Oct. 3, 1944. S. W. SEELEY 2,359,447

ELECTRICAL CIRCUIT

Filed June 20, 1942

Fig. 2.

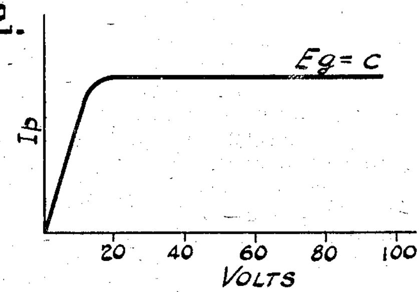
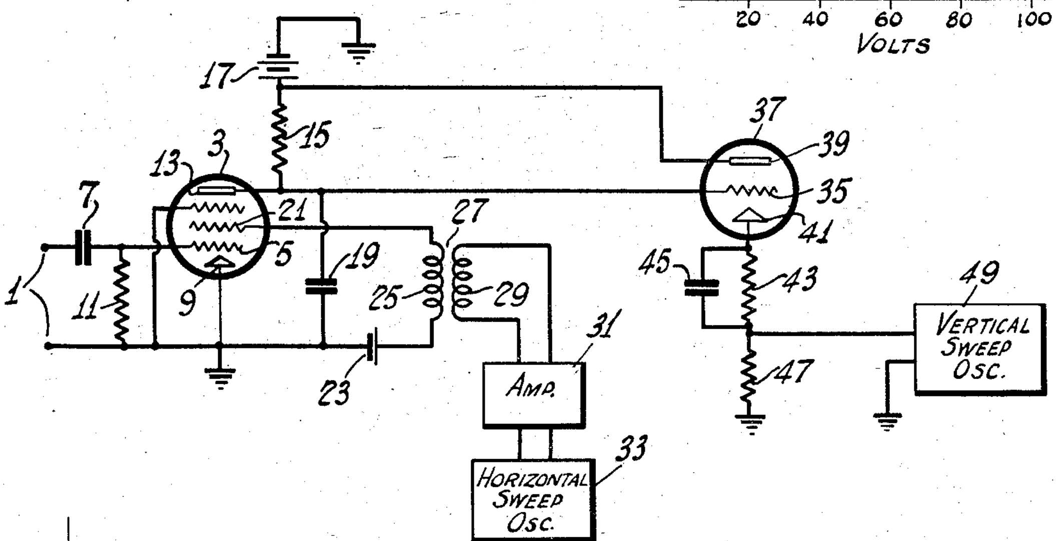


Fig. 1.



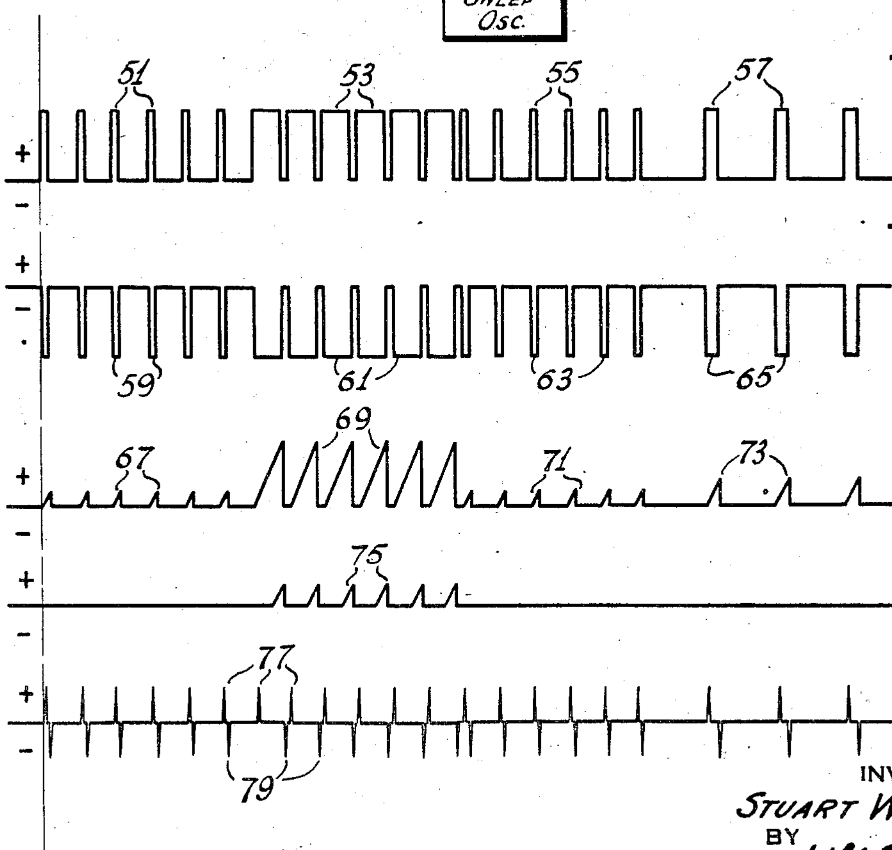


Fig. 3a.

