

April 29, 1947.

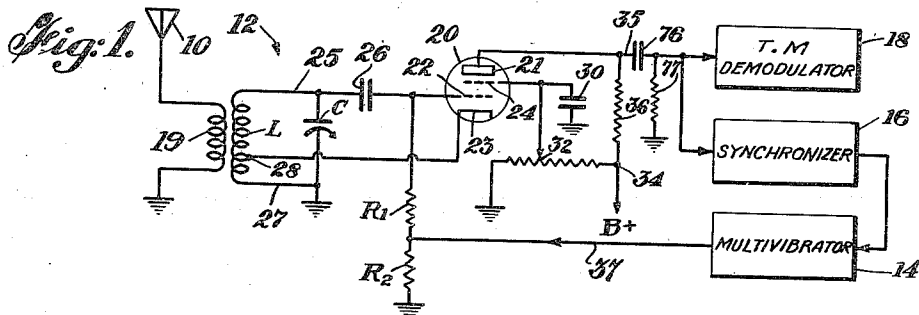
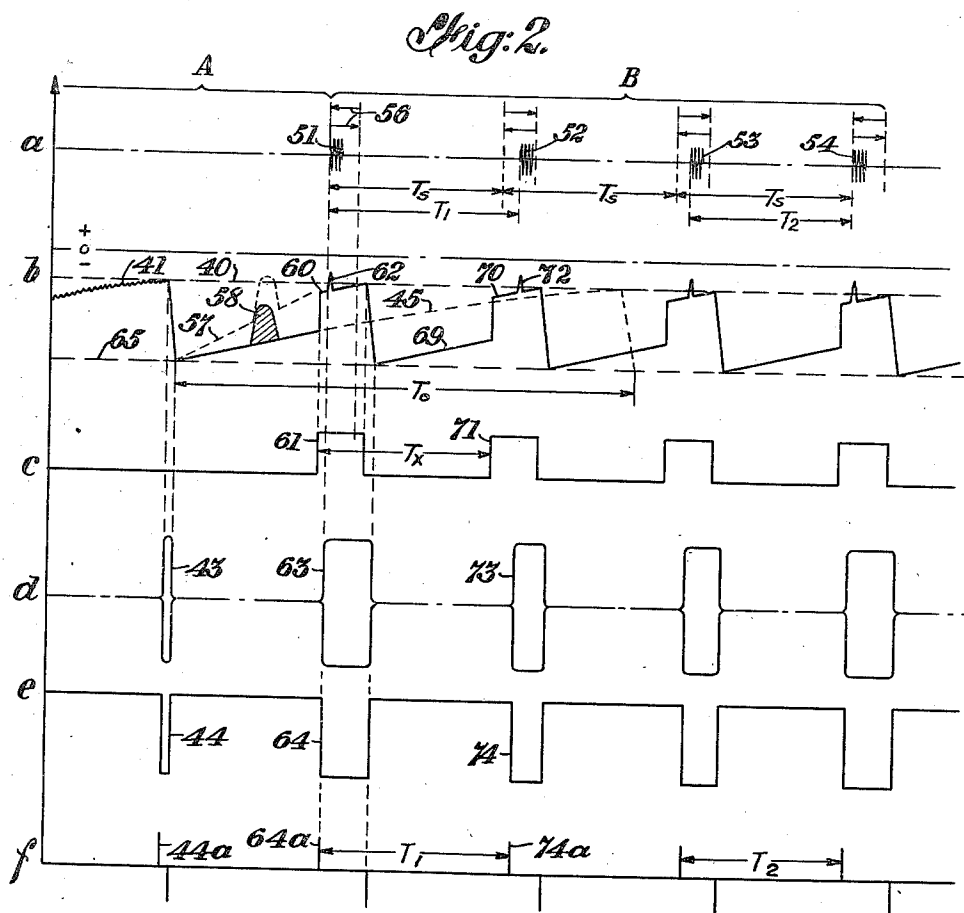
E. LABIN ET AL

2,419,570

RECEIVER CIRCUIT

Filed May 24, 1943

3 Sheets-Sheet 1



INVENTORS  
EMILE LABIN  
DONALD D. GRIEG  
BY  
*Percy R. Lutz*  
ATTORNEY

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E. LABIN ET AL

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Fig. 3.

