May 21, 1963 P. M. CUNNINGHAM ETAL 3,090,887

BACKGROUND IMPROVEMENT CIRCUIT FOR DIRECT VIEW STORAGE TUBE RADAR INDICATOR

Filed Jan. 15, 1960 2 Sheets-Sheet 1

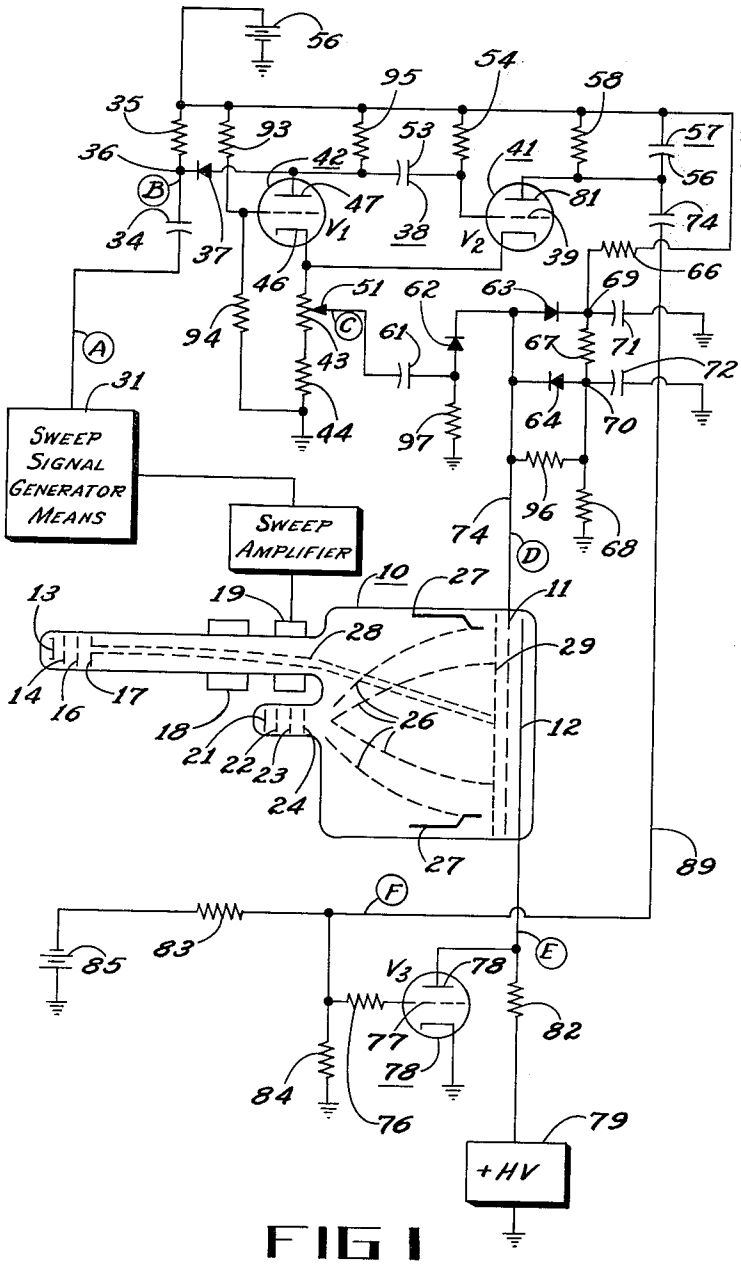


FIG 1

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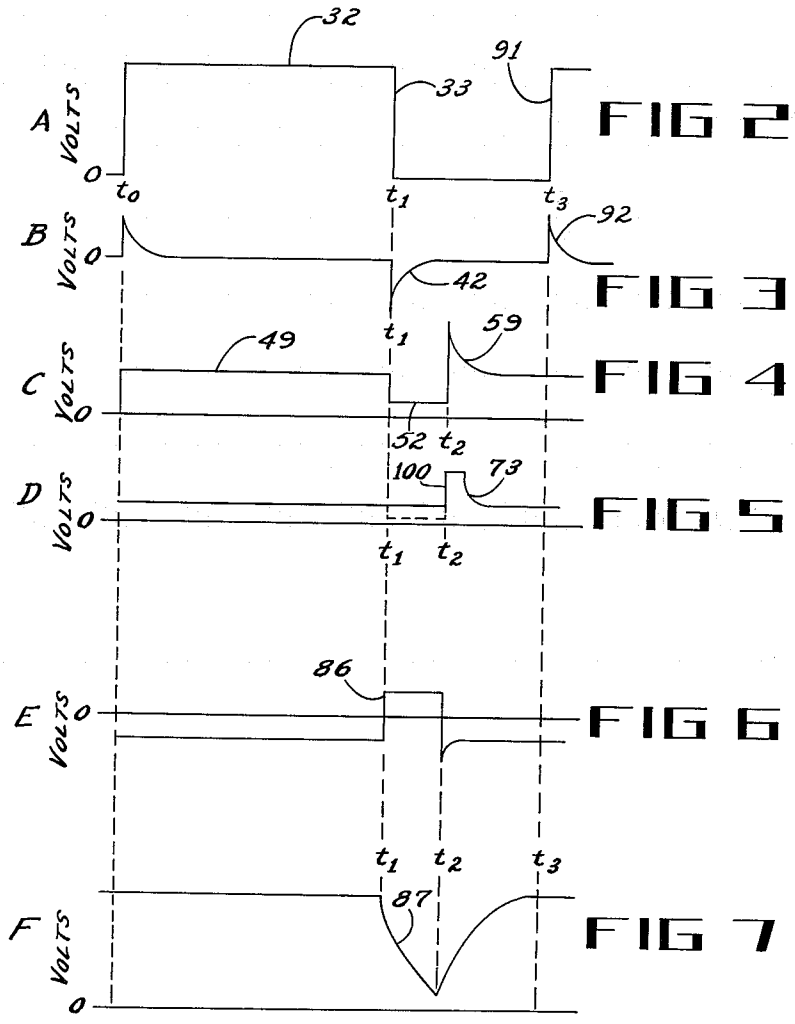


FIG 2

FIG 3

FIG 4

FIG 5

FIG 6

FIG 7

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BACKGROUND IMPROVEMENT CIRCUIT FOR DIRECT VIEW STORAGE TUBE RADAR INDICATOR

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This invention relates generally to means for controlling the brightness contrast of cathode-ray type tubes and more particularly to means for controlling the brightness contrast of cathode-ray type tubes of the type employing both a means for generating and impelling an electron writing beam towards the viewing screen and means for generating and impelling a flood of electrons continuously and uniformly over the general area occupied by the viewing screen.

Recently there has been developed a new cathode-ray tube which produces an image of high contrast and high brightness and with controllable persistence. This new type cathode-ray tube comprises a conventional electron gun with appropriate focusing, accelerating, and deflection means. This conventional electron gun is used as the writing gun and is scanned across a storage mesh electrode positioned in front of the viewing screen in a conventional pattern. Video input signals are applied to the cathode or to the control grid of the writing electron gun to control the quantity of electrons in the beam. This beam of electrons strikes the storage mesh electrode. The storage mesh electrode, in one form of the tube, is an electroformed nickel mesh with a dielectric film deposited on the gun side. A beam of high velocity electrons from the writing gun striking the dielectric film will cause emission of the secondary electrons greater than the quantity in the incident electron beam. Thus, that particular area of the dielectric film being bombarded is charged positively due to the over-all loss of electrons. The resultant positive charge thereon is proportional to the electron intensity of the writing gun beam. The secondary electrons released from the storage mesh flow to another electrode herein identified as the collector mesh which is located in front of the storage mesh, i.e., between the storage mesh and the gun.

