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SYNCHRONIZING PULSE GENERATOR

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2 Sheets-Sheet 1

FIG. 1.

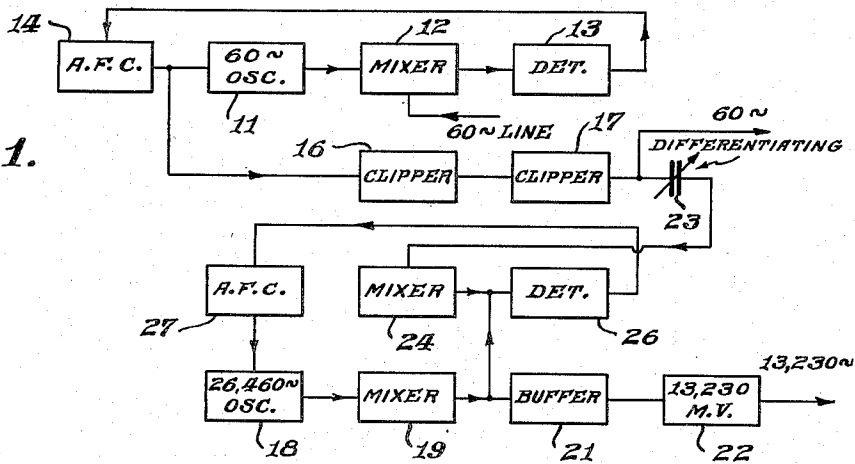


FIG. 2.

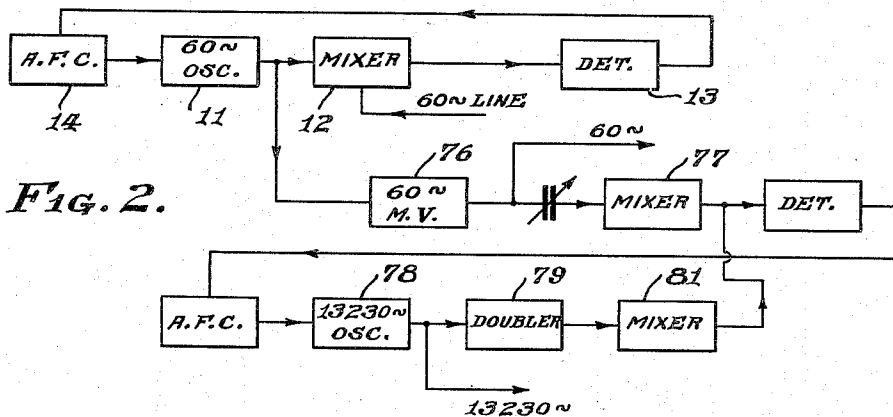
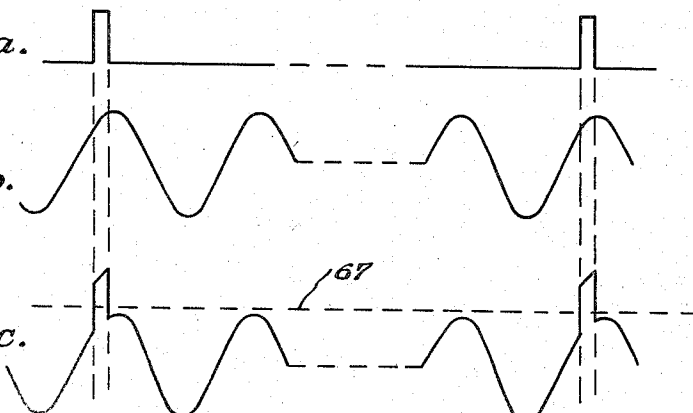


FIG. 3a.

FIG. 3b.

FIG. 3c.



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SYNCHRONIZING PULSE GENERATOR

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6 Claims. (Cl. 178—69.5)

My invention relates to generators of electrical pulses and particularly to generators for producing synchronizing pulses for television systems or the like.

5 An object of my invention is to provide a generator of the above-mentioned type which gives good synchronization and which is comparatively inexpensive to manufacture.

10 A further object of my invention is to provide a simplified generator of the above-mentioned type which gives good interlaced scanning.

In practicing a preferred embodiment of my invention the generator is designed to produce framing pulses and line frequency pulses occurring for example, at the rates of 60 and 13,230 per second, respectively, whereby interlaced scanning may be produced. The 60 cycle framing pulses are produced by a stable 60 cycle oscillator which is locked in with the power line by means of an automatic frequency control circuit having a long time constant. The 13,230 cycle pulses are obtained from a second stable oscillator which may be operated at either 26,460 cycles per second or at the line frequency. If operated at the line frequency, the frequency is doubled for obtaining a lock-in with the 60 cycle oscillator.

