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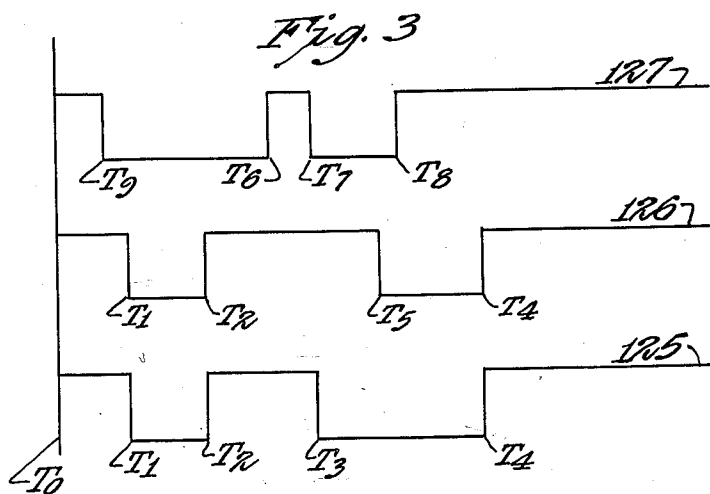
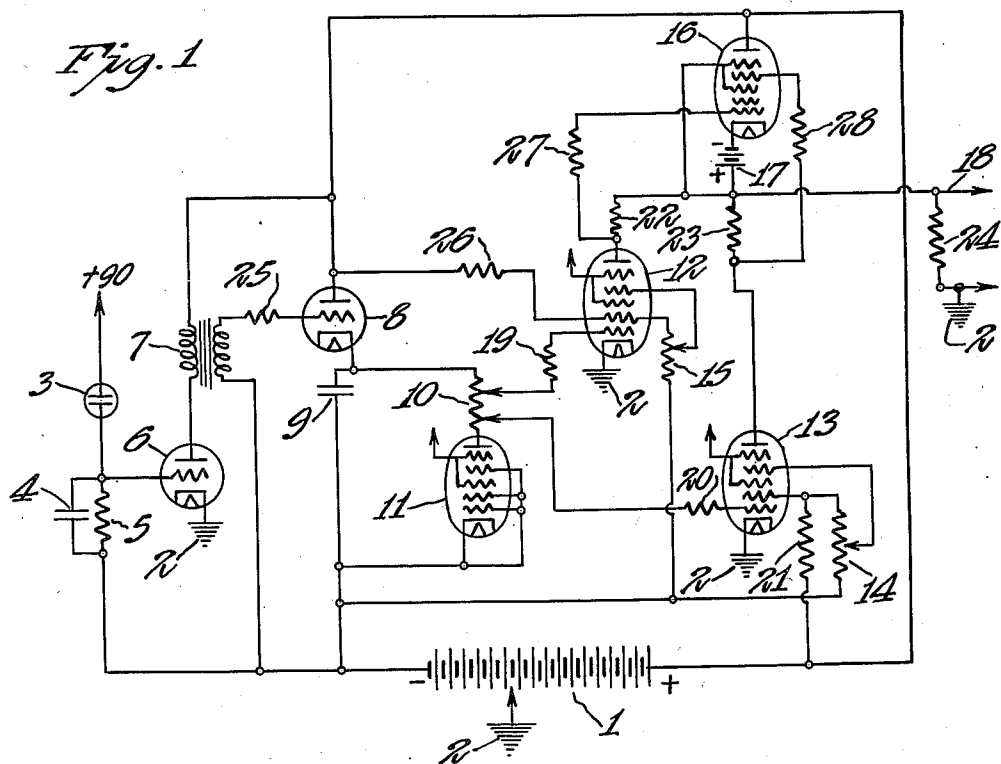
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2,421,022

