

July 4, 1939.

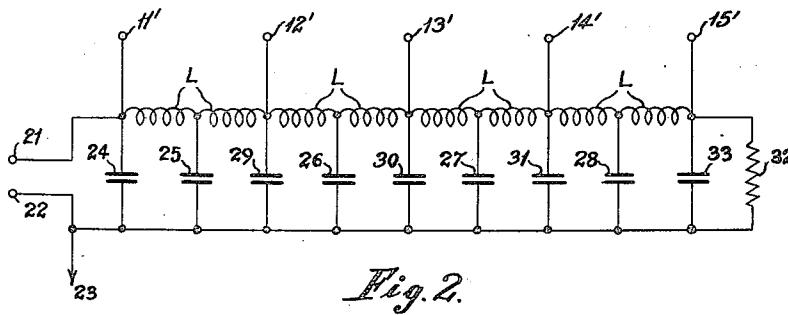
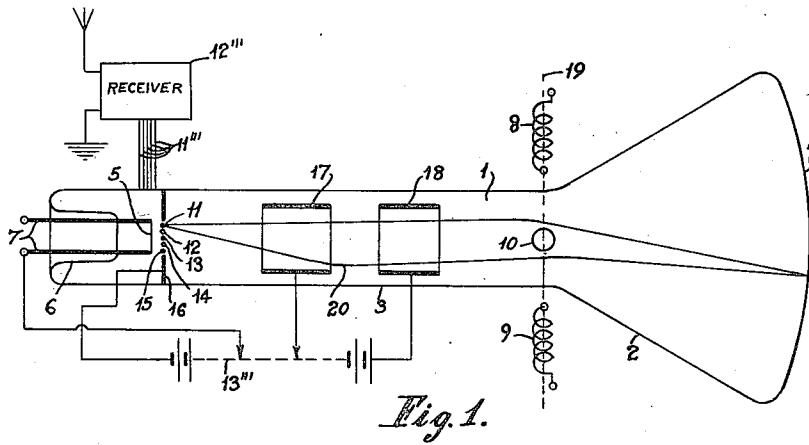
A. D. BLUMLEIN

2,165,028

TELEVISION AND THE LIKE SYSTEM EMPLOYING CATHODE RAY TUBES

Filed March 15, 1935

2 Sheets-Sheet 1



Inventor:

ALAN D. BLUMLEIN

By: *Dr. J. P. Penkeiser*
att'y.

July 4, 1939.

