June 24, 1941. H. A. IAMS 2,246,918

UNIDIRECTIONAL SCANNING

Filed April 27, 1932 2 Sheets-Sheet 1

Fig. 1.

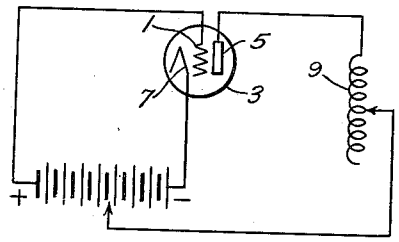


Fig. 2.

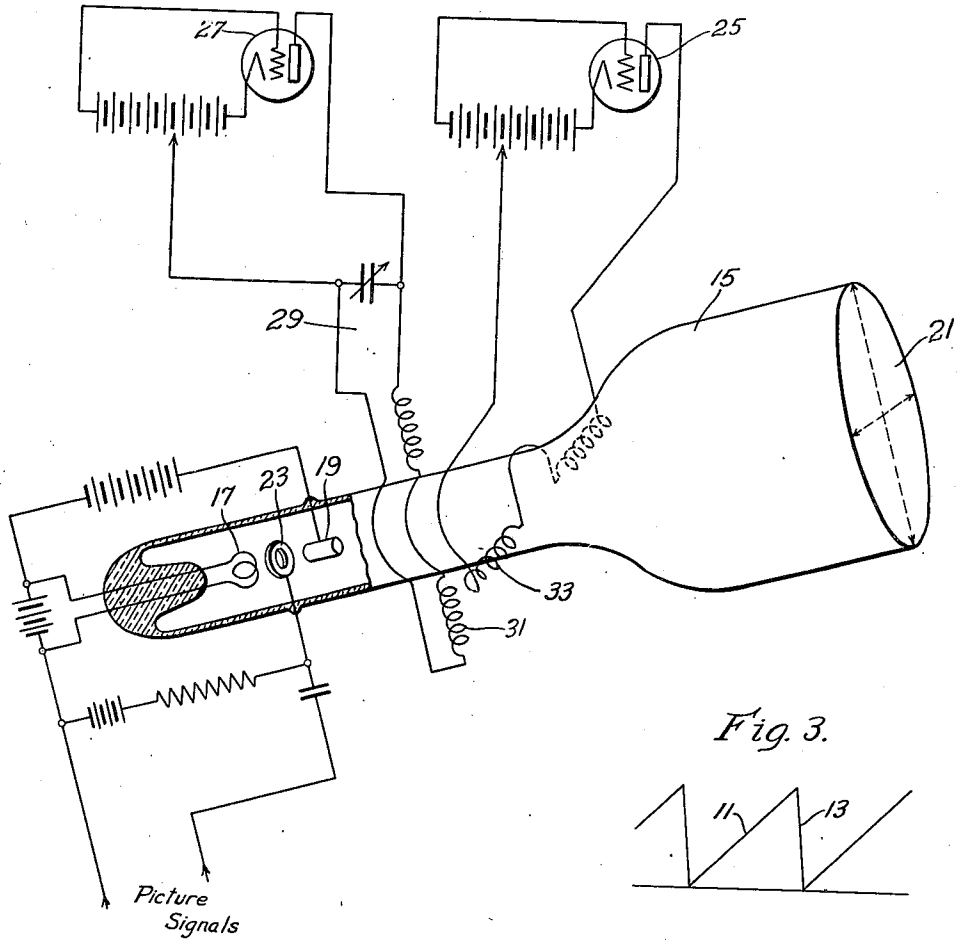


Fig. 3.

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Fig. 4.

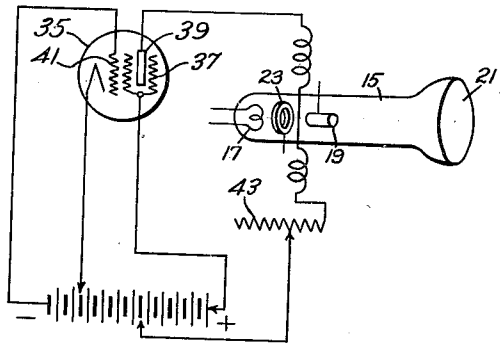


Fig. 5.

