Oct. 10, 1961 R. D. OLSON 3,004,187

CATHODE RAY TUBE INTENSITY CONTROL SYSTEM

Filed Feb. 11, 1960 2 Sheets-Sheet 1

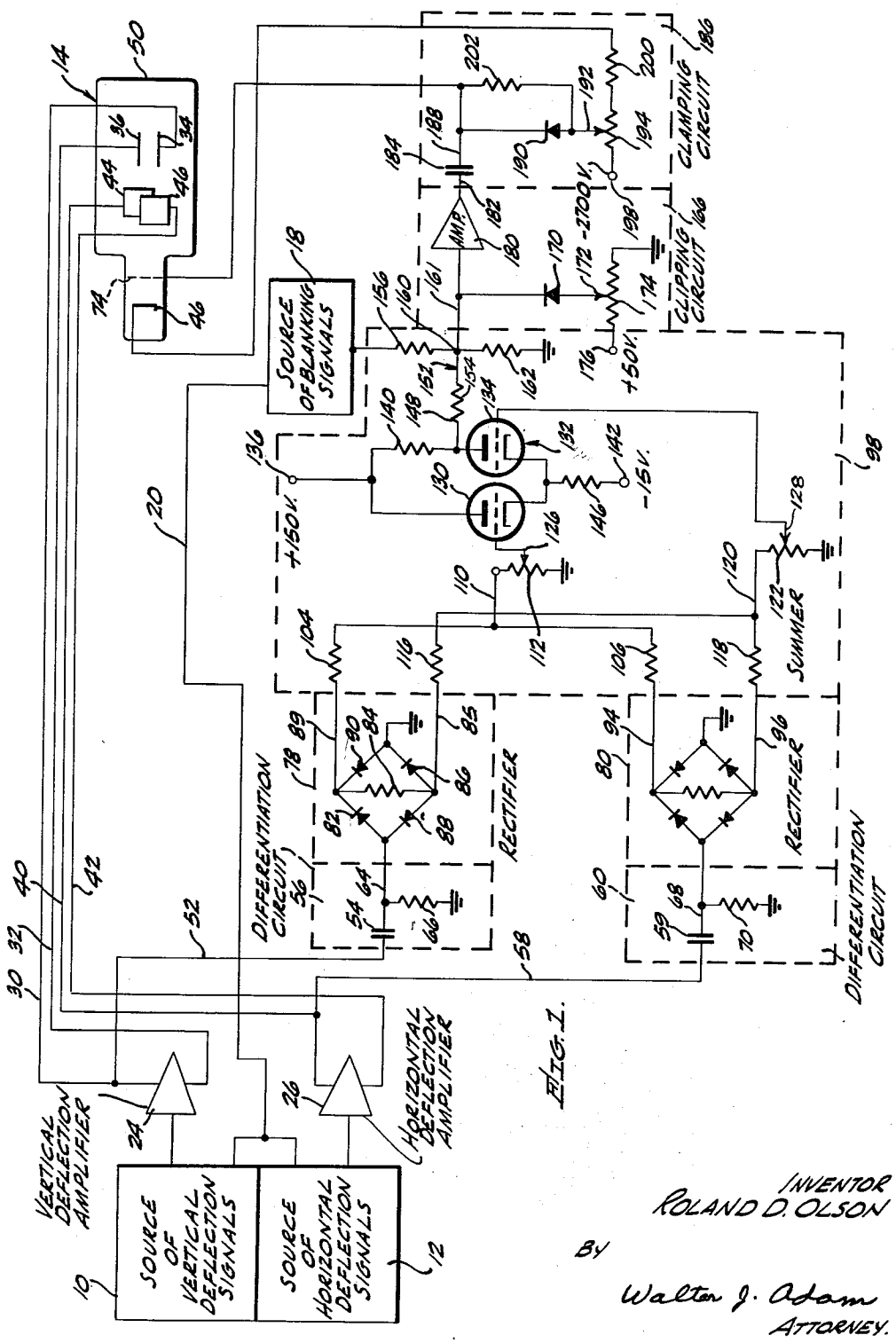


FIG. 1.

INVENTOR
ROLAND D. OLSON

BY

Walter J. Adam
ATTORNEY.

