Aug. 12, 1947. K. SCHLESINGER 2,425,491

DEFLECTION CIRCUIT

Filed June 22, 1943 2 Sheets-Sheet 1

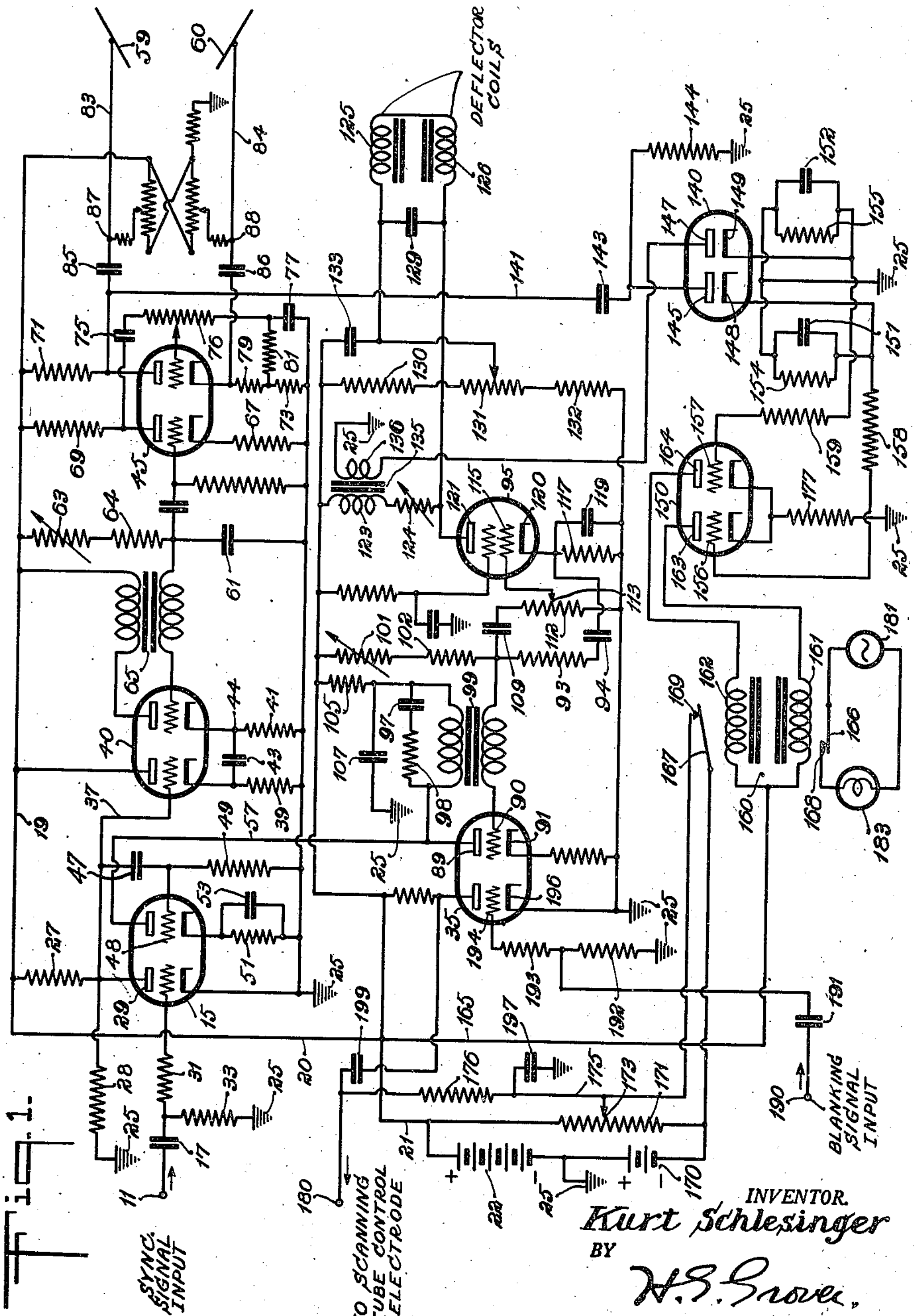

Fig. 1.

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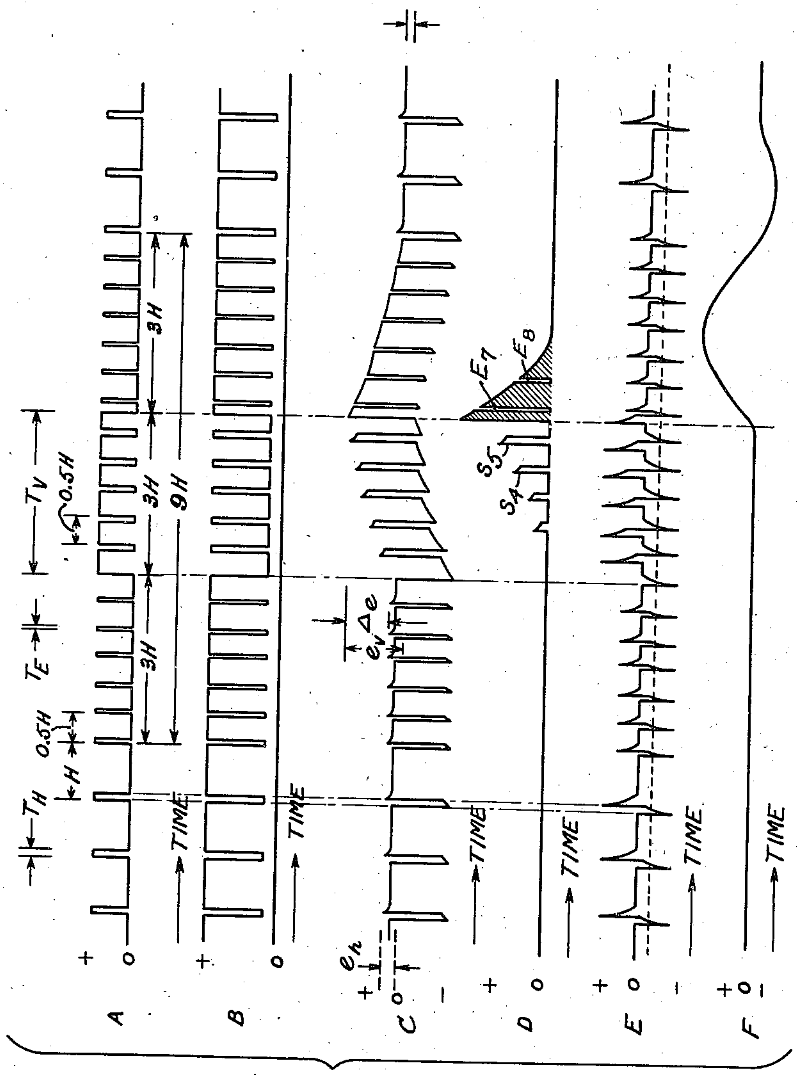

