United States Patent [19]

Hirayama

[11] **3,714,502**

[45] **Jan. 30, 1973**

[54] **CIRCUIT FOR CONTROLLING AN INTENSITY OF A SCANNING IN AN ELECTROMAGNETIC DEFLECTION TYPE CATHODE RAY TUBE**

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Aug. 1, 1969 Japan 44/60381

[52] **U.S. Cl.** **315/30,** 315/22
[51] **Int. Cl.** **H01j 29/52**
[58] **Field of Search** ....315/30, 27 TD, 18, 22 R, 22

[56] **References Cited**

UNITED STATES PATENTS

3,502,937	3/1970	Bader et al.	315/30
3,004,187	10/1961	Olson	315/22
3,325,803	6/1967	Carlock et al.	315/18 X
3,191,090	6/1965	Vitt et al.	315/22

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Assistant Examiner—J. M. Potenza
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[57] **ABSTRACT**

A circuit for controlling an intensity of a scanning in an electromagnetic deflection type cathode ray tube generates an unblanking pulse only when a current change exists in a deflection coil of the cathode ray tube. The unblanking pulse is applied to an intensity modulation grid of the cathode ray tube thereby a fluorescent surface is maintained in an unblanking condition when the current change exists in a deflection coil and in a blanking condition when no current change exists in a deflection coil. As a result of this, an intensisty of a scanning can be in constant brightness independent of the scanning velocity and further, a burning of the fluorescent surface of the cathode ray tube can be prevented in case movement of a brightness spot is stopped.

