

Oct. 24, 1939.

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2,176,973

CATHODE RAY APPARATUS

Filed June 1, 1935

2 Sheets-Sheet 1

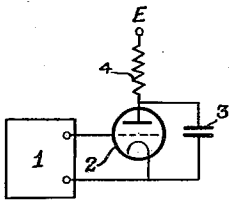


Fig. 1.

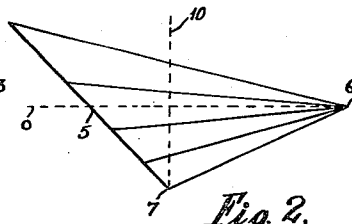


Fig. 2.

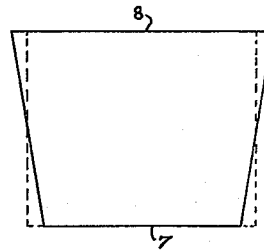


Fig. 3.

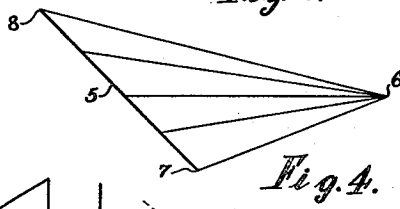


Fig. 4.

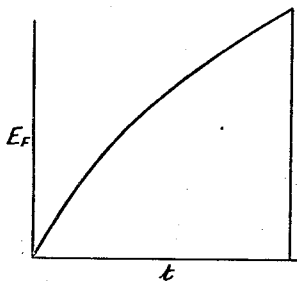


Fig. 5.

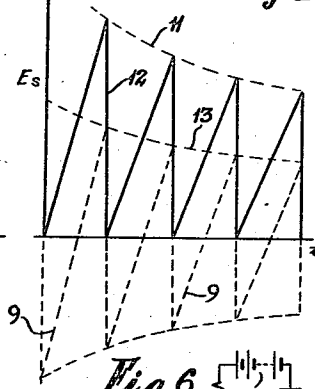


Fig. 6.

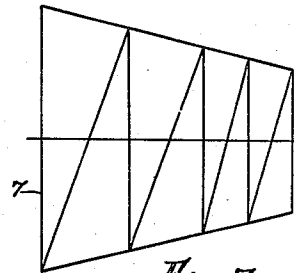


Fig. 7.

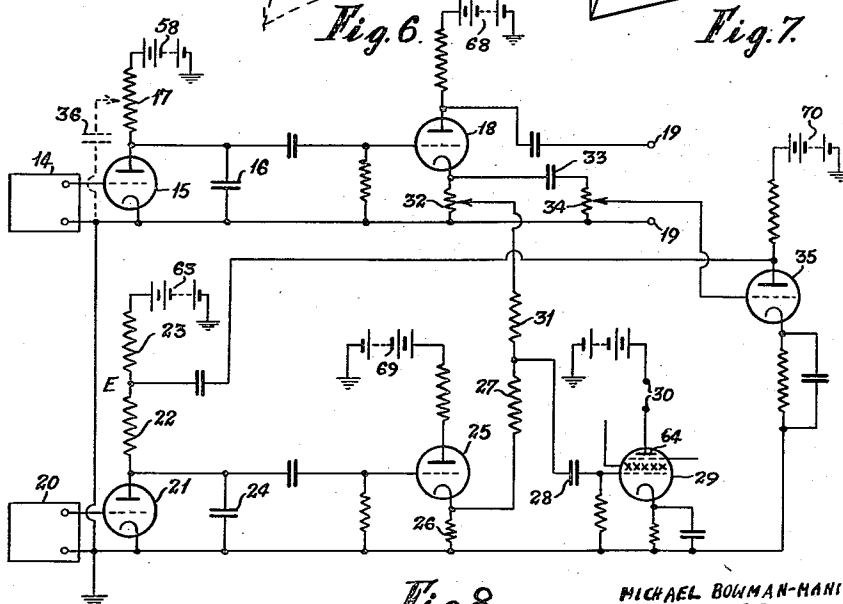


Fig. 8.

