

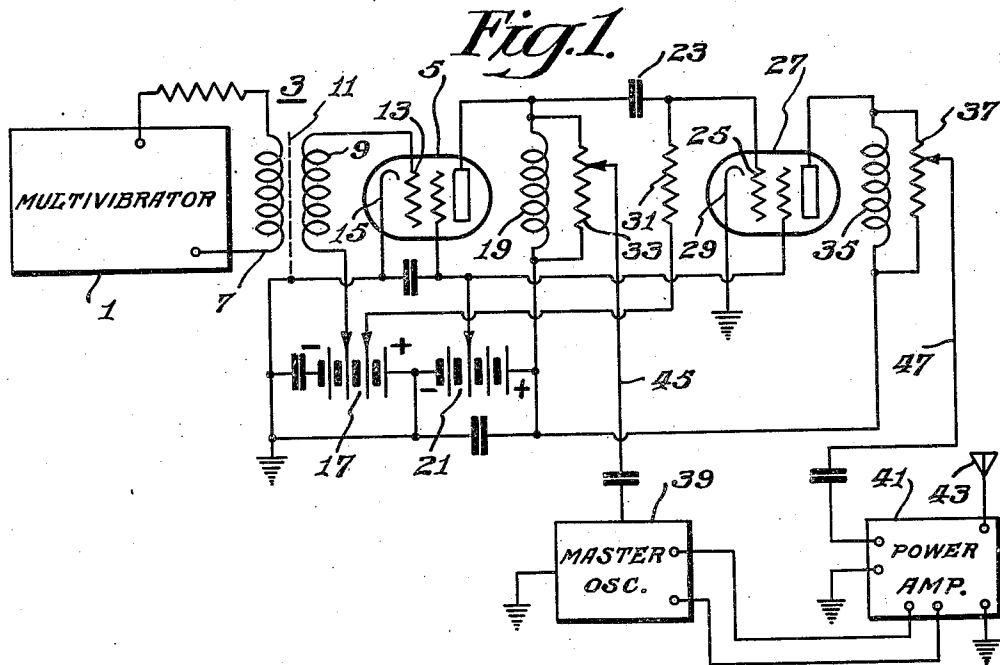
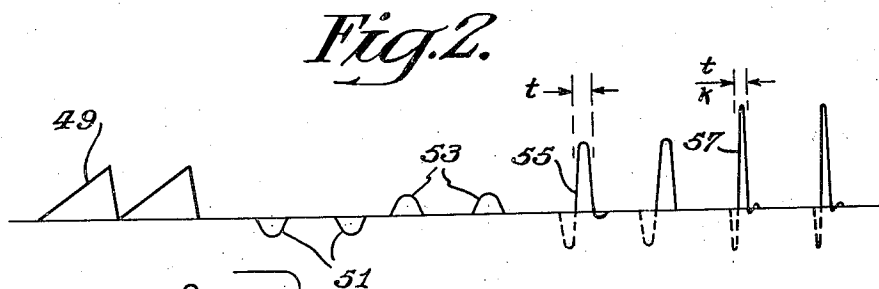
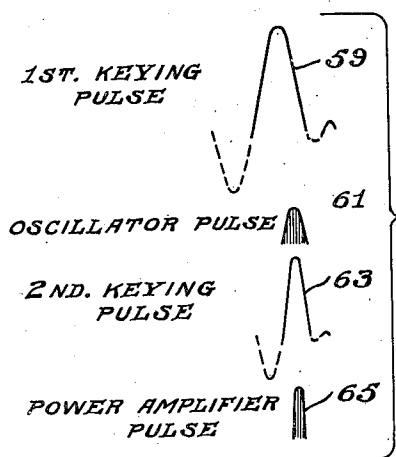
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APPARATUS FOR AND METHOD OF PULSE KEYING

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APPARATUS FOR AND METHOD OF PULSE KEYING

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12 Claims. (Cl. 250—17)

1

This invention relates to apparatus for and the method of pulse keying. More specifically, the invention includes apparatus for creating and transmitting marking impulses of extremely short duration.

Numerous high speed mechanical keying systems have been devised for forming telegraphic characters. In general, these systems have been designed so that the keying prevents an abrupt interruption of the oscillatory currents because such abrupt change causes transient effects which interfere with reception. In general, the prior art keying devices attempt what is known as "rounded" keying.

The present invention does not involve the ordinary Morse keying, but relates to a keying system in which the pulses are of extremely short duration and in which no attempt is made to produce rounded keying. In fact, the present invention has for one of its objects the production of an extremely sharp, well defined keying pulse. Another object of the invention is to provide means for shortening a keying pulse beyond the limits which are practical for oscillator keying. An additional object is to provide means for generating pulses of diminishing duration and applying one of the longer pulses to the oscillator and one of the shorter pulses to a power amplifier.

The invention will be described by reference to the accompanying drawing in which Figure 1 is a circuit diagram of one embodiment of the invention; and Figures 2 and 3 are graphs illustrating the operation of the invention.

