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PULSE SELECTING AND ELIMINATING SYSTEM

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Fig. 1.

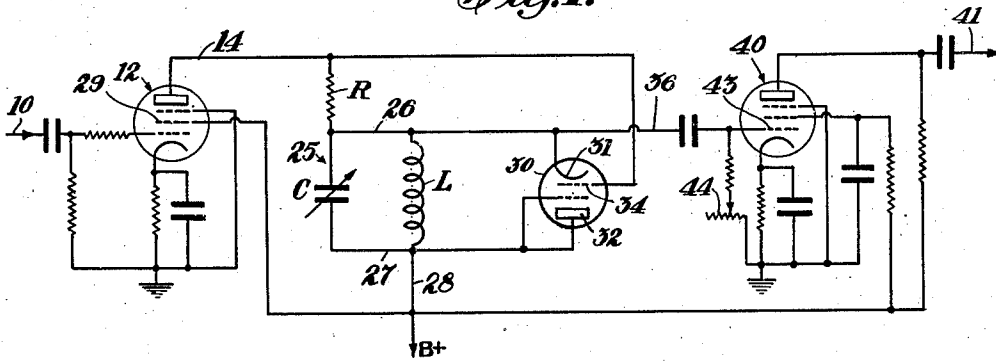
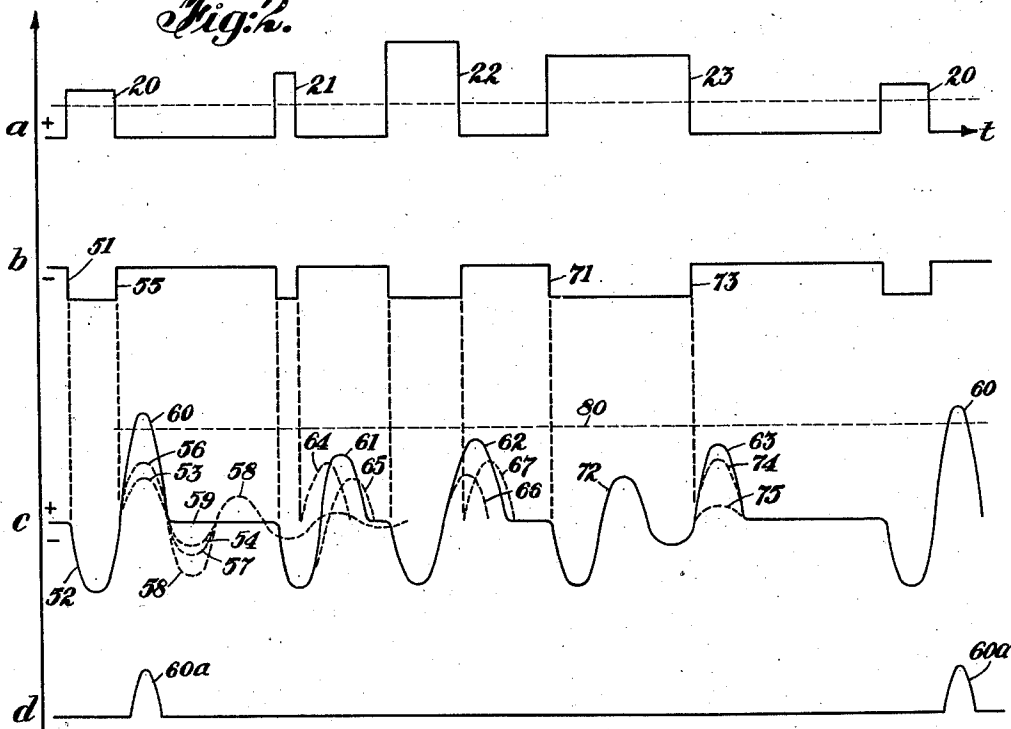


Fig. 2.



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PULSE SELECTING AND ELIMINATING
SYSTEM

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9 Claims. (Cl. 250-27)

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This invention relates to radio impulse systems and more particularly to a system for discriminating between pulses of different widths.