4 Claims, 8 Drawing Figures

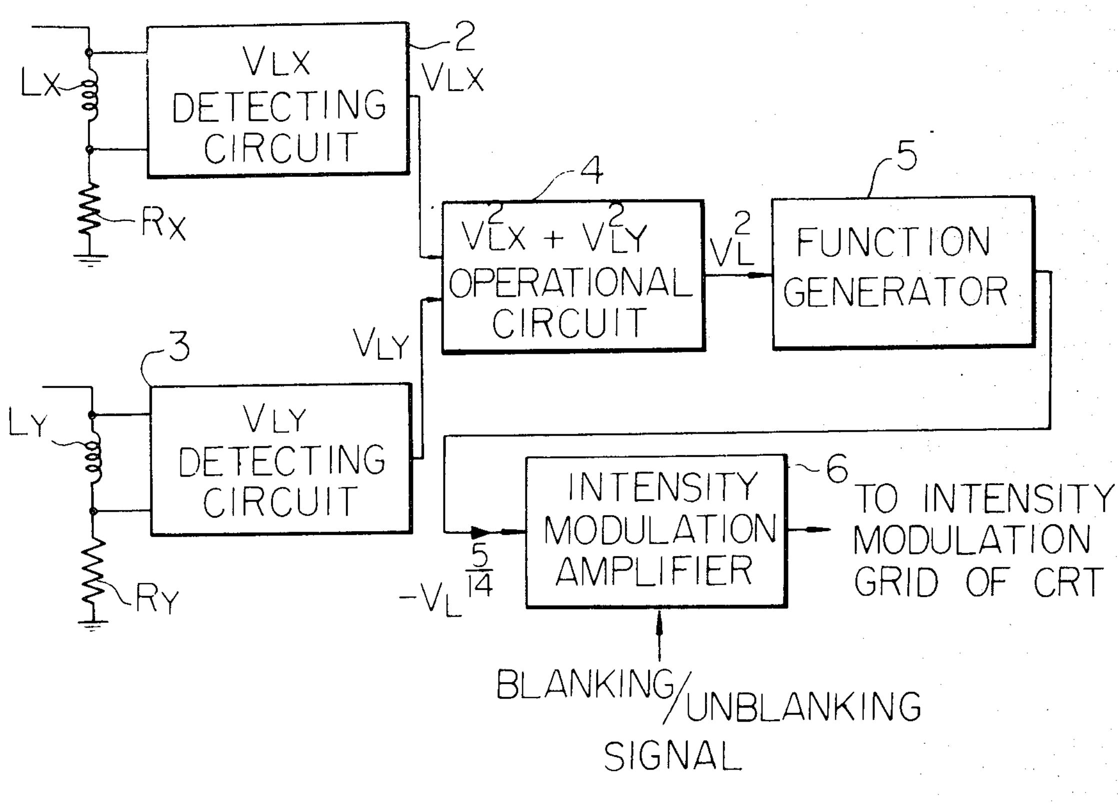


Fig. 1

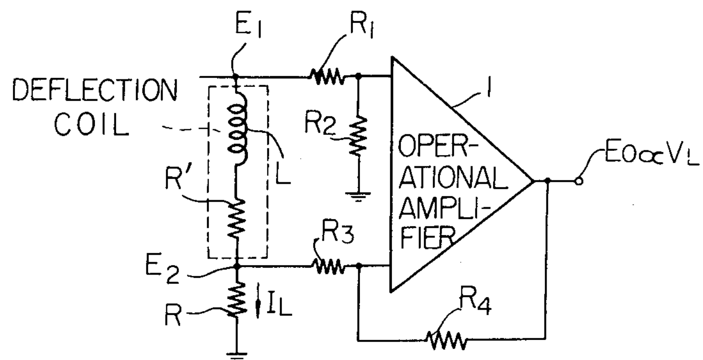

E1
R1
DEFLECTION COIL
L
R2
1
OPERATIONAL AMPLIFIER
Eo∝VL
R'
R3
E2
IL
R
R4

Fig. 2

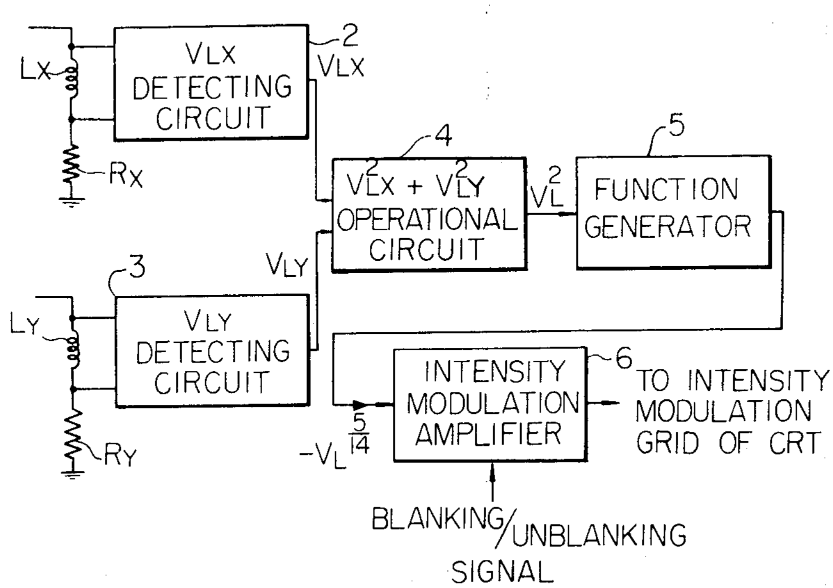

LX
VLX DETECTING CIRCUIT
2
VLX
RX
4
VLX² + VLY² OPERATIONAL CIRCUIT
VL²
5
FUNCTION GENERATOR
3
VLY
LY
VLY DETECTING CIRCUIT
RY
INTENSITY MODULATION AMPLIFIER
6
TO INTENSITY MODULATION GRID OF CRT
-VL 5/14
BLANKING/UNBLANKING SIGNAL

