

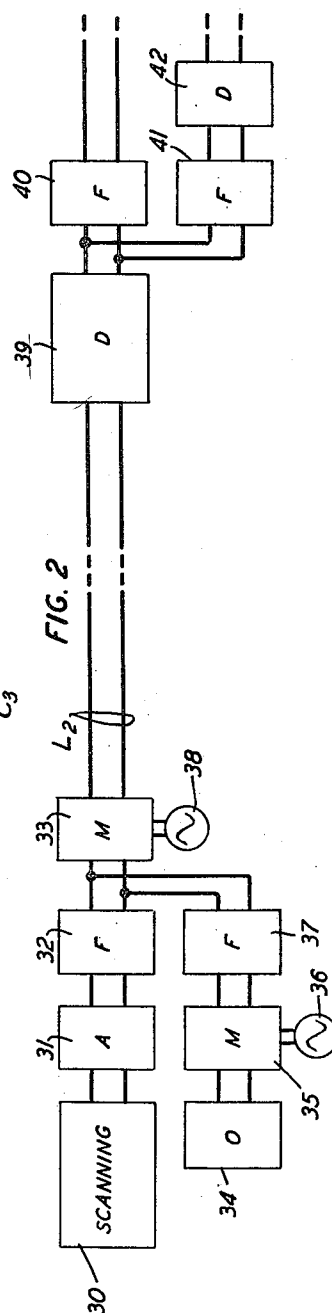
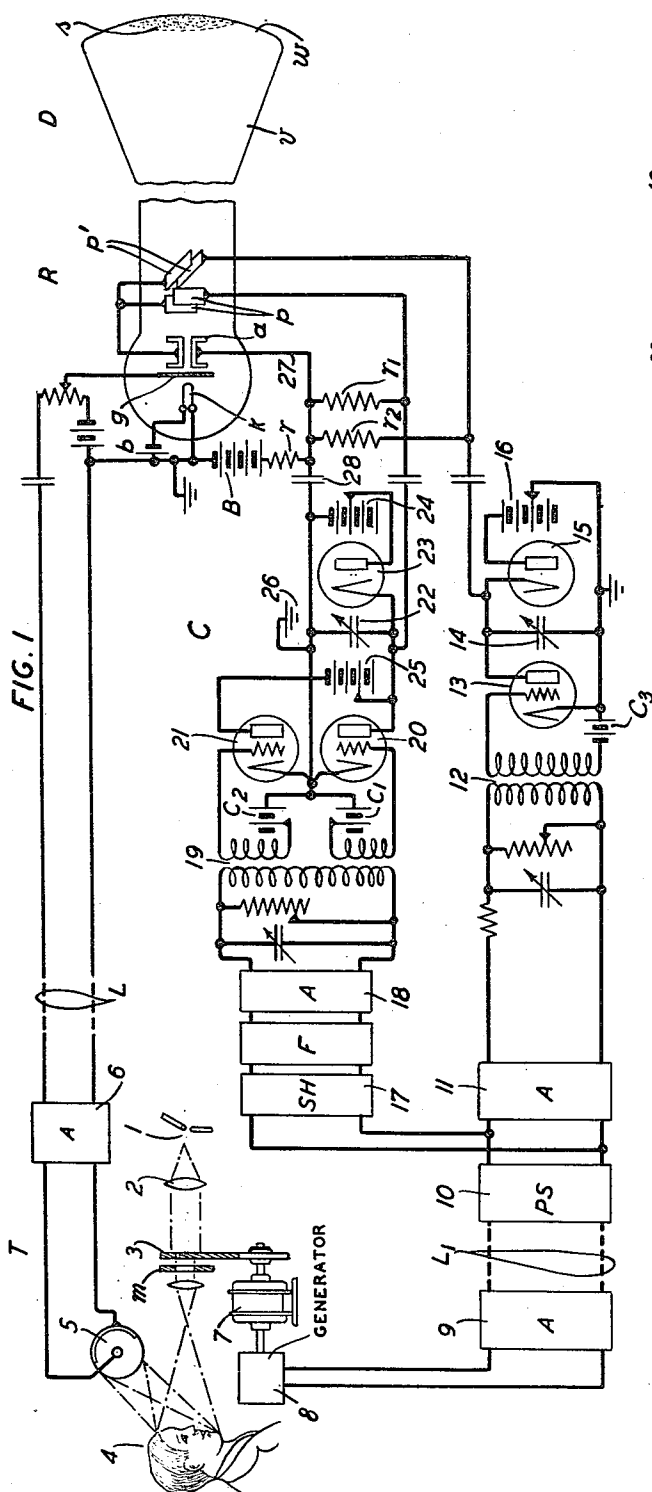
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SCANNING SYSTEM