In the copending application of Emile Labin, Serial No. 467,509, filed December 1, 1942 since issued as Patent #2,418,127, methods and means are disclosed for selectively filtering a wave modulated with pulses differing in width so as to obtain from the pulse modulated wave pulses of a given width to the exclusion of pulses of greater and lesser duration than a wanted pulse.

It is an object of this invention to provide an additional method and means for accomplishing the same result.

Another object of our invention is to provide a pulse selecting or eliminating system which requires only a few parts, is light in weight and takes up a minimum of space.

In accordance with our invention there is provided means to first limit clip a pulse modulated wave to a given amplitude. The wave is then applied to a damped controlled L.-C. circuit similar to that covered in our copending application, entitled "Pulse width measuring system," Serial No. 480,624, filed March 26, 1943, since issued as Patent #2,411,547. The L.-C. circuit is tuned preferably to a period of oscillation equal to twice the width of the wanted pulse. The wave, after the clipping operation, is applied to the tuned L.-C. circuit to produce therein a damped wave of oscillations for each pulse. The first undulation of the damped wave following the trailing edge of the pulse initiating the oscillation has an amplitude which for the wanted pulse is larger than the corresponding undulations produced in response to pulses of greater and lesser duration. This follows from the fact that the pulses of larger and smaller duration are out of step with the tuned frequency of the circuit.

To suppress those undulations which normally follow the representative undulation, we have disposed across the tuned circuit a vacuum tube which when made conductive provides a low resistance shunt adapted to damp out any oscillations occurring in the circuit. The grid of the tube is arranged to receive a negative voltage for the duration of each pulse and the anode and cathode of the tube are so connected across the circuit that when the polarity of the oscillating current is in one direction it blocks conduction by the tube and when in the opposite direction it unblocks the tube. By this arrangement the tube operates to suppress oscillations by becoming conductive when the voltage across the circuit has the right polarity and when the voltage of the ap-

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plied pulse becomes zero. The system according to our invention will therefore produce a representative undulation following the trailing edge of each pulse and thereafter suppress all further oscillations until the next succeeding pulse of the wave is applied to the circuit.

From the foregoing it will be clear that a representative pulse or undulation is produced corresponding to the relation of each of the pulses of the input wave to the tuned frequency. By properly tuning the shock-excitable circuit to a frequency, the wavelength or period of which is twice the duration of the wanted pulse, the undulation corresponding to the wanted pulse will be the maximum undulation obtained. The undulations corresponding to the pulses of greater and lesser widths will be less than the undulation corresponding to the wanted pulse. By threshold clipping the undulations at a proper level, the maximum undulations which correspond to the wanted pulses can be isolated thereby eliminating the undulations corresponding to the pulses of greater and lesser duration.

For a further understanding of the 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 of the pulse eliminating system according to our invention; and

Fig. 2 is a graphical illustration of the steps carried out by the system for pulses of different widths.

Referring to the drawing, a pulse modulated wave such as represented by curve *a* of Fig. 2 is applied to the grid input connection 10 of a known limit clipping tube 12 shown in Fig. 1. This limit clipping operation limits the pulses to substantially the same amplitude as indicated by the clipping level 16. This is necessary in cases where other shaped pulses are imposed on the same carrier frequency for jamming purposes or for other channels of communication. Thus, the anode output of the tube 12 will pass pulse energy of constant amplitude.

The input wave *a* is shown modulated for purposes of illustration with a wanted pulse 20 of a given width and three unwanted pulses 21, 22 and 23. The widths of the pulses 21 and 22 are respectively smaller and larger than the width of the wanted pulse 20. The third pulse 23 is included to give an example of a pulse having a width equal to an odd multiple of the width of the wanted pulse. According to our invention,

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the pulses 21, 22 and 23 may all be eliminated thereby isolating the wanted pulses 20.

The output pulse energy from the tube 12 is applied through a resistor R to a shock-excitable L-C circuit 25. The condenser C of the circuit is preferably adjustable so that the circuit may be tuned to a wavelength the period of which is twice the duration of the wanted pulse. It will be understood, of course, that the inductance coil L may also be made adjustable either in place of an adjustment for the condenser C or together with an adjustable condenser, whichever may be desired.