DURATION IMPULSE RECEIVER

Filed Jan. 4, 1945

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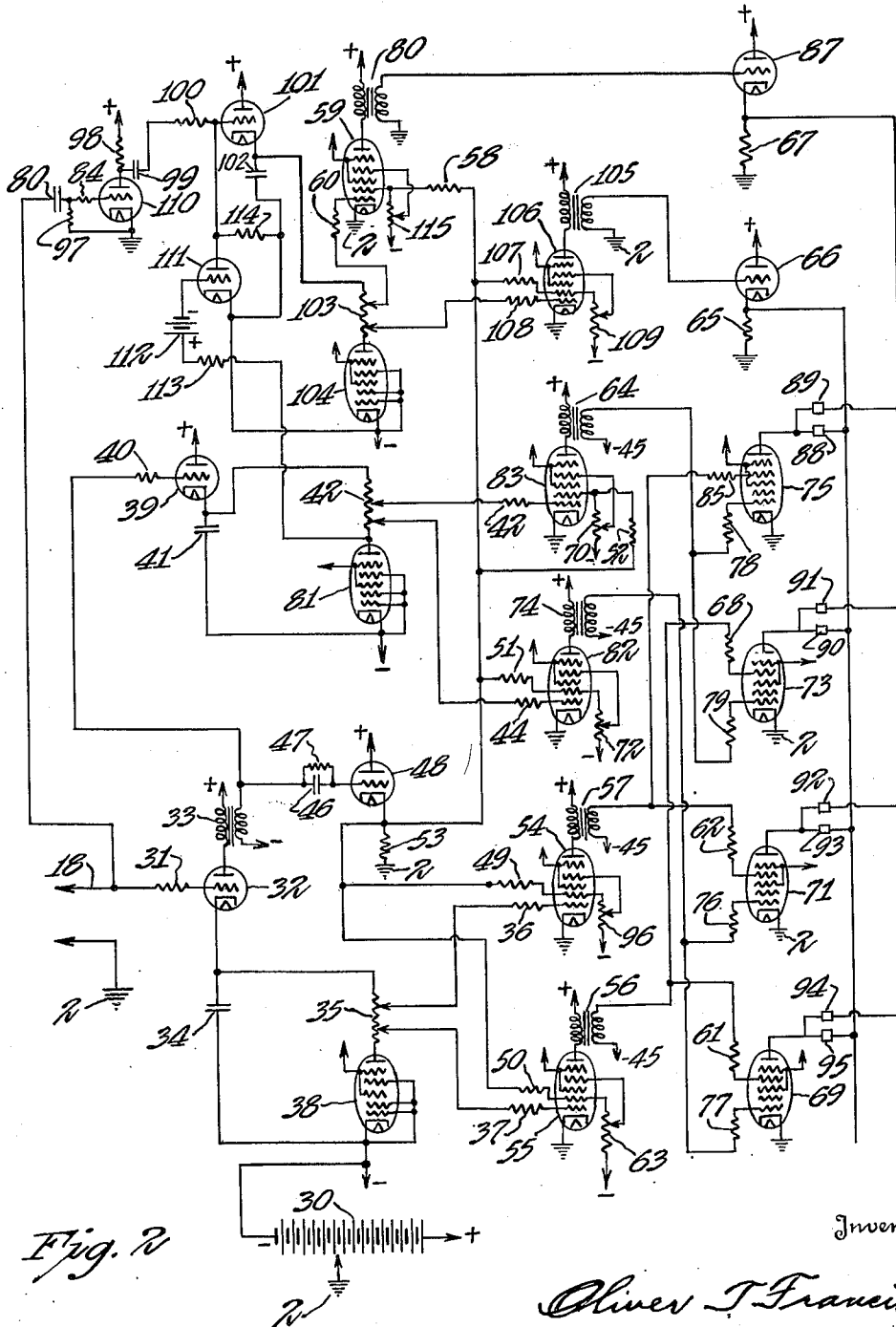
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UNITED STATES PATENT OFFICE

2,421,022

DURATION IMPULSE RECEIVER

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17 Claims. (Cl. 177-353)

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This invention relates to signalling receivers, and more particularly to those in which duration of signal impulses and spacing between impulses determines the intelligence received.

It is a continuation in part of my application Ser. No. 499,757, filed August 24, 1943, now U. S. Letters Patent 2,399,668, granted May 7, 1946, entitled "Impulse duration responsive or indicating device."

Signalling systems have been proposed using coded energy of different lengths of "on" and "off" duration. Sometimes this coded energy is a cyclic pattern and repeated several times to perform one function at the receiving station. Such systems use slow release, or slow pick up mechanical relays or a combination of both as the decoding means. In view of the mechanical inertia involved in mechanical relays high speed transmission has been impossible with such systems. Furthermore the mechanical relays are subject to deleterious effects such as those resulting from change in temperature, wear, etc., and therefore can never be made very accurate. It is one of the objects of this invention to provide a system whereby the operations performed by the slow pick up mechanical relays may be performed entirely by vacuum tube relays, thereby getting away from such undesirable features.

Another object is to provide a signalling receiver for a signal pattern comprising two impulses of different durations separated by a spacing, a first reactance device in which the energy is changed at a predetermined rate for the duration of said impulses, a second reactance device in which the energy is changed for the duration of the spacing and means for recording said energy changes as an indication of the signal received.

Another object is to provide a receiver having a plurality of condensers, vacuum tubes for charging said condensers, means for discharging a first of said condensers at a predetermined rate from the beginning of the first of said impulses to the end of the last impulse, and discharging a second of said condensers from the end of said first impulse to the end of said second impulse, and discharging a third of said condensers from the beginning of the last impulse to its end, and means for indicating the charges remaining on said condensers at the end of said impulses.