Fig. 3

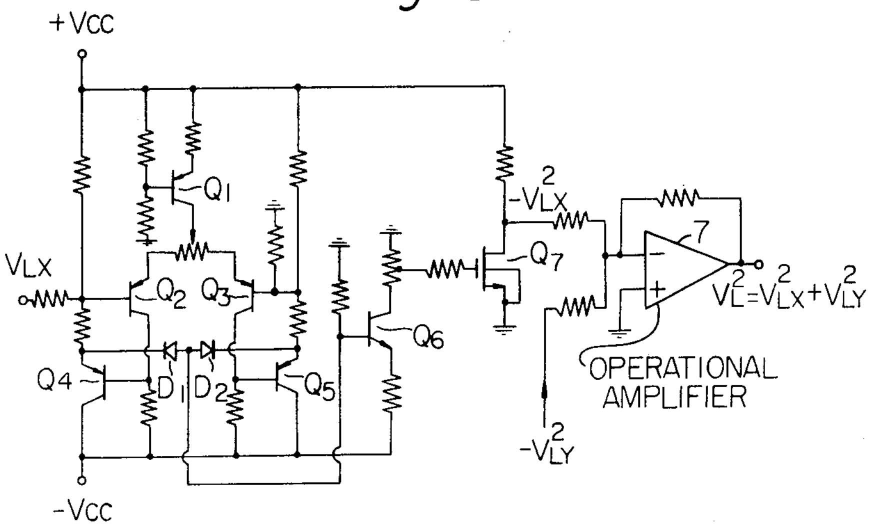


Fig. 4A

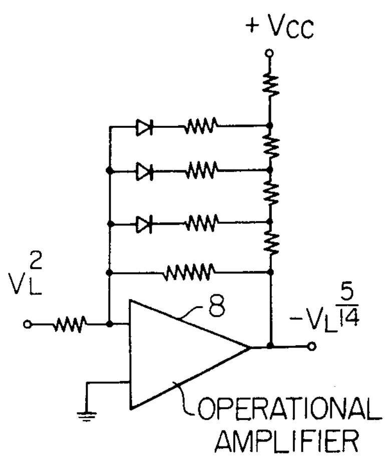


Fig. 4B

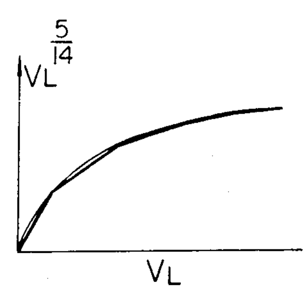


Fig. 5

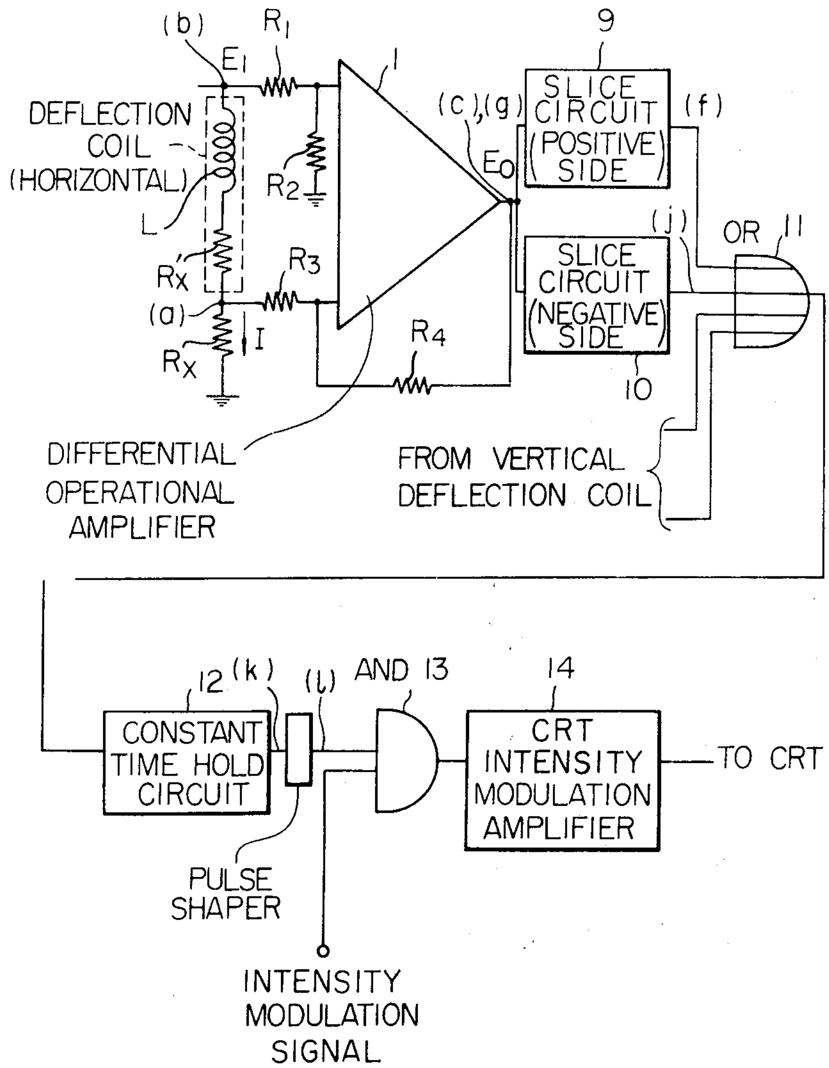

(b)
E_1
R_1
9
1
SLICE CIRCUIT (POSITIVE SIDE)
(c),(g)
(f)
DEFLECTION COIL (HORIZONTAL)
E_0
R_2
L
(j)
OR 11
R_x'
R_3
SLICE CIRCUIT (NEGATIVE SIDE)
(a)
I
R_4
R_x
10
DIFFERENTIAL OPERATIONAL AMPLIFIER
FROM VERTICAL DEFLECTION COIL
12
(k)
(l)
AND 13
14
CONSTANT TIME HOLD CIRCUIT
CRT INTENSITY MODULATION AMPLIFIER
TO CRT
PULSE SHAPER
INTENSITY MODULATION SIGNAL