Fig. 3b.

Fig. 3c.

Fig. 3d.

Fig. 3e.

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Patented Oct. 3, 1944 2,359,447

UNITED STATES PATENT OFFICE

2,359,447

ELECTRICAL CIRCUIT

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Application June 20, 1942, Serial No. 447,780

9 Claims. (Cl. 178—69.5)

This invention relates to synchronizing methods and apparatus and, more particularly, to a method for segregating the individual components of a composite signal representing a plurality of different types of synchronizing signals.

In many instances it is necessary to supply synchronizing signals of divers types to apparatus, each type of synchronizing signal having one or more special characteristics. Often it is necessary to supply these signals over a single channel, and for this purpose a composite signal made up of the various types of synchronizing signals is transmitted over the single channel and then separated into its individual components at the apparatus. Of such equipment, a television receiver is an example.

In a television receiver it is necessary to supply both a vertical synchronizing signal and a horizontal synchronizing signal. The vertical synchronizing signal serves to control the speed of scanning in the vertical direction, while the horizontal synchronizing signal serves to control the speed of scanning in the horizontal direction. In order to economize with respect to the frequency spectrum in television systems, it is the practice to transmit both the vertical and horizontal synchronizing signals over a single channel, and to distinguish one synchronizing signal from the other, it is usual to make the vertical synchronizing pulse of a longer time duration than the horizontal synchronizing pulse with both pulses having substantially the same amplitude. Thus the problem is then to distinguish between signals whose time durations are of different orders and to separate the signals so that each signal may serve to control its own appropriate circuit.

In the past, filtering arrangements have been used utilizing the difference in frequency of the vertical and horizontal synchronizing pulses and included tuned circuits, so that the response would be of considerable magnitude for the signal desired to be extracted and substantially zero for the undesired signal. Alternatively, integrating circuits, together with differentiating circuits, have been used to separate the vertical from the horizontal pulses. All of these arrangements require rather complicated circuit arrangements and, moreover, many such circuits of the prior art do not have optimum operating characteristics from the standpoint of signal selection and separation.

By my invention I provide a very simple separating or segregating circuit which is, broadly speaking, based upon a method and principle of converting the synchronizing pulses of varying time duration into energy pulses of varying amplitude with the amplitude of the pulses being substantially proportional to the time duration of the synchronizing signal. Thus there results a series of pulses having high and low amplitudes. These pulses may then be passed through a threshold limiter which passes only those pulses whose amplitude exceeds a predetermined value. The passed impulses will, therefore, be representative of the pulses having the longer time duration. At the same time, by utilizing an inductive reactance, pulses are derived each time the slope of the original pulses changes abruptly. The resultant pulses will form two sets of pulses, one of positive polarity representing the leading edges of the synchronizing signals, and one of negative polarity representing the lagging edges of the synchronizing pulses. The sets can be separated by an amplitude selector or threshhold keyer so that only the positive pulses, for example, are passed, or the positive pulses, for example, may be used directly to control the periodicity of the synchronizing equipment, provided the synchronizing equipment becomes operative only upon receipt of the positive pulses.

It is thus the main object of my invention to provide a new synchronizing impulse separator.

Another object of my invention is to provide a method and means for segregating individual components of a composite signal where the individual components differ from each other in time duration.

Another object of my invention is to provide a synchronizing signal separator suitable for use in a television receiver.

Another object of my invention is to convert signals of substantially constant amplitude, whose duration with respect to time varies, into signals having variable amplitude and in which the amplitude is substantially proportional to the time duration of the original signals and utilizing the difference in amplitude for separation.

Other objects of my invention will become immediately apparent upon reading the following detailed description in which reference will be made to the drawing.

In the drawing,

Figure 1 shows schematically a circuit arrangement embodying the principles of my method and apparatus for separating longer impulses from shorter impulses.

Figure 2 is a graph showing the relationship existing in a screen grid tube between plate voltage and plate current.

While Figures 3*a* through 3*e* are graphical representations of the composite signal and the various wave forms generated in separating the synchronizing signals.

