

Jan. 27, 1948.

D. M. AMBROSE
APPARATUS FOR CONVERTING PAIRS OF TIME MODULATED
PULSES INTO PULSES OF VARIABLE DURATION
Filed June 24, 1943

2,434,894

2 Sheets-Sheet 1

FIG. 1.

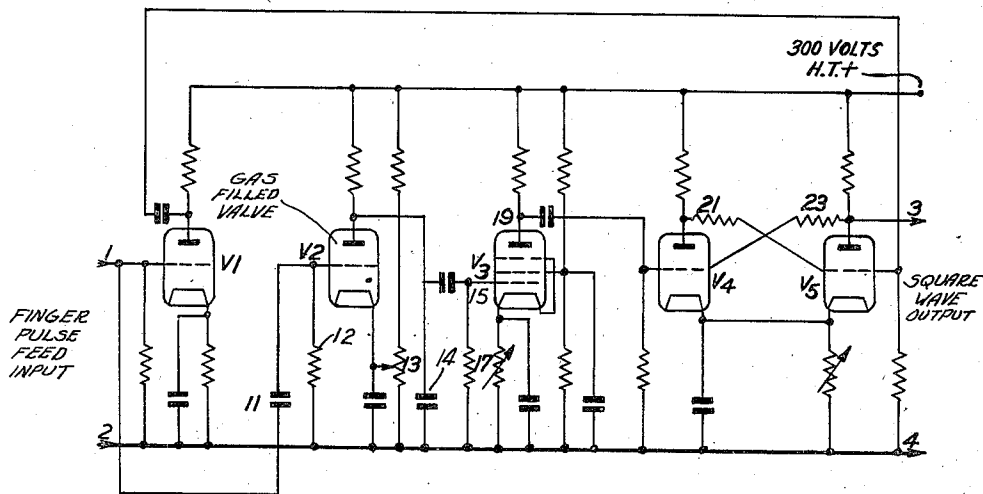
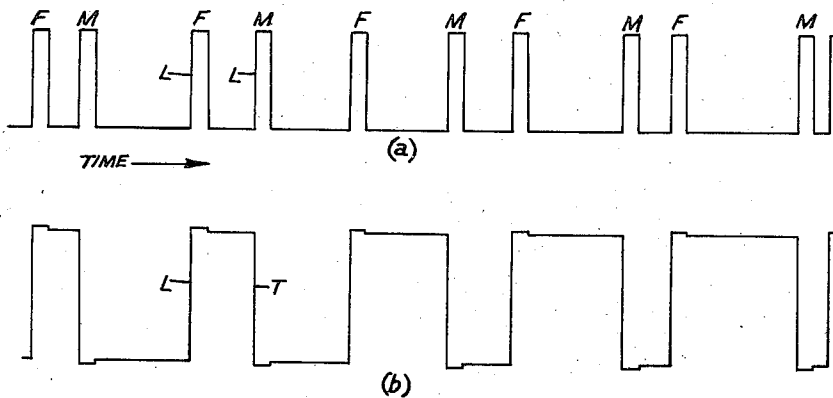


FIG. 2.



