

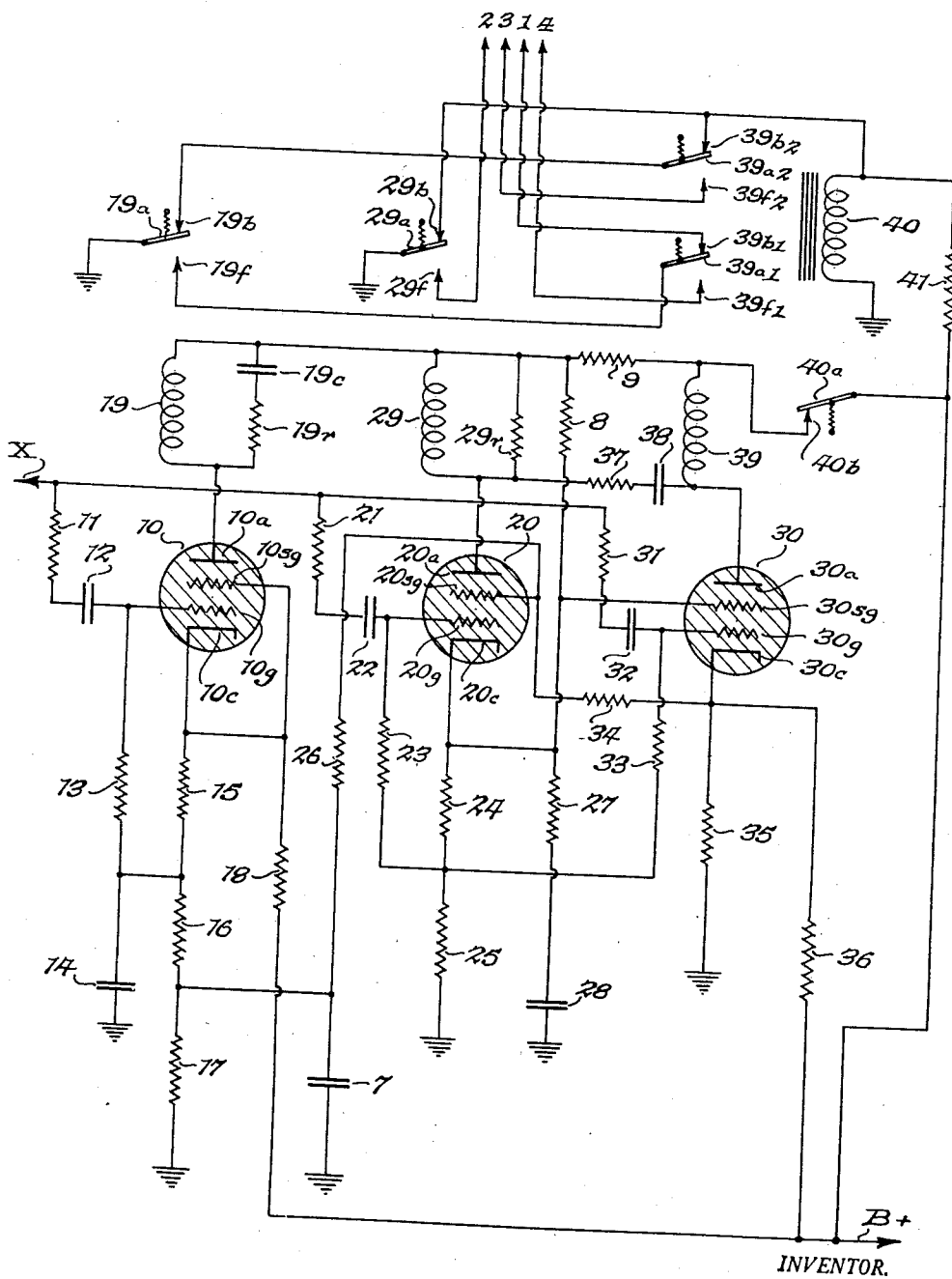
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PULSE CONTROLLED SELECTOR CIRCUIT

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PULSE CONTROLLED SELECTOR CIRCUIT

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This invention relates to pulse controlled circuits, and more particularly to circuits in which the apparatus may be selectively controlled either from a nearby point or remotely, to operate one of a number of circuits as may be desired. It will be understood, however, that my invention is not limited thereto and that the circuit herein disclosed may also operate as a counting circuit.

In apparatus of the class described there will be provided some form of transmitter which will deliver a series of pulses varying in number, and each number corresponding to a particular circuit to be energized, or a particular operation to be performed.