Another object is to provide a novel means of rendering a receiving unit operable only at the end of the signal.

Another object is to provide a system of cross connections between signal responsive vacuum

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tubes whereby the maximum number of electro-responsive devices may be selectively operated by the minimum number of tubes.

These and other objects will become apparent from the claims, description and figures, wherein:

Fig. 1 shows a transmitter for producing a signal pattern of desired durations and spacings.

Fig. 2 shows a receiver for decoding said signals, and,

Fig. 3 shows several signals which may be transmitted.

Referring to Fig. 1, I have shown a means for producing time displaced impulses of variable duration and spacing, comprising a means for producing a source of voltage varying in magnitude, and a plurality of vacuum tubes each of said tubes being conductive between different magnitudes of said voltage, for producing the patterns of signal voltages such as shown in Fig. 3.

The source of variable voltage consists of a "neon tube oscillator" comprising the series connection of a "B" battery 1, a gas discharge device 3, and the parallel connection of condenser 4 and resistance 5. The grid of vacuum tube 6 is connected to the positive terminal of resistance 5. The output circuit of tube 6 can be traced from the positive terminal of battery 1, primary of transformer 7, plate impedance of tube 6, to the ground 2 terminal of battery 1. The grid of vacuum tube 8 is connected through resistance 25, and secondary of transformer 7 to the negative terminal of battery 1. The output circuit of tube 8 can be traced from the positive terminal of battery 1, through plate impedance of tube 8, potentiometer 10, the plate impedance of vacuum tube 11 to the negative terminal of battery 1. Vacuum tube 11 is a screen grid tube and has a high A. C. plate impedance. It is shown as a pentagrid converter tube having its first, second, and fourth grids connected to its cathode and its third and fifth grids connected together internally and to battery 1 at a more positive point than its cathode. Condenser 9 is connected between the cathode of tube 8 and the negative terminal of battery 1.

Vacuum tubes 12 and 13 are conductive to plate current at different magnitudes of voltage across condenser 9. Various types of vacuum tube circuits conductive to input voltages between predetermined magnitudes are known. I prefer to use the pentagrid converter type as described in my above application Ser. No. 499,757. The first grid of tube 13 is connected through resistance 20 to a point on potentiometer 10. Its anode grid is

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connected to the positive terminal of battery 1 through resistance 21, and to the negative terminal of battery 1 through voltage divider 14. Its cathode is connected to ground 2. Its screen grid is connected to a terminal of battery 1 more positive than ground. Its fourth grid is connected to an intermediate point on divider 14.

Similarly vacuum tube 12 has its first grid connected through resistance 19, to potentiometer 10 near the cathode of tube 8. Its cathode is connected to ground 2. Its anode grid is connected through resistance 26 to the positive terminal of battery 1, and through voltage divider 15 to the negative terminal of battery 1. Its fourth grid is connected to an intermediate point on voltage divider 15.

Since tubes 12 and 13 both have high A. C. plate impedances it is essential to efficiency that the load in their output circuits be of high A. C. impedance also. This load consists of a vacuum tube 16 which may be of the pentagrid converter type. Its cathode is connected to the negative terminal of battery 17. Its first grid is connected through resistances 27 and 22 to the positive terminal of battery 17. Its anode grid may be left disconnected. Its third and fifth grids are connected together internally and to the positive terminal of battery 17. Its fourth grid is connected through resistances 28 and 23 to the positive terminal of battery 17.

The output circuit of tube 12 can be traced from the positive terminal of battery 1, plate impedance of tube 16, battery 17, resistance 22, plate impedance of tube 12 to the ground terminal of battery 1.

The output circuit of tube 13 can be traced from the positive terminal of battery 1, through the plate impedance of tube 16, battery 17, resistance 23, plate impedance of tube 13, to the ground terminal of battery 1. Resistance 24 is connected between outgoing line 18 and ground 2.

The operation of Fig. 1 in producing signal patterns such as shown in Fig. 3 is as follows. Gas discharge device 3 breaks down at a frequency depending on the constants of the neon oscillator circuit charging condenser 4 and impressing a positive potential on the grid of tube 6 causing a surge of current through the primary of transformer 7 and a positive potential of brief duration to be impressed on the grid of tube 8 through resistance 25. Condenser 9 is charged through the plate impedance of tube 8.

When condenser 9 is fully charged a positive potential is impressed on the first grids of tubes 12 and 13, rendering them non-conductive to plate current. The reason that tube 13 is non-conductive to plate current when a positive potential is impressed on its first grid through resistance 20 is that a large current flows from the positive terminal of battery 1 through resistance 21, to its anode grid and cathode, producing a large voltage drop across resistance 21, a portion of which voltage drop is applied to its fourth grid by voltage divider 14.