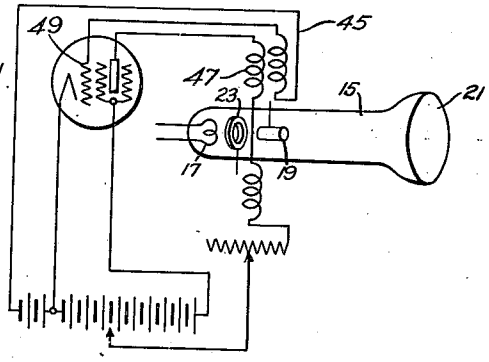


Fig. 6.

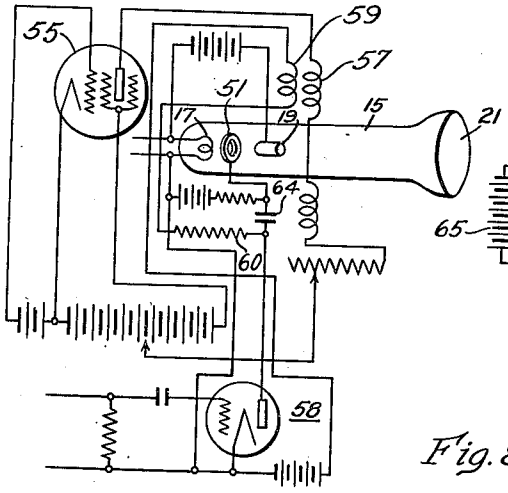


Fig. 7.

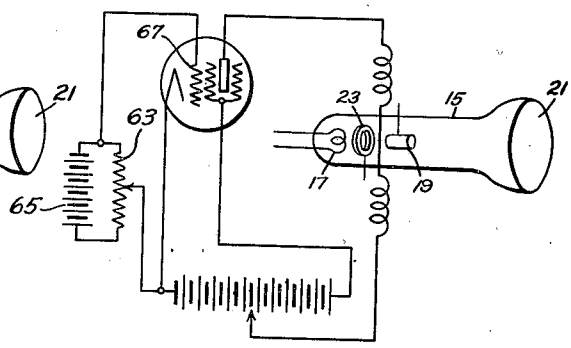
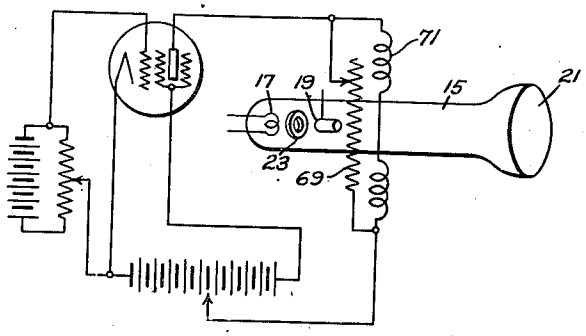


Fig. 8.



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UNITED STATES PATENT OFFICE

2,246,918

UNIDIRECTIONAL SCANNING

Harley A. Iams, Collingswood, N. J., assignor to Westinghouse Electric & Manufacturing Company, a corporation of Pennsylvania

Application April 27, 1932, Serial No. 607,730

5 Claims. (Cl. 178—7.7)

My invention relates to television and more particularly to systems of scanning wherein a cathode ray beam or other similar agency is employed for scanning purposes.

In systems of the above type, the cathode ray is actuated in its scanning movement by means of thermionic devices and associated circuits. In general, the cathode ray which comprises a beam of electrons, is caused to flow between a pair of plates situated in electrostatic relationship to each other, these plates comprising elements in the associated circuits referred to above. By periodically charging the plates as a condenser at a relatively slow rate and discharging the same at a relatively high rate, the cathode beam may be caused to slowly shift in a transverse direction from one plate toward the other during the slow charging operation and then quickly return to its original starting position almost instantaneously on the discharge. A scanning sequence of this type is commonly referred to as saw tooth scanning, since the path traced by the ray on the screen of a cathode ray tube, while the beam is simultaneously deflected at a constant rate in a direction at right angles to that mentioned, resembles saw teeth in shape.