In the circuit shown, by way of example, I have provided for selective response to 1, 2, 3, 4, or 5 pulses. In this instance, the transmission of 1, 2, 3, or 4 pulses closes circuits 1, 2, 3, or 4, as the case may be, and reception of 5 pulses clears the apparatus; that is to say, restores it to initial condition. It will be understood, however, that within the scope of my invention additional circuits may be utilized responsive to a larger number of pulses.

Also, it may be noted that two modes of action are possible with my circuit. If the pulses have a time interval between them which is longer than the time of closure of the relays controlled, then the operation will be sequential; that is to say, if one pulse is sent and then a time interval greater than that required for the relay to close is allowed to elapse before the second pulse is sent, the relay which is operated by one transmitted pulse will operate.

When the second pulse is sent, the relay operated by the first pulse will open and the relay operated by 2 pulses will close unless a third pulse arrives before the relay has had time to operate. However, if the pulses follow each other at a rate faster than that which permits the relays to close, then the circuit will respond to only the total number of pulses received. For example, if 3 pulses are sent in rapid succession, only the circuit responsive to 3 pulses will close, the circuits responsive to 1 and 2 pulses not being put into operation. Thus it will be seen that merely by varying the transmission rate of the pulses the apparatus will function as a sequential or step-by-step control or as an integral control.

The pulses may be transmitted in any desired manner, such as by radio or direct wire, and a great variety of operations may thus be remotely controlled. As an example, tanks, boats, and airplanes may be so controlled. The apparatus also lends itself to the control of industrial equipment, being adapted to counting, sorting, and packaging

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machinery; and many other applications will be apparent to those skilled in the art.

The control may be exercised by the use of direct current pulses, as when sent over wire lines, or as pulse modulated radio frequency waves from low to extremely high frequencies. In the latter case, of course, a suitable form of radio receiver will be employed to convert the incoming radio waves to voltage pulses.

For the purposes of this disclosure a pulse, as the term is employed herein, means a unidirectional current or voltage which increases with a rather steep wave front to some finite value, remains at or near that value for a measurable time interval which may, however, be extremely short, even of the order of microseconds or fractions of a microsecond, and then decreases to zero.

Among the objects of my invention may be mentioned the following:

To provide apparatus of the class described which will count the number of pulses received and operate a particular circuit in response to such a number of pulses.

To provide such apparatus which is positive and reliable in operation.

To provide such apparatus which will operate either as a sequential or step-by-step control or as an integral control.

To provide such apparatus which will respond to pulses as short as fractions of a microsecond, sent at a rate of as high as one thousand per second.

Still other objects and advantages of my invention will be apparent from the specification.

In the drawing, the single figure of the drawing is a circuit diagram of apparatus in accordance with my invention.

Referring more particularly to the drawing, the controlled pulses are applied to the input terminal X. As stated, these pulses may be received by wire line, or they may be derived from the output of any suitable radio receiver. In the embodiment illustrated I have provided 3 tubes, designated as 10, 20, and 30.

These tubes are preferably of the gas ionization type, such as thyatron, and the circuit operation is such that in response to one pulse, only tube 10 is ionized to close No. 1 controlled circuit. For two pulses, tube 20 is fired and tube 10 extinguished, to close No. 2 controlled circuit. For three pulses tube 30 is fired and tubes 10 and 20 are extinguished, thereby closing No. 3 controlled circuit, for four pulses tubes 10 and 30 are fired to close No. 4 controlled circuit, and for five pulses tubes 20 and 30 are fired to clear the

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apparatus and restore it to initial condition. How this is done will now be explained more in detail with reference to the circuit diagram.

Tube 10, as stated, may be a thyratron type of tube, having a cathode 10c, control grid 10g, screen grid 10sg, and anode 10a. Received pulses are impressed between control grid and cathode of tube 10 through resistance 11, condenser 12, resistance 13, and condenser 14, to ground. The intermediate point between condenser 12 and resistance 13 may be connected to the grid 10g and cathode 10c may be connected to ground through resistances 15, 16, and 17, and through resistance 18 to B+, and the intermediate point between resistances 15 and 16 may be connected to the intermediate point between resistor 13 and condenser 14. The screen grid 10sg may be connected to the cathode.

Connected in the anode circuit I may provide relay 19 operating armature 19a, the armature being grounded. The armature 19a is normally spring biased to back contact position against back contact 19b, and when the tube 10 fires, the armature is drawn to front contact position against front contact 19f. The winding of relay 19 may be shunted by condenser 19c in series with resistance 19r. The plate circuit may be connected to the +B terminal through resistance 9, back contact 40b, and armature 40a. The armature 40a is biased to back contact position and is closed at all times except in response to the clearing signal of 5 pulses.

