April 15, 1969 C. GREENBLUM 3,439,219

BEAM CONTROL CIRCUIT

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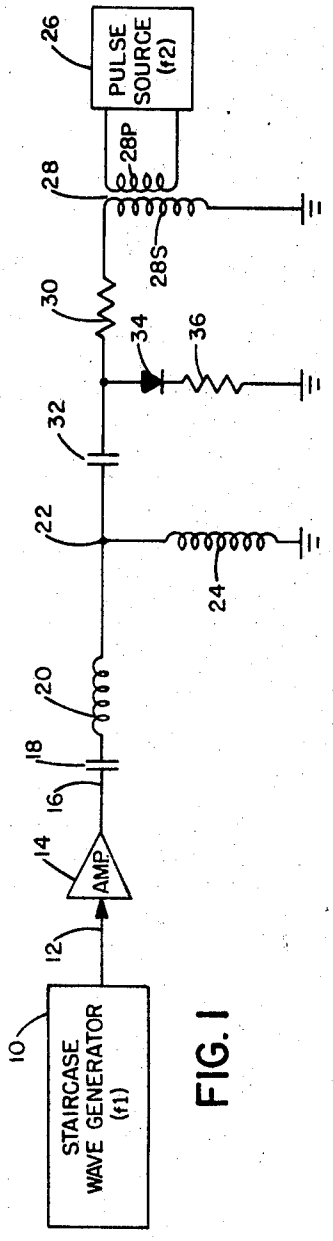


FIG. 1

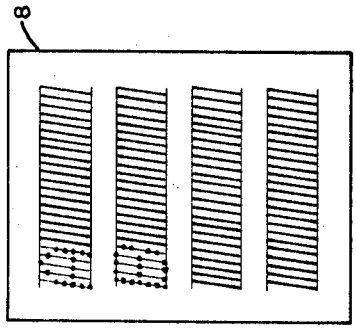


FIG. 3

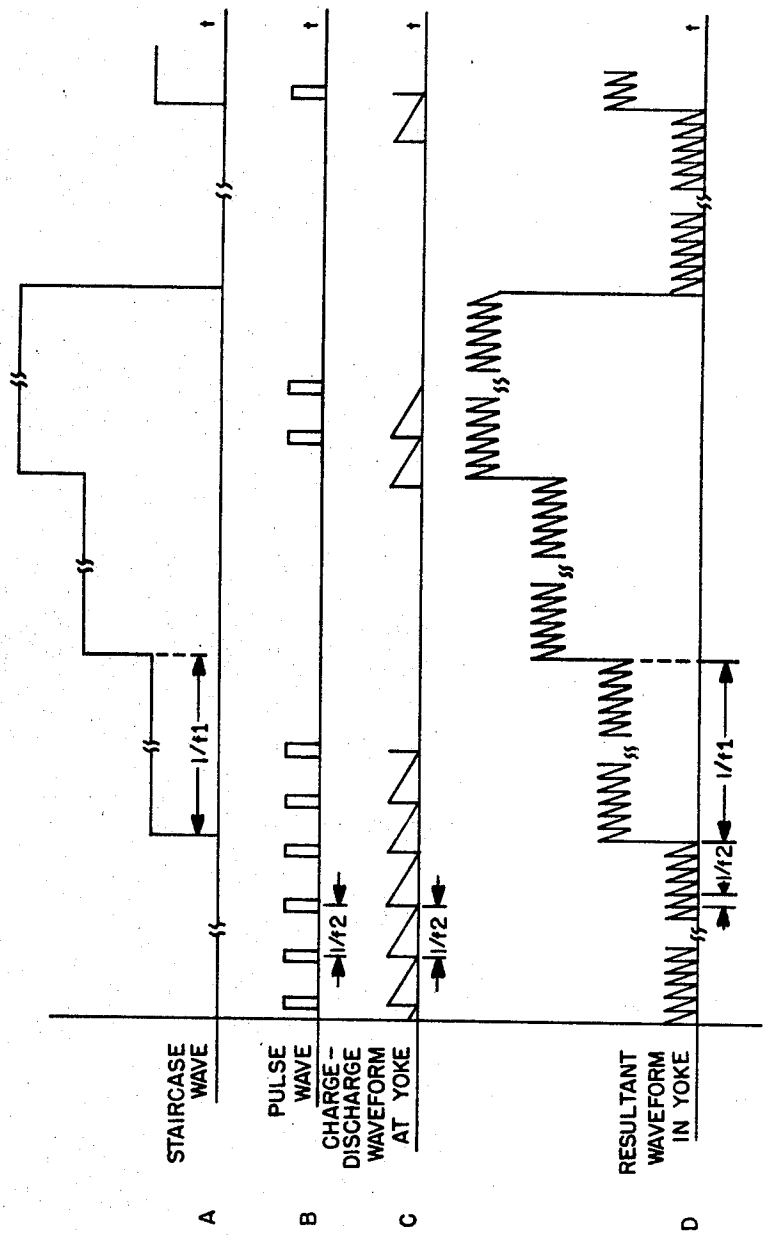
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FIG. 2