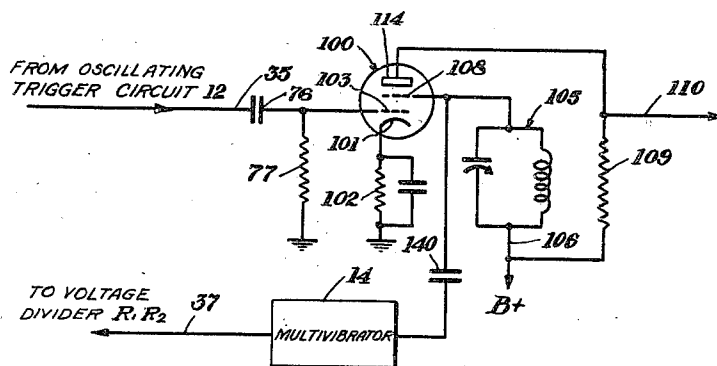
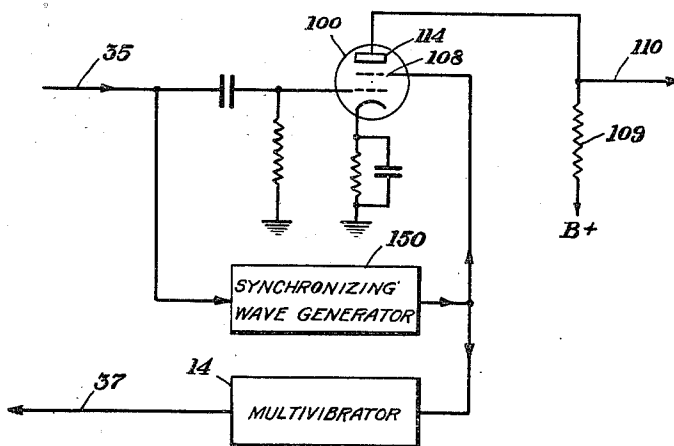


Fig. 4.



INVENTORS  
EMILE LABIN  
DONALD D. GRIEG  
BY  
Percy P. Lantry  
ATTORNEY

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E. LABIN ET AL

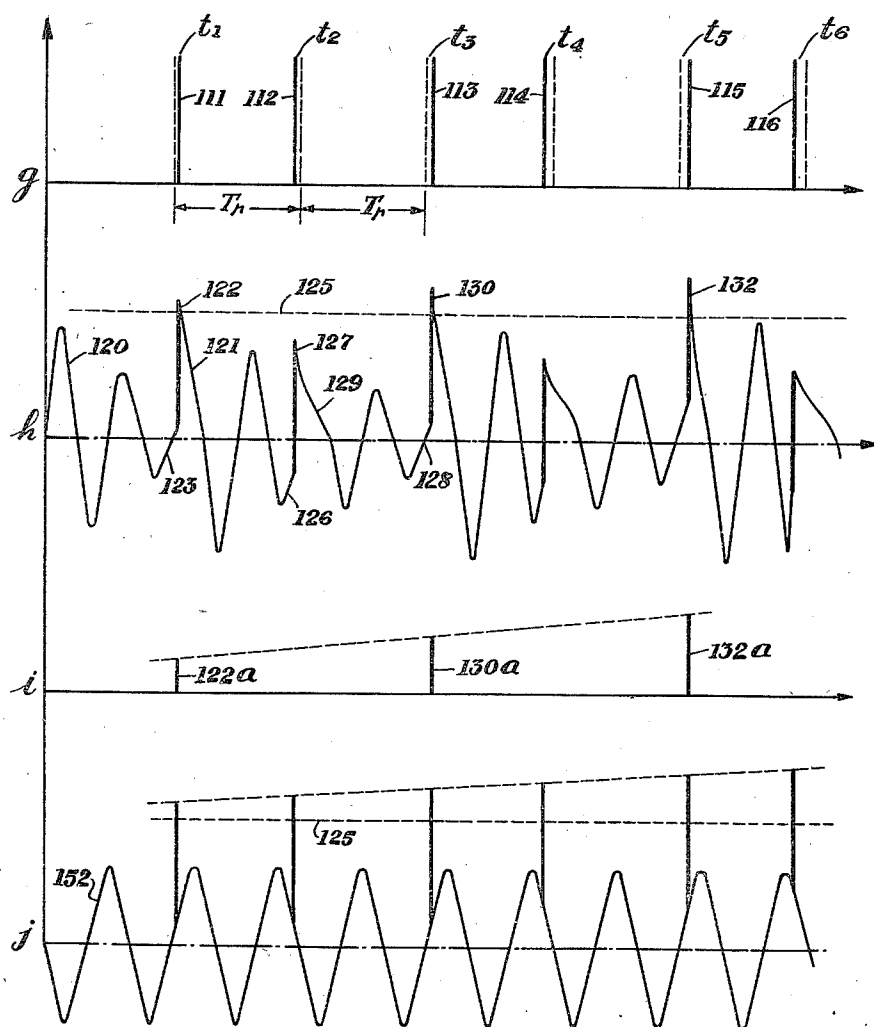
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*Fig. 5.*



INVENTORS  
EMILE LABIN  
DONALD D. GRIEG  
BY  
*Percy P. Lutz*  
ATTORNEY

## UNITED STATES PATENT OFFICE

2,419,570

## RECEIVER CIRCUIT

Emile Labin, New York, and Donald D. Grieg,  
Forest Hills, N. Y., assignors to Federal Tele-  
phone and Radio Corporation, Newark, N. J.,  
a corporation of Delaware

Application May 24, 1943, Serial No. 488,183

19 Claims. (Cl. 250-20)

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This invention relates to radio receiving circuits and more particularly to electrical circuits for translation of pulse energy into impulses of greater intensity.

