Dec. 6, 1949 J. A. BUCKBEE 2,490,026

PULSE WIDTH CONTROL

Filed Oct. 30, 1944

FIG. 1

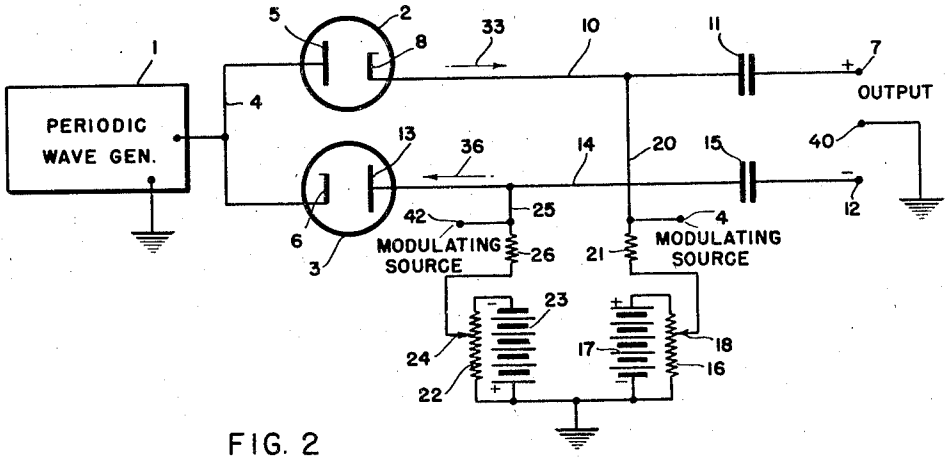


FIG. 2

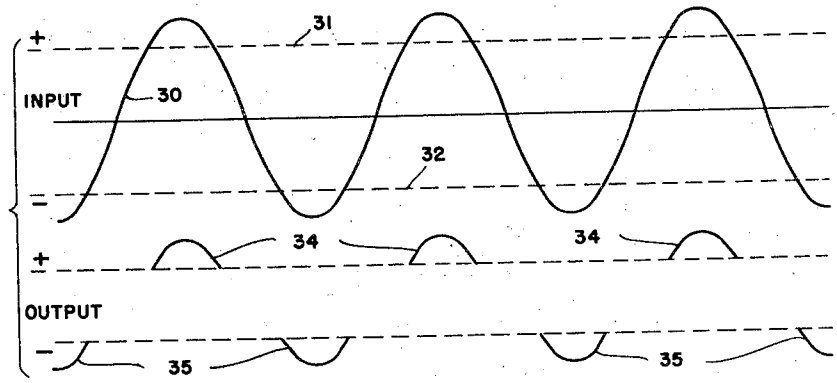
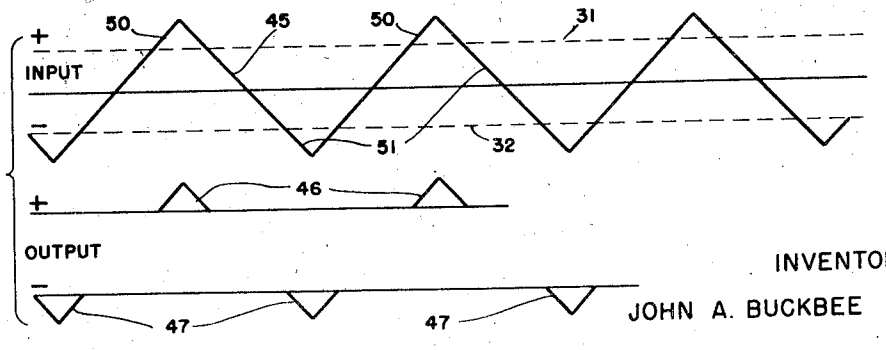


FIG. 3



INVENTOR

JOHN A. BUCKBEE

BY

ATTORNEY

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PULSE WIDTH CONTROL

John A. Buckbee, Fort Wayne, Ind., assignor, by mesne assignments, to Farnsworth Research Corporation, a corporation of Indiana

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12 Claims. (Cl. 332—15)

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This invention relates to pulse width control and particularly to a method and apparatus for controlling the width of impulses derived from a periodic input signal.

The blanking and synchronizing signals utilized in television transmitting systems consist of short impulses, the duration and timing of which must be determined very accurately. To this end it is desirable to provide means for adjusting or controlling the width of pulses utilized in television circuits. Another field of application of the present invention is the control of the width of pulses fed to a class C-operated power amplifier. By modulating the width of the input pulses of the power amplifier amplitude-modulation may be effected. It is also feasible to utilize a pulse width control in a radio communications system where the width of the pulses is modulated for transmitting intelligence.