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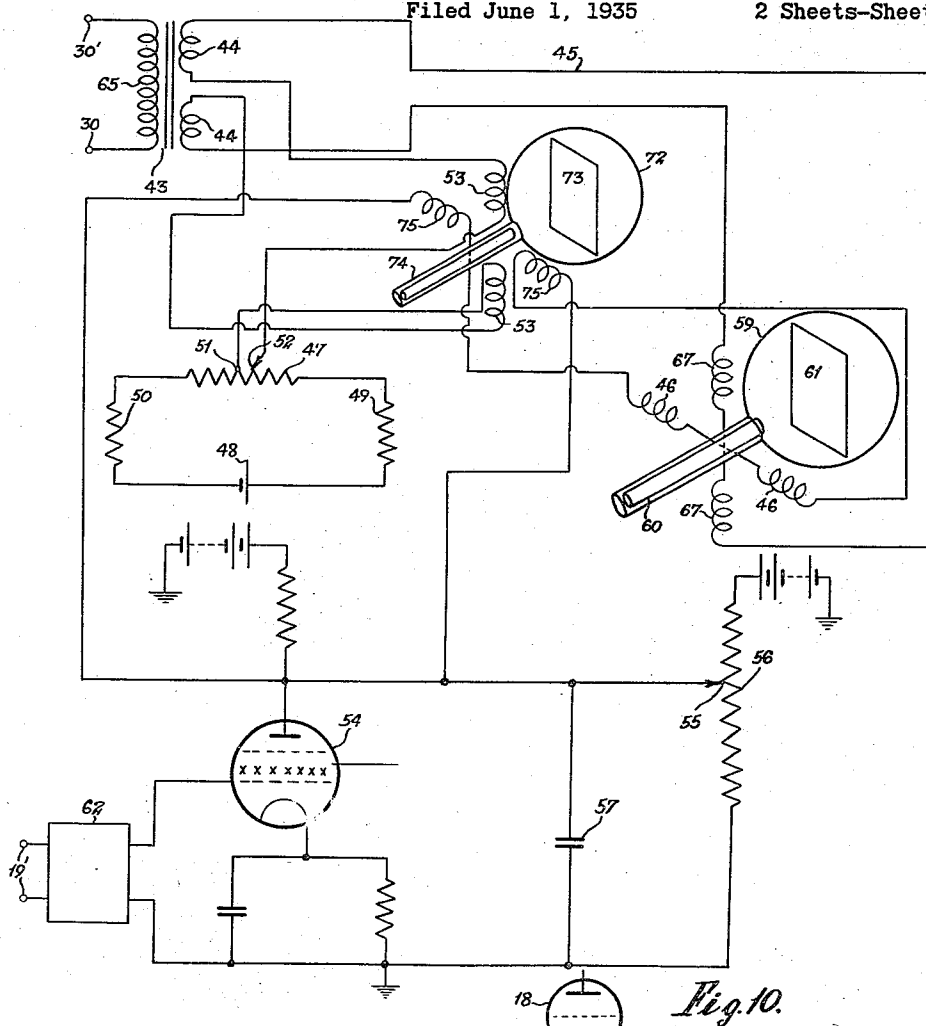


Fig. 10.

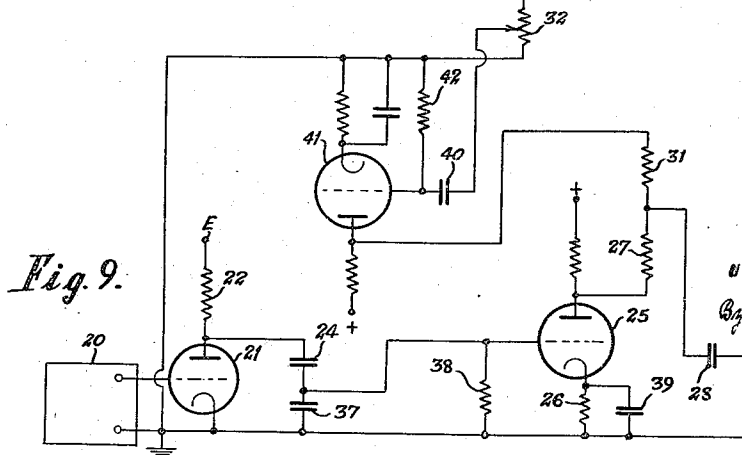


Fig. 9.