In our copending application Serial No. 488,181, filed May 24, 1943, are certain forms of triggerable oscillating circuits tunable for response to a given pulse source such as a carrier wave of time modulated pulses for translation of the carrier pulses into impulses of greater intensity. The oscillating circuits therein disclosed are adjusted for normal interval operation at a frequency slightly lower than the unmodulated pulse repetition rate of the pulse source. The pulses of the source can then control the oscillation intervals of the circuit when the circuit operation is brought into approximate synchronization with the pulse source. While this adjustment of the oscillating circuit can be made to eliminate most noise interference, other interference pulses such as produced for jamming purposes can trigger the circuit to operation and effect a translation of unwanted pulses and the consequent elimination of at least a percentage of the wanted signal pulses.

It is an object of the present invention to provide an improved radio receiving circuit for translation and demodulation of time modulated pulses wherein the translating feature of the circuit is rendered highly susceptible to pulses occurring only during an interval equal to approximately the maximum degree of modulation applied to the pulses of the source the reception of which is desired.

Another object of the invention is to provide a method and means for translation of desired pulse energy into impulses of much greater intensity while eliminating to a high degree noise and other unwanted pulses.

The principles of our present invention are accomplished by providing locally a voltage pulse which is applied to an oscillating trigger circuit to increase the susceptibility of its operation to input pulses during the selected width of the applied voltage pulse. While the applied voltage pulse may be produced by various forms of local generators, we preferably use a multivibrator so as to produce a rectangular form of voltage pulse which is impressed upon the control circuit of the oscillating trigger circuit. The multivibrator is adjusted for operation at a frequency corresponding to the unmodulated pulse repetition rate of pulse source and the width of the rectangular pulse is selected so that each rectangular pulse of energy will cover an interval equal to at least the

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maximum degree of modulation applied to the pulses at said source. This applied multivibrator pulse increases sharply the susceptibility of the circuit and maintains this increased susceptibility throughout the duration of the rectangular pulse so that regardless of the degree of modulation of the input pulses the circuit will be susceptible thereto. The susceptibility of the circuit during the interval between successive multivibrator pulses is low in comparison and the circuit during such intervals normally will not respond to input pulses unless the latter are of exceptionally high intensity.

For a further understanding of the invention, reference may be had to the following detailed description to be read in connection with the accompanying drawings, in which:

Fig. 1 is a schematic diagram of a radio receiving circuit according to the principles of our invention; and

Fig. 2 is a graphical illustration of the translation feature of the invention;

Figs. 3 and 4 are schematic wiring diagrams of pertinent parts of a T. M. demodulator showing different arrangements by which the multivibrator may be associated with the demodulator circuit; and

Fig. 5 is a graphical illustration of the demodulation features of the invention.

Referring to Fig. 1, a T. M. (time modulation) radio receiver is shown therein for purposes of illustrating the principles of our invention. It will be understood that the translation feature of the invention as well as the demodulation feature in combination therewith may be used in connection with wire transmitting systems as well as space transmitting systems. Also, while we illustrate the invention with regard to double pulse modulation, it will be clear from the following description that it is applicable to other forms of time modulation and control pulses.

The receiver of Fig. 1 includes the usual antenna 10, an oscillating trigger circuit 12, a local generator preferably of the multivibrator character 14, a synchronizer 16 for synchronizing the operation of the generator 14 with the pulse repetition rate of any given pulse source, and a T. M. demodulator 18. The oscillating circuit 12 is provided with a resonant LC circuit which is tunable to any particular carrier wave, the R. F. energy of which is obtained from an antenna coupling coil 19. The oscillating circuit 12 includes a vacuum tube 20 having an anode 21, a control grid 22, a cathode 23 and a screen grid 24. One side 25 of the LC circuit is connected through a

blocking condenser 26 to the grid 22. The opposite side 27 of the LC circuit is grounded. For triggering action, the cathode 23 is connected to the coil L at 28. The screen grid 24 is connected to ground through a condenser 30 for by-passing the radio frequency energy. The screen grid is also connected to a movable contact of a potentiometer 32 which is supplied with positive energy from a battery terminal 34. The plate output circuit 35 is connected across a load resistance 36 to the battery terminal 34.