Fig. 2.

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DEFLECTION CIRCUIT

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This invention is directed to television circuits and apparatus. It relates primarily to control equipment and circuits for operating television camera or pick-up tubes upon which an optical image is cast and, by virtue of a scanning operation, there results a formation of wave trains of electrical video signal energy representative of the optical image.

The invention is directed, in addition, to suitable control apparatus for such a form of system wherein provision is made for the protection of the scanning or camera tube from the deleterious effects of a stationary, or substantially stationary, scanning beam which could occur in the event of a complete failure of the electron beam deflecting circuit or a substantial reduction of the scanning below a minimum level at which the scanning or camera tube can safely operate.

In its present form, the invention is particularly concerned with providing ways and means by which the television camera or scanning tube (which, for the purpose of showing one suitable example, may be considered as being of the "Orthicon" type) may be utilized and controlled. A tube of the general type known in the art as the "Orthicon" is described in an illustrative manner in the publication entitled "Principles of Television Engineering," by D. G. Fink, published in 1940 by McGraw-Hill Book Company, Inc., New York, N. Y. In the publication named, the "Orthicon" tube is described particularly in that portion of the text between pages 111 and 116 and a schematic representation of the tube is shown on page 115. Further reference to the "Orthicon" type of camera or scanning tube may be had from the various publications listed in the footnotes on page 111 of the said Fink publication.

The tube of the type herein described as the "Orthicon" is one in which there is provided a mosaic electrode, which electrode usually comprises a signal plate, a dielectric member supported upon the signal plate and in which there is provided a multitude of minute photoelectric particles or globules which are carried upon the dielectric member. Mosaics of this general type are known in the art and explained in the publication above named.

In tubes of the type suggested, the electron scanning beam is directed toward the mosaic electrode so that it will impinge thereon during scanning at substantially all areas thereof along a path normal to the mosaic electrode member. The high speed horizontal deflection in such a tube is provided by a pair of electrostatic deflecting plates which act in combination with an axial magnetic focusing field. The slower speed vertical deflection is accomplished by the aid of a pair of electromagnetic coils also contained within the field of the focusing coil. The result is that by virtue of the application of suitable controlled voltages to the horizontal deflecting plates, and suitable currents through the vertical deflecting coils, a low velocity electron scanning beam can be caused to traverse the mosaic electrode element in a line by line manner so as to neutralize or release bound charges at the different elemental areas of the mosaic, and more or less of the electrons of the scanning beam are absorbed or collected by the mosaic in accordance with the loss of electrons therefrom due to the brilliance of a related area of the optical image. The result of the collection of the electrons of the scanning beam upon the mosaic electrode is that a signal output from the tube is provided. This signal output is known as the train of video signal energy which can be applied across an output impedance of the camera tube through a suitable amplifier and transmission channel to recreate an optical image at monitoring or receiving points, which re-created image corresponds to the initially projected optical image that reaches the mosaic electrode of the camera tube.

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The present invention is most particularly concerned with the circuits by which the deflection of the scanning beam in such a device is controlled in its motion across or relative to the photoelectrically active or light sensitive mosaic electrode. To this end, the presently described apparatus will be seen to include a plurality of stages for providing both the horizontal electrostatic and the vertical electromagnetic deflections and, in addition, will provide for separation of the sync and blanking signals from some suitable form of sync generator which supplies the sync and blanking signals to the complete system. Insofar as the protective system hereinabove described is concerned, it comprises essentially a rectifier arrangement or circuit which is influenced by the outgoing deflection currents and voltages and, while so influenced, causes exciter currents to flow through a twin coil relay which, if the sweep circuits fail or fall below a certain level, provides for an interruption of the scanning beam of the camera tube upon the cessation of the deflection in one or both of its directions of sweep. In this way, the beam current causes the scanning beam to be developed within the described type of scanning or camera tube and is blocked as soon as either one of the two sweeps fails to operate. Other features of the invention will be described in more detail from the specification to follow.

In the light of what has been stated above, it of course becomes apparent that the invention has, as one of its main objects, that of providing a control circuit for a television camera or scanning tube of the type generally known as the "Orthicon."

At the same time, the invention has as another of its objects that of providing a circuit for protecting a television scanning or camera tube of the type described, in the event that a failure should occur in the deflecting circuit.

Other objects of the invention are those of providing a control circuit for a television scanning or camera tube which is of a simplified nature as compared to those heretofore usually known in the art, as well as to provide a control circuit and a protective system which is highly efficient in its use and functioning.

Still other objects of the invention are those of providing both control and protective circuits for use with television or scanning tubes where the said circuits function collectively and in their individual parts to overcome one or more of the defects of the prior art systems and yet serve to increase still further the ease of operation as well as the efficiency of operation.

Other objects and advantages will become apparent and promptly suggest themselves to those skilled in the art to which the invention is directed when the following specification is read in connection with the accompanying drawings, of which,

Fig. 1 is a schematic circuit diagram of one form of the circuit utilized in the invention herein to be described; and

Fig. 2 is a series of curves for the purpose of explaining the operation of the invention as exemplified by the circuit of Fig. 1.

