

United States Patent

[11] 3,569,770

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[21]	Appl. No.	732,600
[22]	Filed	May 28, 1968
[45]	Patented	Mar. 9, 1971
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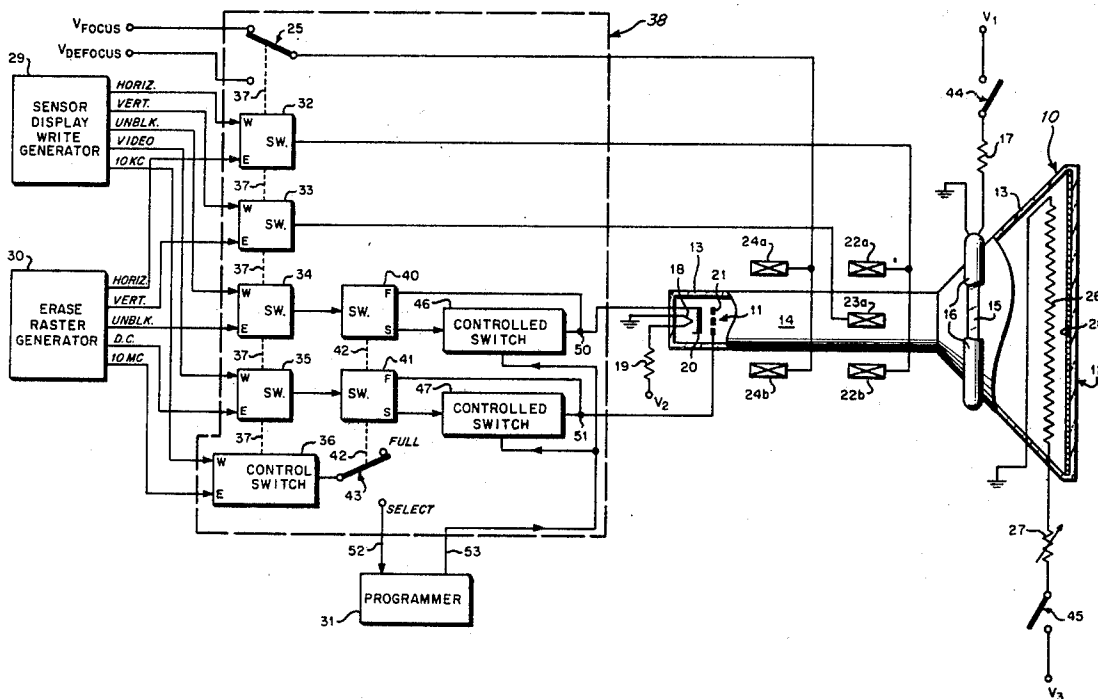
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**[54] SELECTIVE FAST ERASE DARK TRACE SCAN
CONVERTER**
9 Claims, 3 Drawing Figs.

[52] U.S. Cl..... 315/12
[51] Int. Cl..... H01J 29/41
[50] Field of Search..... 346/74
(CRT); 313/91; 315/12

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ABSTRACT: A dark trace tube and selective write/selective erase system therefor, the tube having a P-10 target for long storage of information written thereon. An electron gun provides a beam which is utilized to either write or erase an image on the P-10 target, depending upon the intensity of the beam. Erasure is effectuated by defocusing and increasing the beam energy to generate heat and may be caused to occur rapidly to erase either the entire raster or selected areas thereof. Additionally, a heater is provided about the inner periphery of the P-10 target for slow, controlled erasure capability. Means are also provided both to selectively write upon the P-10 target and to enhance the contrast of the written image.