The flood gun structure emits a large quantity of low velocity electrons in a divergent beam which is directed towards the viewing screen. These low velocity electrons cause emission of a smaller quantity of secondary electrons than the quantity produced by the high velocity writing beam. Therefore, in the unwritten condition, the dielectric film on the storage mesh is charged negatively by the low velocity electrons from the flood gun. This charge reaches equilibrium about a −6 volts, which is below the cut-off voltage, thus preventing the low velocity beam from reaching the viewing screen. In operation then, the writing gun makes certain areas of the storage mesh electrode positive, while the flood gun makes the remaining area of the storage mesh negative. The electrons emanating from the flood gun (hereinafter sometimes referred to as flood gun electrons) are repelled by the negative areas of the storage mesh but pass through the positive areas and strike the viewing screen. The resultant luminescent image on the viewing screen is brightest in the areas corresponding to the most positive areas of the storage mesh and darkest in the areas corresponding to the most negative areas of the storage mesh. The visible image in this new type cathode-ray tube is considerably brighter than the image produced by the conventional type cathode-ray tube because the viewing screen is illuminated continuously by the electron-ray flood guns.

However, persistence of the image on the storage mesh is limited by the effect of positive ions produced by the residual gases within the tube. These ions will migrate to the negatively charged storage mesh and will gradually charge the storage mesh surface in a positive direction which, of course, will tend to permit more electrons to pass through the storage mesh and impinge upon the viewing screen, thus producing a gradual increase in over-all brightness of the viewing screen, which is an undesirable occurrence. In a practical application such as the pulse position presentation employed in weather radar gear, the image should be erased completely after the last radial sweep signal of each complete revolution of radial sweep signals. Such erasing of the storage image on the storage mesh is accomplished by momentarily increasing the bias on the storage mesh to a value more positive than the potential of the flood-gun cathode. Electrons from the flood gun will then strike the surface of the storage mesh and charge the dielectric film thereon to the potential of the flood-gun cathode. When the storage image is then returned to its normal operating bias, the dielectric film will be carried capacitively to below cut-off potential. A problem arises however when the potential of the storage mesh is raised by the erase pulse. Such increase in potential allows the flood gun electrons to pass through the storage mesh and produce bright flashes over the complete viewing screen unless something is done to prevent this effect. These bright flashes produced during the erase pulses represent the principal problem solved by the present invention.

In the prior art this problem has been approached by applying a sinusoidal voltage to the viewing screen, said sinusoidal voltage being phase-synchronized with the erase pulses so that the most negative portion of the sinusoidal voltage occurs during each erase pulse. It will be apparent that certain disadvantages are inherent in such an arrangement. More specifically, there are certain difficulties attendant in phase-synchronizing a sinusoidal signal with a pulse whose repetition rate is the same as the frequency of the sine wave. Such problems of synchronization are increased if the invention is employed in a system such as a weather radar system having several ranges, particularly if the erase pulse is made to occur after each revolution of the radial sweep.

A further disadvantage in the use of sinusoidal waveforms to switch off the high voltage of the viewing screen is the fact that the maximum average voltage applied to the viewing screen can only be about 50 or 60 percent of the maximum rating for the tube depending upon whether the tube is non-aluminized or is aluminized. It is apparent that the nearer the average voltage applied to the viewing screen is to the maximum allowable voltage, the brighter will be the picture and the greater the contrast.

An object of the present invention is to switch off the viewing screen high voltage by relatively short pulses which occur during the erase pulses supplied to the storage mesh, thus permitting the supplying of an average voltage to the viewing screen of about 80 to 90 percent of maximum rating.

Another aim of the invention is to switch off the viewing screen high voltage by means of a pulse coincident with the erase pulse, both pulses occurring after the termination of a first sweep signal and before the initiation of the next sweep signal so as to avoid the possibility of the variation of the storage mesh voltage adversely affecting the visual display on the viewing screen.