In the group of curves of Fig. 2, curve *a* is a schematic illustration of the R. M. A. standard form of sync signal, and is of the general type of wave formation set forth and described, for instance, on page 171 of the book published by D. G. Fink above noted. Such a form of sync signal has also been described in the more recent publication entitled "Television Standards and Practice" which was edited by the same D. G. Fink and published by the same publishers in 1943. This last named text represents certain "Selected Papers from the Proceedings of The National Television System Committee and its Panels." The sync signal hereinabove referred to by curve *a* of Fig. 2 is described in the last named publication quite fully on pages 22 and 23, as well as substantially described on pages 238 and 239 of the same book.

Curve *b* of Fig. 2 represents the output signals from the plate circuit of a tube to which the input signals of the form of curve *a* have been applied. Curve *c* represents the wave shape at the input of one of the tubes later to be described. Curve *d* represents the plate current at the output of the tube to which the input signal of curve *c* is applied, and curve *e* represents the output of the horizontal discriminator, while curve *f* is the output signal from the vertical discriminator.

Referring now more particularly to the drawings, the invention will be seen to comprise, as diagrammatically represented, five stages for horizontal electrostatic and vertical magnetic deflections, as well as for the sync separation and blanking, where the control synchronizing impulses are received at a suitable input terminal in positive polarity at a certain predetermined voltage level. The remaining tubes of the diagrammed circuit function, as will later be set forth, for protecting the "Orthicon" or television scanning or camera tube in the event that either one of the deflection systems fails or has its output reduced below a certain minimum safe operating level. To this end, the complete system will be seen, from what is to be described, to divide itself, strictly speaking, into separate functional groups which will be seen to comprise the sync separator, the horizontal deflector, the vertical deflector, the protective relay system and the blanking system, all for the purpose of controlling the "Orthicon" or television scanning or camera tube.

The sync signals of the type illustratively represented by curve *a* of Fig. 2 are applied first to an input terminal **11** and then fed to the sync separator tube **15** by way of the capacity coupling element **17**. In the arrangement shown, operating voltages are applied to the tube from conductor **19**, which, in turn, derives positive voltage by way of conductors **20** and **21** from a voltage source **22**, having the negative terminal thereof connected to ground **25**, as indicated. The high voltage source **22** is conventionally indicated by the battery, but it should be understood that this is merely for illustrative purposes and actually, in practice, this source may be the voltage divider resistor at the output of a filter circuit associated with an A. C. rectifier of any suitable form.

This voltage from the source **22** energizes the plate circuit of the first half of the sync separator tube **15** by way of the plate resistor **27** and the resistor **28** connected between the plate or anode **29** and ground **25**, where the said resistors together form a voltage divider, as will later be explained. Broadly speaking, the tube **15** has the function of receiving signals of the type shown by curve *a* of Fig. 2 and, after suitably separating and clipping these signals, delivering the resulting output to the vertical and horizontal deflection units which are generally represented by the tubes **35** and **40**, respectively.

In order to insure that proper interlacing of the scanning or the picture takes place, it is desirable that the long frame signal Tv, also represented as the second or centermost period 3H within the 9H period of curve *a*, should be such that during the period of the receipt of this signal, a reasonably sharp step wave front pulse, such as that shown by curve *d*, should be derived as the vertical synchronizing signal pulse. Likewise, to insure a continuous synchronization of the horizontal sweep or deflection, the pulse, as shown by curve *e* of Fig. 2, should be given very small inertia such as to be able to respond during the very short period of the equalizing pulses, which (according to the above named standards) is equal to approximately 0.04H, where "H" is the period represented by one line of picture scanning and, for present standards, represents a time period of about 64 microseconds. Similarly the slot period existing during the vertical frame signal is equal to approximately the time period as represented in curve *a*, and this is equal to 0.08H.

The incoming sync signals of the characters shown by curve *a* of Fig. 2, when impressed upon the input terminal **11**, are to be subjected to a clipping action in the separator tube **15** at both the positive and the negative peaks of the signals. To this end, the series grid resistor **31**, connected to supply the signals to the grid or control electrode of the first half of the tube 15, provides grid current clipping and the voltage divider combination in the form of resistors 28 and 27 provides plate voltage clipping by reducing substantially the plate potential on the first half of the tube.

Automatic bias for the first half of the tube 15 is provided by way of the condenser and resistance combination formed of the coupling condenser 17 and the leak resistor 33, which together function under the influence of grid current resulting from the positive sync signals impressed at a predetermined voltage (for example, about 10 volts) at the input terminal 11.

With this result, the signals which appear in the plate circuit of the first half of tube 15 will be of the general wave form such as those signals shown by curve *b* of Fig. 2. It will be seen from curve *b* of Fig. 2, that the signals, regardless of their duration, assume two precise voltage levels relative to a zero value of voltage indicated, and further, that the signals are sufficiently steep to provide a control of subsequent time-discriminator circuits.

The output energy in the first half of tube 15 is then fed by way of the conductor 37 directly to control a cathode follower stage 40. In this cathode follower stage, plate voltage is derived from the conductor 19. The cathode resistor 39 connected between the tube cathode and ground 25 sets a predetermined normal continuous plate current flow in the tube which is interrupted by the negative direction peaks of the signal or control wave shown by curve *b* of Fig. 2. Actually, the synchronization of the horizontal sweep oscillator is taken care of after differentiation of the interruptions in the coupling system between the two halves of the tube 40, which coupling system comprises the cathode resistors 41 for the second half of the tube and 39 for the first half of the tube and the condenser 43. In this combination, the condenser and resistance combination is so calculated that when the apparent source resistance of the cathode follower stage, comprising the first half of the tube 40, is taken into account, the time constant of the differentiator circuit, including the cathode resistor 41 and the coupling condenser 43, is considerably smaller than the time duration of the slots in the vertical signal and is made of the order of one micro-second. As far as the time duration of the equalizing pulses is concerned (these pulses being shown as occurring during the first and the last periods marked 3H of the 9H control period as in Fig. 2*a*), the produced time constant is less than even the time duration of the equalizing pulses according to the prescribed standards which have been set up as lasting for a period of 0.04H, which substantially corresponds to 2.5 micro-seconds.