Oct. 10, 1961 R. D. OLSON 3,004,187

CATHODE RAY TUBE INTENSITY CONTROL SYSTEM

Filed Feb. 11, 1960 2 Sheets-Sheet 2

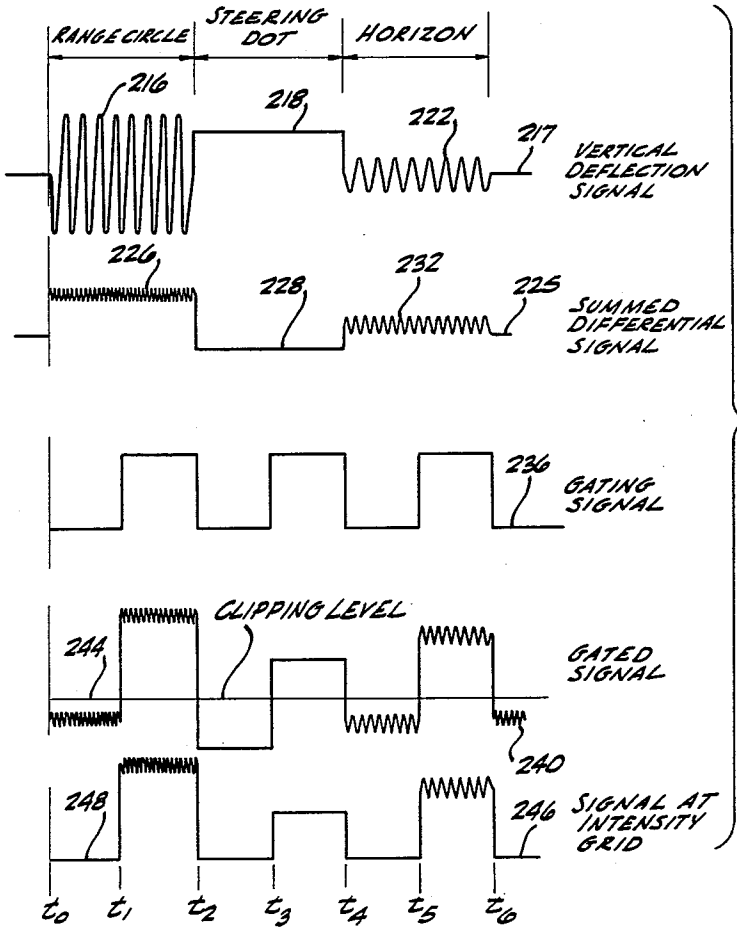


FIG. 3.

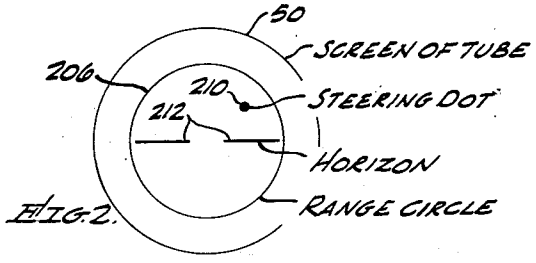


FIG. 2.

INVENTOR.
ROLAND D. OLSON,
BY
Walter J. Adam
ATTORNEY

United States Patent Office 3,004,187 Patented Oct. 10, 1961

3,004,187 CATHODE RAY TUBE INTENSITY CONTROL SYSTEM

Roland D. Olson, Torrance, Calif., assignor to Hughes Aircraft Company, Culver City, Calif., a corporation of Delaware

Filed Feb. 11, 1960, Ser. No. 8,191
7 Claims. (Cl. 315—22)

This invention relates to a system for controlling the intensity of symbols displayed on a cathode ray tube and particularly to a system for providing symbols of constant intensity on a time shared display pattern where a single electron beam develops a plurality of symbols representative of information from independent sources.

In some systems such as in radar, many symbols are required to be displayed on the screen of a cathode ray tube having a single electron gun, which symbols may vary in shape, size and number as determined by the source of deflection signals applied to the deflection plates of the tube from separate sources of symbol information. In order to display a plurality of symbols, a time sharing arrangement is provided so that each symbol is formed during a different portion of a repetitive period with the retentivity characteristics of the phosphor on the screen of the tube retaining a presentation of each symbol while the others are being formed.

In the prior art, when a plurality of symbols are displayed on the screen of a cathode ray tube on a time shared basis, the relative intensity of the symbols, which is a function of the number of electrons striking a particular point on the phosphor of the screen in a given time interval, is set by individually controlling the actual time of write or formation of each symbol. A special gating circuit is provided for intensity setting of each symbol with a selected size and shape by controlling the time of application of each of the deflection signals to the deflection plates or the time the electron beam is formed by controlling the blanking pulses applied to the grid of the cathode ray tube and thus the time of writing of each symbol. However, as each symbol varies from the size or shape at which the gating circuit is selected as may be required by the information being displayed, the intensity varies because there is no means of adjusting the time of writing as the symbol varies. For example, as a large symbol is made smaller, the intensity of presentation increases and as a small symbol is made larger, the intensity of presentation decreases. It is difficult for an observer to accurately interpret a plurality of symbols when they vary in intensity. Another disadvantage of having a special gating circuit to provide a different time of writing for each symbol is the complexity of the gating circuitry. A further disadvantage of this prior art arrangement is that if the deflection voltages are removed for any reason, the beam intensity is applied continually to a single position on the screen so that destruction of the phosphor material may occur at such position.