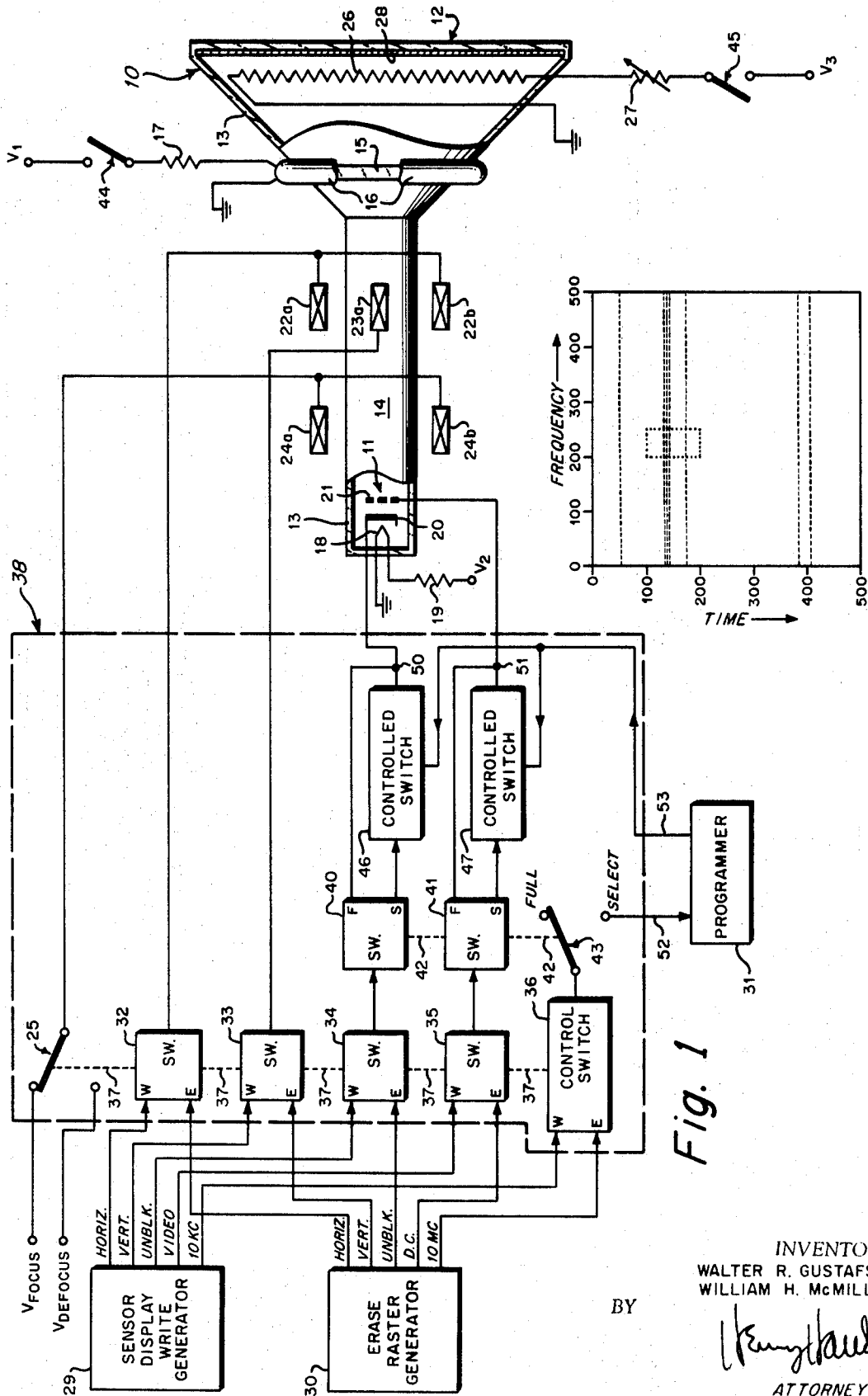


Fig. 1

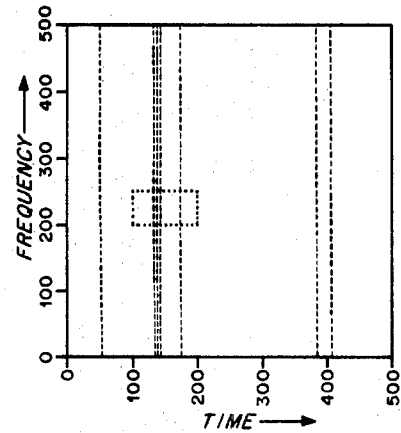


Fig. 3

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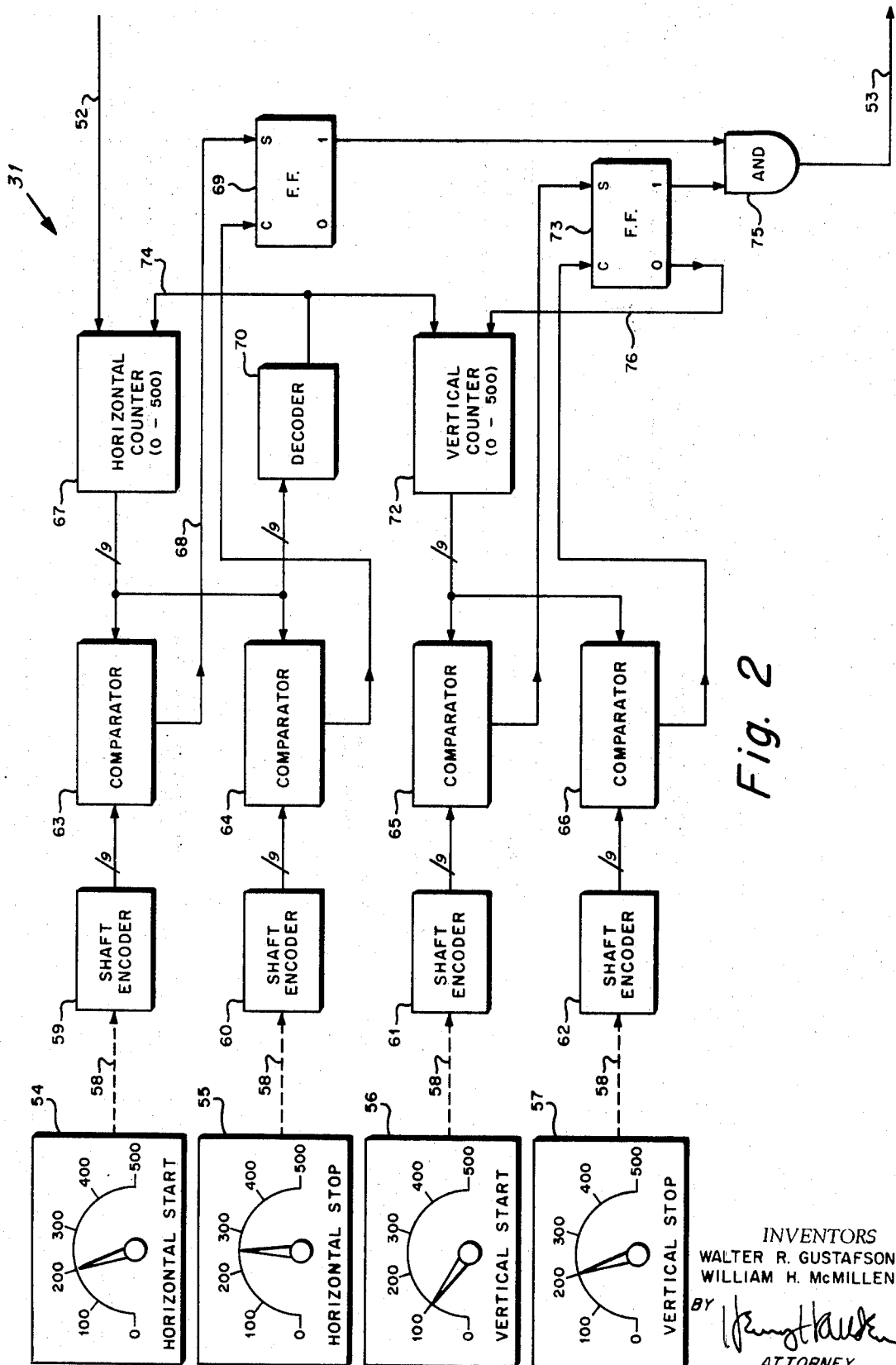


