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[54] **MEANS FOR CONSERVING ENERGY DURING LINE RETRACE OF A RASTER TYPE DISPLAY**

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[21] Appl. No.: **112,358**

[52] **U.S. Cl.** ..... **315/27 TD**, 315/18

[51] **Int. Cl.** **H01j 29/70**

[58] **Field of Search** ..... 315/18, 19, 20, 22, 315/27 TD

[56] **References Cited**

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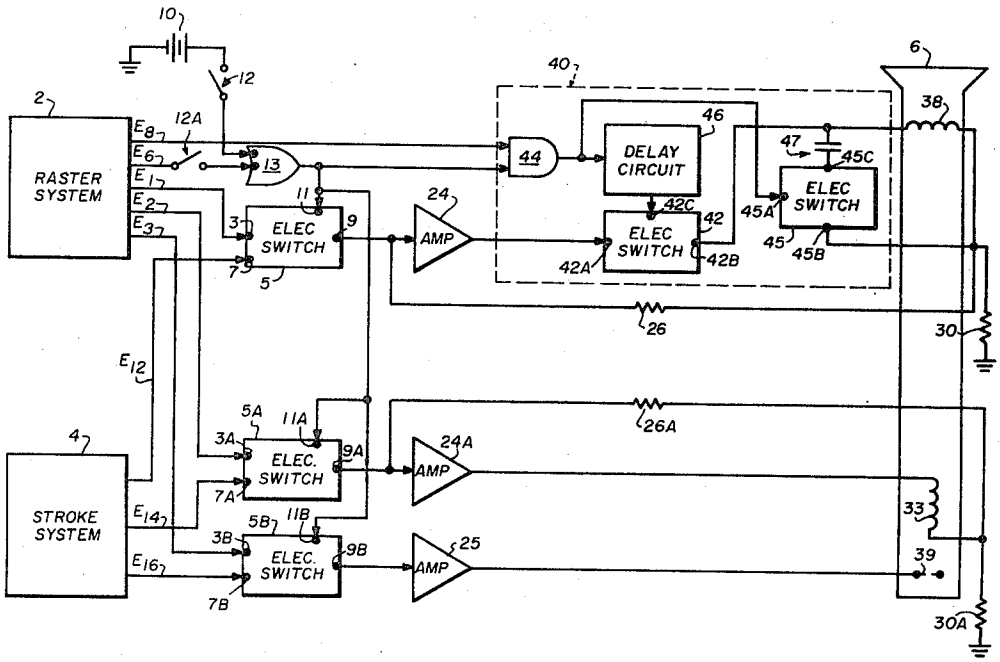
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[57] **ABSTRACT**

A cathode ray tube (magnetic deflection) display system provides pictorial (raster) and symbol (stroke) displays and includes an energy conservation circuit which uses the energy stored in the horizontal deflection coil of the cathode ray tube to achieve retrace of the sweep voltage used in providing the pictorial display.

