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UK CL (Edition J) H4F FJA, H4T TABX TBMA
INT CL[4] G09G, H04N
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(54) Security of video monitors

(57) In order to prevent eavesdropping by detecting radiation given off by a video monitor, the video information is stored in order in alternating field stores 20, 22, and is read out from the stores under control of a random number generator 40, so that the lines of video information are displayed in random order on the cathode ray tube 62, but in the correct position. In order to disguise blank periods in the video information, and inter-line and inter-field periods, radiation generated at random under control of a generator 76 is caused to be given off by a dummy thermionic valve 86.

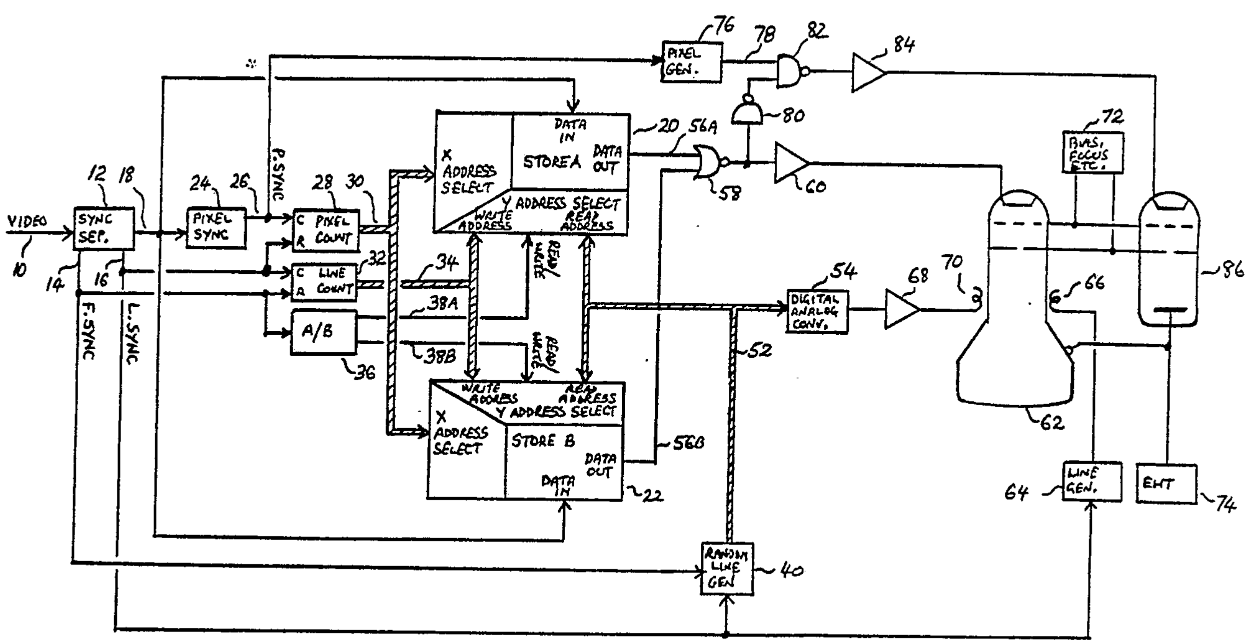

FIG 1.