Fig. 2

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SELECTIVE FAST ERASE DARK TRACE SCAN CONVERTER

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

This invention relates to cathode ray storage tubes and more particularly to a dark trace tube of the long persistence type and to a programmer system for erasing selected portions of the image formed on the tube face thereof.

With long persistence tubes whereupon a still picture situation has been written, it has long been desirable after the picture has been studied and analyzed either to erase the entire situation and/or selective portions thereof and to write new information upon the erased area.

Many techniques have been employed to achieve these ends. For example, light sensitive phosphors have been employed as the storage target and flashbulb and pencil light techniques have been employed to produce complete and selective erasure, respectively. In addition, relatively light insensitive storage targets have been employed and erasure has been effectuated by supplying a potential to a screen positioned between the electron gun and the target to thereby draw off electrons from the storage surface. Other techniques have also been employed.

All of these techniques require complex control circuitry therefor and the inclusion of special tube elements has become both a costly and exacting procedure. In addition, accurate, fast selective erasure is extremely difficult to achieve with these techniques and in many instances desired information has been inadvertently erased.

Thus, the need has arisen for a system which is of relatively simple construction and which has the versatility of providing means for both accurately selectively erasing and writing a still picture on a long persistence storage tube, erasing being accomplished at a very rapid rate.

SUMMARY OF THE INVENTION

Accordingly, it is the general purpose of the present invention to provide a long persistence dark trace storage tube and selective write/erase system therefor, both writing and erasing being accomplished with but a single electron gun. The storage target is affixed to the inner surface of the tube face and an electron gun is caused to sweep thereacross to write the still picture. Fast erase, either selective or full raster, is accomplished by increasing the electron beam energy to a value considerably greater than the write beam energy so that heat is generated thereby. This beam instantaneously erases the written image as the beam sweeps across the tube face. Also during erasure, the beam is slightly defocused.

To accomplish the selection process, a programmer is time shared and provides a control signal to permit the passage of either select write or select erase signals, as desired. Also provided are a separate heater for slow, controlled erasure (and therefore variable persistence) and means for enhancing the contrast of the written image.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic block diagram of a storage tube and selective fast erase/write system according to the invention;

FIG. 2 is a block diagram of a programmer utilized in the system of FIG. 1; and

FIG. 3 is a representative B-scan appearing on the face of the tube of FIG. 1 having an area illustrated therein which is to be erased and written upon.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and more particularly to FIG. 1 there is shown a cathode ray storage tube 10 formed in the shape of an Erlenmeyer flask, as is well known in the art. At the mouth of the flask is positioned an electron gun assembly 11. The tube 10 further comprises a tube face 12 and a neck portion between the mouth and tube face. A glass envelope 13 encloses the tube. Surrounding the glass envelope 13 is a suitable casing or housing 14. Forward and toward the tube face 12, a clear annular ring 15 is positioned. Circumscribing this annular ring 15 is an annular lamp 16 which provides a green light to improve the tube contrast, as will be discussed hereinafter. The lamp 16 is connected at one side thereof to a supply of electrical energy V_1 through a resistor 17 and a switch. The other side of the lamp 16 is connected to ground.

Positioned about the neck of the tube 10 are horizontal deflection coils or plates 22a and 22b and vertical deflection coils or plates 23a and 23b, plate 23b being behind the tube and therefore not shown. The horizontal plates 22a and 22b are positioned 180° apart about the neck of the tube 10 as are vertical plates 23a and 23b. Each horizontal plate is positioned 90° from each vertical plate. The horizontal plates are electrically connected together as are the vertical plates. Also positioned about the tube neck are two focusing coils 24a and 24b. The focusing coils are electrically connected together and are further connected to a switch 25 which may be of the manual type and which functions to permit the passage of either a focusing voltage (V_{Focus}) or a defocusing voltage ($V_{Defocus}$) for reasons to be hereinafter explained.

