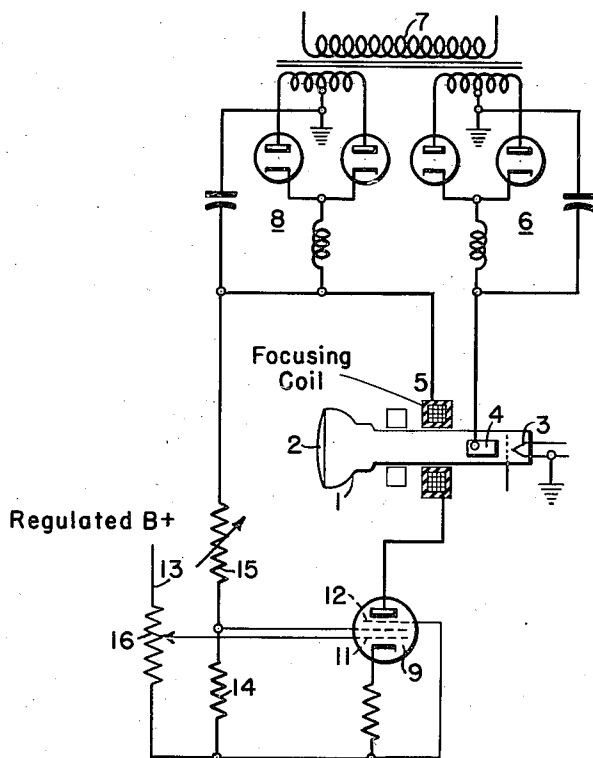


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CIRCUIT FOR STABILIZING FOCUS OF MAGNETICALLY
FOCUSED CATHODE-RAY TUBES
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CIRCUIT FOR STABILIZING FOCUS OF
MAGNETICALLY FOCUSED CATHODE-
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My invention relates to magnetically focussed cathode ray tubes and, in particular, relates to a circuit adapted to minimize the effects on the focusing of variations in current strength through the windings of the focusing magnet.

It is commonplace in the art of cathode ray tubes, in which a stream of electrons emanating from an electron gun impinges on a fluorescent screen, to focus the cathode ray stream to a trace of the desired size on the fluorescent screen by providing a magnetic field substantially parallel to the general direction of the axis of the cathode ray beam. This is usually done by means of a focusing coil traversed by direct current which is substantially coaxial with the major axis of the cathode ray tube. The drawing attached hereto illustrates the general form of such an arrangement.

With a given voltage impressed on the accelerating anode of the cathode ray tube to impart a definite velocity to the electrons impinging on the screen, a definite value of current must flow through the focusing coil in order to maintain a sharp focus of the cathode ray beam on the fluorescent screen. In practical cases, both the value of the voltage on the accelerating anode and the value of current through the focusing coil are likely to vary in undesired fashion because of random variations in the voltage of the sources supplying direct current, to changes in resistance with temperature of the focusing coil, and to similar causes. If the current through the focusing coil is adjusted to the necessary value to focus the cathode ray beam accurately at the beginning of operations, the causes above-mentioned are likely to cause defocusing of the beam from time to time during subsequent operation. It is always expensive, and in many cases impracticable, to provide voltage regulators to maintain the direct current voltage sources so free of random and undesired variations as to maintain the desired degree of focus of the cathode ray beam at all times.

One of the objects of my invention is to provide a novel circuit in which the effects of voltage variation on the above-mentioned direct-current sources on defocusing of the cathode ray beam are substantially eliminated.

Another object of my invention is to provide a cathode ray tube and circuit therefor of such type as to maintain substantially constant focus in the cathode ray beam at all times during use.

Still another object of my invention is to provide an arrangement economical in first cost and simply adjustable to maintain constant the size of the trace of the cathode ray beam on the screen of a fluorescent cathode ray tube.

Other objects of my invention will become apparent upon reading the following description, taken in connection with the drawing in which

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the single figure is a schematic diagram of a circuit supplying accelerating voltage and focusing coil currents to a cathode ray tube, in accordance with the principles of my invention.

Referring in detail to the drawing, a cathode ray tube 1, which may be of any desired conventional type, has at one end a fluorescent screen 2 on which impinges an electron beam produced by acceleration of electrons from an electron emissive cathode 3 by an accelerating anode 4. Such arrangements are conventional in the art and require no extended description. In order to focus the trace of the electron beam to an area of small cross-section on the screen 2, I provide a focusing coil 5 which may also be of a type well known in the art. The voltage for the accelerating anode 4 is furnished by the output of a full-wave rectifier 6 of a type conventional in the art which may be provided by any suitable filtering arrangements, this rectifier being supplied with alternating voltage from a conventional alternating-current supply transformer primary winding 7 connected to an ordinary alternating-current power source (not shown).

Direct current for the focusing coil 5 is supplied from a second rectifier 8 energized from the same source, which likewise may be suitably filtered by arrangements conventional in the art. The current flowing through the focusing coil 5 from the rectifier 8 flows serially through an electron tube 9 of a type conventional in the art, which is provided with a control electrode 11 and a screen grid 12, also conventional in the art. The amount of current through the focusing coil may be initially adjusted by varying the potential impressed on the control grid 11, which is derived from a suitable potentiometer supplied with direct current from the positive terminal 13 of a regulated voltage supply of any type well known in the art to be suitable.