Connected across the tunable circuit 25 is a vacuum tube 30 the cathode 31 of which is connected to the input side 26 of the circuit 25 while the anode 32 is connected to the opposite side 27 of the circuit. The side 27 is also connected to a source of potential B+ to provide a suitable positive bias for the anode connection 14.

The energy output of the anode connection 14 is applied to a grid 34 of the tube 30 so as to block the conduction between the cathode 31 and the anode 32 while pulse energy is applied to the circuit 25. The undulations output of the circuit 25 are taken off through a connection 36 for application to a known threshold clipping amplifier stage 40. The bias on the grid 43 is controlled by adjustment of resistor 44.

The operation of the system of Fig. 1 will be better understood by reference to Fig. 2 in which all the curves are applied to the same time base. Curve a as hereinbefore stated represents the pulse input energy on the grid connection 10 of the limit tube 12. While I have included the limiting action of tube 12 for limiting the amplitude of the pulses, it will be understood that the limiting feature may be dispensed with where the input pulses are of substantially the same amplitude and only differ in width characteristics, or where the limiting action takes place in a previous stage.

Curve b represents the anode voltage across the resistor R. Curve c represents the oscillations produced at the output 36 of the circuit 25 in response to the pulse energy of curve b. Curve d represents the pulse output at 41 after the undulations have been threshold clipped by the tube 40.

When the leading edge 51 of the wanted pulse 20 is applied to the circuit 25, an undulation 52, curve c, is produced. The circuit 25 will oscillate tending to produce in response to the edge 51 a damped wave according to undulations 52, 53, 54, etc. When the trailing edge 55 of the pulse 20 is applied to the circuit 25, a further shock excitation occurs in the opposite direction producing undulations 56, 57, etc. The undulations 53 and 56 are in timed relation since the circuit is tuned to a period equal to twice the duration of the pulse 20 and they combine to produce a maximum undulation 60. The succeeding pairs of undulations produced by the leading and trailing edges of the pulse 20 will produce the damped oscillations indicated by the broken line 58. This damped wave, should it be present when the next succeeding pulse 21 is applied to the circuit 25, will add algebraically to the oscillations produced by the pulse 21 thus interfering with the width measuring properties of the circuit. The damping tube 30, as will be further described hereinafter, eliminates the trailing oscillations 58, and all other trailing oscillations produced by the successive pulses.

The leading and trailing edges of the pulses 21,

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22 and 23 in turn shock excite the circuit 25 initiating successive damped waves producing for each pulse a corresponding undulation 61, 62 and 63. These undulations 61, 62 and 63 are, of course, representative undulations produced in response to these pulses for the one tuned frequency of the circuit 25. The oscillations 64 and 65 produced by the edges of pulse 21 have a period corresponding to the period at which the circuit 25 is tuned, but since the leading and trailing edges of the pulse 21 are closer together than one half of the period, the resulting oscillations produced thereby are out of step. The resulting undulation 61, therefore, is of less amplitude than the undulation 60 produced by the pulse 20.

The same follows for those pulses of greater duration than the wanted pulse 20. The leading and trailing edges of the pulse 22 being further apart than the distance corresponding to a half wavelength at which the circuit 25 is tuned, produce oscillations 66 and 67 which are out of step thereby producing an undulation 62 of lesser amplitude than the undulation 60.

For pulses such as pulse 23 which is in the order of an odd multiple of the duration of the wanted pulse 20, the leading edge 71 initiates the oscillation 72 which in this case passes through three undulations before the trailing edge 73 is applied to the circuit. While the undulations 74 produced by the trailing edge 73 are of an amplitude similar to the amplitude of the undulation 56, the corresponding undulation 75 of the oscillations produced by leading edge 71 is now considerably less due to the natural damping of the tuned circuit so that the resulting undulation produced by the sum of the undulations 74 and 75 is less in amplitude than the undulation 60. It follows therefore that while the leading and trailing edges of a pulse which is an odd multiple of the wanted pulse are in timed relation, the damping effect of the oscillation produced by the leading edge is such that the sum of the combined undulations results in an undulation of less amplitude than the undulation 60.