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BEAM CONTROL CIRCUIT

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U.S. Cl. 315—26 13 Claims

ABSTRACT OF THE DISCLOSURE

A circuit for effecting desired movement of an electromagnetically-controlled beam where the beam is to be moved in one direction in response to simultaneously applied signals operating in vastly different frequency ranges. A single deflection yoke may be used by coupling each of the signals to the yoke through a circuit, which circuit passes a signal of the applied frequency but blocks a signal of the other frequency. The coupling circuit for the high frequency input includes means for smoothing transitions to eliminate instability.

This invention relates to a circuit for effecting desired movement of an electromagnetically-controlled beam and, more particularly, to a circuit which permits such a beam to be simultaneously responsive to signals operating in vastly different frequency ranges while utilizing a single deflection yoke.

One common situation in which an electromagnetically-controlled beam may be simultaneously driven by signals having radically different frequencies occurs when a cathode ray tube (CRT) is being used to provide an alphanumeric display. A system of this type is, for example, shown in copending application, Ser. No. 460,117, entitled "Data Handling Apparatus," filed June 1, 1965, on behalf of R. D. Belcher et al., and assigned to the assignee of the instant application. In these systems a relatively low frequency step wave is applied to the vertical deflection circuit of the tube to control the position at which each line sweep of the display begins. The vertical control circuit also has a relatively high frequency sawtooth wave applied to it which causes the succeeding strokes of each sweep to be generated. This means that the vertical deflection circuit must handle both a low frequency step-wave input, which may operate in a range of 10^3 c.p.s. or less, and a relatively high frequency stroke signal which may vary in the 10^6 c.p.s. range with higher harmonics. The signal frequency components which the vertical deflection circuit is called upon to handle may therefore vary by factors of 10^3–10^5 or more.

The standard solution to the above problem has been to provide a special tube which uses a conventional yoke for the major positioning in response to the low frequency signal and, in addition, contains either a special set of diddle or electrostatic deflection plates, or a separate tweeter yoke, for developing the high frequency stroke signal. A serious disadvantage of either of the above approaches is that, since a special tube must be provided, the cost is substantial. A second, and perhaps equally serious, disadvantage is that the initial deflection by the yoke moves the beam away from the center of the tube, so that the deflection by the second yoke, or the diddle plates, is non-uniform, being influenced more by the near side to the beam and less by the far side, resulting in distortion of the projected image. In effect, the beam is being deflected from two separate origins.

