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IMPULSE GENERATOR

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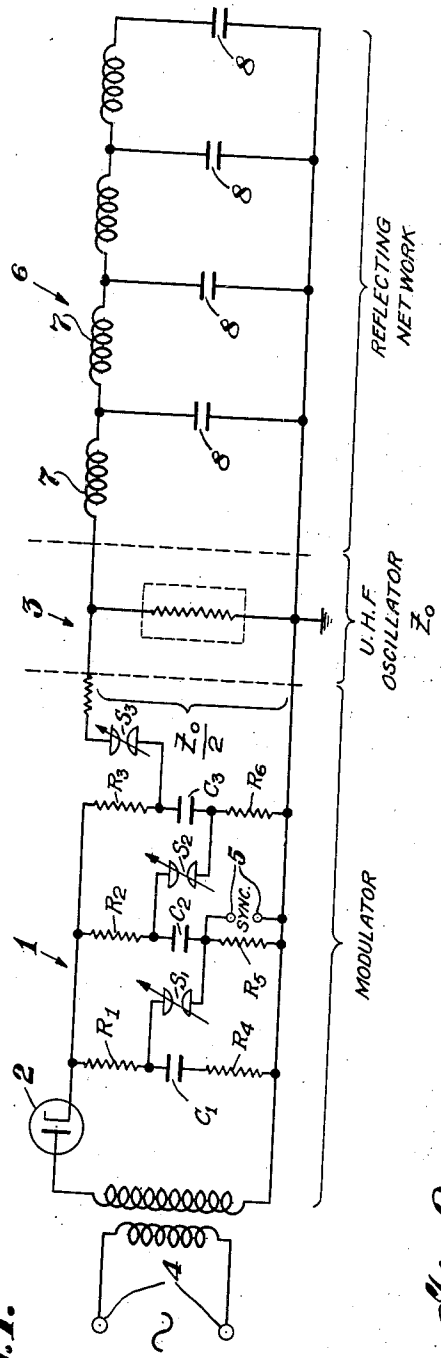


Fig. 1.

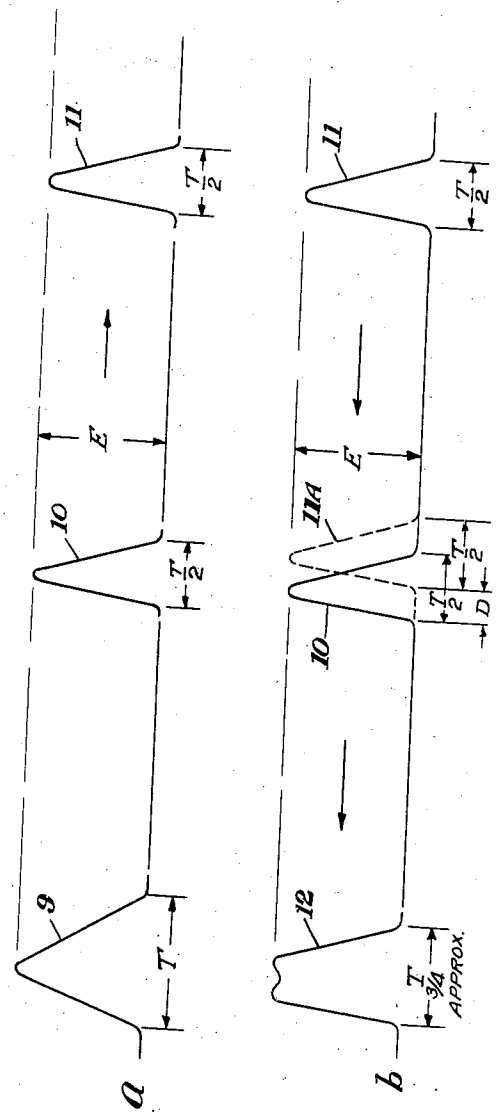


Fig. 2.

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IMPULSE GENERATOR

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3 Claims. (Cl. 250—36)

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This invention relates to radio impulse systems and more particularly to the generation of impulses for use in pulse modulation systems.