As condenser 9 discharges through potentiometer 10 and the plate impedance of tube 11 the first grid of tube 13 assumes a slightly negative potential with respect to its cathode. The voltage drop across resistance 21 is decreased, and the fourth grid of tube 13 assumes a positive potential. The fourth grid of tube 13 being positive and its first grid slightly negative a current passes from the positive terminal of battery 1, through the plate impedance of tube 16, battery 17, resistance 23, the plate impedance of tube

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13, to the ground terminal of battery 1, until its first grid is sufficiently negative to block current. The voltage drop across resistance 23 becomes more than the voltage of battery 17. The fourth grid of tube 16 becomes negative, and its plate impedance very high. The cathode of tube 16 becomes negative and a negative impulse is impressed on line 18. The duration of this negative impulse depends on where the fourth grid of tube 13 is connected to voltage divider 14. If it is connected to the lower portion of voltage divider 14 the first grid of tube 13 must be further negative to block current producing a voltage drop across resistance 21 and tube 13 is conductive to plate current for a shorter period such as shown in pattern 125 of Fig. 3 between T1 and T2. If on the other hand the fourth grid of tube 13 is connected to the upper portion of voltage divider 14, tube 13 is conductive to plate current over a greater magnitude of voltage variation of its first grid, producing a negative impulse such as shown in pattern 127 of Fig. 3 between T3 and T6. It is apparent that desired patterns such as shown in Fig. 3 can be produced across line 18 and ground by keying the points where the fourth grids of tubes 12 and 13 connect to their respective voltage dividers 15 and 14, and the point where the first grid of tube 12 connects to potentiometer 10.

Fig. 2 shows a means for receiving the variable spaced variable duration impulses shown in Fig. 3, and decoding them to operate any one of a plurality of electro-responsive devices 88-95. Line 18 is connected through resistance 31 to the grid of vacuum tube 32, and through condenser 80, and resistance 84 to the grid of vacuum tube 110. The grid of vacuum tube 110 is also connected to its cathode through resistance 97. The plate of tube 110 is connected through resistance 98 to the positive terminal of battery 30, and through condenser 99 and resistance 100 to the grid of vacuum tube 101. The output circuit of tube 101 can be traced from the positive terminal of battery 30, the plate impedance of tube 101, condenser 102, to the negative terminal of battery 30. The grid of tube 101 is connected to the negative of battery 30 through the plate impedance of vacuum tube 111, in parallel with high resistance 114. The grid of tube 111 is connected to the negative terminal of battery 112. The positive terminal of that battery is connected through resistance 113 to the anode of vacuum tube 81. Potentiometer 103 in series with the plate impedance of high A. C. impedance screen grid tube 104 is connected across condenser 102. Vacuum tube 104 is here shown as of the pentagrid converter type. Its first, second and fourth grids are connected to its cathode. Its third and fifth grids are connected together internally and to a terminal of battery 30 more positive than its cathode. Vacuum tube 59 may be of the pentagrid converter type. Its first grid is connected through resistance 60 to a point on potentiometer 103 near the cathode of tube 101. Its anode grid is connected to the positive terminal of battery 30, through resistance 58 and the plate impedance of tube 48, and through voltage divider 115 to the negative terminal of battery 30. Its fourth grid is connected to a point on potentiometer 115. Its output circuit comprises positive terminal of battery 30, primary of transformer 80, plate impedance of tube 59, and the ground terminal of battery 30. The secondary of transformer 80 is connected between ground 2 and the grid of cathode follower

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vacuum tube 87. Resistance 67 is in the common input output circuit of tube 87.

Vacuum tube 106 may also be of the pentagrid converter type. Its first grid is connected through resistance 108 to a point on potentiometer 103. Its anode grid is connected through resistance 107 to the cathode of tube 48, and to the negative terminal of battery 30 through voltage divider 109. Its third and fifth grids are connected to a positive terminal of battery 30. Its output circuit includes the positive terminal of battery 30, primary of transformer 105, plate impedance of tube 106 and ground terminal of battery 30. The secondary of transformer 105 is connected between ground and the grid of vacuum tube 66. The plate of tube 66 is connected to the positive terminal of battery 30. Resistance 65 is connected in its common input output circuit.

The output circuit of tube 32 can be traced from the positive terminal of battery 30, through the primary of transformer 33, the plate impedance of tube 32, condenser 34 to the negative terminal of battery 30. In parallel with condenser 34 is potentiometer 35 and the high A. C. plate impedance of vacuum tube 38, which latter tube may be of the pentagrid converter type. The first, second, and fourth grids of tube 38 are connected to its cathode. Its screen grid is connected to battery 30 at a point more positive than its cathode.