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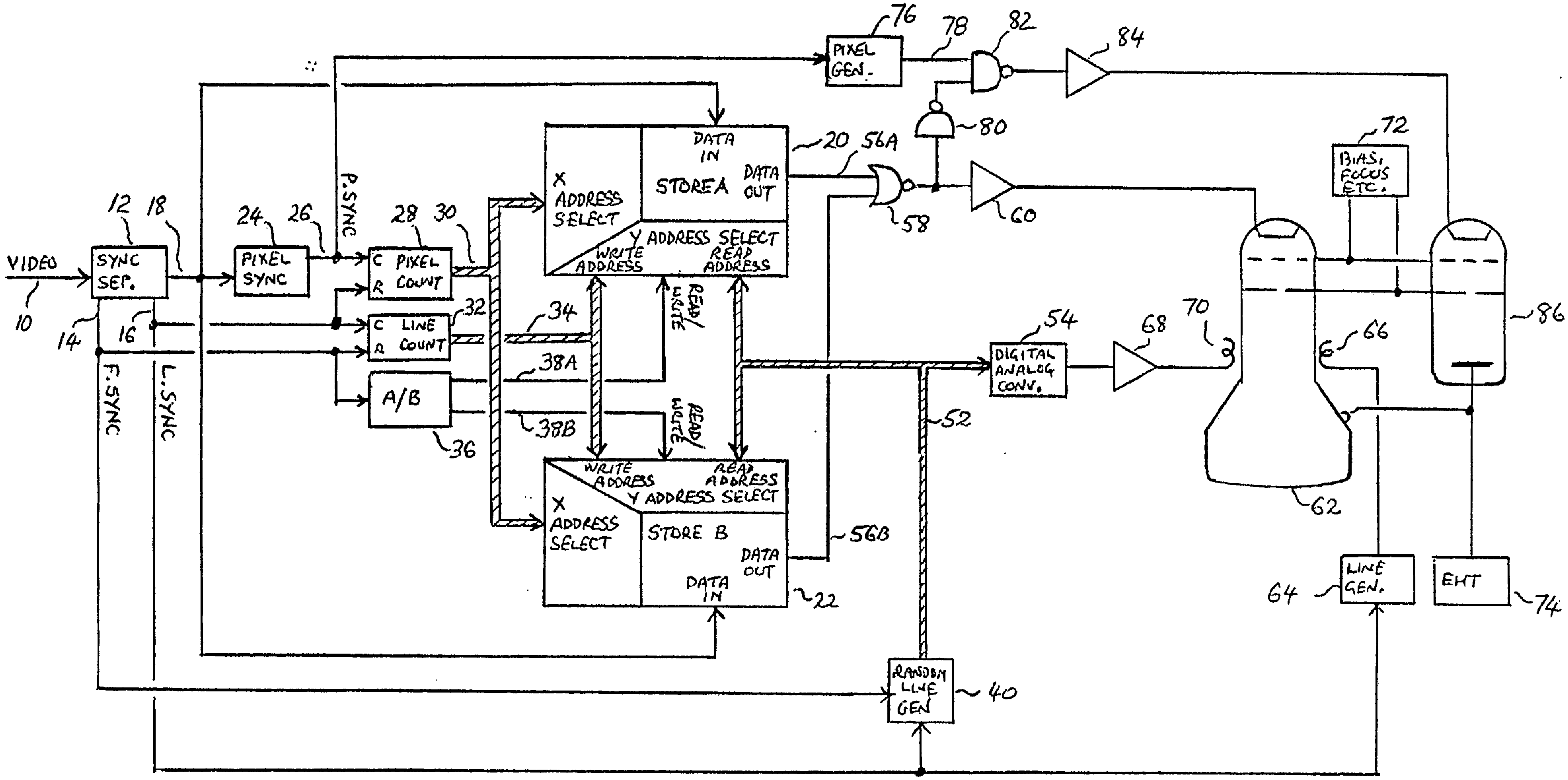

VIDEO
SYNC SEP.
PIXEL SYNC
P. SYNC
C PIXEL R COUNT
C LINE R COUNT
A/B
F. SYNC
L. SYNC
X ADDRESS SELECT
DATA IN
STORE A
DATA OUT
Y ADDRESS SELECT
WRITE ADDRESS
READ ADDRESS
READ/WRITE
READ/WRITE
WRITE ADDRESS
READ ADDRESS
Y ADDRESS SELECT
X ADDRESS SELECT
STORE B
DATA OUT
DATA IN
PIXEL GEN.
DIGITAL ANALOG CONV.
RANDOM LINE GEN
BIAS, FOCUS ETC.
LINE GEN.
EHT

FIG 1.

