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MONOSTABLE MULTIVIBRATOR CONTROL

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Fig. 1.

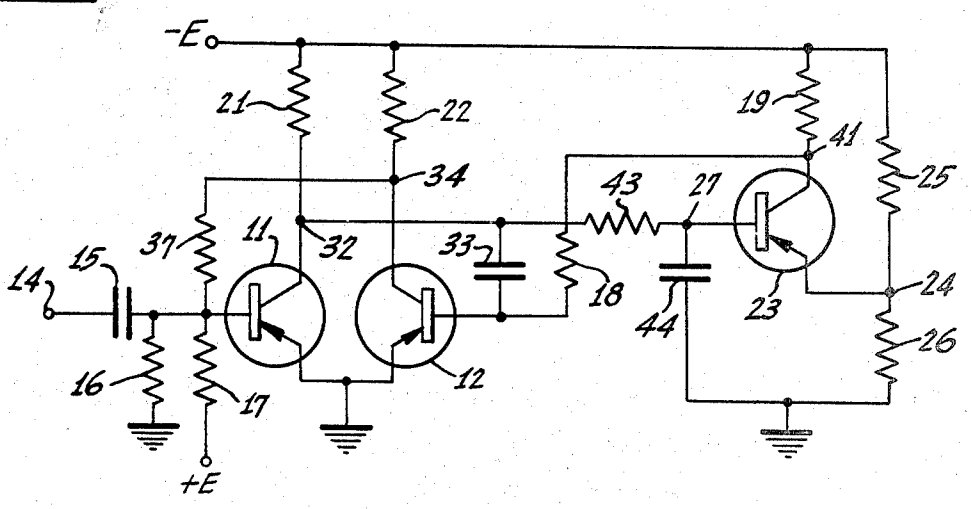
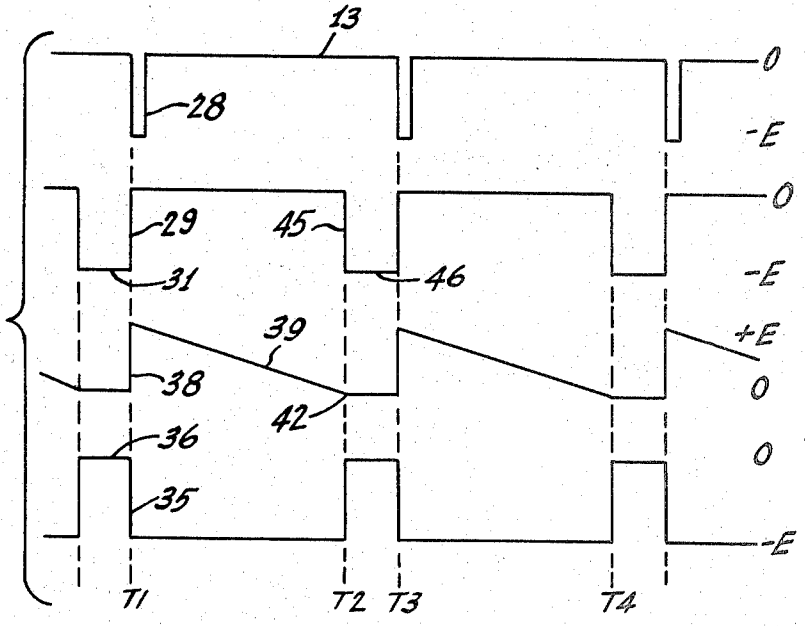


Fig. 2.



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MONOSTABLE MULTIVIBRATOR CONTROL

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ABSTRACT OF THE DISCLOSURE

A monostable multivibrator provides output pulses of predetermined duration in a predetermined time relation with corresponding pulses in a train of input pulses. The operating period of the multivibrator is determined by the time constant of a coupling circuit and by voltage supplied to the coupling circuit. The amplitude of the supplied voltage is responsive to the average duration of the output pulses and serves to maintain such duration substantially constant.