Vacuum tubes 54 and 55 may be of the pentagrid converter type. Their first grids are connected to potentiometer 35 so that their plate impedances will be conductive to space current for different magnitudes of voltage across condenser 34. One terminal of the secondary of transformer 33 is connected to the negative terminal of battery 30. The other terminal is connected through resistance 40 to the grid of vacuum tube 39. The output circuit of vacuum tube 39 may be traced from the positive terminal of battery 30, through the plate impedance of tube 39, and condenser 41 to the negative terminal of battery 30. Potentiometer 42 and the high A. C. plate impedance of vacuum tube 81 is connected in parallel with condenser 41. Vacuum tube 81 may be of the pentagrid converter type. Its first, second, and fourth grids are connected to its cathode. Its third and fifth grids are connected together internally and to a terminal of battery 30 more positive than its cathode. Vacuum tubes 82 and 83 may be of the pentagrid converter type. Their first grids are connected to potentiometer 42 to render these tubes conductive to plate current at different predetermined magnitudes of voltage across condenser 41.

The upper terminal of transformer 33 is also connected through condenser 46 in parallel with resistance 47 to the grid of vacuum tube 48. The output circuit of vacuum tube 48 may be traced from the positive terminal of battery 30, plate to cathode of tube 48 and through seven separate paths back to battery 30. A first of these paths comprises resistance 53 to ground terminal of battery 30. A second path comprises resistance 49, the anode grid, the cathode of tube 54 and ground 2. The third path comprises resistance 50, the anode grid, the cathode of tube 55 and ground 2. The fourth path comprises resistance 51, the anode grid, the cathode of tube 82 and ground. The fifth path comprises resistance 52, the anode grid, the cathode of tube 83 and ground. The sixth path includes resistance 58, the anode

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grid, the cathode of tube 59 and ground. The seventh path includes resistance 107, the anode grid, the cathode of tube 106 and ground.

Potentiometers 63, 96, 12, 70 connect the respective anode grids of tubes 55, 54, 82, 83 to the negative terminal of battery 30.

The output circuit of tube 55 can be traced from the positive terminal of battery 30 through primary of transformer 56, the plate impedance of tube 55 to the ground terminal of battery 30. The output circuit of tube 54 can be traced from the positive terminal of battery 30, through primary of transformer 57, plate impedance of tube 54 to the ground terminal of battery 30. The output circuit of tube 82 can be traced from the positive terminal of battery 30, through the primary of transformer 74, the plate impedance of tube 82 to the ground terminal of battery 30. The output circuit of tube 83 can be traced from the positive terminal of battery 30 through primary of transformer 64, the plate impedance of tube 83 to the ground terminal of battery 30.

Vacuum tubes 69, 71, 73, 75 are of the plural grid type and are here shown as pentagrid converters. Their cathodes are all connected to ground 2. Their third and fifth grids are connected to a terminal of battery 30 more positive than ground. Their anode grids are all left disconnected. One terminal of the secondary of transformer 56 is connected to the fourth grids of tubes 69, 73 through respective resistances 61, 68. One terminal of the secondary of transformer 57 is connected to the fourth grids of tubes 71, 75 through respective resistances 62, 85. One terminal of transformer 74 is connected to the first grids of tubes 69, 71 through respective resistances 77, 76. One terminal of the secondary of transformer 64 is connected to the first grids of tubes 73, 75 through respective resistances 79, 78. The plates of vacuum tubes 69, 71, 73, 75 connect through respective electro-responsive devices 95, 93, 90, 88 to the cathode of tube 66. The plates of tubes 69, 71, 73, 75 also connect through respective electro-responsive devices 94, 92, 91, 89 to the cathode of tube 87.

In operation when a signal such as shown in pattern 125 of Fig. 3 is impressed on line 18, the grid of vacuum tube 110 receives a negative impulse at the beginning of the first impulse, that is at time T1. The plate of tube 110 goes positive and impresses a positive pulse on the grid of tube 101 through condenser 99 and resistance 100. At this instant the resistance of the path between the grid of tube 101 and negative of battery 30 is very high, since resistance 114 is a very high resistance and the grid of tube 111 is biased past its current cut off by battery 112 connected to the plate of tube 81. Condenser 102 charges through the plate impedance of tube 101. The grid of tube 32 is negative during the entire duration of the first impulse of pattern 125, and appreciable current has leaked from condenser 34. At the end of the first impulse the grid of tube 32 goes positive and a current passes through the primary of transformer 33 and its plate impedance to recharge condenser 34. The secondary of transformer 33 impresses a positive potential on the grid of tube 39 through resistance 40, charging condenser 41. The secondary of transformer 33 also impresses a positive pulse on the grid of tube 48 through condenser 46 in parallel with resistance 47, producing a voltage drop across resistance 53, but the plate impedance of tubes 55, 54, 82, 83, 106, 59 are not effected thereby since their first grids are either too positive or too nega-

tive at that instant. The RC time element of resistance 47, condenser 46 is such as to render this surge voltage across resistance 53 very brief.