In a copending application Serial No. 182,418, filed December 30, 1937, for Apparatus for and method of pulse keying, I have described a pulse keying device in which the pulses are first derived from a saw-tooth wave generator. The saw-tooth wave currents are stored in a capacitor which charges through a transformer. The transformer is coupled to an amplifier which responds only to positive pulses. These positive pulses are differentiated by an inductor and are converted into highly damped wave trains. The positive pulses of these highly damped wave trains are selected to be further amplified and converted into other high damped wave trains in which the positive pulses are of lesser duration than the original pulses. A portion of the final positive pulses is used to key an oscillator which is connected to an antenna. Radio frequency pulses radiated from the antenna are used to detect obstacles.

In view of the velocity of propagation of radio waves, it is necessary that the outgoing pulse be

2

extremely short to prevent its overlapping pulses reflected from a nearby object. With the system shown in the above mentioned copending application, it has been practical to generate radio frequency pulses having a duration as short as $\frac{1}{10}$ of a micro-second and at a frequency of the order of 500 megacycles.

In order to have an oscillator generate power with reasonable efficiency, it should have circuit elements having limited damping. This works against the generation of short pulses since the low damped circuits tend to generate persistent oscillations, and, furthermore, the oscillations build up slowly.

In the present invention, I propose to provide means for not only generating a short pulse but, in addition, I propose to sharpen and shorten the pulse by means of an oscillator-power amplifier system which will now be described.

Referring to Fig. 1, a multi-vibrator 1 is connected through a transformer 3 to a vacuum tube amplifier 5, the primary 7 of the transformer 3 may be shielded from the secondary 9 by an electrostatic shield 11. The secondary 9 is preferably of low inductance and, together with the input capacity of the amplifier 5, may be tuned to resonate at the period of the applied pulse. The grid electrode 13 of the amplifier 5 is biased negatively with respect to the cathode 15 by means of a biasing battery 17.

The anode of the amplifier 5 is connected through an inductor 19 to the positive terminals of a B battery 21. The negative terminal of the battery 21 is connected to the positive terminal of the biasing battery 17, the cathode 15 and ground. The inductor 19 is coupled through a blocking capacitor 23 to the grid 25 of a second amplifier 27. The grid 25 is biased negatively with respect to the cathode 29 by a grid resistor 31 which is connected to the negative terminal of the biasing battery 17. The natural period of the inductor 19 and its associated capacities is preferably of the order of, or less than, the natural period of the pulse applied to it. The inductor 19 may be shunted by a potentiometer 33. The anode circuit of the second amplifier 27 is connected through an inductor 35 to the positive terminal of the B battery 21. The inductor 35 may be shunted by a potentiometer 37. The inductor 35 is preferably adjusted so that its natural period is of the order of, or less than, the natural period of the applied pulse.

A master oscillator 39 is connected to a power amplifier 41 which is suitably coupled to an antenna 43. The master oscillator is keyed by a

connection 45 to the potentiometer 33. The power amplifier 41 is keyed by a connection 47 to the potentiometer 37.

In the operation of the device, the amplifier and keying network generates pulses which are shown in Fig. 2. The characteristic output of the multi-vibrator is represented by the saw-tooth wave 49. The pulses 51 are derived from the charging circuit in the multi-vibrator. These pulses 51 appear in the secondary 9 as positive pulses 53. The positive pulses applied to the first amplifier are differentiated, in the mathematical sense, to create the highly damped wave train 55. It will be noted that the period of the first complete oscillation of the damped wave train is of the order of the period of the applied positive pulse 53. The positive pulse of the highly damped wave train 55, or a portion thereof, is applied to the second amplifier 27 to thereby generate a second highly damped wave train 57 which is again, due to the differentiating action of the inductor 35. The period of the positive pulse in the first wave train may be represented by t , while the period of the positive pulse in the second wave train may be represented by t/k , and in which k is preferably of the order of two or more.

The operation of the entire system is represented in Fig. 3 in which the graphs of the wave trains are enlarged to show more clearly the relative timing of the several pulses. The first keying impulse 59 is used to start the master oscillator which generates a pulse 61 of radio frequency energy. This pulse of radio frequency energy is applied to the power amplifier 41. In order that the pulses derived from the power amplifier may be further shortened, the second keying pulse 63 is employed to key the power amplifier. It should be understood that the bias voltages may be so adjusted that all or any portion of the second keying impulse may be used whereby the duration of the impulse 65 in the power amplifier may be made to coincide with any desired portion of the oscillator pulse.

This invention has been described as a pulse generating device or method in which pulses are amplified and at the same time shortened. The longer pulses are used to key the master oscillator and the shorter pulses are so arranged to key the power amplifier during the desired portion of the oscillator keying period. The resultant effect is to diminish the pulse length in the power amplifier and at the same time permit the master oscillator to attain its full power output. It will be observed that the system works automatically without the application of any mechanical keying means. The rate at which the pulses are radiated is determined by the number of pulses applied to the multi-vibrator or generated thereby. When used for detecting obstacles or measuring altitude, the pulse rate is determined by the greatest distance to be observed, while the pulse length is a function of the shortest distance to be measured. While the pulse generator has been shown as employing two stages, it should be understood that any desired number of stages may be employed and the keying may be accomplished by employing connections to any of the stages to thereby regulate the duration of the several pulses.