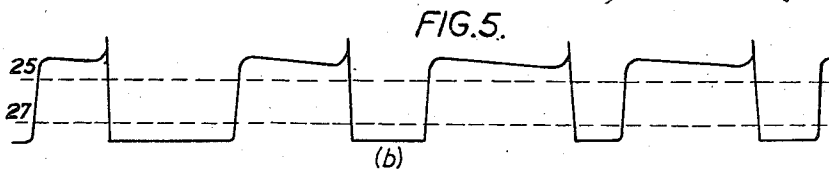
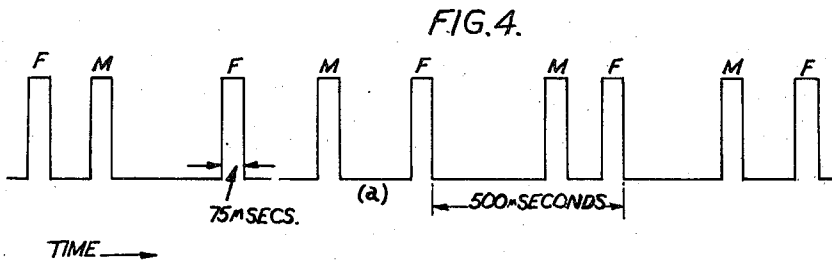
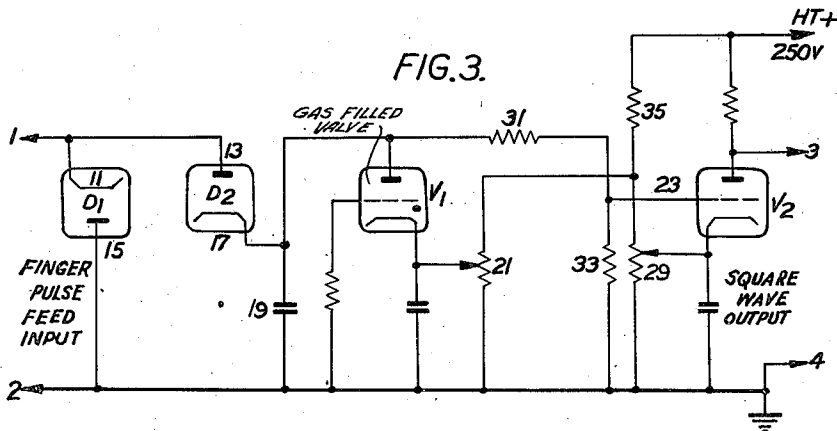
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UNITED STATES PATENT OFFICE

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APPARATUS FOR CONVERTING PAIRS OF
TIME MODULATED PULSES INTO PULSES
OF VARIABLE DURATIONDermot Min Ambrose, London, England, assignor
to Standard Telephones and Cables Limited,
London, England, a British companyApplication June 24, 1943, Serial No. 492,078
In Great Britain September 26, 1941Section 1, Public Law 690, August 8, 1946
Patent expires September 26, 1961

2 Claims. (Cl. 250—27)

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The present invention relates to circuit arrangements for producing variable duration pulses from time modulated pairs of constant duration pulses.

In a known type of electrical communication system the intelligence to be communicated is transmitted as a modulation of the time duration of the pulses occurring at equal intervals of time, the variation in the duration of the pulses, i. e., the time modulation, being proportional to the amplitude of the wave form representing the intelligence at instances equally spaced in time. Such a system is known as a pulse modulation system. In a development of the pulse modulation system, marking pulses, which are in themselves of constant duration are transmitted to mark the beginning and end of a time modulated pulse. These marking pulses are herein referred to as "finger" pulses.

In this specification the following definitions will be used:

A finger pulse comprises a short surge of voltage or current, the duration of which should preferably be less than ten per cent of the repetition time or of that order.

A train of finger pulses is a series of finger pulses occurring at successive intervals of time.

A fixed pulse is a finger pulse which occurs at successive equal time intervals.

A moving pulse is a finger pulse whose time of occurrence with respect to a fixed finger pulse is variable.

The leading edge of a pulse is the edge formed by the initiating change of voltage or current which forms the pulse from its initial state to the peak value of the pulse.

The trailing edge of a pulse is the edge formed by the change of voltage or current which terminates the pulse.

One application of the invention is for the translation of intelligence in a double pulse system for which purpose it is necessary to produce waves having a square wave form from a train of finger pulses in such a manner that the leading and trailing edges of a wave correspond to the two finger pulses marking the leading and trailing edges of the time modulated pulses.

Another application of the invention is in obstacle detection or distance measuring systems utilising the transmission and reflection from an

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obstacle of electrical pulses. The time elapsing between the transmission of a pulse and reception of its echo is a measure of the distance. In one system pulses of duration equal to the time elapsing are produced from the transmitted and received pulses and used to give an indication of the distance required.