Fig. 6

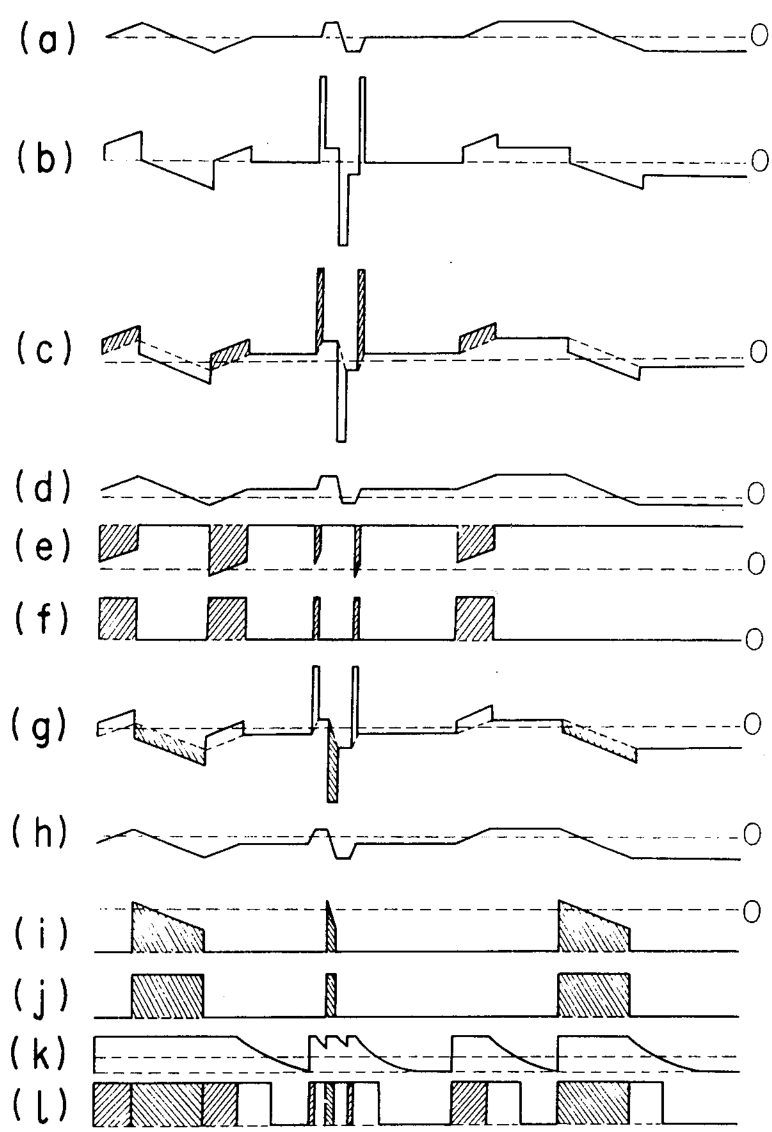
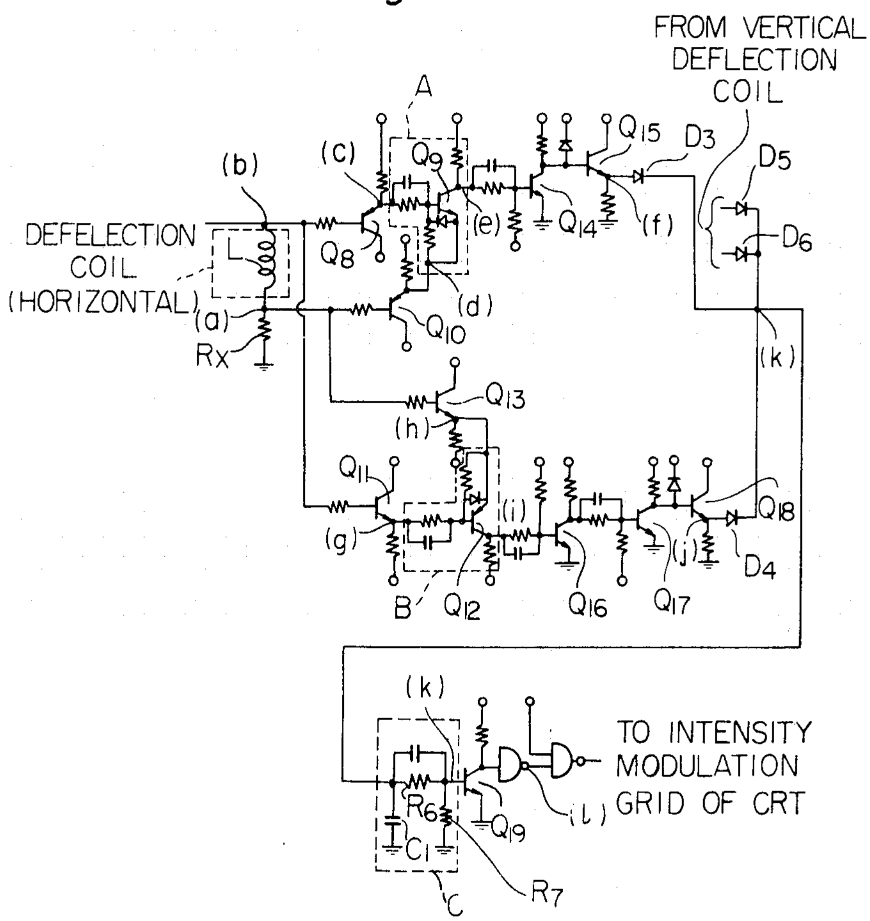


Fig. 7


FROM VERTICAL DEFLECTION COIL
A
(b)
(c)
Q9
Q15
D3
D5
D6
DEFELECTION COIL (HORIZONTAL)
L
(e)
Q14
(f)
Q8
(d)
(a)
Q10
Rx
(k)
Q13
(h)
Q11
(g)
(i)
(j)
Q18
D4
B
Q12
Q16
Q17
(k)
TO INTENSITY MODULATION GRID OF CRT
R6
C1
Q19
(l)
C
R7

CIRCUIT FOR CONTROLLING AN INTENSITY OF A SCANNING IN AN ELECTROMAGNETIC DEFLECTION TYPE CATHODE RAY TUBE

The present invention relates to a circuit for controlling the brightness of a brightening spot displayed in an electromagnetic deflection type CRT by detecting the scanning velocity of an electron beam, thereby maintaining the brightening spot at a constant brightness independent of the scanning velocity and preventing a burning of a fluorescent surface of CRT in the event the spot is fixed to a certain position due to the cause of some unknown or undetectable cause.