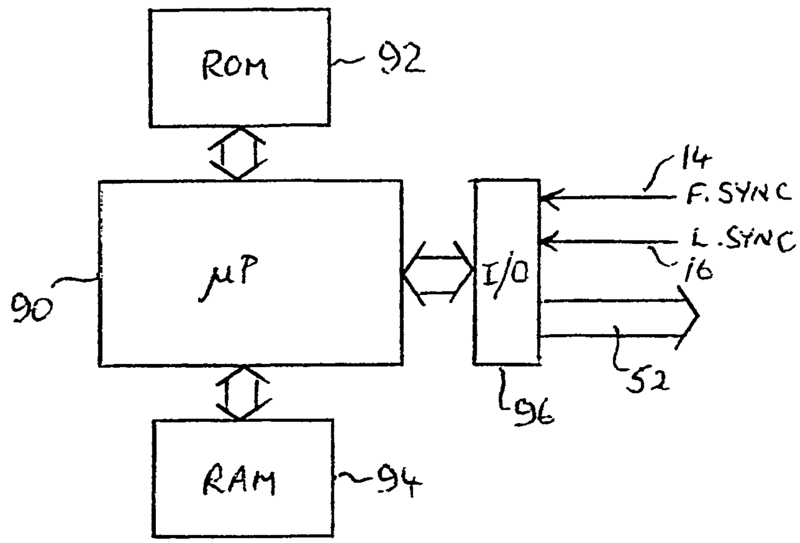
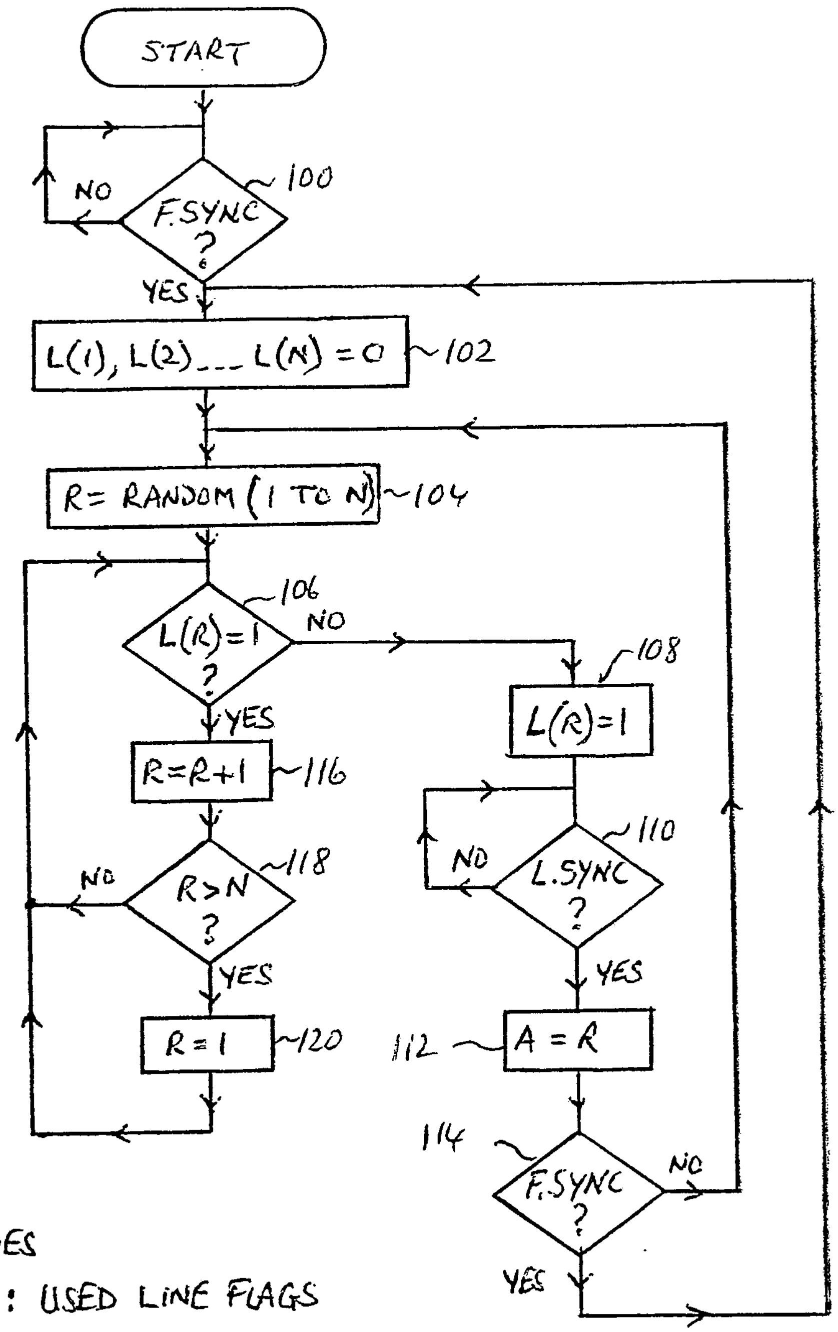


FIG. 2



N: NUMBER OF LINES

L(1), L(2) --- L(N) : USED LINE FLAGS

A: OUTPUT LINE ADDRESS

R: RANDOM VARIABLE

FIG. 3.