It is the object of the present invention to provide circuit arrangements for producing waves having a square topped wave form corresponding to the pairs of fixed and moving finger pulses in a train of finger pulses.

According to the present invention circuit arrangements for producing variable duration electrical pulses from time modulated pairs of constant duration electrical finger pulses comprise a variable voltage device to which the pulses are applied to control the voltage, one of the pulses of a pair producing a sudden voltage change in one direction to a new value and the other pulse returning the voltage suddenly to its original value.

In one arrangement according to the invention, a train of positive finger pulses is fed to a generator of oscillations of sawtooth wave form, herein referred to for brevity as a sawtooth oscillator, in such a manner that the oscillator is triggered by each fixed finger pulse of the train. Finger pulses are formed from the resulting sawtooth wave by limiting the output to the positive tips of the wave and these finger pulses are fed to one of the control grids of a "double stability" circuit. The other control grid of the double stability circuit is fed by a corresponding train of finger pulses which are of the same polarity as the pulses produced from the sawtooth wave form and may be of the same polarity as, or of reversed polarity, and derived from, the original finger pulse train. The output from one anode of the double stability circuit is then in the form of the square waves required.

In another arrangement for producing square wave forms from a train of finger pulses, the pulses are made to charge a condenser across which a gas discharge device, for example one such as those known under the registered trademark "Thyratron" is connected, and by adjustment of the grid bias of said device, it is possible to set the voltage at which it will strike and initiate gas discharge, to be in excess of the volt-

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age caused by charging of the condenser by the first pulse. As the second pulse continues to charge the condenser, the gas discharge device strikes and provides a discharge path for the condenser which remains so discharged until the arrival of the first finger pulse of the next pair to begin another cycle.

Practical embodiments of the invention will now be described with reference to the accompanying drawings in which

Fig. 1 shows circuit arrangements of an embodiment utilising the generator of oscillations of sawtooth wave form;

Fig. 2 shows curves explanatory of the operation of the circuit shown in Fig. 1;

Fig. 3 shows circuit arrangements of an embodiment utilising a condenser and gas discharge device; and

Fig. 4 shows curves explanatory of the operation of the circuit shown in Fig. 3.

Referring now to Fig. 1 of the drawings, a train of fixed and moving positive finger pulses of a constant amplitude are fed across terminals 1 and 2 to the control grid of valve V1 and through a small condenser 11 to the control grid of valve V2. The valve V2 is a "Thyratron," or other like gas discharge device, and the circuit associated with it is of the conventional sawtooth oscillator type. The operation of V2 is synchronized by the pulses impinging on its control grid. The "free-running" speed of the oscillator is adjusted by the resistance 13 to be very nearly the same as that of the fixed pulses, so that the resulting output is of a frequency identical to that of the fixed pulses. The condenser 11 and grid leak resistance 12 of V2 differentiate at their junction the input finger pulses so that shorter alternate positive and negative pulses corresponding respectively to the leading and trailing edges of the input finger pulses are applied to V2. The vertical edge of the sawtooth wave form, may then be synchronised with either of these positive or negative pulses and thus may be made to coincide with either the leading or trailing edge of the input finger pulses.

The operation is found to be stable within limits depending upon the duration of the finger pulses. When this duration becomes very short and the pulse repetition frequency is not increased correspondingly, the circuit has a tendency only to synchronise with the leading edge of the finger pulse since there will, under these conditions, be no sensible change in the charging voltage time of the condenser 14 across the Thyratron V2 in relation to that between the leading and trailing edges of the finger pulses.