This invention relates to multivibrators and particularly to monostable devices of this character by which to produce a train of pulses which effectively lead in phase the trigger pulses by which such apparatus is actuated and in which the width of the produced pulses is automatically controlled.

It often is desirable to produce a train of pulses, the trailing edges of which are locked in phase with the leading edges of the actuating trigger pulses. Such apparatus is particularly useful in television cameras. It is a preferred practice in the operation of television cameras to effectively delete from the signals produced thereby information regarding the marginal areas of the subject being scanned. The reason for such deletion is that these areas contain little or no useful information and frequently contain misinformation. When many of the functions of video signal generation and processing are performed automatically, such misinformation may cause malfunctioning of some of these automatically controlled features. For example, where the black level of the generated video signal is automatically set in response to the darkest portions of the subject, which in many cases is a moving picture film, there often is encountered in such material even darker areas in the marginal portions thereof which comprise no part of the subject and which, if allowed to be reproduced in the form of a video signal, will cause malfunctioning of the automatic black level setting apparatus.

Consequently, it is the practice to effectively gate out of the generated video signals those portions derived from scanning marginal areas of the subject. Such gating is accomplished under the control of trains of the pulses having the necessary repetition rates and widths. Of necessity the pulses must be appropriately related in phase to the waves by which scanning is accomplished. In the pulse trains by which the signals representative of the vertical marginal areas are gated out, the repetition rate is that of the horizontal line scanning frequency which is relatively high and therefore there is no difficulty in controlling the width of the gating pulses where the pulses themselves recur so closely together in time. Similarly, the width of the pulse required to gate out signals representative of the top horizontal marginal area can be generated without difficulty with the necessary width because of the very close relationship in time to the pulses controlling vertical deflection. There is, however, considerable difficulty in controlling the width of the pulses needed to gate out the signals representative of the lower horizontal marginal area because of the relatively long lapse of time (approximately 1/60 of a second) between the

vertical drive pulses controlling the start of a vertical deflection cycle and the leading edge of the required gating pulse.

It, therefore, is an object of this invention to provide for the generation of a pulse train which is locked in phase with a train of trigger pulses and in which the width of the generated pulses is automatically controlled.

In accordance with this invention there is provided a monostable multivibrator which is adapted to operate through a complete cycle in response to each of a train of trigger pulses. The period of the multivibrator is controlled by a time constant circuit which is referenced to a voltage which in turn is maintained in a given relationship to a fixed voltage. The reference voltage for the time constant network is subject to change resulting from any tendency of the generated pulses to vary in width or time duration. To effect a necessary change of such reference voltage a control voltage is developed representing the average voltage of the generated pulse train. The control voltage is applied to control apparatus by which the proper reference voltage for the time constant network is maintained so as to automatically control the pulse width at a desired magnitude.

For a better understanding of the invention reference will be made to the following specification which is taken in conjunction with the accompanying drawing, of which:

FIGURE 1 is a schematic circuit diagram of a triggered monostable multivibrator and control apparatus therefor embodying the invention; and

FIGURE 2 is a representation of waveforms appearing at different points in the circuit of FIGURE 1.

In the drawing, the multivibrator includes a normally non-conductive transistor **11** and a normally conductive transistor **12** both of which, for illustrative purposes, are PNP types. A train of trigger pulses such as represented by the wave **13** of FIGURE 2 is impressed upon a terminal **14**. These pulses, which have a relatively low repetition rate such as sixty per second as for example the vertical drive pulses in a television system, are differentiated by a network including a series capacitor **15** and a shunt resistor **16** and applied to the base electrode of the transistor **11**. The transistor **11**, in the absence of triggering pulses, is held in a non-conductive state by means of a positive biasing voltage applied to its base electrode from a source +E through a resistor **17**. The transistor **12**, in the absence of any voltage applied to its base electrode by the transistor **11**, normally is maintained in a conductive state by the direct connection of its base electrode through resistors **18** and **19** to a source of negative voltage —E. The collector electrodes of the multivibrator transistors **11** and **12** are connected respectively by load resistors **21** and **22** to the negative voltage source —E.