The multivibrator 14 is of a known character operatable between two states of operation and at selected frequencies. By proper adjustment, the duration of one state of operation with respect to the other may be varied thereby determining the width of the pulse produced. For reception of time modulated pulses of a given unmodulated pulse repetition rate, the multivibrator is adjusted according to our invention so as to have a frequency of operation corresponding to the given pulse repetition rate of the source of input pulse energy. The output of the multivibrator is applied to the grid 22 through a connection 37 and a voltage divider  $R_1, R_2$ . The multivibrator pulse which preferably is of a rectangular form is thus applied to the grid 22 thereby increasing considerably and with sharpness the sensitivity of the tube 20. The resistor  $R_1$  is preferably high to provide a high impedance to the R. F. energy of the grid circuit. If desired, however, the connection for applying the multivibrator pulse energy to the tube may be made to the screen grid in place of the grid 22.

While the multivibrator may be manually adjustable to the pulse repetition rate of the R. F. source, it may be desirable to tie in the multivibrator by synchronizing means. This is accomplished in Fig. 1 by using a known synchronizing circuit 16 which is controlled by the double modulation impulse output of the oscillating circuit 12, and which operates to synchronize operation of the multivibrator to the average pulse repetition rate of the pulse source. In other words, the synchronization is such as to time the multivibrator operation at substantially the unmodulated pulse repetition rate of the pulse source. Where the pulse source is other than double modulated, the width of the voltage pulse may be so selected as to compensate for modulation displacements.

In Fig. 2, curve *a* represents a period A of normal operation of the oscillating circuit 12 in the absence of input signals and a period B during which input pulses are received. Curve *b* represents generally the grid voltage of grid 22 during the period represented by curve *a*. Curve *c* represents the rectangular pulse energy applied from the multivibrator 14 to the grid 22. Curve *d* represents the envelope of the oscillating intervals of the circuit 12. Curve *e* represents the impulse output of the plate connection 35 and curve *f* a differentiated output thereof.

Assuming that no input pulses are received (period A) and that no rectangular pulses are applied to the grid circuit, the operation of the oscillating circuit 12 is in accordance with the portion of the curves *b, d* and *e* for the period A. When the potential on the grid 22 builds up to the critical value indicated by the level 40, curve *b*, oscillations will be initiated by thermal or random noise voltage such as indicated by the irregularity of the grid voltage at 41. The oscillations in the circuit 12 build up rapidly as

indicated by the envelope 43, curve *d*. The plate circuit provides an output impulse 44, curve *e*, during the operating interval represented by the envelope 43. The average normal operating period of the circuit 12 is represented by the grid voltage curve as it would normally build up after a blocking operation of the condenser 26 as indicated by the broken line 45 having a period  $T_0$ . This period of operation of the oscillating circuit 12 may, of course, be varied by adjustment of the potentiometer 32 and the time constants of the grid circuit. The period of operation  $T_0$ , however, is preferably selected considerably greater than the period of the unmodulated pulse repetition rate of a desired signal source.

A series of four signal pulses 51, 52, 53 and 54 are shown in curve *a*. The first two pulses 51 and 52 are shown in one extreme position of double time modulation while the pulses 53 and 54 are shown in the opposite extreme position of modulation. The pulses of the time modulated source may be modulated between the limits as indicated by the arrows 55 according to the intelligence to be conveyed. The unmodulated pulse repetition rate is indicated by the period  $T_s$  while the displacement interval between the pairs of pulses 51, 52 and 53, 54 are indicated as  $T_1$  and  $T_2$  respectively.

With the oscillating circuit 12 adjusted at the operating frequency  $T_0$  and in the absence of the multivibrator pulses, approximately only alternate signal pulses will initiate oscillation in circuit 12. By reducing the period  $T_0$  to approximately the pulse repetition rate of the signal source as in our aforesaid application Serial No. 488,181, translation of each of the signal pulses can be obtained. This reduction of the operating interval, as hereinbefore pointed out, increases the build-up rate of the grid voltage as indicated at 57 and the circuit 12 will then become more susceptible to operation by unwanted pulses such as the pulse 58.

In order to make the circuit 12 less susceptible to unwanted pulses and highly susceptible to wanted signal pulses, the rectangular pulse output of the multivibrator 14 is adjusted to a frequency of operation indicated by the period  $T_x$  which corresponds substantially to the period  $T_s$ . The application of the multivibrator pulse energy to the grid 22 superimposes this energy on the grid voltage as indicated by curve *b* thereby decreasing the negative grid voltage as indicated at 60 close to the critical level 40. As is clear from an inspection of curve *b* this application of the multivibrator energy to the grid 22 permits normal adjustment of the oscillating circuit 12 to the period  $T_0$  which is much greater than the period  $T_s$  of the signal pulses. This maintains the grid voltage for intervals of operation between multivibrator pulses to a large negative value such that the occurrence of unwanted pulses will not initiate oscillations unless the unwanted pulses occur in coincidence with the multivibrator pulse and then usually only if they occur just prior to the wanted signal pulse.