Incoming pulses are likewise impressed upon the second tube 20, which may also be a thyratron type tube having cathode 20c, control grid 20g, screen grid 20sg, and anode 20a. The control grid 20g may be connected to the input terminal X through condenser 22 and resistance 21. Cathode 20c may be connected to ground through resistances 24 and 25 and to B+ through resistances 8 and 9 and the contact of relay 40. The screen grid 20sg may be connected through resistance 26 to the intermediate point between resistances 16 and 17 and also through resistance 26 to ground through condenser 7. The anode 20a may be connected through the winding of relay 29 and through resistance 9 and the contact of relay 40 to +B, and the winding 29 may be shunted by resistance 29r.

Incoming pulses are also impressed upon the input circuit of tube 30. This may likewise be a tube of the thyratron type having cathode 30c, control grid 30g, screen grid 30sg, and anode 30a. The control grid 30g may be connected to the input terminal through resistance 31 and condenser 32, and through resistance 33 to the negative end of resistance 24, cathode 30c may be connected to ground through resistance 35 and to +B through resistance 36 and to screen grid 20sg through resistance 34, the screen grid 30sg to cathode 20c and through resistance 27 and condenser 28 to ground, also through resistances 8 and 9 and the contacts of relay 40 to +B. Anodes 20a and 30a may be connected together through resistance 37 and condenser 38.

When no impulses have been received, relays 19, 29, and 39 are open, and their armatures 19a, 29a, and 39a and 39a2 are all in back contact position, so that control circuits 1, 2, 3, and 4 are all open. The operation of the apparatus will now be described.

With tubes of the type described, the point at which the tube will ionize or fire is a function of the control grid voltage, screen grid voltage, and the anode voltage; the more negative the

screen grid is placed with respect to the cathode, the more positive the control grid will have to be for the tube to fire. Under normal conditions tube 10 has a negative bias on its grid of approximately 6 volts, and the screen grid 10sg is at cathode potential. Therefore, if a pulse voltage of +12 volts is applied between cathode 10c and control grid 10g, tube 10 will fire.

The same first pulse voltage is applied to the grids of tubes 20 and 30, but neither of these tubes will fire with such pulse voltage because the normal voltage on the screen grids 20sg and 30sg is approximately -12. Therefore, one pulse will fire tube 10 only. When this occurs, relay armature 19a is closed to front contact 19f, ground is applied through armature 39a1, and back contact 39b1 to control circuit 1, the application of ground to this circuit causing its operation in any suitable and well-known manner.

When the tube 10 fires, the space current through it greatly increases, as will be understood. This space current flowing through resistances 15, 16, and 17 produces an I. R. drop, which makes the point between resistance 16 and resistance 17 more positive with respect to ground and, therefore, reduces the anode-cathode voltage on tube 10 and reduces the negative bias on the screen grid 20sg, preparing the tube 20 to fire on the next pulse. In the arrangement shown I prefer to choose resistance 17 of such value that while tube 10 is ionized the screen grid 20sg is at zero or cathode potential. The apparatus will remain in this condition until the second pulse is received.

When the second pulse is received, the voltage impressed on control grid 20g will now be sufficient to fire the tube 20, closing armature 29a against its front contact 29f and applying ground to control circuit No. 2 to cause operation of such circuit. At the same time the increase in plate current drawn by the tube 20 through resistance 9 reduces the voltage between anode and cathode on tube 10 to such an extent that this tube now deionizes and armature 19a returns to back contact, removing the ground from control circuit 1 and interrupting its operation.

The flow of space current in tube 20 through resistance 25 makes the upper end of this resistance more positive with respect to ground, and since this point is connected to control grid 30g through resistance 33, this grid moves in a positive direction with respect to cathode 30c to such an extent that the third pulse, when it arrives, will cause tube 30 to fire.

At this point it will be noted that since space current is no longer flowing through tube 10, the screen grid 20sg of tube 20 has returned to its normal negative condition, and when tube 30 fires, a negative pulse is applied to anode 20a of tube 20 through condenser 38 to resistor 37, this, of course, being due to the sharp decrease in potential of anode 30g when the tube fires. This is sufficient to extinguish tube 20, since the voltage between anode 20a and cathode 20c is zero volts or less, releasing armature 29a, which returns to back contact position, removing the ground from control circuit No. 2, and putting this circuit out of operation.