A system of this type is disclosed in the patent to V. K. Zworykin No. 1,786,812 of December 30, 1930 and assigned to the Westinghouse Electric and Manufacturing Company.

In some instances, it may be desirable to eliminate the return line during the discharge period. This constitutes a modification of the saw tooth scanning and may be conveniently referred to as unidirectional scanning in that the beam travels across the screen or subject to be televised in one direction only.

In a copending application in the name of R. C. Ballard, Serial No. 519,062, filed Feb. 28, 1931, is disclosed a magnetic means for producing a saw tooth deflection of a cathode ray for scanning purposes. Whereas, the electrostatic means is a voltage operated device, the electromagnetic means is a current operated device.

In practice, it is customary to employ saw tooth scanning for vertical deflection only, of the cathode ray, and utilize the familiar oscillatory or sine wave scanning for the horizontal deflection of the cathode ray. The combined effect of the oscillatory and saw tooth scanning movements results in the cathode ray tracing a path over the area of a screen, the path being similar in appearance to that of a sine wave. The light distribution throughout the picture with this type of scanning would, therefore, not be uniform. If an oscillator capable of developing a saw tooth wave at the frequency of lateral scanning, which occurs at around 1000 cycles, were employed in combination with vertical saw tooth deflection at about 16 cycles per second, the area of the screen would be scanned in parallel and for all practical purposes in horizontal lines. The light distribution therefore, under these conditions, would be made uniform throughout the picture area of the screen.

My invention broadly relates to novel electromagnetic means for causing movement or shifting of the cathode ray in a predetermined manner, and may be employed in conjunction with unidirectional or saw tooth scanning, as described above in connection with either vertical scanning, horizontal scanning or both.

It is one object of my invention to provide novel means for causing a cathode beam or the like to traverse a scanning path in a prearranged manner.

Another object of my invention is to provide a simplified circuit for controlling the action of a cathode beam.

Another object of my invention is to provide means for obtaining a scanning sequence of operation by a cathode beam wherein the rate of scanning is self-controlled.

Another object of my invention is to control the movement of a scanning ray directly from an oscillator.

Additional objects of my invention will be disclosed in the following description of the invention.

To assist in an understanding of the same, I have illustrated in the accompanying drawings various features characteristic of my invention.

Figures 1, 2, 4, 5, 6, 7 and 8 are diagrammatic views showing various circuit embodiments falling within the scope of my invention.

Fig. 3 is a view illustrating the type of wave shape produced in the circuit as of Fig. 2.

Referring specifically to Fig. 1 of the drawings, I have disclosed therein the circuit of an oscillator of the dynatron type. The principal circuit characteristic of the dynatron oscillator resides in the fact that the potential applied to the grid 4 of the thermionic device 3 must be of a higher positive potential than that on the plate 5 of the thermionic tube. This arrangement of potentials results in a peculiar operation of the system as an oscillator as the plate potential is varied from zero volts to a voltage approaching that of

the grid. For the lower values of plate potential, the plate current will flow in the customary manner, that is, it will be due to the primary electrons emitted from the filament 7 and being attracted to the plate. This primary emission reaching the plate will vary in a manner which will not bear any proportional relationship to the increase in plate potential. For example, the plate current will initially increase as the plate potential is gradually shifted from zero to more positive values. However, as the primary emission increases due to increased plate potential, the speed of the electrons will increase to such an extent that the force of these electrons striking the plate will be sufficient to knock out electrons from the plate material, thus creating an emission of electrons in the reverse direction commonly referred to as a secondary emission. This secondary emission, when once started, will increase with a further increase in the plate potential, the result being that, as the plate potential is increased, the current in the plate circuit due to primary emission will be gradually reduced.

