

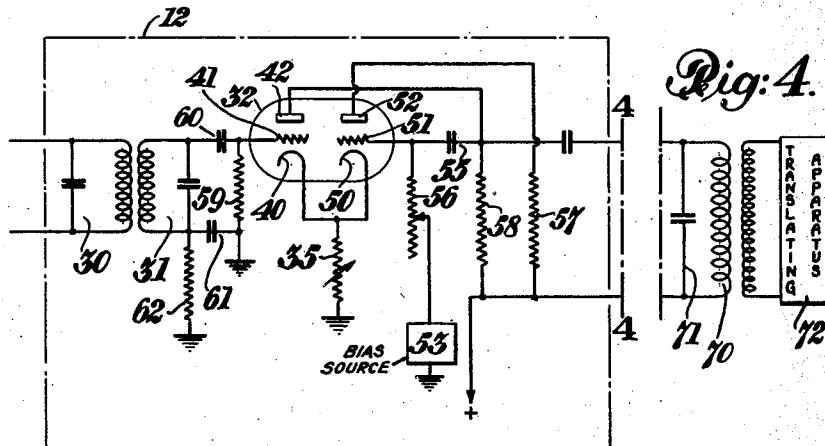
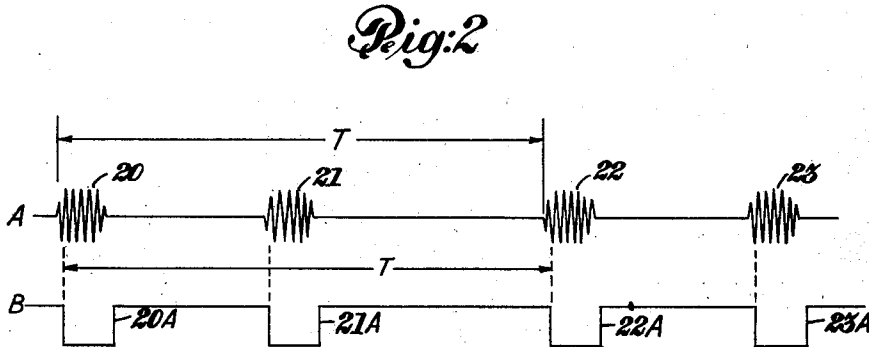
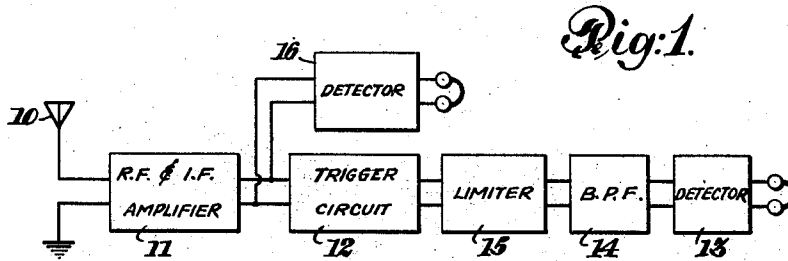
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TRIGGER CIRCUIT

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TRIGGER CIRCUIT

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This invention relates to radio frequency circuits and more particularly to trigger circuits to be controlled by received radio frequency pulses.

For the purpose of economy in power and for preservation of a modicum of secrecy, transmission of energy by time modulated impulses is often resorted to. This type of system is quite fully set forth in United States patents to A. Reeves, Nos. 2,266,401 and 2,256,336 and in United States patent to Edmond M. Deloraine and A. Reeves No. 2,262,383.

A particularly valuable type of such systems from the standpoint of avoiding interception is that described in the copending applications of Edmond M. Deloraine and Emile Labin, entitled "Pulse transmission system," Serial No. 425,108, filed December 31, 1941, and Emile Labin, entitled "Radio receiver," Serial No. 449,595, filed July 3, 1942.

In the last named application is described a system wherein received pulses are amplified, detected and limited, after which they are applied to a trigger circuit. The shaping circuit serves to give to the detected pulses a fixed duration independent of the duration of the received pulse.

It is an object of my invention to provide means for translating and shaping radio frequency pulses into direct current pulses directly without first detecting these pulses to derive the pulse envelope.

It is a further object of my invention to produce from a train of radio frequency pulses; direct current pulses of a duration and amplitude independent of the duration and amplitude of the input pulses.