Within the tube 10, the electron gun assembly 11 is shown to comprise a heater 18 which receives electrical energy from a supply V_2 through a resistor 19, a cathode 20 and an accelerating electrode or grid 21. It is to be understood that certain of the elements of the gun assembly have been omitted for convenience as, for example, a heat shield for the cathode. However, these elements may be added as desired. Circumscribed about the inner periphery of the tube at the tube face 12 is positioned a heater 26, grounded at one side thereof and supplied at the other side thereof with electrical energy from voltage source V_3 through a potentiometer, or the like, 27 and a switch.

The inner surface of the tube face 12 is coated with a layer (or layers) of potassium chloride (KCl) 28, also known as P-10. When an electron beam of sufficient energy strikes P-10 crystals, the crystalline structure thereof changes state such that the formerly white crystals darken to a purplish-black at the point where the beam is applied. In this darkened state the P-10 is not transparent to light and the purplish-black mark will remain almost indefinitely with little or no decay. Accordingly, an image written on such a P-10 tube may be stored for long periods of time. Test results have yielded storage times of months duration. To erase the tube, the addition of more energy heats the P-10 causing it to again change state and revert to its former appearance. In addition, and aside from its long storage capability, the P-10 display is insensitive to strong incident light. Accordingly room light or the bright sunlight shining through the cockpit of a jet plane, for example, cannot wash out a P-10 image.

The electron gun assembly 11 functions as both a write gun and an erase gun. Writing is achieved with video and unblanking signals, applied respectively to the grid 21 and cathode 20, and horizontal and vertical deflection signals supplied respectively to the horizontal and vertical deflection plates. All of these signals are obtained from a sensor display write generator 29. In general, the horizontal signal may be a sawtooth function while the vertical signal may be ramp function increasing with time. The video signal may be derived, for example, from a transducer or transducers which are monitoring and sensing acoustic phenomena occurring at sea. Such transducers may comprise a plurality of hydrophones displaced at predetermined points in the water. The unblanking signal is of the known pulse train type related in time with the video

signals. These signals may be supplied to the sensor 29 which may be of the continually updating type so that information being received thereby is always current.

Erasing is achieved by supplying a DC voltage to the grid 21, of a polarity which renders the grid considerably more positive than it was when in the write mode. Accordingly, this causes electrons to flow from the cathode 20 and to impinge upon the P-10 with energy level sufficiently high so that heat is generated thereby. This heat erases the written image previously presented. In the erase mode, separate horizontal, vertical, and unblanking signals are supplied in a manner analogous to their respective counterparts in the write mode. The erase mode signals are supplied from an erase raster generator 30. It is to be noted, however, that the erasing process is much more rapid than the writing process. In the example discussed hereinafter, the erase function is performed 1000 times faster than the write function. In addition to the write and erase signals supplied respectively from generators 29 and 30, generator 29 provides a 10-kilocycle signal and generator 30 provides a 10-megacycle signal, each signal capable of being switched into a programmer 31 as a command signal therefor. This will be more fully discussed hereinafter.

In order for either the write mode signals or the erase mode signals to be supplied to the tube 10, they must pass through a switching arrangement 38. This arrangement includes a first switch bank comprising switches 32, 33, 34, and 35, shown mechanically connected or ganged together by suitable mechanical linkage 37. These switches are also mechanically connected to the switch 25 and a control signal switch 36. Switches 32-35, inclusive, respectively receive the horizontal, vertical, unblanking, and video or DC signals from generators 29 or 30, depending upon whether it is desired to write or erase. Accordingly, each of the switches 32-35, inclusive, is provided with two input terminals labeled, respectively, W for write and E for erase. The output terminals of switches 32 and 33 are respectively directly connected to the horizontal deflection plates 22a and 22b and the vertical deflection plates 23a and 23b. The output terminals of switches 34 and 35 are connected respectively to the input terminals of a second bank of switches 40 and 41, these switches being mechanically ganged together by suitable mechanical linkage 42. Switches 40 and 41 are further ganged with a selective write/erase switch 43. Second bank switches 40 and 41 each have two output terminals labeled F for full and S selective. The selective output terminals of switches 40 and 41 are connected respectively to the input terminals of a third switch bank comprising switches 46 and 47. The full output terminals of switches 40 and 41 are connected respectively across each controlled switch 46 and 47. Thus the F terminal of switch 40 is connected at point 50 and the F terminal of switch 41 is connected at point 51.

Each of these points is then respectively connected to the unblanking electrode or cathode 20 and the video electrode or control grid 21.

Also provided from both the sensor display write generator 29 and the erase raster generator 30 are, respectively, a 10-kilocycle command signal and a 10-megacycle command signal. The 10-kilocycle signal is fed into the write (W) input terminal of control switch 36 while the 10-megacycle signal is fed into the erase (E) input terminal of switch 36. The output terminal of switch 36 is connected to selective write/erase switch 43 which may be of the manual type and which functions upon closure to switch either the 10-kilocycle signal or the 10-megacycle signal (depending upon whether write or erase is desired) into the programmer 31 along the wire 52. Responsive thereto, programmer 31 provides a signal along wire 53 to each of the controlled switches 46 and 47.

It is to be noted that the switch 25 which functions to switch in either the write generator 29 or erase generator 30 further provides a defocusing voltage to the focus coils 24a and 24b during the erase mode.