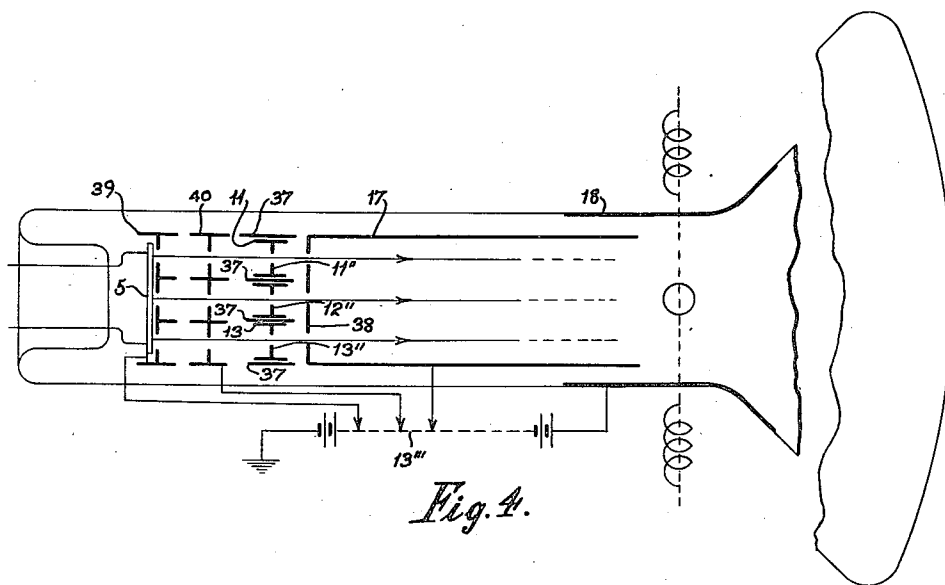
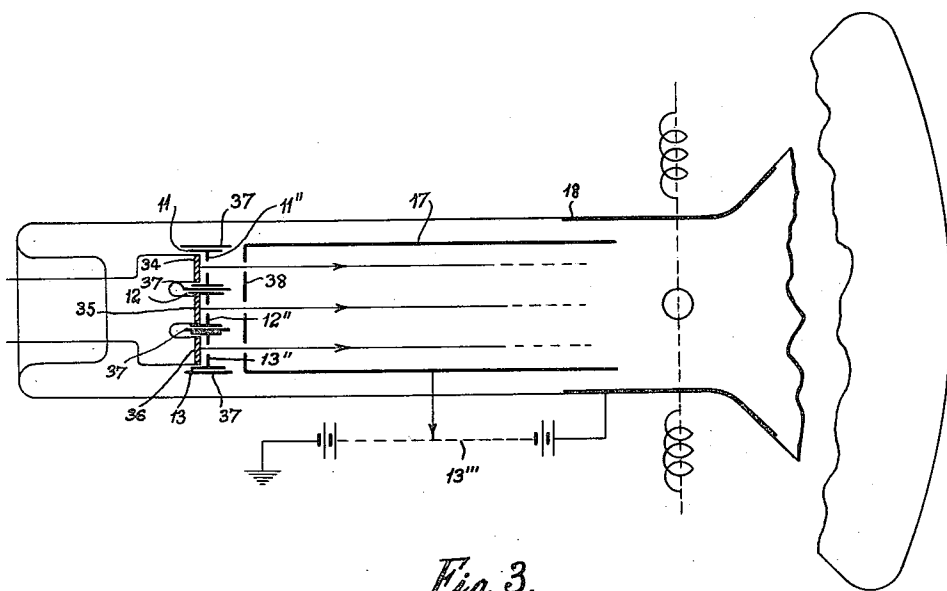
A. D. BLUMLEIN

2,165,028

TELEVISION AND THE LIKE SYSTEM EMPLOYING CATHODE RAY TUBES

Filed March 15, 1935

2 Sheets-Sheet 2



Inventor:
ALAN D. BLUMLEIN
by: *J. J. Pennington*
Atty.

UNITED STATES PATENT OFFICE

2,165,028

TELEVISION AND THE LIKE SYSTEM EMPLOYING CATHODE RAY TUBES

Alan Dower Blumlein, Ealing, London, England,
assignor to Electric and Musical Industries Limited, Hayes, Middlesex, England, a company of Great Britain

Application March 15, 1935, Serial No. 11,186
In Great Britain December 29, 1933

16 Claims. (Cl. 178—7.5)

The present invention relates to television and the like systems of the type in which a cathode ray tube is employed to reconstitute the transmitted image. The invention is particularly concerned with cathode ray tubes for use in such systems.

Television and the like systems have already been proposed in which, at the receiver, the transmitted image is reconstituted by means of a scanning device co-operating with a plurality of light sources which may be controlled by signals received upon a single channel. The signals applied to any one of these light sources are out of phase by a certain definite amount with respect to the signals applied to any of the remaining sources. The several light sources are arranged in spaced relation to each other with respect to the scanning means, and the phase differences between the signals applied thereto are made such that reproduced images due to the several light sources are superimposed one upon the other.

Such arrangements confer the very considerable advantage that, without increasing the number of channels of transmission, the intensity of the reconstituted image may be made several times greater than when it is formed by one similar light source alone. It will be at once appreciated that the use of, say, four modulated light sources instead of only one results, other things being equal, in a fourfold increase in the intensity of the reconstituted image, for the same degree of definition. A similar intensity using only one light source could be obtained either by reducing the scanning speed or by decreasing the number of elementary areas in the reconstituted image, or by decreasing both the scanning speed and the number of elementary areas, but in any case the definition in the reconstituted picture would be reduced correspondingly.

