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A. V. LOUGHREN

2,308,375

TELEVISION SYNCHRONIZING SYSTEM

Filed March 27, 1940

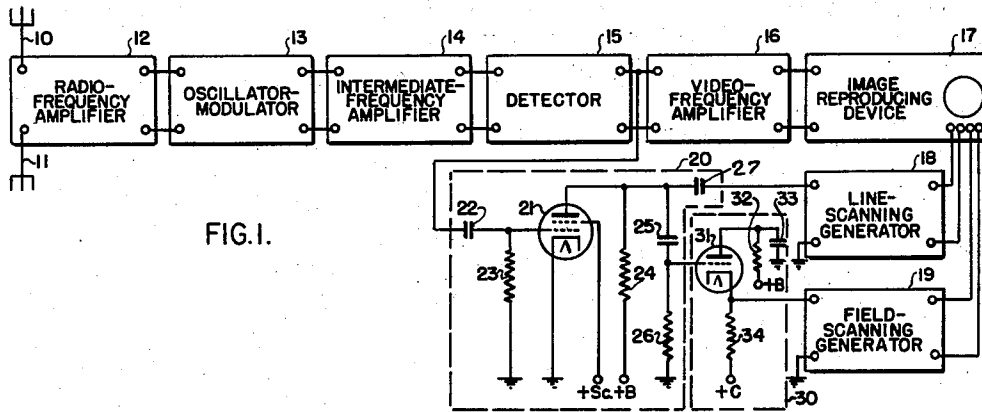


FIG. 1.

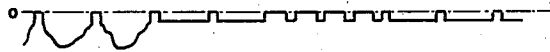


FIG. 2.

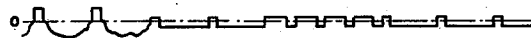


FIG. 3.

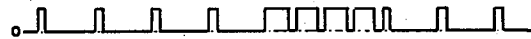


FIG. 4.

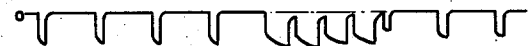


FIG. 5.



FIG. 6.

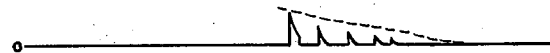


FIG. 7.

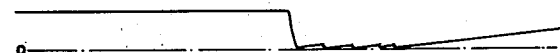


FIG. 8.

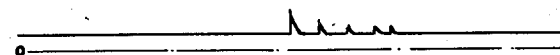


FIG. 9.

INVENTOR
ARTHUR V. LOUGHREN

BY *Lawrence B. Dodds*
ATTORNEY

UNITED STATES PATENT OFFICE

2,308,375

TELEVISION SYNCHRONIZING SYSTEM

Arthur V. Loughren, Great Neck, N. Y., assignor
to Hazeltine Corporation, a corporation of Dela-
ware

Application March 27, 1940, Serial No. 326,163

10 Claims. (Cl. 178—7.5)

This invention relates to television systems and is especially concerned with the provision of an improved means for effecting synchronization of television scanning apparatus.

In accordance with present television practice, there is developed and transmitted a signal which comprises a carrier wave modulated during successive intervals or trace periods by video components representative of the light and shade values of an image being transmitted. During retrace intervals between the trace periods, the carrier wave is modulated by synchronizing pulses or components which correspond to the initiation of successive lines and fields in the scanning of the image. At the receiver, a beam is so deflected as to scan and illuminate a target in a series of fields of parallel lines. The video components of the received signal are utilized to control the intensity of the beam. The line-scanning and field-scanning components are separated from the video components and from each other and utilized to synchronize the operation of the receiver line-scanning and field-scanning apparatus with the similar scanning apparatus utilized at the transmitter in developing the signal. The transmitted image is thereby reconstructed on the target of the receiver.

Various types of television scanning and synchronizing apparatus have heretofore been proposed. The type of synchronizing-signal separating apparatus which is required ordinarily depends upon the type of television signal employed and the type of scanning utilized. For example, in interlaced scanning systems certain of the field-synchronizing pulses generally occur with different time relation to the line-synchronizing pulses than others. In order that line-synchronizing and field-synchronizing pulses may be readily separated from the video components and from each other for utilization, various types of synchronizing signals and separating apparatus have been proposed. For example, there have been proposed synchronizing signals in which the field-synchronizing impulses are of greater amplitude or of longer duration than the line-synchronizing impulses and separating apparatus comprising amplitude-discriminating or integrating circuits. Such arrangements, however, have been found to be subject to various objections, such as instability, requiring an undesirably large portion of the total carrier amplitude and involving relatively complicated separating apparatus.

