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DEFLECTION CONTROL SYSTEM

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The present invention relates to a system and apparatus for velocity control and more particularly to a novel arrangement for improving the system utilized for scanning the elements in a television picture or the like by controlling the velocity of movement or the change in velocity of movement of an exploring point or a scanning beam.

In accordance with the present invention the change in velocity of an exploring point or the like is converted into a frequency change which is subsequently used to produce a change in the relative phase between two potentials. This change in phase is used to provide a control potential which may vary in both magnitude and polarity. This control potential may be used in any desired manner, for example, it may be used to maintain synchronism, or to control the velocity of an exploring point, such as the end of a moving stylus or the spot produced by an electron beam impinging on a surface which is to be explored. The last named example is of particular value in the television art.

One of the major problems encountered in television systems is to provide the desired linearity of scanning. In prior art electronic television systems there are a large number of variables, any one of which can cause sufficient distortion in the deflection system so that the distribution of elements in the television picture at both the pickup and reproducing ends of the system may be seriously distorted. Some of these variables in a typical deflecting system are: nonlinearity of the saw tooth of voltage or current, deflecting yokes producing distorted fields due to the nature of the magnetic circuits, cross talk between the horizontal and vertical fields, and stray magnetic fields from power transformers, reactors and the like. These sources of distortion in prior art deflecting systems have been so difficult to control that it has been practically impossible to produce a deflection system which provides even approximately perfect distribution of the elements in a television picture.

In a monochrome television system in which the picture images are obtained through the use of a single optical system and pickup tube this distribution distortion exhibits itself in the reproduced image as an alteration in the size or shape of the individuals or objects which are being reproduced. In some types of color television systems in which the pictures are either picked up or reproduced by the simultaneous use of a plurality of electronic tubes and optical systems, this distribution distortion is much more serious. With such a system it is essential that each individual picture element picked up by one electronic device be superimposed on the same picture element picked up simultaneously by the other electronic device or devices. This requirement makes it essential to obtain extremely high accuracy of distribution of the picture elements obtained from each pickup and reproducing device.

In accordance with the foregoing a major object of the invention is to provide an arrangement for controlling the scanning velocity or the change in scanning velocity of an exploring point or scanning beam.

Another object of my invention is to provide an arrangement for converting a change in the velocity of an exploring point into a change in a characteristic of a control signal such as a change in the frequency thereof.

A further object of the present invention is to provide for converting a change in frequency of a control signal into a control potential which may vary both in magnitude and polarity.

Still another object of the present invention is to provide a scanning system for television systems and the like in which variations in circuit constants and the characteristics of thermionic devices are automatically compensated.

The foregoing and other objects of my invention will be brought out more clearly in the following description, reference being made to the accompanying drawings in which;

Figure 1 is a diagrammatic showing of a television scanner deflecting system embodying my invention, parts having functions which are well known in the art being omitted;

Figure 2 illustrates certain details of construction of the cathode ray transmitter tube shown in Figure 1; and

Figure 3 shows a modification of the system of Figure 1.

Referring to Figure 1, illustrating an electronic television scanning system, reference character 10 indicates a cathode ray pickup tube, the elements of which are connected to the usual voltage sources so that the tube may function as a television scanning device. This tube 10 comprises an evacuated envelope having therein an electron gun 11, a second anode 12, a grating 14, the construction and function of which will be described later, and a mosaic 15 of light sensitive elements. The grating 14 is preferably spaced from the mosaic 15 as shown for a reason which will appear in the following description.

In the operation of the television scanning system, an optical system of the usual type, indicated conventionally at 16, is used to project onto the mosaic 15 the variations in light and shade which represent the image to be transmitted.