In the conventional electromagnetic deflection type CRT, a displayed figure is maintained to a constant brightness by classifying the brightness signals to several kinds of levels corresponding to several sweeping velocities at a control section where an analog signal is supplied to a CRT deflection system and using them as brightness signals. Further, the conventional circuits used for protecting the tube from a burning are as follows. When the sweeping is not carried out in an oscillograph, a trigger signal has been used for extinguishing the brightness of a spot. Also, when the sweeping stops by turning of a power switch of an apparatus, such as a television receiver, the burning protection method of swinging the brightening spot, by using a blocking oscillator, has been used during the time between the stopping of the scanning and the anode voltage. However, in the cases of the above-mentioned two methods, the means of controlling the brightness of the brightening spot has been selected independent of the change rate of the current (or voltage) in the CRT indicating device, so there have been some problems in protecting the fluorescent surface from damage by extinguishing the brightness of the brightening spot perfectly.

The object of the present invention is to provide a circuit for controlling the brightness of the brightening spot by detecting the sweep velocity of the analog signal applied without burdening the above-mentioned control section thereby keeping constant brightness independent of the sweep velocity.

Another object of the present invention is to provide a circuit which can protect the fluorescent surface from damage, controlling the brightness of the spot by direct detection of the current change rate in the deflection coil by producing an unblanking pulse from the positive change of the current change rate in the deflection coil and by producing an unblanking pulse from a negative change of the current change rate above-mentioned, thereby establishing a condition in which the brightening spot on a CRT fluorescent surface is produced only when the above-mentioned current change exists in the deflection coil, and effecting a blanking condition when the current change in said deflection coil is stopped, thereby extinguishing the brightness spot when the brightness spot is fixed due to any condition.

A further object of the present invention is to provided a circuit for controlling the brightening spot of a scanning system such that of an oscilloscope and television apparatus, especially in the graphic display apparatus due to the random positioning system.

Other features and advantage of the present invention will be apparent from the ensuing description with reference to the accompanying drawing to which, however, the scope of the invention is in no way limited.

FIG. 1 is a block diagram of the principle of the present invention,

FIG. 2 is a block diagram of one embodiment of the present invention,

FIG. 3 is a detailed circuit diagram of FIG. 2,

FIGS. 4A and 4B are circuit diagrams showing one example of a function generator of FIG. 2,

FIG. 5 is a block diagram of another embodiment of the present invention,

FIG. 6 is an explanatory diagram showing waveforms at various portions in FIG. 5,

FIG. 7 is a circuit diagram of another example of the present invention.

Referring to FIG. 1, in a detecting circuit of the present invention, resistor R is connected in series with a deflection coil composed of an inductance L and a DC resistance R′ and the other end of this resistor is grounded. Both ends of the deflection coil are connected, through resistor R_1 and R_3, respectively, to the two input terminals of the operational amplifier 1, the junction point of resistor R_1 and an input terminal of the operational amplifier 1 is grounded through resistor R_2, the output terminal of the operational amplifier 1 is, through resistor R_4, connected to the junction point of resistor R_3 and the other input terminal of the operational amplifier 1. In the circuit connected like this, the voltages E_1 and E_2 at both terminals of the deflection coil are represented as follows:

$$E_1 = I_L(R + R') + L(dI_L/dt) \quad (1)$$

$$E_2 = I_L R \quad (2)$$

where I_L is the deflection coil current as described previously.

From the equations (1) and (2)

$$L\frac{dI_L}{dt} = E_1 - E_2\frac{R+R'}{R} \quad (3)$$

Next, to perform the calculation of Eq. (3), we examine the relation of the values of resistors R_1, R_2, R_3 and R_4 in the operational amplifier 1 and the output voltage Eo is given by the following equation:

$$Eo = \frac{R_2}{R_3}\left(\frac{R_3+R_4}{R_1+R_2}\right)E_1 - \frac{R_4}{R_3}E_2 \quad (4)$$

Putting $R_1 = R_3$, then

$$Eo = \frac{R_2}{R_1}\left(\frac{R_1+R_4}{R_1+R_2}\right)E_1 - \frac{R_4}{R_1}E_2 \quad (5)$$

For Eq. (5) represents ^{L}Eq. (3), the following relation must be satisfied.

$$R_2 = \frac{R_1R_4R}{R_1R + R'(R_1+R_4)} \ (R_1 = R_3) \quad (6)$$

Namely, when Eq. (6) is satisfied, then

$$Eo \alpha L\frac{dI_L}{dt} = V_L$$

and by using R and the above-mentioned operational amplifier 1, eliminating the voltage rising due to the DC resistor R' in the deflection coil, and detection of dI_L/dt can be obtained correctly.

Referring to FIG. 2, horizontal deflection coil L_x and vertical deflection coil L_Y are grounded through resistors R_X and R_Y, respectively. And V_{LX} detecting circuit 2 and V_{LY} detecting circuit 3 are connected to horizontal deflection coil L_X and vertical deflection coil L_Y, respectively, and detect the terminal voltage of each deflection coil L_X or L_Y. The above-mentioned V_{LX} detecting circuit 2 and V_{LY} detecting circuit 3 are connected to $(V_{LX}^2 + V_{LY}^2)$ operational circuit 4 and further, through the function generator 5, connected to the intensity modulation amplifier 6. On the other hand, blanking and unblanking signals are connected from externally to the intensity modulation amplifier 6. And only when the unblanking pulse is applied, the output of the intensity modulation amplifier can be applied to the intensity modulation grid of the CRT.