In copending application Serial No. 196,885, filed March 19, 1938, applicant has disclosed an

improved method of, and means, for effecting scanning synchronization in a television system which overcomes the above-mentioned disadvantages of the prior art. In accordance with the invention of applicant's copending application, there is provided a television synchronizing system adapted to be energized by a composite synchronizing signal including line-synchronizing pulses and field-synchronizing pulses of the same polarity as, but of greater duration than, the line-synchronizing pulses. The system comprises means responsive to the leading edges of the line-synchronizing pulses and to the duration and trailing edges of the field-synchronizing pulses for deriving line-synchronizing and field-synchronizing pulses of opposite polarities. A line-synchronizing circuit is provided which is individually responsive to the derived line-synchronizing pulses and a field-synchronizing circuit is provided which is individually responsive to the derived oppositely poled field-synchronizing pulses.

While the arrangement of applicant's copending application has been continuously used since the date of invention thereof and has been found generally satisfactory, experience has indicated that it is desirable to provide a circuit which has all of the advantages of the arrangement of the above-mentioned copending application but which is effective to provide an improved performance in one particular respect. In the arrangement of applicant's copending application and in other prior art arrangements, the field-scanning generator is adapted to be synchronized at the trailing edge of the first broad pulse of the field-synchronizing signal. However, the succeeding broad pulses of the field-synchronizing signal specified by the Standards of the Radio Manufacturers Association may fire the field-scanning generator in case it is not fired by the first broad pulse. Therefore, an improper operation of the synchronizing-signal separator or misadjustment of the field-scanning generator may cause the generator to trip at a later point in the field-synchronizing signal. Such operation would not be particularly objectionable if it were a steady operating condition. In practice, however, the operation is altered or modified by other factors, such as line-synchronizing signals, residual cross-talk from the line-scanning generator to the field-scanning generator, noise pulses, etc., so that proper interlace may not be obtained unless all fields of the frame trip at substantially the same point in the field-synchronizing signal. Under such conditions the reconstructed image

would be inferior though intelligible and the viewer would be unlikely to know the cause or be able to correct the defect; under such conditions, it may be considered preferable to destroy the intelligibility of the image, as by interrupting the field-synchronizing pulses, thereby forcing the viewer to have the defect corrected.

It is an object of the invention, therefore, to provide an improved means for effecting scanning synchronization in a television system which will overcome the above-mentioned disadvantages of the arrangements of the prior art.

It is another object of the invention to provide an improved means for effecting scanning synchronization in a television system such that the field-scanning generator is fired at a predetermined point in the field-synchronizing signal or is not fired at all by the received field-synchronizing signal during that field-blockout interval.

In accordance with the present invention, a television synchronizing system adapted to be energized by a synchronizing signal including a group of field-synchronizing pulses of the same polarity during each field-blockout interval of the system comprises means responsive to the above-mentioned groups of pulses for deriving field-synchronizing pulses individually corresponding to the pulses of the groups, and means or rendering the above-mentioned means effectively unresponsive to all pulses of the groups other than the first pulse of each group. A field-scanning circuit is provided which is responsive to the derived field-synchronizing pulses.

In accordance with a preferred embodiment of the invention, the means for rendering the system unresponsive to any except the first pulse of each group is responsive to the first pulse of each group and, further in accordance with this embodiment of the invention, this means is responsive to the duration and trailing edge of the first pulse of each group.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the accompanying drawing, Fig. 1 is a circuit diagram, partly schematic, of a complete television receiving apparatus embodying the invention; while Figs. 2-9, inclusive, are graphs illustrating the wave forms of periodic current or voltage waves developed at different points of the system of Fig. 1 to aid in the understanding of the invention.

Referring now more particularly to Fig. 1, the system there illustrated comprises a receiver of the superheterodyne type including an antenna system 10, 11 connected to a radio-frequency amplifier 12, to which there are connected in cascade, in the order named, an oscillator-modulator 13, an intermediate-frequency amplifier 14, a detector 15, a video-frequency amplifier 16, and an image-reproducing device 17, preferably of the cathode-ray tube type. A line-scanning generator 18 and a field-scanning generator 19 are also coupled to the output of detector 15 by way of suitable synchronizing-signal separating apparatus indicated generally at 20 and to the scanning elements of image-reproducing device 17, the field-scanning generator 19 being coupled to unit 20 through a unit 30. The stages or units 12-19, inclusive, may all be of conventional well-known construc-

tion so that detailed illustrations and descriptions thereof are unnecessary herein.

