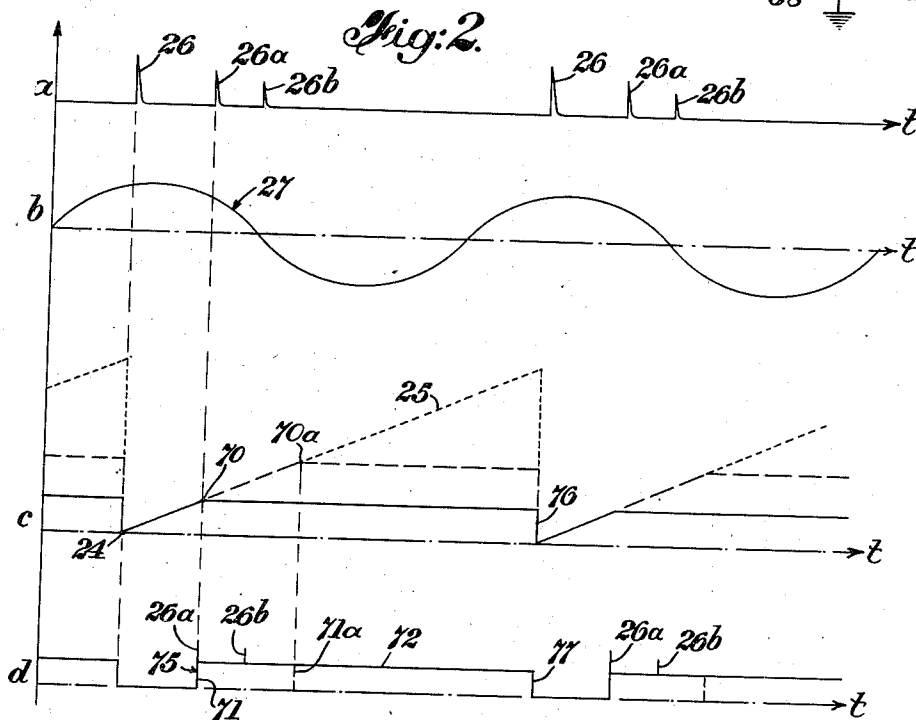
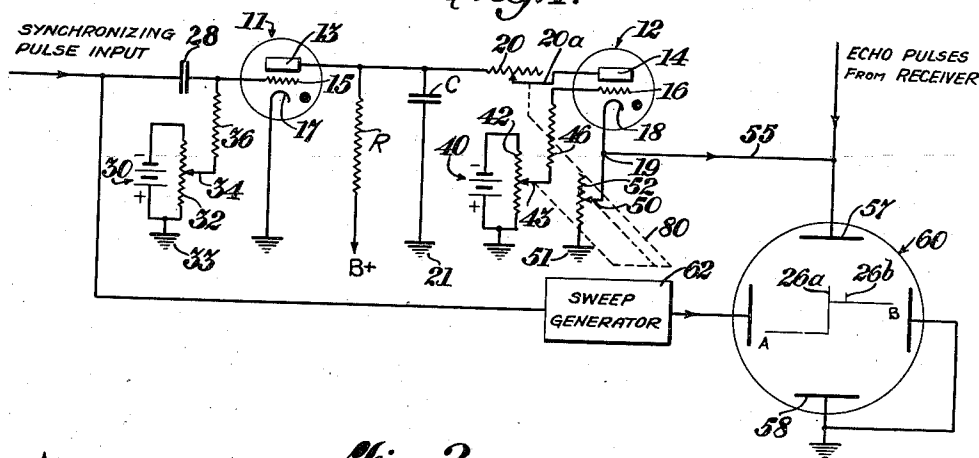


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PULSE RADAR SYSTEM
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Fig:1.



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PULSE RADAR SYSTEM

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My invention relates to radio systems and more particularly to the generation of a pulse of variable width for use in radio and other electrical systems.

