Jan. 13, 1959 Q. W. SIMKINS 2,869,034

PULSE COUNTING DEVICE

Filed March 19, 1953

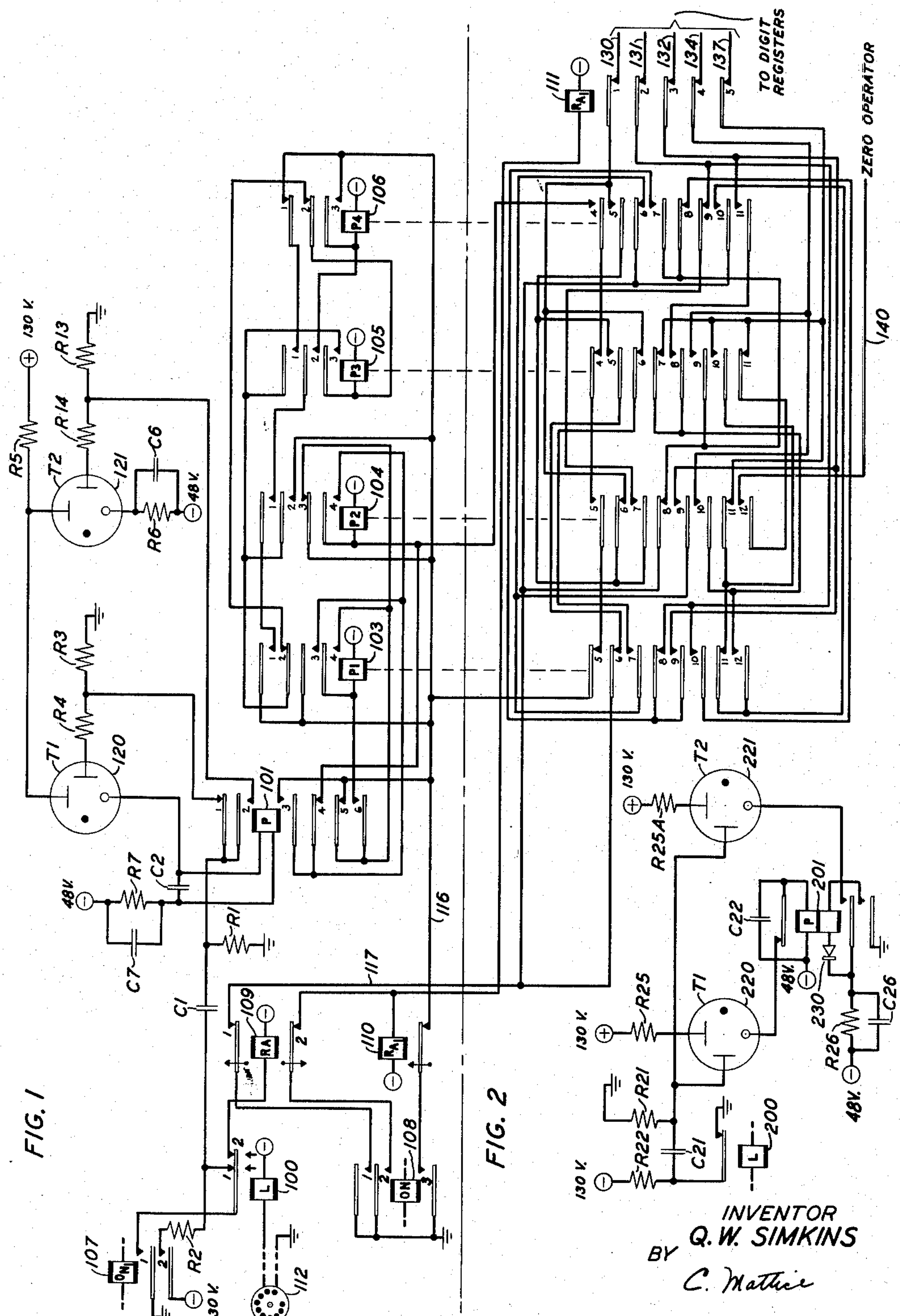

FIG. 1

FIG. 2

INVENTOR
Q. W. SIMKINS
BY C. Mathie
ATTORNEY

United States Patent Office

2,869,034

Patented Jan. 13, 1959

2,869,034

PULSE COUNTING DEVICE

Quinton W. Simkins, Chatham Township, Morris County, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application March 19, 1953, Serial No. 343,285

5 Claims. (Cl. 315—84.5)

This invention relates to telephone systems and more particularly to means for receiving and counting dial pulses for the purpose of controlling the automatic establishment of telephone connections.