Picture signals will be generated when the image illuminated mosaic is scanned by a cathode ray beam 17 projected from the electron gun 11. In accordance with the invention, the grid 14 comprises a series of equally spaced beam intercepting lines or strands 18 which are interposed in the path of the beam, and because of the partial or total interruption of the beam by the lines or strands 18 there is produced a signal in addition to the picture signals. Preferably the additional signal is derived from the grid itself rather than from additional variations in the picture signal derived from the mosaic. The latter form of additional signal recovery is feasible, but it is not preferred. In the preferred arrangement to be described, only the picture signal itself appears as the useful signal output from the mosaic. The frequency in cycles per second of the additional signal due to the strands 18 depends on the velocity of the scanning beam 17 and the number of lines 18. The additional signal appears in a terminal connection 19 connected to the grid 14.

Horizontal beam deflecting coils 20 and vertical deflecting coils 21 cause the beam 17 to traverse the surface of the mosaic 15 from left to right by lines which are closely spaced vertically in a manner usual in facsimile telegraph and television practice.

When an image of a scene to be transmitted is projected on the mosaic, and the mosaic is scanned, picture signals appear as voltage changes at the mosaic terminal 23. Voltage variations in the output terminal 23 due to the presence of the lines 18 in the beam path will be negligible where the lines 18 are in the form of strands or wires the diameter of which is small in comparison with the diameter of the beam at the point where the beam is periodically intercepted. Where the strands are spaced from the surface of the mosaic 15, the beam 17 will be of greater diameter since the beam converges and, therefore, the shadow effect on the electron beam spot impinging on the mosaic will be still smaller. Electrical focus of the beam at the grid 14 must be good enough so that only one strand 18 will intercept the beam 17 at a time. Moreover, an optical image of the grid 14 will not be cast on the mosaic 15 to interfere with the image from the lens system 16 of the object or scene to be televised if the grid is spaced an appreciable distance from the mosaic or focal plane of the lens system 16. The shadow of the grid 14 will be diffused sufficiently under those conditions so as not to be optically reproduced on the mosaic. The spacing of the grid 14 and the mosaic 15 depends on the aperture and the focal length of the lens system 16.

When the cathode ray tube 10 is used as a television transmitter tube, the total number of lines or strands 18 and their spacing is preferably such that the frequency of the signal produced as they are scanned is substantially higher than frequency components of the picture signal. The signals on the mosaic terminal 23 are supplied through a picture amplifier 24 to a radio transmitter 26 and are radiated from an antenna 27 to picture receivers in the usual manner.

Referring to Fig. 2, the strands 18 of Fig. 1 may be strands of fine wire, also designated by reference character 18. The grid 14 should not be photo-electric otherwise the control pulse obtained will vary in amplitude due to variations in light on the picture area. Tungsten wire approximately .001 inch in diameter is suitable for the purpose. These wires are spaced 1/25 of an inch apart, and are supported by a frame 28 which is secured in position in front of the mosaic 15 in a suitable manner, for example, by brackets 29 sealed to the envelope wall of the tube 10.

The deflecting coils 20 in accordance with present day practice cause the beam 17 to scan the mosaic horizontally 15,750 times per second. The frequency of the signal generated by one hundred strands 18 is, therefore, 1,575,000 cycles per second.

The manner of utilizing the signal from the grating or grid 14 will now be described. The signal appearing at the terminal 19 from the grid is supplied to an amplifier 31. The effect of signals due to photo-emission, secondary emission from the mosaic, etc., is minimized by this amplifier which is designed to have a band pass characteristic. The output of amplifier 31 will, therefore, be the desired signal.

This signal appearing in the conductor 30 may be utilized directly by applying it to a frequency discriminating circuit such as shown as network 32. The circuit 37 comprising inductance 39 and condenser 38 is tuned to resonate at the normal frequency generated by the scanning beam crossing the grid 14. The inductance 39 is coupled to the two coils 41 and 42 which are tuned to resonance with the primary by condenser 45 and connected to the diodes 46 and 47. It will be obvious that the elements of the tubes 46 and 47 may be combined in a single tube structure.

