

Dec. 31, 1940.

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2,226,706

PERIODIC WAVE-GENERATING SYSTEM

Filed Nov. 29, 1937

2 Sheets-Sheet 1

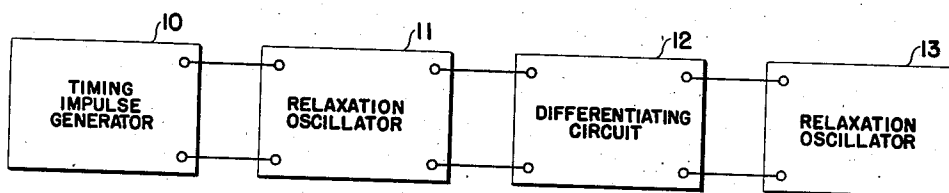


FIG. 1.

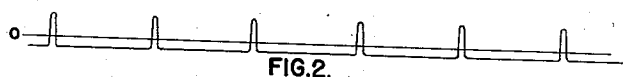


FIG. 2.

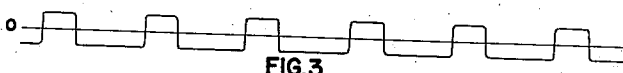


FIG. 3.

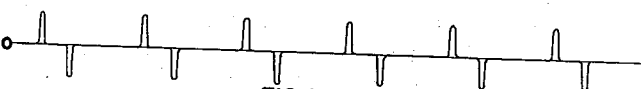


FIG. 4.

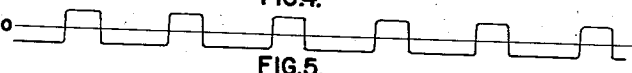


FIG. 5.

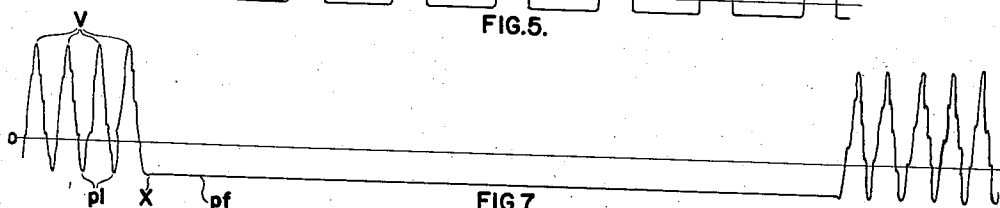


FIG. 7.

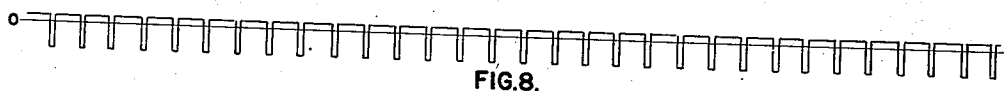


FIG. 8.

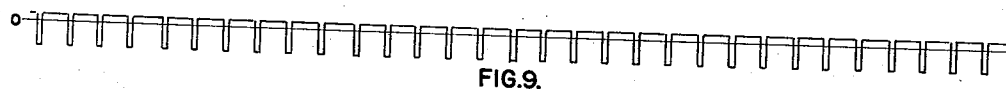


FIG. 9.

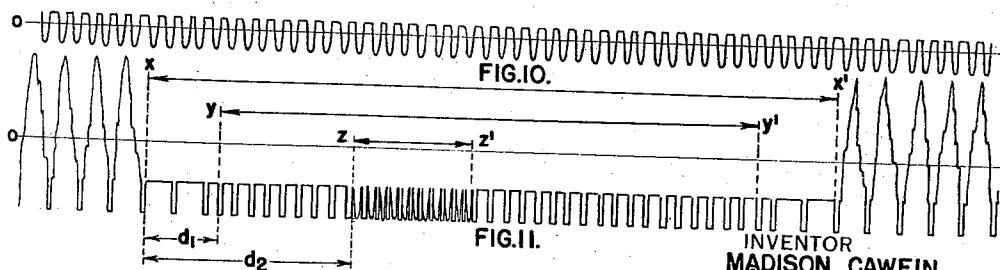


FIG. 10.

FIG. 11.

