

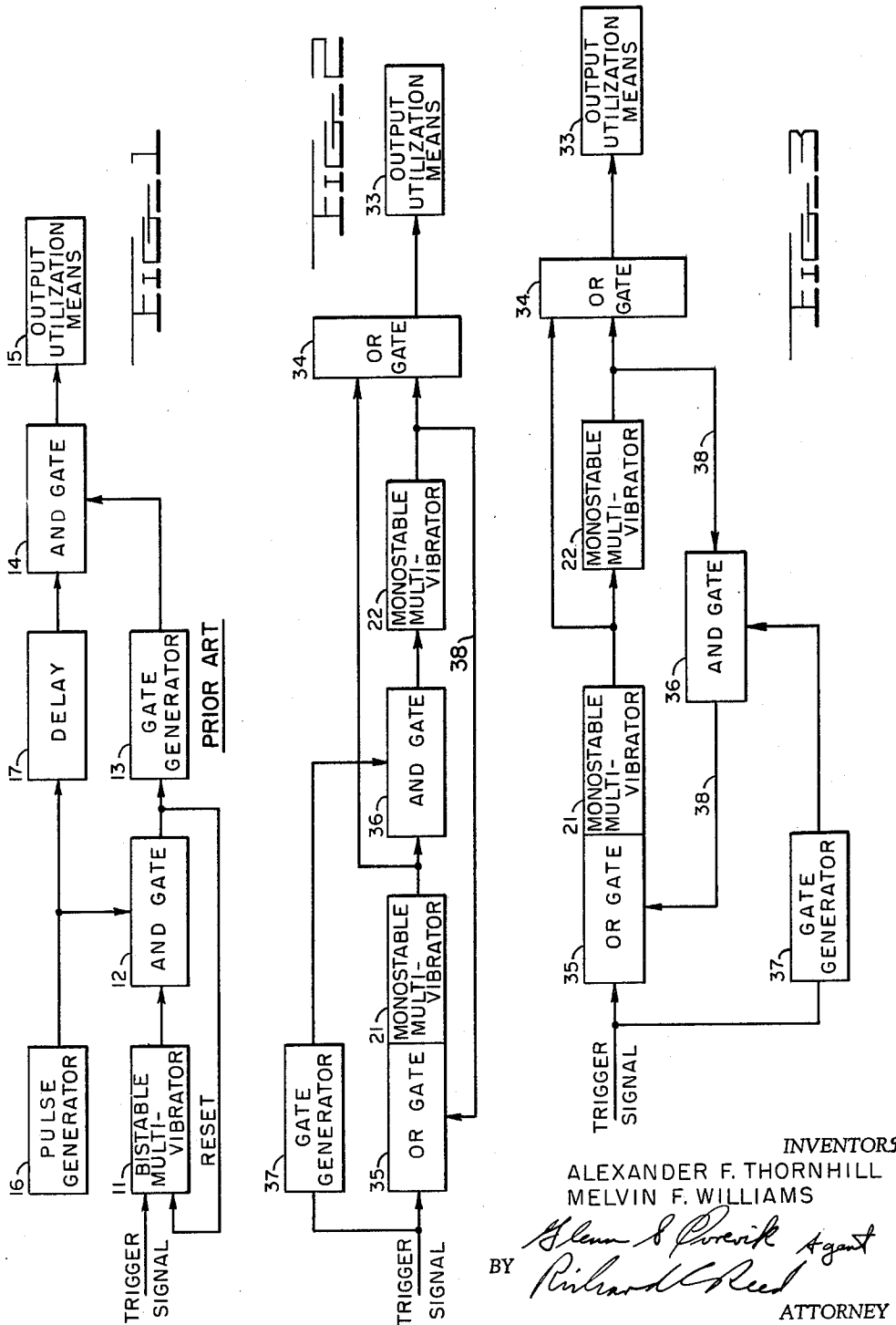
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PULSE TRAIN GENERATOR FOR PRODUCING ODD OR
EVEN NUMBER OF PULSES WITH VARIABLE
PULSE SPACING

