

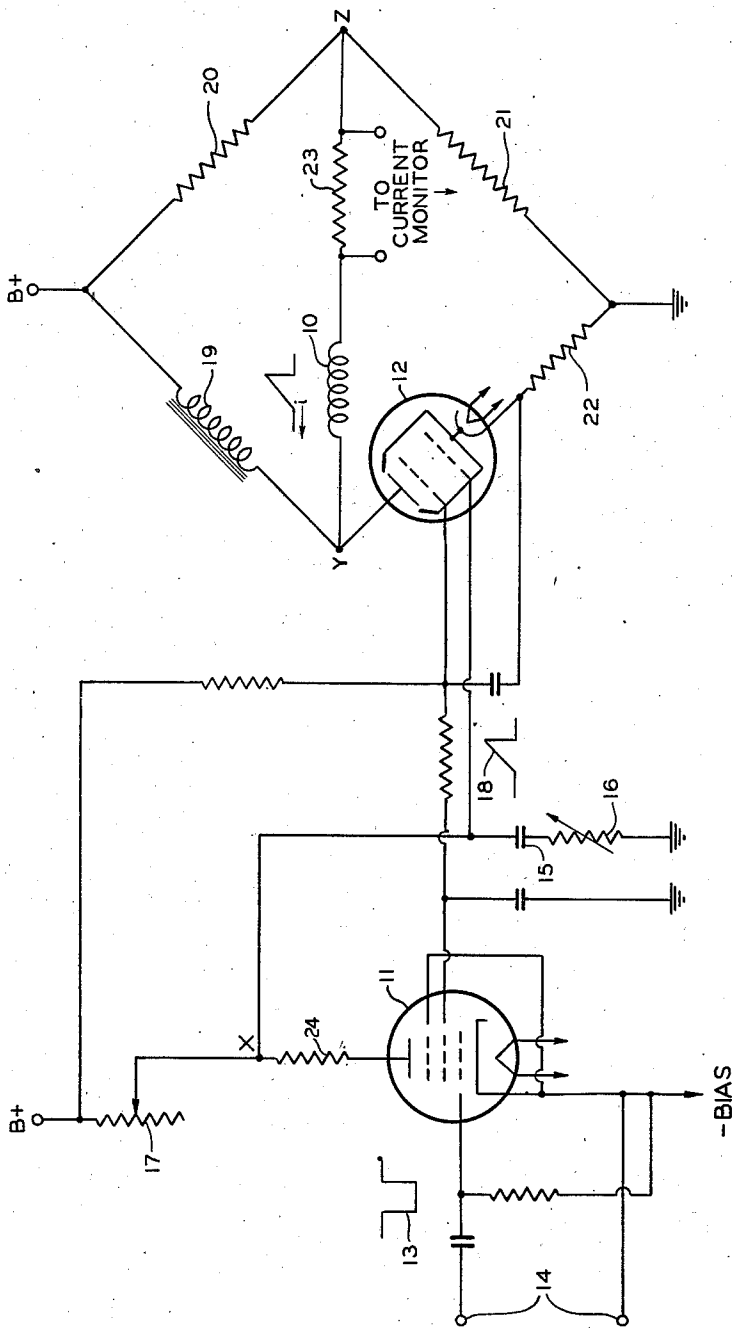
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ELECTRICAL CIRCUIT

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ELECTRICAL CIRCUIT

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The present invention relates generally to circuits for producing voltage variations for deflecting a cathode ray beam in a cathode ray tube, and more particularly to such circuits as employed in conjunction with electromagnetic deflecting coils.

In deflecting a cathode ray beam by means of electromagnetic deflecting coils, it is difficult to maintain a strict linearity of deflection in view of the inductance of the electromagnetic deflecting coils and in view of certain circuit parameters associated with the coils.

Accordingly, it is the principal object of this invention to provide a circuit arrangement for driving a linear sawtooth current through the electromagnetic deflection coils of a cathode ray tube.

It is another object of this invention to provide a circuit of the above type which will afford a substantially linear sweep output voltage of short duration from a square wave input voltage with a minimum number of circuit elements.

Various other purposes and advantages of the present invention will be more apparent to those skilled in the art from the following detailed description when considered in connection with the annexed drawing. The scope of the invention will be pointed out in the accompanying claims.

