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PULSE-MODULATED WAVE-SIGNAL GENERATOR

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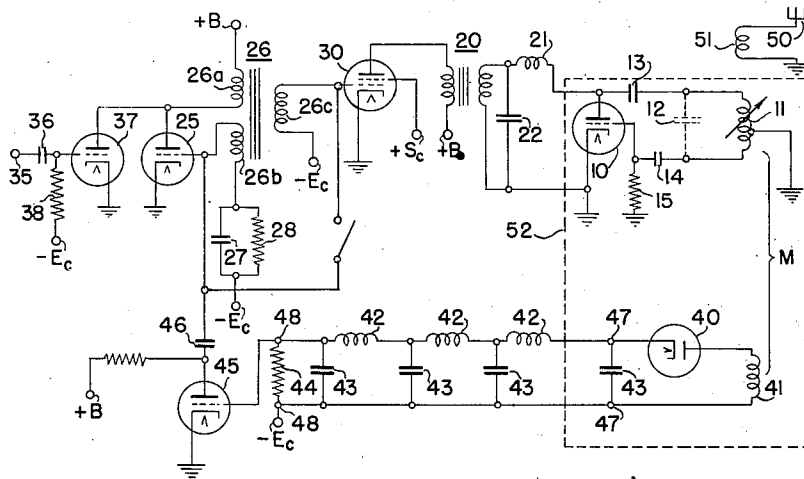


FIG. 1

FIG. 2

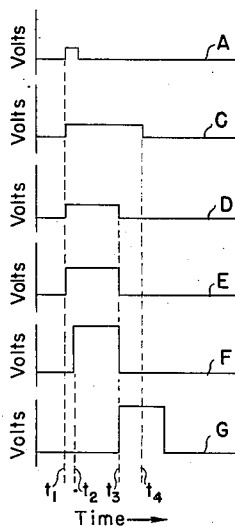
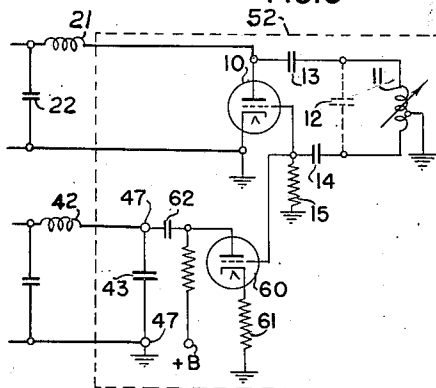


FIG. 3



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PULSE-MODULATED WAVE-SIGNAL
GENERATOR

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9 Claims. (Cl. 250—36)

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This invention relates, in general, to wave-signal generators. It is especially directed to arrangements in which wave signals of pulse wave form having a predetermined duration are produced by controlling an oscillation generator having an operating frequency the period of which is much less than the duration of the pulse signals to be produced. While the invention is subject to a variety of applications, it is particularly suited to radio-locator and direction-finder systems utilizing pulse-modulated high-frequency signals and will be described in detail in that connection.

In certain radio-locator and direction-finder systems a pulse of high-frequency energy having a desired duration is transmitted and a reflection thereof, picked up by a suitable receiver, is used in obtaining the required direction-finding or locating information. Frequently, the transmitting and receiving units are interconnected so that the transmitter is keyed into a succeeding cycle of operation following the receipt at the receiver of a reflection of a given transmitted pulse. In one such arrangement of the prior art, the transmitter comprises a high-frequency oscillation generator which includes a vacuum tube having anode, cathode, and control electrodes but normally having no anode-cathode excitation potential. A keyed or synchronized blocking oscillator is associated with the high-frequency generator for applying a pulse of excitation potential to the anode and cathode electrodes thereof. The applied pulse of potential initiates oscillations in the high-frequency generator and sustains these oscillations as required to produce an output pulse for transmission. Usually, the blocking oscillator is keyed in response to an output signal of the receiver unit to effect pulse-by-pulse operation. That is, an output pulse is transmitted in response to each received pulse in view of the link or control extending from the receiver to the transmitter.