The apparatus also includes a pulse width controlling transistor **23** which is continuously conductive by the connection of its emitter electrode to a point **24** on a voltage divider including resistors **25** and **26** connected to the negative voltage source —E and by the impression upon its base electrode of a more negative voltage developed at a point **27** in a manner which will be later described.

The leading edge of a trigger pulse such as the pulse **28**, occurring at time T1, when differentiated by the circuit including capacitor **15** and resistor **16**, produces a negative-going spike of voltage which is impressed upon the base electrode of transistor **11** causing this transistor to become conductive. As a result, there is produced substantially simultaneously the trailing edge **29** of a negative-going pulse **31** at the collector electrode terminal **32**. The impression of the trailing edge **29** of the pulse **31** upon the base electrode of the transistor **12** by means including the series-connected capacitor **33** is effective

to cause this transistor to become non-conductive. As a result, the trailing edge 35 of a positive-going pulse 36 is produced at the collector electrode terminal 34 of the transistor 12. This voltage is impressed upon the base electrode of the transistor 11 by means including a resistor 37, the result of which is that the transistor 11 remains conductive after the triggering pulse 28 is removed from the terminal 14 and as long as the transistor 12 remains in a non-conductive state.

In FIGURE 2, the leading edge 38 of a generally sawtooth wave 39 is a representation of the voltage produced at the base electrode of the transistor 12 and by means of which this transistor is caused to be held non-conductive. The wave 39 also represents the resulting charge on the capacitor 33 which is gradually dissipated through resistors 18 and 19 as shown by the ramp portion of the wave 39. The rate at which this capacitor charge is dissipated is dependent upon the time constant of the network comprising the capacitor 33 and the resistor 18 and the voltage at the collector electrode terminal 41 of the width control transistor 23.

When, at time T2, the charge on the capacitor 33 has been dissipated to the extent represented by the point 42 on the wave 39, the transistor 12 again becomes conductive and the voltage at its collector electrode terminal 34 is restored to substantially ground or zero potential which, through the connection including the resistor 37, causes the transistor 11 to become non-conductive. In one practical circuit, in which the apparatus embodying the present invention has been successfully employed, the resistor 17 was made relatively large compared with the resistor 37. It was found that by means of such a relationship the return of the transistor 11 to a non-conductive state was effected in a very short time following the return of the transistor 12 to its conductive state.

The train of pulses such as that including the pulse 31 also is impressed upon an integrating or filter circuit including a series resistor 43 and a shunt capacitor 44 so that the pulse train is converted to a substantially steady voltage of negative polarity which is representative of the average of the pulse train which includes the pulse 29. This direct voltage, in combination with the fixed voltage applied to the emitter electrode of the width control transistor 23 from the point 24 on the voltage divider, determines the magnitude of the conductivity of the control transistor 23. Such conductivity, in turn, determines the voltage at the terminal 41 to which the time constant network including resistor 18 and capacitor 33 is connected.

It is seen that the trailing edge 29 of the pulse 31 and the trailing edges of all other pulses in the train are fixed in their time relation to the trigger pulses such as the pulse 28. The timing of the leading edges of these pulses, such as the edge 45, however, depends upon the discharge time of the capacitor 33. For example, if the capacitor discharges too rapidly, the point 42 on the curve 39 is reached prior to time T2 with the result that the leading edge 45 of the pulse 46 is advanced in time, thereby widening the pulse 46. Such pulse widening results in the development of a voltage of greater negative magnitude at the terminal 27 for application to the base electrode of the width control transistor 23. Such a voltage increases conductivity in this transistor which produces a voltage of less negative magnitude at the terminal 41. With a less negative voltage at the terminal 41 the discharge time of the capacitor 33 is lengthened until the point 42 on the ramp portion of the wave 39 again occurs at time T2. As previously described, this establishes the leading edge 45 of the pulse 46 at time T2, thereby producing a pulse having the desired width T2–T3. An undesired narrowing of the pulses, resulting from an excessively long discharge time of the capacitor 33, produces a decreased negative voltage at the point 27 which lessens conduction in the control transistor 23 to increase the negative voltage at point 41 which shortens the capacitor discharge time until equilibrium is reached and the pulses have the desired width.