The result is that the output signals which appear at the output terminal of the discriminator are substantially of the form shown by curve *e* of Fig. 2, and it will be seen that this sequence of signals continues unaltered even during the period of the frame signal, so that the horizontal synchronization takes place undisturbed during the vertical retrace period as well as during the field period.

A consideration of curve *e* of Fig. 2 will show that the negative peaks of the resulting differentiated pulses are always of substantially constant height or amplitude, whereas this is not true of the positive direction peaks. However, the oscillator section constituting the second half of the tube 40 responds, as it can be appreciated, due to the cathode connection at the point 44, only to the negative peaks of the wave form shown by curve *e*, with the result that the varying heights of the positive peaks become immaterial.

As was explained for the horizontal synchronization in what has preceded, and as will be further amplified in what is to follow, horizontal synchronization is provided by discrimination through differentiation rather than by integration. The same is generally true of vertical synchronization, and this is provided by the circuit combination formed as the second half of the sync separator tube 15.

In this circuit embodiment, the levelled output voltage from the first half of the sync separator tube 15, as it appears in conductor 37, is fed through the high-pass filter combination comprising the capacity 47 and the resistor 49 which is grounded at 25, so that there is produced at the grid or control electrode 48 of the second half of the tube 15 an input wave of the general wave formation exemplified by curve *c* of Fig. 2.

In the diagram of Fig. 2, and particularly curve *a*, it will be seen that the duration of each line synchronizing impulse is represented by a time period shown as $T_H(0.08H)$, and that the time duration of the equalizing pulse is indicated by a time period $T_E(0.04H)$ and that the complete group of slotted vertical or frame synchronizing pulses is indicated by the long period T_V, which is equal to the period of three traced lines (3H) on the roster. The long frame signal, however, results in a stronger positive back-kick, which is denoted by the voltage represented as e_v.

In order that the discrimination may be simplified to the greatest extent, there exists an optimum time constant for the filter combination, comprising condenser 47 and resistor 49, which will result in a maximum voltage difference (shown as Δe on curve *c* of Fig. 2) which represents the difference between the voltage resulting from the vertical and the horizontal back-kicks. By suitable choice of circuit parameters, the back-kick voltages for the horizontal and the vertical control signals may be found to be in the ratio of about 1:9, so that if it is assumed, for instance, that the output wave, as in curve *b* of Fig. 2, appearing at the plate of the first half of separator tube 15, is of the order of 30 volts amplitude, the back-kick of the line or horizontal synchronizing pulse will be approximately three volts while the vertical or frame back-kick voltage will be of the order of 27 volts.

To this end, the separator tube constituting the second half of tube 15, in operation, is given a suitable negative grid bias to prevent the horizontal back-kick voltage from producing any effect in the output plate current, as it appears in this half of the tube, which could disrupt or even affect the interlace of the picture. In other words, the blocking bias voltage applied to the second half of the separator tube 15 should amount to approximately the sum of the cut-off voltage of the second half of the tube plus the mean value of the voltage between the values represented e_h and e_v, which, in the example of the assumed voltage range of the signal output, as in curve *b* of Fig. 2 and with a separator tube 15, as exemplified by the double triode type 6F8, for example, may be a bias voltage of the order of about 25 volts.

Such a cathode bias voltage may be automatically set by the average plate current through a suitably chosen cathode resistor 51, which will provide automatic regulation against the amplitude variations. The cathode bias resistor 51 is shunted to ground by a suitable by-pass condenser 53 which is made large enough so that it serves to integrate the effect of the bias over a fairly substantial number of picture field scanning cycles, such, for example, as about 10 picture fields (one-sixth second by present standards).

Under these circumstances, the plate current in the output from the second half of the separator tube 15, as it appears in the output conductor 57, is of the general wave formation exemplified illustratively by the curve *d* of Fig. 2. In this curve, it will be seen that the plate current is of a wave formation such that it exhibits a very steep wave front which is preceded by the residual pulses S_5 and S_4, for instance, which result from the slots in the frame or field synchronizing signal T_v, and the signal itself has slots in it in the place of the original equalizing pulses E_7 and E_8, for instance, representing the seventh and eighth equalizing pulses of the group for instance. The resulting "parasitic" signals are not detrimental to interlace conditions as they have double the line frequency and are of short duration, and thus, a very small energy content. However, if desired, the effects may be eliminated completely from the vertical sync quite readily by the aid of an integrating or selector device of the general character which will be discussed later in connection with the vertical deflection.

At this point it might be pointed out that the use of such integrators subsequent to separation by differentiation, as above explained, can be made to maintain the advantages of that method to define the vertical firing or triggering point of the vertical sweep or deflection with somewhat greater precision due to the steeper wave front than the more conventionally used method of direct integration of the frame or field signal.

It was explained, in the foregoing portion of this disclosure, that in the "Orthicon" tube, which is assumed herein, by way of example, to be the type of scanning or camera tube to which the described arrangement is particularly adapted, the rapid or horizontal deflection of the scanning beam, in its traversal of the mosaic electrode, took place under the control of electrostatic deflecting plates or electrode members. Such plate or electrode systems are conventionally represented herein as embodying the deflector plates 59 and 60.

To control these deflecting plates and to produce the voltages applied thereto, the energizing means comprises, as aforesaid, the horizontal oscillator tube 40 operating in combination with the push-pull unit formed particularly by the second half of the amplifier unit 45, which unit is usually and preferably combined within a single tube envelope with a driver triode first half, so that the tube 45 may, for example, be of the general type known in the art as the double triode 6F8, although it is apparent that separate tubes may be used where desired, or, in some cases, that tubes having slightly different characteristics may be substituted.