At the beginning of the second impulse of pattern 125, that is at time T3, a negative pulse is again impressed on the grid of tube 110, a positive pulse is passed through resistance 100 and the plate impedance of tube 111 to the negative of battery 30. This latter impedance is very low due to the fact that condenser 41 is now charged and the plate of tube 81 highly positive.

At the end of the second impulse that is at T4, considerable current has leaked off of condensers 34, 41, and 102. Condenser 102 has been discharged from T1 to T4 and the voltage impressed on the first grid of tube 59 renders it conductive to plate current when the cathode of tube 48 goes positive. The secondary of transformer 80 impresses a positive voltage on the grid of tube 87. Condenser 41 has discharged from T2 to T4. Tube 83 is rendered conductive and a positive potential is impressed on the first grids of tubes 73 and 75. Condenser 34 has discharged from T3 to T4. Tube 54 is rendered conductive to plate current and a positive pulse is impressed on the fourth grids of tubes 71, 75. Since all grids of tube 75 are positive current passes from the positive terminal of battery 30 through the plate impedance of tube 87, electro-responsive device 89, the plate impedance of tube 75, to ground terminal of battery 1.

If a signal of a different pattern is received such as 126 of Fig. 3, condenser 102 discharges from T1 to T4, rendering tubes 59 and 87 conductive. Condenser 41 discharges from T2 to T4 rendering tube 83 conductive and impressing a positive potential on the first grids of tubes 73, 75. Condenser 34 discharges from T5 to T4, rendering tube 55 conductive and impressing a positive potential on the fourth grids of tubes 69, 73. A current then passes from the positive terminal of battery 30 through the plate impedance of tube 87, electro-responsive device 91 of the plate impedance of tube 73 to ground.

If a pattern such as 127 of Fig. 3 is received condenser 102 discharges from T9 to T8, rendering tubes 106, 66 conductive, condenser 41 discharges from T6 to T8 rendering tube 82 conductive, impressing a positive potential on the first grids of tubes 69, 71. Condenser 34 discharges from T7 to T8 rendering tube 55 conductive and impressing a positive potential on the fourth grids of tubes 69, 73. A current then passes from the positive terminal of battery 30, through the plate impedance of tube 66, electro-responsive device 95, the plate impedance of tube 69 to the ground terminal of battery 30.

Tubes 66, 87, 69, 71, 73, 75 are of the high vacuum type, their use being preferred where practicable. Where, however, the electro-responsive devices require considerable power, the trigger effect of grid controlled gas discharge devices makes possible control of large power by positive pulses of brief duration.

I have illustrated a system where only two magnitude discriminating tubes are supplied with input voltage by each of condensers 34, 41, and 102, thereby making possible the operation of any one of eight electro-responsive devices 88-95. The number of electro-responsive devices varies as the third power of the number of these tubes. That is with four voltage magnitude tubes connected across condensers 34, 41, and 102 the number of electro-responsive devices would be 64. It

would be a two impulse system using impulses and spacings of four different durations.

While a sufficient number of electro-responsive devices for most uses can be operated by two impulse cyclically repeated patterns, where operation of a larger number of electro-responsive devices is necessary three and four impulse patterns may be used by rendering tubes 39, 48 inoperative by voltages existing across one or more of condensers at the end of the second and the beginning of the third impulse, as I have illustrated for tube 101 of Fig. 2.

It is obvious that my invention may take widely different forms from those illustrated without departing from its spirit, and it is to be limited in scope only as defined in the following claims.

What I claim is:

1. In a circuit for receiving time displaced impulses of different duration, as an indication of received intelligence, a plurality of condensers, means for varying the charge at a predetermined rate on a first of said condensers from the beginning of a first of said impulses to the end of a last of said impulses, means for varying the charge at a predetermined rate on a second of said condensers from the end of said first impulse to the end of said last impulse, means for varying the charge at a predetermined rate on a third of said condensers for the duration of said last impulse, and means for indicating the charge remaining on each of said condensers at the end of said last impulse, as an indication of said intelligence.

2. In a circuit for receiving a signal pattern having impulse of different duration, a plurality of condensers, means for charging said condensers, means for discharging a first of said condensers at a predetermined rate between the expiration of a first of said impulses and the expiration of the last of said impulses, means for discharging a second of said condensers at a predetermined rate for the duration of said last impulse, a plurality of electroresponsive devices, and means for operating one of said devices, depending on the various charges remaining on said condensers.