Referring briefly to the general operation of the system just described, television signals intercepted by the antenna circuit 10, 11 are selected and amplified in the radio-frequency amplifier 12 and supplied to the oscillator-modulator 13 wherein they are converted to intermediate-frequency signals which, in turn, are selectively amplified in the intermediate-frequency amplifier 14 and delivered to the detector 15. The modulation components of the signal are derived by the detector 15 and are supplied to the video-frequency amplifier 16 wherein they are amplified and, from which they are supplied to a brilliancy-control electrode of image-reproducing device 17. The intensity of the scanning beam of image-reproducing device 17 is thus modulated or controlled in accordance with the video-frequency voltages impressed upon its control electrode in the usual manner. The modulation components are also supplied to the apparatus 20 wherein synchronizing components are separated from the video-frequency components and the line-synchronizing and field-synchronizing pulses are effectively separated from each other, as further explained hereinafter, and applied to the generators 18 and 19, respectively. Saw-tooth current or voltage scanning waves are generated by the line-scanning and field-scanning generators 18 and 19 which are controlled by the synchronizing pulses supplied from the apparatus 20 and these scanning waves are applied to the scanning elements of image-reproducing device 17 to produce scanning fields, thereby to deflect the scanning beam in two directions normal to each other so as to trace successive interlaced fields of parallel lines on the screen of the image-reproducing device to reconstruct the transmitted image.

Unit 20 comprises the synchronizing-signal separating apparatus of applicant's copending application for the purpose of effectively separating the line-synchronizing and field-synchronizing pulses from the video components and from each other so that they may be separately applied to generators 18 and 19 free from mutual interference. Thus, the apparatus 20 comprises a tetrode vacuum tube 21 having its control grid coupled to the output of the detector 15 by way of a suitable coupling condenser 22 and grid-leak resistor 23. The condenser 22 and the resistor 23 are such as to have a time constant relatively long compared to the period of the positive line-synchronizing pulses translated from the detector 15 and the value of resistor 23 is high compared to the grid-cathode resistance of the tube 21 when the grid is positive. A load resistor 24 is included in the anode circuit of the tube 21 and operating potentials are supplied to the anode of the tube by way of this resistor and directly to the screen from suitable sources indicated as +B and +Sc, respectively. The screen potential is relatively low so that the video components of the signal received from the detector 15 are well below the grid potential corresponding to anode current cutoff.

A differentiating circuit including a condenser 25 in series with a resistor 26 is also included in the anode circuit of tube 21 in parallel with the resistor 24. The elements 25 and 26 are proportioned to have a time constant which is appreciably greater than the duration of the line-synchronizing pulses but not appreciably greater

and preferably less than, the duration of the field-synchronizing pulses. The input circuit of the line-scanning generator 18 is connected across resistor 24 by way of a suitable coupling condenser 27 while the input circuit of the field-scanning generator is connected across resistor 26 through a unit 30 in accordance with the present invention. The generators 18 and 19 may, as stated above, be of any well-known suitable design and in the present case are adapted to be synchronized by negative and positive synchronizing pulses, respectively.

Neglecting for the moment the operation of the unit 30, the operation and results obtained by the system just described may be best understood by reference to the curves of Figs. 2-6, inclusive, of the drawing. Assuming a modulated-carrier wave to have been detected by the detector 15, the modulation signal developed in its output circuit and impressed upon the input circuit of the tube 21 is of a form such as is shown by the curve of Fig. 2. The grid condenser 22 and leak resistor 23 serve so to vary the bias on the control grid of this tube which, in the absence of the signal, is provided with zero bias, that the signal is stabilized, ensuring that the peaks of the synchronizing impulses are at a substantially fixed level as impressed on the control grid. Where the connection between the grid of tube 21 and the detector 15 is substantially a direct one, so that the unidirectional component of the signal is not lost, the signal may be sufficiently stabilized without employing the grid leak 23 and condenser 22. Where a nonconductive coupling, such as condenser 22, intervenes between the detector and the tube 21, however, the signal tends to center itself about its alternating current zero axis and thus to appear as illustrated by the curve of Fig. 3. In this case, therefore, the stabilizing circuit is required.