The horizontal oscillator system, including the tube 40, is preferably of the general type shown and described in United States Patent No. 2,396,439, granted on March 12, 1946, to this same applicant upon an application which was filed on March 16, 1942, as Serial No. 434,805, for an invention entitled "Electron tube circuits." Generally speaking, this combination is provided by means of the sweep condenser 61, which is charged from the voltage source 22 through the resistors 63 and 64 which connect to conductor 19. The first of these resistors 63 is usually made variable for frequency control purposes. The condenser 61 is discharged by way of the grid current pulse from the triode second half of the tube 40 which has connected thereto, in the particular form of blocking oscillator circuit described in the said co-pending application, a feed-back transformer 65, and the second half of the tube 40 is usually cut off with the sweep condenser 61 charged strongly negative.

Synchronization control is obtained by way of the connection at the point 44 into the cathode circuit of the second half of the tube 40 with the synchronizing pulses of negative polarity being applied across the cathode resistor 41. A connection of the character described provides for cooperative use with the first half of the driver triode tube 45 as a differentiator with a time constant shorter than the equalizer or slot period, as already explained, and the cathode resistor 41 also serves to limit the discharge power of the oscillator triode comprising the second half of the tube 40, i. e., to adjust the sweep amplitude. Under these circumstances, a voltage is developed across the condenser 61 which is substantially linear and of saw-tooth wave formation and which may be adjusted to a value of the order of 10% to 15% of that of the source 22 without becoming distorted.

The voltage developed across the condenser 61 is, however, generally insufficient of itself to drive the "Orthicon" deflection electrode system 59, 60, or to drive directly the balanced to ground amplifier section comprising the second half of the push-pull amplifier 45. Therefore, to this end, the first half of the tube 45 provides for both voltage amplification for controlling the deflection of the scanning beam passing between the deflecting plates 59 and 60, and it also prevents distortion. To this end, the cathode element of the first half of the tube 45 has a cathode resistor 67 connecting to ground 25, so that the pre-amplifier section of tube 45 operates generally as a device of the so-called "class AB" type, in the manner explained in the literature. For instance, this "class AB" type of tube operation is described in the book "Ultra-high Frequency Techniques," by Brainerd, Koehler, Reich and Woodruff, published in 1942 by D. Van Nostrand Co., Inc., of New York, N. Y., to which text reference is made, and particularly to page 77, etc., thereof. In this way, the non-linearity of the tube characteristic at the chosen point is of just the sense and the proper magnitude to compensate for any saw-tooth distortion of the input which may occur if the voltage across the condenser element 61 is adjusted for fairly large amplitudes. Accordingly, with this operation, as described, there is developed across the load resistor 69 of the first half of tube 45, a linearly corrected saw-tooth voltage wave to control the operation of the "Orthicon" deflection.

To provide for this form of operation, the "Orthicon" deflector system is operated in a balanced-to-ground state and, to obtain such working conditions, the second half of the tube 45 is arranged between the supply voltage source and ground, with two symmetric resistors 71 and 73 connected to the plate and cathode, respectively, for the second half of the tube 45. In order that sweep amplitude of the resulting deflection may be adjusted, the output of the first half of the tube 45 is fed through the condenser 75 and potentiometer 76, whose other terminal connects to ground 25 through condenser 77 in such a way that the control electrode 78 connects at an intermediate point on the potentiometer. The potentiometer will be seen also to connect into the cathode circuit of the tube through the resistor 79 forming a part of the cathode resistor of the tube.

The filter combination comprising the condenser 77, which connects one end of the potentiometer 76 to ground and the resistor 81, constitutes a filter which eliminates the saw-tooth component from the bias voltage applied to the control electrode 78 of the second half of the driver tube 45. In this way, a control of the deflection from full amplitude down to a zero deflection value is readily obtained by an adjustment of the volume control provided through the use of the slider contact on the potentiometer 76, without changing the working point along the characteristic of tube 45.

The "Orthicon" deflector plates 59 and 60 thus connect by way of the conductors 83 and 84 to the plate and cathode outputs of the second half of the driver tube 45 through the blocking condensers 85 and 86 respectively. The remainder of the balancing arrangement comprising the balanced resistor combinations, indicated as connected between the terminal points 87 and 88 and ground 25 through the first and adjustable resistors, is substantially according to standard practice, and, per se, forms no part of this invention. Further detailed reference to that part of the circuit between the terminals 87 and 85 and ground 25 may be had by reference to the RCA Bulletin describing the preferred operation of the tube known in the art as the "Orthicon 1840."

The vertical deflecting circuit includes the tube element 35 of which the second half, comprising the plate or anode electrode 89, the control electrode 90 and the cathode 91, functions as a vertical oscillator tube in a manner suitable for driving or controlling the vertical amplifier tube 95. Generally speaking, the circuit of the vertical oscillator, comprising the second half of the tube 35, resembles, in a substantial measure, that used for the horizontal deflector circuit as embodied in the second half of tube 40. However, in the arrangement shown, in contrast to what is shown for the horizontal oscillator, a resistor element 93 is connected serially relative to the sweep condenser 94 in such a manner that the resistor may be used to provide adequately for peaking.

In conjunction with the vertical oscillator, the filter unit comprising the condenser 97 and the series resistor 98 serves, together with the secondary winding of the blocking transformer unit 99, to provide an oscillatory circuit with critical damping. Generally speaking, this critically damped circuit, comprising the transformer secondary and the series resistance and capacity network in shunt therewith, has a two-fold effect when tuned to a frequency corresponding substantially to one line period of the deflection, as represented by the period H (see Fig. 2*a*). These effects are that the duration of the recharge phase of the blocking oscillator section, comprising the second half of the tube 35, is made definite and of the order of one line period and, secondly, it provides a circuit whereby the current pulse, shown by curve *d* of Fig. 2, as it is derived at the plate 89 of the tube 35 by way of the conductor 57 from tube 15, is such that all of the undesirable high frequency components, which might be represented by the pre-signals, such as shown at S_4, S_5, or the signals E_7 and E_8 of curve *d* of Fig. 2, are eliminated, so that the resulting current pulse through the transformer primary is approximately as shown and diagrammatically represented by curve *f* of Fig. 2. It thus becomes apparent that the vertical synchronization, as it affects the system herein set forth, will be caused to occur at the end of the frame or field period represented by T_v, for instance, by curve *a* of Fig. 2. Suitable interlacing results from tuning the plate coil once for all, and thereafter, synchronization is so stable that any variations of the frequency control resistor 101, of the resistor pair 101 and 102, which charges the sweep condenser 94 through the peaking resistor 93, change the amplitude of the sweep rather than the sweep frequency.

