and described, it will be apparent to one skilled in the art that many changes and modifications may be made without departing from the true scope and spirit of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In symbol display apparatus for generating selected symbols on a face of a cathode ray tube wherein an unblanking circuit controls impingement of an electron beam on said face as the beam is deflected thereacross in a scanning pattern, a memory device having bits of a binary-coded word stored in uniformly spaced positions along a storage and retrieval path wherein, bits of other words being intermixed between the bits of said word, means for reading out the bits of said word from said memory device over a time interval determined by said scanning pattern of said electron beam over the face of said tube; and

2. A symbol display apparatus for converting an input code into a code of symbols, comprising:

a memory device comprising a plurality of M sectors, where M is the number of bits identifying a symbol, each sector having N bit storage positions, where N is the number of possible symbols that may be generated by the bits of each of the symbols being stored in said memory device and interlaced with bits of other symbols so that bits N positions apart represent one of said symbols;

means for reading out of said memory device, in a predetermined readout time interval, M bits representing a symbol;

a cathode ray tube having a face and an electron beam that scans a predetermined portion of said face in vertical and horizontal directions in a scanning time interval substantially equal to the memory readout time interval;

means for synchronizing the scan of said electron beam with the readout of said memory device so that bits from each of said sectors relate to different predetermined beam positions on said portion of the face of said tube;

a symbol display apparatus for converting an input code into a code of symbols, comprising:

a memory device comprising a plurality of M sectors, where M is the number of bits needed to write a word which identifies a symbol, each sector having N bit storage positions, where N is the number of possible words from which symbols are to be generated, the bits of each of said words being stored in said memory device and interlaced with bits of other words so that bits N positions apart from one of said words, each sector having a sector synchronization pulse recorded in a position corresponding to the beginning of said sector;

means for reading from said memory device in a predetermined time interval, M bits of a word;

a cathode ray tube having a face and an electron beam that scans a predetermined portion of said face in vertical and horizontal directions in a scanning time interval substantially equal to the memory readout time interval; and

synchronizing means for synchronizing the scan of said electron beam with the readout of said memory device so that bits from each of said sectors relate to different predetermined beam positions on said portion of the face of said tube. 

said synchronizing means comprising a counter means triggered by said sector synchronization pulses for controlling scanning of said electron beam in a synchronization with said memory readout.
4. A symbol display apparatus for converting input codes to displayed symbols corresponding thereto comprising:

a memory device comprising a plurality of M sectors, each sector storing N bits of information, N being the number of symbols to be generated, the bits of information of said symbols being stored in said memory device so that all bits representing each symbol are stored (N-1) positions apart from one another; each sector having a sector synchronization pulse recorded in a position corresponding to the beginning of said sector, the first sector having an origin synchronization pulse recorded in a position corresponding to the beginning of said first sector;

means for reading from said memory device in a predetermined time interval, M bits of information representing one symbol;

cathode ray tube having a face and an electron beam that scans a predetermined portion of said face in vertical and horizontal directions in a scanning time interval substantially equal to said predetermined time interval; and

synchronizing means responsive to said sector synchronization pulses and to said origin synchronization pulse for synchronizing the scan of said electron beam with reading from said memory device so that bits from each of said sectors determine blanking or unblanking of said beam at different predetermined beam positions on said portion of the face of said tube.

5. A symbol display apparatus for converting input codes to displayed symbols corresponding thereto comprising:

a memory device comprising a plurality of M sectors, each sector storing N bits of information, N being the number of symbols to be generated, the bits of information of said symbols being stored in said memory device so that all bits representing each symbol are stored (N-1) positions apart from one another; each sector having a sector synchronization pulse recorded in a position corresponding to the beginning of said sector, the first sector having an origin synchronization pulse recorded in a position corresponding to the beginning of said first sector;

means for reading from said memory device in a predetermined time interval, M bits of information representing one symbol;

cathode ray tube having a face and an electron beam that scans a predetermined portion of said face in vertical and horizontal directions in a scanning time interval substantially equal to said predetermined time interval; and

synchronizing means for synchronizing the scan of said electron beam with the origin synchronization pulse and the sector synchronization pulses so that bits of information from each of said sectors representing a single symbol determine blanking or unblanking of said beam at different predetermined beam positions associated with said primary position of the face of said tube.

said synchronizing means comprising counting means triggered by said origin synchronization pulse and said sector synchronization pulses for controlling scanning of said electron beam in a predetermined pattern in synchronism with said memory readout so that when each of said M sectors is read the beam is deflected to a different position within said pattern, the pattern repeating itself with each origin synchronization pulse being sensed.

6. A symbol display apparatus for converting input codes to displayed symbols corresponding thereto comprising:

a memory device comprising a plurality of M sectors, each sector storing N bits of information, N being the number of symbols to be generated, the bits of information of said symbols being stored in said memory device so that all bits representing each symbol are stored (N-1) positions apart from one another; each sector having a sector synchronization pulse recorded in a position corresponding to the beginning of said sector, the first sector having an origin synchronization pulse recorded in a position corresponding to the beginning of said first sector;

means for reading from said memory device, in a predetermined time interval, M bits of information representing one symbol;

cathode ray tube having a face and an electron beam for displaying said symbols on said face at predetermined primary positions;

symbol position generating means for deflecting said electron beam to said primary positions, said symbol position generating means being energized by said origin synchronization pulse to deflect said beam to another primary position in response to each origin synchronization pulse received thereby; and

synchronizing means for synchronizing the scan of said electron beam with each origin synchronization pulse and with the sector synchronization pulses so that bits of information from each of said sectors representing a single symbol determine blanking or unblanking of said beam at different predetermined secondary beam positions associated with said primary position of the face of said tube.