15 In the preferred embodiments of either of the above-mentioned designs, narrow 60 cycle pulses are mixed with 26,460 cycle sine waves whereby a narrow 60 cycle pulse falls on one side of a half sine wave. Thus, the amplitude of the narrow pulse portion of the mixed wave depends upon the phase relation of the 60 cycle oscillator and the high frequency oscillator. Any change in this phase relation is corrected by utilizing the mixed wave to control the high frequency oscillator through another automatic frequency control or A. F. C. circuit. Thus, regardless of the wide difference in the frequencies of the oscillators, they are held tightly locked in with each other.

20 It is not necessary that the low frequency pulses be mixed with sine waves or with waves having an approximately sine wave shape. For example, the 26,460 cycle waves may have a saw-tooth wave shape.

The invention will be better understood from the following description taken in connection with the accompanying drawings in which

50 Figures 1 and 2 are block diagrams of two embodiments of my invention,

Figures 3a, 3b and 3c are curves which are referred to in explaining the invention, and

55 Figure 4 is a circuit diagram of the generator shown in Fig. 1.

Referring to Fig. 1, this particular generator comprises a 60 cycle sine wave oscillator 11 which is locked in with the 60 cycle power line by adding voltages from the oscillator and the power line in a mixer 12 and supplying the resulting wave to a detector 13 having a voltage output which changes with changes in the phase relation of the oscillator and line voltages.

The output of detector 13 is fed to an A. F. C. circuit 14 which holds the oscillator 11 locked in with the power line.

To produce the framing pulses, the sine wave voltage of the oscillator 11 is passed through clipping devices 16 and 17 which pass only the center part of the sine wave and square them up to give the desired rectangular pulses.

The line frequency pulses are obtained from a 26,460 cycle sine wave oscillator 18 which supplies signal through a mixer 19 and a buffer tube 21 to a 13,230 cycle multivibrator 22. The multivibrator 22 divides the frequency of oscillator 18 and supplies the desired rectangular impulses occurring at the line frequency.

In order to lock the oscillators 11 and 18 in with each other, the output of the clipper 17 is passed through a differentiating circuit including a condenser 23 to produce narrow pulses occurring at the rate of 60 per second. These are passed through a mixer 24 and thus added to the 26,460 sine wave voltage to produce a combined wave which is impressed upon a detector 26. The output of detector 26 is fed to an A. F. C. circuit 27 which holds the oscillator 18 and the oscillator 11 in the desired fixed phase relation to each other.

In Fig. 4 there is shown the circuit diagram of the above described generator of Fig. 1. Like parts in Figs. 1 and 4 are indicated by the same reference numerals.

The oscillator 11 comprises a vacuum tube 28 having its plate and grid circuits coupled by an iron core transformer 29. The oscillator is plate tuned by means of a condenser 31 connected across the transformer primary. The oscillator is adjusted for stable oscillation and good sine wave form by adjusting the tap 32 on a resistor 33 connected across the transformer secondary. Proper oscillator bias is provided by means of a self-bias resistor 34 in the cathode lead.

The 60 cycle sine wave voltage is fed through a conductor 36 and a coupling condenser 37 to a voltage divider comprising resistors 38 and 39. From the voltage divider the 60 cycle voltage is supplied to the mixer tube 12 where it is added to the 60 cycle voltage from the power line. This

addition of voltages is obtained by feeding some of the power line current from the cathode heater circuit through a condenser 41 and through a cathode resistor 42.

It will be seen that the resistor 39 and the resistor 42 are in series in the grid-cathode circuit of the tube 12 whereby the two sine wave voltages are added and impressed upon the cathode of the diode detector 13. This detector functions to supply over a conductor 43 and A. F. C. signal which controls the current output of the A. F. C. tube 14. Since the plates of tubes 14 and 28 are connected together (through a resistor 44), the amount the iron core of transformer 29 is saturated depends upon the plate current of tube 14. Therefore, the tuning of the oscillator plate circuit depends upon this plate current, and any change in the phase relation of the two voltages applied to mixer tube 12 causes enough frequency or phase change in the oscillator 11 to restore the original phase condition.

In the specific design of the detector circuit shown, the diode 13 has resistors 46 and 47 connected in series across its plate and cathode, a by-pass condenser 48 being connected between the junction point of the resistors and ground. The operation of the A. F. C. is adjusted by varying the tap 49 on a voltage divider for obtaining the correct bias on the grid of tube 14.