In accordance with a feature of my invention radio frequency pulses, preferably after amplification, are applied over a resonant circuit to the input of a translating circuit. This trigger circuit is preferably in the form of a multi-vibrator with a fixed time constant of operation. The leading edge of an incoming radio frequency pulse serves to operate the trigger circuit and it remains in operation for a definite period independent of the length of the applied pulse. The time period for which the trigger circuit remains operated is greater than the duration of the applied radio frequency pulse and therefore produces a pulse in the output which has a spacing, in time, dependent upon the applied radio frequency pulse but a duration independent thereof. The trigger circuit may also serve to produce pulses of an amplitude independent of the applied radio frequency pulses.

By applying the envelope direct current pulses

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derived from the input pulses to a circuit tuned to a different radio frequency harmonically related to the pulse envelope, a series of output pulses of a different carrier radio frequency and the same relative time spacing which may be readily detected by known means or used for other purposes may be obtained.

A better understanding of my invention and the objects and features thereof may be had from the particular description of an embodiment of my invention made with reference to the accompanying drawings in which:

Fig. 1 is a block diagram of a receiver incorporating my invention;

Fig. 2 is a set of curves used in explaining the operation of my invention;

Fig. 3 is the circuit diagram of a trigger circuit in accordance with my invention; and

Fig. 4 shows an additional output element which may be used with the trigger circuit of Fig. 3.

In Fig. 1 is shown diagrammatically a time modulated impulse receiving system incorporating my invention. This receiver includes the usual antenna 10 and the radio frequency amplifier 11 which may also serve to reduce the received radio frequency signals to a common intermediate frequency. This intermediate frequency preferably also is in the radio frequency range. If the system is to be used for reception of impulses from stations transmitting at different frequencies, it is desirable that the received frequencies be reduced to the same intermediate frequency for the purposes of the invention as will be brought out more fully later.

The radio frequency impulses from the output of amplifier 11 are applied to a trigger circuit 12. This trigger circuit 12 produces direct current impulses having the same spacing with respect to one another in time as the pulses received at 10 but having a duration and preferably also an amplitude independent of the duration and amplitude of the received pulses. Accordingly, the impulses in the output of the trigger circuit will be in the form of direct current impulses with all of the radio frequency carrier removed therefrom. No separate envelope detector circuit and trigger circuit is necessary as in previous circuits of this type.

The output signals from trigger circuit 12 are then applied to a detector 13 over a band-pass filter 14 preferably after being limited in a limiter 15. If the pulses are amplitude modulated as well as time modulated, the signals in the output of amplifier 11 may be applied to another

detector 16 for deriving the amplitude modulated signal.

It will be recognized that the receiver circuit of Fig. 1 performs substantially the same function as the prior art system outlined above. The circuit according to my invention, however, does not require the detecting circuit for the pulses prior to application thereof to the trigger circuit. Likewise, the input limiter is unnecessary in this circuit in accordance with my invention as will be more clearly brought out in the specific description of the shaping circuit.

The trigger circuit which constitutes the principal feature of my invention will now be described with reference to Figs. 2 and 3. The radio frequency impulses in the output of amplifier 11 will be in the form shown in curve A of Fig. 2. The two pulses 20 and 21 which define one pair of time-modulated impulses are each composed of a high frequency carrier wave as shown. Although only a relatively small number of oscillations are shown in the figure, the actual number of oscillations in each pulse may be fairly high. For example, if the entire pulse duration is two microseconds and an intermediate frequency of 50 megacycles is used, there will be 100 oscillations during one pulse. With higher frequencies there will be a correspondingly larger number of oscillations per pulse. The pairs of pulses in the received series, 20, 21 and 22, 23 are separated by a relatively fixed period T.