The described arrangement is satisfactory for many installations but may not provide sufficient control over the duration of the transmitted pulses for other installations. It is found that the starting time of the high-frequency oscillation generator in response to an applied pulse of excitation potential may be variable. By "starting time" is meant the interval between the application of the pulse of potential and the initiation of oscillations. It may vary with such factors as the characteristics of the vacuum tube employed in the high-frequency generator, the circuit components associated therewith and the

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conditions of loading. As a result, the transmitted pulses are shorter than the applied pulse of excitation potential by the starting time and may have an undesirably variable duration.

It is an object of the present invention, therefore, to provide an improved arrangement for generating wave signals of pulse wave form and which substantially avoids the aforementioned limitation of prior art arrangements.

It is a particular object of the invention to provide an improved arrangement including an oscillation generator controlled by an applied control signal to produce wave signals of pulse wave form, each pulse of which has a predetermined duration.

In accordance with the invention, an arrangement for generating wave signals of pulse wave form comprises a wave-signal oscillation generator having an output circuit and normally maintained in a nonconducting condition. The arrangement has means for supplying to the oscillation generator a control pulse which is effective to initiate and sustain oscillations therein to produce a wave signal. There is also provided a time-delay system coupled to the output circuit of the generator to be responsive to the initiation of the aforesaid oscillations for deriving a control potential and for utilizing the control potential effectively to interrupt the control pulse and restore the oscillation generator to its normal nonconducting condition a predetermined time interval following the initiation of oscillations. The arrangement further includes means for deriving from the oscillation generator an output wave signal of pulse wave form, each pulse of which has a duration corresponding to the above-mentioned predetermined time interval.

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

In the drawing, Fig. 1 is a schematic representation of a wave-signal generator embodying the present invention; Fig. 2 comprises graphs used in explaining the operation of the Fig. 1 arrangement; and Fig. 3 represents schematically a modification of a portion of the Fig. 1 arrangement.

Referring now more particularly to Fig. 1, there is represented an arrangement for generating wave signals of pulse wave form, specifically pulses or bursts of high-frequency energy having a desired predetermined duration. The arrange-

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ment comprises a high-frequency oscillation generator to be controlled, in a manner made clear hereinafter, to produce output signals of pulse wave form, each pulse of which has a desired duration. This generator includes an electron-discharge device or triode vacuum tube 10 having an anode, a cathode, and a control electrode. A frequency-determining circuit, provided by an adjustable inductor 11 and a condenser 12, is coupled by way of condensers 13 and 14 to the anode and control electrodes, respectively, of tube 10. Condenser 12 is shown in broken-line construction since it may be comprised, in whole or in part, of the distributed capacitance of inductor 11 and stray capacitances associated therewith. The center tap of inductor 11 is grounded as is the cathode of tube 10, thereby to complete the alternating current paths of the generator. A leak resistor 15 is connected to the control electrode of the tube. This tube is normally maintained in a nonconductive condition since no excitation potential is normally applied to its anode and cathode electrodes. However, oscillations may be initiated and sustained within the generator by applying a control signal or a pulse of excitation potential to tube 10 by way of a pulse transformer 20, the secondary winding of which is directly coupled between the anode and cathode electrodes of tube 10. Inductor 21 is a choke for signals having a frequency corresponding to the operating frequency of the oscillation generator. Condenser 22 is a by-pass for such signals. The frequency-determining circuit of the described oscillation generator is selected to provide an operating frequency the period of which is very much less than the desired pulse duration of the wave signals to be produced.