Various arrangements have been devised for effecting control of the width or duration of pulses. To this end it has been suggested to employ two grid-controlled high-vacuum thermionic tubes which are connected in push-pull fashion by coupling the anode of one tube to the cathode of the other tube. One of the tubes is fed with a sinusoidal input signal while the other tube is supplied with the same signal through a phase shifting network. An output pulse is obtained only when both tubes conduct space current simultaneously. The duration or width of the thus obtained pulses may be adjusted by varying the phase shift of the two input signals. This arrangement requires fairly elaborate circuit means including two triodes and a phase shifting means.

Many circuits including rectifier devices have been proposed for controlling the sequence or timing of short pulses used for synchronizing purposes or for generating saw-tooth waves utilized in television systems. However, a control of the width of the generated pulses was not contemplated in these circuits.

It is an object of the present invention, therefore, to provide a novel method and apparatus of great simplicity for controlling the width of pulses.

Another object of this invention is to provide a method and apparatus for modulating the width of pulses in accordance with a modulating source, the pulses being derived from a periodic input signal.

In accordance with the present invention there is provided a pulse width control system including a rectifier device. Means are provided for

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generating periodic waves which are connected to the input of said rectifier device. Further means are provided for applying a biasing voltage to the rectifier device to derive an output signal consisting of pulses. The biasing voltage is adjusted by another means for controlling the width of the pulses. Alternatively, the biasing voltage may be modulated in accordance with a modulating source.

In accordance with the present invention the method of producing pulses and controlling the width thereof in a network including a rectifier device comprises the initial step of generating a periodic input signal. A biasing voltage is applied to the rectifier device, and the input signal is passed through the biased rectifier device to derive an output signal consisting of pulses. The width of the pulses may be controlled by adjusting the biasing voltage. Instead of adjusting the biasing voltage, the voltage applied to the rectifier device may be modulated in accordance with a modulating source. Thus, modulation of the width of the pulses is effected.

For a better understanding of the invention, together with other and further objects thereof, reference is made to the following description, taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the accompanying drawing, Fig. 1 is a circuit diagram of a pulse width control network embodying the present invention, while Figs. 2 and 3 are curves representing the output voltage variations obtained for different types of input signals and referred to in explaining the operation of the invention.

Referring now more particularly to Fig. 1 of the drawing, there is shown a pulse generating circuit including periodic wave generator 1. The periodic waves derived from generator 1 may, for instance, be of sinusoidal wave form or of saw-tooth wave form. Generator 1 may include a conventional oscillator for generating sinusoidal waves or a relaxation oscillator for generating saw-tooth waves. Generator 1 is connected to inverted rectifiers 2 and 3 arranged in parallel. Rectifiers 2 and 3 are shown in the drawing as diodes such as thermionic high-vacuum diodes and gas diodes. However, other suitable rectifier devices including barrier-layer rectifiers and mercury-arc rectifiers may be used. Input lead 4 connects anode 5 of diode 2 and cathode 6 of diode 3 to generator 1.

The output of diode 2 is obtained from terminal 7 connected to cathode 8 of diode 2 through lead

10. Blocking condenser 11 is arranged in lead 10. The output of diode 3 is obtained from terminal 12 connected to anode 13 of diode 3 through lead 14. Blocking condenser 15 is arranged in lead 14.

Diodes 2 and 3 are each supplied with a biasing voltage. To this end potentiometer 16 is connected to battery 17 having its negative terminal grounded as shown. Tap 18 is connected by lead 20 to diode output lead 10 through resistor 21. Similarly, potentiometer 22 is connected to battery 23 having its positive terminal grounded as shown. Tap 24 is connected by lead 25 to diode output lead 14 through resistor 26. In this manner diode 2 is supplied with a positive biasing voltage through potentiometer 16 and battery 17 while diode 3 is supplied with a negative biasing potential through potentiometer 22 and battery 23. The biasing voltages applied to diodes 2 and 3 will balance the control network so that diodes 2 and 3 conduct current alternately for substantially equal periods of time.

Referring now to the operation of the pulse width control shown in Fig. 1 reference is made to the curves illustrated in Fig. 2. We will assume that generator 1 generates a sinusoidal voltage such as represented by curve 30 shown in Fig. 2. The positive biasing voltage supplied to diode 2 is represented by dashed line 31 while dashed line 32 illustrates the negative biasing voltage supplied to diode 3. When sinusoidal voltage wave 30 is impressed upon lead 4 diode 2 will become conducting as soon as the positive voltage of the input signal exceeds the positive biasing voltage supplied from potentiometer 16 and battery 17. Hence, an output current will flow in output lead 10 in the direction indicated by arrow 33. The output voltage consists of a series of short pulses 34, as shown in Fig. 2. Similarly, a negative voltage impressed upon lead 4 will make diode 3 conducting when the input voltage exceeds the negative biasing voltage 32. Accordingly, the output voltage appearing in lead 14 consists of another series of short pulses 35 as illustrated in Fig. 2. Pulses 35 have the opposite polarity from pulses 34, and the direction of the current pulsating in lead 14 is indicated by arrow 36.