In the copending application of J. W. Dehn, Serial No. 269,815, filed February 4, 1952, which issued as Patent No. 2,676,313 on April 20, 1954, is disclosed a counting relay arrangement for counting the ten pulses as generated by a telephone subscriber's dial and also for indicating a normal and an overflow condition. This arrangement employs six relays having only simple make and break contacts and is made up of two binary counters and two marking relays, one binary counter and the two marking relays being operated in various combinations to register the number of pulses received, while the other binary counter responds once per pulse and drives the actual counter.

The present invention relates to an electronic binary counter suitable for use in place of the driving binary counter of the above-mentioned Dehn application. A feature of the invention lies in the use of a pair of electronic tubes with means for rendering the tubes alternately responsive to the incoming pulses.

More specifically the invention relates to a binary pulse counter comprising two gas-filled tubes with a pulse dividing relay in the output circuit of one of the tubes, this relay when normal directing the pulse controlled circuit to the first tube, and operating, when the first tube is made conducting by a pulse, to extend the pulse controlled circuit to the second tube. When the second tube breaks down in response to a second pulse the first tube is quenched and the pulse dividing relay releases.

The invention will be more clearly understood from a consideration of the following description in connection with the attached drawing in which:

Fig. 1 shows the complete counting arrangement as it might be employed in an originating register such as used in the cross bar system disclosed in Patent 2,585,904 to A. J. Busch, granted February 19, 1952; and

Fig. 2 shows an alternative form of electronic pulse divider.

In the drawing, relay **100** is a pulse receiving relay, while relay **101** is the pulse dividing relay operated under the control of the electron tubes **120** and **121**. Relays **103** and **104** constitute a binary counter and relays **105** and **106** are a pair of marking relays. In addition, two off-normal relays **107** and **108** and three registration advance relays **109**, **110** and **111** are shown which are standard parts of the cross bar system of the above-mentioned Busch patent.

In such a telephone system the origination of a call by a subscriber causes the automatic establishment of a connection between the calling subscriber's line and the pulse receiving relay **100** in the originating register, including the dial **112** at the calling substation. As a part of setting up this connection, off-normal relays **107** and **108** are operated. With off-normal relay **108** operated

a circuit is closed over its contact **2**, contact **2** of relay **109** to battery through the windings of relays **110** and **111**, operating the latter relays. Relay **100** operates as soon as it is connected with the calling line.

The electronic binary counter comprises tubes **120** and **121** each having a control anode, a main anode and a cathode. The main anodes of tubes **120** and **121** are connected in parallel to plus 130-volt battery through resistance R5. The control anode of tube **120** is connected to ground through resistances R3 and R4, the point between resistances R4 and R3 being connected over contact **1** of relay **101** to the pulse controlled circuit. The control anode of tube **121** is also connected to ground through a pair of resistances **R13** and **R14** which have similar values to those of resistances R3 and R4. The point between resistances R13 and R14 is connected to contact **2** of relay **101** so that, with relay **101** operated, the pulse controlled circuit will be extended to the control anode of tube **121**. The cathode of tube **120** is connected through the winding of relay **101** to battery through a network including resistance R7 and condenser C7, with condenser C2 connected across the winding of relay **101**. The cathode of tube **121** extends to battery through a network including resistance R6 and condenser C6.

The pulse controlled circuit extends from minus 130-volt battery over contact **2** of off-normal relay **107** through resistance R2 and condenser C1 to ground through resistance R1, the point between condenser C1 and resistance R1 being connected to armatures **1** and **2** of relay **101**. With relay **101** normal, condenser C1 charges through resistances R1 and R3 in parallel but this charging current is in such a direction that it has no effect upon tube **120**.