An arrangement that is utilized to control intensity of a symbol on the screen of a cathode ray tube, in systems not having time sharing, differentiates the vertical and horizontal deflection voltages and after rectification of the differentiated voltages combines the rectified signals to form a signal proportional to the time rate of change of the deflection voltages, which signal is applied directly to the intensity grid of the tube. However, in display systems it is preferable to bias the cathode of the cathode ray tube at a low voltage relative to ground so that the auxiliary controls such as focus controls and the astigmatism controls are at a potential close to ground rather than to have the cathode at ground with the controls at a high potential. This type of arrangement with the auxiliary controls at a potential close to ground is especially required in aircraft systems for the safety of the pilot, in which systems time shared displays are often utilized. In order to utilize a very low potential at the cathode, a coupling capacitor is required between the intensity control circuitry and the intensity grid which is maintained within a few volts of that of the cathode, so that the intensity control circuitry for varying the potential applied to the intensity grid can be operated at a potential relatively close to ground. However, a coupling capacitor prevents certain differentials of the deflection voltages from passing therethrough, such as a sawtooth deflection voltage which has a differential that is a constant or a D.C. (direct current) voltage. Thus, some symbols cannot be displayed in a reliable manner when a coupling capacitor is utilized. Also, when the differential signals developed from the vertical and horizontal deflection voltages are combined algebraically rather than vectorially, the half wave rectification results in bright spots at certain portions of the symbols.

A display system that provides time sharing for displaying a number of symbols on the screen of the scope and that provides capacitive coupling between the control circuitry and the intensity grid, and that further provides protection against damage to the phosphor in the event of a failure of the deflection voltages would be very valuable to the art.

It is, therefore, an object of this invention to provide a cathode ray tube intensity control system for use with a time shared display arrangement in which the symbols are displayed with uniform intensity regardless of the size, number and shape of the symbols.

It is a further object of this invention to provide an intensity control system for a cathode ray tube for time sharing of a plurality of signals from separate sources that utilizes a clamping circuit to prevent destruction of the screen of the cathode ray tube in the absence of deflection voltages.

It is a still further object of this invention to provide a system for time sharing the writing of a plurality of symbols on the screen of a cathode ray tube which differentiates the deflection voltages, passes the differential signals through full wave rectifiers and combines the rectified signals algebraically in a manner to provide symbols of substantially equal intensity.

It is another object of this invention to provide a system for displaying a plurality of symbols of varying size, shape and number on a cathode ray tube by applying a summed signal indicative of the time rate of change of the horizontal and vertical deflection voltages combined with a carrier wave through a coupling capacitor arranged between the intensity control circuitry and the control grid, which system controls the intensity of the symbols when utilizing deflection voltages having a differential value that is a constant.

According to one feature of this invention, a system is provided for use with a time shared display pattern where several symbols are displayed simultaneously with one electron stream of a cathode ray tube in which all symbol traces are traced at an equal intensity regardless of shape, size or number of the symbols. Horizontal and vertical deflection voltages from sources of information to be displayed are applied on a time shared basis not only to the deflection plates of the cathode ray tube but also through differentiators to develop signals representing the derivative of each of the deflection voltages. The differential signals are applied to a full wave rectifier and then combined in a manner to obtain a signal representing the absolute value of the derivative and the instantaneous intensity requirements of the cathode ray tube. The sig-

nals representating the absolute value of the derivative of the deflection voltages are then applied to a summing network which also receives continuous transient blanking gate signals which blank out unwanted portion of the display such as the trace between symbols. The combined signal developed by the summing circuit which includes the intensity information combined with a carrier wave is then applied to a clipping circuit to establish a stable unchanging base voltage to which the wave form may be clamped. It is then passed through a coupling capacitor and a clamping circuit which maintains the clipping level at a preselected voltage and is applied to the intensity grid of the cathode ray tube. This clipping and clamping arrangement prevents intensity changes as symbols are added, removed or varied in size and further prevents burning of the screen of the cathode ray tube when the deflection voltages are removed. Thus, the transient blanking signals are utilized as a carrier wave for applying differential signals to the intensity grid, which differential signals may be either alternating or direct current signals.

The novel feature of this invention, as well as the invention itself, both as to organization and method of operation, will best be understood from the accompanying description taken in connection with the accompanying drawings in which:

FIG. 1 is a combined schematic circuit and block diagram of the intensity control system for a cathode ray tube in accordance with this invention;

FIG. 2 is a schematic diagram to illustrate one example of a plurality of symbols displayed on the screen of the cathode ray tube of FIG. 1; and

FIG. 3 is a diagram showing waveforms of time versus amplitude appearing at various positions in the system of FIG. 1.

Referring first to FIG. 1, which is a schematic diagram of the intensity control system in accordance with this invention, the general arrangement thereof will be described. A source of vertical deflection signals **10** and a source of horizontal deflection signals **12** are provided to supply vertical and horizontal deflection voltages to a cathode ray tube **14**. The sources of deflection signals **10** and **12** may include independent sources of symbol forming information such as range determining circuitry, steering direction circuitry, and artificial horizon determining means, all of which may be included in an aircraft control system, for example. Circuits for developing the signals of the sources of horizontal and vertical deflection signals **10** and **12** are well known in the art such as described in Patent No. 2,878,466, "Disturbed Line-of-Sight Fire Control System" by R. J. Shank et al., issued March 17, 1959. A source of blanking signals **18** is provided to apply gating signals to the sources of deflection signals **10** and **12** through a gating lead **20** so that the deflection signals are obtained from each source of information in the aircraft for a time shared portion of a repetitive period. The source of blanking signals **18** may be a conventional plurality of sequential flip flop divider arrangement that develop a continuous sequence of similarly spaced pulses of equal time duration.