3. In a circuit for receiving a plurality of impulses, a plurality of condensers, means for charging said condensers, means for discharging said condensers at predetermined rates as follows: a first of said condensers from the beginning of a first of said impulses to the end of said last impulse, a second of said condensers from the end of said first impulse to the end of said last impulse, a third of said condensers during said last impulse, a plurality of electroresponsive devices and means for operation of each of said devices by a different combination of remaining charges on said condensers.

4. In a circuit for receiving a signal pattern having a plurality of impulses, a plurality of vacuum tubes having input and output circuits, a plurality of condensers each connected in the input and output circuit of a separate one of said tubes, an impedance connected in parallel with each of said condensers, means for producing a positive pulse at the beginning of a first of said impulses, means for applying said pulse to the input circuit of a first of said tubes to charge a first of said condensers, means for producing a second positive pulse at the expiration of said first impulse, means for applying said second pulse to the input circuit of a second of said tubes to charge a second of said condensers, a plurality of electroresponsive devices and means for op-

erating any one of said devices depending on the combination of charges remaining on said condensers at the end of said impulses.

5. In a circuit for receiving a cyclic pattern of impulses of different durations, a plurality of condensers, means for varying the charge on said condensers at predetermined rates as follows: a first of said condensers from the end of the first of said impulses to the end of the last of said impulses, a second of said condensers for the duration of said last impulse, means for indicating the charge remaining on said condensers at the end of said last impulse, said last means comprising a plurality of vacuum tubes, each of said tubes being conductive to plate current at a different magnitude of voltage across said condensers, means for rendering said tubes operative only at the end of said last impulse, a plurality of valves, each having a plurality of grids and an output circuit, a separate electroresponsive device connected in the output circuit of each of said valves, and means for selectively controlling said grids with said plate current of said tubes.

6. In a circuit for receiving a cyclic pattern of impulses and spacings of different durations, a plurality of vacuum tubes having input and output circuits, a source of current connected in the common output circuit of each of said tubes, a separate condenser in parallel with a resistance connected in the common input output circuit of each of said tubes, means for producing pulses at the beginning and end of said impulses, means for applying said pulses to selected ones of said input circuits to charge a different one of said condensers with each of said pulses, means for preventing said pulses from being applied to input circuits other than said selected ones, said last means comprising a vacuum tube having a plate, filament, and grid, a second resistance, said second resistance, said plate and said filament being connected in series across said means for producing said pulses, means for connecting said plate and filament in said input circuit, and means for controlling the potential of said grid by the voltage across one of said condensers in the input and output circuit of a different one of said tubes.

7. In a circuit for receiving a signal having a pattern of a plurality of impulses, means for producing a first series of pulses, one at the beginning of each of said impulses, means for producing a second series of pulses, one at the end of each of said impulses, a plurality of condensers, means for charging a first of said condensers by a first pulse of said first series, said last means comprising a vacuum tube having a control electrode, an input and an output circuit, a resistance in parallel with said first condenser connected in said input and said output circuit, means for applying said first series of pulses to said input circuit through a second resistance, a second vacuum tube having a plate, filament and grid, said plate being connected to said control electrode, said filament being connected to the negative terminal of said first condenser, means for controlling the potential of said grid by voltage variations across a second of said condensers to short circuit a second pulse of said first series, means for charging a second of said condensers with a first impulse of said second series, a plurality of electroresponsive devices and means for operating one of said devices depending on the charge remaining on said condensers at the end of said pattern.

8. A circuit for indicating the duration of an

impulse comprising: a vacuum tube having an input and an output circuit, a source of current and the primary of a transformer connected in said output circuit, a condenser connected in said input and said output circuit, a potentiometer in series with the plate impedance of a screen grid tube connected across said condenser, a plurality of pentagrid converter tubes, means for connecting the first grid of each of said tubes to a different point on said potentiometer, a separate plate load connected in the plate circuit of each of said pentagrid tubes, a separate anode grid load connected in the circuit of the anode grid of each of said pentagrid tubes, means for applying a portion of the voltage variations across said anode grid load to the fourth grid of each of said pentagrid tubes, a thermionic valve having an anode, a cathode and a grid, means for connecting said source of current in the circuit of said anode of said valve, means for connecting said anode grid loads of each of said pentagrid tubes in parallel in the common anode grid circuit of said valve, means for applying a positive pulse from the secondary of said transformer to said grid to said valve at the end of said impulse to render one of said pentagrid tubes conductive to plate current depending on the charge remaining on said condenser at the end of said impulse, and means for indicating voltage variations across said plate load.

