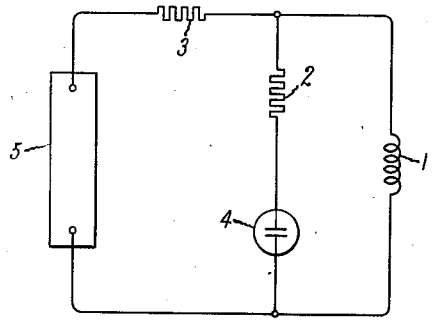
Oct. 22, 1940. D. J. MYNALL 2,219,194

MAGNETIC FOCUSING OF CATHODE RAY TUBES

Filed April 21, 1938

Fig. 1.



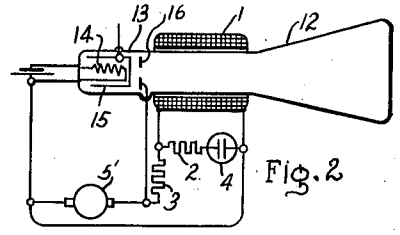
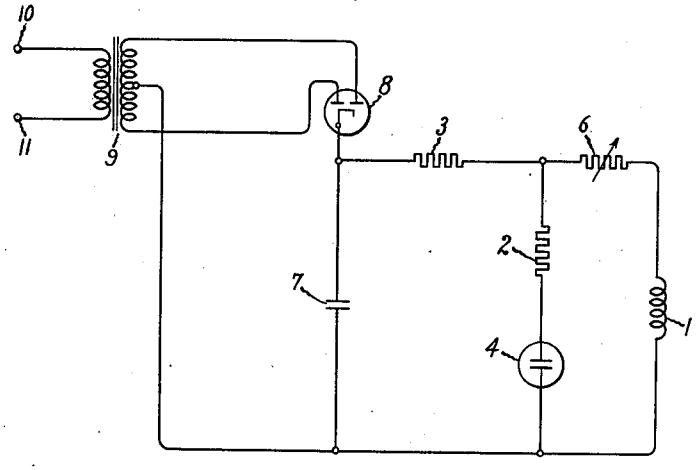


Fig. 2.

Fig. 3.



Inventor:
Dennis J. Mynall,
by Harry E. Dunham
His Attorney.

Patented Oct. 22, 1940

2,219,194

UNITED STATES PATENT OFFICE

2,219,194

MAGNETIC FOCUSING OF CATHODE RAY TUBES

Dennis James Mynall, Rugby, England, assignor to General Electric Company, a corporation of New York

Application April 21, 1938, Serial No. 203,312
In Great Britain May 11, 1937

3 Claims. (Cl. 250—27)

This invention relates to arrangements for the supply of current to magnetically focused cathode ray tubes, such as are used in television reception, or for other purposes of like nature (cathode ray oscilloscopes).

The object of this invention is to provide a means for ensuring the constancy of focus of a magnetically focused cathode ray tube despite variations of the voltage of the electrical mains from which the lens and tube derive their supplies. The present invention is directly applicable to use with lenses of conventional construction.

If I amperes is the current in the windings of a magnetic lens and V volts the anode-cathode voltage of the cathode ray tube, it is known that a relationship of the form

$$I=aV^{\frac{1}{2}}$$

where a is a constant, is the ideal requirement to maintain spot focus independent of variations of V. It follows directly, from the form of the relationship, that, for small changes of V (i. e. variations of the order that obtain in practice, the percentage variation of I must be equal to one-half the percentage variation of V in order to maintain focus, whatever the initial value of V. Now the type of $I-V$ relationship which is normally obtained in practice is closely representable over the working range by $I=bV+c$, where b and c are constants and c may be zero but is, in any case, small compared with bV. It follows immediately that the practical relationship gives a percentage variation of I which is $1/(1+c/bV)$ times that of V, and this factor does not depart appreciably from unity since c/bV may be zero but is, in any case, small compared with unity. So that the actual change in I consequent upon a variation of V is twice the amount required to maintain constancy of focus, and it may be necessary to regain focus by manual adjustment whenever there is a change of mains voltage. This effect is undesirable in a television receiver.

The present invention comprises a circuit arrangement for supplying current to the magnetic lens in such a fashion that a change of I consequent upon a change of mains voltage is automatically restricted to the amount required to compensate for the concomitant change of V, over an adequate working range.

The accompanying drawing shows the manner in which the invention is carried into effect.

Fig. 1 is a circuit diagram illustrating the use of the invention in connection with a direct current source; Fig. 2 shows in somewhat greater detail the manner of use of the circuit of Fig. 1 with a cathode ray tube of conventional construction, and Fig. 3 shows the application of the invention in a case where the primary voltage source is of the alternating current variety.

Fig. 1 shows the essentials of the invention. 1 is the lens winding having a resistance R_1 ohms, 2 and 3 are resistors R_2, and R_3 ohms respectively: 4 is a gas discharge voltage stabilising tube and 5 is a source of D. C. voltage fed from the same supply mains as the cathode ray tube. Let E volts be the voltage of the source 5 and e volts (e less than E) be the working voltage of the stabilising tube 4. Then it is found that, if R_2 and R_3 are suitably proportioned with regard to E and e, it is possible to make the percentage change of I any desired fraction, between zero and unity, of the percentage change of E. In particular the percentage change of I may be made equal to one-half of the percentage change of E, i. e. either exactly or very approximately one-half of the percentage change of V, and this is the condition required to maintain focus. Explicitly, eR_3 must be made equal to ER_2 and when this relation holds R_3 must be less than $(E-e)/I$ in order that the stabilising tube may function.