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CATHODE RAY APPARATUS

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Application June 1, 1935, Serial No. 24,473
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11 Claims. (Cl. 178-7.7)

The present invention relates to electrical circuits for the deflection of cathode ray beams.

In certain forms of cathode ray tube, the cathode ray is required to scan a rectangular area on a screen disposed at an acute angle to the mean direction of the cathode ray which will be referred to as the axis of the ray. An example of this is a cathode ray tube used for television transmission in which the screen is of the mosaic type and in which the image to be transmitted is formed upon the same side of the screen as that upon which the ray impinges. If the deflection is effected in the normal manner using electrical oscillations of rectilinear saw-tooth wave form and constant amplitude for the deflection in both coordinates, the area scanned upon the screen will be of keystone shape and the strips scanned will be more widely spaced in the neighbourhood of the edge of the screen further from the source of the cathode ray, or electron gun, than in the neighbourhood of the opposite edge.

It is an object of the present invention to provide means for overcoming this difficulty.

According to the present invention, there is provided a circuit arrangement comprising a cathode ray tube having an electron gun, a screen inclined at an acute angle to the ray axis and a deflecting circuit provided with means for generating electrical oscillations of saw-tooth wave form of two different frequencies, the first of said oscillations serving to deflect the ray in a direction parallel to a plane containing said axis and the normal to the screen at the point of intersection of said axis with the screen and the second of said oscillations serving to deflect the ray in a direction perpendicular to said plane, wherein the generating means are such that, in the first of said oscillations, the rate of change of voltage or current in said deflecting circuit is greater when the ray is on the part of the screen nearer the electron gun than when the ray is on a part of the screen further from the electron gun and such that the second of said oscillations has a wave form which is a function of the first oscillation and of a substantially rectilinear saw-tooth wave.

It is usually arranged that the first oscillation is that of lower frequency, namely the framing frequency oscillation, the second oscillation being the strip frequency oscillation. In this case the strip frequency oscillation has a rectilinear saw-tooth wave form and its amplitude changes as a function of the frame frequency wave form.

The invention will be described with reference

to the accompanying drawings, in which Fig. 1 is an explanatory circuit diagram, Figs. 2 to 7 are diagrams illustrating the invention, Fig. 8 shows a circuit diagram of one embodiment of the present invention, Fig. 9 shows a modification of a part of the circuit diagram of Fig. 8, and Fig. 10 shows one circuit arrangement whereby the output of the circuit of Fig. 8 is employed for deflecting the beam in a cathode ray tube.

Referring to Fig. 1, there is shown a well known arrangement for generating a saw-tooth potential wave, the frequency of the oscillation generated being controlled by unidirectional pulses from a source indicated by 1, the duration of each of these pulses being very short compared with the intervals between successive pulses. The anode-cathode path of the valve 2 is arranged to be normally insulating and a condenser 3 is charged at a substantially uniform rate through a resistance 4, the end of the resistance remote from the anode being maintained at a fixed positive potential E relatively to the cathode of the valve. When a pulse arrives at the grid of the valve it makes the grid more positive and the anode-cathode path of the valve 2 conducts and discharges the condenser 3, thus completing the cycle. The time constant of the resistance 4 and the condenser 3 is usually made large compared with the time period of the oscillations to be generated. The oscillations generated in this way will be of substantially rectilinear saw-tooth wave form and constant amplitude and one generator of this kind may be used for the strip frequency and another for the frame frequency.

It will be assumed for convenience that the cathode ray tube has its mosaic screen disposed so that the plane containing the ray axis and the normal to the screen (at the point of intersection of the ray axis with the screen) is vertical. Thus the diagram of Fig. 2 may be taken as a view in elevation, the screen being represented by reference 5, the source of cathode rays by reference 6 and the ray axis by o. If normal means (electromagnetic or electrostatic) be used to deflect the ray in such a way that the strips scanned are substantially horizontal, the spacing between adjacent strips will not be uniform. This is illustrated diagrammatically in Fig. 2 where for simplicity the screen is shown as if it were scanned in only four traverses of the ray, the strips being nearly perpendicular to the plane of the paper. It will be seen that the strips are closer together in the neighbourhood of the edge 7 of the screen nearer the source 6 than towards the opposite edge 8.