The programmer 31 of FIG. 1 is shown in greater detail in FIG. 2. Referring now to FIG. 2, the programmer 31 comprises four rotary selector switches 54, 55, 56 and 57. These selector switches are of the manual type and may appear in a control panel on the face of programmer 31 along with switches 25 and 43. Each of the rotary switches is connected through respective mechanical linkages 58 to respective shaft encoders 59, 60, 61, and 62. Each respective shaft encoder is electrically connected to provide a digital word to comparators 63, 64, 65 and 66. Comparator 63 is further electrically connected to receive a digital word from a horizontal counter 67. Horizontal counter 67 receives its input signal along line 52, FIG. 1. Comparator 63 provides an output signal along line 68 to the set (S) input of a set-reset or clear (C) flip-flop 69. Horizontal counter 67 is also connected to comparator 64 and a decoder 70 to supply a digital word thereto. Comparator 64 provides an output signal to the C input of flip-flop 69 via line 71. The decoder 70 provides a signal to a vertical counter 72 which, responsive thereto provides a digital word to comparators 65 and 66. Decoder 70 further provides a reset signal to the counter 67 via line 74. The output signal from the comparator 65 is connected to the set input of flip-flop 73 while the output from comparator 66 is connected to the clear input of the flip-flop 73. Flip-flop 73 is similar to flip-flop 69. The 1 outputs from flip-flops 69 and 73 are fed to an AND gate 75. The common occurrence of the two input signals at AND gate 75 permits the gate to provide an output signal along line 53 to the controlled switches 46 and 47 of FIG. 1.

The comparator 66 provides an output signal to the clear input of flip-flop 73. Responsive thereto, flip-flop 73 provides a signal at its O output along line 76 to reset vertical counter 72.

In a particular embodiment, the tube face 12 may be divided in the vertical direction into 500 optical lines and in the horizontal direction into 500 elements per line. In addition, exemplary operating conditions for the P-10 tube might be as follows.

In the write mode, the horizontal rate might be 50 milliseconds per sweep (20 sweeps per second). The vertical rate might be 25 seconds per sweep and, as noted heretofore, the horizontal and vertical resolutions might respectively be 500 elements and 500 lines.

In the erase mode, it is possible with the use of P-10 to erase at a much faster rate than the write rate. Accordingly the horizontal rate might be 50 microseconds (a 20 kilocycles sweep per second), the vertical rate might be 25 milliseconds per sweep, the horizontal and vertical resolutions again being 500 elements and 500 lines, respectively.

As can be seen from FIG. 2 and in accordance with the operating conditions set forth above, the horizontal start and stop switches 54 and 55 and the vertical start and stop switches 56 and 57 vary from 0 to 500, the horizontal switches functioning to select a particular element in a particular line and the vertical switches functioning to select that particular line. In addition, as the number 500 may be represented in binary notation by a 9-digit figure, in those instances where a digital word is expressed the symbol 9/ is used in FIG. 2 to indicate that there are actually nine wires present to carry the digital code. Of course it is to be understood that the tube face may be divided into fewer or greater elements or lines, or both. It may thus be necessary to vary the number of wires accordingly and the invention is therefore not limited to the embodiment shown.

Referring again to FIG. 1 along with FIG. 2, the operation of the system will be described.

It is first noted that it is possible with the present invention to perform the following operations. Full write (that is, the electron beam may be caused to scan the entire raster); selective write (the electron beam is caused to scan only a preselected area on the tube face); full slow erase of the entire raster; full fast erase of the entire raster; and selective fast erase of a preselected tube face area. The electron gun itself is utilized to perform all of the above operations with the excep-

tion of full slow erase. Further, whenever the electron gun is utilized to erase it is desirable to first defocus the beam thereof.

As shown in FIG. 1, the switches 25 and 43 are positioned such that the electron beam will be caused to scan the entire face of the tube 12. This is the full write mode. Thus, in the position shown, horizontal and vertical deflection signals from sensor display write generator 29 enter, respectively, the write (W) input terminals of the switches 32 and 33 and are passed thereby to the horizontal deflection plates 22a and 22b and the vertical deflection plates 23a and 23b. Additionally, the unblanking signal is fed from the generator 29 into the W input of switch 34 and out through the switch 34 and into and out of the switch 40 from the F terminal thereof to point 50 and the cathode 20. In like manner, the video signal passes through switches 35 and 41 by entering at the W input of switch 35 and exiting from the F output terminal of switch 41. The video signal is then fed across the switch 47 to the point 51 and to the control grid 21.

As noted heretofore, since the write mode is being utilized, the switch 25 is in the up or focus position such that a focusing voltage V_{Focus} is supplied to the focus coils 24a and 24b. Moreover, since the 10-kilocycle signal from generator 29 is utilized during the selective write mode only, switch 43 is in the open or full position and the signal is thus rendered inoperative.

The unblanking signal excites the cathode 20 electrons to a state just below conduction for the particular tube. Conduction is then effectuated in accordance with the application of video signals to the grid 21. The electron beam thus formed is then focused by the focus coils 24a and 24b and caused to scan the entire P-10 raster by the horizontal and vertical deflection signals supplied, respectively, to plates 22a and 22b and plates 23a and 23b.