The output from such apparatus may be taken from either or both of the collector electrode terminals 32 and 34 depending upon whether negative-going or positive-going pulse trains are desired. It may be seen from FIGURE 2 that the two different pulse trains represented respectively by pulses 31 and 36 are leading in phase the pulse train represented by the trigger pulse 28.

It, thus, is seen that the apparatus embodying the present invention operates to produce a train of pulses, the trailing edges of which are securely phase locked to the leading edges of the trigger pulses by which the apparatus is timed. Also, by reason of the described DC control circuit including the width control transistor 23, the width of the generated pulses is accurately and automatically controlled.

The pulse width control provided by this invention is particularly, but not necessarily exclusively, useful in the operation of television signal generating systems. Where pulses 31 or 36 are used to delete video signals produced in the lower three or four lines of a scanned raster the pulse width, represented as T2–T3, needs to be on the order of 200 to 250 microseconds. The time between pulses, represented as T1–T2, of necessity is approximately 1/60 of a second (i.e. about 16,500 microseconds). A 2% error in the T1–T2 timing results in considerably more than a 100% error in the T2–T3 timing which, in the circumstances, is intolerable because of the consequent deletion of too much or too little of the video signal. The control system embodying this invention has been found to hold the width of the generated pulses to the close tolerances required for such television use.

What is claimed is:

1. A monostable multivibrator comprising:
first and second transistors;
means for impressing trigger pulses upon said first transistor to actuate said multivibrator from a stable operating state to an unstable operating state, thereby to initiate the production of first pulses by said first transistor;
a capacitor coupled between said first transistor and said second transistor, said capacitor acquiring a charge in response to the actuation of said multivibrator from said stable operating state to said unstable operating state, whereby to maintain said multivibrator in said unstable operating state;
a third transistor;
means including a resistor coupled to said third transistor and to said capacitor for providing a discharge path for said capacitor to a reference voltage;
the time duration of said unstable operating state of said multivibrator being dependent upon the time constant of the circuit including said capacitor and said resistor and said reference voltage;
means for integrating said first pulses to produce a direct voltage having a magnitude dependent upon the average time duration of said first pulses;
means for coupling said direct voltage to control conduction of said third transistor so as to vary said reference voltage and thereby to maintain the width of said first pulses substantially constant.

2. A monostable multivibrator comprising:
a first normally non-conducting and a second normally conducting transistor, each having input and output electrodes;
means for impressing relatively short duration trigger pulses upon the input electrode of said first transistor to initiate conduction of said first transistor thereby to initiate the production of a first pulse at the output electrode of said first transistor;
means capacitively impressing said first pulse upon the input electrode of second transistor to terminate conduction of said second transistor, thereby to initiate the production of a second pulse at the output electrode of said second transistor;
means coupling the output electrode of said second

transistor to the input electrode of said first transistor to maintain conduction of said first transistor after the termination of a trigger pulse;

a third transistor having input, output and common electrodes;

means to impress a reference voltage upon the common electrode of said third transistor to maintain it in a predetermined state of conduction;

means coupling the input electrode of said second transistor to the output electrode of said third transistor;

the periods of non-conduction of said second transistor and of conduction of said first transistor being dependent upon the time constant of the circuit including said capacitive impressing means and the voltage at the output electrode of said third transistor, thereby producing a train of said first pulses at the output electrode of said first transistor, each of said pulses effectively leading said trigger pulses; and

means responsive to said train of pulses and including a filter circuit coupled to impress upon the input electrode of said third transistor a direct voltage having a magnitude dependent upon the average time duration of said train of pulses,

the magnitude of said direct voltage relative to said reference voltage so controlling conduction of said third transistor as to determine the width of the pulses of said produced pulse train.