Television systems such as those under consideration are known as multiple spot scanning systems, and it is an object of the present invention to provide a television system of this kind in which a cathode ray tube is employed to reconstitute the transmitted image. The invention also provides a cathode ray tube suitable for use in such a system.

According to the present invention, a cathode ray tube comprises a cathode, controlling means adapted to operate electrically to sub-divide a stream of electrons emitted from said cathode into a plurality of beams, and means for focusing said beams upon different points in a fluorescent screen associated with the tube, the arrange-

ment being such that the intensities of said beams may be separately modulated in accordance with picture or like signals applied to said controlling means. The latter preferably comprise a plurality of control electrodes, each adapted to be associated with a separate control circuit. By a control electrode in this specification is meant an electrode so arranged that it may serve to control the intensity of a cathode ray beam.

According to a feature of the invention, in a cathode ray tube in which a stream of electrons emitted from a cathode is sub-divided into a plurality of beams, in which controlling means are provided for modulating the intensities of said beams, and in which means are provided for focusing said beams upon a fluorescent screen associated with the tube to produce a plurality of scanning spots, the arrangement is such that when the intensities of said beams are separately modulated by like picture signals applied in suitable phase relation to said controlling means, the images traced out by the several scanning spots on the screen are substantially identical in nature and position. The controlling means preferably take the form of a plurality of control electrodes.

According to a further feature of the invention, in a cathode ray tube comprising a plurality of control electrodes, each adapted to be associated with a separate control circuit, the control electrodes are spaced from one another in a direction transverse of and preferably at right angles to the longitudinal axis of the tube, and means are provided for focusing electrons from the cathode upon a fluorescent screen associated with the tube, the arrangement being such that the position of the focus when the electron beam co-operates substantially entirely with one of the control electrodes is different from its position when the beam co-operates with another of the control electrodes.

According to yet another feature of the invention, a receiver for a television or the like system comprises a cathode ray tube of the kind specified in any of the three preceding paragraphs, having controlling means in the form of a plurality of control electrodes, and means for applying controlling signals such, for example, as picture signals representing the light and shade values of the transmitted image, to each of said control electrodes, the phase of the signals applied to any one control electrode being different from the phase of the signals applied to any of the remaining control electrodes. Such means

may comprise one or more delay circuits to which the controlling impulses are applied.

Reference will now be made by way of example to the accompanying drawings, in which Fig. 1 shows in cross-section one form of cathode ray tube according to the invention,

Fig. 2 shows a form of delay network suitable for use with the tube of Fig. 1, and

Figs. 3 and 4 show in cross-section two further forms of tube according to the invention.

Like parts in Figs. 1, 3 and 4 are given the same references.

Referring to Fig. 1, a cathode ray tube comprises a glass or like envelope 1 having a frusto-conical portion 2 and a cylindrical portion 3, one end of the latter being sealed to the smaller end of the frusto-conical portion 2, and the other end thereof being closed by a suitable foot 6. The two portions are arranged with their longitudinal axes in substantially the same straight line, and the frusto-conical portion 2 is closed at its larger end by a suitably shaped glass plate 4, on the inner surface of which is provided a screen of fluorescent material.

An electron emitting cathode 5 is mounted upon the foot 6; the cathode preferably comprises a thin wire of tungsten or the like coated with electron emitting material, and so disposed as to lie in a plane containing the longitudinal axis of the tube and to be at right angles to that axis. The cathode 5 is provided with leads 7 which pass through the foot. The control electrodes of the tube are constituted by fine parallel wires 11 to 15 arranged in a rectangular aperture in a screen 16, the screen and the control electrode wires being insulated from one another and lying in substantially the same plane, which is preferably at right angles to the longitudinal axis of the tube as shown. The wires 11 to 15 may be replaced by rods which are preferably flattened in a plane parallel to the longitudinal axis of the tube.

The control electrodes 11 to 15 are arranged in front of the cathode 5, and are so disposed as to lie at right angles thereto. A suitable electron lens, comprising two cylindrical electrodes 17 and 18 adapted to be maintained at different high positive potentials with respect to the cathode, are provided for the purpose of focusing the cathode ray beam upon the fluorescent screen, and magnetic or electrostatic deflecting means are provided for causing the beam to sweep over the screen under the control of electric scanning oscillations applied to the deflecting means.