11 Claims, 2 Drawing Figures



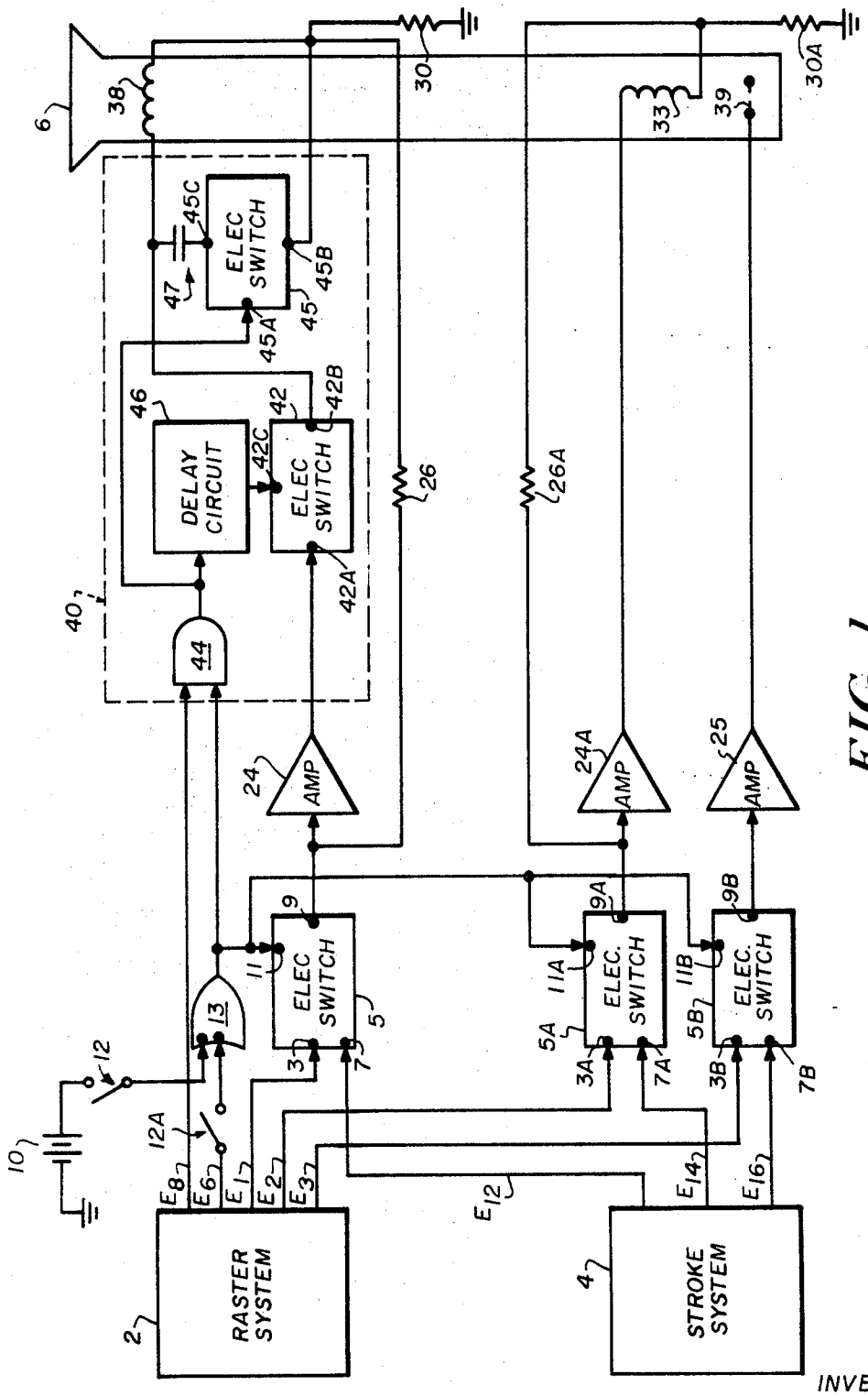


FIG. 1

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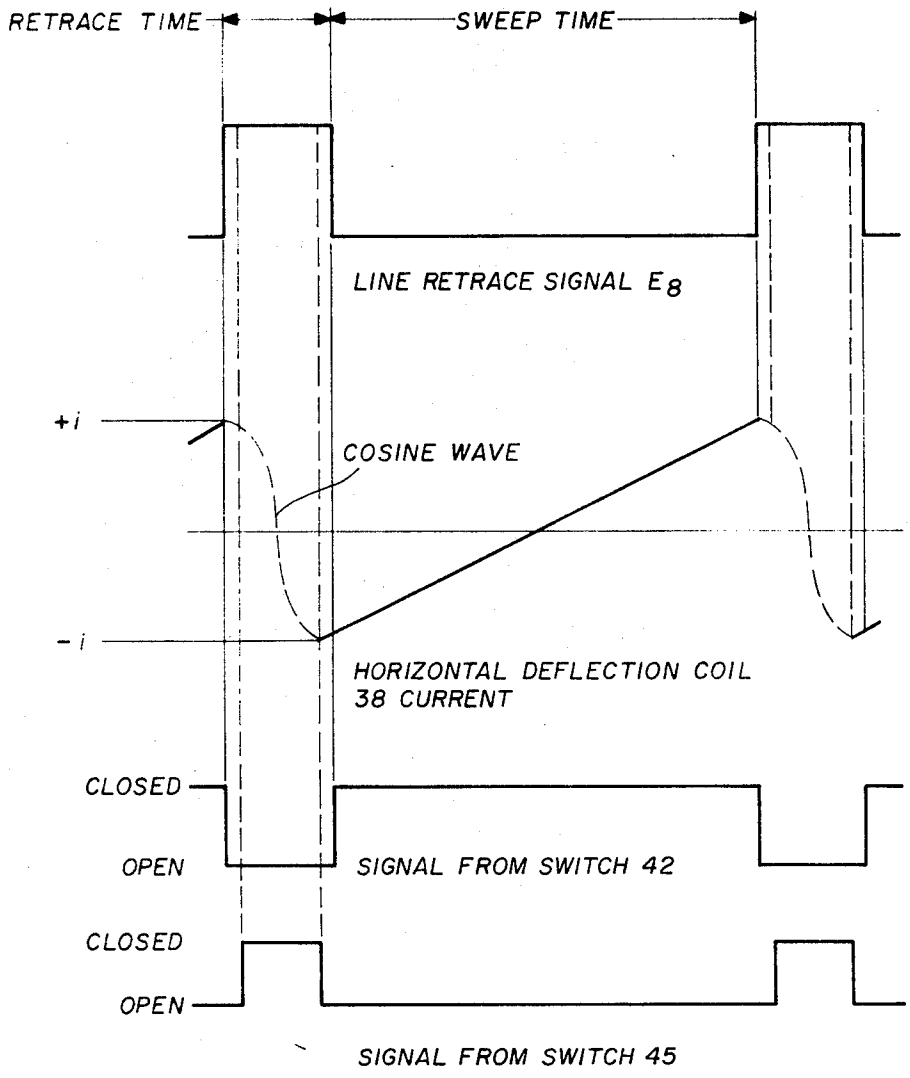