The signal pulse 51 is shown to be received in coincidence with the occurrence of the multivibrator pulse 61 thereby decreasing the negative grid voltage beyond the critical level 40 as indicated at 62 to initiate oscillations in the circuit 12 as indicated by the envelope 63. This oscillation builds up a negative voltage on the blocking condenser 26 which blocks the oscillations when the

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negative voltage reaches the critical level 65 thereby terminating the envelope 63. As hereinbefore stated the oscillating interval represented by the envelope 63 produces conduction in the tube 20 whereby an output impulse 64 is produced across the resistor 35 in the plate output circuit 35.

As the blocking charge on condenser 25 is dissipated through resistors  $R_1$ ,  $R_2$ , the grid voltage curve gradually becomes less negative as indicated by the portion 69 of the curve *b*. The next succeeding multivibrator pulse 71 is superimposed on the grid voltage curve 59 while it is still at a relatively large negative value thereby decreasing the negative grid voltage as indicated at 70. The next succeeding signal pulse 52 occurring during application of the pulse energy 72 is then capable of triggering the circuit 12 into oscillations 73 thereby producing the next succeeding impulse 74. Likewise, the following multivibrator pulses being in coincidence with incoming signal pulses 53 and 54, for example, increases the susceptibility of the circuit 12 for oscillation in response to these signal pulses as shown in Fig. 2.

It will be clear that by proper adjustment of the multivibrator the pulse width of the multivibrator pulses may be selected to cover an interval of time corresponding to the maximum degree of modulation of the signal pulses so that regardless of the degree of modulation of any particular signal pulse, the circuit 12 will be rendered highly susceptible for reception of the signal pulse. It is therefore clear that by applying pulse energy to the grid of the tube 20, the oscillating circuit 12 is rendered highly susceptible during the intervals when signal pulses from a given source are received and maintained less susceptible to input pulses for substantially all of the interval between the reception of successive signal pulses.

The output impulses (curve *e*) of the circuit 12 are preferably first differentiated by the condenser-resistor combination 76, 77 to obtain narrow width impulses 44a, 54a, 74a, etc., curve *f*, which correspond to the leading edges of the corresponding impulses of curve *e*, before demodulation by the T. M. demodulator 13. A suitable demodulator for this purpose is disclosed in the copending application of D. D. Grieg Serial No. 459,959, filed September 23, 1942. The demodulation of the impulses of curve *f* is substantially as set forth in this Grieg copending application. This demodulation function, however, will be explained hereinafter in connection with the additional embodiments illustrated in Figs. 3 and 4.

In Fig. 3, a demodulating circuit of the character disclosed in the aforesaid Grieg application is shown in combination with the multivibrator 14 in a manner to eliminate the need for synchronizer 16 of Fig. 1. The demodulator circuit of Fig. 3 includes a vacuum tube 100 having a cathode 101 self-biased to cut-off by a resistance-capacitance circuit 102. The grid 103 is connected to the condenser-resistor combination 76, 77 of the anode output connection 35 of the oscillating trigger circuit 12 of Fig. 1. Connected to the screen grid 108 of tube 100 is a shock excitable tuned circuit 105. A positive potential for the screen grid 108 is provided by a battery connection 106 at the opposite side of the tuned circuit 105. The anode 114 is connected in circuit with a resistance 109 across which the amplitude modulated pulse output is obtained.

In operation of the demodulating circuit of Fig. 3, assume for purposes of illustration that the time modulated pulses applied thereto are

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pulses 111, 112; 113, 114; 115, 116; etc., curve *g*, Fig. 5, and that the tuned circuit 105 is tuned to a frequency of approximately two times the demodulated pulse repetition rate represented by the period  $T_r$ . The circuit 105 is adapted to be shocked into excitation by the passage of pulse energy through the tube 100 and will produce on the screen grid 108 a damped voltage oscillation such as indicated by the portion 120 of curve *h*. When the pulse 111 is applied to the grid 103 of tube 100, it adds algebraically to the instantaneous value of the wave 120 as indicated on the linear portion 123 of the curve. With the tube 100 biased to cut-off at a level 125, the passage of energy through the tube as suggested by the peak portion of the undulation 122 further shock excites the circuit 105 thereby producing a new oscillating wave 121. The "Q" of the circuit 105 is such as to produce a damping effect on the oscillations established therein so that when the pulse 111 is applied the preceding wave 120 is still of substantial amplitude. The amplitude of the resulting undulation 122 is dependent upon the wave form 120, the amplitude of the input pulse 111 and the degree of modulation thereof, the latter characteristic determining the point on the wave 120 upon which the pulse energy 111 is superimposed. The signal pulses coincide with a zero potential point on the oscillating wave 120. This relation is determined by proper tuning of the circuit 105. By suitably biasing the tube 100 for cut-off at the level 125, energy is therefore passed by the tube to the anode circuit corresponding to the degree of modulation  $t_1$  of the pulse 111.