One of the objects of my invention is to provide a method and means to produce a pulse of variable width or duration in which the leading edge thereof is adjustable relative to a given point such as determined by the trailing edge thereof or by a synchronizing pulse or by other potential point such as a selected potential on the rising part of an alternating current wave.

Another object of my invention is to provide for the production of a reference marker for an oscillograph of a radio detection system adjustable relative to a reference point representing the transmission of an impulse for determination of the time interval between such point and an echo pulse received in response to the transmitted impulse.

According to my invention, I provide a supply of energy to charge at a given rate a condenser or other energy storing device. I provide two controlled conductable paths connected in parallel with the condenser. I use one of the conductable paths to repetitiously discharge the condenser so as to establish a reference point at which the potential build-up on the condenser is initiated. The other of the conductable paths I use to shunt energy from the condenser when a potential build-up reaches a selected potential so as to effect a voltage rise defining the leading edge of a desired pulse. This shunting action occurs at an interval of time after the establishment of a reference point in proportion to the potential at which the shunting action is produced. By using suitable means for effecting the shunting and discharge actions, sharp changes in the pulse potential may be effected. Initiation of the shunting action produces a substantially vertical potential rise defining the leading edge of a rectangularly-shaped pulse. The continuation of the shunting action controls the amplitude for the duration of the pulse and the discharge action terminates the pulse in a substantially vertical trailing edge. The amplitude of the pulse may be permitted to vary in accordance with variations in width or means may be provided to maintain a substantially constant amplitude regardless of variations in width.

By practicing the method of my invention, the leading edge of the pulse may be made to vary with respect to a reference point determined by the initiation of the potential build-up from

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which the pulse is produced. This variable width pulse may be used as a marker for the oscillograph of a radio detection system, the leading edge thereof being used as a marker for adjustment along the trace line to the position of an echo pulse, the reference point above referred to being synchronized with the transmission of impulses of the system. When the echo pulse is caused to be superimposed upon the leading edge of the marker pulse, the setting of the means for controlling the shunting action may be taken as a measure of the time interval or distance corresponding to the space between the reference point and the echo pulse.

For a further understanding of my invention, reference may be had to the following detailed description to be read in connection with the accompanying drawings, in which:

Fig. 1 is a schematic wiring diagram in accordance with my invention, and

Fig. 2 is a graphical illustration of the operating principles thereof.

Referring to the drawings, an embodiment of the variable width pulse generator of my invention is shown in Fig. 1 comprising first and second gas-filled tubes 11 and 12 which preferably are of the type known under the trademark "Thyratron" #884. The tubes 11 and 12 comprise anodes 13, 14, grids 15, 16 and cathodes 17, 18 respectively. The anodes 13 and 14 are interconnected by a resistor 20. Connected to the anode 13 is a condenser C the other side of which is connected to ground at 21. Connected also to the anode 13 through a resistor R is a source of energy B+. The energy supplied to the condenser C from the source B+ is controlled by the time constant RC. This charging rate provides for the build-up of a potential sweep substantially as indicated by the sloping line 25 (curve c, Fig. 2). The initiation and termination of the sweep potential as indicated by curve c is controlled by conduction of the first tube 11. The termination of one sweep potential and initiation of another defines a reference point 24 the use of which is hereinafter described. Conduction of the tube 11 may be produced by application of a source of synchronizing pulses 26 (curve a) to the grid 15 thereof or by application thereto of an alternating current 27 (curve b), the grid in the latter case being suitably biased so that conduction will be produced at a selected potential on the positive half cycle of the alternating current wave.

The input connection to the tube 11 is made through a coupling condenser 23 to the grid 15.

The bias on the grid 15 is produced from a current source such as a battery 30 having a resistor 32 thereacross and connected to ground at 33. The resistor 32 has a contact 34 which is connected to the grid 15, preferably through a second resistor 36. By varying the position of the contact 34 suitable bias can be obtained at the grid 15. After each conduction period of the tube 11 the source of energy B+ charges the condenser C in accordance with the sawtooth voltage indicated by curve c. Should the conduction of the tube 11 be controlled by synchronizing pulses 26 (curve a), the initiation or reference point 24 for each cycle potential build-up will be in timed relation with a pulse 26.