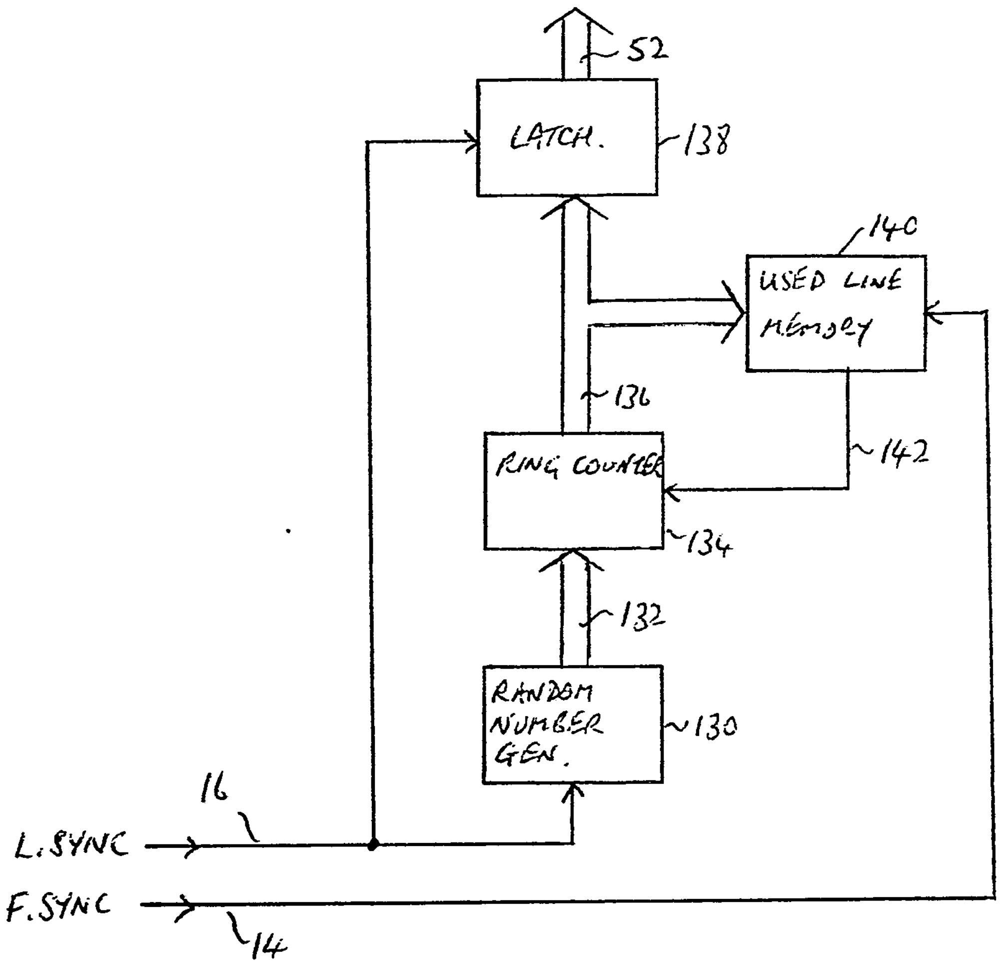

52
LATCH.
138
140
USED LINE MEMORY
136
RING COUNTER
142
134
132
RANDOM NUMBER GEN.
130
16
L.SYNC
F.SYNC
14

FIG.4

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SECURITY OF VIDEO MONITORS

This invention is concerned with security of video monitors.

In a conventional video monitor, a video signal is used to modulate the beam of a cathode ray tube as the beam is raster-scanned over the tube face. This presents a security problem, because the radiation given off by the tube and its circuitry can be detected from a distance, and it is possible to reconstruct the video image.