The grid-bias circuit of the tube 21 and its characteristics are also preferably such as to cause the video-frequency portion of the signal to be cut off or limited so that the wave form of the current in the anode circuit of the tube 21 is as illustrated by the curve of Fig. 4. Due to the high resistance of the tube 21, the voltage developed across the resistor 24 is of substantially the same wave form as the anode current but of reversed polarity, as represented by the curve of Fig. 5, including negatively-poled synchronizing pulses. These pulses are applied through condenser 27 to the synchronizing circuit of the line-scanning generator 18, which, as stated above, is responsive to negatively-poled synchronizing pulses, and are effective to synchronize the operation of this generator with corresponding apparatus at the transmitter in the conventional manner.

The differentiating circuit, including the condenser 25 and resistor 26, is responsive to the duration as well as the trailing edges of the pulses impressed thereacross. The alternating component of the voltage across this circuit is the same as that developed across the resistor 24, as shown in Fig. 5. During the intervals between the pulses of the impressed voltage, the condenser 25 becomes charged to the steady value of this voltage, its charging current falling to zero so that there is no voltage across the resistor 26. Upon the occurrence of the leading edge of an impressed voltage pulse, this sudden voltage transient is passed by the condenser 25 and appears entirely across the resistor 26. For the duration of this pulse, the condenser discharges but at a decreasing rate so that the discharge

current and the voltage across the resistor 26 decrease exponentially. At the trailing edge of the impressed voltage pulse, the condenser again passes this voltage transient, which appears entirely across resistor 26 and the condenser 25 again begins to charge exponentially to its steady-state value. Due to the fact that condenser 25 has discharged only slightly during the short pulse, the transient across resistor 26 comprising the trailing edge of the pulse reverses polarity but the amplitude of the reverse value is very small. As the condenser 25 recharges exponentially to its steady-state value, the voltage across the resistor 26 again decreases exponentially to zero. Upon the occurrence of a relatively long duration field pulse, the condenser 25 discharges substantially and the voltage pulse across resistor 26 of reverse polarity, developed at the trailing edge of the field pulse, is of substantial amplitude. The voltage appearing across the resistor 26, therefore, is of the wave form illustrated by the curve of Fig. 6 including positively-poled field-synchronizing pulses initiating at the trailing edges of the corresponding pulses of the wave impressed upon the input circuit of the tube 21 and of an amplitude dependent upon the duration of such pulses.

It will be appreciated that exact synchronization is unnecessary. With conventional line-scanning systems of the type employing 441 lines for each complete picture of two fields and with a 60-cycle field-scanning frequency, the permissible error is of the order of 0.05 per cent of the respective scanning cycle. The field-synchronizing pulses developed as just described are within this limit and entirely satisfactory.

The positive pulses developed in the manner just described are translated to and utilized by the synchronizing circuit of the field-scanning generator 19 to synchronize the operation thereof with the scanning apparatus at the transmitter, these pulses being applied to field-scanning generator 19 through apparatus 30 in accordance with the invention and in a manner to be hereinafter fully described.

It is noted, however, that the trailing edge of each of the group of field-synchronizing pulses of Fig. 4 provides a pulse in the curve of Fig. 6 which is of substantially the same amplitude so that an improper operation of the synchronizing-signal separator or a misadjustment of the field-scanning generator 19 may cause it to trip on a derived pulse other than the first one. In order to prevent this type of operation, applicant has provided unit 30 in accordance with the present invention. The unit 30 includes means responsive to the groups of pulses for deriving field-synchronizing pulses individually corresponding to the pulses of the groups, which means comprises a vacuum tube 31 having an input circuit coupled across resistor 26 and an output circuit including a resistor 32 through which a unidirectional operating potential $+B$ is supplied. The anode of tube 31 is grounded by condenser 33 while there is included in the cathode circuit of tube 31 a load resistor 34 to which is coupled a second source of unidirectional operating potential $+C$ for tube 31 and across which is coupled the input circuit of field-scanning generator 19.