The pulses of this received series are applied preferably to the tuned primary 30 (Fig. 3) of the tuned input circuit 31 of trigger circuit 12. This trigger circuit comprises a vacuum tube device 32 operating as a multivibrator or trigger circuit. A common envelope with two sets of electrodes is shown but it should be understood that separate vacuum tubes may be used if desired instead of a single tube structure. This multivibrator circuit has two sets of electrodes, cathode 40, grid 41 and anode 42, and cathode 50, grid 51 and anode 52. The cathodes 40 and 50 are interconnected and coupled to ground through an adjustable resistor device 35. This adjustable resistor serves as a common resistance in the anode-cathode circuit of both sets of electrodes and provides the feedback necessary for operation of the arrangement as a multi-vibrator. In the absence of a signal, grid 51 is maintained negative by means of a bias source 53 so that the corresponding set of electrodes is normally non-conductive. The energy flowing through the first section of this tube and through resistance 35 maintains grid 41 slightly negative in the normal condition. Grid 51 also tends to become more negative adding to the negative bias. Upon application of a predetermined negative voltage to grid 41 the electrode system 40, 41 and 42 provides an amplification of this voltage. This operation then swings grid 51 in a positive direction by reason of the drop through resistance 58 and the charge on condenser 55 overcoming the effect of the negative bias on this grid. Simultaneously, the electrode system 40, 41, 42 is driven further negatively to cut-off by virtue of the feedback voltage across resistance 35. Accordingly, an output signal is initiated in the multi-vibrator trigger circuit across resistance 57. If the negative voltage applied to the grid 41 does not continue, the charge on condenser 55 associated with grid 51 will leak off through resistance 56. As soon as this charge has been reduced so that this section of the tube is again cut off by the bias, current ceases between elec-

trodes 50 and 52 and the current between electrodes 40 and 42 commences. The duration of this operative condition of the multi-vibrator trigger means is determined by the adjustment of resistance 35 and the time constant of resistances 56 and 59, condenser 55 and anode load resistor 58 and is independent of the length of the pulse applied to the input grid 41. Of course, if the input pulse is of a duration greater than the time constant of resistance 56 and condenser 55, the tube would remain in operation.

The input pulses such as 20, 21, 22 and 23 successively applied to tuned circuit 31 develop a sufficient potential to initiate operation of tube electrodes 40, 41 and 42. This developed potential is applied to the input over resistance 59 and coupling condensers 60, 61. A decoupling resistance 62 of high value is arranged connected between tuned circuit 31 and ground. Normally, it will take a number of applied oscillations to cause this operation but this number will be relatively small compared to the total number in the pulse. Each negative swing of a received wave train pulse adds to the effect tending to make grid 41 negative. After operation of the trigger circuit, however, the initiated output pulse will last for a period of time determined by the circuit time constants and independent of the length of the applied impulses, 20, 21, 22, etc. Accordingly, the output current from trigger circuit 12 may be indicated by curve B of Fig. 2. It will be noted that the pulses 20A, 21A, 22A and 23A are all initiated at substantially the same time with respect to the corresponding pulses 20, 21, 22 and 23 and that they are all of equal duration, slightly greater than the duration of the initiating pulses. Likewise, the amplitude of these output pulses is independent of the input amplitude since it is controlled entirely by the constants of the trigger circuit and the voltages applied thereto. For this reason it is not necessary to limit the amplitude of the received pulses to a constant level before application to the trigger circuit. Furthermore, it is not necessary to first detect the radio frequency pulses to envelope frequency before application to the multi-vibrator circuit since the multi-vibrator itself performs the function of detecting the signals and is triggered by them for the final signal reproduction.

The trigger circuit of Fig. 3 has been described as an element of the receiver system of Fig. 1. It may, however, be used in other connections. By adding a tuned circuit, Fig. 4, to the output line as indicated at line 4-4 the circuit may operate as a frequency changer to convert the received radio frequency pulses to damped wave-train pulses of a different radio frequency without disturbing their time spacing. By selecting the values of inductance 70 and condenser 71 to any frequency which is a harmonic of the pulses produced in the output of the multi-vibrator impulses of this harmonic frequency having an amplitude and duration determined by the output impulses of the trigger circuit may be produced. These waves may then be passed to any translating apparatus 72 for further operation as desired.

Generally, the direct current impulses in the output of the trigger circuit will not contain frequency components higher than the initiating radio frequency impulses. For this reason, therefore, the circuit 70, 71 should usually be tuned to a frequency lower than the input signals. However, if higher harmonics are present, the circuit may operate as a frequency multiplier. Moreover,

when the constants of 70 and 71 are properly chosen the trigger circuit may be used to produce reshaped output at the same radio frequency as the initiating pulses if desired.