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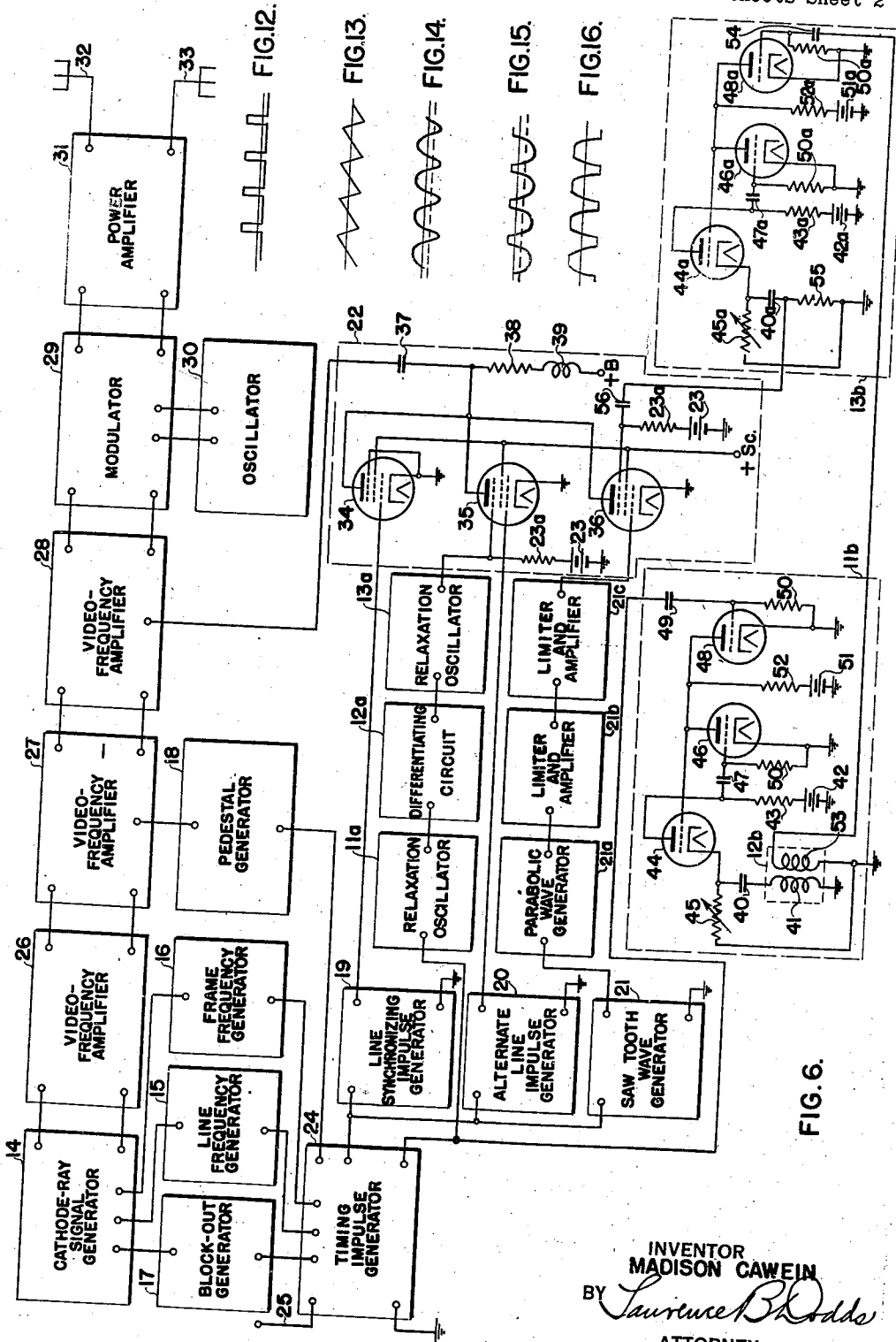
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2 Sheets-Sheet 2



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PERIODIC WAVE-GENERATING SYSTEM

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Application November 29, 1937, Serial No. 176,963

20 Claims. (Cl. 178—7.2)

This invention relates to periodic wave-generating systems such as are adapted for use in television systems and, particularly, to improved systems for developing two periodic impulse waves which are displaced in phase in a predetermined manner and to a predetermined extent.

In certain signaling systems, such as television transmitters, it is frequently necessary to provide a periodic wave comprising periodic voltage impulses and delayed in phase with respect to another periodic voltage-impulse wave. One example of such use is in certain types of television systems which employ so-called interlaced scanning. In such systems, the scanning synchronizing signal may comprise line- and frame-frequency impulses, the latter being of the serrated type and of a frequency equal to a fractional multiple or aliquant of the line-frequency impulses. In order to combine the frame-frequency impulses and the line-frequency impulses without disturbing the line-frequency impulses, in a double interlaced system, the latter are doubled during a part of the retrace portion of each frame-scanning cycle and impulses of parabolic wave form are inserted between certain of the double line-frequency impulses, producing, in effect, a single frame-frequency impulse having serrations in which double line-frequency impulses are inserted. In order to control the line doubling and the parabolic impulse insertion, so that they occur at the proper times in the frame-scanning cycle, there are developed other periodic voltage-impulse waves of the frame frequency, but delayed in phase with respect to the frame-scanning wave. Heretofore, phase delays of periodic voltage-impulse waves of the character referred to have been obtained by the use of various types of filter networks. Such apparatus, however, has been found unsuitable for obtaining the precisely timed, relatively long, delays required in television scanning systems.

It is an object of the invention, therefore, to provide improved means for developing from a first periodic impulse wave a second periodic impulse wave delayed in phase with respect to the first wave.

It is a further object of the invention to provide an improved system for developing a television scanning synchronizing signal.

In accordance with the invention, a periodic-impulse wave-generating system comprises means for deriving from a first periodic-impulse wave of a predetermined frequency a second periodic-impulse wave having impulses initiating at the

occurrences of the impulses of said first wave and of a predetermined duration independent of the duration of the impulses of the first wave. The system also includes means coupled to the above-mentioned means for synchronization by the wave developed thereby for developing a third periodic-impulse wave comprising impulses initiating at the termination of the impulses of the second wave and having a duration independent of the duration of any of the other of said impulses.

In accordance with one embodiment of the present invention, there is provided a signal-generating system including a first generating means for developing a periodic impulse wave of a predetermined frequency and a second generating means for developing a wave having periodic positive impulses of rectangular wave form and of predetermined duration. The second generating means is so controlled by the first that the rectangular impulses are initiated at the leading edge of the impulses of the first wave. Differentiating means are provided for deriving from the rectangular impulse waves a periodic wave of double-impulse form, the positive and negative peaks of which occur, respectively, simultaneously with the leading and trailing edges of the rectangular impulses. A third generating means, developing a wave of periodic impulses of a desired wave form, is so coupled to the double-impulse wave-generating means as to be synchronized by the second and negative peaks of the double impulses, so that the impulses of the third wave are initiated simultaneously therewith. The third periodic-impulse wave is thus of the same frequency as that of the first periodic-impulse wave, but delayed in phase with respect thereto by an amount equal to the duration of a rectangular impulse of the second generated wave.

In one embodiment, the invention is utilized for developing a synchronizing signal of the serrated-impulse type in a television transmitting system employing interlaced scanning. In such a system, the wave developed by the first generating means is at the frame frequency and the delayed-impulse wave derived therefrom is utilized to control the combining of the alternate line-frequency impulses and parabolic impulses with the line-frequency synchronizing impulses in the proper relation to develop a combined synchronizing signal including both line- and frame-frequency impulses, the latter being serrated to permit uninterrupted line-frequency impulses.