To stabilize still further the operation of the system, the plate energy voltage for the second half of tube 35, like the second half of tube 15, is provided through the suitable hum filtering combination comprising the resistor 105 connected in series between the conductor 21 and the plate or anode element 89, with the resistor having one terminal shunted to ground 25 by way of the shunt condenser 107 in such a way that the resistor-condenser combination serves as a hum filter.

The power amplifier tube 95 derives its input energy from connection to the sweep oscillator by way of the coupling condenser 109 and the volume control unit 112, which has one terminal connected to ground 25 and which is tapped at some intermediate point 113 to provide a connection to the control electrode 115 of the power amplifier tube 95. This power amplifier tube 95 has its cathode bias produced across cathode resistor 117.

Normally, some difficulty in vertical amplification would tend to be introduced by negative feed-back produced across the cathode bias resistor 117, which cannot be readily by-passed to ground 25 at the low frequencies involved for the vertical deflection. To this end, and in order to avoid an unusually large by-pass condenser 119 shunting the cathode bias resistor 117 in order to prevent cathode degeneration which has a tendency to cause a loss in low frequency components and thus bring about distortion, the sweep condenser 94 has one terminal thereof connected directly to the cathode element 120 of the power amplifier 95. This connection, rather than the usual connection directly to ground 25, as is provided for instance for the horizontal sweep condenser 61, avoids distortion, as will be described. The result of the connection shown relative to the vertical sweep condenser 94 and the cathode 120 of the power amplifier 95 is that the degenerative voltage drops, which are inherently produced across the cathode bias resistor 117, do not subtract from the cathode to grid voltage but rather subtract from the plate to ground voltage where no detrimental effects result. In fact, improved saw-tooth linearity is achieved even though the condenser 119 is made but a minor fraction of the size normally to be expected in order to prevent the detrimental effects of cathode degeneration.

In connection with the power amplifier 95, the plate or anode element 121 has connected in the circuit thereof a plate impedance element which is provided by way of the inductance element

123, serially connected with the variable resistor 124 through which plate voltage to the tube 95 is supplied. The variable resistance in such connection may then be adjusted, as indicated, so as to make the ratio of the inductance of the winding 123 to the resistance of the resistor 124 in the plate circuit of the tube 95 equal to the corresponding time constant of the vertical deflector coils for the tube, which coils are conventionally represented by the windings 125 and 126. To this end, the plate impedance of the power amplifier tube 95 is made as large as consistent with the plate voltage drop as, in connection with the disclosed arrangement, the ratio of the deflector current to the plate current of the tube 95 approaches unity.

In order that there may be no over-shoot and, at the same time, to provide for a smooth "fly-back" or return-trace of the scanning beam during the rapid portion of the saw-tooth, a tuning condenser 129 is preferably arranged to shunt the deflecting coils.

So that the scanning beam within the scanning or camera tube may be positioned vertically, various bleeder resistors 130, 131 and 132 connect between the high voltage conductor 21 and ground 25. The blocking condenser 133 has one terminal thereof connected to conductor 21 and the other terminal thereof tapped to one of the bleeder resistors 131.

It will be noted that the inductance 123, connected in the plate circuit of the tube 95, is shown as constituting the primary winding of a transformer 135. The secondary winding 136 of this transformer connects, by way of a conductor 137, to control the protective relay system comprising the tubes 140 and 150 and their associated circuit elements.

In any installation of the character hereinabove described, it is, as hereinabove noted, particularly desirable that the camera or image scanning tube, such as the "Orthicon," be protected against any failure of the deflecting circuits in order to prevent any possible damage to the camera tube signal plate (or mosaic) in the event of a failure of any part of the deflecting system, where a stationary or substantially stationary impacting electron beam would cause damage. To this end, the protective system, including the tubes 140 and 150, is so designed and constituted that currents cease to flow therethrough as soon as either the horizontal or the vertical sweep circuit falls below a certain predetermined output level. The system is so adjusted that, in combination with a control relay 160, the simultaneous flow of current, due to both the horizontal and vertical deflection energy, serves to trigger or operate the relay. However, if one of the deflection circuits fails, the remaining current flow is insufficient to provide the control or energization of the relay, with the result that, in the manner to be described, the "Orthicon" beam current is suppressed or blocked as soon as one or the other, or both, of the deflection circuits fails to operate.

The horizontal deflection voltage which was derived at the output of the second half of tube 45 and fed through the coupling condenser 85 and conductor 83, for instance, to the deflecting plate 59 is also supplied by way of the conductor 141 and the coupling condenser 143 across the resistor 144 to the plate element 145 of the double diode tube 140, which tube, for instance, though not necessarily, may be of the general type known in the art as the 7A6.

As was above indicated, the vertical deflection energy is inductively coupled by way of the transformer 135 and its secondary winding 136 to be supplied by the conductor 137 to the second plate or anode 147 of the double diode 140. It thus can be seen that both cathode elements 148 and 149 of the double diode 140 develop positive voltages relative to ground 25 across the condensers 151 and 152, respectively, of which the condenser 152 is larger than 151. These condensers are shunted by suitable resistor elements 154 and 155, and the time constants of the combinations are preferably adjusted to be of the order of approximately one second, which, obviously, determines the speed of response of the protective system.