The deflection voltages from the sources **10** and **12** are respectively applied to a vertical deflection amplifier **24** and a horizontal deflection amplifier **26**. The vertical deflection voltages being 180 degrees out of phase from each other are applied from the amplifier **24** through leads **30** and **32** to vertical deflection plates **34** and **36** of the cathode ray tube **14**. Similarly, the horizontal deflection voltages being 180 degrees out of phase from each other are applied through leads **40** and **42** to horizontal deflection plates **44** and **46** of the cathode ray tube **14**. The vertical and horizontal deflection voltages in the sources **10** and **12** have a phase relative to each other as determined by the requirements of forming a desired symbol. In response to the deflection voltages, the electron beam developed from an electron gun, which includes a cathode **46**, forms a pattern on the phosphor of a screen **50** of the cathode ray tube **14**, which arrangement is well known in the art.

To provide intensity control of symbols formed on the screen **50**, a portion of one of the vertical deflection signals is applied from the amplifier **24** through the lead **30** and through a lead **52** to one plate of a capacitor **54** of a differentiating circuit **56**. Also, a portion of one of the horizontal deflection signals is applied from the amplifier **26** through the lead **40** and through a lead **58** to one plate of a capacitor **59** of a differentiating circuit **60**. The intensity control system in accordance with this invention utilizes only one deflection voltage for intensity control so that the system is applicable to a system different than shown in FIG. 1, which drives the deflection plates by controlling the voltage applied to only a single plate in either the horizontal or vertical dimensions with the other deflection plate in each dimension connected to a fixed potential. The other plate of the capacitor **54** is coupled to a lead **64** which, in turn, is coupled to ground through a resistor **66** to provide the differentiating action. Similarly, the other plate of the capacitor **59** is coupled to a lead **68** which in turn is coupled to ground through a resistor **70** to provide the differentiating action. Thus, the differentiating circuits **56** and **60** develop differential signals equal to respectively the rate of change of the vertical and horizontal sweep voltages or the sweep velocity of the electron beam of the cathode ray tube in the vertical and horizontal direction, which signals will be utilized to control the potential on an intensity grid **74** of the cathode ray tube **14**.

The differential signals are respectively applied from the leads **64** and **68** to full wave rectifiers **78** and **80**, which are conventional bridge rectifier circuits, as well known in the art. In the rectifier circuit **78**, positive differential signals follow a current path from the lead **64** through a diode **82** coupled to a positive lead **89**, through a load resistor **84** and through a diode **86** to ground. Negative differential signals follow a current path from the lead **64** through a diode **88** coupled to a negative lead **85**, through the load resistor **84** and through a diode **90** to ground. In a similar manner positive and negative differential signals are applied from the lead **68** to the rectifier **80** and to ground to develop a positive signal on a positive lead **94** and negative differential signals are applied from the lead **68** through the rectifier **80** to develop negative signals on a negative lead **96**. Full wave rectification of the differential signals is required because the derivatives of some waveforms such as the negative alternations of a sine wave are negative.

In order to provide a signal indicative of the absolute value of the differential signals, a summer **98** is provided to separately combine the positive differential signals and the negative differential signals and to combine the absolute value of the positive and negative signals to give a signal proportional to the instantaneous sweep velocity of the electron beam of the cathode ray tube **14**. The positive signals are applied from the leads **89** and **94** through respective resistors **104** and **106** to a lead **110** and to ground through a common resistor **112**. Similarly, the negative differential signals are applied from the leads **85** and **96** through respective resistors **116** and **118** and to ground through a common resistor **112**. The common resistors **112** and **122** are tapped resistors having respective movable taps **126** and **128** to provide relative intensity adjustment to the system.

The summed positive differential signal is applied from the tap **126** to the grid of a triode **130** of a differential amplifier **132** and the negative summed differential signal is applied from the tap **128** to the grid of a triode **134** also of the differential amplifier **132**. The anode of the triode **130** is coupled to a plus 150 volt terminal **136** and the anode of the triode **134** is coupled to the plus 150 volt terminal **136** through a signal forming resistor **140**. The cathodes of the triodes **130** and **134** are coupled to

a minus 15 volt terminal **142** through a common resistor **146**. An output lead **148** is coupled between the resistor **140** and the anode of the triode **134** to receive a combined signal representing the sum of the absolute value of the positive signal applied to the grid of the triode **130** and the negative signal applied to the grid of the triode **134**. The positive signal at the tap **126** develops a positive response at the cathode of the triode **130** and the negative signal at the tap **128** is effectively inverted and summed with the positive signal to appear as a positive summed derivative signal at the anode of the triode **134**.

A summing circuit **152** is provided to combine the summed derivative signal from the lead **148** with the transient blanking signals from the source **18**. The derivative signal and the blanking signals are applied respectively through resistors **154** and **156** to a common point **160** and to ground through a common resistor **162**. An alternating combined signal including the blanking signal as the carrier wave for the differential signals is applied from the common point **160** to a clipping circuit **166** which, as will be explained subsequently, determines an absolute level for clamping operation. The alternating combined signal is applied from the common point **160** to a lead **161** and through the cathode to anode path of a diode **170** for clipping and to an arm **172** of a tapped resistor **174** having one end coupled to a plus 50 volt terminal **176** and the other end grounded. The alternating combined signal, after clipping, is applied from the lead **161** through an amplifier **180** which is operated class A so that no clipping or limiting occurs therein.