The output of the discriminator 32 is obtained from the resistors 43 bypassed for the R. F. signal by condensers 44. One end of the resistor 43 is connected to a point 57 on the voltage supply for the horizontal output tube 52. The other end of resistor 43 will vary in potential and polarity with respect to point 57, the output being dependent on the velocity of the scanning beam as it crosses the wires of grating 14. This varying votage is applied to the horizontal output tube control grid 51 through resistor 60.

A horizontal deflecting voltage of saw-tooth wave form is supplied from a generator 48 which is controlled in the usual manner by a source of synchronizing pulses connected to the terminals 49. The output of the generator 48 is applied to the control electrode 51 of an amplifier tube 52, the anode circuit of which includes the primary 53 of the transformer 54. The secondary 56 of this transformer is connected to the horizontal deflecting coils 20.

The action is as follows, if the deflection voltage from the sawtooth generator 48 is non-linear the portion which is "stretched" will develop a negative potential at point 59 which will cause the tube 52 to compress this portion of the deflection. Likewise, if the deflection voltage is "compressed" a positive voltage will be developed at point 59 and the tube 52 will expand the compressed portion. In this manner the deflection output of tube 52 is maintained to any desired degree of linearity, the accuracy being controlled by the gain of amplifier 31.

In operation of the system of Figure 1, a scene to be televised is imaged on the mosaic 15 by the lens system 16, the electron gun 11 is placed in operation and currents of the proper wave form are applied to the horizontal and vertical beam deflecting coils 20 and 21, respectively. The cathode ray beam 17 traverses the mosaic 15 in closely spaced horizontal scanning lines generating picture signals in the usual manner. Due to the presence of the strands 18 a signal appears in the output 30 of the amplifier. The picture signal, as well as the usual synchronizing and control signals are amplified and transmitted by the transmitter 26. A receiver reproducing pictures from this composite signal is unaffected by the additional signal generated by the lines 18. Where the lines 18 are formed in or on the mosaic 15 or comprise a grid, such as the grid 14, lying close to the mosaic, the picture signal and the additional signal appear in the output terminal 23 and may be separated by spacing the lines 18 so closely that the additional signal is higher in frequency than modulation components ordinarily produced when scanning the picture illuminated mosaic. This frequency difference will provide for separating the additional signal from the picture signal. However, as stated above, this is not the preferred procedure.

When the beam 17 traverses the mosaic 14 at the desired scanning velocity, the signal produced by the lines 18 is at the resonant frequency of the tuned circuit 37 of the discriminator 32. At resonance the voltages across the primary 39 and secondaries 41 and 42 are 90 degrees out of phase. If the frequency of the signals applied to the primary 39 varies, the phase of the secondary voltage will vary accordingly up to a maximum value of approximately 90 degrees in either direction of rotation from the normal 90 degree relationship. When the voltages are 90 degrees out of phase, the total voltage across the resistor 43 is zero. As the phase relationship changes, the voltage across the resistor 43 will become either positive or negative, and vary in amplitude as a function of the phase difference. When the beam moves across the mosaic at the constant desired velocity, signals of a fixed frequency will be produced, and assuming that the discriminator is tuned to this frequency, no voltage will appear across the resistor 43. If, however, the beam tends to slow up as it moves across the mosaic, the frequency of the generated signals will decrease, and a voltage will appear across the resistor 43, which will tend to make the grid 51 of the tube 52 more positive, thus tending to increase the speed of the beam across the mosaic. If, on the other hand, the beam tends to increase in velocity, the frequency discriminator will cause the grid 51 of the tube 52 to become more negative, slowing down the beam. Since the system tends to keep the scanning velocity of the beam 17 constant, it will cause the beam to scran a fixed area of the mosaic at uniform velocity.

If the tuning of the discriminator is changed by manipulating the condenser 38 so that the grid 51 of the tube 52 becomes increasingly positive, a larger area of the mosaic 14 will be scanned. Conversely, if the discriminator tuning is altered so that the grid of this tube becomes or tends to become increasingly negative, a smaller area of the mosaic will be scanned for each horizontal exclusion of the beam 16. When adjustment is made to cover a smaller portion of the mosaic 14, a horizontally magnified image of this portion will appear at the receiver, unless the receiver size control is manipulated to compensate for the change.