In the embodiment just described, the serrated wave may be developed as follows: there is provided means for developing a first wave of predetermined frequency, for example, double the line-scanning frequency, and of rectangular-impulse wave form, and a plurality of individual generating means are coupled thereto for developing the line-scanning and the alternate-impulse waves in phase with the impulses of the first wave, but of half its frequency, and the parabolic-impulse waves at the predetermined double frequency. For the purpose of deriving the last-mentioned wave, there is developed a periodic wave of saw-tooth wave form and of the predetermined double frequency, for example, by integrating the rectangular-impulse wave. A periodic wave of parabolic wave form is derived from the saw-tooth wave, for example, by integrating the latter and suitable means are provided for limiting and amplifying the parabolic wave to derive the desired periodic wave of parabolic-impulse wave form with the impulses occurring between the rectangular impulses of the first-mentioned wave and, hence, between the line-scanning and alternate impulses.

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

In the accompanying drawings, Fig. 1 is a diagram illustrating schematically apparatus embodying the invention; Figs. 2-5, inclusive, are curves illustrating the wave forms of periodic voltage waves developed at different points in the system of Fig. 1; Fig. 6 is a circuit diagram, partially schematic, of a complete television transmitting system embodying the invention; and Figs. 7-16, inclusive, are curves illustrating the wave forms of waves developed at various points in the system of Fig. 6, to aid in the understanding of the invention.

Referring more particularly to Figs. 1-5, inclusive, in accordance with the present invention there is provided a timing-impulse generator 10 for developing a periodic voltage-impulse wave of a desired predetermined frequency and which may be of a form such as is illustrated in Fig. 2. A relaxation oscillator 11 is provided for developing a periodic impulse wave of rectangular wave form as illustrated, for example, in Fig. 3, the wave being of the same frequency as the wave developed by the generator 10. The oscillator 11 is suitably coupled to the output circuit of the generator 10 to be synchronized thereby so that each rectangular impulse generated by oscillator 11 is initiated at the occurrence of an impulse of the wave of Fig. 2. Each of the rectangular impulses developed by the oscillator 11 is of a predetermined duration which is independent of the duration of the impulses developed by generator 10 and is the determining factor in the delay to be obtained. A voltage-differentiating circuit 12 is provided for differentiating the rectangular-impulse wave to derive therefrom a double-impulse wave, such as is shown in Fig. 4, the positive and negative peaks of the wave occurring, respectively, simultaneously with the leading and trailing edges of the rectangular impulses of Fig. 3. A final relaxation oscillator 13 is provided for developing a third periodic-impulse wave which may be of any desired wave form, for example, rectangular as shown in Fig. 5, and of the same frequency as the first wave,

the impulses of the wave form of oscillator 13 having a duration independent of the durations of the impulses of any of the other wave forms. The oscillator 13 is so coupled to the differentiating circuit as to be synchronized by the negative peak or second peak of each of the double impulses, that is, so that the impulses of the final wave are initiated upon the occurrence of the second and negative peaks of the double impulses which correspond to the terminations or trailing edges of the rectangular impulses of the wave of Fig. 3. The final periodic-impulse wave, therefore, is delayed in phase with respect to the first wave by an amount equal to the duration of a rectangular impulse developed by the oscillator 11. The voltage output of the generator 13 may be applied to any suitable utilization means.

Referring now more particularly to Fig. 6 of the drawings, there is illustrated a television transmitting system comprising a cathode-ray signal generator 14 which may be of conventional design and includes the usual signal-generating tube, camera, and scanning elements. For developing scanning voltages or currents for the generator 14, there are provided a line-frequency saw-tooth wave generator 15 and a field-frequency saw-tooth wave generator 16, the output circuits of these generators being connected to the scanning elements of the signal generator 14 in the usual manner. In order to block out the cathode ray of the generator 14 during the retrace scanning periods, there is provided a block-out wave generator 17 having its output circuit suitably connected to the signal generator 14. For providing pedestal impulses to suppress undesirable signal impulses during retrace scanning periods and to ensure the proper form of the modulation signal to be developed, there is provided a pedestal-impulse generator 18 and, in order to develop a scanning synchronizing signal in accordance with the present invention, there is provided a line-synchronizing impulse generator 19; an alternate line-frequency impulse generator 20; parabolic-impulse wave-generating apparatus including a saw-tooth wave generator 21, a parabolic wave generator 21a, and limiters and amplifiers 21b and 21c connected in cascade, in the order named; and a signal-combining network indicated generally at 22. Time-delay apparatus embodying the present invention and corresponding to that shown in Fig. 1 is provided in connection with the combining network and includes a relaxation oscillator 11a, a differentiating circuit 12a, and a relaxation oscillator 13a, which operate in connection with the generator 20, and a relaxation oscillator 11b including therein a differentiating circuit 12b, and a relaxation oscillator 13b, which operate in connection with the generator 21 and will be described in detail hereinafter.

For the purpose of synchronizing generators 15-21, inclusive, and the oscillators 11a and 11b, in a manner corresponding to the synchronization of oscillator 11 by generator 10 of Fig. 1, there is provided for the system a timing-impulse generator 24 having the input circuits of the generators 15-21, inclusive, and oscillators 11a, 11b coupled thereto. Preferably, the generators 19, 20, and 21 are all connected to a single output circuit of the generator 24 across which the latter generator is adapted to develop a periodic wave of rectangular-impulse wave form and of double the desired line-scanning frequency, for example, 26,460 cycles. The gen-

erators 19 and 20 are arranged to be synchronized by successive impulses of the wave, while the generator 21 develops a wave of the double line frequency. The generator 24 is preferably stabilized by means of a connection 25 to a suitable source of periodic voltage, for example, to the power supply circuit or to the synchronizing voltage source of a motion picture mechanism, where such is employed.