The arrangement of Fig. 1 has means for supplying to the high-frequency generator a control signal that is effective to initiate and sustain oscillations therein in order to produce an output wave signal. This means comprises a relaxation oscillator, specifically a blocking oscillator, coupled to the high-frequency generator and including a triode vacuum tube 25. A source of space current, indicated +B, is connected by way of a first winding 26a of a pulse transformer 26 to the anode of tube 25. A second winding 26b of transformer 26, connected with the control electrode of tube 25 and inductively coupled with winding 26a, provides a regenerative feedback between the input and the output circuits. A time-constant circuit consisting of a condenser 27 and a resistor 28 is also connected with the control electrode of tube 25 to control the operating cycle of the blocking oscillator in well-known manner. Tube 25 is normally blocked by a holding voltage applied to its control electrode from a source of bias potential, indicated -E_c. Preferably, the parameters of the blocking oscillator are so selected that the control pulse or signal generated in each uninterrupted cycle of operation has a duration which is longer than the desired pulse duration of the wave signals to be produced in high-frequency oscillator 10.

A third winding 26c of pulse transformer 26 is coupled to the blocking oscillator for applying the output signal obtained therefrom to a pulse amplifier including the tetrode vacuum tube 30. The primary winding of pulse transformer 20 is included in the output circuit of tube 30 and operating potentials are applied to the tube from the sources indicated +B, +S_c and -E_c. The source -E_c has such a value that the pulse amplifier is normally maintained in a non-conductive

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condition. The windings of pulse transformers 20 and 26 are so poled that the pulse output of the blocking oscillator is applied to the anode-cathode circuit of tube 10 with positive polarity.

A keying or synchronizing circuit is associated with the blocking oscillator for keying the oscillator into operation when a wave signal of high-frequency energy is desired from high-frequency generator 10. The synchronizing circuit comprises an input terminal 35 coupled through a condenser 36 to the input circuit of a triode vacuum tube repeater 37. The anode and cathode electrodes of tube 37 are arranged in parallel relationship with the corresponding elements of tube 25. Repeater 37 is normally biased to anode current cutoff by way of a potential source, indicated -E_c, connected with the control electrode thereof through a resistor 38.

The pulse duration of the wave signal generated by high-frequency oscillator 10 is controlled by a time-delay means responsive to the initiation of oscillations therein for deriving a control potential and for utilizing the control potential effectively to interrupt the control signal applied to tube 10 and restore the high-frequency oscillator to its normal nonconductive condition a predetermined time interval following the initiation of oscillations therein. This means comprises a diode 40 which is coupled with the frequency-determining circuit of high-frequency oscillator 10 by way of an inductor 41, coupled with inductor 11 as indicated by the bracket M. The input terminals 47, 47 of a time-delay network are connected through inductor 41 across the electrodes of diode 40 for utilizing a control voltage derived therefrom. The delay network has a conventional construction including series-connected inductors 42, 42 and intervening shunt-connected condensers 43, 43. The output terminals 48, 48 of the time-delay network are terminated in a resistor 44 selected to provide a termination corresponding to the characteristic impedance of the network. Resistor 44 is included in the input circuit of a vacuum-tube repeater 45 which is normally biased to anode current cutoff by a suitable source indicated -E_c. A condenser 46 couples the output circuit of repeater 45 to the input circuit of blocking oscillator 25.

An antenna-ground system 50, including an inductor 51 coupled with the frequency-determining circuit of high-frequency oscillator 10, constitutes means for deriving therefrom an output wave signal of pulse wave form, each pulse of which has a desired predetermined duration.

The arrangement of Fig. 1 may be utilized as the transmitting unit of a radio-locator and direction-finding system of the type referred to above. Input terminal 35 may indicate an input terminal of the transmitting unit which may be connected with an output terminal of the associated receiver unit so that the operation of the transmitter is controlled by the receiver output. However, since a complete understanding of the present invention may be obtained from the schematic diagram of Fig. 1, the remaining portions of the radio-locator and direction-finding system have been omitted from the drawing.