The rectified voltages which appear in the output of the double diode tube 140 are connected to energize the grids or control electrodes 156 and 157 of the twin triode tube 150 through the series resistor elements 158 and 159, respectively. The twin triode tube 150 may conveniently be in the form of a 6N7 tube, although other types of tubes may be used, or two separate triodes may be used.

With the connection shown, the plate current flow in the twin triode 150 assumes a maximum value corresponding to zero grid bias which remains at substantially the same value, even under conditions where the grid control voltage across condensers 151 and 152 further increases toward a maximum predetermined voltage value.

The control relay element 160 is shown as comprising a pair of coils or windings 161 and 162 which are connected to be energized in accordance with the plate current flowing through each half of the twin triode tube 150, in that the plate or anode electrodes 163 and 164 of this tube receive operating voltage from the voltage source 22 by way of the conductors 21 and 165, respectively. The relay 160 may be of any desired type, although that known in the art as the "Western Electric twin coil unit" has been found to be satisfactory. The relay has its set-up so constituted that, for energization of each of the coils 161 and 162, the armatures 166 and 167 are so controlled that the armature 166 closes upon its contact point 168 while the armature 167 is withdrawn from its contact point 169.

The bias battery 170 (or other suitable bias source) has its positive terminal, as indicated, connected to ground 25 and its negative terminal connected through potentiometer 171 and the tapping point 173 and thence conductor 175 and resistor 176 to the terminal point 180, to which terminal point the grid or control electrode (not shown) of the "Orthicon" image scanning or camera tube is connected.

It can be seen, from the connection indicated, that the potentiometer 171 has its end terminals connected respectively to the negative terminal of the biasing source 170 and the positive terminal of the plate voltage source 22, so that now if the cathode resistor 177 of the twin triode 150 is set for a predetermined current flow through the tube, it can be appreciated that any change in the current flow permitting the armature 167 to close upon contact 169, due to a reduction of the current flowing through the winding 162, will promptly provide a short circuit of that portion of the potentiometer 171 between the point 173 and the negative terminal of the bias source 170, so that negative voltage of the source 170 becomes effective at the grid or control electrode of the camera or scanning tube, which electrode connects, as above stated, at the terminal point 180.

In the preferred circuit arrangement, the tube 150 has its plate current set by adjusting the cathode resistor 177 to a predetermined value for producing a predetermined minimum current in the event the rectifier input fails. At this current flow the relay 160 will be de-energized, in that there is not sufficient current flowing through the tube 150 to actuate it.

Accordingly, under such conditions, with the action as above expressed and the relay 160 de-energized, the relay armature 167 engages the contact point 169, so that a blocking or cut-off bias is supplied from the source 170 to the scanning tube. At the same time, the de-energization of the relay 160 permits the armature 166 to assume a position remote from the contact point 168 so that a circuit through the indicator lamp 183, which, in an energized state of the relay, had been lit by virtue of current flowing from the source 181, is broken. The illumination of the pilot lamp 183 normally is to indicate to the operator that the deflection circuits for both the horizontal deflection, as provided by the deflecting plate pair 59 and 60, and the vertical deflection, as provided by the vertical deflecting coils 125 and 126, is in a state of normal and satisfactory operation.

The remaining portion of the vertical oscillator tube 35, that is, the first half of the tube, functions to control blanking on the scanning or camera tube during the return-line, or snap-back or fly-back period of each deflection cycle, as represented, for instance, by the time duration of the line synchronizing pulses, as represented by the period marked T_H in curve *a* of Fig. 2, and also the blanking period, shown by the designation 9H in Fig. 2. However, where presently accepted standards, as recommended by the R. M. A. and the Federal Communications Commission, are adopted, the vertical blanking period is set to continue for an additional period following the 9H period of curve *a* of Fig. 2, which additional period varies according to desired parameters, so that the total blanking period in the vertical direction is at least 15.4H but not greater than 22H.

Signals for controlling blanking during the stated period are likewise produced according to prescribed standards, and suitable blanking signals are represented in the Fink publication, above cited, particularly by the diagrammatic illustrations on pages 168, 170, 171 and 399 of the said book. Also, blanking signals of the character desired for providing the blanking effect have been described in one form of their production in applicant's co-pending application, Serial No. 452,921, filed July 30, 1942, which is now issued as United States Patent No. 2,366,536, granted June 2, 1945, and also by applicant's co-pending application, Serial No. 485,982, filed May 7, 1943, and now issued as United States Patent No. 2,366,358, granted June 2, 1945.

Thus, blanking signals of this character and of a predetermined peak voltage in the positive direction are impressed at the input terminal 190 and fed through the coupling condenser 191 so as to set up, by reason of the positive peak values thereof, an automatic bias for the first half of the tube 35 across the resistor 192. The applied blanking pulses then have their positive peaks clipped to a predetermined level by means of the grid resistor 193 which is in series with the coupling condenser 191 and connects to the grid or control electrode 194 of the first half of the tube 35. It thus becomes evident that relatively strong negative blanking impulses will appear at the plate or anode electrode 195 of the tube 35, in that the cathode element 196 connects directly to ground 125 and no degeneration takes place.

Accordingly, these strong negative blanking impulses, due to amplification in the first half of tube 35, are supplied by way of the condensers 199 and 197 to the output terminal 180, wherefrom they are supplied to the grid or control electrode of the scanning or camera tube (not shown) along with the bias voltages.

It will be noted that the volume control arrangement provided by the potentiometer 171, and its tapping point 173, provides the voltage for bias on the scanning or camera tube as flowing through the resistor 176 which forms one part of the load impedance of the first half of the tube 35, but whenever the relay coil 162 of the relay 160 becomes de-energized, by reason of a reduction in current flow in the tube 150, the complete blocking voltage of the bias source 170 is applied also at the terminal point 180, since the closure of the armature 167 on contact 169 short circuits a part of potentiometer 171 and makes the voltage of the source 170 effective as a negative bias at the output terminal.