FIG. 2

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and signal E_3, respectively, to the respective amplifiers 24, 24A and 25.

Amplifiers 24 and 24A may be of the high speed magnetic deflection type described in U. S. Pat. No. 3,426,245 issued Feb. 4, 1969 to J. F. Yurasek and Abner Owens and assigned to The Bendix Corporation, assignee of the present invention.

Amplifier 24 operates with a feedback resistor 26 and a grounded sampling resistor 30 connected thereto to apply a signal to a horizontal deflection coil 38 in cathode ray tube 6 through an energy conservation circuit designated generally by the numeral 40.

Amplifier 24A operates with a feedback resistor 26A and a grounded sampling resistor 30A connected thereto to apply a signal to a vertical deflection coil 33 in cathode ray tube 6.

Amplifier 25 applies a signal to a control grid electrode 39 in cathode ray tube 6. Amplifier 25 is a conventional video amplifier well known in the art and normally referred to as such.

It will now be understood that vertical sweep signal E_2 has a long sweep time and therefore does not require excessive power during retrace. For this reason only horizontal sweep E_1 is affected by energy conservation circuit 40 as will be now explained.

Energy conservation circuit 40 includes an electronic switch 42 which is a high speed field effect transistor analog gate having a low "on" resistance and high current handing capability. These switches are commercially available and may be similar to the type manufactured by the Crystalonic Co. and carrying the trade designation CP 650. Switch 42 has an input element 42A connected to amplifier 24, an output element 42B connected to horizontal deflection coil 38 and a control element 42C. Energy conservation circuit 40 further includes an AND gate 44 having an input terminal connected to raster system 2 for receiving horizontal retrace signal E_8 therefrom and another input terminal connected to the output element of OR gate 13 for receiving the output from said OR gate. A delay circuit 46, which may be of the type including two cascaded multivibrators similar to those manufactured by the Texas Instrument Co. and carrying their trade designation Type 54121, is used to generate the necessary timing gates, as illustrated in FIG. 2 and which will be hereinafter explained, is connected to the output element of gate 44 and to control element 42C of electronic switch 42.

An electronic switch 45, similar to electronic switch 42, has an input element 45A connected to AND gate 44, an output element 45B connected to ground through resistor 30 and a control element 45C. A capacitor 47 connects control element 45C of switch 45 to output element 42B of switch 42 so that the capacitor and switch 45 are connected in parallel with horizontal deflection coil 38.

As will now be shown, energy conservation circuit 40 is operative during the retrace portion of horizontal sweep voltage E_1 to achieve said retrace by using the energy stored in horizontal deflection coil 38.