Referring now to the drawing, schematically shown is a deflection circuit for driving linear sawtooth current through the electromagnetic deflection coil 10 of a cathode ray oscilloscope tube (not shown herein). The circuit comprises a voltage generator including a pentode tube 11 and a bridge arrangement incorporating a beam power tube 12. A negative square wave gate voltage such as that shown by form 13 is applied to the control grid circuit of pentode 11 at terminals 14 with a magnitude rendering said tube non-conductive, thereby causing condenser 15 in the plate circuit thereof to commence accumulating a charge at a rate dependent upon the capacity of the condenser and the values of variable resistors 16 and 17. Condenser 15 continues to accumulate charge for the duration of negative gate 13 and the resultant sawtooth wave and the square wave developed across the resistor 16 are directly impressed upon the control grid of beam power tube 12. The resistance-capacitance network (condenser 15 and resistors 16 and 17) is arranged so that only the linear portion of the condenser charging curve is employed in the rising excursion of the sawtooth wave. The bias on pentode 11 is adjusted so that at the conclusion

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of the negative gate wave 13 the pentode 11 is rendered conductive, thereby rapidly discharging condenser 15.

The bridge circuit consists of four arms, one arm having a reactance choke coil 19 inserted therein, the second having a resistor 20, the third a resistor 21, and the fourth a resistor 22 in series with beam tube 12. Deflection coil 10 is connected in series with a resistor 23 across the vertices *y* and *z* of the bridge circuit. The resistance of resistor 20 is small and is not more than a few hundred ohms. Beam tube 12 in combination with resistor 22 behaves essentially as a constant current generator; that is, it has an extremely high resistance as seen at the plate of beam tube 12 which means that the current therethrough is substantially independent of variations in potential at vertex *y*. Choke coil 19 is designed to have a far greater inductive reactance than the reactances of deflection coil 10.

The bridge is arranged so that it is essentially balanced for D.-C. potentials, the potential of vertex *y* being approximately equal to that of vertex *z*. Under these conditions little or no current is flowing in coil 10. Its magnetic field is therefore zero, and hence the beam of the cathode ray tube is undeflected. The bridge is however unbalanced for A.-C. potentials so that any A.-C. signal resulting in a change of impedance in the arm consisting of tube 12 and resistor 22 will pass through the deflection coil 10. The tube 12 is thus used so that it passes a quiescent current large enough to make use of the linear portion of the tube characteristic. This quiescent current flowing through tube 12 in the interval between deflection waves is balanced by a current flowing through resistor 21 so that vertices *y* and *z* are substantially at the same potential.

In operation, as the potential at the control grid of beam tube 12 rises linearly during the sweep, the impedance of the bridge arm incorporating beam tube 12 accordingly decreases in a linear manner. By reason of the large reactance of choke 19 the current therethrough is substantially constant at all times. The decreasing impedance of beam tube 12 tends to cause more current to flow through choke 19 than the average value which results in an induced voltage in the latter, thus causing vertex *y* to decrease in potential. This effects an unbalance in bridge circuit and, in consequence, current flows through deflection coil 10 from vertex *z* to vertex *y*. As the impedance of tube 12 changes linearly with time, the current through deflection coil 10 will also change linearly with time. After each sweep,

quiescent conditions are rapidly restored by virtue of the direct coupling between the sawtooth generator and the grid of beam tube 12.

The initial voltage on the grid of beam tube 12 is preferably made of such magnitude whereby during the period between successive sweeps the vertex *y* is slightly higher or lower in potential than vertex *z*. This produces a slight initial current in deflection coil 10 of an intensity sufficient to cancel the effect of residual magnetism in the magnetic path of said coil thereby insuring that the electron beam of the cathode ray tube will commence at the zero position with the start of each sweep.

This initial current through the deflection coil 10 may be secured in one method by varying the normal bias on the control grid of beam tube 12. This is accomplished by the adjustment of the bias of tube 11. Another method of obtaining an initial current through deflection coil 10 is by varying either resistor 20 or 21 to slightly unbalance the bridge arrangement. This method is plainly a more satisfactory one. Resistor 23 connected in series with deflection coil 10 is of small ohmic value and permits monitoring the current through the deflection coil.

The advantage and effect of direct coupling between the sweep generator circuit and deflection coil 10 is that the quiescent current in the deflection coil 10 is made substantially independent of the repetition rate and the duration of the sawtooth current wave.