It has been above suggested that the deflecting plate pair 59 and 60 functions to produce the line scanning which was stated to be in the horizontal direction. It was also stated that the deflecting coils 125 and 126 would produce the field or frame scanning which was stated to be in the vertical direction.

It is, of course, to be understood that these references are merely illustrative and, if it is desired to have the line scanning in the vertical direction and the field or frame scanning in the lateral direction, that is, each normal to the presently accepted directions, the system herein disclosed will function equally as well when it is borne in mind that the deflecting plate pair 59 and 60 functions to produce the rapid scanning, and the deflecting coils 125 and 126 function to produce the slower field or frame scanning and are each, broadly speaking, independent of limitations as to whether they occur in the vertical or the horizontal directions.

Many modifications of the described arrangement will, of course, be possible, and it is to be understood that within the scope of the disclosure many and various modifications may be utilized.

Having now described the invention, what is claimed is:

1. In a deflection circuit for television apparatus responsive to a signal energy received from a source whereat intermingled energy pulses of different time duration for relatively high frequency line and relatively low frequency field deflection control are developed, a clipper tube means to establish an equal amplitude level for all said received pulses, a pair of oscillators for developing saw-tooth voltage waves of frequencies closely approximating the frequencies of the different energy pulses, signal separator means for separating the high frequency line and the low frequency field energy pulses to develop line and field synchronizing control pulses, said line pulse separating means including a high pass filter and a coupling tube for energizing said filter, and means to control the frequency of the oscillator developing output energy at substantially the line frequency from the output of the high pass filter, said field pulse separating means including a sec-

ond clipper tube, a time discriminator circuit comprising a high pass filter to couple the first said clipper tube to the said second clipper tube and a low pass filter to connect the current output of the second clipper tube into the field frequency oscillator, and means to control the frequency of said field frequency oscillator, a power stage connected to be energized from each oscillator to develop substantially undistorted saw-tooth wave energy output for controlling the deflection of a cathode ray beam.

2. A signal separating circuit for separating intermingled signal energy pulses of different time duration comprising an input clipper tube, a time discriminating network and a second clipper tube connected to receive the output signals from the time discriminating network, and means for applying an automatic bias upon second clipper tube in proportion to the average pulse current passing through the second clipper tube to follow the signal strength variations of the signal energy pulses to be separated.

3. A signal separating circuit for separating intermingled signal energy pulses of different time duration comprising an input clipper tube, a time discriminating network including a high pass filter and a second clipper tube connected to receive the output signals from the time discriminating network, and means for applying an automatic bias to the second clipper tube to follow the signal strength variations of the signal energy pulses to be separated.

4. A signal separating circuit for separating intermingled signal energy pulses occurring at different rates comprising a first and a second clipper tube, and a time discriminating network to couple the output of the first clipper tube to the input of the second clipper tube, said time discriminating network having a time constant of a value intermediate the time duration of the two groups of energy pulses to be separated.

5. A driving circuit for a deflection oscillator responsive to controlled signal energy impulses of predetermined time separation and duration comprising a cathode follower triode, a differentiating network having a time constant shorter than the shortest occurring control pulse duration, and an oscillator tube connected to be controlled as to its frequency of oscillation by the said differentiating network, said cathode follower triode being connected to energize the differentiating network and to prevent reaction from the line oscillator upon the signal source.

6. A driving circuit for a relatively low frequency oscillator for controlling the deflection of a cathode ray beam which comprises a source of low-frequency pulse currents, an integrating low pass filter circuit comprising capacity and resistance elements connected to respond to the said low-frequency pulse currents, an inductive feed-back saw-tooth oscillator tube in the grid circuit of which a saw-tooth voltage wave appears, and means for connecting the pulse source of current to both the plate of the oscillator tube and the integrating network in parallel with one of the inductive feed-back elements of the oscillator, said integrating network inductive element having a time constant oscillatory period comparable to the repetition frequency of energy impulses controlling the more rapid rate of deflection.

7. A driving circuit for a relatively low frequency oscillator for controlling the deflection of a cathode ray beam which comprises a source of low frequency pulse currents, an integrating low pass filter circuit comprising at least a capacity element connected to respond to the said low frequency pulse currents, an inductive feed-back saw-tooth oscillator tube in the grid circuit of which a saw-tooth voltage wave appears, and means for connecting the pulse source of current to both the plate of the oscillator tube and the integrating network in parallel with one of the inductive feed-back elements of the oscillator, said integrating network inductive element having a time constant oscillatory period comparable to the repetition frequency of energy impulses controlling the more rapid rate of deflection.

8. A deflecting circuit for deflecting an electron beam within a cathode ray tube which comprises a power amplifier tube, means for establishing an automatic cathode bias on said tube, a capacitive means across which a saw-tooth voltage wave is developed, an oscillator for controlling the frequency of the saw-tooth voltage wave, and means for connecting the said capacity element in parallel with the grid cathode path of the said power amplifier.

9. A deflecting circuit for deflecting an electron beam within a cathode ray tube which comprises a power amplifier tube, means to establish an automatic cathode bias on said tube, a source of saw-tooth voltage, an oscillator for controlling the frequency of the saw-tooth voltage wave, and means for connecting the said source of saw-tooth voltage in parallel with the grid and cathode path of the said power amplifier.

10. A vertical deflecting circuit for a cathode ray device comprising a power amplifier tube having a control grid and a cathode, a parallel condenser and resistance combination connected between the cathode element of said tube and ground to provide grid bias on the said tube, a source of saw-tooth voltage connected between the grid and cathode of said tube, oscillator means for controlling the frequency of the developed saw-tooth voltage, and a load circuit for said tube.

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The following references are of record in the file of this patent:

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Disclaimer

2,425,491.—*Kurt Schlesinger*, West Lafayette, Ind. DEFLECTION CIRCUIT. Patent dated Aug. 12, 1947. Disclaimer filed June 22, 1950, by the assignee, *Radio Corporation of America.*

Hereby enters this disclaimer to claims 8, 9, and 10 of said patent.

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