Turning now to Figure 1, and assuming merely for purposes of illustration that it is desired to separate horizontal and vertical synchronizing signals in a television receiver, the synchronizing signals, following separation from the picture signals by means well known in the art, are applied to the input terminals **1** of the tube **3**. The separated synchronizing signals are fed to the control grid **5** through condenser **7** and the control grid return path to the cathode **9** is through the resistor **11**. The plate or anode **13** of the tube **3** is energized through the resistor **15** from a source of voltage **17**. Connected between the common junction point of the resistor **15** and the plate **13** is a condenser **19** which is connected to be charged relative to ground from the voltage source **17**. Suitable operating voltage is supplied to the screen grid **21** from a source **23** through the primary **25** of the transformer **27**. Energy induced into the secondary winding **29** of the transformer **27** is fed to a suitable amplifier **31**, and the output of the amplifier controls the operation and periodicity of the horizontal sweep oscillator **33**. The control grid **35** of the tube **37** is connected to the junction of the condenser **19** and the plate **13** of tube **3**. The plate **39** of the tube **37** is also supplied with potential from the source **17**. The cathode **41** is returned to ground through the resistor **43** shunted by the condenser **45**, the parallelly connected elements being connected in series with a resistor **57**. The vertical oscillator **49** is connected to the junction point of the resistors **43** and **47**.

Assuming that it is desired to separate synchronizing signals, such as is used in television, I have shown in Figure 3*a* the portion of the standard synchronizing wave form which shows the composite vertical and horizontal signals and includes six initial double frequency pulses **51**, six slotted vertical impulses **53** of much longer duration, six equalizing pulses **55** of double frequency having the same duration as the impulses **51**, and the horizontal synchronizing impulses **57**. Upon separation of these synchronizing impulses from the picture signal, they are supplied, with inverted polarity, to the terminals **1** of Figure 1, so that the wave form is as shown in Figure 3*b*. During the time that no signal energy is supplied, the grid **5** is substantially at zero potential with respect to the cathode **9**, and consequently plate current flows through the resistor **15**. The internal plate impedance of the tube **3** is consequently very low since the source of potential **23** supplying the screen grid **21** is of a relatively low value, say on the order of 20 volts. Consequently, the condenser **19** is substantially short-circuited.

When a pulse arrives, the grid **5** becomes highly negative with respect to the cathode **9** so that no plate current can flow through the tube. As a consequence, the condenser **19** starts to charge through the resistor **15**, which resistor has a high value, on the order of half a megohm. The charging of the condenser is substantially linear with time since the high value of the resistor **15** provides substantially constant current to the condenser **19**. The condenser **19**, therefore, will continue to charge so long as the negative pulse is present on the grid **5**.

When, however, the pulse drops to zero, the grid **5** likewise acquires zero potential with respect to the cathode **9**, so as to substantially short-circuit the condenser **19** and discharge it. As a result, the potential variation, with respect to the pulse, across the condenser **19** has a substantially sawtooth wave shape, as shown in Figure 3*c*, and the maximum amplitude of the sawtooth wave will be proportional to the duration of the pulse. Thus, the preparatory double frequency impulses **59** will have an amplitude and shape shown at **67**, while the slotted vertical pulses having a longer duration will have a much greater amplitude, as shown at **69** in Figure 3*c*. The equalizing pulses are shown at **71**, while the line synchronizing impulses are shown at **73**. It will be noted that the line synchronizing impulses have greater amplitude than the double frequency impulses **67** and **71**, in view of the fact that their duration is longer as called for by the standards set up by the Federal Communications Commission.

The potential developed across the condenser **19**, and shown in Figure 3*c*, is then supplied to the grid **35** of the tube **37**. The tube **37** acts as a threshold limiter by using a very high resistance value for the resistor **43**, to supply cut-off bias voltage and a relatively low value of resistance for the resistor **47**, to which the output circuit is connected. Thus, for example, the resistor **43** may be on the order of a megohm, while the resistor **47** will be on the order of 1000 ohms. Under these conditions, the tube operates substantially beyond cut-off bias value in the absence of positive pulses from the condenser **19**. When, however, positive pulses are supplied from the condenser **19** to the tube **37**, only the peaks of the higher potential pulses **69** of Figure 3*c* are sufficient to overcome the bias provided by the shunted resistor **43** and the lower potential peaks are ineffectual, so that potential across the resistor **47** will only be available upon the occurrence of the maximum peaks. Since the output is from the cathode circuit, the polarity of the output peaks fed to the vertical oscillator **49** will be the same as the polarity of the pulses fed to the grid **39**. This is shown in Figure 3*d*, where it will be noted that the output voltage appearing across the condenser **19** provides only the sawtooth peaks **75** across the resistor **47**. However, it is to be noted, where simplicity of design is desired, that satisfactory operation can be had without using the threshold keyer stage, since the amplitude of the vertical pulses is so much greater than that of the horizontal pulses. Thus the potential across condenser **19** may be fed directly to the vertical sweep oscillator.