The deflecting means may take the form of two pairs of substantially solenoidal coils; the coils 8, 9 of one pair are arranged one on either side of the tube 1 with their axes lying in the line 19, which passes through the longitudinal axis of the tube, while the coils of the other pair (of which only one, numbered 10, appears in the figure) are similarly arranged with their axes lying in a line at right angles to the line 19. In operation, currents of saw-tooth wave form are caused to flow in the deflecting coils, the current in one pair being of the line scanning frequency, and that in the other pair being of the picture scanning frequency.

The leads 11' from the control electrodes pass to a source 12' of picture signals, such as a wireless receiver. Leads from the screen 16 and the electrodes 17 and 18 to the exterior of the tube are connected to points at suitable potentials in a source of current 13' indicated generically by a battery.

The control electrode wires 11 to 15 are insulated from one another, and each is associated with a separate input terminal (not shown). In operation, the screen 16 and the control electrode wires 11 to 15 are given a negative potential with respect to the cathode 5 such that substantially none of the electrons from the cathode are able to escape through the mesh formed by the control electrodes. The modulating impulses, such for example as the picture signals, are then applied to the control electrodes 11 to 15 in such a sense as to cause their potentials to become less negative with respect to that of the cathode 5. Let it be assumed that a picture signal impulse is applied to the control electrode 11 in such a sense as to make its potential less negative with respect to that of the cathode; electrons escape from the control electrode mesh in the neighbourhood of the control electrode 11, and are brought to a focus on the fluorescent screen, and it is arranged that the luminous spot so formed is approximately equal in area to one picture dot, or one elemental area of the transmitted image. The envelope of the cathode ray in these circumstances is indicated approximately by 20. If now the potential of another of the control electrodes 12 to 15 is reduced, electrons will escape in the neighbourhood of this electrode also, and will be brought to a focus on another point on the screen, also equal in area to substantially one picture dot.

It will be seen, therefore, that the fluorescent screen of the tube is scanned simultaneously by as many luminous points as there are control elements, and the arrangement is, accordingly, a multiple spot scanning system. The picture signals applied to the several control elements may, then, be given such phase relationships that the reproduced images are superimposed upon one another.

The control electrodes may be fed with the picture signals from tappings in a suitable delay network, the picture signals being applied to the input terminals thereof, and taken off from points in the network after suitable phase retardations. One form of delay network, which will be described by way of example, is shown diagrammatically in Fig. 2 and comprises two input terminals 21 and 22 to which the picture signals are applied from a suitable source such for example as a wireless receiver; the terminal 22 is connected to a point 23 in a source of bias potential (not shown), while the terminal 21 is connected to a terminal 11', which is connected in operation to the input terminal of the control electrode 11 of the tube. Four pairs of coils, all of the same inductance, and all connected in series with one another, are connected between the input terminals 21 and 22. These coils are all indicated by the reference L, and the inductance of each coil will also be referred to as L. A condenser 24 of a capacity which will be referred to as C₁ is connected in shunt with the input terminals 21 and 22, and further shunt condensers 25, 26, 27 and 28, of a value which will be referred to as C₁, are provided at the junction of the coils of each pair, while shunt condensers 29, 30 and 31, of a value which will be referred to as C₂, are provided at the junctions between neighbouring pairs of coils. A lead is taken from the junction of each pair of coils with the adjacent pair to terminals 12', 13' and 14' respectively, and these terminals are connected in operation to the input terminals of the control electrodes 12, 13 and 14 respectively; a lead is taken from the end of

the eighth inductance coil to a terminal 15' which is connected in operation to the input terminal of the control electrode 15. The network is terminated by a resistance 32 of a value which will be referred to as R, such that

$$R = \sqrt{\frac{L}{C_1}}$$

and a condenser 33 of the value C_3 is connected in shunt with the terminating resistance 32. The capacity C_3 is made smaller than C_1 by an amount sufficient to compensate for stray capacity introduced by the control electrodes 12, 13 and 14, and the capacity C_3 is made half the capacity C_1 , less an allowance for stray capacity due to the control electrodes 11 and 15. The delay introduced by one section (comprising a series inductance coil and the shunt capacity) of such a network is given by

$$\sqrt{LC_1}$$

and the delay between two successive control electrodes is therefore twice this amount.