Thus, with AND gate 44 receiving the output from OR gate 13 at its one input terminal and receiving horizontal retrace signal E_8 at its other input terminal, the AND gate is enabled when the raster or pictorial display is provided by cathode ray tube 6. This allows retrace signal E_8 to pass through the enabled AND gate 44 to delay circuit 46. Each signal passed by AND gate 44 is applied to input element 45A of switch 45, whereupon switch 45 connects capacitor 47 across horizontal deflection coil 38 in response to the signal from AND gate 44 and disconnects the capacitor when said signal is absent.

Delay circuit 46 delays each signal passed by AND gate 44 for a predetermined interval causing a control signal to be provided. The control signal is a pulse having a width so that the pulse begins just after the signal being passed by AND gate 44 and terminates just prior to the signal being passed by AND gate 44. The pulse so provided is applied to the control element of switch 42 for rendering the switch effective to block the output from amplifier 24.

The capacitance of capacitor 47 is such that when the capacitor is connected across horizontal deflection coil 38 as heretofore noted, a resonant circuit is formed and an oscillatory voltage develops across coil 38 and capacitor 47. The width of the pulse from delay circuit 46 is such that switch 42 passes the output from amplifier 24 and switch 45 disconnects capacitor 47 from across deflection coil 38 at the end of the first half cycle of the oscillatory voltage. Thus, switches 42 and 45 are controlled to take advantage of the first half cycle of the oscillatory voltage to achieve retrace with minimum energy consumption.

OPERATION OF THE INVENTION

With the foregoing description of the invention in mind and with reference to FIG. 2, it will be seen that upon application of horizontal retrace signal E_8 and raster mode signal E_6 to gate 44, a signal is passed to switch 45 and to delay circuit 46 in energy conservation circuit 40. Delay circuit 46 operates so that on the rising of retrace signal E_8, switch 45 will be delayed in closing by a few nanoseconds before switch 42 opens and switch 42 will close just a few nanoseconds after switch 45 opens. This "window type" switching is to limit large voltage transients due to inductive energy in horizontal deflection coil 38.

At the instant switch 42 opens, the coil current is at $+i$. With switch 45 closed and switch 42 open, capacitor 47 and deflection coil 38 provide a tuned circuit having a resonant frequency such that during the first quarter cycle the energy in deflection coil 38 is transferred to capacitor 47 which was previously uncharged. During the second quarter cycle the energy in capacitor 47 is transferred back to coil 38 but with an opposite polarity, thus leaving capacitor 47 again uncharged and the coil current at $-i$.

The resonant frequency of the system is such that one-half cycle time corresponds to raster retrace time. Thus, as switch 42 closes and switch 45 opens, both amplifier 24 and the coil current are set at $-i$, with capacitor 47 uncharged and waiting for the next cycle. Therefore, during the retrace period, where ordinarily the maximum peak power would be required, now, in fact, zero power is required from the system and energy conservation is thus effected.

Although but a single embodiment of the invention has been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes may also be made in the design and arrangement of the parts without departing from the spirit and scope of the invention as the same will now be understood by those skilled in the art.

What is claimed is:

MEANS FOR CONSERVING ENERGY DURING LINE RETRACE OF A RASTER TYPE DISPLAY

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to cathode ray tube systems for providing pictorial and symbol displays. More particularly, the invention relates to means for conserving energy when providing the pictorial display.

2. Description of the Prior Art

Airborne navigation systems using cathode ray tubes for displaying flight condition data are best of the dual deflection type wherein the display can be switched from a pictorial (raster) display to a symbol (stroke) display. Considerable energy is used during retrace of the raster and it is important to conserve this energy to thereby reduce overall system power. Energy conservation assumes more importance when it is considered that many airborne display systems require time sharing of the raster and stroke display modes. This time sharing can occur at relatively fast rates, and the use of two different deflection systems, that is, a stroke system and a raster system, and switching from one to the other is precluded.

SUMMARY OF THE INVENTION

This invention contemplates a magnetic deflection type display system including means for conserving energy during the retrace portions of a periodic signal applied to a deflection coil in the system. A switching device is connected to the deflection coil and is controlled to pass the periodic signal to the coil during the sweep portion and to block said signal during the retrace portion. A capacitor is connected to the deflection coil through another switching device which is controlled to connect the capacitor across the coil during the retrace portion and to disconnect the capacitor during the sweep portion.

One object of this invention is to provide a magnetic deflection display system of the type which can be switched from a raster display to a stroke display and including means for conserving energy to reduce overall system power.

Another object of this invention is to provide means for conserving energy during raster retrace.