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SCANNING SYSTEM

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This invention relates to scanning systems and more particularly to scanning systems including cathode ray discharge devices and methods for controlling their operation.

It has heretofore been proposed to provide television systems including a cathode ray discharge device, the electron beam of which is deflected in two directions to scan successive parallel lines of a field of view for the purpose of either controlling the operation of light sensitive means which is thereby activated to cause the production of an image current varying as the tone values of elemental areas of the field of view, or to activate a fluorescent or phosphorescent screen for the purpose of producing an image of a field of view scanned at a transmitter.

In certain of the systems heretofore proposed, the cathode beam is deflected to traverse successive lines of the field in the same general direction thereacross, each complete scanning cycle is effected in a time interval within the period of persistence of vision and the beam is so deflected that, during successive scanning cycles, it traverses identically positioned lines of the field.

The present invention relates to systems of the type described above, and one of its objects is to so control the deflection of the cathode beam that scanning of a field of view is effected in successive parallel lines and in such manner that the scanning lines partially overlap.

Another object is to cyclically vary the intensity of one of the fields which controls the deflection of the cathode beam.

Other objects will appear from the specification and claims.

According to one embodiment of the present invention, the cathode beam is deflected at a line scanning rate by a suitable field and at a rate corresponding to a complete scanning by a second field, which second field is so controlled that during alternate complete scanings the cathode beam traverses successive lines which partially overlap.

In the system to be herein specifically described for purposes of illustration, the invention is applied to a television receiver comprising a cathode ray discharge device having two pairs of deflecting plates. One pair of deflecting plates is supplied with a saw-toothed current under control of an alternating current received from the transmitting station to produce a deflecting field adapted to cause the cathode beam to traverse successive parallel lines in synchronism with the line scanning at the transmitter, and the other pair of deflecting plates is supplied with a

saw-toothed current under control of a low frequency current derived from the alternating current received from the transmitting station. The first deflecting current causes the cathode beam to be deflected to trace parallel lines in the same general direction across a fluorescent screen during each scanning cycle, and the second deflecting current, which determines the number of scanning cycles per second, causes the lines traced on the screen during alternate scanning cycles to partially overlap, the two deflecting currents cooperating with the beam which excites the screen to cause the production of an image of the field scanned at the transmitter at a rate within the period of persistence of vision during each scanning cycle. Any well known means may be used to produce the saw-toothed currents. A suitable apparatus for this purpose, which involves charging-up and discharging a condenser is disclosed in U. S. Patent 1,613,954, January 11, 1927, to Knoop. Partial overlapping of the lines traced during alternate scanning cycles is effected by applying the derived low frequency synchronizing current in opposite phase to the grids of two gas-filled space discharge devices having their grids negatively polarized to prevent the flow of space current through them. The output circuits of the gas-filled discharge devices are connected in parallel and have a common portion including a condenser to be charged and discharged, and one of said circuits includes a battery in series with the condenser. During one-half cycle of the low frequency wave, a negative potential is applied to the grid of one tube augmenting the polarizing potential impressed thereon, thus maintaining this tube non-conductive, whereas the other grid has applied thereto a positive potential which, at a selected point in this half cycle, completely neutralizes the applied polarizing potential and thereby permits the condenser to abruptly discharge across the space path of this tube. During the reverse half cycle of the low frequency synchronizing current, the grid of the second tube will have applied thereto a negative potential augmenting its polarizing potential, whereas the polarizing potential applied to the grid of the first tube will be neutralized when the voltage of the synchronizing wave reaches a given value, and the condenser will be discharged across the space path of this tube. Due to the presence of the battery in series with the condenser in one output circuit, the condenser will not be completely discharged when the associated tube becomes conductive, whereas when the

other tube becomes conductive the condenser will be completely discharged; consequently the cathode beam will occupy different positions on the screen at the beginning of and throughout alternate scanning cycles. By adjusting the polarizing potential applied to the grids of the gas-filled discharge devices and that of the battery in series with the condenser, the initial position of the cathode beam and the lines traced thereby during successive scanning cycles may be regulated to cause the lines scanned during alternate cycles to overlap to any desired degree.