The sawtooth waveform from the oscillator V2 is fed to the control grid 15 of a high impedance pentode V3. This grid is biased negatively by the resistance 17 in such a manner as to cause the valve to accept only a small positive tip of the sawtooth wave. The output from the anode 19 of V3 is thus a negative pulse the width of which may be varied by the bias control 17. This pulse is fed to one end (in this case the grid of valve V4) of a "double-stability" circuit comprising valves V4 and V5 which are medium impedance triodes and are interconnected by resistances 21 and 23 as shown. It will be seen from the circuit that if the control grid of V4 goes negative, V4 ceases to pass anode current, and hence its anode goes positive causing the control grid of V5 to go more positive and hence V5 to draw increased anode current. This causes the anode of V5 to become more negative and hence

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the control grid of V4 more negative, thus "locking" the circuit in this stable condition. Now if a negative pulse be applied to the control grid of V5, sending the anode of V5 positive and also control grid of V4 positive the circuit locks in its other stable condition, this being obtained when the operations explained in conjunction with V5 are happening with V4 and those in V4 happening in V5.

Thus, by applying negative pulses to the grids of this double stability circuit, the anodes of V5 and V4 go alternately positive and negative. In other words, when negative pulses are impinged on the grid of V4 the anode of V5 will be more negative, and vice versa.

The original finger pulse train after being reversed in polarity by valve V1 is fed to the control grid of V5 and the generated pulse from the saw-tooth wave is fed to the control grid of V4. This latter is of slightly longer duration than the corresponding pulse (i. e., fixed pulse) in the original train, the duration being adjusted by bias control 17 as already stated. Thus the "double-stability" circuit is actuated by the generated pulse on one grid whilst the moving pulse only is effective on the other grid.

The output of the desired waveform is taken between terminals 3 and 4.

Referring to Fig. 2 of the drawings, curve *a* shows the fixed finger pulses F and the moving finger pulses M. The leading edge of a pulse is indicated L.

Curve *b* indicates the waveform obtained at the output terminals 3 and 4 after reversal in sign. It will be observed that the leading edge L of the waveform coincides with the leading edge L of the corresponding fixed finger pulse and the trailing edge T of the waveform coincides with the leading edge L of the corresponding moving finger pulse.

Referring now to Fig. 3 of the accompanying drawings which shows the circuit arrangements utilising a condenser and gas discharge device, the train of positive fixed and moving finger pulses are fed across terminals 1 and 2. These pulses are thus impinged on to the cathode 11 of diode D1 and anode 13 of diode D2. Diode D1 is for D. C. restoration purposes only, i. e., any negative voltage appearing on its cathode 11 causes current to flow from its anode 15 thus by-passing all negative pulses. This valve may be used in the circuit but is not essential to the working of the circuit. The positive pulses pass through D2 from its anode 13 to cathode 17 and charge the condenser 19. The charge is held on the condenser by the high impedance which D2 offers to the discharge of the condenser.

Connected across the condenser 19 is a "Thyratron" or other like gas discharge device V1 whose bias is adjusted by the resistance 21 to such a value that the striking voltage necessary is greater than the voltage produced by the charge on the condenser 19 due to the first pulse and less than the voltage produced by the charge due to two successive pulses.

The value of the condenser 19 depends upon the input pulse width, i. e., the time during which the surge occurs and also on the amount of power which is available in the pulses. For example, if the pulses used be of a 75 microsecond duration and, this combined with a medium impedance triode feeding the circuit with pulses, the optimum value of the condenser is found to be approximately .001 microfarad.

The wave-forms of the finger pulses and the

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pulses across the output of valve V1 are shown in curves *a* and *b* of Fig. 4, respectively. As in Fig. 2 the fixed pulses are marked F and the moving pulses are marked M.

Thus before a fixed finger pulse F arrives the condenser 19 is discharged and at the reception of a fixed pulse F the charge and therefore the voltage across the condenser suddenly rises as shown on the left hand side of a pulse, in curve *b*. Then during the interval between finger pulses F and M the charge remains substantially constant. On the reception of a finger pulse M the charge of the condenser suddenly increases as shown by the peak on the right hand side of a pulse on curve *b*. During the charging up of the condenser on the reception of a pulse M, the voltage exceeds the striking voltage of the gas discharge device V1 which ignites and provides a path for the discharge of condenser 19, so that the voltage across the condenser drops suddenly as shown by the right hand side of a pulse, curve *b*, Figure 4. Thus the pulses in curve *b* are of the same durations as the durations between the corresponding fixed and moving finger pulses.

