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R. C. ENTENMANN
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IN ELECTROMAGNETIC DEFLECTION YOKES
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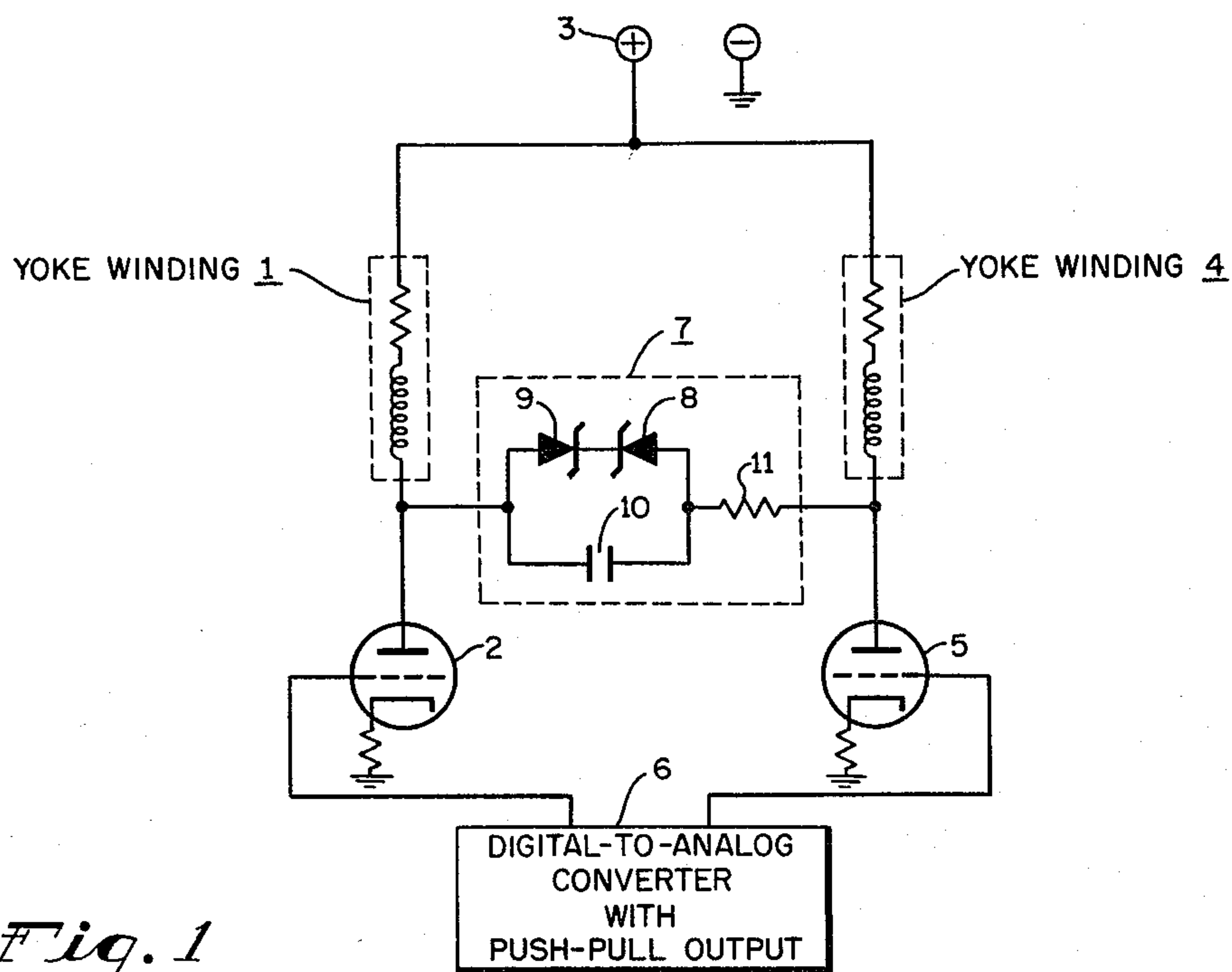