The second tube 12 controls the occurrence of a potential derived from the energy applied to the condenser C to produce the pulse potential desired. The occurrence of conduction of the tube 12 is controlled by a source of energy such as the battery 40 across which is provided a variable resistor 42 having a movable contact 43 connected through a fixed resistor 46 to the grid 16. The cathode 18 is connected to a movable tap 50 of a variable resistor 52 which, being grounded at 51, is in effect connected between the cathode terminal 19 and the condenser C. A pulse output connection 55 is taken off at the terminal 19 and as shown may be applied to deflection plates 57 and 58 of an oscillograph 60. Where a source of synchronizing pulses 26 is supplied to the tube 11, they may also be supplied to operate a sweep generator 62 for the oscillograph 60 to generate a sweep potential therefor thereby producing a trace line A-B in synchronism with the potential build-up cycles of the pulse generator.

The production of the pulse output by which the leading edge may be used as a marker for the trace line A-B is determined by the bias on the grid 16 of the tube 12. This bias may be varied as desired by adjustment of the contact 43. Assuming that the bias is such as to require a potential on the condenser C of an amplitude corresponding to the line 70 (curve c) the condenser will then build-up to the potential corresponding to the amplitude 70 before the tube 12 fires. The firing of the tube 12 produces a sudden increase in potential at the cathode terminal 19 as indicated by a vertical line 71 thereby defining a leading edge for the pulse 75. The height and flatness of the top 72 of the pulse 75 is controlled by the ganged control of the resistor contacts 20a, 43 and 50. The amplitude of the pulse is largely controlled by adjustment of the contact 50. Independent adjustment of the contacts 20a and 43 will cause change in amplitude of the pulse 75, but this variation is compensated for by the adjustment of contact 50 so that a substantially constant amplitude may be had regardless of variations in width. Without corresponding adjustments of the contact 20a as the contact 43 is adjusted for tube firing at different condenser potentials the top of the pulse would deviate from the flat shape due to the exponential characteristic of the condenser potential. Corresponding adjustment of the contact 20a, however, compensates for the exponential effect of the potential 25 and maintains the top 72 substantially flat, or any other predetermined shape desired. In the absence of a ganged adjustment of the contacts 20a, 43 and 50, a limiting clipper may be added to the output at 19 to insure a constant amplitude flat top pulse.

Should the contact 43 be moved along the re-

sistor 42 so as to produce a negative bias corresponding to the sweep potential at a level 70a (the contact 20a being also moved by connection 80), the tube will fire thereby producing a potential rise at 19 defining the leading edge for the pulse 75 as indicated by broken lines 71a. This bias control therefore causes the leading edge of the pulse 75 to vary in time relationship to the preceding reference point 24. When the tube 11 fires again the condenser potential is reduced to zero as indicated by the vertical line 76 thereby producing a voltage drop at the terminal 19 defining the trailing edge 77. Thus, by controlling the occurrence of the leading edge for the pulse the duration of the pulse is varied. The resulting adjustment of the leading edge 71 relative to the preceding reference point 24 may therefore be determined by the setting of the contact 43.

Assuming that echo pulses 26a and 26b appear on the screen of the oscillograph in response to transmission of impulses 26, the distance to the obstacle producing the pulse 26a may be determined by adjusting the position of the leading edge 71 as a marker until the pulse 26a is superimposed thereon. The setting of the contact 43 will thus determine the distance to the obstacle causing the echo 26a. Likewise, the distance to the obstacle causing the echo pulse 26b may be obtained by a further adjustment of the contact 43.

While I have described above the principles of my invention in connection with specific apparatus, it is to be understood that this description is made only by way of example and not as a limitation of the scope of my invention as set forth in the objects thereof and the appended claims.