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Filed Nov. 29, 1961

2 Sheets-Sheet 1



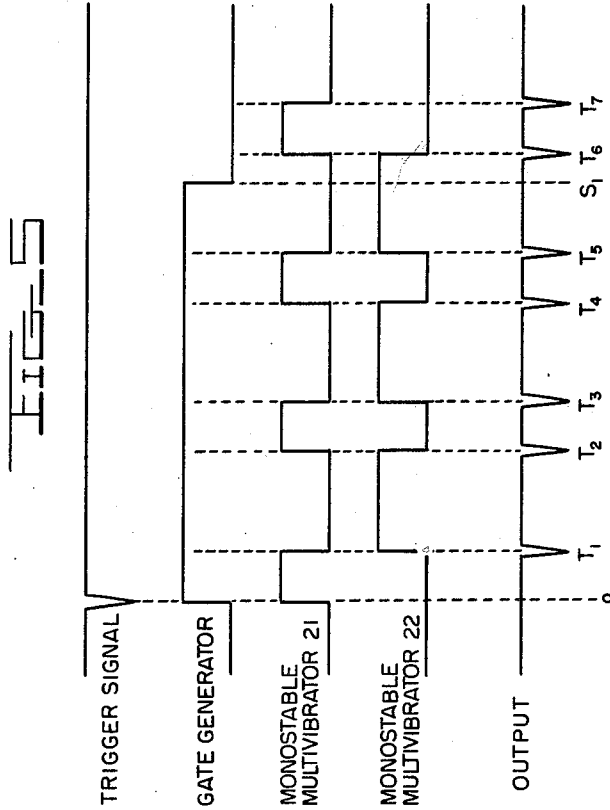
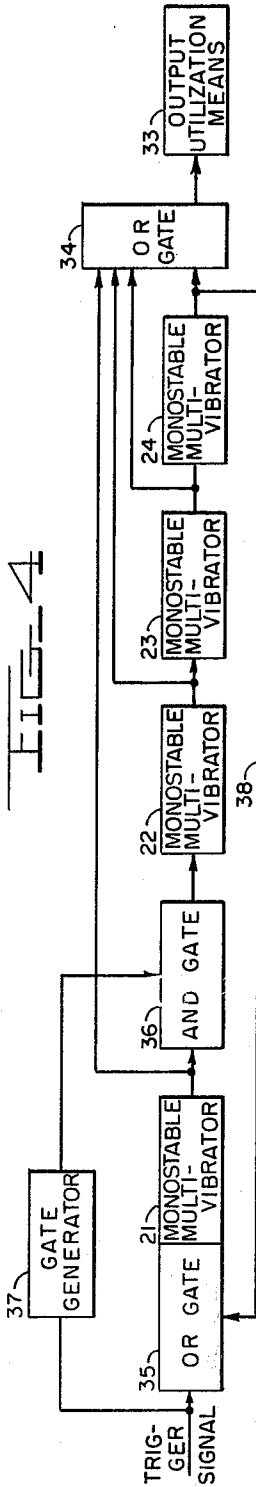
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3,167,716

PULSE TRAIN GENERATOR FOR PRODUCING ODD OR EVEN NUMBER OF PULSES WITH VARIABLE PULSE SPACING

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6 Claims. (Cl. 328—38)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates in general to pulse train generators and in particular to means for generating a train of a selected odd or even number of pulses.

With the advent of the data handling era, a wide variety of pulse train generators have been devised for use in computer circuitry and the like. In general, the pulse train generators in the prior art have been characterized by one or more performance compromises such as width of pulse, shape of pulse, number of pulses, stability gating requirements, etc., or by one or more circuitry compromises such as size, weight, durability, etc.

The permissible error tolerance in the gating means has been a particular problem in many prior art pulse train generators. In many cases, the tolerance requirement is $\pm 5\%$, that is, the gating must occur within the interval of 1 pulse. This problem becomes of paramount importance, of course, as the operational frequency increases.

Accordingly,

It is an object of this invention to provide an improved pulse train generator which may be adapted to produce an odd or an even number of pulses.

It is another object of this invention to provide an improved pulse train generator which may be adapted to produce a pulse train with a multitude of different spacings between pulses.

It is still another object of this invention to provide an improved pulse train generator which allows the use of relatively inaccurate gating signals to produce a pulse train of relatively high accuracy.

Other objects of the invention will become apparent upon a more comprehensive understanding of the invention for which reference is had to the following specification and drawings wherein:

FIG. 1 is a block diagram showing of a typical prior art pulse train generator.

FIG. 2 is a block diagram showing of one embodiment of the device of this invention.

FIG. 3 is a block diagram of a second embodiment of the device of this invention.

FIG. 4 is a block diagram showing of a third embodiment of the device of this invention.

FIG. 5 is a graphical presentation of the outputs of the circuitry shown in FIGURES 1 through 4.

Briefly, this invention is a unique triggered ring assembly of a plurality of monostable multivibrators with means for gating interposed whereby the pulse train output is relatively insensitive to gate deviations.