At the same time armatures 39a1 and 39a2 of relay 39 are moved to front contact position putting ground on control circuit No. 3, through armature 19a, back contact 19b, armature 39a2, and front contact 39f2. Control circuit No. 4 is prepared by the closure of armature 39a1 against front contact 39f1, but since this circuit is open at front contact 19f, ground is not applied to cir-

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cuit 4. The apparatus is now in a condition in which tube 30 is ionized, tube 10 is prepared to fire, since tube 20 is out, but tube 20 has its screen grid biased negatively so that it cannot fire on the next pulse.

The next or fourth pulse does not interfere with the operation of tube 30, which remains in its ionized condition, but it does cause tube 10 to fire in exactly the same way as the first pulse did, thus closing armature 19a against front contact 19f and applying ground to control circuit 4 through the prepared circuit as already described, and removing the ground from control circuit 3, which is now open at the back contact 19b. At the same time tube 20 is prepared to fire exactly, as it was for the second pulse, by the removal of the negative bias from the screen grid 20sg because of the I. R. drop developed in resistance 17.

When the fifth pulse occurs, tube 20 again fires exactly as it did for the second pulse, opening back contact 29b of relay 29, thereby opening a short-circuit around relay 40, which was previously maintained through back contact 39b2 and armature 39a2, and back contact 19b the armature 19a to ground, thence to relay 40. The relay 40 is thereupon energized, opening the B supply circuit to all the tubes by movement of armature 40a away from back contact 40b. This opening of the B supply circuit, of course, de-ionizes tubes 10, 20, and 30, and the apparatus returns to initial condition.

The following comments may be helpful in understanding detailed points in connection with the operation. Relay coil 19 is shunted by condenser 19c to prevent any inductive surge which might cause faulty operation of relay 19, and resistance 19r is included to prevent any resonance effects. Resistance 29r is included to eliminate any resonant effects. Resistance 41 is included to prevent short-circuiting of the B supply. Relays 19, 29, and 39 are preferably 5 mil relays.

It will be noted also that tubes 10 and 20 are de-ionized through the application of voltages developed in the circuit, and do not require the interruption of the B supply, but this is not the case of tube 30. Once this tube fires, it will remain in ionized condition until the B supply is opened by relay 40. Tubes 10 and 20 can never both be ionized at the same time because the plate voltage supplied through R9 is not sufficient to maintain both in ionized condition, although it will maintain either tube 10 or tube 20.

It may now be seen that if the pulses are of such short duration and follow each other so rapidly that relays 19, 29, and 39 do not have time to operate, the apparatus will operate as an integral device; that is to say, if 4 pulses are sent, control circuits Nos. 1, 2, and 3 will not have time to be closed, and only the circuit 4 will be closed, while if the pulses are of sufficient duration to fire the thyratrons but follow each other at time intervals which permit relays 19, 29, and 39 to close, the apparatus will operate in sequence; that is to say, control circuit 1 will be closed at the first pulse and opened at the second pulse, 2 at the second pulse and opened at the third, 3 at the third pulse and opened at the fourth, and 4 at the fourth pulse and will be opened at the fifth.

Let us assume that the apparatus has registered three pulses; that is, control circuit No. 3 is closed and the clearing signal (five impulses) be now sent at a rate faster than the electro-mechanical relays can operate. On the first im-

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pulse of the clearing signal, the tubes progress from condition 3 to condition 4, but the relays do not have time to set up circuit 4.

Before circuit 4 can be set up, the second of the five clearing pulses is received, setting up the tubes electronically for the clearing operation, but clearing relay cannot yet operate because it has not had time. Consequently the tubes will not be responsive to any additional impulses. Therefore, the receipt of impulse No. 3 does nothing, receipt of No. 4 does nothing, and receipt of No. 5 does nothing. Armature 40a has not yet opened. By the time it catches up with the electronic operation and opens, thereby deionizing all of the tubes and restoring the apparatus to initial condition, the impulses have stopped coming in and there are no impulses for the tubes to count.

Thus, if circuit No. 2 is closed and it is desired to open it and close No. 4, the operator would not send two more pulses only, but would send the clearing signal (five pulses) followed by the new signal (four pulses).

It has been found in actual use of the circuit that it will respond to pulses of the order of microseconds' duration or less sent at a pulse rate of as high as 1,000 per second, at a rate of about ten groups per second.

For the purpose of completing the disclosure, but not by way of limitation, the following table of values is given:

Resistances in ohms unless otherwise stated

11	50K
13	meg 2.2
15	820
16	6800
17	820
18	10K
19r	2200
21	56K
23	meg 2.2
24	2200
25	3300
26	10K
27	3900
29r	10K
8	50K
9	25K
31	56K
33	meg 2.2
34	220K
35	6800
36	82K
37	10K
41	40K

Capacities in mfd. unless otherwise stated

7	0.05
12	mmfd 100
14	.05
19c	.25
22	mmfd 100
28	.05
32	mmfd 100
38	.02
+B	volts 250
K	ohms 1000

While I have shown and described certain preferred embodiments of my invention, it will be understood that modifications and changes may be made without departing from the spirit and scope thereof, as will be clear to those skilled in the art.