A more detailed description of the invention follows and is illustrated in the attached drawing.

Fig. 1 is a diagrammatic showing of a television system including apparatus for practicing the invention as applied to a wire line.

Fig. 2 diagrammatically illustrates a similar system in which carrier transmission is used.

The system of Fig. 1 comprises a transmitting apparatus T connected by a transmission line, comprising two pairs of conductors L and L₁, to a receiving apparatus R.

The transmitter includes a source of light of constant intensity 1, herein shown as an arc, associated with an optical system comprising a lens system, represented by a lens 2, a scanning disc 3 having a series of apertures arranged in a spiral line for producing a moving beam of light, adapted to pass through an opening in a mask or shutter *m* for limiting the area of the field scanned, to illuminate successive elemental areas of an object 4. Light reflected from the object activates light sensitive electric means 5, herein shown as a photoelectric cell, to cause the production of an image current adapted to be repeated by an amplifier 6 and supplied to the line L over which it is transmitter to the receiving station including the apparatus R.

The scanning disc 3 is driven by a motor 7 at a rate such that the object is completely scanned once per revolution and within the period of persistence of vision. Included in the transmitting apparatus and preferably driven by the motor 7 is a source 8 adapted to produce an alternating current having a frequency equal to the number of image lines scanned per second. The source 8 should be so aligned with the disc 3, that the current cycles are in phase with the scanning operation effected by the apertures. The alternating current produced by the source 8, used for synchronizing purposes, is transmitted to the receiving apparatus over the line L₁. If necessary or desirable, the synchronizing current may be amplified by the amplifier 9 before it is transmitted.

The receiver comprises a cathode ray discharge device D, and an apparatus C for controlling its operation to produce an image of the field scanned at the transmitter.

The discharge device D comprises a vessel *v* enclosing a cathode *k*, and anode *a*, a control electrode or grid *g*, two pairs of deflecting plates *p* and *p'* and a fluorescent or phosphorescent screen *s* on the end wall *w* of the vessel. The cathode *k* is heated to electron emitting temperature by current from the source *b*, and a source B connected through a resistance *r* to the anode *a* serves to produce the cathode ray or electron beam.

The control apparatus C comprises a phase adjuster 10 connected by two branch circuits to an amplifier 11 and a subharmonic producer 17. One branch circuit includes the amplifier 11 hav-

ing its output coupled by a transformer 12 to a gas-filled space discharge device 13, the output circuit of which includes a condenser 14 in series with a voltage saturated two-electrode space discharge device 15, i. e., a device having a filament at a temperature so low that all electrons emitted pass to the plate throughout the range of voltage applied to the device, and a charging source 16. A polarizing potential is applied to the grid of discharge device 13 from a source C₃. The other branch circuit includes a subharmonic producer 17, a filter F and an amplifier 18 having its output circuit coupled by a transformer 19 through two secondary windings, respectively, connected between the grid or control electrode of the gas-filled space discharge devices 20 and 21 and their cathodes. The output circuits of devices 20 and 21 are connected in parallel and have a common portion. The output circuit of device 20 includes the condenser 22 in series with a voltage saturated, two-electrode discharge device 23, similar to 15, and a charging source 24, and that of device 21 comprises these elements and a battery 25 in series with the condenser 22. The phase of the received synchronizing current may be regulated, if necessary, by the phase adjuster 10.

One plate of condenser 22 and the cathodes of the discharge devices 20 and 21 are connected to ground at 26, and the grids of these devices are supplied with polarizing potentials by the sources *c*₁ and *c*₂, respectively.

The grid of discharge device 13 and those of the tubes 20 and 21 are so negatively polarized that no space current flows between the cathode and anode of either of these devices when no current is applied to their input circuits.