Since the pulses of curve *g* are modulated in push-pull fashion, the next succeeding pulse 112 occurs on a linear portion 126 of wave 121 while the wave is negative so that the initial undulation 127 of the next succeeding wave portion 129 occurs below the level 125. The first pulse 113 of the next succeeding pulse pair being modulated in a direction opposite to the modulation of pulse 112 occurs on the positive portion 128 of wave 129 thereby producing an output of energy corresponding to the peak portion of undulation 130 which extends above the level 125. Since the degree of modulation  $t_3$  for pulse 113 is greater than the degree of modulation  $t_1$  for pulse 111, the energy passed by the tube in accordance with the peak 130 is correspondingly larger than the energy passed in accordance with the peak portion of undulation 122. For the still greater degree of modulation  $t_5$  of pulse 115 an undulation 132 is produced, and the energy passed by the tube in response thereto is of corresponding greater amplitude. The pulse energy 122a, 130a and 132a passed by the tube according to the peak portions of these undulations is illustrated by curve *i*. It will be observed that the variation in amplitude of the pulse energy of curve *i* corresponds in proportion to the degree of modulation of the pulses of curve *g*. For a more detailed discussion of the demodulation principles, reference should be had to the aforesaid Grieg application.

It will be noted that since the resonant circuit 105 is tuned to a particular frequency the successive waves of curve *h* have the same period. Referring back to Fig. 3, use of this constant frequency of oscillation of the resonant circuit 105 is made for synchronizing the multivibrator 14. This is done by connecting the input side of the multivibrator through a coupling condenser 140 to the terminal of the screen grid 108. Thus,

the oscillating voltage of the resonant circuit 105 being applied to the multivibrator the latter may be adjusted in known manner so as to respond to certain of the oscillations for actuation from one state of operation to a second state of operation from which the multivibrator is adapted to return after a predetermined interval, thereby producing a rectangular wave form such as curve *c*, Fig. 2. It will be understood, of course, that the wave relationship of curve *h*, Fig. 5, and curve *c*, Fig. 2, are not intended to correspond but are merely presented for purposes of illustrating the principles of the invention. In actual practice the frequency of the wave *h* would be selected at a higher value so that the operation of the multivibrator could be controlled more sharply as regards the unmodulated repetition rate of the signal source and in addition at a suitable frequency so that all pulses including the pulses 112, 114, 116 etc. contribute to the modulation envelope. A lower frequency has purposely been selected for illustration in curve *h* so that the character of modulation of the demodulator could be more easily illustrated.

In Fig. 4, a further modification of the circuit of Fig. 3 is shown wherein the tuned resonant circuit 105 is replaced by a known synchronizing wave generator 150 adapted to produce in response to the average repetition rate of input pulses from connection 35. These pulses being double modulated in push-pull manner control the generator 150 to produce a sinusoidal wave 152, curve *j*, Fig. 5, having a frequency which is preferably a selected multiple of the unmodulated repetition rate of the signal pulses of curve *g*.

The output of the generator 150 is applied both to the screen grid 108 of tube 100 and to the input of multivibrator 14. As in the embodiment of Fig. 3, the multivibrator is adjustable to operate in the desired manner in response to the sinusoidal wave to produce a rectangular wave for application to the control grid of the tube 20 of the oscillating circuit 12 of Fig. 1. The application of the sinusoidal wave 152 to the screen grid 108 operates in a similar manner to the oscillating voltage of the tuned circuit 105 to effect a translation of the degree of modulation of the input pulses to produce output pulses which vary in amplitude according to the degree of modulation of the corresponding input pulses. The mixing action of the tube 100 with respect to the input pulses and the sinusoidal wave 152 is illustrated by curve *j* and since the tube is biased to cut-off at a level 125, output pulse energy is produced corresponding to the pulse portions which extend above the level 125.

From the foregoing, it is clear that in the embodiments, the synchronizing and demodulation means are simplified. It will also be clear to those skilled in the art that many additional changes are possible without departing from our invention. It is to be understood, therefore, that the embodiments herein illustrated are given by way of example and not as limiting the scope of the invention as set forth in the objects and the appended claims.