In pulse modulation systems, particularly where high power impulses are employed for the modulation of ultra-high frequency oscillators, it is desirable to obtain frequency stable modulation. This is expressed in an improvement of the form factor of the modulating pulse, that is, an increase in the ratio of the duration of the pulse crest to the build-up and decay time. Such a condition is of particular importance in connection with certain types of pulse generators employing spark-gap condenser combinations which are used to generate short duration, high voltage and high peak power impulses at high repetition rates for employment in pulse modulation in radio detection systems.

Attempts which have been made in the past to improve the form factor of pulses of this type have generally resulted in appreciable loss of the peak voltage, a loss of 50% being not uncommon.

It is therefore an object of this invention to provide a method and means for improving the form factor of high voltage impulses.

It is another object to provide a method and means for improving the frequency stability in the modulation of a high frequency wave.

It is a further object to give a flatter top and steeper sides to a highly damped pulse without the loss of the peak voltage thereof.

In accordance with my invention, I provide an impulse wave generator which utilizes an open-ended and substantially non-dissipative delay network such as a lumped or distributed constant line, in shunt with the load which in this instance is an oscillator, or a similar resistive device. The impedance of the load is equal to that of the network, so that the applied pulse energy is equally divided between the two, that is one-half of the pulse energy is transmitted toward the open end of the line. Upon reflection from the open end of the line the pulse, with a delay which is determined by the line constants, appears as an echo to join the initial half-energy pulse across the load, thereby resulting in a total improved pulse with respect thereto and to be dissipated therein.

The above and other features and objects of this invention will become more apparent upon consideration of the following detailed description to be read in connection with the accompanying drawings, in which:

Fig. 1 is a schematic representation of a circuit in accordance with my invention; and Fig. 2

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is a graphical illustration of the operation of the circuit of Fig. 1.

Referring to Fig. 1 of the drawing, there is shown a modulator 1 which is substantially similar to the pulse generator disclosed in the copending application of E. Labin-E. M. Ostlund, Serial No. 475,733, filed February 13, 1943, Patent No. 2,418,128, dated April 1, 1947, and which comprises three condensers C_1, C_2, and C_3, adapted to be charged in parallel through isolating resistors R_1, R_2, R_3, R_4, R_5, and R_6, from a rectifier represented by the diode 2. It will, of course, be understood that any other suitable type of rectifier means may be substituted for the diode. The condensers C_1 and C_2 are connected in series relation by a spark gap S_1, the condensers C_2 and C_3, being connected in series by the gap S_2, and the output side of the condenser C_3 being connected to a third spark gap S_3. By this arrangement the three condensers are charged in parallel arrangement and discharged in series through the load circuit which may comprise, for example, an ultra-high frequency oscillator 3 of a resistive type impedance of the value Z_0. The power supply for the pulse generator or modulator 1 may comprise any available source of alternating current applied to the input of the circuit at the terminals 4. If it be desired that the pulse generating circuit is to discharge only at given times, the generator may be arranged to be supplied from a source of synchronizing pulses so as to cause the breakdown of the respective spark gaps at a selected point along a cycle of the applied alternating current wave, in which case the spark gaps are made normally non-conductive for the peak voltage attained by the condensers in response to a cycle of the applied alternating current wave. These synchronizing voltage pulses for controlling the breakdown of the spark gaps may be applied at a suitable time over the input terminals 5 across the resistor R_5. These synchronizing voltage impulses may be applied instead, if desired, at other points in the circuit to produce the required voltage rise across a given spark gap.

The oscillator 3 may be any known type now used in pulse modulation systems. The only significance of the oscillator in this case is that it generates an ultra-high frequency wave and that its effective load impedance with respect to the modulator is of a resistive character amounting to a given value such as Z_0. In shunt with the oscillator 3, there is shown connected a known form of reflecting or delay network 6, which also has an effective impedance of the value Z_0, and

which is comprised of inductance 7 and condensers 8. It will be apparent that the total load impedance presented to the pulses from the modulator 1 is of the value $Z_0/2$.