With the tube 30 in the circuit, the undulations following the first undulation after the trailing edge of each pulse are suppressed by the damping function of the tube. The grid 34 of the tube is applied with a potential corresponding to the voltage across the resistor R when a pulse such as pulse 20 is applied to the circuit. This potential being negative (curve b) blocks conduction in the tube 30 so that the "Q" of the circuit 25 will remain high and the circuit will respond to the leading edge of the pulse to initiate the oscillation. The connection of the cathode 31 and the anode 32 of the tube 30 across the circuit 25 is such that the polarity of the undulation 60 directly following the trailing edge of pulse 20 is such that the tube is again blocked against conduction. Thus, the tube remains blocked for the duration of the undulations 60, 61, 62 and 63. When the energy of oscillation changes in polarity from positive to negative, the change immediately produced conduction in the tube 30 thereby shunting the low resistance of the tube across the circuit 25. This shunting operation so lowers the "Q" of the circuit as to absorb the energy that would normally produce the next succeeding undulation, thereby suppressing the further tendency of the circuit to produce oscillations. This shunting action results in a substantially zero output 59 (curve c) following the undulation 60 until the leading edge of the next succeeding pulse 21 is applied to the circuit. This damping opera-

tion of the tube 30 suppresses the unwanted oscillations produced by the pulses so that they will not interfere or adversely affect the oscillations produced by later occurring pulses.

The clipping operation of the tube 40 which may be adjusted to clip the output at a level 80 thereby eliminating the undulations 61, 62 and 63 resulting in a final output of undulation pulses 60a corresponding to the wanted pulses 20. The interfering or unwanted pulses are effectively eliminated. The output pulses 60a may, of course, be amplified and sharpened or otherwise treated as may be desired depending on the use intended for the pulse energy thus obtained.

While we have shown and described the principles of our invention in connection with a specific embodiment, we recognize that various changes and modifications may be made therein without departing from the invention. It is our aim, therefore, to cover in the appended claims all such changes and modifications as fall within the scope of the invention.

We claim:

1. A system for selecting from a pulse wave a pulse of a given duration to the exclusion of pulses of greater and lesser duration comprising a resonant circuit, means to apply said wave for shock excitation of said circuit by the leading and trailing edges of pulses thereof, control means to maintain the circuit in oscillatory condition for the duration of each pulse so that the oscillations initiated by the edges of each pulse combine to form an undulation following the trailing edge of the pulse, means to damp out the oscillations so that oscillations produced by one pulse will not affect the oscillations produced by the next pulse comprising means adapted to form a low resistance shunt connection across the tuned circuit and control means responsive to the pulse of said wave to block said shunt connection for the duration of each pulse, said circuit being tuned to a period equal to twice the duration of said wanted pulse so that the oscillation set up by the edges of the wanted pulses are timed one half period apart to provide an undulation of maximum amplitude and the undulations produced by the edges of pulses of greater or lesser duration are timed greater and lesser apart than half a period to form undulations of amplitude less than said maximum undulation, and means for threshold clipping said undulations to obtain a pulse output corresponding to the pulses of said given duration.

2. A system for selecting from a pulse wave a pulse of a given duration to the exclusion of pulses of greater and lesser duration comprising a resonant circuit, means to apply said wave for shock excitation of said circuit by the leading and trailing edges of pulses thereof, control means to maintain the circuit in oscillatory condition for the duration of each pulse so that the oscillations initiated by the edges of each pulse combine to form an undulation following the trailing edge of the pulse, means to damp out the oscillations so that oscillations produced by one pulse will not affect the oscillations produced by the next pulse comprising means adapted to form a low resistance shunt connection across the tuned circuit and means responsive to the pulses of said wave to block the shunt connection for the duration of each pulse plus the duration of the undulation following the trailing edge of the pulse, said circuit being tuned to a period equal to twice the duration of said wanted pulse so that the oscillations set up by the edges of the wanted

pulse are timed one half period apart to provide an undulation of maximum amplitude and the undulations produced by the edges of pulses of greater or lesser duration are timed greater and lesser apart than half a period to form undulations of amplitude less than said maximum undulation and means for threshold clipping said undulations to obtain a pulse output corresponding to the pulses of said given duration.

