SUBJECT: Announcement of NASA-Owned U.S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code KSI, the attached NASA-owned U.S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No. : 3 778 786

Government or Corporate Employee : Lockheed Electronics Co.

Supplementary Corporate Source (if applicable) :

NASA Patent Case No. : MSC-14053-1

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

Yes [X] No [ ]

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of column No. 1 of the Specification, following the words "... with respect to an invention of ...".

[Signature]

Elizabeth A. Carter
Enclosure
Copy of patent cited above
Method and apparatus for the storage of digital or analog electrical signals are provided by a memory storage system employing a conventional vidicon tube. At the beginning of an operating cycle, the vidicon is conditioned to accept electrical data input by exposing its photosensitive target to a short, high intensity light flash. A first electron beam scan of the photosensitive surface by an electron beam modulated by the input data then sets up a charge pattern on the photosensitive target which is representative of the input data. A second electron beam scan of the photosensitive surface by an unmodulated electron beam then develops an output signal across an output resistor by means of capacitive currents. The conditioning and scanning steps are operated repetitively at high speed using conventional television camera scan, sync and power supply circuitry to provide a low cost data storage system.
**Fig. 1**

- Blanking Amplifier
- Sync Generator
- Vertical Sync Only
- Divide by 2 Binary Divider
- Deflection Circuitry
- Strobe Control Circuitry
- Power Supply CIRCUITS AS REQUIRED
- Focus Regulator
- Strobe Lamp
- Digital Data Input
- Gate
- 20
- TO BIAS POWER SUPPLY +300 VOLTS
- TO POWER SUPPLY -280 VOLTS
- TO DIGITAL DATA CONTROL CIRCUITS
- TO DIGITAL DATA INPUT
- TO POWER SUPPLY -300 VOLTS
- TO POWER SUPPLY -280 VOLTS
- TO DIGITAL DATA OUTPUT
- TO DIGITAL DATA OUTPUT

**Fig. 2**

- Vertical Scans
- STROBE FLASH
- DATA INPUT
- DATA OUTPUT
- TIME

**Fig. 3**

- To Alternate Vertical Sync Pulses
- Data In
- Gate
- Vidicon 1
- Vidicon 2
- Gate
- To Alternate Vertical Sync Pulses
DATA STORAGE, IMAGE TUBE TYPE

ORIGIN OF THE INVENTION

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85-568 (72 Stat. 435; 45 U.S.C. 2457).

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the storage of data in the form of electrical signals, and more particularly to the storage of analog and/or digital data by the use of a low cost television vidicon tube configured as a serial readout memory. As an exemplary application, the present invention is intended for use in a television color converter designed for the NASA Space Shuttle program.

2. Brief Description of the Prior Art

Modern technology for data processing has produced very efficient memory devices such as magnetic drum memories, magnetic core memories and thin film transistor logic memories for the storage of data. Some such devices are capable of storing analog data while others are better suitable for the storage of digital data. A relatively few devices such as disc file memories or the like may be used interchangeably for the storage of analog or digital data. Usually, however, such devices are relatively expensive, perhaps bulky, and critical in regard to their operating conditions. Magnetic recorders employed for storage also exhibit varying amounts of undesirable time base instability.

Electrostatic storage tubes were used in the early days of digital computers as memory devices for digital data. These tubes were very sensitive to operating voltages and environmental conditions, they were expensive and often proved unreliable. The time required to prepare these early tubes for storage was also undesirable. As computer technology progressed, the use of these tubes was generally discontinued for these reasons. In the meantime, vidicon tubes which were initially developed for use in television transmission have become relatively inexpensive to obtain and are readily available in rather high quality configurations. Typically, vidicon tubes having less than 10 percent shading characteristics are presently available in the low price range. Tube-to-tube differential shading of less than five percent also exhibited in modern vidicon tubes. The present invention contemplates the use of such high quality, low cost vidicon tubes configured as electrical signal-in, electrical signal-out storage devices for analog or digital data.

SUMMARY OF THE INVENTION

The present invention provides a data storage system in which a conventional high quality, low cost television vidicon tube is employed as the data storage medium for an electrical input, electrical output signal system. Conventional vidicon scan circuitry, blanking circuitry and power supply circuitry are used in the system. The vidicon storage medium is conditioned for data storage at the beginning of each operating cycle of the system by exposing the photosensitive surface to an intense light flash from a strobe lamp which forms a uniform charge distribution over the surface. The vidicon's photosensitive surface is then scanned with an electron beam which is modulated in current intensity by electrical input signals representative of the analog and/or digital data to be stored. The charge pattern on the photosensitive surface is thus altered or redistributed to correspond to the input data. A second unmodulated electron beam scan of the photosensitive surface then provides an electrical output signal which is modulated in accordance with the altered charge pattern on the vidicon's photosensitive surface. Thus, the input data is reproducible in an electrical output signal at will, providing storage of the input data.