The subharmonic producer 17, which may be of the type disclosed in U. S. Patent 1,733,614, issued October 29, 1929, to W. A. Marrison, operates under control of the incoming synchronizing current to supply current components harmonically related thereto, from which may be selected by the filter F a harmonic which corresponds in frequency to the field scanning rate at the transmitter, i. e., the rate at which complete scanings of the field are repeated.

When the negative half cycle of the incoming synchronizing current received over the line L₁, which corresponds to the line scanning rate at the transmitter, is applied to the grid or control electrode of device 13 and until the positive half cycle reaches a predetermined value, the condenser 14 is charged from the battery 16 at a constant rate through the voltage saturated device 15. However, when the synchronizing current reaches the selected positive value, there will be applied to the grid of tube 13 a positive potential which neutralizes the polarizing potential applied thereto, with the result that the device 13 becomes conductive and condenser 14 abruptly discharges across the space path of this discharge device, as disclosed in the above mentioned Knoop patent. The condenser 14 being connected across the deflecting plates *p'* of the cathode ray discharge device, the charge accumulated by the condenser 14 will set up a constantly varying field therebetween which deflects the electron beam uniformly from one side of the screen to the other, for example, from left to right. When the discharge device 13 becomes conductive, the cathode beam will abruptly return to the left hand side of the screen. This cycle of operation being repeated at the line scanning rate employed at the transmitter and in synchronism therewith, the electron beam will

trace a line across the fluorescent screen *s* once per cycle of the synchronizing current.

The grids of the discharge devices 20 and 21 being so negatively polarized that, when no current is supplied through the transformer 19, no current flows across the space path between the cathode and anode of either device, the condenser 22 will be supplied with a charge at a uniform rate through the voltage saturated discharge device 23. However, when current is supplied by the subharmonic generator 17 through the transformer 19, a positive potential will be applied to the grid of one device, for example 20, and simultaneously therewith a negative potential will be applied to the grid of the other tube 21 augmenting that already applied thereto, during one-half cycle of the current, and similarly during the next half cycle the negative potential applied to the grid of tube 20 will be augmented and a positive potential will be applied to the grid of tube 21. During each cycle of the current supplied by the generator 17, the condenser 22 will accumulate a charge at a uniform rate through the voltage saturated device 23 which will be abruptly discharged through the device 20 and then accumulate a second charge at the same uniform rate, which will be abruptly discharged through the device 21. Since the condenser 22 is connected to the pair of deflecting plates *p*, there will be set up between them a uniformly varying field which deflects the electron beam in a direction at right angles to that caused by the field produced between the plates *p'* and at the rate corresponding to and in synchronism with that at which complete scanings are effected at the transmitter.

During each cycle of operations controlled by the tube 20, the condenser 22 will be charged and completely discharged, but during each cycle of operations controlled by the tube 21, the charge on the condenser 22 will merely be reduced to a value determined by the voltage of the battery 25 connected in series with it. As a result, deflecting fields of different intensities, controlled by the current supplied by the subharmonic generator 17, will be successively produced between the pair of plates *p*.

The incoming image current after being amplified, if desired, is applied to the grid *g* of the cathode ray tube to control the electron beam and thereby vary the intensity of the excitation of the fluorescent screen in accordance with the tone values of successive elemental areas of the field scanned at the transmitter.

The electron beam is deflected by the cooperative action of the fields between the pairs of plates *p'* and *p* to trace successive parallel lines in the same direction across the fluorescent screen *s* during each scanning period to produce an image of the field scanned at the transmitter. However, because the intensity of the field between the plates *p* is different during successive scanning periods, the position of the beam at the beginning of and during the successive scanings of the screen *s* will not coincide but will be somewhat displaced. In other words, the image field scanned during one scanning period will be displaced with respect to that scanned during the succeeding scanning period and hence the lines traced by the beam during the respective scanning periods will more or less overlap. Under given operating conditions, the amount of overlap will depend upon the value of the polarizing potential applied to

the grids of the gas-filled tubes 20 and 21 and the voltage of the battery 25 and may be controlled by changing the value of either such polarizing potential or the voltage of the battery. Preferably the polarizing potential applied to the tubes 20 and 21 and the voltage of the battery 25 should be so chosen as to cause an overlap of at least 50 per cent of the line width.