In accordance with the invention there is provided in combination with a cathode-ray tube of the type above described which comprises a viewing screen, flood gun means, writing gun means, storage mesh electrode, and a collector mesh electrode cooperating in the manner described above, and sweep signal generating means for

causing the electron beam produced by said writing gun to scan said storage mesh electrode, an erase pulse generating means responsive to the operation of said sweep signal generating means to produce a first and a second pulse at the termination of each sweep signal. Means responsive to said first pulse are provided to create a low impedance between said viewing screen and ground potential for the duration of said first pulse to remove the high voltage from said viewing screen. As a practical matter this last-mentioned means may be a vacuum tube which is normally nonconductive but which responds to the said first pulse to become conductive and effectively shunt the viewing screen potential to ground potential. Further, the erase pulse generating means further is constructed to produce a second pulse in response to the operation of the sweep signal generating means, which second pulse is delayed a short interval of time after said first pulse. The said second pulse which is the erase signal, and which is positive-going, is supplied to the storage mesh electrode for purposes of erasing described hereinbefore. The said second pulse must be delayed a little past the occurrence of said first pulse since the erasing should not occur until after removal of the potential from the viewing screen. Actual removal of the viewing screen potential also is delayed past the occurrence of said first pulse due to the capacitance in the circuit, which capacitance results in an exponential decay of the viewing screen potential.

In accordance with a feature of the invention the potential of the veiwing screen is reduced and then raised again in a relatively short period of time, perhaps 15 to 20 percent of the sweep frequency period, thus permitting an average viewing screen potential which is within 80 or 90 percent of the allowable maximum.

The above-mentioned and other objects and features of the invention will be more fully understood from the following detailed description thereof when read in conjunction with the drawings in which:

FIG. 1 is a schematic diagram of a preferred form of the invention; and

FIGS. 2 through 7 are waveforms of signals appearing at the various points in the circuit of FIG. 1.

Referring now to FIG. 1 the cathode-ray tube **10**, which is old in the art, will be described first. Subsequently the circuitry for generating and supplying the erase pulse to the storage mesh **11** of tube **10** and the circuitry for removing the high voltage potential of the viewing screen **12** of tube **10** will be discussed. It is the two last-mentioned circuits and the cooperation therebetween which comprise the essence of this invention.

The tube **10** comprises a writing gun assembly which includes cathode **13**, a control grid **14**, a focusing electrode **16**, an accelerating electrode **17**, a stationary deflecting yoke **18**, and a rotating deflecting yoke **19**. The flood gun assembly comprises cathode **21**, control electrode **22**, focusing electrode **23** and accelerating electrode **24**. As indicated hereinbefore the flood gun functions to produce a uniform and continuous flood of electrons, represented by the dotted lines **26**, over the storage mesh electrode **11**. This flood-like distribution of electrons is effected largely by collimator electrode **27** which is in the form of an angular ring.

The writing gun assembly produces a pencil-like beam of electrons designated generally by the dotted lines **28** which pass through the collector electrode **29** and impinge upon the storage mesh **11**. Each portion of the storage mesh is charged in accordance with the intensity of the pencil-like beam (writing beam) as it scans the storage mesh.

The flood-gun assembly produces a flood of electrons which sprays the entire storage mesh continuously and uniformly with electrons. In accordance with the amount of electrical charge created upon the storage mesh by the writing beam varying proportions of the flood of electrons will either be collected on the storage mesh or will pass through the storage mesh to impinge upon the viewing screen thereby causing luminescence thereon.

The function of the collector electrode **29** is to collect the secondary emission electrodes knocked out of the storage mesh electrode when the writing beam or flood electrons impinge upon such storage mesh.

Now, as indicated hereinbefore, the collection of stray due to positive ions upon said storage mesh which gradually raises the potential thereof so that too many flood electrons are passing on through to the viewing screen, it is necessary to periodically supply an erase pulse to said storage mesh to, in effect, erase this positive charge from said storage mesh. Generally speaking this erasing process is accomplished by momentarily increasing the potential of the storage mesh so that it will collect flood electrons. Then, when the positive erase pulse is removed from the storage mesh, the potential of the storage mesh will decrease, by capacitive action, to a value more negative than what it was before the application of the positive pulse.