The horizontal synchronizing impulses are obtained from the transformer **27** in the screen grid circuit of the tube **3**. Each time there is an abrupt change in the plate current of the tube **3**, there will be an abrupt change in the screen grid current, and this abrupt change of screen grid current flowing through the primary **25** of the transformer **27** will induce in the secondary **29** of the transformer **27** a peaked pulse equal to the product of the mutual inductance of the transformer times the rate of change of current with respect to time.

The induced peaks in the secondary **29** are supplied to the amplifier **31**, as shown in Figure 3*e*. It will be noted that there is a peak for each leading edge and each trailing edge of the various impulses, but if only those pulses **77** of the leading edges are utilized, the inactive pulses corresponding to that of the lagging edges 79 are suppressed either in the amplifier 31, by biasing the amplifier to cut-off, or else in the horizontal sweep oscillator 33, which normally would have high negative bias.

It will, of course, be readily apparent that the pulses may be supplied to a limiter before being supplied to the amplifier, or alternatively a threshold keyer or limiter may be inserted between the amplifier and the horizontal oscillator. In practice, it has been found that perfectly stable operation of the oscillators 33 and 49 is afforded by the circuit as shown.

It will also be evident that the pulses supplied from the resistor 47 to the vertical sweep oscillator 49, and shown in Figure 3*d*, may be fed to an integrating or countercircuit to provide one pulse representative of the sum of the six pulses shown at 75. However, the peaked output appearing across the resistor 47 is of sufficient amplitude and sufficiently sharp to insure stable synchronization of the amplifier without integration.

Of course, it will be appreciated that the condenser 19 must not have too large a value in order that sufficient potential be built up across its terminals during its charging period, and that it may be discharged in a relatively short time compared to the duration of the impulses. In one example, where the charging resistor was ½ megohm and the potential supply 17 was 200 volts, the condenser had a value of approximately 500 micro-microfarads in a system using the standard television synchronizing wave form, and this circuit successfully met the above requirements. It will be understood, of course, that depending on the type of tubes used, the values, mentioned here by way of example, may be altered in accordance with the frequency of the impulses to be separated, as well as their duration.

While the invention has been described with reference to the separation of the component parts of a composite television synchronizing signal, it will be distinctly understood, of course, that the method and apparatus of my invention are not restricted to use with such signals, but may be used wherever the components of a signal distinguish from each other by differences in time duration.

From the above description, it, of course, will be apparent that many and varied modifications of the invention may be made without departing from the general principles described and outlined hereinabove, and I, therefore, believe myself to be entitled to make any and all of these modifications such as would suggest themselves to those skilled in the art to which the invention relates, provided, of course, that such modifications and changes fall fairly within the spirit and scope of the invention as set forth in the hereinafter appended claims.

Having now described my invention, what I claim is:

1. In a television system, apparatus for separating components of a composite synchronizing signal, comprising means for receiving a composite synchronizing signal in which the impulse components have substantially equal amplitude but different time durations, means for deriving from the composite signal a train of signals whose individual impulse components have an amplitude substantially proportional to the time duration of the impulse components of the composite signal, means for limiting the train of signals to pass only those impulses which exceed a predetermined value of amplitude, said limited signals representing one component of the composite signal, and means for simultaneously producing a signal pulse for each abrupt change in amplitude of the composite signal, said pulses representing another component of the composite signal.

2. In a television system, apparatus for separating components of a composite synchronizing signal and synchronizing wave energy by the separated components, comprising means for receiving a composite synchronizing signal in which the impulse components have substantially equal amplitude but different time durations, means for deriving from the composite signal a train of signals whose individual impulse components have an amplitude substantially proportional to the time duration of the corresponding impulse components of the composite signal, means for limiting the train of signals to pass only those impulse components which exceed a predetermined value of amplitude, said limited signals representing one component of the composite signal, means for simultaneously producing a signal pulse for each abrupt change in amplitude of the composite signal, said pulses representing another component of the composite signal, means for controlling the frequency of wave energy by the limited signals and means for controlling the frequency of production of periodic energy by the produced pulses.