The above conditions are not sufficient to determine the circuit elements absolutely and it is generally found convenient to choose the mean current to be taken by the tube 4, when the circuit becomes determined and the values of R_1, R_2, and R_3 are readily calculable by known methods.

For practical reasons it may be desirable to make the resistors 2 and/or 3 variable elements in order to provide initial adjustment, and the current in the lens 1 may be initially adjusted by series and/or parallel resistance, in which case R_1 must be taken to represent the resistance of the lens branch considered as a unit and I the current into the whole branch (to which the lens current is equal or bears a definite ratio). Where the source 5 contains effective internal D. C. resistance this must be considered as part of R_3 and may, in the extreme case, constitute the whole of R_3.

In Fig. 2 I have shown the application of the circuit arrangement of Fig. 1 to a cathode ray tube of conventional type. The tube itself comprises a bulbous screen-enclosing portion 12 and an elongated shaft portion 13 which contains a cathode 14, a modulating electrode 15 and an accelerating anode 16. The tube may include

additional elements such, for example, as a system of deflecting electrodes (not shown).

Voltage is impressed between the cathode and anode by means of a direct current source conventionally represented as a generator 5'. The focusing coil 1, which is positioned around the shaft portion of the envelope, is energized by connection to this same source through a regulating circuit of the type described in connection with Fig. 1.

Fig. 3 shows the preferred embodiment of the invention. The elements 1, 2, 3 and 4 have the same meanings as in Fig. 1. 6 is a variable resistor, the primary purpose of which is to provide initial adjustment of focus. A subsidiary function of the resistor 6 may be to reduce the variation of R_1 with change of temperature of the coil winding, but this is not considered an essential feature of the invention. 7 is a condenser the function of which is to reduce the ripple voltage from the rectifying tube 8 so that the tube 4 is maintained continuously in action, and 9 is a transformer connected to alternating current supply mains via terminals 10 and 11. Further smoothing, effective on the branch containing 4 and/or the branch containing 1, may be employed if necessary. The method of smoothing does not affect the direct current action of the circuit provided only that the smoothing is effective enough, and so is not considered to be a feature of the invention.

It will be recognised by those skilled in the art that the resistance of the windings of the transformer 9 and the internal D. C. resistance of the rectifying tube 8 together provide an effective proportion of the value of R_3, and may even be designed to constitute the whole of it, in which case the resistor 3 is not required as a separate entity. It will also be appreciated that the source voltage, E, used in calculating the circuit is not the actual open-circuit output voltage of the rectifier but rather the fictitious open-circuit voltage which is obtained by linear extrapolation to zero load from the working range on the rectifier load characteristic.

It is found in practice that the variations which may exist between individual tubes constituting the elements 4 and 8 are not usually sufficiently large to call for readjustment of the ratio R_2/R_3 when a replacement is made, so that it is practicable to make the resistors 2 and 3 fixed in value, all necessary adjustment being made by means of resistor 6.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. For use with a cathode ray tube of the type which comprises electrostatic means for producing and accelerating an electron beam and magnetic means for focusing the beam, the combination which includes a common source for supplying voltage to the beam-accelerating means and current to the beam-focusing means, and circuit means interposed between the source and the focusing means for causing percentage variations of the focusing current produced by changes in the potential level of the said source to correspond closely to one-half the similarly produced percentage variations of the accelerating voltage, whereby a substantially constant focusing effect is obtained.

2. For use with a cathode ray tube of the type which comprises electrostatic means for producing and accelerating an electron beam and magnetic means for focusing the beam, the circuit combination which includes a common source of potential of normal value E for supplying voltage to the beam-accelerating means and current to the beam-focusing means, a series resistance of value R_3 interposed between the said source and focusing means, another resistance of value R_2 and a discharge device having a constant breakdown voltage e connected serially with respect to one another and to the first resistance but in shunt to the focusing means, the proportioning of the resistances and the voltages being such that $eR_3=ER_2$, whereby a constant focusing action is obtained irrespective of variations in the potential of the supply source.

3. For use with a cathode ray tube of the type which comprises electrostatic means for producing and accelerating an electron beam and magnetic means for focusing the beam, the combination which includes a common source for supplying voltage to the beam-accelerating means and current to the beam-focusing means, a series resistance interposed between the said source and focusing means, and another resistance and a discharge device having a constant breakdown voltage connected serially with respect to one another and to the first resistance but in shunt to the focusing means, the said resistances being so proportioned with respect to the voltage of said source and with respect to the breakdown voltage of the said discharge device that percentage variations of the focusing current produced by changes in said source correspond closely to one-half the similarly produced percentage variations of the accelerating voltage, whereby a substantially constant focusing effect is obtained irrespective of changes in the voltage source.

DENNIS JAMES MYNALL.