As indicated above it is desirable to apply this erase pulse after the termination of a sweep pulse or during the fly-back period of the writing gun in order to avoid interference with the visual display. Ordinarily this would not be a particularly difficult thing to accomplish since it would involve, essentially, circuit means for recognizing the end of a sweep signal and thereupon generating a positive pulse which would be applied to the storage mesh. However, complications arise in that it is desirable to have the viewing screen voltage removed when the erase pulse is applied in order to avoid periodic bright flashes on the viewing screen. Due to the large voltages involved and the relatively large capacitance existing between the viewing screen and other elements within the cathode-ray tube there is a short time delay involved in reducing the screen voltage. It will be apparent then that the erase pulse must be delayed a short interval of time to permit the removal of the screen voltage first.

Both the erase pulse and the pulse employed for removing the potential of the viewing screen are derived from the sweep signal generating means **31** which is constructed to produce in addition to the sweep signal, a train of pulses as shown in FIG. 2, which pulses are rectangularly shaped and coincide substantially with the duration of the sweep pulse. At time t_0 a sweep pulse (not shown) begins and the pulse **32** (FIG. 2) begins. At time t_2 the sweep pulse terminates causing a termination of the pulse **32**. The negative trailing edge of negative pulse **32** is differentiated by capacitor **34** (FIG. 1) and resistor **35** to produce at terminal **36** a waveform as shown in FIG. 3 and which consists of positive and negative spikes. Due to the presence of diode **37** only the negative spikes such as the negative spike occurring at time t_1 are permitted to pass through coupling capacitor **38** to the control grid **39** of triode **41**. Triode **41** and triode **42** form the two tubes of a one-shot multivibrator in which triode **41** is normally conductive in the quiescent state and in which tube **42** is normally nonconductive in the quiescent state.

When the negative pulse **42** (FIG. 3) is applied to grid **39** of tube **41** the plate current therethrough begins to decrease, which will produce a decrease in voltage across the common cathode resistor comprised of resistors **43** and **44** thus lowering the potential of cathode **46** of tube **42**. The tube **42** will then begin to conduct which will produce a decrease in the potential of anode **47**, which decrease in potential will be impressed upon the grid **39** of tube **41** through coupling capacitor **38**. This regenerative process will continue until tube **41** is completely nonconductive and tube **42** is conductive. The process occurs very rapidly and for purposes of simplicity and clarity is shown as happening instantaneously at time t_1 in the curve of FIG. 4.

The voltage level **49** of FIG. 5 represents the potential of tap **51** during the time that tube **41** is conductive and

tube 42 is nonconductive and voltage level 52 represents the potential of tap 51 after tube 41 has become nonconductive and tube 42 has become conductive.

During the time (t_1) that tube 41 is becoming nonconductive the plate 53 of capacitor 38 acquires a negative charge. As soon as a stable condition is obtained, i.e., regeneration ceases this negative charge on plate 53 begins to discharge through resistor 54 to positive supply battery 56. When the potential of plate 53 increases positively to a value just above the plate current cut-off potential of grid 39 the tube 41 will begin to conduct. The plate current through the tube current 41 will cause an increase in the voltage drop across the common cathode resistors 43 and 44 and tend to decrease the plate current through the triode 42, which in turn will increase the potential of the anode 47 thereof. The increase in anode 47 potential will be impressed upon the grid 39 of triode 41 through capacitor 38. This regenerative process occurs very rapidly and will cause tube 41 to become conductive and tube 42 to become nonconductive. For purposes of simplicity and clarity this regenerative process is shown as occurring instantaneously at time t_2.

At this point it should be noted that during the time tube 41 is cut off, i.e., between times t_1 and t_2 (FIG. 4) the plate 56 of capacitor 57 will acquire a positive charge through resistor 58 from battery source 56. Then, when triode 41 begins to conduct the energy stored in the capacitor 57 produces a surge of current through the tube 41. This surge of current also flows through the common cathode resistors 43 and 44 and produces a voltage peak at the tap 51. This voltage peak is represented by the voltage peak 59 of the waveform of FIG. 4 and is the pulse from which the erase pulse is directly derived. More specifically, the derivation of the erase pulse is as follows. The peak pulse 59 is coupled through coupling capacitor 61 and blocking diode 62 to the storage mesh 11 of tube 10. The diodes 63 and 64 form clamping circuits which limit the upper and lower values of the pulse applied to the storage mesh 11. More specifically, resistors 66, 67, and 68 form a voltage divider circuit across battery source 56 so that the potentals of junctions 69 and 70 respectively determine the upper limit and the lower limit of the potential of the pulse supplied to the storage mesh 11. In one specific form of the invention, the component values of which are set out later herein, the potential of the points 69 and 70 are positive 18 volts and a positive 5 volts respectively. Capacitors 71 and 72 are R-F by-pass capacitors. As a result of the action of diodes 63 and 64 the pulse 59 of FIG. 4 is altered to have a shape as represented by the pulse 73 of FIG. 5. The curve of FIG. 5 generally represents the potential of the conductor 74 of FIG. 1.