Fig. 1

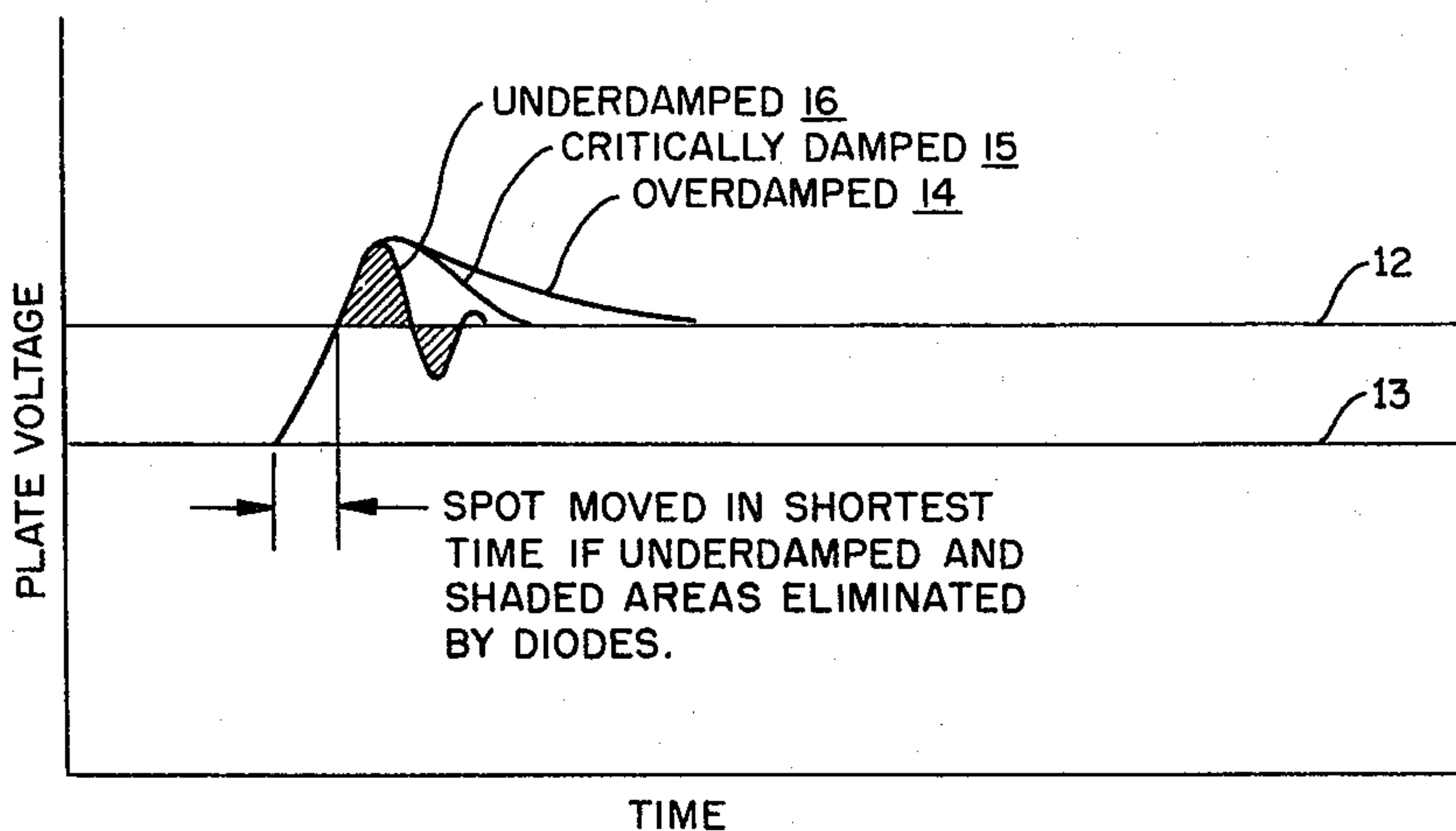


Fig. 2

INVENTOR.
RICHARD C. ENTENMANN

BY
Robert L. Nathan
ATTORNEY

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CONTROL CIRCUIT FOR DAMPING TRANSIENTS IN ELECTROMAGNETIC DEFLECTION YOKES

Richard C. Entenmann, San Diego, Calif., assignor, by mesne assignments, to Stromberg-Carlson Corporation, Rochester, N.Y., a corporation of Delaware

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5 Claims. (Cl. 315-27)

The present invention relates to cathode-ray tube control circuits and more particularly to cathode-ray tube control circuits for damping transients.

Numerous high-speed data processors employ cathode-ray tube readouts for converting electrical data into visible data. An electron beam is shifted from one position within the tube to another under the control of electrical data. Such readout equipment often utilizes electromagnetic yokes for controlling the shifting. During this shift period the beam is generally blanked and remains blanked until the beam settles at the second position, which could be a spot on the face of the tube or, in the case of a shaped-beam tube, a particular position on the beam forming matrix within the tube. This shifting is caused by changing the current through X-direction and Y-direction electromagnetic yokes, as is well known to those skilled in the art. However, transients are produced by these yoke windings due to the aforementioned sudden current changes, which transients often cause the beam to overshoot the target position and increase the time required for the beam to settle in the new position. Since these beams are shifted in periods measured in microseconds, it follows that any reduction in these periods, owing to the elimination of the transients, greatly increases the amount of visible data which may be displayed each second.

Accordingly, it is a principal object of the present invention to provide a new and improved cathode-ray tube control circuit for dampening transients due to sudden abrupt current changes manifested within the electromagnetic control yokes as rapidly as possible.