Referring to the drawings:

In the prior art pulse train generator of FIG. 1, the trigger sets the bistable multivibrator into operation. The outputs of the bistable multivibrator 11 and the pulse generator 16, in coincidence, then actuate the "AND" gate 12 which performs two functions (1) to trigger gate generator 13 and (2) to reset the bistable multivibrator. Gate generator 13, as its principal function,

opens the "AND" gate 14 long enough to pass the desired number of pulses through to the output.

This prior art circuitry is satisfactory for some applications, of course. A major disadvantage, however, lies with its inherent precision gating requirement. With such precision requirement, extreme precaution must be taken to insure the accuracy of the gate generator output. It will be appreciated that in applications where the prior art device might be subject to significant ambient condition variations it is difficult, if not impossible, to avoid deviations in the gate generator output. Often the precautions to be taken add greatly to the overall size and/or weight of the prior art and in this manner preclude its adaption to otherwise suitable applications where size and weight are critical factors.

The embodiment of the invention shown in FIG. 2 incorporates a plurality of monostable multivibrators. In this instance multivibrators 21 and 22 are connected to output utilization means 33 via "OR" gate 34. The input trigger signal is applied in this embodiment via one input of "OR" gate 35 to the multivibrator 21 and the output of the multivibrator 21 is connected not only to the output utilization means 33 but to an input of "AND" gate 36 which is connected to actuate the multivibrator 22 upon concurrent receipt of the output of monostable multivibrator 37, which is triggered by the same input trigger signal applied to multivibrator 21. Likewise, the output of multivibrator 22 is connected not only to the output utilization means 33 but to another input of "OR" gate 35 via feedback means 38, such that multivibrator 21 is again actuated.

Thus in the basic embodiment of FIG. 2 an odd number of pulses are generated for each trigger signal. The monostable multivibrator 37 serves as the gate generator and opens "AND" gate 36 such that multivibrator 21 activates multivibrator 22 which activates multivibrator 21, etc., until the gate generator ceases operation, whereupon, as will be discussed hereinafter, multivibrator 21 produces the last pulse in the train and the width of the gate can vary an amount equal to twice the time between consecutive pulses.

The second embodiment of the invention, shown in FIG. 3, incorporates the same component parts as the embodiment of FIG. 2 but in such arrangement as to provide an even number of pulses in the pulse train per trigger signal. In this embodiment multivibrators 21 and 22 are connected to output utilization means 33 via "OR" gate 34. The input trigger signal is applied via one input of "OR" gate 35 to the multivibrator 21 and the output of multivibrator 21 is connected not only to the output utilization means 33 but to the input of multivibrator 22 to actuate same. Likewise, the output of multivibrator 22 is connected not only to output utilization means 33 but to another input of "OR" gate 35 via feedback means 38 such that multivibrator 21 is again actuated. In this embodiment, however, "AND" gate 36 is interposed in the feedback means 38 and is adapted to pass the output of multivibrator 22 to multivibrator 21 upon concurrent receipt of the output of multivibrator 37 which, as in the embodiment of FIG. 2, is triggered by the same input trigger signal applied to multivibrator 21.

Thus in the basic embodiment of FIG. 3, an even number of pulses, at least two, are generated for each trigger signal. Again, the monostable multivibrator 37 serves as the gate generator and opens "AND" gate 36 such that multivibrator 21 activates multivibrator 22 which activates multivibrator 21, etc., until the gate generator ceases operation, whereupon as will be discussed hereinafter, multivibrator 22 produces the last pulse in the train and the width of the gate can vary an amount equal to twice the time between consecutive pulses.

The third embodiment of the invention, shown in FIG.

4, is substantially similar to the embodiment of FIG. 2, but incorporates additional multivibrators 23 and 24. In this embodiment the additional multivibrators are activated in turn by the output of multivibrator 22 and the output of the last multivibrator 24, is connected not only to the output utilization means 33 but to another input of "OR" gate 15 via feedback means 38 such that multivibrator 21 is again actuated. Thus it will be appreciated that the basic embodiment of FIG. 2 may be adapted in the manner shown in FIG. 4 to provide an output with either an even or an odd number of pulses and the gate width may vary "n" times the time between consecutive pulses where "n" is an integer representative of the number of monostable multivibrators involved, exclusive of the gating generator. Further it will be appreciated that with "n" monostable multivibrators employed, "n" different pulse spacings may be obtained.