The voltage $+C$ is so chosen that tube 31 is operated beyond cutoff in the absence of derived input field-synchronizing pulses from resistor 26, as represented by the curve of Fig. 6. The unidirectional anode-cathode resistance R_{31} of tube 31 is so chosen that the discharge time constant

R_{31} C_{33} of tube 31 and condenser 33 is small and preferably less than the duration T_1 of one of the derived positive field-synchronizing pulses of the curve of Fig. 6. In the system described, T_1 is about 5 microseconds and R_{31} C_{33} should not exceed more than about half this value if succeeding pulses are to be adequately suppressed. In a preferred embodiment of the invention, R_{31} is about 30 kilohms and C_{33} is about 90 micro-microfarads. R_{32} must be made large to make the charging time constant R_{32} C_{33} , when tube 31 is nonconductive, long compared to the interval between pulses; in the embodiment of the invention specifically described, R_{32} preferably has a value of 5 megohms which results in a charging time constant of 450 microseconds or about 6 lines. As will be described more fully hereinafter, this proportioning of the time constants of resistor 32 and condenser 33 provides means for rendering tube 31 effectively unresponsive to all pulses of the groups other than the first pulse of each group. R_{34} must be made sufficiently high to permit a proper synchronizing-pulse voltage to be developed thereacross but should not be sufficiently large to affect the time constants of the system.

Reference is made to the curves of Figs. 6-9, inclusive, for a description of the operation of the circuit of unit 30. The solid curve of Fig. 6 thus represents the voltage applied to the grid of tube 31 while the top dotted line of Fig. 6 represents the cutoff point of this tube so that only pulses which extend above this line are effective to fire tube 31. The anode current of tube 31 in response to the applied voltage represented by the curve of Fig. 6 is illustrated by the curve of Fig. 7 which results in an anode voltage as represented by the curve of Fig. 8; that is, upon the occurrence of the first derived synchronizing pulse of Fig. 6, condenser 33 is rapidly and substantially discharged and, in one embodiment, may be substantially completely discharged, and, due to the long charging time constant R_{32} C_{33} , it does not charge up to an appreciable potential during the succeeding field-synchronizing pulses so that they cannot result in succeeding discharge pulses of appreciable amplitude. The voltage across resistor 34 in response to this excitation is illustrated by the curve of Fig. 9. It will be understood that, if field-synchronizing pulses of opposite polarity of those of Fig. 9 are acceptable, resistor 34 may be included in the anode circuit of tube 31 in series with condenser 33. It is seen that a positive impulse is applied to field-scanning generator 19 at a time coincident with the trailing edge of the first field-synchronizing pulse of the group of field-synchronizing pulses illustrated by the curve of Fig. 4 and that all other field-synchronizing pulses of the group are effectively suppressed by being substantially reduced in amplitude.

The sensitivity curve during the field-blockout interval of the field-scanning generator 19 to the derived field-synchronizing pulses is represented by the dotted curve of Fig. 7. It is seen that the first derived pulse is sufficient to cause the generator 19 to fire, but that the succeeding derived pulses decrease in amplitude at a rate faster than the sensitivity curve of field generator 19 decreases so that only the first derived pulse is of sufficient amplitude to cause the field generator 19 to fire. It will be understood that, if condenser 33 is substantially completely discharged by the first pulse during a field-block-

out interval, the derived pulses succeeding the first derived pulse will be of the same amplitude and will all be of insufficient amplitude to fire the field-scanning generator 19. By this arrangement, therefore, the field-scanning generator is fired only by the first broad pulse during a field-blockout interval or is not fired at all during that interval.

While there has been described what is at present considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A television synchronizing system adapted to be energized by a synchronizing signal including a group of field-synchronizing pulses of the same polarity during each field-blockout interval of the system comprising, means responsive to said groups of pulses for deriving field-synchronizing pulses individually corresponding to the pulses of said groups, means for rendering said first-mentioned means effectively unresponsive to all pulses of said groups other than the first pulse of each group, and a field-scanning circuit responsive to said derived field-synchronizing pulses.

2. A television synchronizing system adapted to be energized by a synchronizing signal including a group of field-synchronizing pulses of the same polarity during each field-blockout interval of the system comprising, means responsive to said groups of pulses for deriving field-synchronizing pulses individually corresponding to the pulses of said groups, means responsive to the first pulse of each of said groups of pulses for rendering said first-mentioned means effectively unresponsive to all pulses of said groups other than the first pulse of each group, and a field-scanning circuit responsive to said derived field-synchronizing pulses.

3. A television synchronizing system adapted to be energized by a synchronizing signal including a group of field-synchronizing pulses of the same polarity during each field-blockout interval of the system comprising, means responsive to the duration and trailing edges of the pulses of said groups of pulses for deriving field-synchronizing pulses individually corresponding to the pulses of said groups, means for rendering said first-mentioned means effectively unresponsive to all pulses of said groups other than the first pulse of each group, and a field-scanning circuit responsive to said derived field-synchronizing pulses.