It can be shown readily that the maintenance of a constant size of the focal spot of the electron beam on the screen 2 requires that the following equation shall be fulfilled:

$$(1) \quad H^2 V^{-1} = K$$

where

H=magnetic field strength in the tube due to the focus coil.

V=accelerating potential of the cathode ray tube.

K=a constant.

Suppose now that the electron beam has been adjusted to the desired focus initially with a voltage V_0 impressed from the voltage source 6 and with a magnetic field strength of H_0 . Now suppose that the alternating-current supply connected to winding 7 undergoes an increase so that the voltage impressed by the source 6 on accelerating anode 4 increases by a small fraction a .

Then the following quantity, corresponding to the left-hand side of Equation 1, will represent the condition in respect to the focus of the cathode ray beam on the screen 2:

$$(2) \quad H^2 V^{-1} = H^2 [V_0(1+a)^{-1} = H^2 V_0^{-1}(1-a+a^2-\dots)]$$

Since a is small, we may neglect a^2 and higher powers in the following discussion.

Since the same source which furnishes voltage to rectifier 6 likewise furnishes voltage to rectifier 8, it is evident that the voltage impressed by rectifier 8 on the circuit through focusing coil 5 will likewise increase; and since the circuit through that focusing coil embodies a non-linear impedance (i. e. electron tube 9), the current through the focusing coil 5 will increase by a small fraction b which will, in general, be different from a . Hence the conditions at the focus of the cathode ray beam in tube 1 will be represented by a modification of the left-hand member of Equation 1 which will take the form

$$(3) \quad H_0^2(1+2b+b^2)V_0^{-1}(1-a)$$

Since the fraction b is a small one, b^2 may be neglected from further consideration.

It will be evident that Equation 1 may then be rewritten in the form

$$(4) \quad H_0^2 V_0^{-1}(1+2b-a) = K$$

It is evident that if we can make $2b$ equal to a , the conditions at the cathode ray beam focus, being represented by $H_0^2 V_0$, will be independent of both b and a . In other words, the focus of the cathode ray beam will be maintained constant, regardless of any small fluctuations which may take place in the voltage supplied from the power source.

Since the electron tube 9 is a non-linear resistor, it is readily possible, by properly adjusting the value of the voltage impressed on the screen electrode 12, to insure that the percentage change in current flowing through the focusing coil 5 is exactly one-half of the voltage change impressed by the voltage source 8 to cause that current flow. The voltage impressed on the screen electrode 12 is determined by the relative magnitudes of the resistors 14 and 15, and by properly varying these resistors, the condition that the rate of current change in the plate circuit of tube 9 shall be one-half as great as the direct-current voltage supplied to that circuit by source 8 may be readily fulfilled.

The initial focusing of the cathode ray beam on the screen 2 may be effected by varying the potential impressed by the potentiometer 16 on the control electrode 11. The potentiometer 16 is supplied with voltage from a regulated direct-current source, which may be of small cost because it merely supplies voltage to a control electrode.

The time constants of the circuit supplying voltage to the screen grid and the circuit supplying accelerating voltage to the anode 4 should be as nearly as possible the same in order that voltage fluctuations shall be quickly compensated for.

I claim as my invention:

1. In combination with means for producing an

electron beam by means of an accelerating anode, a focusing magnet for said electron beam, a power supply and means for impressing voltage therefrom on said accelerating anode, means for impressing voltage on said focusing magnet from a current source energized by said power supply in series with said focusing magnet and with an electron tube having an anode, a cathode, a first control electrode adjacent said cathode and a second control electrode between said first control electrode and said anodes, means for impressing voltage derived from said supply on said second control electrode, and means for so adjusting the voltage impressed on said control electrodes that the fractional change in current energizing said focusing magnet due to changes in said power source is substantially one-half the fractional change in the voltage impressed on said accelerating anode.

2. In combination with means for producing an electron beam by means of an accelerating anode, a focusing magnet for said electron beam, a power supply and means for impressing voltage therefrom on said accelerating anode, means energized by said supply for impressing voltage on said focusing magnet from a current source in series relation with said focusing magnet and with an electron tube having an anode, a cathode, a first control electrode adjacent said cathode and a second control electrode between said first control electrode and said anodes, means for impressing voltage derived from said supply on said second control electrode, and means for so adjusting the voltage impressed on said control electrodes that the fractional change in current energizing said focusing magnet due to changes in said power source is substantially one-half the fractional change in the voltage impressed on said accelerating anode.

3. In combination with means for producing an electron beam by means of an accelerating anode, a focusing magnet for said electron beam, a power supply and means for impressing voltage therefrom on said accelerating anode, means for impressing voltage on said focusing magnet from a current source energized by said power supply in series with said focusing magnet and with an electron tube having an anode, a cathode, a first control electrode adjacent said cathode and a second control electrode between said first control electrode and said anodes, means for impressing voltage from said current supply on one of said control electrodes, and means for so adjusting the voltage impressed on said control electrodes that the fractional change in current energizing said focusing magnet due to changes in said power source is substantially one-half the fractional change in the voltage impressed on said accelerating anode.

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