Accordingly, it is an object of the invention to provide a relatively low cost memory storage system which may be used for analog or digital data storage.

It is a further object of the invention to provide an electrical input and electrical output signal storage system employing low cost, high quality vidicon television tubes as the data storage media.

It is a still further object of the invention to provide a vidicon data storage system employing electrical input and electrical output signals but which uses optical conditioning of the storage media for rapidity of operation.

The foregoing and other objects, advantages and features of the present invention will be more readily apparent from the following specification, claims and the related drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic circuit diagram of one embodiment of the invention for use as a digital data storage system;

FIG. 2 is a timing diagram for the operation of the embodiment shown in FIG. 1; and

FIG. 3 is a schematic circuit diagram showing a modified embodiment for use as a long term storage system.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Referring initially to FIG. 1, a schematic diagram illustrating the principles of the present invention is illustrated generally at 10. A conventional, high quality, low cost vidicon tube indicated generally at 11 (shown within a dotted box) is shown configured as a memory storage device for electrical input signals representative of digital data. Control circuitry of a conventional nature such as that commonly employed in modern television camera systems is provided for operation of the vidicon memory system. Conventional deflection circuitry 12 and focus circuitry 13 are provided for sweeping and focusing an electron beam from a cathode of vidicon 11 across a photosensitive target surface 14 of the vidicon. The deflection circuitry 12 and strobe control circuits 16 are provided with control signal voltage pulses and sweep synchronization pulses by conventional sync generator circuitry 15. As known in the art, the sync generator circuitry normally provides horizontal sync pulses to control the horizontal deflection of the electron beam scan across the photosensitive target 14 on each of 262 1/2 horizontal scans and also supplies vertical sync voltage pulses at the end of each sequence of 262 1/2 horizontal scans as in a conventional video system. The vertical sync pulse is also amplified by a conventional blanking amplifier 18 and used to shut off the electron scan beam during retrace.

In the present invention, the vertical sync pulses are...
also supplied via line 24 to a binary divide-by-two di- 3
vider 17 which thus produces an output trigger pulse on 4
line 23 for each two vertical sync pulses input to it on 5
line 24.

The trigger pulses supplied on line 23 are input to 6
strobe control circuitry 16 which, upon receipt of the 7
trigger pulse, generates a high voltage pulse across a 8
strobe lamp 22 causing the lamp 22 to produce an 9
intense light output pulse or flash of approximately 5 mi- 10
cro-seconds duration.

Digital input data in the form of electrical signals is 11
supplied on line 25 by a conventional gate circuit 19 12
and is capacitively coupled via a coupling capacitor 26 13
to the cathode K of the vidicon tube 11. The gate cir- 14
cuit 19 is conditioned to stop the flow of input data 15
being supplied on line 25 on alternate vertical sync 16
 pulses. The control pulses for this purpose are pro- 17
duced on line 27 by the divide-by-two binary divide circuit 17 18
previously discussed. It will be appreciated that these 19
same control pulses may be supplied, for example, via 20
line 28, to digital data output control circuits (not shown) 21
to condition the output flow of data as desired.

Output information in the form of voltage pulses is 22
developed across an output resistor R 25 which is con- 23
nected across a transparent conducting backplate 29 of 24
vidicon 11. The voltage pulses are capacitively coupled 25
via a coupling capacitor 31 to an output preamplifier 26.
The amplified digital output data signals may then 27
be supplied, as desired, to the digital data output con- 28
 trol circuits (not shown).

Power supply circuits 20 for powering all the above 29
circuits are provided. These circuits may be of conven- 30
tional design as known in the art for this purpose. The 31
circuits supply the cathode and target bias voltages for 32
the vidicon tube 11, operating voltages for the strobe 33
lamp 22, and appropriate operating voltages for the re- 34
maining circuit components of the system.