Referring now to FIG. 3, a few representative written lines of information are shown as they might appear on the P-10. As can be seen, the video signals provide information horizontally across the tube. The information shown is of varying intensity and increases with frequency from left to right across the tube face 12. Time is measured in the downward direction and the information is read by integrating each of the particular frequencies with time (that is, by reading in a vertical direction from top to bottom along a constant frequency line. Typically, a frequency range of interest may be from 0 to 300 cycles per second. The information shown is conventionally known as a B-scan.

From the typical operating parameters recited above, it is seen that an entire scan occurs in 25 seconds. The information thus produced is stored by the P-10 and appears thereon as a purplish trace. The contrast may be improved considerably by providing the green lamp 16 positioned as shown to illuminate the written on side of the P-10. The combination of the green light and the purple trace produces a well-defined black mark in contrast with the white unwritten on P-10 area.

The information thus produced may be stored for considerably long periods of time and hence is highly suitable for long term study and analysis purposes. Should it be desired to erase either all or selected portions, however, this may be accomplished by heating the P-10.

Erasing may be accomplished either at a slow, controlled rate or very rapidly. Slow, controlled erase permits variable persistence control over the entire raster. Also, rapid erase may be accomplished over either the entire raster or selected portions thereof.

Should it be desired to slowly erase the entire tube face 12, it is necessary only to close the switch interposed between V_3 and the potentiometer 27, thereby supplying a heating current to the heater 26. By varying the resistance of potentiometer 27, the current through heater 26 may be controlled. As controlling this current controls the heat generated by the heater 26, the rate of decay of the P-10 may be controlled to provide a variable persistence capability.

It is not necessary during the slow, controlled erase procedure to inhibit the write gun. Accordingly, should it be desired, it is possible to write information on the tube while the slow, controlled erasure process is being effectuated. Of course this information will decay as a function of the heat supplied by the heater 26.

If it is desired to erase the entire tube face 12 at a rapid rate, the same electron gun assembly 11 that was heretofore employed in the writing mode is used in the following manner. Switch 25 is moved to the defocus position thereby permitting a defocusing voltage to be supplied to focus coils 24a and 24b. Since switch 25 is ganged to switches 32—36, inclusive, by the mechanical linkage 37, moving switch 25 to the defocus position also moves switches 32—36, inclusive, to the erase (E) mode position. Accordingly, horizontal and vertical deflection signals as well as an unblanking and DC signal are supplied respectively from erase raster generator 30 to switches 32, 33, 34 and 35 at the erase (E) input terminals thereof. The horizontal and vertical signals are directly respectively applied to the horizontal plates 22a and 22b and the vertical plates 23a and 23b while the unblanking and DC signals are passed respectively to and through the switches 40 and 41 from the respective full (F) output terminals thereof. The signals having been thus passed, are applied across switches 46 and 47 to the points 50 and 51. From these points the signals are respectively supplied the cathode 20, and control grid 21.

Since the erase rate is on the order of a 1000 times faster than the write rate, it is necessary to provide separate horizontal and vertical deflection signals as well as a separate unblanking signal in combination with the DC erase signal (supplied to the grid 21 in lieu of the video signal supplied theretofore from generator 29).

The polarity of the DC erase signal supplied to the grid 21 is such so as to render the grid 21 more positive with respect to the cathode 20. Accordingly, cathode electrons are accelerated toward the P-10 with far greater energies than was imparted to them during the write mode. Upon impact with the P-10, this additional energy is immediately released in the form of heat. The heat thus generated immediately causes the P-10 to change state and revert to its original white, crystalline structure. As noted above for the typical operating parameters given, this entire fast erase process is accomplished in 25 milliseconds. While the particular relationship between erase and write energies or erase and write currents is generally a function of the physical size of the tube, the thickness of the P-10 layer or layers, the magnitude of the erase voltage and other variables, it has been found that for the present embodiment a current of approximately 1 microamp is sufficient to write upon the P-10. It has further been found that a current of about 200 microamps is sufficient to cause the electrons bombarding the P-10 to have sufficient energy to generate the heat for erasure.

It is noted that during the erase mode it is necessary to defocus the electron beam slightly so as not to apply too intense a beam and thereby char the P-10. The degree of defocus is minimal, however, and can be made such that the beam width is still smaller than the distance between successive optical lines so that desired information is not inadvertently erased.

Should it be desired to erase a selected portion of the tube face, the switch 25 is again moved to defocus position and the switch 43 is moved from the full position to the select position. Closing the switch 25 permits the respective erase signals from generator 30 to enter the switches 38—41, inclusive, as discussed heretofore. Also, the horizontal and vertical deflection signals are supplied again as before respectively to plates 22a and 22b and plates 23a and 23b. Now, however, since the switch 43 is mechanically ganged by means of linkage 42 to the switches 46 and 47 the unblanking and DC erase signals no longer exit from the full (F) output terminals but rather from the selective (S) output terminals of these switches. Accordingly, these signals are then respectively fed into controlled switches 46 and 47. Switches 46 and 47 permit the

passage of these signals upon receiving along the line 53 a control signal from programmer 31. Programmer 31, in turn, receives a 10-megacycle command signal pulse train from erase raster generator 30 upon the movement of switch 43 to the select position. That is, the 10-megacycle command signal enters the erase (E) terminal of control switch 36 and flows through switch 43 and line 52 to the programmer 31. The duration of the 10-megacycle signal is pre-timed by means within erase raster generator 30 (as by a clock or time delay, for example, not shown) to persist for a period equal to the total time necessary for the electron beam to complete an entire scan in the erase mode. Thus, for the example shown, the 10-megacycle command signal will persist for 25 milliseconds. The frequency of the command signal is determined by forming the product of the horizontal rate in cycles per second and the horizontal resolution.