In the absence of any source of synchronizing pulses for triggering the modulator 1, the spark gap S_1 (the gaps preferably being adjustable) may be adjusted narrower than gaps S_2 and S_3. This will enable the system to be triggered by the peak potential of the positive one-half cycle of the alternating current applied to the terminals 4. Thus, as the potential of the applied power rises from zero to the positive crest the gap S_1 will be caused to break down at a selected potential and thereby provide a conductive path. With the first gap conducting, current flows in the adjacent circuit loops so as to produce a break down voltage across the second gap S_2. Break down of the two gaps S_1 and S_2, connects C_1, C_2 and C_3 in series with the output gap S_3 which fires to connect the condensers in series with the load circuit 3. A complete discharge of the series break down of the condensers thus takes place through the load circuit and the resistance series parallel combinations of the ioslating resistors. The rate of discharge of the series combination of the three condensers is determined by their capacitances and the value of the resistive load Z_0. By a proper choice of the values of these discharge parameters, a voltage impulse 9 as shown in graph *a* of the Fig. 2 is obtainable for application across the load circuit as a source of high voltage energy for pulse modulating purposes. As already indicated above, when a synchronizing pulse is used in connection with the pulse generator, the occurrences of the pulse discharges may be controlled, the spark gaps in that case being adjusted so that they will not be conductive for any voltage value due to the alternating current source alone. The pulse discharge as at 9 in Fig. 2, will be repeated for the instance shown in Fig. 1 with each positive one-half cycle of the applied alternating current unless the synchronizing pulses applied at 5 cause a controlled predetermined timing different therefrom.

As the pulse discharge 9, which has a peak potential E, is applied across the load circuit, a pulse 10 of only one-half of the energy of the pulse 9 but of substantially the same voltage peak value is impressed across the oscillator 3, while an identical pulse 11 of an energy value equal to the other half of pulse 9 is transmitted from the load 3 toward the open end of the line 6. This division of the pulse energy is, of course, caused by the fact that two equal impedances are here connected in parallel. However, due to the open end character of the delay or reflecting network 6, the pulse 11 is here reflected and returned to appear across the oscillator 3. This is shown by appropriate arrows in graph *b* which indicate how the pulse 11 is reflected back toward the load where it appears in broken lines as at 11A. The oscillator 3, being of a resistive character, the reflected pulse 11A is here completely dissipated due to the Z_0 line termination, and accordingly appears as a delayed or echo pulse thereacross which adds with a given time delay to the initial one-half energy pulse 10. The delay of the echo pulse 11A referred to as D in graph *b*, with respect to the occurrence of the pulse 10 is dependent on the line constants of the network 6. If such delay is properly selected, the flatness of the top of the resulting pulse 12 may be obtained to any required degree. The duration of the pulse 12 for modulating the output of the oscillator 3 in the instance illustrated amounts to approximately ¾ of that of the orginal pulse 9. This relation, of course, may be varied by changing the amount of delay D.

From the above it will be seen that I have provided a method and means for improving the form factor of highly damped pulses without the loss of the original peak voltage thereof.

While I have described the above invention in connection with a specific application such as the modulation of an oscillator, and in connection with specific circuits, it will be apparent that the description is by way of illustration only and that the scope thereof is not to be limited thereby except as set forth in the appended claims.

I claim:

1. A pulse modulation system, comprising a modulator for producing impulses, a radio frequency oscillator having a given resistive impedance serving as a load for said modulator, and means for improving the form factor of said modulator impulses, comprising an open-ended substantially non-dissipative delay network having an impedance equal to said given impedance arranged in shunt with said oscillator and of an electrical length whereby an initial impulse of a given amplitude transmitted down the network is reflected from the open end thereof and combines with a portion of the initial impulse appearing across said load to provide a single improved impulse having said given amplitude.

2. A system for producing modulating pulses comprising means for producing primary pulses, said primary pulse producing means comprising an impulse generator, means for improving the form factor of said primary pulses comprising a load impedance for said generator having a given value comprised of a resistive portion and a substantially non-dissipative portion arranged in parallel therewith, each of said portions having an impedance value which is twice the said load impedance said non-dissipative portion comprising a circuit for delaying an initial impulse applied to said portion in parallel from said generator for a given time period and means for combining said delayed impulse with a portion of said initial impulse appearing at the parallel coupling of said two portions to provide a single improved impulse of the same amplitude as said initial impulse.

3. An arrangement according to claim 2, wherein said resistive portion comprises an oscillator circuit to be modulated by said improved impulse.

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