In considering the operation of the described arrangement, reference is made to the curves of Fig. 2 in which curve A represents a synchronizing signal applied at the time t_1 with positive polarity to input terminal 35. The synchronizing signal is repeated by repeater 37 and translated by way of transformer windings 26a and 26b to the input circuit of blocking oscillator 25 where it also

appears with positive polarity. The synchronizing pulse thus initiates a cycle of operation of the blocking oscillator which, if permitted to continue uninterruptedly, produces the output pulse of curve C in well understood manner. This pulse has a duration t_1-t_4 which exceeds the pulse duration of the wave signal to be produced in high-frequency generator 10. However, the operation of the blocking oscillator is interrupted, in a manner to be described presently, so that its output signal is represented by curve D.

If the time of signal translation through the pulse amplifier 30 be neglected, the amplified pulse output of the blocking oscillator is applied at the time t_1 to the anode and cathode electrodes of tube 19 with positive polarity, as represented by curve E. At the time t_2 oscillations are initiated in high-frequency oscillator 10, where the interval t_1-t_2 represents the starting-time interval defined herein before. The oscillations once initiated continue for the remaining duration of the applied pulse of excitation potential and produce the required output wave signal of high-frequency energy. In view of the coupling between inductor 11 of high-frequency oscillator 10 and inductor 41, the generated oscillations are rectified so that there is applied, substantially at the time t_2 , a control pulse of positive polarity to the input terminals 47, 47 of the time-delay network. This control pulse is represented in curve F. It traverses the time-delay network and arrives at the terminating resistor 44 at the time t_3 as shown by curve G, where the interval t_2-t_3 represents the delay of the network. At the time t_3 the control pulse or potential renders repeater 45 conductive and appears in the output circuit thereof as a signal pulse of negative polarity. This signal pulse of negative polarity is added into the input circuit of the blocking oscillator 25 to block or interrupt the normal operation of the blocking oscillator at the time t_3 . At this same time t_3 , the output pulse of the blocking oscillator and the input pulse of excitation potential supplied to high-frequency oscillator 10 are terminated. The high-frequency oscillator 10 is thus restored to its normal non-conductive condition, terminating oscillations therein. Therefore, it is apparent that the high-frequency oscillator generates oscillations and produces an output wave signal during the interval t_2-t_3 corresponding to the time delay of network 42, 43. The time delay of the network is adjusted to provide the desired pulse duration for the output wave signal obtained from high-frequency oscillator 10 and transmitted by antenna system 50, 51.

In Fig. 3 there is represented a modification of that portion of the Fig. 1 arrangement enclosed within the broken-line rectangle 52. It represents the vacuum tube and frequency-determining circuit of the high-frequency oscillation generator, the several elements thereof being designated by the same reference characters as in Fig. 1. It also represents the coupling between high-frequency oscillator 10 and the input terminals 47, 47 of the time-delay network. Only the input terminals, the first shunt-connected condenser 43 and the first inductor 42 of the delay network are shown. This circuit comprises a triode amplifier 60 which has an input circuit coupled across resistor 15 of the high-frequency generator and an output circuit coupled to the time-delay network through a condenser 62. Tube 60 is provided with a cathode impedance 61 for developing a self-bias which

maintains the tube in a predetermined conductive condition.

The operation of the wave-signal generator modified in the manner of Fig. 3 is generally similar to that of Fig. 1. In Fig. 3 advantage is taken of the fact that the high-frequency oscillation generator 10 develops its own bias by grid current rectification. In view of this fact, a voltage pulse of negative polarity is established across resistor 15 in the input circuits of tubes 19 and 60 almost as soon as the oscillations are initiated. This voltage pulse of negative polarity is translated by vacuum tube 60, appearing in the output circuit thereof and at the input terminals 47, 47 of the time-delay network with positive polarity. The control potential traverses the time-delay network, terminating the operation of blocking oscillator 25 and high-frequency oscillation generator 10, in the manner already described, after a time interval which corresponds to the desired pulse duration of the wave signal to be transmitted.