Another object of this invention is to conserve energy during raster retrace so that using a single magnetic deflection display system for dual raster and stroke display modes is practical and a significant reduction in power is achieved.

The foregoing and other objects and advantages of the invention will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawings where one embodiment of the invention is illustrated by way of example. It is to be expressly understood, however, that the drawings are for illustration purposes only and are not to be construed as defining the limits of the invention.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram-electrical schematic of a cathode ray tube or magnetic deflection type display system including energy conservation means constructed according to the invention.

FIG. 2 is a graphic representation showing waveforms of signals provided at various points in the system of FIG. 1.

DESCRIPTION OF THE INVENTION

A raster system **2**, which may be a conventional type television system for televising the terrain over which an aircraft is flying, provides horizontal and vertical sweep signals E_1 and E_2, respectively, and which signals have a saw tooth waveform. Raster system **2** further provides a video signal E_3, a raster mode signal E_6 and a horizontal retrace signal E_8.

A stroke system **4**, which may be of the type disclosed in U. S. Pat. No. 3,237,199, issued to J. Schiffman on Feb. 22, 1966 and assigned to The Bendix Corporation assignees of the present invention, provides horizontal and vertical deflection signals E_{12} and E_{14} and a display bright-up signal E_{16}.

Raster system **2** and stroke system **4** are connected as will be hereinafter explained to a cathode ray tube **6**. Cathode ray tube **6** is responsive to the signals from raster system **2** for displaying, by way of example, a picture of the terrain over which the aircraft is flying. Cathode ray tube **6** is responsive to the signals from stroke system **4** for displaying, by way of example, symbols related to aircraft attitude. These displays may be provided simultaneously, wherein one is superimposed over the other or individually, as the case may be.

Accordingly, horizontal sweep signal E_1 and horizontal deflection signal E_{12} are applied to cathode ray tube **6** through an electronic switch device **5**. Vertical sweep signal E_2 and a vertical deflection signal E_{14} are applied to cathode ray tube **6** through an electronic switching device **5A** and a video signal E_3 and bright-up signal E_{16} are applied to cathode ray tube **6** through an electronic switching device **5B**. Electronic switching devices **5**, **5A**, and **5B** are high speed field effect transistor analog gates having a relatively low "on" resistance. The switches used are commerically available and may be of the type manufactured by the Crystalonics Co. and carrying the trade designation GAG **10**.

Each of the switches have input elements **3**, **3A**, **3B** and **7**, **7A**, **7B**, respectively, for receiving the aforenoted signals from raster system **2** and from stroke system **4**; output elements **9**, **9A** and **9B**, respectively, to which the received signals are passed; and control elements **11**, **11A** and **11B** for receiving controlling signals to control passing and blocking of the signals received at the aforenoted input elements.

A control circuit for providing controlling signals to control elements **11**, **11A** and **11B** of switches **5**, **5A** and **5B** includes a source of direct current shown as a battery **10** connected through a manually operated switch **12** to an input terminal of an OR gate **13**. Raster mode signal E_6 is applied through a switch **12A** to another input terminal of the OR gate.

OR gate **13** is effective for controlling switches **5**, **5A** and **5B** so that when OR gate **13** provides an output at its output terminal, switch **5** is effective for passing signal E_{12} to an amplifier **24**, switch **5A** is effective for passing signal E_{14} to an amplifier **24A** and switch **5B** is effective for passing signal E_{16} to an amplifier **25**. Amplifiers **24**, **24A** and **25** are connected to the respective output elements **9**, **9A**, **9B** of switches **5**, **5A** and **5B**. When the output from OR gate **13** is absent switches **5**, **5A** and **5B** are effective for passing signal E_1, signal E_2