We claim:

1. In a radio receiver for time modulated pulse reception, an oscillating trigger circuit operating at a lower frequency than the unmodulated pulse repetition rate of a given time modulated pulse source for production of an impulse for each operating interval thereof, pulse generating means operating to produce voltage pulses at substantially the unmodulated pulse

repetition rate of said pulse source, said circuit having voltage means for controlling the operating rate of said circuit, and means for applying said voltage pulses to said voltage means to increase the susceptibility of said circuit to actuation by input pulses for pulse reception intervals at least as large as the maximum degree of modulation of the pulses from said source.

2. The radio receiver defined in claim 1, wherein the voltage pulse generating means includes means for synchronizing the pulse generating means with the pulses from said source so that each voltage pulse occurs during reception of a pulse from said source.

3. The radio receiver defined in claim 1 wherein the pulse generating means includes a multivibrator adjustable to produce a rectangular pulse of predetermined duration.

4. The radio receiver defined in claim 1 wherein the oscillating trigger circuit includes a vacuum tube having plate, at least one grid and a cathode electrode, said one grid and said cathode being in operative connection with the means for applying pulses from said source, means connected to the plate electrode for receiving the output impulses thereof in response to oscillations established in the tube circuit, and means adjustable to control the bias of said tube.

5. In a radio receiver for time modulated pulse reception, an oscillating trigger circuit operating to produce pulse energy at a lower frequency than the unmodulated pulse repetition rate of a given time modulated pulse source for production of an impulse for each operating interval of the circuit, said circuit including energy means for controlling the rate of operation of said circuit, a voltage pulse generator for applying energy to said energy means to increase the sensitivity thereof, and means to synchronize the pulse generator with the unmodulated pulse repetition rate of said source, whereby susceptibility of the circuit to actuation by input pulses is increased for a pulse reception interval equal to the maximum degree of modulation of the pulses of said source.

6. The radio receiver defined in claim 5 wherein the pulse generator includes a multivibrator for producing rectangular voltage pulses, whereby the change produced in the susceptibility of the circuit is sharply defined.

7. A circuit for translating the time modulated pulses of a given source into an equivalent train of time modulated impulses comprising an oscillating trigger circuit operating at a lower frequency than the unmodulated pulse repetition rate of said given source for production of an impulse for each operating interval of said circuit, said circuit including energy means for controlling the operating rate of said circuit, a pulse generator for producing substantially rectangular pulse energy, said generator being adjustable to an operating period substantially such as to make the rectangular pulse of a width sufficient to cover a pulse reception interval equal to the maximum degree of modulation with respect to time of the pulses of said source, and means to apply said rectangular pulse energy to said energy means to increase for the duration of said rectangular pulse energy the susceptibility of the circuit to actuation by input pulses.

8. The circuit defined in claim 7, in combination with means for synchronizing the pulse generator with the pulses from said source so

that each rectangular pulse coincides with a pulse from said source regardless of the degree of modulation of the pulse.

9. The circuit defined in claim 7 wherein the pulse generator includes a multivibrator in combination with means for synchronizing the operation of the multivibrator with the unmodulated pulse repetition rate of said pulse source.

10. The circuit defined in claim 7 wherein the oscillating trigger circuit includes a vacuum tube having plate, at least one grid and cathode electrodes, means for applying pulses from said source to said one grid and cathode electrodes, means connected to the plate electrode for forming the output impulses in response to oscillations established in the tube circuit, and means adjustable to control the bias of said tube.

11. In an electrical circuit having an oscillating trigger circuit normally operating at a considerably lower frequency than the unmodulated pulse repetition rate of a given pulse source, said circuit including energy means for controlling the operation of said oscillating trigger circuit, so that the circuit is normally susceptible to operation by wanted and unwanted pulses only during the latter portion of its normal operating period, the circuit when triggered operating to produce an impulse; pulse generating means operating to produce a voltage pulse having a repetition rate substantially equal to the unmodulated pulse repetition rate of said source, and means for applying said voltage pulses to said energy means to increase the susceptibility of the circuit for the duration of the voltage pulses so that the circuit is highly susceptible during signalling intervals when desired signal pulses occur and much less susceptible during the space between said signalling intervals.

12. The radio receiver defined in claim 11 wherein the pulse generating means includes a multivibrator adjustable to produce a rectangular pulse of predetermined duration, whereby the change produced in the susceptibility of the circuit is sharply defined.