9. A circuit for indicating the duration of an impulse, comprising: a vacuum tube having an input and an output circuit, a source of current and the primary of a transformer connected in said output circuit, a condenser in parallel with a resistance connected in said input and said output circuit, a plurality of plural grid vacuum tubes each conductive to plate current at a different magnitude of voltage across said condenser, a thermionic valve having a plate circuit and a grid circuit, means for connecting said source of current in said plate circuit, a second resistance connected in said plate and said grid circuit, means for applying a positive pulse from the secondary of said transformer to said grid circuit, said last means including the parallel connection of a grid leak, grid condenser, the RC time element of said grid leak, grid condenser being such that said impulse produces a voltage drop of very brief duration across said second resistance, means for applying voltage variations across said second resistance to one grid of each of said plural grid tubes to render one of said last tubes conductive to plate current during said brief duration, and means for indicating said plate current.

10. In a circuit for receiving a signal pattern having a plurality of impulses of different durations, a plurality of condensers, means for discharging said condensers at predetermined rates during the following periods: a first of said condensers from the beginning of the first of said impulses to the end of the last of said impulses, a second of said condensers during said last impulse, a plurality of cathode follower vacuum tubes having a cathode, an input and an output circuit, means for applying a positive pulse to the input circuit of one of said tubes depending on the charge remaining on said first condenser at the end of said last impulse, a plurality of valves each having a plate, filament, and grid, a separate load connected between the cathode of each of said follower tubes and the plate of each of said valves, and means for impressing a positive pulse on the grid of one of said valves

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depending on the magnitude of the charge remaining on said second condenser at the end of said second impulse.

11. In a circuit for receiving a signal pattern of a plurality of impulses, a plurality of condensers, means for varying the charge on said condensers at a predetermined rate from different points in said pattern to the end of said pattern, a plurality of cathode follower vacuum tubes each having an anode, a cathode and a control electrode, means for applying a positive pulse to the control electrode of one of said tubes depending on the charge remaining on a first of said condensers at the end of said pattern, a plurality of vacuum tubes each having a plate, filament and grid, a separate load connecting the cathode of each of said follower tubes to the plate of each of said vacuum tubes, and means for applying a positive pulse to the grid of one of said vacuum tubes depending on the voltage of the charge remaining on a second of said condensers at the end of said pattern.

12. In a circuit for receiving a signal pattern of impulses and spacings, a receiver for said pattern, comprising: a plurality of sources of voltages variable at predetermined rates, means for actuating each of said sources at a different point in said pattern, a separate vacuum tube magnitude selective device, connected across each of said sources, each device having a plurality of tubes each conductive to a different magnitude of input voltage, a plurality of electro-responsive devices, and means for operating one of said devices depending on the combination of said tubes conductive at the end of said pattern.

13. In an electric circuit, means for initiating a plurality of varying voltages at time displaced intervals, a plurality of electroresponsive devices, and means for operating any one of said devices depending on the combination of the instantaneous values of said voltages at a predetermined time subsequent to the initiation of one of said variable voltages.

14. In an electric circuit, means for operating one of a plurality of electroresponsive devices depending on the combination of instantaneous values of a plurality of different voltages comprising: a plurality of groups of vacuum tubes each of said tubes having an input and an output circuit, means for applying each of said voltages to said input circuit of different groups of said tubes, each of said tubes being conductive to space current for one value of input voltage only, and means for operating any one of said devices depending on the combination of said tubes rendered conductive.

15. In a selective circuit, a plurality of vacuum

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tubes, a separate space charge control means in each of said tubes for controlling space current in each of said tubes, a plurality of thermionic valves, each having an anode, a cathode and a control electrode, a plurality of vacuum tubes each having a plate, filament and grid, a separate electroresponsive device connecting each of said cathodes to each of said plates, means for controlling the potential of said control electrodes and said grids with said space current flowing in different ones of said first tubes to selectively operate said electroresponsive devices by said space current of said different ones of said first tubes.

16. In a circuit for receiving a signal pattern having a plurality of impulses of different duration, a plurality of condensers, means for effecting a change in the charge on each of said condensers for a period from a different point on said pattern to its end, the magnitude of said change depending on the length of said period, a plurality of electroresponsive devices, and means for operating one of said devices depending on the combination of remaining charges on said condensers at the end of said pattern.

17. In a circuit for receiving a signal pattern of a plurality of components of different duration, a plurality of condensers, means for effecting a change in the charge on each of said condensers for a period from a different point on said pattern to its end, the magnitude of said change depending on the length of said period, a plurality of electroresponsive devices and means for operating one of said devices depending on the combination of remaining charges on said condensers, at the end of said pattern.

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