The A. F. C. signal supplied over conductor 43 is impressed upon the tube 14 through a circuit having a slow time constant whereby fast or sudden variations in the power line voltage will not effect a sudden change in the frequency of the oscillator 11. The desired time constant is obtained by selecting proper values for a resistor 51 in series with conductor 43 and for a condenser 52 connected between the grid and cathode of the tube 14.

It is not important whether the detector 13 functions to give an A. F. C. signal which is a measure of the peak or of the area of the two added 60 cycle waves. In the circuit shown it acts to a certain extent as a peak detector because the condenser 52 (together with resistor 51) is in shunt to the resistor 46 whereby a certain biasing voltage is built up across resistor 46.

The above-described portion of the generator functions to produce across the voltage divider 38—39 a 60 cycle sine wave voltage of large amplitude which is locked in with the power line but which does not follow any fast line voltage variations. This sine wave voltage is converted to rectangular pulses recurring 60 times per second as follows: Due to the large amplitude of the sine wave voltage (150 volts, for example) and due to the resistor 53 next to the grid of tube 16, the positive half waves are flattened off since the input impedance of tube 16 is low when the grid is driven positive. The other half of the sine wave is flattened off by clipping since the amplitude of the negative halves of the sine wave drive the tube 16 considerably past plate current cut-off. These clipped negative halves appear on the grid of tube 17 with positive polarity.

The tube 17 is grid-leak biased by making the values of the grid condenser 54 and the grid resistor 56 such that the condenser holds a substantial part of its charge between successive positive pulses. Since the tube 17 passes only the more positive parts of the signal applied to its grid, the negative half pulses supplied from tube 16 do not appear in the plate circuit of the tube 17.

The 60 cycle pulses supplied by tube 17 may be utilized in any suitable way for driving or synchronizing a deflecting circuit.

For the purpose of locking in the 60 cycle oscillator 11 and the 26,460 cycle oscillator 18, 60 cycle rectangular pulses from tube 17 are passed through a differentiating circuit including the condenser 23 to obtain very narrow rectangular pulses occurring at the rate of 60 per second.

The differentiated pulses are impressed upon the mixer tube 24 which is self-biased by means of the cathode resistor 57 shunted by a condenser 58. The grid resistor 59 of tube 24 functions as part of the differentiating circuit, the width of the differentiated pulse depending upon the relative values of condenser 23 and resistor 59.

While both positive and negative narrow pulses appear at the grid of tube 24, only the pulses appearing in the plate circuit with positive polarity affect the detector 26. These pulses, which are shown in Fig. 3a, mix with 26,460 cycle sine waves (Fig. 3b) in the plate resistor 61 which is common to mixer tubes 24 and 19.

Referring now to the portion of the generator which produces the line frequency synchronizing pulses, sine waves at double line frequency may be produced by a 26,460 cycle sine wave oscillator 18 comprising a self-biased tube 62 having a tuned plate circuit coupled by a transformer 63 to the grid circuit. A variable tap 64 is adjusted to give minimum feed-back for stable oscillation and good wave form.

The sine waves may be taken off the grid circuit through a voltage divider 66 and supplied to the mixer tube 19. The sine wave voltage appearing in the common plate resistor 61 is shown in Fig. 3b. The sum of the 26,460 cycle sine wave voltage and the 60 cycle impulse voltage which is impressed upon the diode 26 is shown in Fig. 3c.

By making the 60 cycle impulse narrow as compared with a half wave of the 26,460 cycle signal, any change in the phase relation of the 60 cycle oscillator 11 and the 26,460 cycle oscillator 18 will change the location of the narrow pulse on the side of the half sine wave and thus change its amplitude.

This change in amplitude is utilized for frequency or phase control as follows: The diode 26 is so biased that only the peaks of the combined signals are passed by the diode as indicated by the dotted line 67 in Fig. 3c. The diode bias may be set at the proper value by means of the variable tap 68.

The signal portions passed by diode 26 are integrated or smoothed in the diode plate circuit by means of a condenser 69 whereby there is produced a steady A. F. C. control voltage which changes in value only in response to a phase shift in the oscillator outputs. This control voltage is supplied through a conductor 71 to an A. F. C. circuit which may be of any suitable design.