The circuit remains in this condition until the subscriber operates his dial. As the dial returns to normal, it opens the circuit of relay **100** a plurality of times in the well-known manner. At the first release of relay **100**, a circuit is closed from ground over the contact **1** of relay **107**, contact **2** of relay **100** to battery through the winding of relay **109**. This relay operates quickly but is slow to release so that it remains operated throughout the reception of each digit. At its contact **2**, it opens the circuit of relays **110** and **111** so that these relays release and remain released throughout the reception of the digit.

When relay **100** releases in response to the first pulse, ground is connected over contact **1** of relay **107** and contact **1** of relay **100** to condenser C1, raising the potential on this side of condenser C1 from −130 volts to ground, and condenser C1 discharges. The current flow through resistance R3 as a result of this discharge creates a potential on the control anode of tube **120** which causes the control gap to break down, followed by the main gap, which causes relay **101** to operate. With relay **101** operated, the pulse controlled circuit is extended over contact **2** of relay **101** to resistances R13 and R14. However, the constants of relay **101**, condenser C1 and resistances R1 and R3 are so selected that when relay **101** operates there will not be sufficient residual charge on condenser C1 to cause tube **121** to break down and conduct.

When relay **100** reoperates at the end of the pulse, condenser C1 is again charged but, as in the case of tube **120**, the direction of the charging current is such that tube **121** is not affected thereby. When relay **100** releases in response to the second dial pulse, condenser C1 discharges through resistances R1 and R13 creating a potential on the control anode of tube **121** which causes the control gap to break down followed by the main gap.

With both tubes **120** and **121** drawing current through resistance **R5** the potential at the main anodes of the two tubes drops below the sustaining voltage and tube **120** is extinguished, causing relay **101** to release and restore the connection between the pulse controlled circuit and the control anode of tube **120**. As above-mentioned, the circuits are so designed that, when relay **101** releases, there will not be sufficient residual charge on condenser **C1** to break down tube **120**. When tube **120** breaks down as a result of the third pulse, tube **121** is extinguished.

From the foregoing it will be apparent that, following each odd numbered pulse, relay **101** remains operated and following each even numbered pulse, relay **101** is released.

With relay **101** operated following the first pulse, a circuit is closed from ground over contact 3 of relay **108**, contact of relay **110**, conductor **116**, contact 3 of relay **104**, contact 6 of relay **101** to battery through the winding of relay **103**. Relay **103** operates and locks over its contact 4 and contact 3 of relay **104** to ground on conductor **116**.

With relay **101** released following the second pulse, a supplementary locking circuit is closed for relay **103** over contact 4 of relay **103** and contact 5 of relay **101** to ground on conductor **116**. At the same time, a circuit is closed from ground on conductor **116**, contact 3 of relay **103**, contact 4 of relay **101** to battery through the winding of relay **104**. Relay **104** operates in this circuit and locks over its contact 4 and contact 3 of relay **103** to ground on conductor **116**. With relay **101** operated following the third pulse the locking circuit of relay **103** is opened and that relay releases, but relay **104** is held operated in a circuit from battery through its winding and over its contact 4, contact 3 of relay **101** to ground on conductor **116**.

With relay **101** released following the fourth pulse, the holding circuit of relay **104** is opened and that relay releases and the relay binary counter is ready for reoperation. In the manner above described, relay **103** is operated following the fifth pulse and relay **104** is operated following the sixth pulse, while relay **103** is released following the seventh pulse and relay **104** is released following the eighth pulse. Similarly relay **103** is reoperated after the ninth pulse and relay **104** is reoperated after the tenth pulse. If a false eleventh pulse should be received, relay **101** would reoperate in response to that pulse, releasing relay **103**.

The marking relays **105** and **106** are operated under the control of relays **103** and **104**. With relay **104** operated and relay **103** released after the third pulse, a circuit is closed from battery through the winding of relay **105**, contact 2 of relay **106**, contact 2 of relay **103**, contact 2 of relay **104** to ground on conductor **116**. Relay **105** operates in this circuit and locks over its contacts 3 and 1 and contact 1 of relay **106** to ground on conductor **116**. An additional locking circuit is closed from battery through the winding of relay **105**, contact 3 of relay **105**, contact 2 of relay **104** to ground on conductor **116**.