Connected in cascade to the output circuit of the cathode-ray signal generator 14, in the order named, are video-frequency amplifiers 26, 27, and 28, a modulator 29 and associated coupled oscillator 30, a power amplifier 31, and an antenna system 32, 33, all according to conventional practice. The output circuit of the pedestal generator 18 is coupled to the video-frequency amplifier 27, while the output circuit of the combining network 22 is coupled to the video-frequency amplifier 28.

Neglecting for the moment the details of the synchronizing signal-generating apparatus and parts of the system associated therewith in accordance with the present invention, the system just described comprises the elements of a television transmitting system of conventional design and, the various parts thereof illustrated schematically being of any well-known construction, a detailed description of the general system and its operation is unnecessary. Briefly, however, the image of a scene to be transmitted is focused on the target of the cathode-ray tube of the signal generator 14, in which tube a cathode ray is developed, focused, and accelerated toward the target in the usual manner. Scanning or deflecting currents or voltages developed by the generators 15 and 16 are applied to the scanning elements of the generator 14 to provide electric fields which serve to deflect the cathode ray horizontally and vertically, thereby to scan successive series of parallel lines or fields upon the target. The deflecting currents or voltages and, hence, the scanning fields are of well-known sawtooth wave form, providing a relatively slow linear trace and rapid retrace. The number of lines per field are determined by the relative field and line frequencies. Block-out impulses developed by the generator 17 are applied to a control electrode of the cathode-ray tube to suppress or block out the beam during retrace portions of the scanning cycles, while pedestal impulses developed by the generator 18 are applied to the amplifier 27 to modify the shape of the resultant video-frequency wave developed to aid in separation of line- and frame-frequency synchronizing impulses at the receiver.

The synchronizing impulses developed by the generators 19, 20, and 21—21c and the apparatus associated therewith are combined in the network 22 and injected in the modulation amplifier 28, timing impulses developed by the generator 24 being applied to the generators 15—21, inclusive, to lock these generators in synchronism.

The photosensitive elements of the target in the cathode-ray tube of the generator 14 being electrically affected to an extent depending upon the varying values of light and shade at the corresponding incremental areas of the images focused thereon, as the cathode ray scans the target a video-frequency voltage of correspondingly varying amplitude is developed in the output circuit of the generator 14 and applied to the video-frequency amplifier 26, wherein this voltage is amplified and from which it is translated to the amplifier 27. Here the video-frequency

voltages are further amplified and mixed with the pedestal impulses supplied from the generator 18. The mixed amplified voltages in the output circuit of the amplifier 27 are thereupon applied to the amplifier 28, wherein they are further amplified and mixed with the synchronizing impulses supplied from the combining network 22. The modulation voltages are then supplied to the modulator 29, wherein they are impressed on the carrier wave generated by the oscillator 30 and 10 the resultant modulated-carrier signal is delivered to the power amplifier 31 for amplification and is thereafter impressed upon the antenna system 32, 33 to be broadcast.

Referring now more particularly to the apparatus embodying the present invention and the circuits associated therewith, the relaxation oscillator chains 11a—12a—13a and 11b—12b—13b may be entirely similar so that only one need be described in detail. The oscillator 11b is conventional in form, but also embodies the differentiating circuit 12b, in accordance with the present invention. More particularly, this oscillator includes a condenser 40 and an inductance 41 in series, the latter having an impedance 25 which is relatively very small compared to that of the condenser at the oscillation frequency. A charging circuit is provided for the condenser 40 which includes a source of direct current, for example, a battery 42 preferably grounded at its negative terminal, a resistor 43, and the space current path of a vacuum tube 44. A discharge circuit comprising an adjustable resistor 45 is connected across the condenser for discharging it at a predetermined rate. A regenerating tube 35 46 is provided in connection with the tube 44, having its cathode grounded and its anode connected to the control electrode of the tube 44. The control grid of the regenerating tube 46 is connected by way of a suitable coupling condenser 47 to the anode of tube 44. A buffer amplifier tube 48 is interposed between the oscillator, per se, and the timing-impulse generator 24 to which it is coupled by way of a suitable coupling condenser 49 to receive synchronizing or 45 control impulses of frame-synchronizing frequency. Suitable grid-leak resistors 50 are connected between the control grids and cathodes of the tubes 46 and 48, while operating potentials may be supplied to the anodes of these tubes 50 from the positive terminal of a battery 51 by way of a common load resistor 52.

The differentiating circuit is here provided by the inductance 41 of the oscillator 11b and a secondary winding 53 coupled thereto which is, 55 in turn, coupled by way of a suitable condenser 54 to the input circuit of the oscillator 13b for synchronizing the operation thereof.

The relaxation oscillator 13b is of substantially the same construction and operation as the oscillator 11b, similar elements being designated by the same reference numerals with the suffix a. However, in generator 13b a resistor 55 is included in series with the charging condenser 40a instead of an inductance and the output circuit of the oscillator is connected across the resistor 55 and coupled, by way of a suitable condenser 56, to the suppressor grid of the tube 36.

In the operation of the generator 11b (and similarly of the oscillator 13b), the condenser 40 is rapidly charged from the source 42 by way of the tube 44 and is discharged at a relatively slow rate through the resistor 45. The discharging action continues until the potential difference developed across the tube 44 is sufficient, 75

upon the application of a synchronizing impulse to its control grid from the generator 24 by way of the buffer amplifier 48, to break down the tube 44 and initiate a charging action there-through. The initial surge of charging current results in a voltage impulse across the resistor 43 which is impressed negatively by way of the condenser 47 upon the control grid of the regenerating tube 46, reducing the conductivity of this tube. A positive impulse peak is thereby developed across the load resistor 52 and applied to the control grid of the tube 44 to accelerate the charging action. The synchronizing or timing impulses, supplied from the generator 24 and applied to the control grid of the tube 44, by way of the condenser 49 and buffer amplifier 48, serve to synchronize the operation of the oscillator at the frame-synchronizing frequency.