I claim:

1. In pulse controlled apparatus, in combination, a series of ionizable thermionic tubes, each comprising a cathode, an anode, and a control electrode, an electro-magnetic relay for each of said tubes operated by the space current in the respective tubes, said relays being incapable of operation in the time in which said tubes ionize or deionize, a plurality of control circuits exceeding the number of said tubes, said circuits being made by operation of individual relays and combinations of relays, means for impressing control pulses on all of said tubes, and means for causing said tubes to operate successively and in successive combinations in response to impressed pulses said apparatus operating either as a sequence or as an integral controller, depending on the duration and spacing of received pulses.

2. In pulse controlled apparatus, in combination, a series of ionizable thermionic tubes, each comprising a cathode, an anode, and a control electrode, an electro-magnetic relay for each of said tubes operated by the space current in the respective tubes, said relays being incapable of operation in the time in which said tubes ionize or deionize a plurality of control circuits exceeding the number of said tubes, said circuits being made by operation of individual relays and combinations of relays, means for impressing control pulses on all of said tubes, and means for causing said tubes to operate successively and in successive combinations in response to impressed pulses, said last mentioned means including means having a longer operating time than said tubes for causing the last operation of the combination to clear the apparatus for initial operation said apparatus operating either as a sequence or as an integral controller, depending on the duration and spacing of received pulses.

3. In pulse controlled apparatus, in combination, a series of ionizable thermionic tubes, each comprising a cathode, an anode, and a control electrode, an electro-magnetic relay for each of said tubes operated by the space current in the respective tubes, said relays being incapable of operation in the time in which said tubes ionize or deionize a plurality of control circuits exceeding the number of said tubes, said circuits being made by operation of individual relays and combinations of relays, means for impressing control pulses on all of said tubes, and means for causing said tubes to operate successively and in successive combinations in response to impressed pulses, said last mentioned means including means having an operating time longer than said tubes for causing the last operation of the combination to open the space current circuit of each of said tubes to restore the apparatus to initial condition, said apparatus operating either as a sequence or as an integral controller, depending on the duration of spacing of received pulses.

4. In pulse controlled apparatus, in combination, a series of ionizable thermionic tubes, each comprising a cathode, an anode, and a control electrode, an electro-magnetic relay for each of said tubes operated by said space current in the respective tubes, said relays being incapable of operation in the time in which said tubes ionize or deionize, a plurality of control circuits exceeding the number of said tubes, said circuits being made by operation of individual relays and combinations of relays, means for impressing control pulses on all of said tubes, means for normally maintaining a negative bias on one control electrode of each of said tubes other than the first to prevent firing of said tubes, and connections between each of said tubes other than the first, and the preceding tube, such that as each tube fires it reduces the negative bias on the control electrode of the succeeding tube and means having an operating time longer than said tubes for restoring the apparatus to initial condition in response to a predetermined signal, said apparatus operating either as a sequence or as an integral controller, depending on the duration and spacing of received pulses.

5. In pulse controlled apparatus, in combination, a series of ionizable thermionic tubes, each comprising a cathode, an anode, and a control electrode, an electro-mechanical relay for each of said tubes operated by the space current in the respective tubes, a plurality of control circuits exceeding the number of said tubes, said circuits being made by operation of individual relays and combinations of relays, means for impressing control pulses on all of said tubes, means for causing said tubes to operate successively and in successive combinations in response to impressed pulses, and an electro-mechanical relay for clearing said apparatus in response to a predetermined clearing signal irrespective of the condition of said apparatus when said clearing signal is received.

6. In pulse controlled apparatus, in combination, a series of ionizable thermionic tubes, each comprising a cathode, an anode, and a control electrode, an electro-mechanical relay for each of said tubes operated by the space current in the respective tubes, a plurality of control circuits exceeding the number of said tubes, said circuits being made by operation of individual relays and combinations of relays, means for impressing control pulses on all of said tubes, means for causing said tubes to operate successively and in successive combinations in response to impressed pulses, said last mentioned means including an electro-mechanical relay responsive to a predetermined clearing signal and independent of the condition of the apparatus when the said clearing signal is received for opening the space current circuit of each of said tubes to restore the apparatus to initial condition, the operation time of said relays being greater than the time required by said tubes to ionize.

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