FIG. 3 shows an actual example of $(V_{LX}^2 + V_{LY}^2)$ operational circuit 4. In connection with this, the circuit comprising transistors Q_1, Q_2, Q_3, Q_4 and Q_5 is a type of differential amplifier. Now, the positive or negative signal V_{LX} is applied to the input terminal of the above-mentioned differential amplifier. The emitter follower outputs of transistors Q_4 and Q_5 are combined and converted through diodes D_1 and D_2 into the signal of the same polarity. The output at the junction point of diodes D_1 and D_2 is amplified by transistor Q_6 and applied to the field effect transistor Q_7. As it is possible to give square law detection characteristics between gate voltage and drain current of the field effect transistor Q_7, so V_{LX}^2 proportional to the square of V_{LX} is obtained as an output of field transistor Q_7. It is possible to obtain the output $V_{LX}^2 + V_{LY}^2$, i.e. V_L^2 by adding both V_{LX}^2 and output V_{LY}^2 of the circuit which calculate V_{LY}^2 (this is the same as the V_{LX}^2 and therefore, it is not shown in the drawing) using output voltage V_{LY} of Y-axis in the operational amplifier 7.

FIGS. 4A and 4B shows an example of the function generator.

In general, in a CRT, the brightness of beam B has the following relation, assuming the brightening spot area is constant.

$$B \alpha (I_{P3})p/V_S \quad (7)$$

where I_{P3} is the 3rd plate current, V_S is the sweeping velocity of the beam and the value of P, depending on the fluorescent substance, lies between 0.7 and 0.9.

Furthermore, in an electromagnetic deflection type CRT for general TV is

$$I_{P3} = 0.9\, I_K \quad (8)$$

where I_K is the cathode current of the CRT. This current is expressed by the following equation:

$$I_K \alpha\, Vd^{7/2}/Vo^2 \quad (9)$$

In Eq. (9), Vo is the cut-off voltage of intensity modulation grid, Vd is the intensity modulation grid voltage taking Vo as a reference voltage.

On the other hand, the deflection velocity of the beam is

$$V_S \alpha\, dI_L/dt \quad (10)$$

where I_L is the deflection coil current. Furthermore, putting V_L as the terminal voltage of the deflection coil, then

$$dI_L/dt \alpha V_L \quad (11)$$

From Eqs. (7) – (11), the relation of V_L and Vd which keeps the brightness of beam constant is obtained. For example, in the electromagnetic deflection for TV described herein, putting $P = 4/5$ in Eq. (7), then a functional relation of

$$Vd \alpha V_L^{5/14} Vo^{4/7} \quad (12)$$

is obtained. The relation of Eq. (8) and (9) though it differs from the structure of a CRT, is a functional relation nearly the same as Eq. (12) concerning Vd and V_L.

The function generator 5 produces the function which satisfies the relation of the foregoing Eq. (12). In Eq. (12), assuming the cut-off voltage of the intensity modulation grid in CRT is constant, then

$$Vd \alpha V_L^{5/14} \quad (13)$$

On the other hand, since

$$V_L^2 = V_{LX}^2 + V_{LY}^2$$

$$\text{we have } Vd \alpha (V_L^2)^{5/28} \quad (14)$$

Although the index 5/14 in Eq. (13) is somewhat variable corresponding to the types of CRT, it remains always to be as a monotone increasing function. Therefore, as in the circuit shown in FIG. 4A, adjusting the values of resistors properly, an arbitrary monotonous increasing function approximate to the curve denoted in Eq. (13) or (14), as shown in FIG. 4B, can be obtained.

In this invention, as above-explained, it is possible to maintain the brightness constant independent of the sweeping velocity by obtaining an output proportional to Vd which satisfies the relation in Eq. (13), as an unblanking level of the intensity modulation signal, and supplying this from the intensity modulator to the intensity modulation grid of the CRT and controlling the brightness of the brightening spot.

FIG. 5 shows another embodiment of the present invention. That is, the circuit referring to FIG. 5 is an example of the fluorescent surface burning protection circuit. Referring to FIG. 5, the explanation is given for the electromagnetic deflection CRT, however, the same explanation is applied to the case of the electrostatic deflection system. The displacement of the brightening spot on the fluorescent surface of CRT depends on the flux change in the deflection coil, i.e. the deflection coil current change. Therefore, in order to prevent damage of the fluorescent substance of the CRT fluorescent surface, when the deflection coil current change is stopped, it may be well to change the condition of the CRT fluorescent surface into the blanking condition. In other words, it may be well to produce the unblanking signal only when the deflection coil current changes. FIG. 5 is shown in the case of the horizontal defection coil. However, in the case of the vertical deflection coil, its operation principle is the same, then its explanation will be omitted. FIG. 6 shows the waveform at several locations in FIG. 5.