In conventional operation of a vidicon, such as vid- 35
icon tube 11, the surface of photosensitive target mate- 36
rial 14 is, because of prior electron beam scanning, ini- 37
tially at the potential of cathode K i.e., −300 volts). At 38
the same time, because of the 280-volt D.C bias on the 39
backplate 29, a +20 volt potential difference exists be- 40
tween the front and back surfaces of the photosensitive 41
target 14. When a pattern of light is focused through 42
glass plate 30 (i.e., as by a lens system, not shown) on the 43
target 14, the target conductivity increases at illu- 44
minated portions in proportion to the intensity of the 45
light illumination. Elements of the target material 14 46
 will shift their potential difference relative to the back- 47
 plate 29 by varying amounts due to leakage currents to 48
the backplate 29. When the target material 14 is 49
scanned by an electron beam (represented by the ar- 50
rows of FIG. 1) controlled by magnetic field H, varia- 51
tions in beam current across R 25 will be produced in pro- 52
portion to the target 14 element location potential 53
being scanned. A negative charge will be deposited on each 54
target element of 14 proportional to the amount of 55
potential shift which occurred in that element on 56
writing, that is, when exposed to the optical pattern via 57
glass 30. As a result, capacity current variations will 58
flow to the backplate 29 and voltage variations corre- 59
sponding to the output light signal will be produced across 60
the output resistor R 25.

In the present invention, no optical input of data is 61
contemplated, although a predetermined bias or coding 62
pattern could be superimposed on glass plate 30 for 63
such a purpose, if desired. Referring now to the timing 64
diagram of FIG. 2 in conjunction with FIG. 1, the oper- 65
ation of this embodiment of the invention may be de- 66
scribed as follows. An operating cycle commences 67
when, on a vertical sync pulse the divide-by-two divider 68
circuit 17 produces a trigger pulse to strobe control cir- 69
cuit 16 and strobe lamp 22 is fired to produce its short 70
(5 microseconds) duration high intensity light pulse. 71
This light pulse charges the entire target material 14 to 72
the level to accept input data, thus conditioning the tar- 73
get. The input data then modulates the electron beam 74
intensity from cathode K by introducing variations in the 75
300-volt cathode potential. As the electron beam 76
scans the target material 14 on a first or input scan, the 77
input data is placed onto the target material 13 ele- 78
ments and appear as potential variations due to the 79
varying scan current intensity while providing an out- 80
put signal current across R 25. At the end of the input scan (i.e., scan number 1) the target thus retains all the 81
input data in storage.

A second or read scan of the target 14 material is 82
then initiated by the deflection circuitry 12. As the un- 83
modulated electron beam scans the target, voltage 84
variations in proportion to the stored data are pro- 85
duced across the output resistor R 25 by the same mecha- 86
nism of capacitive currents described above with re- 87
spect to the conventional operation of a vidicon. Actu- 88
ally, the readout signal on the read scan (i.e., scan num- 89
ber 2) is inverse to the initial input scan signal in polar- 90
ity, but, when desired, this minor difference may easily 91
be accounted for by the use of an inverter circuit (not 92
shown) in the output. A new operating cycle is then 93
commenced upon generation of the third vertical sync 94
pulse after the initialization vertical sync pulse and the 95
entire process repeated. If desired, the described sys- 96
 tem may be designed to provide two read scans for 97
each input scan. This mode of operation is particularly 98
suited when the encoded information is in a form which 99
is relatively unaffected by the shading characteristics of the tube.

If two such memory circuits as shown in FIG. 1 are 100
connected as indicated in FIG. 3, so that the output sig- 101
nal of one is connected through gating circuitry which 102
may be conditioned similarly to gate 18 of FIG. 1, to 103
the input signal terminal of the other and vice versa, 104
data may be permanently stored by the process of con- 105
tinually reading out of one and into the other. This is 106
indicated schematically by the system 110 which per- 107
mits updating and permanent storage of data. Also, 108
while the circuit 10 provides a serial readout data stor- 109
age system, it will be appreciated by those skilled in the 110
art that random access to a particular portion of the 111
data may be provided by logic circuitry capable of posi- 112
tioning the electron scan beam on selected areas of the 113
target material 14 as desired.

While the embodiment of the invention shown in FIG. 1 114
shows the data input connected to the cathode 11, it will be appreciated by those skilled in the art that input and output signals may be provided from other tube elements of the vidicon tube 11. For example, the output or input signals could be derived from current variations at collector mesh M and applied to grid G, respectively, if desired.

The above described memory storage circuits are ap- 115
licable to the storage of either digital or analog data or even a mixture of each, since the modulation of the input data waveform does not materially affect the
functioning of the circuit to a reasonable degree. Thus, the above description is intended as illustrative only and not as a limitative boundary on the concepts of the invention. Memory storage circuitry according to the invention may be utilized for television scan conversion, data time-base conversion, serial to parallel color television conversion and to various types of digital memories. The stored data may include analog video, FM carrier, AM carrier and other forms. The invention may also be employed in stop motion television by utilizing FM modulation and continuous data transfer between two tubes.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof, and various changes in the size, shape and materials as well as in the details of the illustrated construction may be made within the scope of the appended claims without departing from the spirit of the invention.