I claim:

1. A pulse generator to produce a pulse of selected duration comprising an energy storing device, means to supply energy to build-up a potential on said device, means for shunting part of the energy from said device when a given potential is reached so as to produce a voltage rise thereby defining the leading edge for the pulse, said shunting means including an electron tube, a resistor to control the flow of current there-through, means to control the bias on the tube to select the potential at which conduction occurs, and means for discharging energy from said device to produce a voltage drop thereby defining a trailing edge for the pulse.

2. A variable width pulse generator comprising a condenser, first and second gas-filled tubes connected in parallel with said condenser, means to supply energy to said condenser to build-up a potential thereon, means to control repetitiously the ionization of said first tube to discharge said condenser and thereby determine initiation of potential build-ups on said condenser, means to control ionization of the second tube at a selected potential to shunt energy from said condenser to produce an increase of voltage at the output of said second tube and thereby define the leading edge of a pulse, the means for controlling ionization of the second tube including means to vary the bias on the electrodes of the tube so as to control the occurrence of the leading edge of the pulse with respect to the initiation of the potential build-up, and the initiation of a succeeding potential build-up by conductive operation of said first tube operating to extinguish said second tube and thereby terminate said pulse.

3. A variable width pulse generator comprising

a condenser, first and second gas-filled tubes connected in parallel with said condenser, means to supply energy to said condenser to build-up a potential thereon, means to control repetitiously the ionization of said first tube to discharge said condenser and thereby determine initiation of potential build-ups on said condenser, means to control ionization of the second tube at a selected potential to shunt energy from said condenser to produce an increase of voltage at the output of said second tube and thereby define the leading edge of a pulse, the initiation of a succeeding potential build-up by conductive operation of said first tube operating to extinguish said second tube and thereby terminate said pulse, the means for controlling the ionization of the second tube including a first variable resistor to control the bias on said second tube, a second variable resistor interposed between the anode of said second tube and said condenser, and means for controlling the first and second resistors, the first resistor operating to vary the occurrence of the leading edge of the pulse with respect to the said reference point, and the second resistor operating to maintain the amplitude of the pulse substantially constant for the duration thereof.

4. In a radio detection system having an oscillograph to indicate echo pulses received in response to a transmitted impulse; the combination therewith of means to produce a marker pulse for the oscillograph to determine the interval of time between the transmission of an impulse and echo pulses appearing on the oscillograph in response to said impulse comprising an energy storing device, means to supply energy to said device to build-up a potential thereon, means responsive to transmission of said impulse to discharge said device so as to synchronize the initiation of a potential build-up with transmission of said impulse, control means to shunt energy from said device when a selected potential is reached by said potential build-up means to synchronize the sweep potential of the oscillo-

graph with transmission of said impulse, and means to apply the marker potential to the deflection circuit of the oscillograph for adjustment along the sweep line thereof in response to control of occurrence of the shunting action until the marker is brought into coincidence with an echo pulse, whereby the interval of the time between such echo pulse and the transmission of said impulse is proportional to the setting of said control means.

5. A method of measuring the time interval between a transmitted impulse and echo pulses detected on an oscillograph in response to the transmitted impulse, comprising establishing a reference time point in synchronism with the transmission of said impulse, building up a first potential at a given rate starting with said reference point, effecting a voltage rise when said first potential reaches a given value, producing in response to said voltage rise a marker pulse indication on the screen of said oscillograph, and controlling the said given value of said first potential to shift the marker pulse indication to coincide with a particular echo pulse as viewed on the oscillograph to determine the time interval represented by the location of such echo pulse with respect to said reference point.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,227,596	Luck	Jan. 7, 1941
2,260,906	Hudec	Oct. 28, 1941

FOREIGN PATENTS

Number	Country	Date
482,956	Great Britain	Apr. 7, 1938
502,743	Great Britain	Mar. 23, 1939