In FIG. 5, assuming the deflection coil inductance is L, and its DC resistance R', the following explanation is given. The resistor R connected in series with the above L and R' is provided for detecting the coil current. If deflection coil current is I, the voltages of both ends are E_1, E_2, and the output voltage of the differential operational amplifier is Eo, then the following equations are obtained from Eq. (6).

$$R_2 = \frac{R_1 R_4 R}{R_1 R + R'(R_1 + R_4)} \quad (R_1 = R_3) \quad (15)$$

when Eq. (15) is satisfied, we obtain

$Eo\alpha L\ dI/dt$

Thus, we can detect the current change rate dI/dt eliminated the voltage drop due to the DC resistance in the deflection coil. Namely, supplying the deflection current waveform as shown in FIG. 6(*a*) and the voltage waveform of the deflection coil as shown in FIG. 6(*b*) to the input circuits in FIG. 5, the resultant waveform of hatching parts of FIGS. 6(*c*) and (*g*) appears at the output terminal of the operational amplifier 1. The positive side of the output wave in the above-mentioned operational amplifier is shaped in the positive side slice circuit 9 (corresponding to the location A in FIG. 7) and the waveform appearing at its output terminal corresponds to FIG. 6(*f*) and furthermore, applied to an OR circuit 11. Quite similarly, the negative side of the output wave in the above-mentioned operational amplifier 1 is shaped in the negative side slice circuit (corresponding to the location B in FIG. 7) and the waveform appearing at its output terminal corresponds to FIG. 6(*j*) and furthermore, applied to an OR circuit 11.

Also, similarly, the unblanking pulse due to the vertical coil current change is, together with the above-mentioned unblanking pulse due to the horizontal deflection coil current, applied, through the OR circuit 11 to a constant time hold circuit 12. The constant time hold circuit 12 is represented by a dotted line C in FIG. 7, and its capacitor C_1 is charged with low impedance through the OR circuit 11 in a charging condition, and discharged with a comparatively high impedance through comparatively high resistors R_6 and R_7 in a discharging condition. Accordingly, the waveform at point (K) becomes as shown in FIG. 6(*k*). Slicing this waveform at some level and inversing its phase, its waveform becomes FIG. 6(*l*). We can achieve the desired object by adding the logical product of this waveform as the intensity modulation signal to the intensity modulation circuit of CRT.

By the method described in FIG. 5, we can detect the deflection coil current change dI/dt correctly by using the differential type operational amplifier 1, but when the DC resistance in the deflection coil is negligible, we can perform the circuit construction by using simpler components as shown in FIG. 7. When the deflection voltage waveform (*b*) in FIG. 6 is applied to the input terminal (*b*) in FIG. 7, the waveform (*a*) in FIG. 6 appears at the junction point of the deflection coil L and the series resistor R. Waveforms (*a*) and (*b*) are applied to PNP transistors Q_8 and Q_{10} respectively, and emitter follower output waves (*c*) and (*d*) of transistors Q_8 and Q_{10} are applied differentially to the base and emitter of transistor Q_9, respectively. Namely, the voltage between the base and emitter of transistor Q_9 is the potential difference between waveforms (*c*) and (*d*), i.e. this is the potential difference of waveforms (*a*) and (*b*). In other words, this is the voltage proportional to the current change rate dI/dt. Transistor Q_9 detects this potential difference and the waveform at the collector of Q_9 is as shown in FIG. 6(*e*). Transistor Q_{14} shapes this waveform (*e*) and applies it to transistor Q_{15} and the waveform (*f*) in FIG. 6 appears at the output of the emitter follower transistor Q_{15}. The above circuit, which comprises transistors Q_8, Q_9, Q_{10}, Q_{14} and Q_{15}, detects the positive change rate of the deflection coil current. Similarly, the negative change rate of the deflection coil current is detected by the circuit comprising transistors Q_{11}, Q_{12}, Q_{13}, Q_{16}, Q_{17} and Q_{18}. In this case, the phases of the waveforms (*e*) and (*i*) at the collectors of transistors Q_9 and Q_{12} are inverse, respectively. However, after passing through the phase inverse circuit Q_{16}, the phases at the points of (*f*) and (*j*) become concurrent. Again, similarly, the unblanking pulse due to the vertical coil current change rate also, together with the above-mentioned unblanking pulse due to the horizontal coil current change rate, charge capacitor C_1 through diodes D_5 and D_6. As the operation after capacitor C_1 is quite the same as in the case of FIG. 5, and therefore, will be omitted here. From the above-mentioned explanation, it is clear that the feature of the circuit shown in FIGS. 5 and 7 are by correctly detecting the current change rate dI/dt in the deflection coil and producing the unblanking pulse and keeping it under the condition so as being capable of producing a brightness spot on the fluorescent surface of CRT, and when the current change rate dI/dt become zero, it is possible to protect the damage on the fluorescent surface even when the spot is located at any point on the CRT fluorescent surface. Next, as condenser C_1 is charged with a low impedance and discharged with a comparatively high impedance, when the spot begins to move from the stop position, the signal changes as shown in FIG. 6(*l*) from the blanking state to the unblanking state with a considerably short time lag and the gate for the Z signal is opened. Also, when the spot, from the state of moving, stops, as the discharge of C_1 is performed with a comparatively long time constant $C_1(R_6 + R_7)$, the gate for the Z signal is opened for a period of time after the spot is stopped. This fact is well-fitted to the operation of such a CRT display apparatus due to the random positioning, especially, to satisfy the required conditions for such a program.