1. A display system comprising:
signal providing means including means for providing periodically occurring sweep and retrace signals;
display means responsive to signals from the signal providing means for providing a display;
first connecting means including first switching means for connecting the signal providing means to the display means;
second connecting means including control means for connecting the signal providing means to the first switching means and affected by the presence of the retrace signal for controlling the first switching means to block signals from the signal providing means, and affected by the absence of the retrace signal for controlling said switching means to pass signals from the signal providing means to the display means;
signal storage means connected intermediate the first switching means and the display means for storing signals passed by the first switching means;
second switching means connected to the signal storage means, the second connecting means and the display means and affected by the presence of the retrace signal for connecting the storage means to the display means whereupon the stored signals are applied to said display means, and affected by the absence of said retrace signal for disconnecting the storage means from the display means;
the first connecting means further including means for providing a constant level signal, means for providing a display mode signal, means connected to the contant level signal means and the display mode signal means and responsive to the signals therefrom for providing a controlling signal, third switching means connected to the signal providing means, amplifier means for connecting the third switch means to the first switching means, and the third switching means connected to the controlling signal means and controlled by the signal therefrom for passing the sweep signal to the amplifier means; and
the second connecting means further including gating means connected to the means for providing a controlling signal and to the signal providing means for providing a first signal when the controlling signal and the retrace signal are present and for providing a second signal when the retrace signal is absent, and the controlling means being responsive to the first signal for controlling the first switching means to block signals, and being responsive to the second signal for controlling said switching means to pass signals.

2. A display system as described by claim 1, wherein:
the second switching means is connected to the gating means in the second connecting means, and is responsive to the first signal for connecting the storage means to the display means and to the second signal for disconnecting the storage means from the display means.

3. A display system as described by claim 2, wherein the control means includes time delay means for controlling the first switching means and:
the second switching means is responsive to the first signal for connecting the storage means to the display means a predetermined interval before the first switching means is controlled by the time delay means to block signals; and
the first switching means is controlled by the time delay means to pass signals a predetermined interval after the second switching means is responsive to the second signal for disconnecting the storage means from the display means.

4. A display system as described by claim 1, wherein:
the sweep signal is a horizontal sweep signal;
the retrace signal is a horizontal retrace signal; and
the deflection coil is a horizontal deflection coil.

5. A display system as described by claim 4, including:
the display means having a vertical deflection coil;
the signal providing means providing a vertical sweep signal;
fourth switching means connected to the signal providing means and to the vertical deflection coil; and
the fourth switching means connected to the controlling signal means and controlled by the signal therefrom for passing the vertical sweep signal to the vertical deflection coil in the display means.

6. A display system as described by claim 5, including:
means for providing a vertical deflection signal connected to the fourth switching means.

7. A display system as described by claim 4, including:
means for providing a horizontal deflection signal connected to the third switching means.

8. A display system as described by claim 5, including:
amplifier means connecting the fourth switching means to the vertical deflection coil; and
grounded resistor means connected intermediate the fourth switching means and the amplifier means and connected to the vertical deflection coil.

9. A display system as described by claim 1, including:
the display system being a video system;
the signal providing means providing a video signal; and
means for providing a display bright-up signal.

10. A display system as described by claim 9, including:
the video system having a control grid electrode;
fifth switching means connected to the signal providing means, to the bright-up signal means and to the control grid electrode; and
the fifth switching means connected to the controlling signal means and controlled by the signal therefrom for passing the video signal and the bright-up signal to the control grid electrode.

11. A display system comprising:
signal providing means including means for providing periodically occurring sweep and retrace signals;
display means responsive to signals from the signal providing means for providing a display;
first connecting means including first switching means for connecting the signal providing means to the display means;
second connecting means including control means for connecting the signal providing means to the first switching means and affected by the presence of the retrace signal for controlling the first switching means to block signals from the signal providing means, and affected by the absence of the retrace signal for controlling said switching means to

pass signals from the signal providing means to the display means;

signal storage means connected intermediate the first switching means and the display means for storing signals passed by the first switching means;

second switching means connected to the signal storage means, the second connecting means and the display means and affected by the presence of the retrace signal for connecting the storage means to the display means whereupon the stored signals are applied to said display means and affected by the absence of said retrace signal for disconnecting the storage means from the display means;

the first connecting means further including means for providing a constant level signal, means for providing a display mode signal, means connected to the constant level signal means and the display mode signal means and responsive to the signals therefrom for providing a controlling signal, third switching means connected to the signal providing means, amplifier means for connecting the third switching means to the first switching means, and the third switching means connected to the controlling signal means and controlled by the signal therefrom for passing the sweep signal to the amplifier means; and

the display means including magnetic deflection means having a deflection coil connected to the signal storage means and connected to the third switching means, a grounded resistor connected to the deflection coil and to the second switching means, and the second switching means being affected by the presence of the retrace signal to connect the storage means across the coil and being affected by the absence of the retrace signal for disconnecting the storage means from across the coil.

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