With relays **103** and **104** operated after the sixth pulse, a circuit is closed from ground on conductor **116**, contact 1 of relay **103**, contact 1 of relay **104**, contact 2 of relay **105** to battery through the winding of relay **106**. Relay **106** operates in this circuit locking over its contact 3 directly to ground on conductor **116**. Relay **106** opens one locking circuit for relay **105** but the latter relay is held operated under the control of relay **104** until the eighth pulse at which time both relays **104** and **105** release.

Whenever a digit ends, relay **100** remains operated for a sufficient time to permit relay **109** to release and reoperate relays **110** and **111**. Following the release of relay **109**, ground is connected over contact 1 of relay **108** and contact 1 of relay **109** to conductor **117** which is extended over contacts of relays **103** to **106** to conductors **130**, **131**, **132**, **134** and **137** in accordance with the two-out-of-five code as shown in the subsequent table. Relays **110** and **111** are slow to operate and during their operate time, ground is extended over the normally closed contacts of relay **111** to the digit register. The normally closed contacts of relay **111** are included in these circuits so that, when the locking circuits for the operated counting relays are opened by the operation of relay **110** no false registration can take place if the counting relays do not release simultaneously.

The non-symmetrical operation of relays **105** and **106** provides twelve unique combinations of the relays **103**, **104**, **105** and **106**. Ten of these combinations serve to distinguish one to ten dial pulses and the translating circuits over the contacts of relays **103**, **104**, **105** and **106** shown at the bottom of the figure grounds two out of the five conductors **130**, **131**, **132**, **134** and **137** during the interdigital time to correspond to the dialed digit. With none of the relays operated, none of the registering conductors are grounded and none of them are connected to any other. If an eleventh pulse is received a circuit is immediately closed which holds relay **104** operated and results in a trouble indication by the originating register. When a digit 0 is received, in addition to the coded indication of a digit 0, a special circuit is closed to ground conductor **140** which may be used by the originating register in setting up a call to the zero operator, when zero is the first digit dialed.

Following is a table showing the relays operated and the conductors grounded for each digit dialed:

Digit	Relays Operated	Conductors Grounded
1	103	130, 131
2	103, 104	130, 132
3	104, 105	131, 132
4	105	130, 134
5	103, 105	131, 134
6	103, 104, 105, 106	132, 134
7	104, 105, 106	130, 137
8	106	131, 137
9	103, 106	132, 137
10	103, 104, 106	134, 137
11	104, 106	----------

In the binary counter of Fig. 2 the pulse controlled circuit, which is essentially the same as that of Fig. 1, is connected directly to the control anodes of tubes **220** and **221**. The main anodes of the two tubes are connected through individual resistances to +130 volt battery. The cathode of tube **220** is connected over contact 1 of relay **201** to −48 volt battery through the winding of that relay, in parallel with condenser **C22**, while the cathode of tube **221** is connected to normally opened contact 2 of relay **201**. When relay **200** releases in response to a pulse, condenser **C21** discharges, providing a sufficient potential to break down the control gap of tube **220**. The main gap of tube **220** breaks down, causing the operation of relay **201**. Neither gap in tube **221** breaks down since the cathode circuit of tube **221** is open at contact 2 of relay **201**. Relay **201** closes a locking circuit for itself from −48 volt battery through the network including resistance **R26** and condenser **C26**, rectifier **230**, lower winding of relay **201** to ground at contact 3 of relay **201**. Relay **201**, at its contact 1, disconnects its upper winding from the cathode of tube **220**, thereby extinguishing tube **220**. When relay **200** reoperates, the discharge path for condenser **C21** is opened.

When condenser **C21** discharges in response to the second dial pulse, the control gap of tube **221** now extends over contact 2 of relay **201** to −48 volt battery through the network including resistance **R26** and condenser **C26**. When the main gap of tube **221** breaks down, the current flow through resistance **R26** is such that insufficient current can flow through rectifier **230** to hold relay **201** operated, and relay **201** releases. The release of relay **201** opens the main gap circuit of tube

221 thereby quenching that tube. With relay **201** released, the cathode circuit of tube **220** is restored so that tube **220** responds to the next dial pulse.

The circuit of Fig. 2 has an advantage over that of Fig. 1 since the tubes are extinguished as soon as they have performed their function of operating or releasing relay **201** with the consequence that the life of the tubes would be considerably increased.

Relay **201** would also have a set of contacts similar to contacts **3** to **6** of relay **101** by which it would control a set of pulse counting relays.