The anode *a* and one plate of each pair *p* and *p'* are connected together through resistance *r* to the positive terminal of source B by a conductor 27, a condenser 28 intervenes between this connection and ground 26, whereby the anode and these plates are maintained at the same direct current potential. High resistances *r*₁ and *r*₂ are connected between the conductor 27 and the other plates of the respective pairs *p* and *p'*, for the purpose of maintaining them at the same direct current potential as the plates connected through resistance *r* and the anode *a*.

In Fig. 2, 30 is a scanning mechanism, similar to that shown in Fig. 1 adapted to produce an image current which is amplified by the device 31, selected by a filter 32, and supplied to a modulator 33. A source 34 which may be coupled to the motor driving the scanning disc of the scanning means, as in Fig. 1, supplies synchronizing current to a modulator 35 which is also supplied from the source 36 with alternating carrier current of a frequency outside the range of the image current. The synchronizing and carrier currents are combined in the modulator to produce modulation products representing a carrier modulated by the synchronizing current and an unmodulated component of carrier frequency, which are selected by the filter 37 and are supplied to the modulator 33.

The image current passed by filter 32 and the synchronizing modulated carrier supplied through filter 37 are combined in the modulator 33 with oscillations of the desired frequency supplied by the source 38 and the modulation products resulting from such combination are supplied to the transmission circuit L₂, which is herein shown as a line. However, the above described terminal apparatus may be connected to the receiving station by a radio link. In either case, amplifiers may be used to raise the modulation products to the desired energy level before they are supplied to the transmission circuit.

At the receiving station, the incoming modulation products may be selected, amplified and detected by the apparatus 39. The resulting image current is selected by the filter 40 and supplied to the grid *g* of the cathode ray tube D (Fig. 1) and the synchronizing current modulated carrier is selected by the filter 41 and detected by the device 42 to yield the synchronizing current, which is supplied to the apparatus C of Fig. 1, to control the deflection of the cathode ray beam in the manner described above.

By way of example, if the field of view is scanned twenty times per second and each complete scanning is effected in seventy-two lines, the frequency of the current supplied by sources 8 and 34 will be 1440 cycles and the subharmonic producer 17 would operate to produce a component of twenty cycles, which is selected by the filter F. The image current may cover a frequency band width extending approximately from zero to seventy kilocycles or more, the source 36 may supply oscillations of a frequency equal to the upper limiting frequency of the

image band plus an amount just sufficient to provide frequency spacing between it and the upper limiting frequency of image band to permit selection by the filters 40 and 41 at the receiving station, and source 38 may supply oscillations of the order of one to several hundred thousand cycles or several million cycles, depending upon the frequency characteristics of the carrier channel connecting the two terminal stations.

In carrier transmission, if the frequency range of the channel over which the modulation products are to be transmitted includes a part of that occupied by the applied input current, i. e., the image band and the synchronizing current modulated carrier, modulation cannot be effected in one stage for the reason that the input current would be repeated by the modulator operating as an amplifier and hence overlap the lower side-band of the modulation products, with the result that serious distortion would be introduced at the receiver. In order to overcome this difficulty, modulation may be effected in two or more stages. In this case, the image band and the synchronizing current modulated carrier would be combined with a carrier of sufficiently high frequency to permit the use of a filter, which preferably selects one side-band of the resulting modulation products and the carrier and suppresses the repeated band, after which the selected side-band is combined with a second carrier to produce a modulated wave of the frequency desired for transmission.

In either of the cases described above, if single side-band transmission is desired, the device 33, or its corresponding element in the two-stage equipment, may include a filter which operates to select one of the side-bands and the unmodulated component produced by it and to suppress the other side-band, as well as any undesirable components repeated by the modulator.

While for purposes of illustration certain specific details and numerical values have been given, it is to be understood that this invention is not limited thereby, but only by the scope of the attached claims.

What is claimed is:

1. An electro-optical system comprising a cathode ray discharge device, means for deflecting the cathode beam of said device to scan substantially parallel and successive elemental strips in the same general direction across a field, a source supplying current of selected frequency, and means supplied with current from said source for controlling the deflecting means, including means for causing alternate scanings of said field to be displaced with respect to each other.