In the illustrated embodiments of the invention, the control potential derived in the output circuit of repeater 45 in response to the initiation of oscillations in high-frequency generator 10 is applied directly to the blocking oscillator to interrupt its normal operation. It will be understood that this control potential may, if desired, be utilized to reduce the gain of pulse amplifier 30. In that case, the output circuit of repeater 45 is also to be connected to the control electrode of tube 30. This may be accomplished by closing the switches indicated in Fig. 1. By reducing the gain of this amplifier, the pulse of excitation potential applied to tube 19 may be so reduced in intensity at the time interval t_3 that oscillations are interrupted in high-frequency oscillator 10 to terminate the generation of the output wave signal. Where this mode of operation is employed, the control signal or pulse of excitation potential applied from the blocking oscillator to the high-frequency oscillation generator may be said to be effectively interrupted.

In the preferred embodiments of the invention, the circuit of blocking oscillator 25 is so adjusted that its normal or uninterrupted conductive period, represented t_1-t_4 in Fig. 2, is not very much longer than the desired pulse duration of the wave signals obtained in high-frequency generator 10. Where this adjustment is made, the control potential applied to the blocking oscillator from repeater 45 may have a relatively low intensity and yet be able to block the operation of tube 25. This adjustment also prevents the generation of excessively long pulses by the blocking oscillator in the event of failure of tubes 30 or 19.

While there have been described what are at present considered to be the preferred embodiments 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. An arrangement for generating wave signals of pulse wave form comprising, a wave-signal oscillation generator having an output circuit and normally maintained in a nonconducting condition, means for supplying to said generator a control pulse effective to initiate and sustain oscillations therein to produce a wave signal, a time-

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delay system coupled to said output circuit of said generator to be responsive to the initiation of said oscillations for deriving a control potential and for utilizing said control potential effectively to interrupt said control pulse and restore said generator to its normal nonconducting condition a predetermined time interval following the initiation of said oscillations, and means for deriving from said generator an output wave signal of pulse wave form, each pulse of which has a duration corresponding to said predetermined time interval.

2. An arrangement for generating wave signals of pulse wave form comprising, a wave-signal oscillation generator having an output circuit and normally maintained in a nonconducting condition, means for supplying to said generator a control pulse effective to initiate and sustain oscillations therein to produce a wave signal, a control system coupled to said output circuit of said generator to be responsive to the initiation of said oscillations for deriving a control potential, time-delay means for utilizing said control potential effectively to interrupt said control pulse and restore said generator to its normal nonconducting condition a predetermined time interval following the initiation of said oscillations, and means for deriving from said generator an output wave signal of pulse wave form, each pulse of which has a duration corresponding to said predetermined time interval.

3. An arrangement for generating wave signals comprising, a wave-signal oscillation generator having an output circuit and normally maintained in a nonconducting condition, means for supplying to said generator a control pulse effective to initiate and sustain oscillations therein to produce a wave signal, means coupled to said output circuit of said generator and including a rectifier for rectifying said oscillations to derive a control potential and a time-delay network for utilizing said control potential effectively to interrupt said control pulse and restore said generator to its normal nonconducting condition a predetermined time interval following the initiation of said oscillations, and means for deriving from said generator an output wave signal of pulse wave form, each pulse of which has a duration corresponding to said predetermined time interval.

4. An arrangement for generating wave signals comprising, a wave-signal oscillation generator having an output circuit and normally maintained in a nonconducting condition, means including an auxiliary generator for supplying to said oscillation generator a control pulse effective to initiate and sustain oscillations therein to produce a wave signal, a time-delay system coupled to said output circuit of said oscillation generator to be responsive to the initiation of said oscillations for deriving a control potential and for utilizing said control potential effectively to block said auxiliary generator and restore said oscillation generator to its normal nonconducting condition a predetermined time interval following the initiation of said oscillations, and means for deriving from said oscillation generator an output wave signal of pulse wave form, each pulse of which has a duration corresponding to said predetermined time interval.