The alternating combined signal is applied from the amplifier **180** through a lead **182** to a coupling capacitor **184** so as to isolate a D.C. (direct current) bias of the intensity grid **74** from the control circuitry previously described. The coupling capacitor **184** is part of a clamping circuit **186** which firmly clamps the clipping level of the combined signal to provide reliable intensity control and to prevent destruction of the screen **50** in the event of a failure of the vertical and horizontal deflection signals. The coupling capacitor **184** is coupled to a lead **188** which, in turn, is coupled through the cathode to anode path of a diode **190** to a movable tap **192** of a tapped resistor **194**. One end of the resistor **194** is coupled to a minus 2700 volt terminal **198** and the other end is coupled through a biasing resistor **200** to the cathode **46** of the cathode ray tube **14**. A shunting resistor **202** is coupled from the tap **192** to the lead **188** to provide a discharge path for the coupling capacitor **184**.

Referring now to FIG. 2 which shows the screen **50** of the cathode ray tube **14**, as well as to FIG. 1, an example of various symbols which may be time shared will be explained. A range circle **206** may have a diameter which varies to indicate to a pilot the remaining range between his present position and a target, for example, thus varying from a large diameter circle to a very small diameter circle at the center of the screen **50**. A steering dot **210** may be provided to indicate to the pilot the direction which he is flying relative to a calculated position such as a target, which dot is maintained with a constant size. The position of the steering dot **210** on the screen **50** relative to the center of the screen **50** may indicate the variation of the flight of a craft utilizing the display from a desired flight path toward a target. A horizon line **212** may be provided to indicate the attitude of the craft relative to a horizontal position, which line may vary in size and may be utilized only during a portion of a flight. The system in accordance with this invention may be utilized with many more signals than indicated on FIG. 2 by using the time sharing arrangement thereof.

Referring now also to FIG. 3 which is a graph of amplitude versus time as well as referring to FIG. 1, the operation of the intensity control system will be further explained. For the display shown in FIG. 2, a period of time t_0 to t_6 will be utilized to form the three symbols, which period is continually repetitive as determined by the source of blanking signals **18** and the sources of deflection signals **10** and **12** synchronized with the source **18**. Between the period t_0 and t_2, sine wave **216** of a waveform **217** may be applied from the source **10** to the vertical deflection amplifier **24** and similar signals 90 degrees out of phase from the signals **216** may be applied from the source **12** to the horizontal amplifier **26** to develop the range circle **206**. Between times t_2 and t_4, the steering dot **210** is formed by a pair of signals such as **218** from the sources **10** and **12**. As is well known, the steering dot **210** is developed by a pair of signals such as **218** having fixed levels for deflecting the electron beam to a desired position on the screen **50**. Between times t_4 and t_6, the horizon line **212** is formed from signals **222** of the waveform **217** from the source **10** and similar signals in phase therewith from the source **12**. The signals applied to the amplifiers **24** and **26** are then applied 180 degrees out of phase from each other from the amplifier **24** to the leads **30** and **32** and similarly from the amplifier **26** to the leads **40** and **42**.

The range circle signals **216** are then applied to the differentiation circuit **56** and to the full wave rectifier **78** to form positive and negative differential signals whose absolute values are summed in the differential amplifier **132** to form a summed differential signal **226** of a waveform **225**. It is to be noted that the summed differential signal **226** has a plurality of amplitude variations indicating the algebraic sum of the rate of change of the vertical and the horizontal deflection voltages. Because full wave rectification and summing is provided, this algebraic sum is the instantaneous magnitude, which is very nearly proportional to the rate of the sweep of the electron beam of the cathode ray tube **14**. Thus, variations of intensity due to error of algebraic addition as compared to vectorial addition is greatly minimized so that bright spots on the symbols caused by incorrect algebraic addition at the peaks of the signals **216**, for example, are substantially eliminated. The summed differential signal for the steering dot **210** is a D.C. signal **228** having a constant level and the summed differential signal for the horizon line **212** is a signal **232** having instantaneous variations in magnitude resulting from full wave rectification and summing of the pair of sine waves such as the signal **222**.

The gating or blanking signal applied to the summing circuit **152** is shown by a waveform **236** and during the time of writing of each symbol has both a low and a high voltage level. During times t_0 to t_1, t_2 to t_3 and t_4 to t_5, blanking time is provided for the electron beam to move from one symbol to the other without forming a trace on the screen **50**. During times t_1 to t_2, t_3 to t_4 and t_5 to t_6, which are writing times, the symbols are formed on the screen **50**. All symbols are retained on the screen **50** because of the retentivity characteristics of the phosphor material. It is to be again noted that the gating signal of the waveform **236** may be utilized to control or synchronize the time sharing in the source **10** and **12** of the deflection voltages developed therein. It is to be noted that for blanking out small portions of the symbols such as the range circle **206**, the gating signals of the waveform **236** between times t_1 and t_2 may include short period voltage changes between the high and the low voltage level thereof.