In the example illustrated, the A. F. C. circuit comprises a tube 27 having a resistor 72 and a condenser 73 connected between its plate and cathode whereby a voltage substantially 90 degrees out of phase with the plate current may be applied to the grid 70 through a coupling condenser 74. Since the tube 27 is connected across the tuned plate circuit of oscillator 18, the out of phase voltage on the grid 70 causes the tube to function as a reactance across the tuned plate circuit. Thus, the A. F. C. circuit determines the oscillator frequency and the amount of frequency control depends upon the bias on grid 70. An A. F. C. circuit of this type is described and

claimed in application Serial No. 19,563, filed May 3, 1935, in the name of Charles Travis, entitled Automatic frequency control, and assigned to the Radio Corporation of America.

From the foregoing it will be seen that any change in the phase relation of oscillators 11 and 18 causes a change in the A. F. C. signal supplied over conductor 71 which causes the A. F. C. circuit to bring the oscillators back substantially to their original phase relation.

The output of oscillator 18 thus controlled may be utilized in any suitable way for driving or synchronizing the horizontal deflecting circuits. In the circuit shown it is fed through a buffer stage 21 to a multivibrator 22 which is adjusted to lock in at the line frequency of 13,230 per second.

It will be apparent that my invention may be practiced in various embodiments other than the one described above. For example, the design shown in Fig. 2 may be utilized. In this figure parts similar to those in Fig. 1 are indicated by like reference numerals.

In Fig. 2 the 60 cycle oscillator is locked in with the power line the same as previously described. The 60 cycle sine wave is changed to rectangular pulses occurring at the framing frequency by means of a multivibrator 76. These pulses may be narrowed in any suitable manner as by a differentiating circuit and supplied to a mixer circuit 77.

The high frequency oscillator 78 in this case operates at the line frequency of 13,230 cycles. The double frequency of 26,460 per second is obtained by means of a frequency doubler 79 and applied to a mixer circuit 81. The outputs of mixers 77 and 81, after being added, are impressed upon the detector 26 to produce the A. F. C. signal for controlling the A. F. C. circuit 27 as previously described.

It may be noted that the sine wave signal which is mixed with the 60 cycle pulses is made a multiple of the line frequency in order that the narrow pulse will fall on the same side of the half sine wave for successive picture frames.

In the drawings the values of certain circuit elements have been indicated in ohms, megohms, microfarads and micro-microfarads. These values are given merely by way of example and may be varied within wide limits.

One important feature of my invention is that the time constant of the circuit 51-52 through which the frequency of oscillator 11 is controlled is so slow that successive narrow pulses derived from oscillator 11 always fall on the same side of the high frequency waves. That is, the time constant of circuit 51-52 and the stability of the oscillators are such that between successive 60 cycle pulses a change in line voltage or frequency cannot change the frequency of oscillator 11 rapidly enough to make a pulse fall on the wrong side of a 26,460 cycle half wave. It may be said that as a limiting condition the narrow 60 cycle pulses which are added to the high frequency wave must stay within a half cycle of this wave.

It should also be noted that one A. F. C. circuit is utilized for locking a low frequency oscillator in with the power line while another A. F. C. circuit is utilized for locking a high frequency oscillator in with the first oscillator and thereby locking it in indirectly with the power line.

Obviously, there are many embodiments of my invention other than those illustrated. As an example, the oscillator 11 might be operated at 30 cycles per second to produce 30 cycle pulses

for combining with the 26,460 cycle waves (either sine or saw-tooth) and a frequency doubler employed to obtain the 60 cycle framing pulses.

Also, while this is not a preferred embodiment, 60 cycle pulses may be combined with 13,230 cycle waves with alternate pulses of the combined wave being of greater amplitude than the remaining pulses whereby only the pulses of greater amplitude are effective for frequency control.

I claim as my invention:

1. A generator of electrical pulses comprising a comparatively low frequency oscillator, a comparatively high frequency oscillator for producing recurring waves each of a certain duration, means for obtaining from said first oscillator regularly recurring pulses having a sub-harmonic relation to said waves and each having a duration less than said certain duration, means for adding said pulses and said waves whereby said pulses extend above said waves by an amount depending upon the phase relation between said pulses and said waves, means for clipping off said pulses at substantially a fixed level and for supplying them to a storage circuit to produce an automatic frequency control voltage, and means for controlling the frequency of said high frequency oscillator in accordance with said control voltage.

2. A synchronizing pulse generator comprising means for producing electrical pulses of short duration and occurring at a comparatively low framing frequency, a sine wave oscillator for producing sine wave voltage having a comparatively high frequency which bears a harmonic relation to said low frequency, the duration of said pulses being less than the duration of a half wave of said sine wave voltage, means for adding said pulses and said sine wave voltage whereby the resulting voltage waves has an amplitude greater than said sine wave and which is dependent upon the phase relation between said pulses and said sine wave, means for producing a control signal which varies in accordance with variations in said amplitude, and means for controlling the frequency of said sine wave oscillator in accordance with said control signal.

