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GENERATOR FOR DYNAMIC FOCUSING OF CATHODE-RAY TUBES

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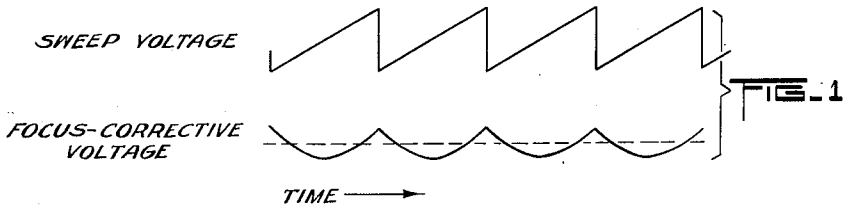

FIG. 1

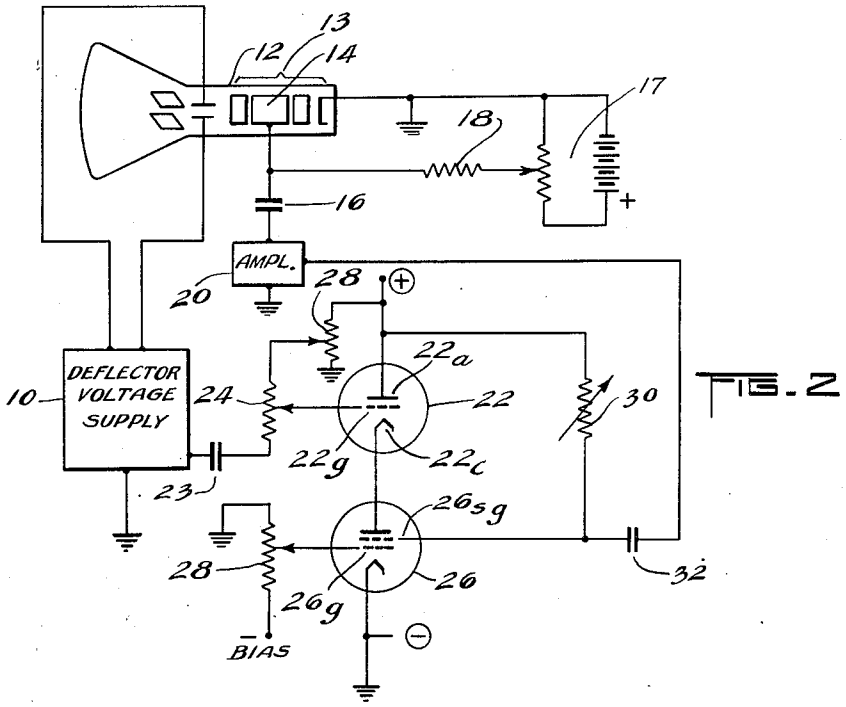

FIG. 2

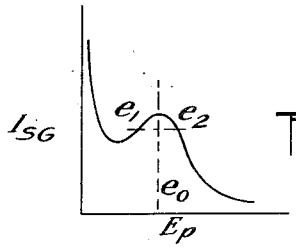

FIG. 3

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GENERATOR FOR DYNAMIC FOCUSING OF CATHODE RAY TUBES

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The present invention relates to electronic apparatus. An object of the invention is to generate a voltage wave that is suited to correct for deflection defocusing in cathode-ray tubes. A feature of the invention is the simple and reliable apparatus provided which develops the desired focus correcting voltage in relation to the sweep voltage, substantially without regard to the time rate of sweep whether at a particular deflection point or over an entire sweep cycle.

The nature of the invention, together with further objects and features of novelty, will be better appreciated from the following detailed disclosure of an illustrative embodiment thereof. In the accompanying drawings:

Fig. 1 is a diagram showing the wave-form of an illustrative sweep voltage and the required focus-correcting voltage along a common time base;

Fig. 2 is a wiring diagram of an illustrative embodiment of the invention for providing focus-correcting voltage; and

Fig. 3 is the screen current versus plate voltage characteristics of a tetrode which appears as an element in Fig. 2.

It is a commonly observed phenomenon that the focus of a cathode-ray beam in oscilloscopes and like instruments can be made sharp at the center of the screen, but with such adjustment the focus at the extremes of deflection tends to be impaired. Likewise, if the focus is correct for the extremes of deflection, it is improper at the center so as to create a fuzzy trace and one which is particularly unsuited to photographic reproduction.

It is commonly required that the horizontal sweep of the electron beam be given a linear displacement in relation to time. For this purpose, a sawtooth voltage as in Fig. 1 is applied to the horizontal deflection plates of the cathode-ray tube. Where the beam is properly focused at the center of the screen, the required focus-correcting voltage, to be superimposed on the direct-current potential applied to a focusing electrode in the beam-forming gun of the cathode-ray tube, is shown in the lower part of Fig. 1. Even though the frequency of the sweep voltage is changed over a wide range it is desirable that the focus-correcting voltage should at all times be the required value at each instant to correct for deflection defocusing. Where a non-linear time base is used and consequently a sweep voltage is used having a form other than sawtooth variation with time, the focus-correcting voltage and deflection voltage should have the same relationship at every instant that they do in Fig. 1.