2. An electro-optical system comprising a discharge device including means for producing a cathode beam and a plurality of pairs of deflecting plates, a source supplying current of selected frequency, and means controlled by current from said source for applying sweep voltages to the respective pairs of plates for deflecting the cathode beam of said device to scan successive parallel elemental strips of a field of view, including means for causing alternate scanings of said field to be displaced with respect to each other, said last-mentioned means comprising means for varying the sweep voltage applied to one pair of said plates.

3. A television scanning means comprising a cathode ray tube including means for producing a cathode beam and a plurality of pairs of deflecting plates, a source supplying current of selected frequency, and means controlled by cur-

rent from said source for applying voltages to the respective pairs of plates to cause deflection of said beam in substantially parallel lines in one general direction across a field, including means for applying voltages of different values to one pair of said plates during successive scanning cycles.

4. A signal system comprising a cathode ray device having means for producing a cathode beam, means for controlling said beam, a screen and means for deflecting the cathode beam in two directions to cause the production of a pattern, a source supplying current of selected frequency, and means controlled by current from said source for varying the deflection in one direction to produce successive patterns which are displaced with respect to each other.

5. An electro-optical system comprising a cathode ray discharge device having means for producing a cathode beam, means for controlling said beam, a fluorescent screen, means for deflecting said beam to trace a pattern on said screen, a source supplying current of selected frequency, and means controlled by said source for causing the production of successively displaced patterns, comprising means for cyclically varying the deflecting field.

6. An electro-optical system comprising a cathode ray discharge device including means for producing and controlling the intensity of a cathode ray beam, a fluorescent screen, pairs of deflecting means associated with said device, a source supplying current of selected frequency, and means, controlled by current from said source, for applying varying control potentials to the respective pairs of said deflecting means, said control potential applying means comprising means for causing the application of varying potentials of different values to at least one pair of said deflecting means during successive scanings.

7. An electro-optical system comprising a cathode ray discharge device including means for deflecting the cathode ray beam and means for controlling the potential applied to said deflecting means, comprising a condenser, a plurality of space discharge devices, and means for rendering said devices alternately conductive to control the charge applied to said condenser.

8. An electro-optical system comprising a cathode ray discharge device having deflecting means for deflecting the cathode ray beam and means for cyclically varying the control potential applied to said deflecting means comprising a plurality of space discharge devices having grids, means for applying a control potential in opposite phase to said grids, a condenser included in a common portion of the output circuits of said plurality of space discharge devices and a source of voltage in the output circuit of one of said space discharge devices and in series with said condenser.

9. A cathode ray discharge device having means for producing a cathode beam, a plurality of deflecting means therefor and means for supplying sweep currents which are different in frequency to the respective deflecting means, comprising a control current, and means supplied with said control current for successively varying the limiting values of the sweep current supplied to one of said deflecting means.

10. Television scanning apparatus comprising means for producing a beam of cathode rays, means for repeatedly moving said beam across the field of view in parallel paths under control

of two periodically varying potentials of high and low frequency relative to each other to effect complete scanings of the field in succession, and electrical biasing means for periodically producing an additional displacement of said beam in a direction transverse to said paths.

11. Television scanning apparatus comprising means for producing a beam of cathode rays, means for repeatedly moving said beam across a field of view in parallel paths under control of two periodically varying potentials of high and low frequency relative to each other to effect complete scanings of the field in succession, said varying potentials being of saw-tooth wave form and one of said frequencies being an integral multiple of the other, and means for causing overlapping path scanning comprising electrical biasing means for periodically producing an additional displacement of said beam in a direction transverse to said paths without changing the phase relation between said varying potentials.

12. The combination with means for producing a periodically varying potential of saw-tooth wave form and of relatively high frequency, means for producing a second periodically varying potential of saw-tooth wave form and of a frequency which is a subharmonic of that of said first potential, means for causing alternate cycles of said subharmonic wave to be of uniformly different values throughout from the intermediate cycles, and means for jointly utilizing said varying potentials.