Although the invention is illustrated as being applied to the horizontal deflection circuits, it is apparent that it may also be applied to control vertical deflection in a similar manner. Also, the invention may be applied to a picture reproducing tube to maintain constant velocity of deflection of the scanning beam or point. A grid or grating of the type shown in Fig. 1 or 3 of the drawings may be used in front of the fluorescent surface of the reproducing tube to produce a control signal. The grid in this case may be connected through a resistor or resistors to a source of potential, for example, a source of approximately 25 volts negative with the second anode of the reproducing tube. Although the beam current in the reproducing tube varies in accordance with the reproduced values of light and shade, the beam current even in darker portions of the picture is still sufficient to insure that a control signal will be obtained from the grid. If the amplitude of the control signal varies greatly, it can be applied to some means, for example, a means to minimize amplitude variations, and an amplifier such as 31 in Fig. 1.

Fig. 3 of the drawings discloses a modification of the arrangement shown in Figs. 1 and 2 in which provision is made for minimizing capacity coupling between the mosaic and the outer grids. The pick-up tube is shown in Fig. 3 as being viewed from the top. In the form shown a screen 70 is used which is composed of fine metallic strands such as wires or the like 71. It will be understood that these wires are supported at their ends in any suitable manner, for example, that disclosed in Fig. 2 of the drawings and that these wires 71 are all electrically joined and connected to a terminal 72 which projects exteriorly of the tube envelope, a fragmentary portion of which is indicated by reference character 73. The usual elements are also shown comprising the second anode 74 and the first anode 76, the cathode 77, together with their external connections.

A grating or grid 78 corresponding to the grid 14 of Figs. 1 and 2 of the drawings is composed of a series of spaced strands or wires 79 and an additional set of spaced strands or wires 81.

The set of wires 79, which are spaced uniformly in a vertical direction as viewed on Fig. 3 of the drawings are located further from the mosaic 82 than the set of vertically spaced wires 81. All of the wires 79 are electrically joined at their ends and are connected to a terminal 84. In a like manner, the wires 81 are electrically joined at their ends and are connected to a terminal 86. The terminals 84 and 86 and the output connection 88 of the signal plate 89 extend through the wall 73 of the tube. The terminals 84 and 86 are connected through suitable high resistances 90 and 91 to a source of negative potential indicated on the drawings. The screen 72 is connected in the manner shown to ground. The lead 88 from the signal plate 89 carries the video output signal which may be applied to an amplifying transmitter shown in Fig. 1 of the drawings.

The control signal generated by the group of wires 79 is fed to a discriminator arrangement such as the discriminator 32 of Fig. 1 by way of an amplifier such as amplifier 31. The connection to the amplifier is indicated on Fig. 3 by the reference character 94.

The spacing of the groups of wires 79 from the group 81 and the horizontal displacement or amount of stagger is such that the electron beam shown conventionally and indicated by the reference character 96 is intercepted by one of the wires 79 and one of the wires 81. As the beam moves horizontally the scanning spot which impinges on the mosaic 82 is of constant intensity, since as the beam is leaving one of the wires 79, for example, another wire 79 is entering the path of the beam, so that the resultant electron stream maintains a scanning spot of constant intensity on the mosaic 82. The beam, however, intercepts at any instant only one of the group of wires designated 79 so that pulses are produced by the variation in current through resistor 90. Similar pulses are also produced in resistor 91. The potential variations occurring across either or both resistors can be used. A push pull type of circuit is required if both pulses are to be used. The grid 78 and the screen 70 are preferably located at a distance from the mosaic so that a defined shadow or optical image of these parts will not be cast on the mosaic as was explained in connection with the grid 14 of Fig. 1. The wires 79 and 81 may be in the same plane rather than being at different distances from the mosaic as shown. Their position with respect to the beam, however, is to be as set forth above, namely, the beam is to intercept at any instant only one of the group of wires 79. The distance between the centers of a wire 79 and a wire 81 will be approximately equal to the width of the beam 96 at the plane of the wires.