It is known, in order to tackle this problem, to shield the monitor in an attempt to reduce the radiation given off, but this is expensive, cumbersome, and not entirely successful.

In accordance with one aspect of the present invention, the scanning of the electron beam is scrambled, preferably in a random manner, while still maintaining the integrity of the displayed video image.

In accordance with another aspect of the present invention, the monitor is caused to give off radiation, optionally of a random nature, in addition to that caused by the tube and its circuitry.

Preferably, the two aspects of the invention are combined, and the additional radiation is given off during blank periods during display of a field and/or during the inter-line and inter-field periods of the raster-scanning by the electron beam.

A specific embodiment of the present invention will now be described by way of example, with reference to the accompanying drawings in which:

Figure 1 is a schematic illustration of a video monitor embodying the invention;

Figure 2 is a schematic diagram illustrating one form of random line generator employed in the arrangement of figure 1;

Figure 3 is a flow diagram illustrating the method employed by the random line generator shown in figure 2; and

Figure 4 is an alternative form of random line generator.

Referring to the drawing, a standard composite video signal is received on input line 10. For each field of the video image, the video signal contains a series of video lines. A sync separator 12 extracts from the video signal a field sync signal on line 14 and a line sync signal on line 16. After sync separation, the video signal at line 18 is passed to the data inputs of two frame stores, store A 20 and store B 22 and also to a pixel sync separator 24, which produces a pixel sync signal on line 26. Thus, the pixel sync signal on line 26 pulses with each input pixel; the line sync signal on line 16 pulses with each line of input pixels; and the field sync signal on line 14 pulses with each field of input lines.

The pixel sync pulses on line 26 are counted by a pixel counter 28, which is reset by the line sync signal on line 16, and the output count value on bus 30 is used for X address selection of store A 20 and store B 22. The pulses of the line sync signal on line 16 are counted by a line counter 32, which is reset by the field sync signal on line 14, and the output line count value on bus 34 is used for Y address selection for store A 20 and store B 22 during writing to the stores. The field sync signal on line 14 is also supplied to a bistable flip-flop 36 which supplies read/write selection signals on lines 38A, 38B alternately and oppositely to store A 20 and store B 22 so that for one field period store A 20 is being written to and store B 22 is being read from, and for the next field period store B 22 is being written to, and store A 20 is being read from.

From the above, it is will be appreciated that the video information for successive fields of the input video signal on line 10 is successively written to store A 20 and store B 22 and that while one of the stores is being written to, the other store is enabled for reading by the signal on the appropriate line 38A, 38B. Whereas the input video lines are written into the stores in the order in which they arrive, the video lines are read out from the stores in random order, as described in detail below.

A random line number generator 40, described in detail below, is responsive to the field sync pulses on line 14 and the line sync pulses on line 16 and provides a random line number on bus 52. With each line sync pulse, a different line number is output on the bus 52, until all of the permissible line numbers have been output and a field sync pulse is received. The random line number is supplied on bus 52 to the read address inputs of store A 20 and store B 22 and also to a digital-to-analogue converter 54. Therefore, data is read out on line 56A or 56B from that one of store A 20 and store B 22 which is enabled for reading by the signal on line 38A or 38B, the data corresponding to that one of the lines denoted by the random number on bus 52, and all of the pixels for that line are read out by virtue of incrementation of the value on the pixel count bus 30. The output data on line 56A or 56B is input to a gate 58 and is supplied via an amplifier 60 to the grid or cathode of a cathode ray tube 62. Therefore, as the electron beam is raster-scanned across the tube, it is modulated by the output data. In order to provide for scanning of the electron beam in the horizontal direction, the line sync signal on line 16 is supplied to a line generator circuit 64, which supplies a saw tooth driving signal to a horizontal deflection coil 66 of the cathode ray tube 62. In order to provide that the line of video data is positioned on the face of the cathode ray tube 62 at the correct position, the output of the digital-to-analogue converter 54 is supplied to a field amplifier 68, which in turn drives a vertical deflection coil 70 of the cathode ray tube 62. As shown in the drawing, a circuit 72 is provided for supplying biassing, focussing and other control voltages to the cathode ray tube 62, and a power supply 74 is included for providing EHT to the tube 62.