The control electrodes 11 to 15 of the tube of Fig. 1 may be so spaced that the distance apart of the portions of the fluorescent screen illuminated by the electrons controlled by adjacent electrodes is, say, two thirds of the width of one elemental area. If, then, t is the dot time, that is to say the time of scanning one picture dot at the transmitter, the network is designed in accordance with the equation

$$2\sqrt{LC_1} = \frac{2t}{3}$$

The network is also preferably made such that its cut-off frequency is well above the highest frequency of the picture signals, so that the delay introduced is substantially the same for all picture frequencies.

It should be noted that the separation in time of the action of the control electrodes of two-thirds of the dot time is only chosen by way of example, and any other time separation may be employed as desired. Similarly, more or less sections of the delay network than the two shown and described may be connected between each control electrode, and the network may be of a type more complex than that described and capable of being worked nearer to its cut-off frequency without introducing appreciable differences in the delay for the various picture frequencies. Many suitable networks will readily suggest themselves to those versed in the art.

The electrode arrangement in the cathode ray tube described with reference to Fig. 1 is one of the simplest contemplated, and it will be apparent to those versed in the art that many other arrangements, constituting a plurality of electrode systems for producing a plurality of scanning spots on the fluorescent screen, may be constructed. It will be clear that in a tube comprising a plurality of separate electrode systems each producing its own scanning spot, certain electrodes of the several systems, such as the first anodes, may be united to form a single common structure, provided that the modulating electrodes are kept separate from one another so that the effect of each is confined to its own electron beam. Such an arrangement is shown in Fig. 3, in which 34, 35 and 36 are separate indirectly heated cathodes arranged with their heaters in series, 11, 12 and 13 are separate control electrodes, or modulators, 17 is a common first anode and 18 is a common second anode. The modulators 11, 12 and 13 are of cylindrical

form, each containing an apertured diaphragm 11'', 12'', 13'' respectively, and metallic screens 37 are arranged to screen the modulators electrostatically from one another. Provision is made for holding the screens 37 at a fixed low potential relative to the cathode.

The anodes 17 and 18 are connected to points at suitable positive potentials in the source of current 13''', while the modulators are earthed through suitable input circuits and the cathodes are connected together and to a point at a suitable positive potential relative to earth.

The first anode 17 is closed at the end nearest the cathode by a diaphragm 38 having a number of slit-like apertures arranged opposite the apertures in the modulator diaphragms 11'', 12'', 13''. The second anode 18 may be constituted by a silvering on the wall of the envelope of the tube.

A cathode ray tube according to this invention may be of the type described in co-pending application Serial No. 745,838. A tube of this kind is shown in Fig. 4, and comprises an indirectly heated cathode 5 of rectilinear form, a cathode screen 39, an accelerator electrode 40, three separate control or modulator electrodes 11, 12, 13, a first anode 17 and second anode 18. The modulators 11, 12, 13 have apertured diaphragms 11'', 12'', 13'' and the cathode shield 39, the accelerator 40 and a diaphragm 38 at the cathode end of the first anode 17 all have apertures which are aligned with one another and with the apertures in the modulator diaphragms. Screens 37 are provided to screen the modulators electrostatically from one another, and the second anode 18 is constituted by a silvering on the wall of the envelope. The apertures in the diaphragm 38 are preferably made wider in the direction in which the cathode ray beam moves in scanning a line than in the transverse direction.

In the operation of such a tube, the accelerator 40, the first anode 17 and the second anode 18 are biased so as to accelerate the electrons from the cathode, the modulators are arranged to serve as decelerators and the cathode shield 39 is given a potential equal to or not widely differing from the cathode potential. The screens 37 are held at a low potential relative to the cathode. Referring to the figure, the anodes 17 and 18 are connected to points at suitable positive potentials relative to the cathode in the current source 13''', the accelerator 40 is also given a positive potential, less than the potential of the first anode, the cathode 5 and the cathode shield are connected together and to a point at a positive potential less than that of the accelerator, and the modulators may be earthed through suitable input circuits.