For the above reasons, it is advantageous to use a single deflection yoke to provide the required response to both the high frequency and low frequency deflection inputs. One way in which this may be accomplished is to logically

combine the signals in an amplifier or similar device before applying the signals to the yoke. To do this, however, requires that the amplifier employed have a very wide frequency response with minimal distortion over the range. Amplifiers of this type are difficult to obtain and are, for this reason, expensive. Other attempts to utilize a single yoke with deflection inputs of radically different frequencies have been frustrated by signal interference and distortion resulting from a variety of other causes.

It is therefore a primary object of this invention to provide an improved deflection circuit for an electromagnetically-controlled beam.

A more specific object of this invention is to provide a circuit which is capable of deflecting an electromagnetically-controlled beam in response to input signals of vastly different frequencies without requiring special tubes or expensive additional equipment and without introducing any significant distortion into the system.

In accordance with these objects this invention provides a circuit for effecting desired movement of an electromagnetically-controlled beam which circuit has a first input signal applied to it at a frequency $f1$ and a second input signal applied to it at a frequency $f2$, where $f2$ may be many times greater than $f1$. The signal at frequency $f1$ and the signal at frequency $f2$ are each coupled through a separate coupling circuit to a single beam-control deflection yoke. The coupling circuit for coupling the signal at frequency $f1$ to the deflection yoke includes a filter for blocking passage in either direction of signals at frequency $f2$ and the circuit for coupling the signal at frequency $f2$ includes a filter for blocking passage in either direction of a signal at frequency $f1$. The coupling means for the signal at frequency $f2$ also includes a means for causing the deflection yoke to be cyclically charged at a frequency $f2$ and a discharge circuit for the yoke. Transitions between the charging and discharging of the yoke are smoothed to prevent distortion by providing a rectifying element which is substantially back-biased during the charging intervals and conducting during the discharge intervals, but whose response characteristics are such that it does not immediately become cut-off during the charging interval or, in other words, has certain storage characteristics.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings.

In the drawings:

FIG. 1 is a semi-block schematic diagram of a preferred embodiment of the invention.

FIG. 2 is a waveform diagram illustrating the signals appearing at various points in the circuit of FIG. 1.

FIG. 3 is a diagram illustrating a display pattern which may be achieved by use of the circuit of this invention.

Referring first to FIG. 3, it is seen that the display format for a CRT display system utilizing the preferred embodiment of the invention includes a number of parallel lines (4 in the figure) with a large number of sawtooth writing strokes for each lines. The vertical starting position for each line of the display is determined by the potential of a step wave input. The time required to write a line is approximately one millisecond. Therefore, the step wave frequency is approximately 10^3 c.p.s. The sawtooth writing strokes are achieved by applying a high frequency pulse wave to the vertical deflection control circuit. Assuming one thousand strokes to the line, which is a reasonable assumption, the frequency of the pulse wave would be 10^6 c.p.s. The advancing of the strokes across the line, which advancing forms no part of the present invention, is achieved by applying a low frequency

sawtooth to a horizontal deflection control circuit. Character writing is achieved by selectively energizing the beam as it traces the above described raster pattern on the face of CRT **8**. An overall system for achieving a display of the type described above is described in detail in the before-mentioned Belcher et al., application.

FIG. 1 shows, in detail, the preferred embodiment of a vertical deflection control circuit suitable for use in the above-described system. A staircase waveform at a frequency $f1$ (for example, 10^3 c.p.s.) is applied by a staircase wave generator **10** through a line **12** to an amplifier **14**. Amplifier **14**, which has an extremely low frequency response, causes the input on line **12** to appear as a low impedance driving source. The output from amplifier **14** on line **16** is applied through coupling capacitor **18** and inductance coil **20** to input terminal **22** of vertical deflection yoke **24**. The capacitance of apaitor **18** is very large, thereby preserving the low frequency response of this leg of the circuit, while, at the same time, eliminating D-C response. While the inclusion of capacitor **18** is optional, the elimination of D-C response does make the line positions on the face of CRT **8** (FIG. 3) impervious to drift due to power supply variations, temperature, etc. Coil **20** serves as a filter, transmitting the low frequency position signals from generator **10** while preventing the high frequency signals, to be presently described, from coupling back to disturb amplifier **14**. Line A of FIG. 2 is an illustration of the staircase wave component of the signal applied to terminal **22**. From this figure it is seen that the duration of each step of the wave is $(1/f1)$ seconds and that, for a four-line display, there are four steps before the cycle repeats. An increase in the deflection current causes the beam to move down on the face of tube **8**.