From the above, it will be appreciated that while one field of video information is being written in order into one of the stores 20, 22, the previous field of video information is being read out of the other store line-by-line in random order, with the lines of video information being displayed in the correct position on the cathode ray tube 62. Therefore, the radiation given off by the tube 62 and its associated circuitry will be scrambled by comparison with the sequence of video data received on the input line 10.

The random line number generator 40 described above may be implemented by a microcomputer, as shown in figure 2, comprising a microprocessor 90 with associated ROM 92 storing programme data, RAM 94, and input-output port 96 connected to the field and line sync pulse lines 14, 16 and the line address bus 52.

The microprocessor 90 is programmed to perform the steps of operation illustrated by the flow diagram of figure 3. In the step 100, a field sync pulse is awaited on line 14 indicating the beginning of a new field. When the field sync pulse is received, variables L(1) L(2)....L(N) are set to zero in step 102. These variables are used line flags, and when set to zero they indicate that the respective line has not been used in the current field, and when set to one, they indicate that the line has been used in the current field. N is the number of lines in a field. In step 104, variable R is set to a random integer number between one and N the number of lines in a field. In step 106, it is determined whether the line having the number R has already been used in the current field. If not, then in step 108 the used line flag for line R is set to one, and in line 110 a line sync pulse on line 16 is awaited. When the line sync pulse is received, then in step 112 the output line address on bus 52 is set equal to the random number. In step 114, it is determined whether a field sync pulse is also present on line 14, and if so, then the routine returns to step 102. However, if there is no field sync pulse, then the routine returns to step 104. In step 106, if the used line flag for line R has already been set, then in step 116 the variable R is incremented by one. Then the routine returns to step 106, unless it is determined in step 118 that the variable R is greater than the number N of lines in a field, in which case the variable R is set to one in step 120, before returning to step 106. Thus, it will be appreciated that, after a field sync pulse has been received, then with every line sync pulse a new line number is output on the bus 52 until all of the lines in the field have been output.

In a modification of the above arrangement, an increment of one and a decrement of one may be used alternately in step 116 for successive random line numbers to be generated.

Rather than implementing the random line address generator using a microprocessor and software, as described above with reference to figures 2 and 3, a hardware implementation of the random line generator may be used, as now described with reference to figure 4. A random number generator 130 generates a random number on a bus 132 in response to a line sync pulse on line 16, the random number having a value between one and the maximum number of lines in a field. The random number on bus 132 is added to the count in a ring counter 134. The ring counter 134 employs modular arithmetic having a base equal to the maximum number of lines in a field. The result of the addition is output on bus 136 to a latch circuit 138 which is enabled by the line sync signal on line 16 and also to a used line memory 140. The used line memory provides a flag for each line of the field, and the flag for a particular line is set when that line number appears on the bus 136. The used line memory 140 also has the function of outputting on line 142 a signal in the case where the line number on bus 136 has already been flagged, and the signal on line 142 is used to increment to the ring counter by the value of one. All of the flags in the used line memory 140 are reset at the beginning of each field by the field sync pulse on line 14. It will thus be appreciated that the output from the latch 138 on the address line bus 52 will not be repeated during any particular field, and that within a particular field period a series of random line numbers will appear on a bus 52.

With the random line address generation described above with reference to figure 2 and 3 or with reference to figure 4, it will be noted that large jumps in the line address can arise, and it is even possible for the first line of the field to be addressed and for this to be followed by the last line of the field. Such a system will therefore require large changes in the current to the vertical deflection coil 70, resulting in high energy consumption. In order to improve power economy, the software of figure 3, or the hardware of figure 4 may be modified in order to ensure that there is a limit on the maximum jump of line number between two consecutive lines, for example a maximum jump equal to half of the number of lines in a field.