Referring now to FIG. 2 along with FIG. 3, the operation of the programmer 31 will be described. For the purposes of illustration, it has been assumed that it is desired to erase the area bounded by the horizontal elements 200 to 250, inclusive, which appear between vertical lines 100 to 200, inclusive, as shown in FIG. 3. Accordingly, prior to moving the switch 43 to the select position, horizontal start switch 54 (FIG. 2) is moved to the 200 position, horizontal stop switch 55 is moved to the 250 position, the vertical start switch 56 is moved to the 100 position, and the vertical stop switch 57 is moved to the 200 position. Positioning the horizontal and vertical start and stop switches 54-57, inclusive, drives position servoes (not shown) which are shaft coupled by linkage 58 to the respective shaft encoders 59, 60, 61 and 62. These devices convert the received analogue positional information into digital words respectively representative of the horizontal and vertical positions indicated by the numbers 200, 250, 100 and 200. These digital words are respectively applied to the comparators 63-66, inclusive. At this point, the switch 43 is moved to the select position. An indicator lamp or the like (not shown) may be provided to inform the operator that the shaft encoders have converted the received analogue positional information to digital form. Responsive to this signal the operator may then move the switch 43 to the select position.

Upon moving the switch 43 to the select position, the 10-megacycle command signal enters the horizontal counter 67 of programmer 31 via line 52. Responsive thereto, the counter begins counting the 10-megacycle pulse train. When the count reaches 200 the comparator 63 provides an output along the line 68 to the set input of flip-flop 69. Flip-flop 69 provides an output signal to AND gate 75. However, as this is the only signal received by the AND gate 75, no output signal is produced. When the horizontal counter 67 reaches the count of 250 the comparator 64 provides a signal along line 71 to the clear terminal of flip-flop 69, thereby inhibiting it. The counter 67 continues to count, however, and when it reaches the count of 500, the decoder 70 provides both a signal along line 74 to reset the horizontal counter 67 and a signal to the input of vertical counter 72. Upon being reset, horizontal counter 67 again begins to count to 500 and at the 200th and 250th count, flip-flop 69 is again set and cleared but no signal is passed by AND gate 75. When the counter 67 reaches the 500th count a second time, the decoder 70 again is rendered operative thereby to again reset horizontal counter 67 and again supply a signal to vertical counter 72. It can thus be seen that for every 500 counts from horizontal counter 67, vertical counter 72 receives and counts but a single pulse. Additionally, comparator 63 provides a signal along line 68 every time the horizontal counter 67 counts to 200 and comparator 64 provides a signal along line 71 every time the horizontal counter 67 counts to 250. Flip-flop 69 is thus set and reset but AND gate 75 does not provide a signal.

Referring to FIG. 3, these events may be explained illustratively as follows. At $t=0$, when switch 43 is closed, since the horizontal and vertical signals are respectively supplied directly to the horizontal plates 22a and 22b and the vertical plates 23a and 23b, the electron gun starts to move from left to

right along line 1. When the gun aligns with the point 200, flip-flop 69 is energized and remains energized until the gun aligns with the point 250. No output appears from AND gate 75, however. The gun continues to sweep across the tube until it reaches the point 500 whereupon the horizontal counter 67 is reset and the vertical counter 72 is supplied with a pulse. Accordingly, the electron gun flies back and positions itself at vertical line 2, horizontal element 0 and continues across the tube face in like manner as discussed hereinabove, until it sweeps across the face of the tube 99 times.

Since vertical start switch 56 and vertical stop switch 57 are calibrated such that the dial reading of a number corresponds to one more than the number of flybacks the gun has taken, after the 99th flyback the comparator 65 provides a signal to the set (S) input of flip-flop 73, which in turn provides from its 1 output terminal a signal to AND gate 75. Now as the gun sweeps across line 100 and the comparator 63 again provides a signal along line 68 to the set input of flip-flop 69 the output signal from the 1 output terminal thereof, in combination with the output signal from flip-flop 73, renders AND gate 75 operative. Accordingly, AND gate 75 provides an output signal along 53 to the controlled switches 46 and 47 (FIG. 1) and the beam begins to erase the P-10 image. Erasure of the 100th line continues until flip-flop 69 is reset at the 250th element of line 100. The gun continues to sweep, however, and erasure continues with the flip-flop 69 providing a signal as the gun sweeps between elements 200 and 250 while flip-flop 73 provides a signal for every signal it receives from comparator 65 after the 100th line. The gun continues to sweep until the 200th line, 250th element whereupon the comparator 66 provides a signal to the clear input of flip-flop 73. Responsive thereto, flip-flop 73 provides a reset signal to vertical counter 72 along the line 76. Because the duration of the 10-megacycle pulse is equal to the time necessary for the electron gun to complete one complete scan, erasure cannot be again effectuated until the gun has swept across the entire raster.

For selective writing, the same programmer 31 is employed in combination with the same electron gun assembly 11. To selectively write the switch 25 is of course first placed in the focus position. All other operations and functions are the same except that since the write rate is 1,000 times slower than the erase rate, a 10-kilocycle command signal in lieu of a 10-megacycle command signal is employed. The duration of the 10-kilocycle signal is preset within the generator 29 to persist for the time required for the write beam to completely scan the raster in a manner analogous to the 10-megacycle-erase-rate command signal.