The differential signal of the waveform **225** and the gating signal of the waveform **236** are thus combined in the summing circuit **152** to form a gated or combined signal of a waveform **240** which being an A.C. (alternating current) signal will always pass through the coupling capacitor **184**. It is to be noted that the differential signals **228** of the steering dot **210** is a D.C. signal and would be blocked by the coupled capacitor **184** so as to prevent intensity control if it were not for combining the differential information with the alternating gating signal of the waveform **236**. The gated signal of the waveform **240** is applied to the clipping circuit **166**

before being applied to the coupling capacitor **184** to positively establish a clipping level **244** so that the gating signal can be reliably clamped at this level. The gated signal of the waveform **240** after clipping is applied through the coupling capacitor **184** to the clamping circuit **186** as a waveform **246** with the clipping level **244** clamped at a desired clamping level **248**. The voltage of the clamping level **248** is selected so that an electron beam with an intensity controlled by that voltage does not damage the screen **50** when applied continually thereto. Thus, in the absence of deflection voltages the intensity grid **74** is maintained at the clamping level **248** and the electron beam does not have sufficient intensity to burn the phosphor on the screen **50**. The clamped signal of the waveform **246** is then applied to the intensity grid **74** to control the intensity of the symbols on the screen **50**.

Between the times t_0 to t_1, the electron beam projected on the screen **50** with an intensity determined by the clamping level **248** is deflected from a previous symbol to the position of the range circle **206** on the screen **50**. The clamping level **248** is selected so that no visible trace of the electron beam is formed on the screen **50**. Between the times t_1 and t_2, the range circle **206** is formed with the instantaneous intensity control voltage of the waveform **246** varying as determined by the full wave rectification and summing operation. Similarly, the steering dot **210** is formed on the screen **50** during the times t_3 to t_4 with the intensity control voltage determined by the fixed level of the waveform **246**. Also, the horizon line **212** is formed on the screen **50** during the times t_5 to t_6 with the instantaneous varying intensity control voltages of the waveform **246**.

In the absence of one symbol such as the horizon line **212** during the times t_4 to t_6, for example, the intensity of the remaining signals remain constant with this system. If it were not for the clipping and clamping arrangement in accordance with this invention, an average D.C. value would be determined by the number of symbols being written thus causing the intensity of the symbols on the screen **50** to vary with the number of symbols presented. The clamping circuit **186** by clamping the gating signal at the clipping level **244** maintains a constant intensity on the screen **50** regardless of the number of signals on the sources **10** and **12** that are desired to be displayed. It is again to be noted that the clamping circuit **186** provides absolute protection of the screen **50** during a failure of the deflection voltages, for example, because the clamping level **248** is selected to provide an electron intensity that will not damage the phosphor over any period of time. Further, the clamping level **248** is selected so that the electron beam between one symbol and the other will not form a visible trace on the screen **50**.

Thus, there has been described an intensity control system for a cathode ray tube utilizing time sharing for writing a plurality of symbols with a single electron gun, each symbol having the same writing time, which system provides symbols of equal intensity regardless of the size, shape and number of symbols displayed. The system provides a reliable means of determining the velocity of movement of the electron beam so as to minimize the difference between the algebraic sum and the vectorial sum of the rate of change of the vertical and horizontal deflection potentials, thus greatly reducing bright spots on the symbols. Further, the system provides a means for positively protecting the phosphor on the screen from burning during the failure of deflection voltages.

What is claimed is:

1. An intensity control system for controlling the intensity grid of a cathode ray tube having horizontal and vertical deflection plates and an electron beam which is time shared during repetitive periods to develop a plurality of symbols each being formed repetitively on a screen during symbol portions of the repetitive periods comprising a source of horizontal and vertical deflection signals coupled respectively to the horizontal and vertical deflection plates, said source controlled so that the deflection signals during each period represent a respective symbol, first and second differentiating means coupled respectively to said source of horizontal and vertical deflection signals, first and second full wave rectifiers coupled respectively to said first and second differentiating means, first summing means coupled to said first and second rectifiers for developing a summed signal representing the summed absolute value of the differentials of the horizontal and vertical deflection signals, a source of gating signals synchronized with said source of horizontal and vertical deflection signals for defining a blanking period and a writing period during each symbol period, second summing means coupled to said first summing means aid to said source of blanking signals to develop a combined signal, slipping means coupled to said second summing means, an isolating capacitor coupled between said clipping means and the intensity grid, a source of biasing potential, and clamping means coupled between said source of biasing potential and said intensity grid, whereby the potential of said source of biasing potential is isolated from said second summing means and the plurality of symbols are formed on the screen with equal intensity.