3. A synchronizing pulse generator for a television system or the like wherein a cathode ray is deflected at a certain framing frequency and simultaneously at a certain line frequency, said generator comprising an oscillator which produces a voltage wave at a low frequency of the order of said framing frequency, means for mixing voltages from said low frequency oscillator and from a power line, means for obtaining a control signal from said mixed voltage which is a measure of the phase difference between said oscillator voltage and said line voltage, an automatic frequency control circuit for said oscillator, means for applying said control signal to said automatic frequency control circuit through a circuit having a time constant long enough to prevent said oscillator from following fast changes in the line voltage, a second oscillator for producing a voltage wave at a high frequency of the order of said line frequency, means for obtaining recurring voltage pulses from said low frequency oscillator which are of less width than a half cycle of said high frequency wave, means for adding said narrow pulses and said high frequency waves whereby the amplitude of the resulting signal varies with variations in the phase relation between said two oscillators, an automatic frequency control circuit for said second oscillator, and means for applying to said last-mentioned

automatic frequency control circuit a control signal which varies in response to variations in said amplitude for maintaining said last-mentioned phase relation substantially constant.

5 4. A synchronizing pulse generator for a television system or the like wherein a cathode ray is deflected at a certain framing frequency and simultaneously at a certain line frequency, said generator comprising an oscillator which produces a voltage wave at a low frequency of the order of said framing frequency, means for mixing voltages from said low frequency oscillator and from a power line, means for obtaining a control signal from said mixed voltage which is a measure of the phase difference between said oscillator voltage and said line voltage, an automatic frequency control circuit for said oscillator, means for applying said control signal to said automatic frequency control circuit through a circuit having a time constant long enough to prevent said oscillator from following fast changes in the line voltage, a second oscillator for producing a voltage wave at a high frequency of the order of said line frequency, means for obtaining recurring voltage pulses from said low frequency oscillator which are of less width than a half cycle of said high frequency wave, means for adding said narrow pulses and said high frequency waves whereby the amplitude of the resulting signal varies with variations in the phase relation between said two oscillators, an automatic frequency control circuit for said second oscillator, and means for applying to said last-mentioned automatic frequency control circuit a control signal which varies in response to variations in said amplitude for maintaining said last-mentioned phase relation substantially constant, the said time constant and the stability of said oscillators being such that successive narrow pulses stay within a half cycle of said high frequency waves.

5. A synchronizing pulse generator comprising means for producing electrical pulses of short duration and occurring at a comparatively low framing frequency, a sine wave oscillator for producing sine wave voltage having a comparatively high frequency which bears a harmonic relation to said low frequency and which is twice the line scanning frequency, the duration of said pulses being less than the duration of a half wave of said sine wave voltage, means for adding said pulses and said sine wave voltage whereby

the resulting voltage waves has an amplitude greater than said sine wave and which is dependent upon the phase relation between said pulses and said sine wave, means for producing a control signal which varies in accordance with variations in said amplitude, means for controlling the frequency of said sine wave oscillator in accordance with said control signal, and means for producing line scanning pulses occurring at a frequency equal to one-half said high frequency.

6. A synchronizing pulse generator for a television system or the like wherein a cathode ray is deflected at a certain framing frequency and simultaneously at a certain line frequency, said generator comprising a sine wave oscillator which produces a sine wave voltage at a low frequency of the order of said framing frequency, means for mixing voltage from said low frequency oscillator and from a power line, means for obtaining a control signal from said mixed voltage which is a measure of the phase difference between said oscillator voltage and said line voltage, an automatic frequency control circuit for said oscillator, means for applying said control signal to said automatic frequency control circuit through a circuit having a time constant long enough to prevent said oscillator from following fast changes in the line voltage, a second oscillator for producing a sine wave voltage at a frequency double said line frequency, means for obtaining recurring voltage pulses from said low frequency oscillator which are of less width than a half cycle of said double frequency sine wave, means for adding said narrow pulses and said double frequency sine waves whereby the amplitude of the resulting signal varies with variations in the phase relation between said two oscillators, an automatic frequency control circuit for said second oscillator, means for applying to said last-mentioned automatic frequency control circuit a control signal which varies in response to variations in said amplitude for maintaining said last-mentioned phase relation substantially constant, and means for obtaining synchronizing pulses occurring at said line frequency which are locked in with said double frequency, said framing frequency going into said line frequency a whole number of times plus one-half whereby interlaced scanning is produced.

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