13. The combination with electric storage means, of a source of potential for charging said means, a discharge circuit for said means comprising a plurality of parallel paths, means associated with said paths for abruptly changing their conductivity from a low to a high value periodically and non-concurrently, and a source of direct potential in one of said paths directed to oppose the discharge of said storage means.

14. The combination with electric storage means, of a source of potential for charging said storage means, means controlling the flow of charging current from said source to effect the charging at a uniform rate, a discharge circuit for said storage means comprising a plurality of parallel paths, means associated with said paths for abruptly changing their conductivity from a low to a high value periodically and non-concurrently, and a source of direct potential in one of said paths directed to oppose the discharge of said storage means.

15. Scanning means comprising means for generating a scanning beam of radiant energy and means for causing said beam to scan a field cyclically in parallel paths so that successive scanings are displaced with respect to each other, said last-mentioned means comprising a condenser, means for periodically slowly charging said condenser and for abruptly discharging it, and means for applying an additional charge to said condenser and for maintaining said charge during one of said first-mentioned charging periods and for repeating this cycle of operations periodically.

16. Scanning means comprising means for generating a scanning beam of radiant energy and means for causing said beam to scan a field cyclically in parallel paths so that successive complete scanings are displaced with respect to each other, said last-mentioned means comprising a condenser, means for periodically building up a charge on said condenser and for subsequently

abruptly reducing said charge to form a train of waves, and means for periodically temporarily applying an additional charge to said condenser at intervals less than the periodicity of said waves.

17. In combination with a cathode ray tube having a cathode ray beam adapted to scan a picture field, means for deflecting said beam, comprising a pair of deflecting elements positioned to deflect said beam in two directions, a high frequency oscillator supplying one of said elements, a low frequency oscillator supplying the other of said elements, said oscillators having commensurable frequencies, means for interlocking said frequencies, and means for cyclically modifying the output of said low frequency oscillator at a frequency that is a fraction of said low frequency.

18. In a television system, a cathode ray tube, means for deflecting the cathode ray horizontally at a certain frequency, and means for deflecting the cathode ray vertically at a comparatively low frequency, said second means comprising a condenser, a charging circuit for said condenser, a discharging circuit for said condenser, and means for making the discharging current in said circuit different for each of a series of condenser discharges, and means for causing said series of discharge current values to be repeated for succeeding discharges.

19. In a television system, a cathode ray tube, means for producing saw-tooth waves occurring at a certain frequency and for deflecting the cathode ray horizontally in accordance with said waves, means for producing saw-tooth waves occurring at a comparatively low frequency characterized in that successive waves have unlike characteristics, and means for simultaneously deflecting the cathode ray vertically in accordance with the second-mentioned saw-tooth waves.

20. The invention, according to claim 19, characterized in that the second means produces a series of saw-tooth waves in which successive waves are unlike in amplitude.

21. The invention, according to claim 19, characterized in that the second means produces a series of saw-tooth waves in which successive waves have different amplitudes and in which alternate waves have the same amplitude.

22. The method of scanning a picture field with a cathode ray beam which comprises deflecting said beam vertically with a relatively low frequency, deflecting said beam horizontally with a relatively high frequency, interlocking said frequencies, and cyclically shifting the course of said beam relative to said picture field between successive low frequency deflections by a distance smaller than the distance between horizontal lines.

23. The method of scanning a picture field with a cathode ray beam which comprises applying deflection forces to said beam in two directions with commensurable and interlocked frequencies to scan a portion only of said field, and applying a third deflection force to said beam to cyclically shift successive scanned areas to cover said field in a given number of scanings.

24. In combination, an envelope, a picture field within said envelope, a cathode ray beam positioned to scan said field, means for deflecting said beam with simultaneous and interlocked high and low frequencies to scan a portion of said field, and additional means for deflecting said beam to successively change the portion scanned.

25. In an electro-optical system, a cathode ray tube, means for producing waves occurring at a certain frequency and for deflecting the cathode ray horizontally in accordance with said waves, means for producing other waves occurring at a comparatively low frequency characterized in that successive waves of repeated groups of waves have unlike amplitudes but corresponding waves of said repeated groups have the same amplitudes, and means for simultaneously deflecting the cathode ray beam vertically in accordance with said other waves.

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