Furthermore the ray instead of sweeping out a rectangular patch such as that shown in dotted lines in Fig. 3 will sweep out the keystone shaped area shown in full lines. It is of course desired that the ray should sweep out a rectangular area and that the strips should be uniformly spaced as shown in Fig. 4. The time of scanning each strip is of course the same and hence so far as the framing deflection (that in the direction from 7 to 8) is concerned, the angular deflection of the ray near edge 7 is required to be greater than that produced by the normal deflecting means and the angular deflection near edge 8 is required to be less than that produced by the normal deflecting means. In the case of the strip frequency deflection it will be seen that the amplitude is required to decrease as the ray moves from the neighbourhood of edge 7 towards edge 8.

The desired deflection in the framing dimension can be obtained with a tube having normal deflecting means by giving the framing oscillation a wave form of the kind shown in Fig. 5. Here the deflecting voltage E_F (or current if electromagnetic means are used) increases more rapidly for small values of time t , where the ray is in the neighbourhood of the edge 7, than for larger values of t . The curvature of the wave form is arranged to be such as to give uniform spacing of the strips as indicated in Fig. 4.

Similarly the ray can be caused to sweep out a rectangular area on the screen by applying to strip deflecting means of normal type a voltage (or current) wave of the form indicated by the dotted line 9 in Fig. 6. Here the deflecting voltage E_s is plotted against time t . It will be seen that the frequency of the oscillation in Fig. 6 is constant and that the amplitude decreases proceeding from near edge 7 towards edge 8. The envelope of this saw-tooth wave 9 is constituted by curves 13 which are functions of the curve of Fig. 5. The effect of using deflecting oscillations of the form shown in Figs. 5 and 6 is to scan in a plane normal to the axis (such as plane 10 in Fig. 2) along a track somewhat as indicated in Fig. 7, but a rectangular area with uniform strip spacing on the screen 5.

A generator of the kind shown in Fig. 1 can be caused to generate a wave form such as is shown in Fig. 5 by a suitable choice of the values of resistance 4 and condenser 3, the product of the resistance and capacity being made smaller than where a substantially straight line wave form is desired.

The wave form 9 of Fig. 6 can be obtained as follows: If the potential E in Fig. 1 be caused to change as a function of E_F , and if it is arranged that the condenser 3 is substantially fully discharged each time the valve 2 becomes conducting, the potential of the condenser 3 at the instant of discharge, represented by curve 11 of Fig. 6, will be proportional to E and may be represented by $K - kE_F$, where K and k are constants. Thus the wave generated will be of the form shown in full lines at 12 in Fig. 6. By subtracting from curve 12 the curve 13, which is a function of curve 11, the curve 9 can be obtained.

One circuit arrangement in which these results can be obtained is shown in Fig. 8. A source 14 of frame frequency impulses is associated with a valve 15, condenser 16 and resistance 17 in the same way as the elements 1, 2, 3 and 4 are associated in Fig. 1, a source 58 being provided to supply the potential E . The time constant of the condenser 16 and resistance 17 is chosen so

that the wave form of the oscillation generated is of the kind shown in Fig. 5. This oscillation is amplified by a valve 18 and fed to terminals 19 which are connected to input terminals 19' of Fig. 10. In the circuit of Fig. 10, oscillations fed to terminals 19' are amplified by valve 54 and fed to deflecting coils 46 of a cathode ray tube 59. The tube 59 has an electron gun 60 and a mosaic screen 61, the screen 61 being inclined at an acute angle to the mean direction of the electron beam from the gun 60. The axis of coils 46 is horizontal and current passed therethrough serves to deflect the beam in a vertical direction. A suitable circuit 62 may be provided between terminals 19' and valve 54 whereby the potentials at terminals 19' are distorted so that a current of the wave form shown in Fig. 5 can be passed through the deflecting coils 46.