The secondary electrons by reason of the higher positive potential on the grid will be attracted to the grid. If the plate potential be increased sufficiently, the secondary emission will predominate over that of the primary emission and the current in the plate circuit will actually reverse in direction.

The above is but a brief discussion of the current changes taking place in a dynatron oscillator. A more comprehensive description of an oscillator of this type may be found in an article by A. W. Hull entitled "The Dynatron" which appears in the proceedings of the I. R. E. for January 1918. Oscillators of the type described in the above article embody a tuned circuit in the plate circuit of the oscillator and the wave produced is similar in appearance to that of a sine wave.

I have found that by merely employing a coil 9 alone in the plate circuit of an oscillator of this type that a peculiar wave shape of the plate current may be obtained. The exact explanation of the phenomena occurring in the circuit producing this peculiar wave is not clearly understood at this time, but it appears that the current in the plate circuit gradually builds up through the coil in the plate circuit of the oscillator and suddenly collapses. The flux, accordingly, produced by this current will, in turn, change in like manner.

In Fig. 3, I have illustrated a wave bearing the characteristics described above. The long sloping portion 11 represents the gradual building up of the current through the coil or the flux around it whereas the short steep portion 13 represents the collapse of the current or the flux produced by it. A flux variation following the characteristics of this curve is very suitable for guiding the cathode ray in its function of scanning the screen of a cathode ray tube.

The cathode ray tube as employed in practice comprises a substantially evacuated glass envelope 15 relatively narrow at one end and flared out at the other end. A cathode ray is produced by means of a source of electrons 17 and an anode 19 at a positive potential with respect to the source of electrons. These elements are enclosed within the tube. The source of electrons may comprise a heated filament, or a cold electrode capable of producing electrons may be employed. The electron stream thus produced will strike a screen 21, usually of fluorescent material, located on the flared end of the tube. A grid element 23 is located between the source of electrons and the anode and this grid is normally employed for modulating the cathode ray, this grid being preferably resistance coupled to the output circuit of an amplifier normally comprising an element of a picture signal source, whereby the cathode ray will be modulated according to the intensity of the elemental areas of a subject which is being transmitted or received.

The particular tube illustrated is of the type adapted for the reception of television signals, but since the scanning sequence of the cathode ray in the receiving tube must coincide and be synchronous with that of a corresponding transmitter, a description of my invention as applied to a receiving tube will apply equally as well to a transmitting tube.

To cause the scanning ray to cover the picture portion of the receiving screen, two simultaneous movements are customarily imparted to the cathode ray, namely, a vertical movement and a horizontal movement. One of these movements determines the number of lines to the picture whereas the other movement will determine the number of pictures reproduced per second. Therefore, one of the movements must occur as many times that of the other as there are lines to the picture.

In practicing my invention, to obtain the above scanning movements of the ray, I provide two oscillators 25 and 27 at least one of which comprises the characteristics of the oscillator described in connection with Fig. 1. In the particular embodiment disclosed in Fig. 2, this oscillator 25 is employed for the vertical scanning component whereas the other oscillator 27 is employed for the horizontal component. While any sine wave oscillator may be employed for the horizontal scanning, the oscillator 27 which I have shown for the horizontal component is also of the dynatron type, but differs from the oscillator 25 in that it employs a tuned circuit 29 in the plate circuit of the oscillator, thereby giving a sine wave characteristic to the current which flows through the coil 31. The coils of the oscillator are applied in close proximity to the tube 15 at right angles to each other, as shown, the effect of one coil being to produce a vertical deflection at a rate dependent upon the frequency of the current through it, whereas the other coil will cause a horizontal deflection in the same manner.

The frequency of the current in the plate circuit of the oscillator 25 is determined by the inductance of its plate circuit coil 33 and consequently may be altered by changing the inductance of this coil. For this purpose I have shown this coil as being of the variable type. While this oscillator, as illustrated, is capable of producing a current following a saw tooth wave, it has its limitations as to the range of frequencies which can be obtained therefrom. I have, accordingly, improved this oscillator whereby a greater range of frequency shifts might be made and still maintain a saw tooth wave characteristic.