The periodic charging and discharging of the condenser 40 causes a voltage to be developed thereacross which has a saw-tooth wave form and, hence, a current flows through the condenser 40 and inductance 41 which has a periodic rectangular-impulse wave form, such as is shown in Fig. 3, that is, which is the first derivative of the saw-tooth voltage wave. The reactance voltage drop across the inductance 41 is the first derivative of the current therethrough and, hence, is of the double-impulse form shown in Fig. 4. This voltage is induced in the winding 53 and is so impressed upon the input circuit of the oscillator 13b that the second impulse of each double impulse thereof is a negative impulse and serves as a synchronizing impulse for this oscillator. The oscillator 13b operates in substantially the same way as the oscillator 11b, except that, since the resistor 55 is included in series with the condenser 40a instead of an inductance, the voltage developed across this resistor is of the same wave form as the current through the condenser 40 and resistor, that is, of the periodic rectangular-impulse wave form as shown in Fig. 5. Since the periodic rectangular-impulse waves developed by the oscillator 13b are synchronized or initiated by the second and negative peaks of the double impulses developed across the inductance 41, it will be appreciated that the leading edges of the rectangular impulses of the wave across resistor 55 are delayed in phase with respect to the leading edges of the current impulses through condenser 40 by amounts equal to the duration of a current impulse through condenser 40.

The duration of the rectangular impulses developed by the oscillators 11b and 13b may be suitably determined by adjustment of the circuit constants of these oscillators. For example, the resistance of the tube 44 when conductive is very low and may be arbitrarily indicated by r and the period of the generated wave may be taken as unit time or 1, with the trace part of the cycle indicated as a fraction, b . The duration of the rectangular impulse, which is equal, in time, to the retrace part of a cycle, therefore, is $1-b$. When proper circuit adjustments exist,

$$\frac{b}{1-b} = \frac{R}{r}$$

where R is the resistance of the discharge resistor 45 and the width of the impulse may be determined by adjusting either the value of r or, more conveniently, the value of R . In order to obtain relatively large adjustments, while still maintaining stable oscillations, it may sometimes be necessary to adjust the capacitance of the

condenser 40. In general, however, the desired control may be obtained simply by adjusting the value of resistor 45.

The parabolic-impulse wave-generating apparatus 21-21c may best be described with reference to Figs. 12-16, inclusive. The timing-impulse wave generator 24, as stated above, is adapted to develop in one of its output circuits a periodic wave of rectangular-impulse wave form such as is illustrated by the curve of Fig. 12, this wave being of double the desired line-scanning frequency, for example, 26,460 cycles. The saw-tooth wave generator may comprise a suitable circuit for deriving from the rectangular impulse wave a saw-tooth wave, such as is illustrated in Fig. 13, of the same frequency as the rectangular-impulse wave and with its retrace portions occurring during the rectangular impulses. The parabolic wave generator 21a comprises suitable circuits for deriving, from the saw-tooth wave, a wave of the same frequency and of parabolic wave form, such as is illustrated in Fig. 14, with the positive portions thereof occurring during the trace periods of the saw-tooth wave. The circuits of the generators 21 and 21a preferably comprise integration circuits, as, for example, high impedance pentode tubes having capacitance elements included in their anode circuits whereby the voltages impressed upon their input circuits cause currents of similar wave form to flow in their anode circuits and voltages to be developed across the capacitance elements having wave forms which are infinitesimal calculus functions of, specifically the integrals of, the impressed voltage wave forms.

The limiter and amplifier 21b may comprise a conventional vacuum tube having its grid circuit so biased as to cut off a portion of the parabolic wave impressed on its input circuit, for example, the portion indicated below the broken line in Fig. 14, thereby to develop a wave of parabolic-impulse wave form, such as illustrated by the curve of Fig. 15. The limiter and amplifier 21c may comprise apparatus similar to that of the limiter and amplifier 21b and be similarly arranged to cut off a portion of the wave impressed upon its input circuit, as, for example, the portion indicated below the broken line in Fig. 15, and to amplify this wave, thereby to develop a wave of the double line frequency and of truncated parabolic-impulse wave form such as is illustrated by the curve of Fig. 15. It will be noted that the impulses of the last-mentioned wave occur between the rectangular impulses of the first wave from the timing-impulse generator. The line-synchronizing impulses and alternate line impulses which are developed by the generators 19 and 20, on the other hand, as stated above, occur at the same time as, or in phase with, corresponding impulses of the double-impulse wave. These relations are correct for the purpose of developing the final composite serrated synchronizing wave, as will be apparent from the description of the general operation of the system hereinafter set forth.

The combining network 22 includes three pentode amplifier tubes 34, 35, and 36. The output circuits of the generators 19 and 20 and the limiter and amplifier 21c are coupled, respectively, to the control grids of tubes 34, 35, and 36, while the anode circuits of these tubes are connected in parallel and coupled to the amplifier 28 by way of a suitable coupling condenser 37. Operating potentials are supplied to the anodes of the tubes, by way of a load resistor 38 and choke 39, and 75

to their screens from suitable sources indicated, respectively, at $+B$ and $+Sc$. The suppressor grid of the tube 34 is connected in conventional manner to its cathode, while the suppressor grids of the tubes 35 and 36 are normally biased sufficiently negative to render these tubes nonconductive, as by means of suitable batteries 23 and leak resistors 23a. The suppressor grids of the tubes 35 and 36 are also coupled to the output circuits of the oscillators 13a and 13b, respectively.