Other objects and advantages of the invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of the invention, reference may be had to the accompanying drawing, in which:

FIG. 1 discloses a preferred embodiment of the invention; and

FIG. 2 discloses a wave diagram which will aid in the understanding of the invention.

Referring now to FIG. 1, yoke winding 1 is disclosed coupled to driver tube 2 and the positive terminal 3 of a power supply. In like manner, yoke winding 4 is disclosed coupled to driver tube 5 and the positive terminal 3 of the power supply. The cathodes of tubes 2 and 5 are grounded through current-limiting resistors, as shown. The negative terminal of the power supply is, of course, connected to ground. A digital-to-analog converter 6 is schematically disclosed coupled to the control grids of the driver tubes, as shown. A damping network 7 is disclosed coupled between the plates of the driver tubes, as shown.

In the absence of an A.C. signal applied to the driver tubes, a substantially equal current will flow through yoke windings 1 and 4 since the push-pull arrangement disclosed is designed to operate as a push-pull class A amplifier. Under this condition, each yoke winding generates a magnetic field which has an equal and opposite effect upon the electron beam in the X direction. As far as controlling the vertical position of the beam is concerned, a second arrangement similar to the arrangement shown in FIG. 1 is utilized. Where equal currents flow through

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yoke windings 1 and 4, the beam remains centered as far as the X direction is concerned. To change the position of the beam in one direction, the voltage applied to the grid of driver tube 5, for instance, would be increased and the voltage applied to the control grid of tube 2 would be decreased. As a result, the electromagnetic field produced by yoke winding 4 would be increased, whereas the electromagnetic field produced by yoke winding 1 would be decreased so that the beam would be pulled in one direction by the windings. Should the opposite effect be desired, the voltage applied to the grid of driver tube 5 would be decreased and a complementary increase in voltage would be applied to the control grid of tube 2. In other words, the push-pull arrangement disclosed in FIG. 1 operates in seesaw fashion to change the position of an electron beam under the control of converter 6.

The change in voltage levels applied to the driver tubes are quite abrupt so that the change of current through the yoke windings produce transients which are very undesirable for high-speed operation, as discussed hereinbefore.

Let it be assumed that a heavy increase of current through yoke winding 4 is produced together with a heavy decrease in current flow through yoke winding 1. In the absence of damping circuit 7, the plate of the driver tube 2 would go sharply positive owing to the collapsed field associated with yoke winding 1. Likewise, the plate of tube 5 would go sharply negative owing to the back E.M.F. produced within yoke winding 4. Since the L/R time constant of the tube circuits is relatively large, the transients will take time to die out, thereby to slow up the readout process, as discussed hereinbefore. Damping circuit 7 is designed to cause these transients to die out as quickly as possible. Damping circuit 7 further comprises Zener diodes 8 and 9 connected back to back, together with capacitor 10 and resistor 11 arranged as shown in FIG. 1. Capacitor 10 and resistor 11 form a damping circuit with yoke windings 1 and 4.

In the case where the current flow through driver tube 2 is sharply reduced and the current through driver tube 5 is sharply increased, the collapsing field of yoke winding 1 will cause the plate of tube 2 to go sharply positive, whereas the plate of tube 5 will go negative due to the counter E.M.F. set up within yoke winding 4. As the field within yoke winding 1 collapses, the plate of driver tube 2 approaches the new steady state D.C. value shown in FIG. 2 as level 12. Level 13 represents the D.C. level which existed at the plate of tube 2 before the aforementioned reduction in current flow took place. As is obvious to those skilled in the art, a circuit which includes inductance, capacitance, and resistance, such as the circuit of FIG. 1, can be made to oscillate by an abrupt change in D.C. current through the inductors. This state of oscillation would be produced if the parameters were such that an underdamped system was set up. In the overdamped situation, no oscillation is set up, but the new steady state D.C. level 12 would not be attained as rapidly as desired. As mentioned hereinbefore, it is the object of the present invention to switch from one steady state D.C. level to the other as rapidly as possible, or, in other words, it is desirable to eliminate the effect of transients as rapidly as possible. In the case where the current flow through tube 2 is sharply reduced and resistor 11, for instance, is relatively large, the voltage at the plate of tube 2 would look like overdamped curve 14 shown in FIG. 2. In other words, because resistor 11 is fairly large relative to the other components, it will take considerable time for the energy to be transferred from the collapsing field of yoke winding 1 into capacitor 10. If the resistance of resistor 11 is decreased, the critically damped curve 15 would be produced at the plate of tube 2. In the critically damped case, the voltage produced by the collapsing field of wind-

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ing 1 would drop to zero just as the voltage across capacitor 10 reaches that value which reflects the new steady state differential voltage between the plates of the tubes. If the resistance of resistor 11 is further decreased, the underdamped situation is produced, that is, the charging rate of capacitor 10 will be relatively high so that the voltage developed across capacitor 10 will shortly overcome the voltage of the collapsing field in yoke winding 1 to cause the capacitor to put energy back into the field of yoke winding 1 which, in turn, decreases the voltage across the capacitor and increases the voltage across the inductor until energy is again fed back from the inductor into the capacitor. This action is, of course, oscillatory and is indicated by the underdamped curve 16 of FIG. 2.