Referring again to FIG. 1, it is seen that pulses at a frequency $f2$ from a pulse source **26** are applied to the primary **28P** of a transformer **28**. Source **26** may, for example, be a D-C source in series with a synchronous periodically-operated switch. Transformer **28** steps up the voltage of the pulses from source **26** to a very high amplitude. The voltage pulses are converted into constant current pulses by resistor **30** whose value is such that, in combination with the inductance L of yoke **24**, the time constant (L/R) is small when compared with the sawtooth pulse width $(1/f2)$. The pulses from resistor **30** pass through capacitor **32** before reaching terminal **22**. Capacitor **32** is of such a value as to be an effective closed circuit to the high frequency pulses such as those from transformer **28** while being is effect an open circuit to the low frequency step signals emanating from amplifier **14**. In other words, capacitor **32** serves as a high-frequency filter passing the high-frequency stroke generating pulses to yoke **24**, while blocking the passage of the staircase voltages back to pulse source **26**.

The pulses passing from secondary coil **28S** of transformer **28** through resistor **30** and capacitor **32** to coil **24** are shown on line B of FIG. 2. These constant current pulses serve to charge yoke **24** to a maximum stroke level (related to the character stroke height shown in FIG. 3). During the charging time the current through the coil increases, as shown on line C of FIG. 2, causing the beam on the face of CRT **8** to move down from the vertical position determined by the staircase waveform. During the charging of the yoke, diode **34** is substantially back-biased, and therefore open. After the charging pulse is over, yoke **24** discharges through the circuit composed of capacitor **32**, diode **34**, and resistor **36** to ground. As indicated previously, the inductive reactance of coil **20** is large enough to make it an effective open circuit to the high-frequency discharge current. Since the capacitance of capacitor **32** is chosen so as to be a closed circuit to signals at frequency $f2$, and higher harmonics thereof, the discharge time constant is established by the forward resistance of diode **34** in combination with the resistance of resistor **36**. Since this resistance is low, the time constant between it and the yoke inductance is such that the current discharge is very linear, yielding excellent vertical linearity of the display strokes. The resistor **36** is optional but should generally be included to aid in making more uniform the discharged time constant by reducing the effect of variations in the forward resistance of the diodes employed.

One problem which is encountered when using a circuit of the type shown in FIG. 1 is instability in the output waveform resulting from the sharp transitions between the charging and discharging of the yoke. This instability decreases the quality of the display which may be obtained on the face of CRT **8**, often obliterating one or more of the index positions at the beginning or end of a stroke, and may become serious enough so as to render the system totally inoperative. It has been found that this instability may be effectively eliminated by selecting a diode **34** which has a certain amount of storage time so that it does not become immediately cut off when a pulse is applied through resistor **30**. If the response time of the diode is such that it does not become fully cut off during the initial portion of the pulse interval, the diode serves to effectively damp the instability oscillations, particularly those at the discharge-charge junction, resulting in a charge-and-discharge pattern across the yoke which is substantially that shown on line C of FIG. 2. The actual current waveform which appears across yoke **24**, which is a combination of the waveforms shown on lines A and C of FIG. 2, is shown on line D of this figure.