In cathode ray tubes such as those described, it may be found that the application of a signal potential to one control electrode (or modulator) may affect the electron flow in the neighbourhood of adjacent control electrodes (or modulators). This effect may be counteracted by applying to the adjacent electrodes signal impulses of opposite phase and smaller amplitude, and these reverse signals may be obtained from a delay network similar to that described with reference to Fig. 2, but fed with signals of the opposite phase. Alternatively, the wave form of the modulating signals may be so modified that a change in one sense in the amplitude of the signals is preceded and followed by a slight change in the opposite sense, and this may be accom-

plished by applying the signals to three suitable delay networks, and combining the outputs thereof in such magnitudes and senses as to produce the required wave form.

I claim:

1. A cathode ray tube comprising a plurality of cathodes for emitting a plurality of separate beams of electrons, a fluorescent screen, a plurality of control electrodes each associated with one of said cathodes for separately modulating the intensities of said beams, screening means for screening said control electrodes electrostatically from one another, and electrode means common to all of said beams for focusing said beams upon different points on said screen.

2. A cathode ray tube comprising a plurality of cathodes for emitting a plurality of separate beams of electrons, a fluorescent screen, a plurality of control electrodes each associated with one of said cathodes for separately modulating the intensities of said beams, screening means for screening said control electrodes electrostatically from one another, and two tubular electrodes common to all of said beams arranged one behind the other in the paths of said beams for focusing said beams upon different points in said screen.

3. A cathode ray tube comprising a cathode, a cathode shield for sub-dividing electrons from said cathode among a number of beams, a fluorescent screen, and, disposed between said shield and said screen, in the order named, means for accelerating said beams, a plurality of control electrodes for decelerating said beams and for separately modulating the intensities thereof, and electrode means common to all of said beams for focusing said beams upon different points in said screen.

4. A cathode ray tube comprising a cathode, a cathode shield for sub-dividing electrons from said cathode among a number of beams, a fluorescent screen, and, disposed between said shield and said screen, in the order named, means for accelerating said beams, a plurality of control electrodes for decelerating said beams and for separately modulating the intensities thereof, said control electrodes being associated with screening means for screening said control electrodes electrostatically from one another, and electrode means common to all of said beams for focusing said beams upon different points on said screen.

5. A cathode ray tube comprising a cathode, a cathode shield for sub-dividing electrons from said cathode among a number of beams, a fluorescent screen, and, disposed between said shield and said screen, in the order named, means for accelerating said beams, a plurality of control electrodes for decelerating said beams and for separately modulating the intensities thereof, said control electrodes being associated with screening means for screening said control electrodes electrostatically from one another, and two tubular electrodes common to all of said beams arranged one behind the other in the paths of said beams for focusing said beams upon different points in said screen.

6. A receiver for a picture transmission system including a cathode ray tube comprising a cathode for emitting a stream of electrons, a fluorescent screen, a plurality of control electrodes for sub-dividing said stream into a plurality of beams and for separately modulating the intensities of said beams, and electrode means common to all of said beams for focusing said beams upon dif-

ferent points on said screen, a circuit for receiving picture signals, a channel connecting each of said control electrodes with said circuit, and means arranged in at least one of said channels for changing the phase of signals passed therethrough relative to the phase of signals passed through another of said channels.

7. A receiver for a picture transmission system including a cathode ray tube comprising a plurality of cathodes for emitting a plurality of separate beams of electrons, a fluorescent screen, a plurality of control electrodes each associated with one of said cathodes for separately modulating the intensities of said beams, and electrode means common to all of said beams for focusing said beams upon different points on said screen, a circuit for receiving picture signals, a channel connecting each of said control electrodes with said circuit, and means arranged in at least one of said channels for changing the phase of signals passed therethrough relative to the phase of signals passed through another of said channels.