The parameters of the components are selected to match the underdamped case mentioned hereinabove so that the collapsing field within yoke winding 1 causes a relatively rapid build-up of voltage across capacitor 10. When the voltage across capacitor 10 reaches the reverse breakdown voltage of Zener diode 8, the impedance of diode 8 drops sharply and the time constant of the circuit including the diodes and capacitor is sharply reduced so that the energy due to the collapsing field is rapidly dissipated in this circuit. This rapid dissipation eliminates most of the shaded area shown in FIG. 2 so that the new steady state level 12 is rapidly attained and the objects of the invention are therefore attained as discussed hereinbefore.

In summary, the disclosed circuitry causes an extremely rapid transfer of energy from the yoke windings into capacitor 10 and the use of threshold device in shunt with capacitor 10 causes this energy to be rapidly dissipated after the transfer. It should be apparent that in the case where the current is increasing through yoke winding 1 and decreasing through yoke winding 4, the plate of tube 5 would be sharply positive with respect to the plate of tube 2 and, accordingly, diode 9 would break down rather than diode 8 which would now be in the forward biased direction.

The above circuit built by applicant's assignee comprises the following components:

Diodes 8 and 9; 6.2 volt Zener IN753A
Yokes 1 and 4; 1.5 millihenries Celco type EY164-P479
Resistor 11; 3K ohms
Capacitor 10; 1200 micromicrofarads mica
Tubes 2 and 5; JAN-6384
Power supply; 250 volts

While there has been disclosed what is at present considered to be the preferred embodiment of the invention, other modifications will readily occur to those skilled in the art. It is not, therefore, desired that the invention be limited to the specific arrangement shown and described, and it is intended in the appended claims to cover all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A circuit for sharply reducing the effect of transients in a cathode-ray tube driving circuit employing an electromagnetic yoke comprising a first and second point of fixed potential, a circuit coupled between said first and second points of fixed potential and including a current control device and a yoke winding connected in series, means coupled to said current control device in regulation thereof for adjusting the current through said yoke winding at a high rate resulting in the formation of transient voltage pulses across said yoke winding, damping circuit means forming an underdamped oscillatory circuit with said yoke winding coupled between said second point of

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fixed potential and said yoke winding and including a resistor and a capacitor in series and means for discharging said capacitor in response to increase in voltage across said capacitor to a predetermined level as a result of the manifestation of said transients.

2. The combination as set forth in claim 1, wherein said means for discharging said capacitor includes a Zener diode coupled in shunt with said capacitor.

3. A circuit for sharply reducing the effect of transients in a cathode-ray tube driving circuit employing electromagnetic yokes comprising a first and second point of fixed potential, a first circuit coupled between said first and second points of fixed potential and including a first current control device and a first yoke winding connected in series, a second circuit coupled across said points of fixed potential and including a second current control device and a second yoke winding connected in series, means coupled to said current control devices in regulation thereof for adjusting the current through said first yoke and adjusting the current through said second yoke at a high rate resulting in the formation of transient voltage pulses across said yoke windings, damping circuit means forming an underdamped oscillatory circuit with said yoke winding coupled between said first and second yoke windings and including a resistor and a capacitor, and means for discharging said capacitor in response to increase in voltage across said capacitor to a predetermined level as a result of the manifestation of said transients.

4. The combination as set forth in claim 3 wherein said means for discharging said capacitor includes Zener diodes coupled together back to back in shunt with said capacitor.

5. A circuit for sharply reducing the effect of transients in a push-pull cathode-ray tube driving circuit employing electromagnetic yokes comprising a first and second point of fixed potential, a first circuit coupled between said first and second points of fixed potential and including a first current control device and a first yoke winding connected in series, a second circuit coupled between said points of fixed potential and including a second current control device and a second yoke winding connected in series, means coupled to said control devices in regulation thereof for adjusting the current through said first yoke in a first direction and adjusting the current through said second yoke in a second direction simultaneously at a high rate resulting in the formation of transient voltage pulses across said yoke windings, damping circuit means forming an underdamped oscillatory circuit with said yoke winding coupled between said first and second yoke windings and including a resistor and a capacitor in series and means coupled in shunt with said capacitor for discharging said capacitor in response to increase in voltage across said capacitor to a predetermined level as a result of the manifestation of said transients.

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