In Fig. 2 there is shown a circuit for providing and applying a focus-correcting voltage to a cathode-ray tube, which circuit has the characteristic of yielding a change in voltage in the same direction for changes in deflection voltage in either direction from the value corresponding to a centered beam. Voltage supply **10** is connected to the horizontal deflection plates of a cathode-ray tube **12** as used in an oscilloscope, for example. The gun **13** in this cathode-ray tube is appropriately focused by proper static potential supplies so that the sharpest possible focus will be had all across the screen when static and correction voltages are applied to an appropriate focusing electrode **14**. The static voltage is adjusted for best focus with the beam at points on the screen where the dotted average-voltage line in Fig. 1 intersects the focus-corrective voltage wave. The amplitude of the corrective voltage is concurrently adjusted for best focus at all points along the deflection path. Thus the defocusing caused

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by the deflection plates is corrected without notable effect on the degree of deflection. It is evident that the static voltage differs from that which would be applied for perfect focus of a centered beam in the absence of focus-correction.

The corrective voltage is applied to electrode **14** through a coupling condenser **16**, with the static potential supply **17** for that electrode isolated from the focusing electrode by a resistor **18**. Voltage from the focus-correcting voltage generator is applied to condenser **16** by amplifier **20**, in which a certain degree of refinement of wave-shaping may be effected.

The illustrative focus-correcting voltage generator comprises a triode **22** having its grid **22*g*** coupled to deflection voltage supply **10** through coupling condenser **23** and potentiometer **24**, so that an appropriate portion of the deflection voltage is applied. Anode **22*a*** is connected directly to the positive terminal of a direct-current supply and cathode **22*c*** is returned to the negative terminal of the supply through the plate cathode space of a tetrode **26**. The normal, static bias of grid **22*g*** is applied from the B supply by potentiometer **28** which is of a very low resistance so that the signal obtained from potentiometer **24** may be superimposed on that D.-C. base. Potentiometer **24** may be one megohm and potentiometer **28** may be one-tenth that large. The plate-cathode space of tube **26** functions somewhat as a non-linear cathode-follower resistor for triode **22**, the value of which depends upon the bias on its grid **26*g*** which as fixed by bias potentiometer **28** and the bias voltage supply, and by the screen voltage. The sweep voltage is applied between grid **22*g*** and the negative return of tetrode **26**.

The voltage on screen grid **26*sg*** is derived from a higher potential point than that applied as an average, through resistor **30**. The screen grid functions as an electron-collecting electrode and has a characteristic curve as shown in Fig. 3. For increases in plate voltage up to a point the screen-grid current decreases, then increases and finally reverses again. The inverse curve between e_1 and e_2 is due to secondary-emission from the anode. This curve is sufficiently symmetrical about the value e_0 and is of such shape that a nearly ideal voltage form is developed at the screen grid for focus-correction after appropriate amplification. Screen grid **26*sg*** is coupled through condenser **32** to amplifier **20** to focusing electrode **14**.

The voltage variations on the anode of tetrode **26** are effected almost precisely as required by triode grid **22*g***. A voltage variation is developed at screen grid **26*sg*** which changes roughly according to the square-law in relation to the voltage instantaneously applied to grid **22*g***, and the voltage yielded increases both for increases and for decreases in instantaneous values of voltage on grid **22*g*** above and below the voltage corresponding to a centered beam.

Tetrode **26** is illustrative, beam tetrode 7A5 having been found excellent for the purpose. Other tetrodes will be found useful, as well as other devices having a comparable secondary-emissive electrode. Since the result is effected through variation of electronic characteristics, the generated voltage follows the related available voltage according to the same law without appreciable regard to frequency. Circuit design imposes a limitation on the generator as a practical matter, because of the frequency characteristics of coupling condensers, distributed capacities and the like; but with proper design, the generator is nevertheless useful over a wide range of sweep frequencies, and the full variation in focus-corrective voltage may be realized even through, for a constant low sweep rate, any small or large part of the sweep-voltage cycle is utilized in full-scale deflection of the cathode-ray tube.

The focus-correction is useful for cathode-ray tubes of conventional design, where it is applied to spherical focusing; or to specially constructed cathode-ray tubes. The conversion from sawtooth wave to cusp-shaped wave (or comparable instantaneous conversion of voltages on an other-than-linear time base) will also be found to have applications other than that illustrated. Therefore, I desire the appended claims to be given broad interpretation, consistent with the spirit of the invention.