The final output from this circuit arrangement has to be kept at a high enough impedance to prevent the condenser discharging between the pulses by more than 10% of its initial charge. There are three possible paths of discharge, viz.:

- (1) Through D2 and D1.
- (2) Through the "Thyratron" V1.
- (3) Through resistance 31 and 33.

In case (1) the impedance of D2 is 15 to 20 megohms and in case (2) the impedance of V1 when it is not in its ionised condition is 30 megohms since it passes 10 micro-amperes at 300 volts.

Thus case (3) is the limiting factor and in a practical case 3 megohms was found to be sufficient for the pulses used which were of a repetition time of 2000 per second and a duration of 75 microseconds.

The pulses in the output of V1 may be tapped off on a suitable point of the series resistances 31, 33.

Owing to the fact that the output waveform is not perfectly rectangular the top and bottom of the waveform has to be limited.

The limiting action may be obtained in one valve of medium impedance but a higher impedance valve V2 is preferred in order to utilise the shorter grid swing and the sharper cut-off. The pulses obtained in a tapping from 31-33 are applied to the control grid 23 of the valve V2. The resistance chain formed by resistance 35, and parallel connected resistances 21 and 29 may be replaced by only two resistances in series across the H. T. supply. The reason for using such a chain as that shown for supplying bias should be obvious to those conversant with the art both for the proper operation of the "Thyratron" V1 and for V2, the latter being the limiter valve. The amplitude of the signal output from V1 is arranged to be considerably in excess of the grid swing voltage of valve V2. Thus the valve V2 is run from

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the overload point to the cut-off point of the anode current and so the top and base of the square wave-form are limited. The accepted amplitude limits are shown between the broken lines 25 and 27 curve *b* Fig. 4 and these limits may be moved between the limits of the amplitude of the pulses fed to V2 by means of the bias control resistance 29.

What is claimed is:

1. Arrangement for producing variable duration electrical pulses from a source of time modulated pairs of electrical finger pulses each said pair comprising a fixed pulse and a moving pulse, comprising a double stability electronic device including a pair of anode-cathode space discharge paths and a pair of control electrodes one in each of said paths, connections from the anode of each said path to the control electrode of the other path, an output circuit connected across one of said space discharge paths, means for producing a train of electrical pulses of substantially the same periodicity as said input fixed finger pulses but of longer duration, means for synchronizing said train of electrical pulses with said fixed finger pulses, means for applying said train of electrical pulses to one of said control electrodes and means for applying the input finger pulses from said source to said other control electrode.
2. Arrangement for producing variable duration electrical pulses, from a source of time modulated pairs of electrical finger pulses each said pair comprising a fixed pulse and a moving pulse, comprising a double stability electronic device including a pair of anode-cathode space discharge paths and a pair of control electrodes one in each of said paths, connections from the anode of each said path to the control electrode of the other path, an output circuit connected across one of said space discharge paths, means for generating saw-tooth waves of substantially the same periodicity as said input fixed finger pulses, means for applying said input finger pulses to said last-mentioned means to synchronize said saw-tooth waves with said input fixed finger pulses, a limiter device, means for applying said saw-tooth waves to said limiter device to cause it to pass only small tips of the saw-tooth waves, means for converting said small tips and said input finger waves to like polarity, means for applying said small tips to one of said control electrodes, and means for applying said input finger pulses to the other of said control electrodes.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,266,401	Reeves	Dec. 16, 1941
2,092,887	Luck	Sept. 14, 1937
2,086,918	Luck	July 13, 1937