While the values selected for the various elements shown in FIG. 1 may vary over a fairly wide range, the following set of values has been found to give satisfactory results:

$f1=10^3$ c.p.s.
$f2=.25$ to $.33\times10^6$ c.p.s.
Voltage across coil **28S**=300 volts
Yoke current=2–5 amps. with 10% from source **10** and 90% from source **26**
Yoke inductance=650 microhenry
Inductance **20**=1–2 millihenry
Capacitance **18**=$1–2\times10^3$ microfarad
Capacitance **32**=0.01 microfarad
Resistor **30**=2.5K ohms
Transformer **28** is a pulse transformer with open circuit inductance=75 microhenry
Diode **35** is an IN4385 specially selected to have a storage time of about 1×10^{-6} second

As indicated above, the special selection of the diode **34** to have the requisite storage time is important in order to achieve stable operations of the circuit. In the alternative, a biasing circuit may be placed in series with the diode in order to alter the effective capacitance of the diode and to some extent achieve the desired storage effect.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that the foregoing and other changes of form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A circuit for effecting desired movement of an electro-magnetically controlled beam comprising:

a beam-control deflection yoke;

a first input signal at a frequency $f1$;

a second input signal at a frequency $f2$, $f2$ being significantly greater than $f1$;

first means for coupling said first input signal to said deflection yoke, said first coupling means including means for effectively blocking the passage therethrough in either direction of a signal at frequency $f2$; and

second means for coupling said second input signal to said deflection yoke, said second coupling means including means for blocking the passage therethrough in either direction of a signal at a frequency $f1$.

2. A circuit of the type described in claim 1 wherein said second coupling means includes means for cyclically charging and discharging said deflection yoke at a frequency *f*2.

3. A circuit of the type described in claim 2 wherein said charging and discharging means includes means for smoothing the transitions between charging and discharging to prevent distortion in the beam movement.

4. A circuit of the type described in claim 3 wherein said charging and discharging means includes:

a rectifying element; and

means for biasing said rectifying element to conduct during time intervals when said deflection yoke is discharging and to be substantially back-biased during time intervals when said yoke is charging;

the response characteristics of the rectifying element being such that it does not immediately become fully back-biased during the yoke-charging intervals, thereby serving to smooth charge and discharge transitions.

5. A circuit of the type described in claim 4 wherein said rectifying element is a diode.

6. A circuit of the type described in claim 1 wherein said electromagnetically-controlled beam is the writing beam of a cathode ray tube.

7. A circuit of the type described in claim 1 wherein said deflection yoke has an input terminal; and

wherein said first and said second coupling means both apply their respective input signals to said input terminal, whereby the inputs from said first and second coupling means are summed in said deflector yoke.

8. A circuit of the type described in claim 1 wherein said second coupling means includes means for applying a relatively high-voltage, constant-current pulse train at a frequency *f*2 to charge said deflection yoke; and

means operative at the end of each pulse for permitting said yoke to discharge.

9. A circuit of the type described in claim 8 wherein said yoke discharge means includes:

a rectifying element; and

means for biasing said rectifying element to be substantially cut off when pulses are being applied to said yoke and to conduct to provide a discharge path for said yoke when pulses are not being applied thereto.

10. A circuit of the type described in claim 9 wherein said rectifying element is a diode, the response time of which is such that it does not immediately become cut off when pulses are being applied to said yoke, whereby the charge and discharge transitions of said yoke are effectively smoothed.

11. A circuit of the type described in claim 10 wherein said first coupling means includes means for blocking the passage therethrough in either direction of a signal at a frequency *f*2; and

wherein said second coupling means includes means for blocking the passage therethrough in either direction of a signal at a frequency *f*1.

12. A circuit of the type described in claim 11 wherein said deflection yoke has an input terminal; and

wherein said first and said second coupling means both apply their respective input signals to said input terminal, whereby the inputs from said first and second coupling means are summed in said deflection yoke.

13. A circuit of the type described in claim 8 wherein said pulse train applying means includes a transformer the secondary of which is coupled to said yoke; and

means for applying a pulse train a frequency *f*2 to the primary of said transformer.

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