4. A television synchronizing system adapted to be energized by a synchronizing signal including a group of field-synchronizing pulses of the same polarity during each field-blockout interval of the system comprising, a vacuum-tube repeater having an input circuit adapted to be energized by said synchronizing signal and having an output circuit including a high resistance element connected directly in parallel with a capacitance element and low resistance element in series for deriving field-synchronizing pulses individually corresponding to the pulses of said groups, means for rendering said field-synchronizing pulse-deriving means effectively unresponsive to all pulses of said groups other than the first pulse of each

group, and a field-scanning circuit responsive to said derived field-synchronizing pulses.

5. A television synchronizing system adapted to be energized by a synchronizing signal including a group of field-synchronizing pulses of the same polarity during each field-blockout interval of the system comprising, means responsive to said groups of pulses for deriving field-synchronizing pulses individually corresponding to the pulses of said groups, means including a condenser having a time-constant circuit so proportioned that its charge is changed in one sense in response to the first pulse of each of said groups of pulses and a time-constant circuit so proportioned that its charge is substantially changed in the other sense between succeeding ones of said first pulses for rendering said first-mentioned means effectively unresponsive to all pulses of said groups other than the first pulse of each group, and a field-scanning circuit responsive to said derived field-synchronizing pulses.

6. A television synchronizing system adapted to be energized by a synchronizing signal including a group of field-synchronizing pulses of the same polarity during each field-blockout interval of the system comprising, means including a vacuum tube responsive to said groups of pulses for deriving field-synchronizing pulses individually corresponding to the pulses of said groups, means for rendering said vacuum tube effectively unresponsive to all pulses of said groups other than the first pulse of each group, and a field-scanning circuit responsive to said derived field-synchronizing pulses.

7. A television synchronizing system adapted to be energized by a synchronizing signal including a group of field-synchronizing pulses of the same polarity during each field-blockout interval of the system comprising, means including a vacuum tube having a time-constant anode circuit including a series-connected resistor and condenser for deriving field-synchronizing pulses individually corresponding to the pulses of said groups, means for rendering said vacuum tube effectively unresponsive to all pulses of said groups other than the first pulse of each group, and a field-scanning circuit responsive to said derived field-synchronizing pulses.

8. A television synchronizing system adapted to be energized by a composite synchronizing signal including line-synchronizing pulses and a group

of field-synchronizing pulses of the same polarity during each field-blockout interval of the system comprising, means for effectively separating said field-synchronizing pulses from said line-synchronizing pulses, means coupled to said separating means and responsive to said groups of pulses for deriving field-synchronizing pulses individually corresponding to the pulses of said groups, means for rendering said last-mentioned means effectively unresponsive to all pulses of said groups other than the first pulse of each group, and a field-scanning circuit responsive to said derived field-synchronizing pulses.

9. A television synchronizing system adapted to be energized by a composite synchronizing signal including line-synchronizing pulses and a group of field-synchronizing pulses of the same polarity as said line-synchronizing pulses occurring during each field-blockout interval of the system comprising, means responsive respectively to said line-synchronizing pulses and to the duration and trailing edges of said groups of pulses for deriving line-synchronizing pulses of one polarity and field-synchronizing pulses individually corresponding to the pulses of said group and of opposite polarity, means for rendering said field-synchronizing pulse-deriving means unresponsive to all pulses of said groups other than the first pulse of each group, and line-scanning and field-scanning circuits individually responsive to said oppositely-poled line-synchronizing and field-synchronizing derived pulses.

10. A television synchronizing system adapted to be energized by a field-synchronizing signal including a group of field-synchronizing pulses of the same polarity during each field-blockout interval of the system comprising, means responsive to said groups of pulses for deriving field-synchronizing pulses corresponding to said group, a field-scanning circuit having a synchronizing sensitivity which decreases during the field-blockout interval of the system, means for causing said derived field-synchronizing pulses to decrease at a faster rate than said sensitivity of said field-scanning circuit decreases, and means for applying said derived field-synchronizing pulses to said field-scanning circuit to synchronize said field-scanning circuit only by the first of said derived pulses during a given field-blockout interval.

ARTHUR V. LOUGHREN.

CERTIFICATE OF CORRECTION.

Patent No. 2,308,375.

January 12, 1943.

ARTHUR V. LOUGHREN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 5, second column, line 27, claim 9, after "means" insert --effectively--; line 39, claim 10, for "corresponding to said group" read --individually corresponding to the pulses of said groups--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 6th day of April, A. D. 1943.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)