8. A receiver for a picture transmission system including a cathode ray tube comprising a cathode, a cathode shield for sub-dividing electrons from said cathode among a number of beams, a fluorescent screen, and, disposed between said shield and said screen, in the order named, means for accelerating said beams, a plurality of control electrodes for decelerating said beams and for separately modulating the intensities thereof, and electrode means common to all of said beams for focusing said beams upon different points in said screen, a circuit for receiving picture signals, a channel connecting each of said control electrodes with said circuit, and means arranged in at least one of said channels for changing the phase of signals passed therethrough relative to the phase of signals passed through another of said channels.

9. A receiver for a picture transmission system including a cathode ray tube comprising a cathode for emitting a stream of electrons, a fluorescent screen, a plurality of control electrodes for sub-dividing said stream into a plurality of beams and for separately modulating the intensities of said beams, and electrode means common to all of said beams for focusing said beams upon different points in said screen, a plurality of impedance elements arranged as a delay network, means for applying picture signals to said network, and connections from different points in said network to said control electrodes respectively.

10. A cathode ray tube comprising means for producing a plurality of electron beams, means for separately modulating the intensity of each of said beams, a screen, electrode means common to all of said beams for concentrating the electrons in each of said beams upon a small spot each on said screen, said spots lying close to one another in substantially a straight line, and a single means common to all of said spots for causing said spots to scan said screen in a plurality of strips lying substantially perpendicular to said straight line.

11. A cathode ray tube comprising a source of electrons, a plurality of control electrodes for subdividing said electrons among a plurality of beams, a plurality of terminals, means for connecting each of said electrodes and one of said terminals respectively, enabling thereby different controlling signals to be applied to each of said electrodes, a screen, electrode means common to all of said beams for concentrating the electrons

in each of said beams upon a small spot on said screen, said spots lying close to one another in substantially a straight line, and a single means common to all of said spots for causing said spots to scan said screen in a plurality of strips lying substantially perpendicular to said straight line.

12. In a cathode ray tube according to claim 11, said cathode of substantially rectilinear form, said electrodes constituted by substantially straight parallel rod-like members, said members arranged in a direction transverse of said cathode and at right angles to the longitudinal axis of said tube.

13. A cathode ray tube comprising a source of electrons, a plurality of control electrodes spaced from one another in a direction transverse of the longitudinal axis of said tube, said electrodes sub-dividing said electrons among a plurality of beams, a plurality of terminals, means for connecting each of said electrodes and one of said terminals respectively, enabling thereby different controlling signals to be applied to each of said electrodes, a screen, and electrode means common to all of said beams for focusing said beams upon said screen, the position on said screen of the focus of electrons co-operating with one of said electrodes being different from that of the focus of electrons co-operating with another of said electrodes, said foci all lying in substantially the same straight line on said screen.

14. A cathode ray tube comprising means for producing a plurality of electron beams, controlling means for separately modulating the intensity of each of said beams, a screen, electrode means common to all of said beams for concen-

trating the electrons in each of said beams upon a small spot on said screen, said spots lying close to one another in substantially a straight line on said screen and a single means common to all of said spots for causing said spots to scan said screen in a plurality of strips lying substantially perpendicular to said straight line.

15. A cathode ray tube comprising means for producing a plurality of electron beams, controlling means for separately modulating the intensity of each of said beams, a screen, electrode means common to all of said beams for concentrating the electrons in each of said beams upon a small spot on said screen, said spots lying close to one another in substantially a straight line on said screen, and a single means common to all said beams for causing said spots to scan said screen in a plurality of strips lying substantially perpendicular to said straight line.

16. A cathode ray tube comprising a plurality of cathodes for emitting a plurality of separate beams of electrons, a plurality of control electrodes each associated with one of said cathodes for separately modulating the intensity of said beams, a screen, electrode means common to all of said beams for concentrating the electrons in each of said beams upon a small spot on said screen, said spots lying close to one another in substantially a straight line on said screen, and a single means common to all of said spots for causing said spots to scan said screen in a plurality of strips lying substantially perpendicular to said straight line.

ALAN DOWER BLUMLEIN.