Obviously many modifications and variations of the present invention are possible in light of the above teachings. For example, it is contemplated that heater 26 may be eliminated and, in lieu thereof, a layer of beryllium oxide or the like may be provided in contact with the unwritten on side of the P-10. Heat would then be supplied to the beryllium oxide and would be conducted thereby to erase the image on the P-10. Of course this supplied heat could be controlled to thereby control the persistence of the tube. In addition, it is possible to provide an optical window in the side of the flask portion of the tube on the same side as the write/erase gun assembly. Further, a television camera or vidicon tube or the like may be positioned in alignment with the optical window to read the information appearing on the P-10 target. Providing this optical window and television camera on the same side as the written on information is desirable as the contrast of the information is more pronounced on this side of the tube. However, it is also contemplated that a television camera may be positioned to view the unwritten on side of the P-10 with merely an air interface therebetween. Additionally, it is contemplated that a tube may be fabricated having a write/erase gun in accordance with the invention hereinabove disclosed and a read gun in the same envelope and in axial alignment therewith positioned to face the unwritten on side of the P-10 to thereby form a scan converter tube. The two guns would be separated by a inner-face comprising the P-10, a fiber optics plate (for optical

transmission of the written picture) a transparent conductor, and a photoconductor.

It is also contemplated that a green filter may be provided on the face of the tube of FIG. 1 and white light only be directed toward the P-10 to improve the contrast. Aside from being the functional equivalent of the green light, the green filter also serves to minimize the glare which occurs when the high energy erase electrons impinge upon the P-10.

Accordingly, it is to be therefore understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

We claim:

1. A long persistence storage tube and control system therefor comprising:

an electron gun assembly for supplying electrons in response to the receipt of a signal;

heat erasable target means for receiving and storing said supplied electrons;

programmer means for providing a control signal;

first means for supplying a set of writing signals to said gun assembly for producing electrons of a first energy level including first switch means connected with said programmer means and responsive to said control signal to apply to said gun assembly one of said sets of write signals and erase signals; and

second means for supplying a set of erasing signals to said gun assembly for producing electrons of a second energy level having a magnitude greater than said first energy level for generating heat to erase said target means immediately upon impact therewith, including second switch means connected with said programmer means being responsive to said control signal to apply to said gun assembly one of said sets of write signals and erase signals.

2. A long persistence storage tube and control system therefor according to claim 1 further including: switch means connected with said programmer means for providing a command pulse signal thereto.

3. A long persistence storage tube and control system therefor according to claim 2 wherein said programmer comprises:

first resettable counter means adapted to receive and count said command pulse signal;

first comparator means connected with said first counter means and responsive thereto to provide a signal when said first counter means has reached a first preselected count;

second comparator means connected with said first counter means and responsive thereto to provide a signal when said first counter means has reached a second preselected count;

decoder means connected with said first counter means and responsive thereto to provide a signal when said first counter means has reached a third predetermined count;

second resettable counter means connected with said decoder means to count the signal therefrom;

third comparator means connected with said second counter means and responsive thereto to provide a signal when said second counter means reaches a first preselected count;

fourth comparator means connected with said second counter means and responsive thereto to provide a signal

when said second counter means reaches a second predetermined count; and

means operatively connected with said first comparator means and said third comparator means to provide said control signal to said first switch means and said second switch means upon the common occurrence of a signal from said first comparator means and said third comparator means.

4. A long persistence storage tube and control system therefor according to claim 3 wherein said programmer means further includes:

first set-reset flip-flop means connected at the set terminal thereof to said first comparator means and at the reset terminal thereof to said second comparator means; and second set-reset flip-flop means connected at the set terminal thereof to said third comparator means and at the reset terminal thereof to said fourth comparator means.

5. A long term persistence storage tube and control system therefor according to claim 4 wherein:

first decoder means is operatively connected to reset said first counter means; and said second flip-flop means is operatively connected to reset said second counter means upon the receipt thereto of a signal from said fourth comparator means.

6. A long persistence storage tube and control system therefor according to claim 1 further including: means in proximity with said target means for heating said target means to vary the persistence thereof; and means positioned forward of said electron gun assembly for enhancing the contrast of the information written on said target means.

7. A long persistence storage tube and control system therefor according to claim 1 wherein:

said target means includes a thickness of potassium chloride, whereby a dark trace appears thereon upon said target being impinged by electrons having said first energy level.

8. A long persistence storage tube and control system therefor according to claim 1 further including:

switch means operatively connected with said first means and said second means for providing a defocusing voltage during the presence of said second signals having said second energy level.

9. A long persistence storage tube and control system therefor comprising: an electron gun assembly for supplying electrons in response to the receipt of a signal;

heat erasable target means for receiving and storing said supplied electrons;

means in proximity with said target means for heating said target means to vary the persistence thereof;

means positioned forward of said electron gun assembly for enhancing the contrast of the information written on said target means;

first means for supplying a set of writing signals to said gun assembly for producing electrons of a first energy level; and

second means for supplying a set of erasing signals to said gun assembly for producing electrons of a second energy level having a magnitude greater than said first energy level for generating heat to erase said target means immediately upon impact therewith.