3. The method of separating the components of a composite signal in which the impulses of each of the components have substantially equal amplitude and different time durations, which includes the steps of deriving from the composite signal a train of signals whose individual impulses have an amplitude substantially proportional to the time duration of the corresponding impulses of the composite signal, limiting the train of signals to pass only those individual impulses which exceed a predetermined value of amplitude, the limited signals representing one component of the composite signal, and simultaneously producing a signal pulse for each abrupt change in amplitude of the composite signal, the pulses representing another component of the composite signal.

4. The method of separating the components of a composite signal in which the impulses of each of the components have substantially equal amplitude and different time durations and synchronizing wave energy by the separated components, which includes the steps of deriving from the composite signal a train of signals whose individual impulses have an amplitude substantially proportional to the time duration of the corresponding impulses of the composite signal, limiting the train of signals to pass only those individual impulses which exceed a predetermined value of amplitude, the limited signals representing one component of the composite signal, simultaneously producing a signal pulse for each abrupt change in amplitude of the composite signal, the pulses representing another component of the composite signal, controlling the frequency of wave energy by the limited signals and controlling the frequency of production of periodic energy by the produced pulses.

5. A synchronizing circuit comprising a thermionic amplifier having at least a cathode, a control electrode, a screen electrode and an anode, an input circuit connected between said control electrode and said cathode, means connected be-

tween said anode and cathode for developing a sawtooth wave potential under the control of signals supplied to said input circuit, a threshold limiter actuated by said developed potential, a source of wave energy connected to and actuated by said threshold limiter, means connected between said screen electrode and said cathode for deriving pulse energy in accordance with abrupt amplitude changes of the signals supplied to said input circuit, and wave energy means controlled by said derived pulses.

6. The method of separating the components of a composite signal in which the impulses of each of the components have substantially equal amplitude and different time durations, which includes the steps of deriving from the composite signal a corresponding train of signals whose individual impulses have an amplitude substantially proportional to the time duration of the corresponding impulses of the composite signal to provide signals representative of one of the components of the composite signal, and simultaneously producing a signal pulse for each abrupt change in amplitude of the composite signal to produce signals representative of another component of the composite signal.

7. The method of separating the components of a composite impulse signal series in which the impulses representing each component have substantially equal amplitude and different time duration, and synchronizing wave energy by the separated components, which includes the steps of deriving from the composite impulse signal series a corresponding train of signals whose individual amplitudes are substantially proportional to the time duration of the impulses representing the components of the composite signal to provide signals representative of one of the components of the composite signal, simultaneously producing a signal pulse for each abrupt change in amplitude of the composite signal to produce signals represenative of another component of the composite signal, independently producing wave energies normally at each of a plurality of predetermined frequencies, controlling the frequency of one of the produced wave energies by the derived signals, and controlling the frequency of another of the produced wave energies by the produced signal pulses.

8. A synchronizing circuit comprising a thermionic relay device having at least a cathode, a control electrode, a screen electrode and an anode, an input circuit connected between said control electrode and said cathode, means to apply substantially constant amplitude variable time duration impulses to said control electrode, means connected between said anode and cathode for developing a sawtooth wave potential for each impulse applied to said input circuit, the amplitudes of the developed sawtooth wave potentials being determined by the time duration of the impulses, a source of wave energy of a first predetermined frequency, means to control the frequency of said source of wave energy by the developed sawtooth wave potentials having an amplitude in excess of a predetermined amount, means connected between said screen electrode and said cathode for deriving pulse energy in accordance with abrupt amplitude changes of the impulses applied to said input circuit, and a source of wave energy of a second predetermined frequency controlled by said derived pulses.

9. A synchronizing circuit comprising a thermionic relay device having at least a cathode, two cold electrodes and an anode, an input circuit connected between said cathode and one of said cold electrodes, means to apply substantially constant amplitude variable time duration impulses to said input circuit, a condenser connected between said anode and cathode for developing a sawtooth wave potential for each impulse applied to said input circuit, the amplitudes of the developed sawtooth wave potentials being determined by the time duration of the impulses, a source of wave energy of a first predetermined frequency, means to vary the frequency of said source of wave energy under the control of the developed sawtooth wave potentials having an amplitude greater than a predetermined amount, transformer means connected between the other of said cold electrodes and said cathode for deriving pulse energy in accordance with abrupt amplitude changes of the impulses applied to said input circuit, a source of wave energy of a second predetermined frequency, and means to vary said second frequency under the control of said derived pulses.

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