Blocking condensers 11 and 15 separate the direct current supplied from batteries 17 and 23 from output terminals 7 and 12. The output signal which may be taken from output terminals 7 and 12 consists of pulses 34 and 35 of opposite polarity. If pulses of only one polarity are desired, they may be obtained either from terminals 7 and 40 or 40 and 12, terminal 40 being connected to ground. In that case one of diodes 2 or 3 may be omitted depending upon the required sign of the output pulse.

It will now be evident that the width of pulses 34 and 35 may be adjusted by adjusting the biasing voltages supplied to diodes 2 and 3. To this end taps 18 and 24 may be adjusted either simultaneously or individually. This has the effect of moving potential lines 31 and 32 up or down depending upon whether the biasing voltages are increased or decreased. In this manner the width of pulses 34 or 35 may be increased or decreased at will either separately or together.

Instead of adjusting the width of pulses 34 and 35 it is also feasible to modulate the width of the pulses. To this end a modulating source may be connected to terminals 41 and 42 connected to leads 20 and 25, respectively. Preferably biasing voltages of suitable value are supplied to diodes 2 and 3 from batteries 17 and 23, respectively. In that case the modulating source increases or decreases the biasing voltages to modulate the width of the pulses accordingly.

Diodes 2 and 3 may also be supplied with a symmetrical saw-tooth input wave as shown in Fig. 3. In that case the input voltage impressed upon lead 4 is represented by curve 45 of Fig. 3. Dashed lines 31 and 32 again illustrate the biasing voltages supplied to diodes 2 and 3, respectively. The output pulses obtained from terminal 7 are illustrated by pulses 46 in Fig. 3. The pulses of negative polarity obtained from terminal 12 are shown by curves 47. Control or modulation of the width of the pulses obtained with a symmetrical saw-tooth input wave may be effected in the same manner as explained hereinabove.

Instead of using an input signal of symmetrical saw-tooth shape as illustrated in Fig. 3 it is also feasible to employ an unsymmetrical saw-tooth wave of the type utilized for effecting deflection of the electron beam in television transmitting and receiving tubes. By properly adjusting the slope of leading edge 50 and trailing edge 51 of saw-tooth wave 45 shown in Fig. 3 the time distance between the positive and negative output pulses can be adjusted. If, for instance, the slope of trailing edge 51 of the saw-tooth wave is steeper than the slope of leading edge 50, a negative output pulse will closely follow a positive output pulse.

While there has been described what is at present considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A pulse width control network including two inverted parallel rectifiers, means for applying equal biasing voltages to said rectifiers to balance them, means for generating periodic waves of constant amplitude and frequency connected in the same polarity to the input of said rectifiers to render said rectifiers alternately conducting for substantially equal periods of time, means connected to the output of said rectifiers for deriving an output signal consisting of pulses of opposite polarities, and means for adjusting said biasing voltages thereby to control the width of said pulses.

2. A pulse width control network including two inverted parallel rectifiers, means for applying equal biasing voltages to said rectifiers to balance them, means for generating periodic waves of constant amplitude and frequency connected in the same instantaneous polarity to the input of both of said rectifiers to render said rectifiers alternately conducting for substantially equal periods of time, means connected to the output of said rectifiers for deriving an output signal consisting of pulses of opposite polarities, a modulating source, and means for modulating said biasing voltages in accordance with said modulating source thereby to modulate the width of said pulses.

3. The method of producing pulses and controlling the width thereof comprising the steps of generating a periodic input wave of constant

amplitude and frequency, segregating from said wave the positive crests above a threshold level and the negative crests below another threshold level to derive pulses of opposite polarities, said threshold levels being positioned symmetrically with respect to said crests so that one of said segregated positive crests and the succeeding segregated negative crest have substantially equal durations, and adjusting said threshold levels to control the duration of the derived pulses.

4. The method of producing pulses and controlling the width thereof comprising the steps of generating a periodic input wave of constant amplitude and frequency, segregating from said wave the positive crests above a threshold level and the negative crests below another threshold level to derive pulses of opposite polarities, said threshold levels being positioned symmetrically with respect to said crests so that one of said segregated positive crests and the succeeding segregated negative crest have substantially equal duration, and modulating said threshold levels to modulate the duration of the derived pulses.