What is claimed is:

1. In cathode-ray apparatus having a sweep-voltage supply and a static beam-focusing supply, a dynamic focusing generator including a tetrode having a secondary electron-emissive anode, and screen grid and a triode, said tetrode and said triode having their plate-cathode circuits series-connected, the control grid of said triode being coupled to said sweep-voltage supply, a resistor connected to the screen grid of said tetrode, and a coupling circuit between said screen grid and said focusing supply.

2. In cathode-ray apparatus, a sweep voltage supply and a static beam-focusing supply, a dynamic focusing generator including two electron-discharge devices having their plate-cathode circuits series connected, one of said devices having a control grid coupled to said sweep voltage supply, the other of said devices having a secondary-electron-emissive electrode and a secondary electron collecting electrode, a series impedance for the secondary electron-collecting electrode of the other of said devices, and a coupling circuit between said electrode and said beam-focusing supply.

3. In cathode-ray apparatus having a sweep voltage supply and a static-beam-focusing supply, a dynamic focusing generator including a tetrode having a secondary electron-collecting electrode, a coupling circuit between the anode of said tetrode and said sweep voltage supply for varying the voltage on said anode in accordance with said sweep voltage supply variations, and a coupling circuit between said electrode and said beam-focusing supply.

4. In cathode-ray apparatus having a sweep voltage supply and a static beam-focusing supply, a dynamic focusing generator including an electron-discharge device having an anode, a cathode and a screen grid, a circuit between said sweep voltage supply and said anode, and a circuit between said screen grid and said beam-focusing supply.

5. A focusing-correcting generator for cathode-ray apparatus wherein a sawtooth deflection voltage supply is available which causes distortion, said generator comprising a tetrode having a screen grid and a triode having a control grid, the plate-to-cathode spaces of said tetrode and triode being series-connected, and an unbypassed resistor in series with said screen grid, whereby sawtooth variations impressed on the control grid of said triode will yield cusped variations at said screen grid.

6. A voltage generator for converting a sawtooth input to a cusped output comprising a pair of electron-discharge devices having their anode-cathode spaces series-connected, one of said devices having a control grid for application of the sawtooth voltage and a source of sawtooth voltage connected to said grid, the other of said electron-discharge devices having a secondary-emissive anode and an electron-collecting screen electrode, an unbypassed resistor connected in series with said electrode, a source of high voltage having a positive terminal connected to said resistor, whereby cusped variations appear at the connection of said resistor to said electrode, and a utilization circuit coupled to said electrode.

7. The generator according to claim 6 wherein the electron-discharge device having a secondary emissive anode has, in addition, a control grid and a fixed potential supply for said control grid.

8. In cathode-ray apparatus, a sweep voltage supply and a static beam-focusing supply, a dynamic focusing generator including a tetrode having a screen grid and a secondary-emissive anode, a series resistor connected to said screen grid, a coupling circuit between said tetrode and said sweep voltage supply, and a coupling circuit between said screen grid and said beam-focusing supply.

9. In cathode-ray apparatus having a sweep-voltage supply and a static beam-focusing supply, a dynamic focusing generator including a triode and a non-linear resistance device connected to the cathode of said triode, a coupling circuit between the control grid of said triode and the remote terminal of said non-linear resistance device, and a coupling circuit between said non-linear resistance device and said beam-focusing supply.

10. In cathode-ray apparatus, a sweep-voltage supply and a static beam-focusing supply, a dynamic focusing generator including an electron-discharge device coupled to said sweep-voltage supply and including a pair of electrodes the current characteristic of one of which undergoes a reversal in relation to unidirectional voltage change of the other, and a coupling circuit between said device and said beam-focusing supply.

11. In cathode-ray apparatus, a sweep-voltage supply and a beam-focusing supply, a dynamic focusing generator including an electron-discharge device coupled to said sweep-voltage supply and including three electrodes one of which is a primary electron emitter and one of which is a secondary electron emitter imparting an inverse current characteristic to said device, and a coupling circuit between said device and said beam-focusing supply.

12. In cathode ray apparatus having a sweep-voltage supply and a static beam focusing supply, a dynamic focusing generator including a triode and a tetrode having a secondary-electron-emissive anode and a screen grid, said tetrode and said triode having their cathode-plate circuits connected in series, the control grid of said triode being coupled to said sweep-voltage supply, a resistor connected to the screen grid of said tetrode, and a coupling circuit between said screen grid and said focusing supply.

13. A voltage generator for converting a saw-tooth input to a cusped output including a cathode-follower and a tetrode connected in series with the tetrode as the load of the cathode follower, said cathode follower having a source of saw-tooth voltage connected in control relation thereto, said tetrode having a secondary-emissive anode and an electron collecting screen grid, and unbypassed resistor connected to said screen electrode, a source of high voltage having a positive terminal connected to said resistor, and a utilization circuit coupled to said screen electrode.

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