It will be observed that the leading edge 100 of the pulse 73 (FIG. 5) is delayed after the termination of the sweep signal by the time interval between t_1 and t_2. As indicated above, this time delay is provided to permit the high voltage to be removed from the viewing screen 12. The specific circuitry involved in removing this high voltage from the viewing screen will now be discussed. At time t_1 when the triode 41 changes from a condition of conductivity to a condition of nonconductivity the plate 81 voltage thereof increases in a positive direction. This positive increase in the voltage of anode 81 is supplied through coupling capacitor 74, conductor 89, and resistor 76, to the grid 77 of triode 78. In the absence of such a pulse the triode 78 is normally in a nonconductive condition, thus presenting a very high impedance from the viewing screen 12 to ground potential. The high voltage of high voltage source 79 is then supplied at maximum value to the viewing screen 12. However, when the positive pulse from the anode 81 of triode 41 is supplied to the grid 77 of triode 78, the triode 78 becomes highly conductive and causes most of the high voltage to be dissipated across the dropping resistor 82. Resistors 83 and 84 form a voltage divider circuit across negative biasing battery 85 to provide the cut-off bias to the grid 77 during quiescent condition. The pulse supplied to the grid 77 of triode 78 is represented by the pulse 86 of FIG. 6, the leading edge of which functions to produce conductivity in the triode 78. However, due to the relatively large capacitance existing between the viewing screen 12 and the other elements in the cathode ray tube 10 and, further, due to the high voltages involved there is a considerable time delay in the decay of the high voltage of the viewing screen 12. This decay is represented by the negative waveform 87 of FIG. 7 which begins at time t_1 and ends at time t_2. The circuit is designed so that at time t_2 the high voltage on the screen 12 has decayed to a value such that the erase pulse can be applied to the storage mesh 11 without producing a bright flash on the viewing screen 12. At time t_2, then, the erase pulse 73 of FIG. 5 can be applied to storage mesh 11 and also at time t_2 the tube 78 can be made nonconductive to permit the high voltage of the viewing screen to begin to increase. Tube 78 is made nonconductive due to the fact that tube 41 becomes conductive at time t_2. When the tube 41 becomes conductive the plate thereof decreases rapidly in potential which causes a negative pulse to be supplied through coupling capacitor 74, conductor 89, resistor 76 to the grid 77 of tube 78. Due to the capacitance between storage mesh 11 and the other electrode in cathode-ray tube 10 a relatively long time interval is required for the viewing screen to build up to its normal quiescent value, which is of the order of 8 kilovolts. At time t_3 the viewing screen 12 has recovered its high voltage and the circuit is ready for the generation of the next sweep signal (not shown) from the sweep signal generating means 31. At time t_3 the generator means also functions to produce another rectangular signal 91 shown in FIG. 2 to begin the cycle anew. It is to be noted that the spike 92 of FIG. 3 produced by the differentiator circuit consisting of resistor 35 and capacitor 34 on the leading edge of pulse 91 (FIG. 2) will have no effect on the grid of tube 41 due to the blocking effect of diode 37.

For purposes of convenience and clarity it is to be noted that the curves of FIGS. 2 through 7 are identified by letters A through F which are also found on FIG. 1 to identify the portion of the circuit at which the waveforms occur.