A further feature of the arrangement shown in the drawing to disguise inter-pixel, inter-line and inter-field spaces will now be described. A pixel generator 76 is supplied with the pixel sync signal on line 26 and provides on line 78 a series of pixel signals which are combined with the data read out from the stores 20, 22 by a pair of gates 80, 82 so that a dummy pixel signal is output from the gate 82 when there is no pixel data being output from either store 20, 22. The dummy pixel signal is then applied via an amplifier 84 to the cathode or grid of a dummy thermionic valve 86, which may be of similar construction to the gun of the cathode ray tube 62. The dummy valve 86 is supplied with anode voltage from the EHT supply 74, and may also be supplied with bias and focussing voltages from the circuit 72. Thus, whenever data is not supplied to the cathode ray tube 62, dummy data is supplied to the valve 86 and dummy radiation is created. To an eavesdropper, this disguises the radiation given off as a result of the data supplied to the cathode ray tube 62, and it also makes it difficult, if not impossible, to detect the line and field synchronisation of the cathode ray tube 62.

It will be appreciated that many modifications and developments may be made to the arrangement described above. For example, even if the dummy valve 86 is not used, then security will be improved. Furthermore, the dummy valve idea may be used with a conventional monitor in order to obscure the radiation given off by the monitor. Moreover, if desired, rather than producing dummy radiation whenever there is no radiation from the tube 62, the dummy radiation may be randomised. Furthermore, although one particular arrangement of logical circuit devices has been described, it will be appreciated that many other alternative forms are possible.

CLAIMS:

1. A method of operation of a video monitor wherein a stream of video information is received in one order, characterised in that the stream of video information is displayed on the monitor in a different order.

2. A method as claimed in claim 1, wherein the order of display of the video information is arbitrary.

3. A method as claimed in claim 2, wherein the order of display of the video information is random.

4. A method as claimed in any preceding claim, wherein the video information is received as a series of video lines which are stored in a memory in one order, the lines of video information being read out from the memory in a different order and displayed on the monitor in the appropriate positions.

5. A method as claimed in claim 4, wherein the lines of video information are stored in the memory in the sequence in which they are received, and wherein a signal representing a sequence of random numbers is generated, the sequence of reading out of the video

lines from the memory being determined by the sequence of random numbers, and the position of display of each video line on the monitor being determined by the respective random number.

6. A method as claimed in claim 4 or 5, wherein the reading out of a video line from the memory more than once is inhibited.

7. A method as claimed in any of claims 4 to 6, wherein there are two such memories, fields of the video information being alternately stored in and read from the two memories.

8. A method as claimed in any preceding claim, wherein the video information is displayed on the monitor intermittently, and further comprising the step of generating dummy radiation during the non-display of video information.

9. A method of operation of a video monitor, wherein a stream of video information is displayed on the monitor intermittently, characterised in that dummy radiation is generated during the non-display of video information.

10. A method as claimed in claim 8 or 9, wherein the dummy radiation is of a random nature.

11. A method of operation of a video monitor substantially as described with reference to the drawings.

12. A video monitor constructed and adapted to operate in accordance with the method of any preceding claim.

13. A video monitor comprising means to receive a stream of video information in one order, means to store the received stream of video information, means to read from the storage means a stream of the video information in a different order, and means for displaying the read stream of video information in that different order.

14. A monitor as claimed in claim 13, further comprising means for addressing the storage means during writing thereto so that the received video information is stored therein in the order in which it is received, means for addressing the storage means during reading therefrom, including a random number

generator, so that the stored video information is read therefrom in a random order.

15. A monitor as claimed in claim 14, wherein the video information is stored line-by-line, and wherein it is the lines which are read out in random order.

16. A monitor as claimed in claim 15, wherein the random number generator is associated with a means to inhibit reading of a line from the storage means more than once.

17. A monitor as claimed in any of claims 13 to 16, wherein the storage means comprises a pair of storage sections, and means being provided to control the storage sections so that while one block of video information is being written into one of the storage sections, a previously written block of video information is being read from the other storage section.

18. A monitor as claimed in any of claims 13 to 17, further comprising means for detecting when video information is not being displayed, and means for generating dummy radiation in response to such a detection.

19. A video monitor comprising means to receive a signal containing an intermittent stream of video information, means for displaying the video information, means for detecting when such video information is not being displayed, and means for generating dummy radiation in response to such a detection.

20. A monitor as claimed in claim 18 or 19, wherein the means for generating dummy radiation comprises a thermionic valve.

21. A monitor as claimed in claim 20, wherein the means for generating dummy radiation comprises a random generator, and means for controlling the thermionic valve in response to the random generator.

22. A video monitor substantially as described with reference to the drawings.

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