FIG. 5 depicts in proper time relation the output of the gating generator 37, the output of each of the multivibrators 21 and 22 in the basic embodiment of FIG. 2 and the output of the device as produced thereby.

In FIG. 5, at time 0 a trigger signal, in this instance a negative spike pulse, activates gate generator 37 and monostable multivibrator 21 to produce pulses of duration S_1 and T_1 respectively. Irrespective of the duration of the pulse output of gate generator 37, the pulse output of monostable multivibrator 21 produces an output spike pulse coincident with the trailing edge of the pulse output of monostable multivibrator 21, at time T_1 .

Assuming S_1 is greater than T_1 as shown, multivibrator 22 is at time T_1 to produce a pulse output having a trailing edge at time T_2 , which also produces an output spike pulse coincident therewith, and activates multivibrator 21 again to produce a third output spike pulse at time T_3 of duration $T_3 - T_2$. Depending on the duration of the gating pulse, S_1 , the process continues to produce a pulse train having a selected odd number of pulses therein. As in the example depicted in the drawing, with the duration, S_1 , greater than T_5 but less than T_6 , the device will produce an output train of 7 pulses.

It will be appreciated that the duration of the pulse output of each of the multivibrators may be identical or may differ, as shown, and that as a consequence the device of this invention offers great versatility, not only in the width of the gate but in the substantially unlimited number of different pulse spacings permissible. In the embodiment of FIG. 4, for example, the four monostable multivibrators would afford four different pulse spacings if desired.

Likewise, it will be seen that tolerance to error deviations in the duration of the gating pulse increases in proportion to the number of monostable multivibrators in the feedback ring. For example, considering 101 pulses in a pulse train with each pulse of the same length, for simplicity, the prior art device of FIG. 1 has a requisite gating pulse accuracy of $\pm .5$ percent, whereas the embodiment of FIG. 2, would require a gating pulse accuracy of ± 1.0 percent, the embodiment of FIG. 4 would require a gating pulse accuracy of ± 2.5 percent an embodiment in accordance with the teaching of FIG. 4 but employing 6 monostable multivibrators would require a gating pulse accuracy of ± 3.5 percent, etc. Further, it will be seen that the gating pulse accuracy requirement of the prior art device does not vary irrespective of the number of multivibrators involved. Obviously, the notable advantage of a lesser accuracy requirement becomes of increasing importance as the operating frequency increases.

While the several embodiments of this invention exemplarily shown in the drawings each include a plurality of monostable multivibrators, it is understood that it is within the purview of this invention to substitute other types of one pulse producing means therefor in selected applications of the device. In the higher frequency range, it would be permissible if desired, to substitute delay line components up to the 10 microsec. region, for example, dependent upon size and weight limitations, if any.

Moreover, while the "OR" gate 36 and the first monostable multivibrator 21 are shown as separate components in the drawings, it will be appreciated that the monostable multivibrator might incorporate a two isolated inputs feature in which case the "OR" 36 gate could be eliminated.

Finally, it is understood that this invention is to be limited only by the scope of the claims appended hereto.

What is claimed is:

1. A pulse train generator comprising a plurality of "n" monostable pulse forming means, where "n" is an integer, electrically coupled in a ring for energizing each of said pulse forming means in consecutive order, each of said "n" monostable pulse forming means having an input and an output, or "OR" gate having a plurality of "n" inputs and an output, output utilization means connected to said output of said "OR" gate, means connecting the output of each of said pulse forming means to a respective input of said "OR" gate, an "AND" gate coupled in said ring of pulse forming means, said "AND" gate having an output and at least two inputs with one input coupled to a first monostable pulse forming means and the output thereof coupled to another of said monostable pulse forming means, gate generator means coupled to another input of said "AND" gate for providing an output signal of selected duration, and trigger means coupled to said gate generator means and to one of said pulse forming means for concurrent energization thereof.

2. The pulse train generator as defined in claim 1 wherein said monostable pulse forming means are monostable multivibrators.

3. The pulse train generator as defined in claim 2 wherein "n" is the integer 2.

4. The pulse train generator as defined in claim 2 wherein said trigger means is coupled to a monostable multivibrator which is in turn coupled to another monostable multivibrator by said "AND" gate.

5. The pulse train generator as defined in claim 3 wherein said trigger means is connected to that monostable multivibrator which is coupled to energize another monostable multivibrator by said "AND" gate.

6. The pulse train generator as defined in claim 2 wherein said first monostable multivibrator has an "OR" gate input which includes at least two inputs, one input thereof coupled to said trigger means and another input thereof coupled to the output of said "nth" monostable multivibrator.

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