What is claimed is:

1. In a pulse counting arrangement, a pulsing relay responsive to each pulse to be counted, two gas-filled tubes, each tube having an input circuit and an output circuit, means under the control of said pulsing relay to activate said input circuits, a pulse dividing relay in the output circuit of one of said tubes, and means under the control of said pulse dividing relay to render said tubes alternately responsive to the activation of said input circuits.

2. In a pulse counting arrangement, a normally operated pulsing relay released in response to each pulse to be counted, two gas-filled tubes, each tube having a control anode, a main anode and a cathode, a source of sustaining potential connected to said main anodes, a pulse dividing relay connected to the cathode of one of said tubes and a network connected to the cathode of the second of said tubes, a circuit controlled by each release of said pulsing relay to generate a breakdown potential, and means under the control of said pulse dividing relay to alternately connect said breakdown potential to the control anode of said first tube and to the control anode of said second tube.

3. In a pulse counting arrangement, a normally operated pulsing relay released in response to each pulse to be counted, two gas-filled tubes, each tube having a control anode, a main anode and a cathode, a source of sustaining potential connected through a common resistance to said main anodes, a pulse dividing relay connected to the cathode of one of said tubes, a network connected to the cathode of the second of said tubes, and a circuit controlled by each release of said pulsing relay to generate a breakdown potential, said pulse dividing relay normally connecting said breakdown circuit to the control anode of said first tube whereby said pulse dividing relay operates as a result of the breakdown of said first tube in response to the first release of said pulsing relay, said pulse dividing relay when operated connecting said breakdown circuit to the control anode of said second tube whereby the next release of the pulsing relay causes the breakdown of said second tube, the current flow through said second tube and said network quenching said first tube and releasing said pulse dividing relay.

4. In a pulse counting arrangement, a normally operated pulsing relay released in response to each pulse to be counted, two gas-filled tubes, each tube having a control anode, a main anode and a cathode, a resistance, a source of potential connected through said resistance to the main anodes of both tubes normally supplying a sustaining potential at said anodes, a pulse dividing relay connected to the cathode of one of said tubes, a network connected to the cathode of the second of said tubes, and a circuit controlled by each release of said pulsing relay to generate a breakdown potential, said pulse dividing relay normally connecting said breakdown circuit to the control anode of said first tube whereby said pulse dividing relay operates as a result of the breakdown of said first tube in response to the first release of said pulsing relay, said pulse dividing relay when operated connecting said breakdown circuit to the control anode of said second tube whereby the next release of the pulsing relay causes the breakdown of said second tube, the current flow through said second tube and said network reducing the potential on said main anodes below the sustaining value so that said first tube is quenched and said pulse dividing relay is released to restore the connection of said breakdown circuit to said first tube.

5. In a pulse counting arrangement, a normally operated pulsing relay released in response to each pulse to be counted, two gas-filled tubes, each tube having a control anode, a main anode and a cathode, a resistance, a source of potential connected through said resistance to the main anodes of both tubes normally supplying a sustaining potential at said anodes, a pulse dividing relay connected to the cathode of one of said tubes, a network connected to the cathode of the second of said tubes, a breakdown control circuit including a condenser, a circuit for normally charging said condenser, and means controlled by each release of said pulsing relay to discharge said condenser to generate a breakdown potential, said pulse dividing relay normally connecting said breakdown circuit to the control anode of said first tube whereby said pulse dividing relay operates as a result of the breakdown of said first tube in response to the first release of said pulsing relay, said pulse dividing relay when operated connecting said breakdown circuit to the control anode of said second tube whereby the next release of the pulsing relay causes the breakdown of said second tube, the current flow through said second tube and said network reducing the potential on said main anodes below the sustaining value so that said first tube is quenched and said pulse dividing relay is released to restore the connection of said breakdown circuit to said first tube.

References Cited in the file of this patent

UNITED STATES PATENTS

2,234,690	Depp	Mar. 11, 1941
2,277,579	Burger et al.	Mar. 24, 1942
2,576,099	Bray	Nov. 27, 1951
2,649,502	Odell	Aug. 18, 1953
2,649,580	Dunn	Aug. 18, 1953
2,651,006	Mederos	Sept. 1, 1953