Adjustment of resistor 17 adjusts the slope of the sawtooth voltage wave produced by tube 11.

Resistor 24 prevents the sawtooth voltage wave produced by tube 11 from returning to its quiescent state in too short a time.

Resistance 16 is adjusted to add a small square wave in voltage to the sawtooth wave in order to compensate for any resistance which may be in coil 10 or for a damping resistor which may be placed in parallel with coil 10. It will be seen that both a sawtooth and a square wave is impressed on the grid-cathode circuit of the tube 12.

Thus there has been shown a circuit arrangement which is particularly useful for driving linear sawtooth current wave through the magnetic deflection coils of a cathode ray tube.

While there has been described what is at present considered a preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention. For example, the invention is not limited to the use of a beam tube 12 but may in place thereof incorporate any other tube having suitable characteristics. It is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. The combination in a circuit for driving current through the electromagnetic deflection coil of a cathode ray tube comprising a four-arm bridge arrangement having the deflection coil shunted across one pair of vertices, a source of direct current potential applied across the other pair of vertices of said bridge, a high reactance choke inserted in the first arm of said bridge, an electron discharge device having its plate circuit inserted in the second arm of said bridge adjacent to said first arm, a first resistor inserted in the third arm of said bridge, a second resistor inserted in the fourth arm of said bridge, the values of said first and second resistor being

such as to substantially balance the bridge when said discharge device is in a quiescent condition, means for slightly unbalancing the bridge arrangement whereby a slight current is made to flow in the deflection coil when said discharge device is in a quiescent condition in order to overcome the residual magnetism of said deflection coil, a saw-tooth voltage generator, and means for directly applying the output of said generator to the control circuit of said discharge device whereby the bridge is unbalanced and a current is made to flow through the deflection coil whose form is identical to the saw-tooth applied to said discharge device.

2. The combination in a circuit for driving current through the electromagnetic deflection coil of a cathode ray tube comprising a four-arm bridge arrangement having the deflection coil shunted across one pair of vertices, a source of direct current potential applied across the other pair of vertices of said bridge, a high reactance choke inserted in the first arm of said bridge, an electron discharge device having its plate circuit inserted in the second arm of said bridge adjacent to said first arm whereby the said reactance choke will develop an induced voltage corresponding in form to the variation in current flow through said second named arm, a first resistor inserted in the third arm of said bridge, a second resistor inserted in the fourth arm of said bridge, the values of said first and second resistor being such as to balance the bridge when said discharge device is in a quiescent condition, means for slightly unbalancing the bridge arrangement whereby a slight current is made to flow in the deflection coil when said discharge device is in a quiescent condition in order to overcome the residual magnetism of said deflection coil, a voltage generator to produce both sawtooth and square waves, and means for directly applying the output of said generator to the control circuit of said discharge device.

3. The device according to claim 2 wherein the voltage generator comprises an electron discharge device adapted to be rendered non-conductive upon application to its control circuit of a negative square wave gate voltage and a resistance-capacitance circuit connected between the anode of said device and ground, the said resistance-capacitance circuit being adapted to develop a sawtooth wave across the capacitance and a square wave across the said resistance.

4. A system to produce a linear deflection in an electromagnetic coil of a cathode ray tube comprising a source of sawtooth and square voltage waves and a bridge arrangement having the said electromagnetic coil connected across one pair of vertices and a source of direct current potential connected across the other pair of vertices; the said source of voltage waves consisting of a first electron discharge device adapted to be cut off upon application of a negative square wave gate voltage to its control circuit and a variable resistance-capacitance circuit connected between the anode of said first electron discharge device and ground to generate both the sawtooth wave and a square wave; the said bridge arrangement consisting of four legs successively composed of the plate circuit of a second electron discharge device having its control circuit electrically connected to the aforesaid resistance-capacitance circuit and adapted to pass a quiescent current whereby the linear portion of the tube characteristic may be utilized, a high inductance reactance choke to generate an induced voltage that

varies as the sawtooth component of the voltage wave that is impressed on the control circuit of said second electron discharge device whereby a current through said deflection coil will vary as the variation of said induced voltage, a first resistor and a second resistor; and means whereby the bridge arrangement may be slightly unbalanced to produce a quiescent current to overcome the residual magnetism of said deflection coil.

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