I claim:

1. A method for storing and reading out electrical information signals comprising the steps of:
   a. conditioning a first photosensitive target by exposing it to light to provide a first uniformly charged target area;
   b. scanning said first area with a first electron beam which is modulated as a function of the data to be stored to thereby alter the charge distribution pattern on said first area;
   c. retrieving data stored on said first area by scanning said first area with a second electron beam to produce a first electrical output signal which varies as a function of the charge distribution pattern on said first area;
   d. conditioning a second photosensitive target by exposing it to light to provide a second uniformly charged target area;
   e. scanning said second area with a third electron beam which is modulated as a function of the data to be stored to thereby alter the charge distribution pattern on said second area;
   f. retrieving data stored on said second area by scanning said second area with a fourth electron beam to produce a second electrical output signal which varies as a function of the charge distribution pattern on said second area;
   g. conditioning said first target by exposing it to said light;
   h. conditioning said first target by exposing it to said light;
   i. sequentially repeating steps d-h hereof to form a long term data storage system.

2. A method for storing and reading out electrical information signals comprising the steps of:
   a. conditioning a first photosensitive target by exposing it to light to provide a first uniformly charged target area;
   b. scanning said first area with a first electron beam which is modulated as a function of the data to be stored to thereby alter the charge distribution pattern on said first area;
   c. retrieving data stored on said first area by scanning said first area with a second electron beam to produce a first electrical output signal which varies as a function of the charge distribution pattern on said first area;
   d. said first photosensitive target is provided by a vidicon tube;
   e. said light is produced as a high intensity, short duration pulse from a strobe light;
   f. conditioning a second photosensitive target by exposing it to light to provide a second uniformly charged target area;
   g. scanning said second area with a third electron beam which is modulated as a function of said first output signal to thereby alter the charge distribution pattern on said second area;
   h. conditioning said first target by exposing it to said light;
   i. retrieving data stored on said second area by scanning said second area with a fourth electron beam to produce a second electrical output signal which varies as a function of the charge distribution pattern on said second area;
   j. scanning said first area with said first beam while modulating said first beam as a function of said second output signal and;
   k. sequentially repeating steps f-j hereof to form a long term data storage system.

3. Apparatus for storing and reading out electrical information signals comprising:
   a. photosensitive target means including a vidicon tube;
   b. conditioning means including strobe lamp means for conditioning said target means to produce a first uniformly charged target area;
   c. input scan means for input scanning a first electron beam across said first area;
   d. modulating means for modulating said first beam by an input data signal to produce a charge distribution pattern on said first area which varies as a function of said input data signal;
   e. output scan means for output scanning an unmodulated electron beam across said first area following production of said charge distribution pattern to form a first electrical output signal which varies as a function of said pattern;
   f. second photosensitive target means, conditioning means, input scan means, modulating means and output scan means having an input supplied by said first output signal to form a second output signal which varies as a function of the input data signal; and
   g. connecting means supplying said second output signal as said input data signal to form a long term storage system.

4. Apparatus as defined in claim 3 further including means for forming two output scans for each input scan.

5. An electronic apparatus for storing and reading out electrical information comprising:
   a. vidicon tube means having a photosensitive target and a cathode means for emitting a beam of electrons;
   b. means for focusing deflecting, and aligning the electron beam emitted by said cathode;
   c. scanning means for sequentially scanning across the photosensitive target by an electron beam from said cathode, said scanning means including;
   d. sync pulse generating means for generating horizontal sync voltage pulses for controlling horizontal deflection of the electron beam in horizontal scan across said target and for generating vertical
sync voltage pulses for controlling the vertical sweep of said electron beam across said target;
e. blanking amplifier means responsive to vertical sync voltage pulses from said sync pulse generating means for shutting off the electron scan beam during the retrace interval of said beam scan;
f. strobe lamp means responsive to said vertical sync voltage pulses for delivering a high intensity light pulse to said photosensitive target upon occurrence of alternate vertical sync voltage pulses for conditioning said target to produce a uniformly charged target area;
g. input scan means for input scanning said electron beam across said conditioned target area, said input scan means including;
h. modulating means for modulating said beam by an input data signal to produce a charge distribution pattern on the target area which varies as a function of said input data signal; and
i. output scan means for output scanning a second electron beam across said target area following production of the charge distribution pattern to form a first electrical output signal which varies as a function of said charge distribution pattern.

* * * * *