13. In an electrical circuit having an oscillating trigger circuit operating at a lower frequency than the pulse repetition rate of a given pulse source for production of an impulse for each operating interval of the circuit, said trigger circuit including means for producing control energy for controlling the operating rate of said trigger circuit and being actuable by the pulses of said source and also by undesired pulses when said controlling energy added to such pulses exceeds a critical operating value; the method of decreasing the possibility of operation in response to said undesired pulses and increasing susceptibility to operation in response to the pulses of said source comprising producing rectangular voltage pulses having a repetition rate substantially equal to the repetition rate of the pulses of said source, and applying the rectangular pulses to said controlling energy in a manner to approximate the critical operating value only for the duration of said rectangular pulses.

14. In an electrical circuit having an oscillating trigger circuit operating at a considerably lower frequency than the unmodulated pulse repetition rate of a given time modulation pulse source for production of an impulse for each operating interval of the circuit, said circuit including means for producing control energy for controlling the operating rate of said trigger circuit and being actuable by pulses of said source and by undesired pulses when the pulses

added to said control energy produce in said circuit a voltage exceeding a predetermined potential level; the method of decreasing the possibility of operation in response to said undesired pulses and increasing susceptibility to operation in response to the pulses of said source comprising producing voltage pulses having a repetition frequency equal to the unmodulated repetition rate of the pulses of said source, selecting the width of the voltage pulses thus produced sufficient to cover a pulse reception interval at least equal to the maximum degree of modulation of the pulses of said source, and applying the voltage pulses to said control energy in a manner to approximate said potential level only for the duration of said voltage pulses.

15. The method defined in claim 14 wherein the voltage pulses produced are of rectangular shape so as to define sharply the change in susceptibility.

16. A radio receiver for time modulated pulse energy reception comprising an oscillating trigger circuit operating at a lower frequency than the unmodulated pulse repetition rate of a given time modulated pulse energy source for production of an impulse for each operating interval thereof, said circuit including means for producing control energy for controlling the operating rate of said trigger circuit, pulse generating means operating at the unmodulated pulse repetition rate of said pulse energy source to apply a voltage pulse to said control energy to approximate said given value and to thereby increase the susceptibility of said circuit to actuation by input pulses for pulse reception intervals at least as large as the maximum degree of modulation of the pulses from said source, means to demodulate said impulses, the demodulating means including means responsive to said impulses for producing a wave voltage, and means to apply said wave voltage to said pulse generating means to control the operation thereof.

17. The radio receiver defined in claim 16 wherein the means for producing said wave voltage includes a resonant circuit tunable to the unmodulated pulse repetition rate of said impulses to produce sinusoidal wave energy, said demodulator means further including means for combining said wave energy and the time modulated pulse energy, whereby the resulting pulse portions above a given reference value correspond in amplitude to the time displacement of the corresponding pulse energy.

18. A radio receiver for time modulated pulse energy reception comprising an oscillating trigger circuit operating at a lower frequency than the unmodulated pulse repetition rate of a given time modulated pulse energy source for production of an impulse for each operating interval of the circuit, said circuit including means for producing control energy adapted to render said circuit operative at a given energy value, a voltage pulse generator for applying energy to said control energy to approximate said given value and to thereby increase the sensitivity of said circuit, said pulse generator supplying energy pulses of a duration at least equal to the maximum degree of modulation of the pulses of said source, means to synchronize the pulse generator with the unmodulated pulse repetition rate of said source, whereby susceptibility of the circuit to actuation by input pulses is increased for a pulse reception interval equal to the maximum degree of modulation of the pulses of said source, and means to demodulate the impulses, the de-

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modulating means including means for using the output of said synchronizing means for combining action of said time modulated energy with that of said energy pulses whereby the resulting pulse portions above a given reference value correspond in amplitude to the time displacement of the corresponding pulse energy.

19. A radio receiver for time modulated pulse reception comprising an oscillating trigger circuit operatable at a lower frequency than the unmodulated pulse repetition rate of a given time modulated pulse source for production of an impulse for each operating interval of the circuit, said circuit including energy means for rendering operative said circuit at a given energy value, a voltage pulse generator for applying energy to said energy means to approximate said given value and to thereby increase the sensitivity of said circuit, said pulse generator supplying energy pulses of a duration at least equal to the maximum degree of modulation of the pulses of said source, means for producing a synchronizing voltage wave having a frequency equal to a multiple of the pulse repetition rate of said source, means to apply said voltage wave to control said generator whereby susceptibility of the circuit to actuation by input pulses is in-

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creased for a pulse reception interval equal to the maximum degree of modulation of the pulses of said source, a demodulator for translation of the time modulation of said impulses into amplitude modulated energy, said demodulator including a vacuum tube having two grid electrodes, means to apply said synchronizing wave energy to one of said grid electrodes, means to apply said impulses to the other of said grid electrodes, and means to bias said tube to produce a threshold clipping effect of the combining energy applied to said grid electrodes for the production of said amplitude modulated energy.

EMILE LABIN.

DONALD D. GRIEG.

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