Referring again to Fig. 8, a source 20 of strip frequency pulses is associated with a saw-tooth generator, also of the kind shown in Fig. 1, comprising valve 21, anode resistances 22, 23, condenser 24 and a source of potential 63. This valve 21 is coupled to a valve 25 having a resistance 26 connected between its cathode and earth. The cathode of valve 25 is connected through a resistance 27 and a condenser 28 to the control grid of a pentode 29 the anode 64 of which is connected through the primary winding 65 of transformer 43 of Fig. 10 to a source of potential 66, terminals 30 of Fig. 8 being connected to terminals 30' of Fig. 10. The secondary windings 44 of transformer 43 are connected to deflecting coils 67 of cathode ray tube 59. Deflecting coils 67 serve to deflect the beam in a horizontal direction. The control grid of the pentode 29 is also connected through condenser 28 and a resistance 31 to a tapping point, which may be variable, upon a resistance 32 arranged between the cathode of valve 18 and earth. In parallel with the resistance 32 are arranged a condenser 33 and a resistance 34 in series and a tapping point on resistance 34, which may also be variable, is connected to the control grid of a valve 35, the anode of which is connected to the junction point of resistances 22 and 23. Further sources of potential 68, 69, 70 are provided to supply positive potentials to the anodes of valves 18, 25 and 35. The negative poles of sources 58, 63, 66, 68, 69 and 70 are earthed.

The potential E at the upper end of resistance 22 will thus have a constant component due to the voltage source 63 and a varying component proportional to the frame frequency wave form. The output of the valve 21 will be of the form shown at 12 in Fig. 6. The inclination of the curve 11 can be altered by adjusting the tapping point on resistance 34. The subtraction from this wave form 12 of a quantity proportional to that defined by curve 11 is obtained by mixing in resistances 27 and 31 the potential drop across resistance 26 with the potential drop across a part of resistance 32 and feeding the resultant, which may be adjusted to be of the form shown at 9 in Fig. 6, to the pentode 29. The resistances 27 and 31 are of large value compared with resistances 26 and 32.

The wave form shown in Fig. 5 may be adjusted without substantial alteration in the amplitude with the aid of a condenser of large value shown in dotted lines connected between a variable tapping point on resistance 17 and earth. If the condenser 36 is of sufficiently large value, the terminal thereof remote from earth remains at a substantially constant potential and the effective

value of the resistance 17 is that portion thereof between the anode of valve 15 and the tapping point.

The amplitudes of the frame and strip frequency oscillations can be varied by varying the potentials applied to the upper ends of resistances 17 and 23 respectively.

In the circuit of Fig. 8 it may be difficult or impossible to avoid appreciable loss, in the coupling between valves 21 and 25, of low frequency components of the signals which are fed from valve 21 to valve 25. This loss causes distortion of the frame frequency component of the signals, that is, of the envelope 11 of the saw-tooth wave 12. In order to eliminate or reduce this distortion the modification of Fig. 8 shown in Fig. 9 may be employed.

Referring to Fig. 9 a condenser 37 is connected in series with condenser 24 on the earth side thereof. The common point of condensers 24 and 37 is connected to the control grid of valve 25 and through a grid leak 38 to earth. Resistance 26 in the cathode circuit of valve 25 is shunted by a decoupling condenser 39 and the end of resistance 27 remote from resistance 31 is now connected to the anode of valve 25. The tapping point on resistance 32 is connected through a coupling condenser 40 to the grid of a triode valve 41, a grid leak 42 being provided between the grid and earth. The anode of valve 41 is connected to the end of resistance 31 remote from resistance 27.

It is preferably arranged that condenser 37 has a capacity of about five times that of condenser 24 and that grid leak 38 has a suitable very high value. The loss of low frequency components of the signals in the coupling between valves 21 and 25 is then governed by the time constant of condenser 37 and grid leak 38.

In the input circuit of valve 41 it is arranged that the time constant of condenser 40 and grid leak 42 is substantially equal to that of condenser 37 and grid leak 38 in the input circuit of valve 25. The percentage loss of low frequency components is therefore substantially equal in these two circuits. Curve 13 (Fig. 6) and the envelope 11 of curve 12 therefore suffer substantially equal distortion and when these curves are subtracted by combining the outputs of valves 25 and 41 in resistances 27 and 31 a substantially undistorted resultant of the form of curve 9 is obtained.