3. A system for selecting from a pulse wave a pulse of a given duration to the exclusion of pulses of greater and lesser duration comprising a resonant circuit, means to apply said wave for shock excitation of said circuit by the leading and trailing edges of pulses thereof, control means to maintain the circuit in oscillatory condition for the duration of each pulse so that the oscillations initiated by the edges of each pulse combine to form an undulation following the trailing edge of the pulse, means to damp out the oscillations comprising a vacuum tube connected across the tuned circuit and control means to bias the tube to cut off for the duration of the pulse, the polarity of the circuit connections across the tube being such during the formation of said undulation as to maintain the tube at cut off for the duration of said undulation and the change in polarity of the oscillating energy at the end of said undulation operating to produce a state of conduction in said tube thereby damping out the oscillation in said circuit so that oscillations produced by one pulse will not affect the oscillations produced by the next pulse, said circuit being tuned to a period equal to twice the duration of said wanted pulse so that the oscillations set up by the edges of the wanted pulses are timed one half period apart to provide an undulation of maximum amplitude and the undulations produced by the edges of pulses of greater or lesser duration, are timed greater and lesser apart than half a period to form undulations of amplitude less than said maximum undulation and means for threshold clipping said undulations to obtain a pulse output corresponding to the pulses of said given duration.

4. A system for selecting from a pulse modulated wave those pulses of a given duration to the exclusion of pulses of greater and lesser duration, comprising a shock excitable circuit, means to apply the wave to the circuit to produce oscillations therein in response to the leading and trailing edges of the pulses, the oscillations initiated by the edges of a pulse combining normally to form undulations following the trailing edge of each pulse, means to tune said circuit to a wavelength the period of which is twice the duration of said wanted pulse so that the undulations produced by the wanted pulse are of greater amplitude than the corresponding undulations of the pulses of greater and lesser duration, a vacuum tube having anode, cathode and grid electrodes, means connecting the anode and cathode electrodes across said circuit, means to apply each pulse to said grid electrode to block said tube for the duration of said pulse, and the anode and cathode connections being arranged to produce a blocking potential for the tube for the duration of the first undulation following the trailing edge of each pulse, the change in polarity of the oscillating energy at the end of said first undulation operating to unblock said tube for damping of further oscillations so that the oscillations of one pulse will not affect oscillations produced by the next succeeding pulse, and means to threshold

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clip the undulations to obtain a pulse output corresponding to the pulses of said given width.

5. The system defined in claim 4, in combination with an input limiting tube to limit the pulses of the wave to a given amplitude before application of the pulses to the shock excitable circuit.

6. A system for distinguishing by greater amplitude a wanted pulse of a given duration from pulses of greater duration but of substantially the same amplitude, comprising a resonant circuit, means to apply the pulses for shock excitation of said circuit by the leading and trailing edges of the pulses, control means to maintain the circuit in oscillatory condition for the duration of each pulse so that the oscillations initiated by the edges of each pulse combine to form an undulation following the trailing edge of the pulse, means to damp out the oscillations normally following said undulation, means to render the means for damping out oscillations inoperative for the duration of each applied pulse, said circuit being tuned to a wavelength the period of which is twice the duration of said wanted pulse so that the oscillations set up by the edges of the wanted pulse are timed one half wavelength apart to provide an undulation of maximum amplitude and the oscillations produced by the edges of pulses of greater duration are timed greater distances apart than said one half wavelength to form undulations of amplitude less than said maximum undulation, and means for threshold clipping the peak portions of the maximum undulations.

7. The system defined in claim 6, wherein the means to damp out the oscillations comprises means adapted to form a low resistance shunt connection across the tuned circuit and the con-

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trol means includes means responsive to the pulses to block said shunt connection for the duration of each pulse.

8. The system defined in claim 6, wherein the means to damp out the oscillations comprises a vacuum tube connected across the tuned circuit, and the control means includes means to bias the tube to cut-off for the duration of the pulse, the polarity of the circuit connections across the tube being such during the formation of said undulation as to maintain the tube at cut-off for the duration of said undulation, and the change in polarity of the oscillating energy at the end of said undulation operating to produce a state of conduction in said tube thereby damping out the oscillations in said circuit.

9. The system defined in claim 6, in combination with an input limiting tube to limit the pulses to a given amplitude before application of the pulses to the resonant circuit.

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