2. An intensity control system for a cathode ray tube displaying a plurality of symbols on a screen by forming each symbol during a separate symbol period of a repetitive period with the symbols being retained on the screen by the retentivity characteristics thereof, the cathode ray tube having an electron stream, horizontal and vertical deflection plates and an intensity grid comprising a source of horizontal deflection signals, a source of vertical deflection signals, said deflection signals having phase and amplitude characteristics during each symbol period representative of a different one of said plurality of symbols, a horizontal and a vertical deflection amplifier coupled respectively to said source of horizontal and vertical deflection signals and coupled respectively to the horizontal and vertical deflection plates, horizontal and vertical differentiation means coupled respectively to said horizontal and vertical amplifiers, horizontal and vertical full wave rectifiers coupled respectively to said horizontal and vertical differentiation means, first summing means coupled to said horizontal and vertical rectifiers for developing a summed signal representative of the sum of the absolute values of the differential of the horizontal and vertical deflection signals, a source of blanking signals synchronized with said source of horizontal and vertical deflection signals having a blanking level and a writing level during each symbol period, second summing means coupled to said first summing means and to said source of blanking signals for receiving said summed signal and the blanking signals to develop a combined signal, a clipping circuit coupled to said second summing means for establishing a fixed clipping level of said combined signal, a coupling capacitor coupled to said clipping circuit for passing the clipped combined signal therethrough, and a clamping circuit coupled between said coupling capacitor and the intensity grid for clamping the clipping level of said clipped combined signal, thereby controlling the intensity of the electron beam so that symbols are presented on the screen with an equal intensity.

3. An intensity control system for a cathode ray tube having an electron beam, an intensity grid, horizontal and vertical deflection plates for receiving during each of a plurality of repetitive symbol periods symbol information for developing a different one of a plurality of symbols, the symbol information being received from a source of horizontal deflection signals and from a source of vertical deflection signals, comprising means coupling the source of vertical deflection signals and the source of horizontal deflection signals respectively to the horizontal

and vertical deflection plates to cause the electron beam to be deflected in response thereto, first and second differentiation circuits coupled to said source of deflection signals for developing first and second differential signals representative of the horizontal and vertical velocity vectors of the electron beam, first and second full wave rectifiers coupled respectively to said first and second differentiation circuits for separating positive and negative portions of said first and second differential signals, first summing means coupled to said first and second rectifier for combining the negative portions of said first and second differential signals, second summing means coupled to said first and second rectifiers for combining the positive portions of said first and second differential signals, third summing means coupled to said first and second summing means for combining the absolute value of said positive and negative portions to form a summed signal representative of the velocity of deflection of said electron beam, a source of gating signals synchronized with said source of horizontal and vertical deflection signals, the gating signals having a blanking level and a writing level for each symbol period, fourth summing means coupled to said third summing means and to said source of gating signals to develop an alternating intensity control signal, a clipping circuit coupled to said fourth summing means for establishing a predetermined clipping level to said alternating signal, a coupling capacitor coupled between said clipping circuit and said intensity grid, and a clamping circuit coupled to said intensity grid for maintaining said clipping level of said alternating signal at a predetermined voltage, whereby the intensity of the electron beam is controlled in response to the velocity of deflection thereof and during each symbol period a symbol is formed on the screen and during each blanking period the electron beam is deflected to a position on said screen for forming a different symbol.

4. A system for developing a plurality of symbols on the screen of a cathode ray tube by time sharing separate symbol forming information to be displayed as individual symbols, the cathode ray tube having horizontal and vertical deflection plates, an electron stream and an intensity grid comprising a source of horizontal and vertical deflection signals indicative of the separate symbol forming information, signal applying means coupled between said source and the horizontal and vertical deflection plates for respectively applying the horizontal and vertical deflection signals thereto, first and second differentiation means coupled to said source for respectively receiving a portion of said horizontal and vertical deflection signals to develop differential signals, first and second rectifying means coupled respectively to said first and second differentiation means, each of said rectifying means developing positive and negative portions of said differential signals, first summing means coupled to said first and second rectifying means for summing said positive portions, second summing means coupled to said first and second rectifying means for summing said negative portions, third summing means coupled to said first and second summing means for developing a summed differential signal representative of the absolute value of the differential signals developed by said first and second differentiating means, a source of alternating signals synchronized with said source of horizontal and vertical deflection signals, fourth summing means coupled to third summing means and to said source of alternating signals for developing a combined alternating signal, clipping means coupled to said fourth summing means for establishing a predetermined clipping level to said combined alternating signal, a coupling capacitor coupled between said clipping means and the intensity grid, and clamping means coupled to said intensity grid for maintaining said clipping level at a predetermined level whereby the intensity of the symbols is maintained substantially constant.