5. The method of producing pulses and controlling the width thereof comprising the steps of generating a substantially sinusoidal input wave of constant amplitude and frequency, segregating from said wave the positive crests above a threshold level and the negative crests below another threshold level to derive pulses of opposite polarities, said threshold levels being positioned symmetrically with respect to said crests so that one of said segregated positive crests and the succeeding segregated negative crest have substantially equal durations, and adjusting said threshold levels to control the duration of the derived pulses.

6. The method of producing pulses and controlling the width thereof comprising the steps of generating a substantially saw-tooth input wave of constant amplitude and frequency, segregating from said wave the positive crests above a threshold level and the negative crests below another threshold level to derive pulses of opposite polarities, said threshold levels being positioned symmetrically with respect to said crests so that one of said segregated positive crests and the succeeding segregated negative crest have substantially equal durations, and adjusting said threshold levels to control the duration of the derived pulses.

7. The method of producing pulses and controlling the width thereof comprising the steps of generating a substantially sinusoidal input wave of constant amplitude and frequency, segregating from said wave the positive crests above a threshold level and the negative crests below another threshold level to derive pulses of opposite polarities, said threshold levels being positioned symmetrically with respect to said crests so that one of said segregated positive crests and the succeeding segregated negative crest have substantially equal durations, and modulating said threshold levels to modulate the duration of the derived pulses.

8. The method of producing pulses and controlling the width thereof comprising the steps of generating a substantially saw-tooth input wave of constant amplitude and frequency, segregating from said wave the positive crests above a threshold level and the negative crests below another threshold level to derive pulses of opposite polarities, said threshold levels being positioned symmetrically with respect to said crests so that one of said segregated positive crests and the succeeding segregated negative crest have substantially equal durations, and modulating said threshold levels to modulate the duration of the derived pulses.

9. A pulse width control network comprising, two inverted parallel rectifiers having an input circuit and an output circuit, means for applying equal biasing voltages to said rectifiers to balance them, means for generating substantially sinusoidal waves of constant amplitude and frequency, means coupling said wave generating means to the input circuit of said rectifiers for impressing said waves in the same instantaneous polarity upon both of said rectifiers, whereby to render said rectifiers alternately conducting for substantially equal periods of time, means connected to the output circuit of said rectifiers for deriving an output signal consisting of pulses of opposite polarities, a modulating signal source, and means coupling said modulating signal source to said rectifiers in a manner to modulate said biasing voltage in accordance with said modulating signal, whereby to modulate the width of said pulses.

10. A pulse width control network comprising, two diode rectifiers having the anode of one connected to the cathode of the other to form an input circuit, an output circuit being derived from the cathode of said one rectifier and the anode of said other rectifier, means for applying equal biasing voltages to the output circuit of said rectifiers to balance them, means for generating substantially sinusoidal waves of constant amplitude and frequency, means coupling said wave generating means and said rectifiers to impress said saw-tooth waves upon the input circuit of said rectifiers whereby to render said rectifiers alternately conducting for substantially equal periods of time, means connected to the output circuit of said rectifiers for deriving an output signal consisting of pulses of opposite polarities, and means for adjusting said biasing voltages to control the width of said pulses.

11. A pulse width control network comprising, two inverted parallel rectifiers having an input circuit and an output circuit, means for applying equal biasing voltages to said rectifiers to balance them, means for generating substantially saw-tooth waves of constant amplitude and frequency, means coupling said wave generating means to the input circuit of said rectifiers for impressing said waves in the same instantaneous polarity upon both of said rectifiers, whereby to render said rectifiers alternately conducting for substantially equal periods of time, means connected to the output circuit of said rectifiers for deriving an output signal consisting of pulses of opposite polarities, a modulating signal source, and means coupling said modulating signal source to said rectifiers in a manner to modulate said biasing voltage in accordance with said modulating signal whereby to modulate the width of said pulses.

12. A pulse width control network comprising, two diode rectifiers having the anode of one connected to the cathode of the other to form an input circuit, an output circuit being derived from the cathode of said one rectifier and the anode of said other rectifier, means for applying equal biasing voltages to the output circuit of said rectifiers to balance them, means for generating substantially saw-tooth waves of constant amplitude and frequency, means coupling said wave generating means and said rectifiers to impress said saw-tooth waves upon the input circuit of said rectifiers whereby to render said rectifiers alternately conducting for substantially

equal periods of time, means connected to the output circuit of said rectifiers for deriving an output signal consisting of pulses of opposite polarities, and means for adjusting said biasing voltages to control the width of said pulses.

JOHN A. BUCKBEE.

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