Component values for one specific design of the invention are given below:

Resistors

R35	150K
R43	10K
R44	2.2K
R54	560K
R58	33K
R66	147K
R67	8.25K
R68	3.16K
R75	100K
R82	2.2M
R83	220K
R84	100K
R93	100K
R94	10K
R95	56K
R96	3.9K

Capacitors

C34	μμf	470
C38	μμf	390
C57	μμf	2200
C61	μμf	1000
C71	μf	.047
C72	μf	122
C74	μf	.01

Diodes

D37	1N645
D63	1N645
D64	T126

Tubes

T41	Type 5670
T42	Type 5670
T78	Type 2653

Battery Supplies

B56	volts	−250
B85	do	−150
B79	kilovolts	+8

The display tube 10 is a type 7033 manufactured by the Electronics Division of the Hughes Aircraft Company.

It is to be understood that the form of the invention shown herein and described is but a preferred embodiment thereof and that various changes may be made in circuit design and in component values without departing from the spirit or scope of the invention.

We claim:

1. In a circuit for visually displaying a representation of a received signal comprising a direct-view storage tube having a viewing screen, means including a writing gun for producing and impelling a pencil-like electron beam towards said viewing screen, means including a flooding gun for producing and impelling a flood of electrons continuously and uniformly over the entire viewing screen, a constant high value direct voltage source means for supplying a direct voltage to said viewing screen, storage mesh means interposed between said guns and said viewing screen, collector mesh means interposed between said guns and said storage mesh means, means for generating a sweep signal for deflecting said electron beam, an erase pulse generating means responsive to the operation of the sweep signal generating means for producing an erase pulse at the termination of each sweep signal, means for supplying said erase pulse to said storage mesh means to momentarily increase the potential of said storage mesh means in a positive direction, said erase pulse generating means constructed to produce a second pulse after the termination of each sweep signal and before the initiation of the next subsequent sweep signal, and means responsive to said second pulses to substantially decrease the potential of said viewing screen below the threshold voltage necessary for collection of electrons derived from said flood of electrons during said erase pulse, said last-mentioned means further constructed to return the potential of said viewing screen above said threshold voltage before the initiation of said subsequent sweep signal.

2. A circuit means in accordance with claim 1 in which said erase pulse generating means comprises a one-shot multivibrator circuit including a normally nonconductive electron discharge device and a normally conductive discharge device each having an electron emitting electrode and an electron collecting electrode, impedance means common to the said electron emitting electrodes, separate load impedance means connected to each of said electron collecting electrodes, said normally conductive electron discharge device responsive to the operation of said sweep signal generating means to become nonconductive for a short interval of time, said second pulse being derived from the change in the electron collector potential of said normally conductive electron discharge device when said normally conductive electron discharge device becomes nonconductive, storage capacitor means connected across at least a portion of the impedance means connected to said electron collecting electrode of said normally conductive electron discharge device, said storage capacitor functioning to discharge through said normally conductive discharge device and through the common impedance means when said normally conductive discharge device becomes conductive again at the termination of a cycle of operation of the one-shot multivibrator, said erase pulse being derived from the surge of current through said common impedance means when said storage capacitor discharges.

3. A circuit in accordance with claim 1 in which said means responsive to each of said second pulses comprise an impedance means connected in series with said high voltage source and said viewing screen, a normally nonconducting electron valve comprising electron collecting electrode means, control electrode means and electron emitting electrode means, means for supplying said second pulse to said control electrode means, said electron valve constructed to respond to said second pulse to become conductive to produce a low impedance between said viewing screen and ground potential to greatly reduce the voltage supplied to said viewing screen.

4. A circuit in accordance with claim 1 in which said erase pulse generating means comprises a one-shot multivibrator including a first electron valve which is normally nonconductive and a second electron valve which is normally conductive, both of said electron valves comprising an electron emitting means and an electron collecting means, first impedance means common to the electron emitting means of said first and second electron valves, second and third impedance means connected respectively to the electron collecting means of first and second electron valves, said second electron valve constructed to become nonconductive in response to the operation of the means for generating a sweep signal, means for deriving said second pulse from the change in voltage of the electron collecting means of said second electron valve when said second electron valve becomes nonconductive, storage capacitor means connected across said third impedance means to acquire a positive charge during the nonconductive period of said second electron valve and to discharge through said second electron valve and through said first impedance means when said second electron valve becomes conductive again at the termination of the cycle of operation of said one-shot multivibrator, and means for deriving said erase pulse from the voltage produced across said first impedance means when the discharge current from said storage capacitor discharges therethrough.