In considering the general operation of the scanning synchronizing system, reference will be had to the curves of Figs. 7-11, inclusive, which show the wave forms of the currents or voltages developed at different points in the system. The curve of Fig. 7 represents the signal appearing at the output of the video-frequency amplifier 27, the video-frequency impulses indicated at V having been supplied from the cathode-ray signal generator 14 by way of amplifiers 26 and 27 and the line and frame pedestals p_l and p_f having been supplied from the generator 18 and mixed with the video signal in the amplifier 27. The curve of Fig. 8 represents the line-synchronizing impulse wave developed by the generator 19, while the curves of Figs. 9 and 10 represent the alternate line-frequency impulse wave and parabolic-impulse wave, the latter being at double the line frequency developed by the generators 20 and 21-21c, respectively. As explained above with reference to Figs. 12/16, inclusive, the alternate line impulses are timed to occur intermediate the line-synchronizing impulses, while the parabolic impulses are timed to occur between succeeding impulses when the line-synchronizing and alternate-line impulse waves are combined.

The final desired modulation signal developed by the system is of the wave form shown in Fig. 11. To develop such a wave, the line-synchronizing impulses are repeated continuously by the tube 34 and are doubled by adding the alternate line-frequency impulses during a part of the retrace portion of each field-frequency cycle, which portion corresponds to the duration of the field pedestal. During a part of the line doubling period, the parabolic impulses are inserted between the doubled impulses to provide, in effect, relatively long, serrated, field-synchronizing impulses for each field cycle without interruption of the line-synchronizing impulses, and the combined synchronizing signal is combined with the video signal.

It is necessary that the alternate and parabolic impulses be added to the line-synchronizing impulses only during predetermined portions of each frame cycle. In Figs. 7 and 11, points x and x' correspond to the beginning and termination of a frame pedestal impulse such as supplied by the pedestal generator 18. The line doubling, or addition of the alternate-impulse wave, takes place between the points y and y' , the initiation of this action being delayed for the period represented at d_1 while the addition of the parabolic impulses takes place between the points z and z' , the initiation of the latter action being delayed for a period represented at d_2 .

The output circuits of the tubes 34, 35, and 36 being connected in parallel, when these tubes are conductive, the signals impressed on their input circuits are combined in their common output circuit. The tube 34 continuously repeats the line-synchronizing impulses (Fig. 8) received from generator 19. However, the tubes 35 and 36 are normally biased beyond cutoff by the fixed

biases applied to their suppressor grids. The periodic rectangular impulses developed by the oscillators 13a and 13b, delayed by intervals d_1 , d_2 , respectively, in a manner corresponding to that illustrated in Figs. 3-5, inclusive, however, are applied positively to the grids of the tubes 35 and 36, respectively, and serve to unblock these tubes for the durations $y-y'$, $z-z'$, respectively, of the impulses, so that the signals applied to their control grids from the generator 20 and limiter and amplifier 21c, respectively, are repeated only during the intervals $y-y'$, $z-z'$, respectively, in the common output circuit and are combined with the line-synchronizing impulses. Due to the predetermined delays effected by the delay apparatus of the present invention and the control of the duration of the rectangular-impulse waves generated by the oscillators 13a and 13b, the alternate and parabolic impulses are thus mixed with the line impulse during the precise desired part of the retrace portion of each frame cycle, initiating at points delayed with respect to the starting point x in the frame pedestal. The combined synchronizing signal is supplied to the amplifier 28 and therein mixed with the video signal, and the resultant modulation signal of the desired form shown in Fig. 11 is thus obtained.

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 periodic-impulse wave-generating system comprising means for deriving from a first periodic-impulse wave of a predetermined frequency a second periodic-impulse wave having impulses initiating at the occurrences of the impulses of said first wave and of predetermined duration independent of the duration of the impulses of said first wave, and means coupled to said first means for synchronization by the wave developed thereby for developing a third periodic-impulse wave comprising impulses initiating at the termination of the impulses of said second wave and having a duration independent of the duration of any of the other of said impulses.

2. A periodic-impulse wave-generating system comprising a first generator adapted to be synchronized by a periodic-impulse wave of a predetermined frequency for developing a periodic-rectangular-impulse wave comprising impulses having their leading edges initiating with the impulses of said first wave and of predetermined duration independent of the duration of the impulses of said first wave, a second generator for developing a periodic-impulse wave of said predetermined frequency, the duration of the impulses of the wave of said second generator being independent of the duration of any of the other of said impulses and means coupling said second generator to said first generator to synchronize the operation thereof and thereby to initiate the impulses of the wave developed by said second generator at the occurrences of the trailing edges of said rectangular impulses.

3. A periodic-impulse wave-generating system comprising means for deriving from a periodic-impulse wave of predetermined frequency a periodic-rectangular-impulse wave having impulses

initiating on the occurrence of the impulses of the first said wave and of predetermined duration independent of the duration of the impulses of said first wave, means for deriving from said rectangular-impulse wave a periodic-impulse wave having double impulses, the first and second impulses of each cycle of which occur, respectively, with the leading and trailing edges of one of said rectangular impulses, and means coupled to said double-impulse generating means for developing a periodic-impulse wave having impulses initiating on the occurrences of the second of said double impulses and having a duration independent of the duration of any of the other of said impulses.

4. A periodic-impulse wave-generating system comprising means for deriving from a periodic-impulse wave of a predetermined frequency a periodic-rectangular current-impulse wave having impulses initiating on the occurrence of the impulses of said first wave and of predetermined duration independent of the duration of the impulses of said first wave, current-differentiating means for deriving from said rectangular-current-impulse wave a periodic-impulse wave having double voltage impulses, the first and second impulses of each cycle of which occur, respectively, with the leading and trailing edges of one of said rectangular impulses, and means coupled to said double-impulse generating means for developing a periodic-voltage-impulse wave having impulses initiating on the occurrences of the second of said double impulses and having a duration independent of the duration of any of the other of said impulses.