In Fig. 4 I have shown an oscillator, of the type illustrated in Fig. 1, embodying a screen grid tube 35. This oscillator is shown in combination with a cathode ray tube for governing the scanning movement of the cathode ray. In this particular circuit, the potential on the screen

grid 37 is of a higher positive potential than that on the plate 39. The bias on the normal grid 41 of the tube may be varied, as well as the relative potentials on the screen grid and plate. A variable resistor 43 or equivalent impedance in the plate circuit of the oscillator may be employed for controlling the amplitude of the current in said circuit thereby providing means for controlling the extent of shift or movement of the cathode ray.

In an oscillator, which I have constructed according to that of Fig. 4, I have employed a tube of the UY224 type with a negative bias of 6 volts, a positive plate potential range from 45 to 67 volts and a screen grid potential of 180 volts. The resistor in the plate circuit was variable between zero and 10,000 ohms. The above specified values, however, are not to be considered as limiting my invention but are cited merely as one example of the constants which might be employed.

In employing saw tooth wave scanning in conjunction with cathode ray tubes, it is desirable that either the return line consume as little time as possible or that it be eliminated altogether, since the return line if not speeded up or eliminated, will show up on the screen of the tube.

In Fig. 5, I have illustrated a modification of the circuit of Fig. 4 whereby the return line may be made very fast. To accomplish this, the grid circuit 45 is inductively coupled to the coil 47 in the plate circuit of the oscillator and in such a direction that the potential induced in the grid circuit during the collapse of the flux in the coil 47 of the plate circuit will make the grid 49 suddenly more negative, thereby assisting in reducing within a shorter interval of time the plate current to its minimum value at discharge.

Where it is desired to completely eliminate the return line so that it will not be visible on the screen, a negative bias may be placed on the grid of the cathode ray tube at such times as the return line would normally make its appearance. The coil 57 (Fig. 6) provides an ideal source from which to obtain this biasing potential since when obtained from the source, it automatically will occur at the right moments and the problem of synchronizing the biasing potential with the return line phenomenon is inherently solved.

The circuit of Fig. 6 illustrates just how this biasing function to eliminate the return line may be obtained. Coupled to the grid circuit of the cathode ray tube by a resistance coupling is a source of picture signals which I have illustrated as an amplifier 58 which may be associated with some scanning system. The plate circuit of the amplifier will include a resistor 60 in series with a coil 59, this coil being coupled to the deflecting coil 57 of the saw tooth oscillator 55.

Since the voltage induced by reason of the collapsing flux is high as compared to any other current or flux changes in the plate coil 57, the grid coupling coil 59 may be so loosely coupled to the plate coil that the average picture impulse voltages impressed on the grid 51 of the cathode ray tube or the ordinary flux changes in the plate circuit of the oscillator will produce an unappreciable, if any, reaction on the scanning movement of the cathode ray. The rate of collapse of the flux in the plate circuit of the oscillator, however, will be so rapid as to induce an appreciable voltage in the plate circuit of the amplifier tube 58, and this will be reflected on the grid 51 of the cathode ray tube through the coupling condenser 64. The direction of the voltage should be such as to place negative bias on the grid 51 and the degree of coupling between the coils should be such that the cathode ray be entirely extinguished at this moment. Thus by correlating this effect with the horizontal movement of the cathode ray, the ray may be extinguished between complete picture scannings and thus eliminate the return line.

I have found in experimenting with oscillators of the type described above that the frequency thereof may be varied between wide limits by altering the grid bias on the grid of the oscillator. In the circuit of Fig. 7, I have illustrated one way of accomplishing this result. A potentiometer 63 connected across a grid bias battery 65 may be employed in the manner disclosed in the circuit of Fig. 7. The greater the negative bias on the grid 67, the greater will be the frequency of the oscillator. Employing this expedient for shifting the frequency of the oscillator, it has been found that the frequency may be shifted from about 8 to 10 cycles per second upward to 480 cycles and more. As an alternative for the method just described, a variable resistor may be inserted in the cathode lead of the oscillator to the negative end of the plate supply. When the resistor is employed in this portion of the oscillator circuit, it not only varies the grid bias but at the same time will vary the potential on the anode and on the screen grid. In this sense it might be employed as a control for the amplitude of the current in the plate circuit of the oscillator.