5. In a circuit for visually displaying a representation of a received signal comprising a direct view storage tube having a viewing screen, means including a writing gun for producing and impelling a pencil-like electron beam towards said viewing screen, a constant high value direct voltage source for supplying direct voltage to said viewing screen, storage mesh means interposed between said guns and said viewing screen, collector mesh means interposed between said writing gun and said storage mesh means, means including a flooding gun for producing and impelling a flood of electrons continuously and uniformly over the storage mesh means, and means for generating a sweep signal for deflecting said pencil-like electron beam, an erase pulse generating means responsive to the operation of the sweep signal generating means for producing a first pulse at the termination of each sweep signal and a second pulse delayed a short predetermined interval of time from the occurrence of said first pulse but occurring before the initiation of the next succeeding sweep signal, means responsive to each of said first pulses for substantially decreasing the potential of said viewing screen below the threshold voltage necessary for collection of electrons of said flood of electrons, means for supplying said second pulse to said storage mesh means to momentarily increase the potential of said storage mesh means in a positive direction to cause said storage mesh means to collect electrons from said flood of electrons and thus assume a more negative potential upon termination of said second pulse than the potential thereof before the initiation of said second pulse.

6. A circuit means in accordance with claim 5 in which said erase pulse generating means comprises a one-shot multivibrator circuit including a normally nonconductive electron discharge device and a normally conductive discharge device each having an electron emitting

electrode and an electron collecting electrode, impedance means common to the said electron emitting electrodes, separate load impedance means connected to each of said electron collecting electrodes, said normally conductive electron discharge device responsive to the operation of said sweep signal generating means to become nonconductive for a short interval of time, said first pulse being derived from the change in the electron collector potential of said normally conductive electron discharge device when said normally conductive electron discharge device becomes nonconductive, storage capacitor means connected across at least a portion of the impedance means connected to said electron collecting electrode of said normally conductive electron discharge device, said storage capacitor functioning to discharge through said normally conductive discharge device and through the common impedance means when said normally conductive discharge device becomes conductive again at the termination of a cycle of operation of the one-shot multivibrator, said second pulse being derived from the surge of current through said common impedance means when said storage capacitor discharges.

7. A circuit in accordance with claim 5 in which said means responsive to each of said first pulses comprises an impedance means connected in series with said high voltage source and said viewing screen, a normally nonconducting electron valve comprising electron collecting electrode means, control electrode means and electron emitting electrode means, means for supplying said first pulse to said control electrode means, said electron valve constructed to respond to said first pulse to become conductive to produce a low impedance between said viewing screen and ground potential to greatly reduce the voltage supplied to said viewing screen.

8. A circuit in accordance with claim 5 in which said erase pulse generating means comprises a one-shot multivibrator including a first electron valve which is normally nonconductive and a second electron valve which is normally conductive, both of said electron valves comprising an electron emitting means and an electron collecting means, first impedance means common to the electron emitting means of said first and second electron valves, second and third impedance means connected respectively to the electron collecting means of first and second electron valves, said second electron valve constructed to become nonconductive in response to the operation of the means for generating a sweep signal, means for deriving said first pulse from the change in voltage of the electron collecting means of said second electron valve when said second electron valve becomes nonconductive, storage capacitor means connected across said third impedance means to acquire a positive charge during the nonconductive period of said second electron valve and to discharge through said second electron valve and through said first impedance means when said second electron valve becomes conductive again at the termination of the cycle of operation of said one-shot multivibrator, and means for deriving said second pulse from the voltage produced across said first impedance means when the discharge current from said storage capacitor discharges therethrough.

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