In a preferred arrangement the saw-tooth generators operate at low amplitude and additional stages of amplification may then be provided between terminals 19 and 19' and between terminals 30 and 30'. Distortion may be avoided and the wave form may be improved in these amplifiers by the use of anti-regenerative feedback.

In cathode ray tubes of the type described above it is often desirable to provide means whereby the rectangular area scanned upon the screen may be moved as a whole in directions parallel to its pairs of parallel sides. Where electromagnetic deflecting means are employed this result may be obtained by superimposing an adjustable D. C. component on the deflecting coil currents.

Where the output stage of a synchronising signal generator is provided with an output transformer the circuit of the upper part of Fig. 10 may be employed. The output transformer 43 has a secondary winding comprising two similar coils 44, the outer ends of which are connected

through a transmission line 45 to the deflecting coils 67 of cathode ray tube 59. This tube 59 may be arranged at a point distant from the generators. A potentiometer 47 is supplied with current from a source 48 through resistances 49, 50. The centre point 51 and a variable tapping point 52 on potentiometer 47 are connected between the inner ends of the deflecting coils 53 of a local monitor tube 72 having a fluorescent screen 73 to enable the area traced out by the ray from the electron gun 74 to be observed. The outer ends of coils 53 are connected to the inner ends of coils 44. It will be seen that, with this arrangement, the potentiometer 47 and the deflecting coils 53 of the local monitor 72 are symmetrically connected at the centre of the secondary winding of transformer 43. By adjusting the position of tapping point 52 on potentiometer 47 the magnitude of the direct current through the deflecting coils 46 may be varied to adjust the position of the rectangular area scanned upon the screen.

The monitor tube 72 is provided with a second pair of deflecting coils 75 which serve to deflect the beam in a vertical direction. These coils 75 are connected in series with the deflecting coils 46 of tube 59. The deflecting coils 46 and 53 are connected at one end to the anode of the output valve 54 and at the other end to a variable tapping point 55 on a potentiometer 56. One end of potentiometer 56 is earthed, the other end being connected to a suitable point in an anode current source 76, the negative terminal of which is earthed. A condenser 57 is connected between tapping point 55 and earth. Variation of tapping point 55 on potentiometer 56 changes the magnitude of the direct current through the deflecting coils 46 and hence moves the area scanned upon screens 61 and 73.

I claim:

1. The circuit arrangement for varying keystone and "crowding" distortions comprising means to develop non-triangular wave energy, means to develop triangular wave energy, means to subtract a portion of the developed non-triangular energy from the developed triangular energy, and means to supply the difference of the two energies to magnetic coils.

2. A circuit arrangement for varying keystone and "crowding" distortions comprising means to develop non-triangular wave energy of predetermined frequency, means to develop triangular wave energy of a predetermined higher frequency bearing a multiple relation to the frequency of the non-triangular energy, means to subtract a portion of the developed non-triangular energy from the developed triangular energy, and magnetic means to control a stream of electrons in accordance with the difference of the two developed energies.

3. A circuit arrangement for varying keystone and "crowding" distortions comprising a cathode ray tube having an electron gun for projecting a beam of electrons, magnetic coils for deflecting the beam of electrons, means to develop non-triangular wave energy of predetermined frequency, means to develop triangular wave energy of predetermined multiple frequency of the non-triangular frequency, means to subtract a portion of the developed non-triangular energy from the developed triangular energy, and means to supply energy representative of the difference of the two energies to the magnetic coils.