In order to generate a saw tooth wave at the very low frequencies of about 8 to 20 cycles not only must the bias of the tube be decreased but a rather large inductance must be employed in the plate circuit of the oscillator. It has been found that the use of such a high inductance frequently resulted in an extremely high potential being generated during collapse of the flux in the plate circuit and that this high potential produced distortion and frequent sparking between the elements of the thermionic device. To overcome these deleterious effects, I have shown in Fig. 8 a variable resistor 69 employed as a by-pass circuit or absorption circuit shunting the inductance 71 in the plate circuit of the oscillator. It has been found that this resistor, in addition to being used for preventing sparking and distortion, could be employed for varying the time constant of the return line of the saw tooth characteristic.

A glow tube connected across the inductance in lieu of the resistor would function to produce the advantageous results obtained through the use of the resistor.

While I have disclosed a number of features of my invention as comprising means for producing various changes in the saw tooth scanning, all of these features may preferably be combined into a single oscillator and by so combining them, a cooperation between the various circuit elements will provide means whereby practically any desired change in the scanning movement of the cathode ray may be obtained.

One of the desirable features of the oscillator described by me is that it may be made to generate a saw tooth wave at any one of a wide band of frequencies. Therefore, by employing one of these oscillators for vertical scanning at a comparatively low frequency, and another for pro-

ducing the horizontal scanning component at a much higher frequency, a practically ideal scanning arrangement will be obtained. The lines across the screen produced by the movement of the beam will be straight and parallel and for all practical purposes horizontal, thereby resulting in uniform light intensity distribution throughout the screen, thus giving to the reproduced picture a more natural and undistorted appearance.

By incorporating the features described in connection with Fig. 6 for eliminating the return line, another undesirable feature in connection with the reproduction of pictures and the like will be removed.

It will be apparent, therefore, that I have described means for accomplishing the objects of my invention. Various changes in the above described circuits might be made or might occur to one skilled in the art and I, therefore, do not desire to be limited to the exact details shown and described, except as they are defined by the appended claims.

I claim as my invention:

1. In combination, scanning means of the cathode ray type comprising a screen and a beam of energy impinging upon said screen, and means comprising a dynatron oscillator having an inductor for causing said beam to sweep across said screen a plurality of times in one direction only.

2. For use in combination with scanning means of the cathode ray type comprising a screen and a beam of energy impinging on said screen, means for repetitiously causing said beam to sweep across said screen in one direction at one rate of speed and in another direction at another rate of speed, said means comprising an oscillator of the dynatron type having an inductor which deflects said beam in its output circuit, the capacitance of said output circuit being minimized.

3. For use in combination with scanning means of the cathode ray type comprising a screen and a beam of energy impinging on said screen, means for repetitiously causing said beam to sweep across said screen in one direction at one rate of speed and in another direction at another rate of speed, said means comprising an oscillator of the dynatron type having an output circuit in which capacitance is held to substantially the minimum practicable value but including an inductor, said inductor being adapted to be positioned in operative relationship to said beam.

4. For use in combination with scanning means of the cathode ray type comprising a screen and a beam of energy impinging on said screen, means for repetitiously causing said beam to sweep across said screen in one direction at one rate of speed and in another direction at another rate of speed, said means comprising an oscillator of the dynatron type having an output circuit in which capacitance is held to substantially the minimum practicable value but including an inductor, said inductor being variable whereby the frequency of said repetitious movement of said beam may be varied at will.

5. In combination a saw tooth wave generator comprising an electron discharge device having an input and output circuits, a cathode ray device positioned within the influence of said oscillator whereby the cathode ray will be caused to travel in one direction at one rate and in another direction at another rate and means for increasing the rate of travel of said beam in one of said directions only, said means comprising an inductive coupling between said input and output circuits.

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