5. An arrangement for generating wave signals comprising, a wave-signal oscillation generator having an output circuit for producing an output wave signal of pulse wave form having a predetermined pulse duration but normally maintained

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in a nonconducting condition, a relaxation oscillator coupled to said oscillation generator for normally supplying thereto a control pulse having a duration substantially exceeding said predetermined duration and effective to initiate and sustain oscillations in said oscillation generator to produce said output wave signal, a time-delay system coupled to said output circuit of said oscillation generator to be responsive to the initiation of said oscillations for deriving a control potential and for utilizing said control potential effectively to block said relaxation oscillator and restore said oscillation generator to its normal nonconducting condition at a time interval following the initiation of said oscillations equal to said predetermined pulse duration, and means for deriving said output wave signal from said oscillation generator.

6. An arrangement for generating wave signals comprising, a wave-signal oscillation generator having an output circuit for producing an output wave signal of pulse wave form having a predetermined pulse duration but normally maintained in a nonconducting condition, a blocking oscillator coupled to said oscillation generator for normally supplying thereto a control pulse having a duration substantially exceeding said predetermined duration and effective to initiate and sustain oscillations to said oscillation generator to produce said output wave signal, a time-delay system coupled to said output circuit of said generator to be responsive to the initiation of said oscillations for deriving a control potential and for utilizing said control potential effectively to block said blocking oscillator and restore said oscillation generator to its normal nonconducting condition at a time interval following the initiation of said oscillations equal to said predetermined pulse duration, and means for deriving said output wave signal from said oscillation generator.

7. An arrangement for generating wave signals comprising, a wave-signal oscillation generator having an output circuit and including an electron-discharge device having an anode and a cathode for producing an output wave signal of pulse wave form having a predetermined pulse duration but normally maintained in a nonconducting condition, a relaxation oscillator for normally applying between said anode and cathode a pulse of excitation potential having a duration substantially exceeding said predetermined duration and effective to initiate and sustain oscillations in said oscillation generator to produce said output wave signal, a time-delay system coupled to said output circuit of said generator to be responsive to the initiation of said oscillations for deriving a control potential and for utilizing said control potential effectively to block said relaxation oscillator and restore said oscillation generator to its normal nonconducting condition at a time interval following the initiation of said oscillations equal to said predetermined pulse duration, and means for deriving said output wave signal from said oscillation generator.

8. An arrangement for generating wave signals comprising, a wave-signal oscillation generator including an electron-discharge device having an anode, a cathode, and a control electrode but normally maintained in a nonconducting condition, means for supplying to said generator a control pulse effective to initiate and sustain oscillations therein to produce a wave signal, time-delay means coupled between said cathode

and control electrode and responsive to the initiation of said oscillations for deriving a control potential and for utilizing said control potential effectively to interrupt said control pulse and restore said generator to its normal nonconducting condition a predetermined time interval following the initiation of said oscillations, and means for deriving from said generator an output wave signal of pulse wave form, each pulse of which has a duration corresponding to said predetermined time interval.

9. An arrangement for generating wave signals of pulse wave form comprising, a wave-signal oscillation generator having an output circuit and having an operating frequency the period of which is very much less than the pulse duration of the wave signals to be generated but normally maintained in a nonconducting condition, means for supplying to said generator a control pulse effective to initiate and sustain oscillations therein to produce a wave signal, a time-delay system coupled to said output circuit of said generator to be responsive to the initiation of said

oscillations for deriving a control potential and for utilizing said control potential effectively to interrupt said control pulse and restore said generator to its normal nonconducting condition a predetermined time interval following the initiation of said oscillations, and means for deriving from said generator an output wave signal of pulse wave form, each pulse of which has a duration corresponding to said predetermined time interval.

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