5. An intensity control system for time sharing a plurality of symbol information signals to be displayed as a plurality of symbols on the screen of a cathode ray tube having an electron beam and an intensity grid, first and second horizontal deflection plates and first and second vertical deflection plates comprising a source of the horizontal and vertical deflection signals having, during each of a plurality of symbol periods, a phase and amplitude relation for developing a respective symbol, first and second deflection amplifier means coupled respectively to said source of horizontal and vertical deflection signals and respectively to the horizontal and vertical deflection plates, first and second differentiation circuits coupled respectively to said first and second deflection amplifier means for receiving horizontal and vertical deflection signals having a phase relationship similar to that of said source of horizontal and vertical deflection signals and for developing differential signals, first and second rectifier circuits coupled respectively to said first and second differentiation circuits for developing positive and negative portions of the horizontal and vertical differential signals, first summing means coupled to said first and second rectifier circuits for developing a summed signal of the absolute value of the positive and negative portions of the differential signals, a source of blanking signals synchronized with said source of horizontal and vertical deflection signals for developing blanking signals having a blanking level and a symbol writing level during each of said symbol periods, second summing means coupled to said first summing means and to said source of blanking signals for developing a combined signal with the summed differential signals appearing at the blanking level and at the symbol writing level of said blanking signals, a clipping circuit coupled to said second summing means for clipping said combined signal at a level to remove said summed signals therefrom from the blanking level thereof, a coupling capacitor coupled between said clipping circuit and the intensity grid for applying the clipped combined signal therethrough, a biasing source, and a clamping circuit coupled between said biasing source and said intensity grid for clamping the clipping level of said combined signal, whereby said biasing source is isolated from said clipping circuit by said coupling capacitor and said intensity grid is controlled so that the symbols developed on the screen have substantial equal intensity.

6. An intensity control system for a cathode ray tube to display a plurality of symbols on the screen thereof in response to time shared information, the cathode ray tube including first and second horizontal deflection plates, first and second vertical deflection plates, an electron beam and an intensity control grid comprising a source of horizontal deflection signals, a source of vertical deflection signals, said horizontal and vertical deflection signals having a phase and amplitude relation representative of said plurality of symbols, first inverting means coupled to said source of horizontal deflection signals for developing first and second horizontal deflection voltages being 180 degrees out of phase from each other, second inverting means coupled to said source of vertical deflection signals for developing first and second vertical deflection voltages being 180 degrees out of phase from each other, said first horizontal and vertical deflection voltages having a phase and amplitude relation similar to that of the horizontal and vertical deflection signals at said source, said first inverting means being coupled to the first and second horizontal deflection plates for applying said first and second horizontal deflection voltages thereto to deflect the electron beam horizontally, said second inverting means being coupled to said first and second vertical deflection plates for applying said first and second vertical deflection voltages thereto to deflect said electron beam vertically, a first differentiation circuit coupled to said horizontal deflection means for receiving said first horizontal deflection voltage to develop a first differential signal representing rate of horizontal deflection of said electron beam, a second differentiation circuit coupled to said second inverting means for receiving said first vertical deflection

voltages to develop a second differential signal representing the rate of vertical deflectiton of said electron beam, a horizontal full wave rectifier coupled to said first differentiation circuit, a vertical full wave rectifier coupled to said second differentiation circuit, a first summing means coupled to said horizontal and vertical rectifier for combining negative portions of the rectified first and second differential signals, a second summing means coupled to horizontal and vertical rectifiers for combining the positive portions of said first and second differential signals, differential amplifier means coupled to said first and second summing means for combining said positive and negative portions to develop a summed signal from the absolute values of said positive and negative portions, said summed signal representing the rate of deflection of said electron beam, a source of blanking signals synchronized with said source of horizontal and vertical deflection signals, third summing means coupled to said differential amplifier means and to said source of blanking signals for developing an alternating signal, a clipping circuit coupled to said third summing means for clipping the lower level of said alternating signal at a preselected clipping voltage, a coupling capacitor coupled to said clipping circuit, a clamping circuit coupled to said coupling capacitor for maintaining said clipping level at a preselected clamping voltage, said clamping circuit being coupled to the intensity grid for controlling the intensity of the electron beam in response to the velocity of deflection thereof so as to present the plurality of signals on the screen with equal intensity.

7. An intensity control system for developing a plurality of symbols on the screen of a cathode ray tube and for time sharing information from a source to develop each of the symbols during a different symbol period, the cathode ray tube including a screen, an electron stream, an intensity grid, a cathode, and horizontal and vertical deflection plates coupled to the source for responding to

horizontal and vertical deflection signals during each symbol period to deflect the electron stream so as to develop a symbol on the screen comprising a source of blanking signals having a blanking voltage level and a writing voltage level during each symbol period, first and second differentiation means coupled to said source for developing first and second differential signals indicative of the rate of change of the horizontal and vertical deflection signals, said differential signals having alternating and direct current characteristics, first and second full wave rectifiers coupled respectively to said first and second differentiation circuits, first summing means coupled to first and second rectifiers for developing a summed signal indicative of the absolute value of said first and second differential signals, second summing means coupled to said source of blanking signals and to said first summing means for developing a combined signal utilizing the blanking signals as a carrier wave, a clipping circuit coupled to said second summing means for establishing a clipping level to said combined signal, a coupling capacitor coupled between said clipping circuit and the intensity grid, a potential source coupled to the cathode of said cathode ray tube, a clamping circuit coupled between said potential source and the intensity grid for maintaining said clipping level at a predetermined clamping level, said coupling capacitor isolating said potential source from said second summing means and said combined signal passing through said coupling capacitor to control the intensity of said symbols when said differential signal has either alternating characteristics or direct current characteristics.

References Cited in the file of this patent

UNITED STATES PATENTS

2,700,741	Brown	Jan. 25, 1955
2,745,036	Symer	May 8, 1956
2,758,247	Johnson	Aug. 7, 1956
2,860,284	McKim	Nov. 11, 1958