4. A circuit arrangement for varying keystone and "crowding" distortions comprising a

cathode ray tube having an electron gun for projecting a beam of electrons, a screen inclined at an acute angle to the mean direction of said beam for receiving said electrons, a first deflecting means for deflecting said beam, from said mean direction, in a direction parallel to a plane containing said mean direction and normal to said screen, a second deflecting means for deflecting said beam in a direction perpendicular to said plane, a first oscillation generator for generating a first scanning oscillation of non-triangular wave form, a second oscillation generator for generating a second scanning oscillation of triangular wave form, the frequency of said first oscillation being less than the frequency of said second oscillation, said second oscillation generator comprising a condenser, a resistance, a source of potential difference for charging said condenser through said resistance, means for periodically discharging said condenser and a coupling between said source and said first oscillation generator for controlling the effective charging potential of said source in accordance with said first scanning oscillation, means for feeding to said first deflecting means an oscillation from said first generator, means for feeding to said second deflecting means an oscillation from said second generator.

5. A circuit arrangement for varying keystone and "crowding" distortions comprising a cathode ray tube having an electron gun for projecting a beam of electrons, a screen inclined at an acute angle to the mean direction of said beam for receiving said electrons, a first deflecting means for deflecting said beam, from said mean direction, in a direction parallel to a plane containing said mean direction and normal to said screen, a second deflecting means for deflecting said beam in a direction perpendicular to said plane, a first oscillation generator for generating a first scanning oscillation of non-triangular wave form, a second oscillation generator for generating a second scanning oscillation of triangular wave form, the frequency of said first oscillation being less than the frequency of said second oscillation, said second oscillation generator comprising a condenser, a resistance, a source of potential difference for charging said condenser through said resistance and means for periodically discharging said condenser and a coupling between said source and said first oscillation generator for controlling the effective charging potential of said source in accordance with said first scanning oscillation, means for feeding to said first deflecting means an oscillation from said first generator, combining means for combining an oscillation from said second generator with said first scanning oscillation and means for feeding the combined oscillation to said second deflecting means.

6. A circuit arrangement for varying keystone and "crowding" distortions according to claim 5, wherein said combining means comprise two impedances, and comprising in addition means for feeding to said impedances oscillations from both said generators and means for deriving from said impedances a combined oscillation, dependent upon the difference between these two oscillations.

7. A circuit arrangement for varying keystone and "crowding" distortions according to claim 5, comprising in addition a first coupling circuit coupling said first generator to said combining means, a second coupling circuit coupling said second generator to said combining means, said first coupling circuit being associated with a first frequency selective circuit for attenuating low frequencies with respect to high frequencies, said second coupling circuit being associated with a second frequency selective circuit for attenuating low frequencies with respect to high frequencies wherein the attenuation of low frequencies with respect to high frequencies in said first coupling circuit is substantially equal to the attenuation of low frequencies with respect to high frequencies in said second coupling circuit.

8. A circuit arrangement for varying keystone and "crowding" distortions as claimed in claim 5 and comprising in addition an output transformer associated with said combining means and having two secondary windings, a monitoring cathode ray tube having an electron gun for projecting a beam of electrons, a fluorescent screen for receiving said last mentioned electrons and a pair of deflecting coils, and a potentiometer connected at its ends to a source of direct current and having two tapping points intermediate its ends at least one of said tapping points being variable, wherein said pairs of deflecting coils and said secondary windings are connected in series between said two tapping points.

9. A circuit arrangement for varying keystone and "crowding" distortions as claimed in claim 5 and comprising in addition an impedance element, a potentiometer having a variable tapping point and a source of direct current wherein said combining means and said impedance element are connected in series across said source of direct current, said potentiometer is connected across said source of direct current, and said deflecting coils are connected between said tapping point and the junction of said source of scanning oscillations and said impedance element.

10. The method of correcting for keystone "crowding" distortion in a cathode ray tube, wherein an electron beam is used for scanning, which comprises the steps of developing one deflecting field, varying the deflecting field linearly with respect to time, simultaneously reducing said linearly increasing field exponentially with respect to the elapsed time, simultaneously producing a deflecting field at right angles to said first deflecting field, linearly increasing said second deflecting field, and simultaneously modifying said second deflecting field in accordance with the first of said deflecting fields, and subjecting the electron beam to the simultaneous action of said deflecting fields.

11. The method of correcting "crowding" distortion in a cathode ray tube, comprising the steps of developing a beam of electrons, developing a deflecting field, and simultaneously varying said deflecting field increasing linearly with time and decreasing exponentially with time.

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