Modifications of the herein disclosed circuits will occur to those skilled in the art and various combinations of the circuits will be capable of use together for achieving the desired results of the invention. The scope of the invention is to be interpreted accordingly as defined by the appended claims.

What I claim and desire to secure by Letters Patent is:

1. Circuitry for controlling the intensity of a brightening spot during scanning of an electromagnetic deflection type cathode ray tube, comprising a deflection coil circuit for a cathode ray tube, means coupled to said deflection coil circuit for generating a voltage V_L proportional to the current change rate dI/dt in said deflection coil circuit, function generator means coupled to said V_L generating means for generating a voltage Vd having a value which increases exponentially with respect to V_L, and means coupled to said function generator means for applying a voltage Vd proportional to an intensity modulation grid of the cathode ray tube, thereby maintaining the brightening spot at a constant intensity during scanning of the cathode ray tube.

2. A circuit for use in controlling the intensity of scanning in an electromagnetic deflection type CRT, said CRT having a deflection coil and an intensity modulation grid, said circuit comprising, means for detecting a voltage V_L proportional to a sweep current change rate dI/dt in a deflection coil of a CRT between terminals of said deflection coil, an operational amplifi-

er, said means for detecting said voltage comprising a resistor R connected to one terminal of said deflection coil having a DC resistance R' and ground resistors R_1 and R_3, respectively, connected to terminals of said deflection coil and input terminals of said operational amplifier, a resister R_2 connected between one input terminal of said operational amplifier and ground, a resistor R_4 connected between an output terminal of said operational amplifier and the other input terminal of said operational amplifier, and the following relation existing between the resistance values of said resistors R, R', R_1, R_2, R_3 and R_4:

$$R_2=\frac{R_1R_4R}{R_1R+R'(R_1+R_4)} \text{ where } R_1=R_3,$$

means for generating an unblanking pulse, means for applying the output of said operational amplifier to said means for generating an unblanking pulse, means receptive of the output of said means for generating an unblanking pulse applying it to the intensity modulation grid of said electromagnetic deflection type cathode ray tube.

3. A circuit for use in controlling the intensity of scanning in an electromagnetic deflection type cathode ray tube according to claim **2**, wherein said means for generating an unblanking pulse is composed of a first slice circuit means for slicing said positive voltage and a second circuit means for slicing said negative voltage connected in parallel, means connecting said first and second slice circuit means to said output of said operational amplifier, means connecting outputs of said first slice circuit and said second slice circuit each to a different input terminal of an OR circuit, an OR circuit receptive of said outputs of said first slice circuit means and second slice circuit means applying them to a constant time hold circuit, a constant time hold circuit provided with a capacitor charged at low impedance through said OR circuit and discharged at a comparatively high impedance, a pulse shaper receptive of the output of said constant time hold circuit and shaping it, an intensity modulation smplifier, means applying the output of said pulse shaper applied via said intensity modulation amplifier to the intensity modulating grid of said electromagnetic deflection type CRT.

4. A circuit for use in controlling the intensity of scanning in an electromagnetic deflection type CRT, said CRT having a deflection coil and an intensity modulation grid, said circuit comprising, means for detecting a voltage V_L proportional to a sweep current change rate dI/dt in a deflection coil of a CRT between terminals of said deflection coil, said means for detecting said voltage comprising a resistor R connected to one terminal of said deflection coil and to ground, a first amplifier, a second amplifier, a third amplifier and a fourth amplifier, one terminal of said deflection coil being connected to the first and second amplifiers, the other terminal of said deflection coil being connected to the third and fourth amplifiers, said first and third amplifiers being provided for amplifying a positive voltage, said second and fourth amplifiers being provided for amplifying a negative voltage, first slice circuit means for slicing said positive voltage, second slice circuit means for slicing said negative voltage, means connecting a difference output between said first and third amplifiers to said first slice circuit means for slicing said positive voltage, means connecting the difference output between said second and fourth amplifier to said second slice circuit means for slicing said negative voltage, an OR circuit, means connecting outputs of said first slice circuit and said second slice circuit to different input terminals of said OR circuit, a constant time hold circuit, said OR circuit passing said outputs of said first slice circuit and second slice circuit to said constant time hold circuit, said constant time hold circuit having a capacitor charged at a low impedance through said OR circuit and discharged at a comparatively high impedance, a pulse shaper, the output of said constant time hold circuit being shaped by said pulse shaper, an intensity modulation amplifier, means applying the output of said pulse shaper via said intensity modulation amplifier to an intensity modulating grid of said electromagnetic deflection type CRT.

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