It is clear that many other known forms of trigger circuits may be used in place of the particular circuit shown in Fig. 3. For example, any type of multi-vibrator circuit may be used so long as it is properly biased and is provided with a suitable tuned input circuit to develop the necessary operating voltage directly from the radio frequency impulses. It is further clear that an amplifier such as shown at 11 is only necessary in order that the amplitude of the received impulses be increased. Even if no amplifier is provided, the trigger circuit will operate providing the received pulses are of sufficiently great amplitude themselves.

While the trigger circuit of my invention is particularly useful in receivers for time modulated impulse systems or for converting the received radio frequency, it is clear that the principles of my invention are not limited to this particular combination. The trigger circuit may be useful in obstacle detection systems for reshaping the reflected impulses prior to applying them to the control electrodes of an indicator. Furthermore, in accordance with my invention, the trigger circuit disclosed may be used in any case where it is desired to produce direct current pulses corresponding in space to alternating current impulses but independent of these pulses in amplitude and duration.

Many modifications of my invention will occur to those skilled in the art and the particular examples described are not to be considered as limitations on the scope of my invention but merely as an illustration thereof.

What is claimed is:

1. A circuit for producing output direct current pulses of predetermined character in response to applied radio frequency pulses of a given duration comprising a trigger circuit for producing a pulse of predetermined duration at least as great as said given duration in response to applications to said circuit of a predetermined voltage, an input circuit for said trigger circuit comprising a tuned circuit resonant to the radio frequency of said radio frequency pulses for developing said predetermined voltage to cause operation of said trigger circuit, and an output circuit for said trigger circuit for deriving therefrom the produced direct current pulses.

2. A circuit according to claim 1, further comprising a circuit tuned to a predetermined radio frequency component of said direct current pulses coupled to said output circuit whereby radio frequency pulses whose duration is independent of said applied radio frequency pulses are obtained.

3. A radio receiver for time modulated pulse reception, comprising a receiving amplifying means for amplifying a succession of received pulses of a given radio frequency, a circuit for detecting said amplified radio frequency pulses and shaping the resultant detected pulses, said circuit comprising an input circuit tuned to said radio frequency for developing a predetermined voltage, a trigger circuit normally in unoperated condition and operative into operated condition in response to said predetermined voltage, means for coupling said tuned circuit to said trigger circuit, and time constant means for maintaining said trigger circuit operated for a substantially

constant period of time at least as great as the duration time of said amplified pulses, means coupled to the output of said circuit for deriving a direct current pulse in response to each operation of said shaping circuit, and means for deriving the time modulation envelope of said received pulses from said direct current pulses.

4. A radio receiver according to claim 3 wherein said circuit further comprises means for determining operation of said trigger circuit to a predetermined amplitude, to control the amplitude level of said direct current pulses to substantially a constant value independent of said applied pulses.

5. A radio receiver for time modulated pulse translation, comprising a receiving amplifying means for amplifying a succession of received pulses of a given radio frequency, a circuit for detecting and shaping the detected envelope of said amplified radio frequency pulses, said circuit comprising an input circuit tuned to said radio frequency for developing a predetermined voltage, a trigger circuit normally in unoperated condition and operative into operated condition in response to said predetermined voltage, means for coupling said tuned circuit to said trigger circuit and means for maintaining said trigger circuit operated for a substantially constant period of time at least as great as the duration time of said amplified pulses, means coupled to the output of said circuit for deriving a direct current pulse in response to each operation of said circuit, and means tuned to a fixed radio frequency which is a component of said direct current pulses for deriving reshaped time modulated pulses from said direct current pulses.

6. A circuit for detecting radio frequency input pulses and producing therefrom output pulses having substantially the same timed relation to one another as the input pulses and amplitudes and duration periods independent of those of the input pulses, comprising an impulse trigger circuit having an input circuit and an output circuit, means normally maintaining said trigger circuit in unoperated condition, means responsive to a predetermined input voltage for rendering said trigger circuit operative, duration control means for maintaining said trigger circuit operative for a predetermined interval after application of said predetermined voltage, means in said input circuit resonant to said radio frequency for receiving said radio frequency pulses and developing said predetermined voltage in response to each said received pulses to cause operation of said trigger circuit, and means in the output circuit of said trigger circuit for deriving pulses of predetermined amplitude and duration in response to operation of said trigger circuit.

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