7. A symbol display apparatus for converting input codes to displayed symbols corresponding thereto comprising:

a memory device comprising a plurality of M sectors, each sector storing N bits of information, N being the number of symbols to be generated, the bits of information of said symbols being stored in said memory device so that all bits representing each symbol are stored (N-1) positions apart from one another; each sector having a sector synchronization pulse recorded in a position corresponding to the beginning of said sector, the first sector having an origin synchronization pulse recorded in a position corresponding to the beginning of said first sector;

means for reading from said memory device, in a predetermined time interval, M bits of information representing one symbol and producing pulses in accordance therewith; and

cathode ray tube having a face and an electron beam for displaying said symbols on said face at predetermined primary positions;
symbol position generating means for deflecting said electron beam to said primary positions,
said symbol position generating means being energized
by said origin synchronization pulse to deflect said
beam to another primary position in response to
each origin synchronization pulse received thereby;
synchronizing means for synchronizing the scan of said
electron beam with each origin synchronization pulse
and with the sector synchronization pulses so that
bits of information from each of said sectors represen-
ting a single symbol relate to different predetermined
beam secondary positions associated with said primary
position of the face of said tube,
said synchronizing means comprising counting means
triggered by said origin synchronization pulse and
synchronizing means for counting means triggered
by said origin synchronization pulse and said sector
synchronization pulses for controlling scanning of said electron beam in a predetermined
pattern in synchronism with said memory readout so
that when each of said M sectors is read the beam
is deflected to a different secondary position within
said pattern, the pattern repeating itself in response
to each origin synchronization pulse received;
binary counting means for counting down from (N−1)
to zero and producing a pulse at zero when a binary
counting means being operable to count
from numbers set therein corresponding to said input
codes and actuated by said origin synchronization
pulse and by said clock pulses; and
synchronizing means energized by the pulses produced by said
counter means and said reading means and by said sector
synchronization pulse for controlling blanking
or unblanking of said electron beam in accordance
with the M pulses supplied by said reading means so
that the beam is blanked or unblanked at each of the
secondary positions within said scanning pattern,
thereby displaying said symbol in accordance with said input codes.

8. A symbol display apparatus for converting input
codes to displayed symbols corresponding thereto com-
prising:
a memory device comprising a plurality of M sectors,
attaining the number of bits of information represent-
ing each of said symbols,
each storing N bits of information, N being the
number of symbols to be generated;
bits of information of said symbols being stored in
the said device so that all bits representing each symbol are stored (N−1) positions apart from one another,
each sector having a sector synchronization pulse re-
corded in a position corresponding to the beginning
of said sector,
the first sector having an origin synchronization pulse
recorded in a position corresponding to the beginning
of said first sector,
the bits in all sectors having clock pulses recorded in
positions corresponding thereto;
means for reading from said memory device, in a pre-
determined time interval, M bits of information repre-
senting one symbol and producing pulses in ac-
cordance therewith;
a cathode ray tube having a face and an electron beam
for displaying said symbols on said face at predetermined
primary positions;
symbol position generating means for deflecting said
electron beam to said primary positions,
said symbol position generating means being energized
by said origin synchronization pulse to deflect said
beam to another primary position in response to each
origin synchronization pulse received thereby;
synchronizing means for synchronizing the scan of said
electron beam with each origin synchronization pulse
and with the sector synchronization pulses so that bits
of information from each of said sectors represent-
ing a single symbol relate to different predetermined
response to each origin synchronization pulse received;
binary counting means for counting down from \( (N-1) \) to zero and producing a pulse at zero,
said binary counting means being operable to count from numbers set therein corresponding to said input codes and actuated by said origin synchronization pulse and by said clock pulses, said binary counting means being automatically resettable from zero to \( (N-1) \); and

gating means energized by the pulses produced by said counter means and said reading means and by said sector synchronization pulse for controlling blanking or unblanking of said electron beam in accordance with the \( M \) pulses supplied by said reading means so that the beam is blanked or unblanked at each of the secondary positions within said scanning pattern, thereby displaying said symbol in accordance with said input codes.

10. Apparatus responsive to an input code identifying a symbol for displaying that symbol, said apparatus comprising:
   a cathode ray tube including means for generating an electron beam;
deflection means for deflecting said beam to cause it to describe a matrix of display points;
a memory comprising a movable recording medium defining a plurality of sectors equal to the number of points in said matrix, each of said sectors including a plurality of bit positions equal to the number of different symbols to be displayed;
means synchronized with said deflection means and responsive to said input code for sequentially reading a correspondingly positioned bit from each of said sectors; and
intensity control means responsive to said bits read from said memory for controlling the intensity of said beam.

11. The apparatus of claim 10 wherein said intensity control means includes a one bit memory.

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