3. A monostable multivibrator comprising:

first and second transistors each having input and output electrodes;

means for biasing said first transistor normally to a nonconductive state;

means for biasing said second transistor normally to a conductive state;

a source of trigger pulses;

means coupling said source of trigger pulses to the input electrode of said first transistor to initiate conduction of said first transistor so as to initiate the production of a first pulse at the output electrode of said first transistor;

means capacitively impressing said first pulse upon the input electrode of said second transistor to terminate conduction of said second transistor so as to initiate the production of a second pulse at the output electrode of said second transistor;

means coupling the output electrode of said second transistor to the input electrode of said first transistor to maintain conduction of said first transistor after the termination of a trigger pulse;

a third transistor having input, output and common electrodes;

means to produce a reference voltage connected to the common electrode of said third transistor to maintain it in a predetermined state of conduction;

means coupling the output electrode of said third transistor to a source of voltage;

means coupling the input electrode of said second transistor to the output electrode of said third transistor,

the periods of non-conduction of said second transistor and of conduction of said first transistor being dependent upon the time constant of the circuit including said capacitive impressing means and the voltage at the output electrode of said third transistor, thereby producing a train of said first pulses at the output electrode of said first transistor and a train of said second pulses at the output electrode of said second transistor, both of said trains of pulses effectively leading said trigger pulses; and

means responsive to said train of first pulses and including an integrating filter circuit coupled to impress upon the input electrode of said third transistor a direct voltage having a magnitude dependent upon the average time duration of said train of first pulses,

the magnitude of said direct voltage relative to said reference voltage so controlling conduction of said third transistor as to determine the width of the pulses of both of said produced pulse trains.

4. A monostable multivibrator comprising:

first and second PNP transistors each having base, emitter and collector electrodes, said base electrodes being connected to ground;

means including a source of positive voltage connected to the base of said first transistor to bias said first transistor normally to a non-conductive state;

means including a source of negative voltage connected to the base of said second transistor to bias said second transistor normally to a conductive state;

a source of negative-going relatively short duration trigger pulses;

means including a differentiating circuit coupling said source of trigger pulses to the base of said first transistor to initiate conduction of said first transistor in response to the leading edge of each trigger pulse so as to initiate the production of a positive-going first pulse at the collector electrode of said first transistor;

means including a series-connected capacitor coupling the collector electrode of said first transistor to the base electrode of said second transistor to terminate conduction of said second transistor in response to the leading edge of said positive-going first pulse so as to initiate the production of a negative-going second pulse at the collector electrode of said second transistor;

means including a first series-connected resistor coupling the collector electrode of said second transistor to the base electrode of said first transistor to maintain conduction of said first transistor after the termination of a trigger pulse;

a third PNP transistor having base, emitter and collector electrodes;

means including a voltage divider connected to said source of negative voltage to produce a reference voltage connected to the base electrode of said third transistor to maintain it in a predetermined state of conduction;

means including a second series-connected resistor coupling the collector electrode of said third transistor to said source of negative voltage;

means including a third series-connected resistor coupling the base electrode of said second transistor to the collector electrode of said third transistor,

the periods of non-conduction of said second transistor and of conduction of said first transistor being dependent upon the time constant of the circuit including said capacitor and said third resistor and the voltage at the collector electrode of said transistor, thereby producing a train of negative-going pulses at the collector electrode of said first transistor and a train of positive-going pulses at the collector electrode of said second transistor both of said trains of pulses effectively leading said trigger pulses; and

means including an integrating filter circuit coupling the collector electrode of said first transistor to the base electrode of said third transistor to impress upon said base electrode a direct voltage having a magnitude dependent upon the average time duration of a series of said first pulses,

the magnitude of said direct voltage relative to said reference voltage so controlling conduction of said third transistor as to determine the width of the pulses of both of said produced pulse trains.

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