5. A periodic-impulse wave-generating system comprising a source of periodic-voltage-impulse waves of predetermined frequency, a relaxation oscillator for developing a periodic-rectangular current-impulse wave having impulses of predetermined duration independent of the duration of the impulses of said first wave, means coupling said oscillator to said generator for synchronizing said oscillator to initiate said rectangular impulses on the occurrence of the impulses of said first wave, current-differentiating means for deriving from said rectangular-current-impulse wave a periodic-impulse wave having double-voltage impulses, the first and second impulses of each cycle of which occur, respectively, with the leading and trailing edges of one of said rectangular-current impulses, a relaxation oscillator for developing a periodic-voltage-impulse wave at said predetermined frequency, and means coupling said last-mentioned oscillator to said differentiating means for synchronizing the operation thereof to initiate the occurrences of the impulses of the wave developed thereby at the occurrences of the second of said double-voltage impulses.

6. In a television system, a synchronizing-signal generator comprising means for developing a periodic-impulse wave of a predetermined frequency, means for deriving from said wave a second wave having impulses initiating on the occurrence of the impulses of said first wave and of predetermined duration independent of the duration of the impulses of said first wave, means coupled to said first means for synchronization by the wave developed thereby for developing a periodic-impulse-control wave having impulses initiating at the termination of the impulses of said second wave and having a duration independent of the duration of any of the other of

said impulses, a plurality of separate periodic-impulse wave generators, means for combining the signal outputs of said plurality of generators to develop a single synchronizing signal, and means for utilizing said control wave for controlling the operation of said combining means.

7. In a television system, a synchronizing-signal generator comprising means for developing a periodic-impulse wave of a predetermined frequency, means for deriving from said wave a second wave having impulses initiating on the occurrence of the impulses of said first wave and of predetermined duration independent of the duration of the impulses of said first wave, means coupled to said first means for synchronization by the wave developed thereby for developing a periodic-impulse-control wave having impulses initiating at the termination of the impulses of said second wave and having a duration independent of the duration of any of the other of said impulses, a plurality of separate periodic-impulse wave generators, means for combining the signal outputs of said plurality of generators to develop a single synchronizing signal, and means for utilizing said control wave to control the duration of, and effect a phase delay in, the operation of said combining means.

8. In a television system, a synchronizing-signal generator comprising means for developing a timing periodic-impulse wave of a predetermined frequency, a plurality of separate control networks each comprising a first means for deriving from said timing wave a second wave having impulses initiating on the occurrence of the impulses of said timing wave and of predetermined durations independent of the duration of the impulses of said first wave, means coupled to said first means for synchronization by the wave developed thereby for developing a periodic-impulse-control wave having impulses initiating at the termination of the impulses of said second waves and having a duration independent of the duration of any of the other of said impulses, a plurality of separate periodic-impulse wave generators, means for combining the signal outputs of said plurality of generators to develop a single synchronizing signal, means for utilizing the control wave developed by one of said networks to control said combining means periodically to effect combining of the wave developed by one of said generators with the wave developed by a second of said generators, and means for utilizing the control wave developed by another of said networks to control said combining means periodically to effect combining of the wave developed by another of said generators with said wave developed by said second generator.

9. In a television system, a synchronizing-signal generator comprising means for developing a periodic line-scanning impulse wave of a predetermined frequency, means for developing an alternate periodic-impulse wave of said predetermined frequency and having impulses occurring intermediate said line-scanning impulses, means for developing a periodic-parabolic-impulse wave of double said predetermined frequency and having impulses occurring between said line-scanning and alternate impulses, means for developing a periodic frame-frequency impulse wave of a predetermined frequency less than said line frequency, means for combining said alternate and parabolic-impulse waves with said line impulse waves, means for deriving from said frame-frequency wave a periodic-impulse wave having

impulses occurring at the initiation of said frame-frequency impulses and of predetermined duration, and means coupled to said last-mentioned means for synchronization thereby for developing a periodic-impulse-control wave having impulses initiating at the termination of the impulses of said last-mentioned wave, and means for utilizing said control wave for effecting operation of said combining means only during a predetermined period of each frame-frequency cycle delayed with respect to the initiation of the frame-scanning impulse.

10. In a television system, a synchronizing-signal generator comprising means for developing a periodic line-scanning impulse wave of a predetermined frequency, means for developing an alternate periodic-impulse wave of said predetermined frequency and having impulses occurring intermediate said line-scanning impulses, means for developing a periodic-parabolic-impulse wave of double said predetermined frequency and having impulses occurring between said line-scanning and alternate impulses, means for developing a periodic frame-frequency impulse wave of a predetermined frequency less than said line frequency, means for developing a periodic-pedestal-impulse wave at said frame frequency and having impulses of predetermined duration initiating at said frame-frequency impulses, means for combining said alternate and parabolic impulses with said line impulses, two separate means for controlling said combining means each including means for deriving from said frame-frequency impulses a first periodic-impulse wave having impulses occurring on the initiation of said frame-frequency impulses and of predetermined duration and means coupled to the last-mentioned means for synchronization by the wave developed thereby for developing a periodic-control-impulse wave comprising impulses occurring at the termination of the impulse of said first wave, means for utilizing one of said control waves to effect operation of said combining means with respect to said alternate impulses for predetermined periods corresponding to a given portion of said frame-pedestal impulses and delayed with respect to said frame-frequency impulses, means for utilizing the other of said control means to effect the operation of said combining means with respect to said parabolic impulses for predetermined periods corresponding to a given portion of said first-mentioned portions of said frame-pedestal impulses and delayed with respect to said frame-frequency impulse for a period greater than said first-mentioned delay, and means for combining the output of said combining means with said pedestal-impulse wave.

11. A periodic-impulse wave-generating system comprising means for developing a first periodic wave of predetermined frequency, means for deriving from said first wave a periodic line-scanning rectangular-impulse wave of half said predetermined frequency, means for deriving from said first wave an alternate periodic-rectangular-impulse wave of half said predetermined frequency and having impulses occurring intermediate said line-scanning impulses, means for deriving from said first wave a periodic-parabolic-impulse wave of said predetermined frequency and having impulses occurring between said line-scanning and alternate impulses, and means for combining said line-scanning, alternate, and parabolic-impulse waves.