The bias voltage figures on the elements of the tube 73 are indicated by way of example and for the sake of complete disclosure of an illustrative embodiment.

From the foregoing description of the modified system of Fig. 3 and the description of the operation of the system disclosed in Fig. 1, it is believed that the operation of the arrangement of Fig. 3 will be obvious.

Various alterations and modifications may be made in the present invention without departing from the spirit and scope thereof, and it is desired that any and all such modifications be considered within the purview of the present invention except as limited by the hereinafter appended claims.

Having now described my invention, what I claim as new and desire to have protected by Letters Patent is:

1. In a system for obtaining a voltage available for control purposes, a generator of alternating voltages comprising an exploring point and a member having a field traversed by said exploring point, means associated with said field to cause generation of an alternating voltage when said point explores said field, and means for deriving a variable potential having positive and negative values related to changes in the velocity of said deflectable exploring point.

2. In a system for obtaining a voltage available for control purposes, a generator of alternating voltages comprising an exploring point and a member having a field traversed by said exploring point, means associated with said field to cause generation of an alternating voltage when said point explores said field, means for producing an alternating voltage in quadrature with said generated voltage, means for varying the sense and degree of phase difference of said produced alternating voltage, and means for deriving a variable potential having positive and negative values related to the changes in phase of said produced voltage.

3. A system for determining the velocity of a deflectable exploring point, comprising means for deflecting said point along a predetermined path, means for generating an alternating voltage of a frequency related to the velocity of said exploring point, means for producing an alternating voltage in quadrature with said first named alternating voltage, means for varying the sense and degree of phase difference of said produced alternating voltage, means for producing a variable potential having positive and negative values in response to said phase changes, and means for applying said potential changes to said deflecting means to vary the velocity of said exploring point.

4. A system for determining the velocity of a deflectable exploring point, comprising means for deflecting said point along a predetermined path, means for generating an alternating voltage of a frequency related to the velocity of said exploring point, means for producing a variable potential in response the frequency of said alternating voltage having positive and negative values, and means for applying said potential changes to said deflecting means to vary the velocity of said exploring point.

5. A television transmitter comprising a cathode ray tube, a photo-sensitive member in said tube adapted to receive an optical image thereon, means to produce a deflectable scanning ray for scanning said member, means to produce ray deflecting fields for causing said ray to scan said member, means associated with said member to cause generation of an alternating voltage when said ray scans said member, means for producing an alternating voltage in quadrature with said generated voltage, means for varying the sense and degree of phase difference of said produced alternating voltage, means for producing a variable potential having positive and negative values in response to said phase changes, and means for applying said potential changes to said means for producing one of said ray deflecting fields to vary the velocity of said deflectable scanning ray.

6. A television transmitter comprising a cathode ray tube, a photo-sensitive member in said tube adapted to receive an optical image thereon, means to produce a deflectable scanning ray for scanning said member, means to produce ray deflecting fields for causing said ray to scan said member, means associated with said member to cause generation of an alternating voltage of a frequency higher than frequencies generated in the absence of said last named means when said ray scans said member, means for producing an alternating voltage in quadrature with a harmonic of said generated voltage, means for varying the sense and degree of phase difference of said produced alternating voltage, means for producing a variable potential having positive and negative values in response to said phase changes, and means for applying said potential changes to said means for producing one of said ray deflecting fields to vary the velocity of said deflectable scanning ray.

7. A television transmitter comprising a cathode ray tube, a light sensitive mosaic in said tube, means to produce a deflectable scanning ray for scanning said mosaic, a series of spaced strands positioned in the path of said scanning ray, a deflecting coil for deflecting said ray over said mosaic in one direction, a frequency discriminator for producing a potential of one polarity when said scanning ray moves in excess of a predetermined velocity over said series of spaced strands, and of an opposite polarity when said scanning ray moves at a velocity less than a predetermined