I claim as my invention.

1. A pulse generator device including, in combination, a source of rapidly varying currents, means for generating pulses from said currents, 75

means for amplifying and shortening said pulses, a master oscillator, means for keying the master oscillator by applying thereto the first mentioned pulses, a power amplifier, means for keying the power amplifier by applying thereto the amplified and shortened pulses.

2. A pulse generator device including, in combination, a source of rapidly varying currents, means for generating pulses from said currents, means for amplifying said pulses, means for further amplifying and shortening said pulses, a master oscillator, means for keying the master oscillator by applying thereto the first mentioned amplified pulses, a power amplifier, means for keying the power amplifier by applying thereto the second mentioned amplified pulses.

3. A pulse generator device including, in combination, a source of rapidly varying currents, means for generating pulses from said currents, means for amplifying and shortening said pulses, means for further amplifying and shortening said pulses, a master oscillator, means for keying the master oscillator by applying thereto the first mentioned amplified pulses, a power amplifier, means for keying the power amplifier by applying thereto the second mentioned amplified pulses.

4. A pulse generator device including, in combination, a source of rapidly varying currents, means for generating pulses from said currents, means including a biased tube for amplifying said pulses, means including a biased tube for further amplifying and shortening said pulses, a master oscillator, means for keying the master oscillator by applying thereto the first mentioned amplified pulses, a power amplifier, means for keying the power amplifier by applying thereto the second mentioned amplified pulses.

5. A pulse generator device including, in combination, a source of rapidly varying currents, means for generating pulses from said currents, means including a biased tube for amplifying and shortening said pulses, means for further amplifying and shortening said pulses, a master oscillator, means for keying the master oscillator by applying thereto the first mentioned amplified pulses, a power amplifier, and means for keying the power amplifier by applying thereto the second mentioned amplified pulses.

6. An obstacle detecting system including, in combination, a master oscillator and a power amplifier to be keyed by pulses of respectively shorter duration, a source of discrete pulses, means for converting said discrete pulses into a first source of highly damped wave trains, means for applying the first positive pulses of said wave trains to key said oscillator, means including said first named means for creating a second source of highly damped wave trains, and a power amplifier connected to said oscillator means for applying the first positive pulse of said second source of highly damped wave trains to key said power amplifier.

7. A keying device including, in combination, a keying circuit, a source of current pulses, means for transforming said pulses into a series of wave trains, means for highly damping said wave trains, said trains including negatively phased pulses and positively phased pulses, means for amplifying the first of each of said positively phased pulses, an oscillator, means for applying said positive pulses to key said oscillator, means responsive to said positively phased pulses for creating a second series of wave trains, means

5

for highly damping said second series of wave trains, said second series of wave trains including negatively phased pulses and positively phased pulses, a power amplifier, means for applying the first of each of the last mentioned positively phased pulses to key said power amplifier.

8. The method of establishing pulses of radio frequency energy which includes generating pulses of current, generating radio frequency oscillations, controlling the duration of said oscillations as a function of said pulses, amplifying said pulses, amplifying said controlled radio frequency oscillations, and limiting the duration of said amplification of controlled oscillations as a function of said amplified pulses.

9. The method of establishing pulses of radio frequency energy which includes generating pulses of current, generating radio frequency oscillations, controlling the duration of said oscillations as a function of said pulses, amplifying and shortening said pulses, amplifying said controlled radio frequency oscillations, and limiting the duration of said amplification of controlled oscillations as a function of said amplified pulses.

10. The method of establishing pulses of radio frequency energy which includes generating pulses of current, amplifying and shortening said pulses, generating radio frequency oscillations, controlling the duration of said oscillations as a function of said amplified and shortened pulses, further amplifying and shortening said pulses,

6

amplifying said controlled radio frequency oscillations, and limiting the duration of said amplification of controlled oscillations as a function of said amplified pulses last mentioned.

11. The method of generating sharply defined pulses of radio frequency energy which comprises generating saw-tooth oscillations, converting said saw-tooth oscillations into discrete pulses, transforming said discrete pulses into wave trains including highly damped negatively and positively phased pulses, generating radio frequency oscillations, regulating the duration of said oscillations by applying to them said positively phased pulses, amplifying said positively phased pulses, amplifying said radio frequency oscillations and controlling the duration of said amplification by applying thereto the amplified positively phased pulses.

12. The method of establishing pulses of radio frequency energy which includes generating highly damped wave trains, generating radio frequency oscillations, controlling the duration of said oscillations as a function of the first positive pulse of each of said wave trains, amplifying said positive pulses to form second highly damped wave trains, amplifying said radio frequency oscillations, and controlling the duration of the last mentioned amplification by applying the first positive pulse of each of the second series of highly damped wave trains.

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