12. A periodic-impulse wave-generating system comprising means for developing a first periodic

wave of a predetermined frequency, means for deriving from said first wave a periodic line-scanning rectangular-impulse wave of half said predetermined frequency, means for deriving from said first wave an alternate periodic-rectangular-impulse wave of half said predetermined frequency and having impulses occurring intermediate said line-scanning impulses, means for deriving as an infinitesimal calculus function of said first wave a parabolic-impulse wave of said predetermined frequency and having impulses occurring between said line-scanning and alternate impulses, and means for combining said line-scanning, alternate, and parabolic-impulse waves.

13. In a television system, a synchronizing-signal generator comprising means for developing a periodic line-scanning rectangular-impulse wave of a predetermined frequency, means for developing an alternate periodic-rectangular-impulse wave of said predetermined frequency and having impulses occurring intermediate said line-scanning impulses, means for developing a periodic-parabolic-impulse wave of double said predetermined frequency and having impulses occurring between said line-scanning and alternate impulses, means for periodically combining said alternate wave with said line-scanning wave for predetermined periods, and means for periodically combining said parabolic wave with the combined line-scanning and alternate waves for predetermined periods comprising given portions of said first-mentioned predetermined periods.

14. In a television system the combination of means for developing a periodic frame-pedestal impulse wave of a predetermined frequency, means for developing a periodic line-scanning rectangular-impulse wave of a predetermined frequency, means for developing an alternate periodic-rectangular-impulse wave of said predetermined line-scanning frequency and having impulses occurring intermediate said line-scanning impulses, means for developing a periodic-parabolic-impulse wave of double said predetermined line-scanning frequency and having impulses occurring between said line-scanning and alternate impulses, means for periodically combining said alternate waves with said line-scanning waves for predetermined periods comprising given portions of said frame-pedestal impulses, means for combining said parabolic-impulse wave with said combined line-scanning and alternate waves for predetermined periods comprising given portions of said first-mentioned predetermined periods, and means for combining said combined line-scanning, alternate, and parabolic waves with said frame pedestal-impulse wave.

15. A periodic-impulse wave-generating system comprising means for developing a first periodic wave of a predetermined frequency and of saw-tooth wave form and including trace and retrace portions, means for deriving as an infinitesimal calculus function of said saw-tooth wave a periodic wave of said predetermined frequency and of parabolic wave form, and means for limiting and amplifying said last-named wave to derive therefrom a periodic wave of said predetermined frequency comprising only parabolic impulses occurring during the trace portions of said saw-tooth wave.

16. A periodic-impulse wave-generating system comprising means for developing a first periodic wave of a predetermined frequency and of rectangular-impulse wave form, means for deriving from said first wave a periodic wave of said predetermined frequency and of saw-tooth wave form in-

cluding trace periods and having retrace periods occurring during said rectangular impulses, means for deriving as an infinitesimal calculus function of said saw-tooth wave a periodic wave of said predetermined frequency and of parabolic wave form including portions occurring during said saw-tooth wave trace portions, and means for limiting said parabolic wave to derive a periodic wave of said predetermined frequency comprising only parabolic impulses occurring intermediate said rectangular impulses of said first wave.

17. The method of developing a periodic-impulse wave having impulses delayed in phase with respect to the impulses of a first periodic-impulse wave, which comprises deriving from said first wave a second periodic-impulse wave having impulses initiating on the occurrence of the impulses of said first wave and of predetermined duration independent of the duration of the impulses of said first wave, and deriving from said second wave a third periodic-impulse wave comprising impulses initiating at the termination of the impulses of said second wave and having a duration independent of the duration of any of the other of said impulses.

18. The method of developing a periodic-impulse wave having impulses delayed in phase with respect to impulses of a first periodic-impulse wave, which comprises deriving from said first wave a second periodic-impulse wave having rectangular impulses initiating on the occurrence of the impulses of said first wave and of predetermined duration independent of the duration of the impulses of said first wave, differentiating said rectangular-impulse wave to derive a third periodic-impulse wave having double impulses, the first and second impulses of each cycle of which occur, respectively, with the leading and trailing edges of said rectangular impulses, and deriving from said third wave a fourth periodic-impulse wave having impulses initiating on the occurrence of the second of said double impulses and having a duration independent of the duration of any of the other of said impulses.

19. The method of developing a television synchronizing-impulse wave which comprises developing a first periodic line-scanning rectangular-impulse wave of a predetermined frequency, developing an alternate periodic-rectangular-impulse wave of said predetermined frequency and having impulses occurring intermediate said line-scanning impulses, developing a periodic-parabolic-impulse wave of double said predetermined frequency and having impulses occurring between said line-scanning and alternate impulses, periodically combining said alternate wave and said line-scanning wave for predetermined periods, and periodically combining said parabolic wave with the combined line-scanning and alternate waves for predetermined periods comprising given portions of said first-mentioned predetermined periods.

20. The method of developing a television signal which comprises developing a periodic frame-pedestal impulse wave of a predetermined frequency, developing a periodic line-scanning rectangular-impulse wave of a predetermined frequency, developing an alternate periodic-rectangular-impulse wave of said predetermined line-scanning frequency and having impulses occurring intermediate said line-scanning impulses, developing a periodic-parabolic-impulse wave of double said predetermined frequency and having impulses occurring between said line-scanning and alternate impulses, periodically combining said alternate wave with said line-scanning wave for predetermined periods comprising given portions of said frame-pedestal impulses, combining said parabolic-impulse wave with said combined line-scanning and alternate waves for predetermined periods comprising given portions of said first-mentioned predetermined periods, and combining said combined line-scanning, alternate, and parabolic waves with said frame-pedestal impulse wave.

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