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SIGNALING SYSTEM

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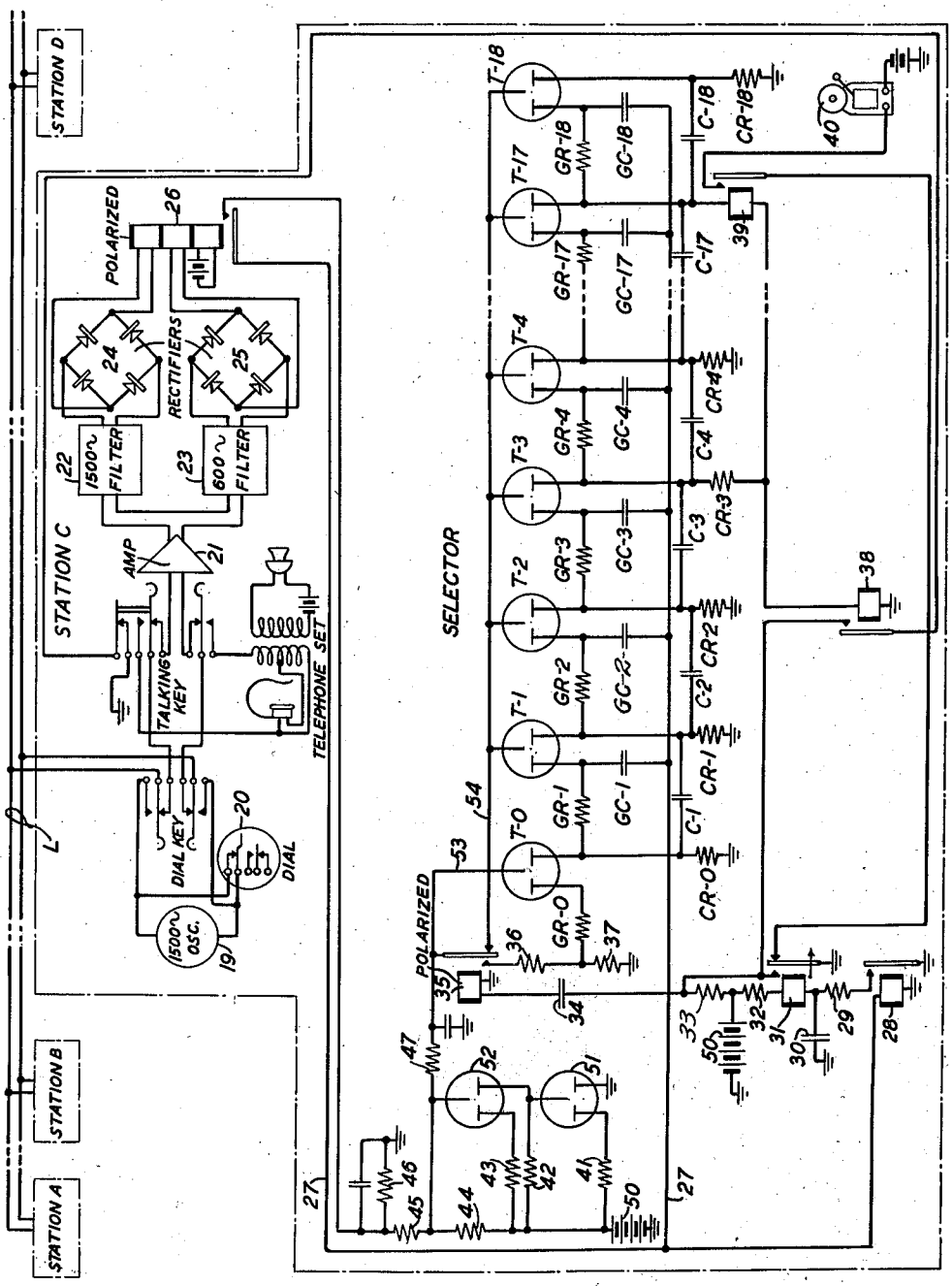


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## SIGNALING SYSTEM

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This invention relates to signaling systems and particularly to switching means selectively responsive to signal impulses.

The object of the invention is to provide an efficient and reliable selective signaling device which is simple and economical in construction and operation.

This invention is a selective switching device comprising a plurality of ionic tubes arranged to respond to signal impulses corresponding to a plurality of digits to close a signaling circuit only if the signal impulses correspond to one particular combination of digits.

According to this invention a signaling system comprises a plurality of interconnected stations, a selective switching device and signaling circuit at each station, and means for transmitting signal impulses corresponding to a plurality of digits to all of the stations simultaneously. Each of the selective switching devices comprises a plurality of ionic tubes arranged to respond to all impulses transmitted and to close the associated signaling circuit only in response to signal impulses corresponding to one particular combination of digits.

According to a feature of the invention, a selective switching device comprises a plurality of three-element cold-cathode type tubes arranged to respond to signal impulses corresponding to a plurality of digits to close a signaling circuit only if the signal impulses correspond to one particular combination of digits.

Another feature of the invention is a selective switching device comprising a chain of gas-filled discharge tubes operatively responsive to signal impulses for controlling a signaling circuit, there being two more tubes than the total number of impulses to which the device is selectively responsive. The first tube of the chain prepares the device for selective response to digit impulses, the intermediate tubes are responsive to signal impulses to close the signaling circuit only if the impulses correspond to one particular combination of digits, and the last tube of the chain is provided to prevent the closing of the signaling circuit if the number of signal impulses exceeds the exact number required for closing the signaling circuit.

Another feature of the invention is a chain of gas-filled discharge tubes arranged for successive operation one at a time in response to signal impulses, with control means whereby the first impulse of a digit other than the first is effective to cause the operation of the next tube in the chain if the preceding digit is a particular digit and is effective to cause the operation of the same tube as was operated by the first impulse of the preceding digit if the preceding digit was any other than said particular digit.

Another feature of the invention is the combination of a chain of gas-filled discharge tubes, operatively responsive one at a time to signal impulses corresponding to a plurality of digits, with control means including an auxiliary gas-filled discharge tube for preparing the first tube of the chain for response to the first impulse of a digit and control means responsive to the operation of the tube corresponding to the last impulse of this digit for holding this tube operated if the digit is a particular digit and for resetting this tube and causing the reoperation of the auxiliary gas-filled tube whereby the first impulse of the next succeeding digit will be effective to reoperate the same tube as was operated by the first impulse of the first mentioned digit.

A more complete understanding of the invention may be obtained by considering the specific embodiment of the invention shown in the drawing which forms a part of this specification. The invention is not, however, limited in its application to the particular arrangement shown and is, in general, applicable to any signaling system in which the operation of a signal is controlled by series of signal impulses corresponding to a particular numerical code.

Referring to the drawing, L represents a line to which are permanently connected for intercommunication, a plurality of stations, four of which are shown. The apparatus at each station is alike except that the selectors are each arranged to close a local signaling circuit only in response to signal impulses corresponding to the particular code assigned to the station at which the selector is located. Stations A, B and D are represented schematically by dotted rectangles but the equipment for station C is shown in detail.

The line L may be a simple two-wire line, a side-circuit, a phantom circuit, or any combination of these, and with or without repeaters. The station equipment, as shown at station C, includes a telephone set, a talking key for connecting the telephone set to the line L, a dial for use in calling the other stations, an oscillator 19 which supplies the dial signal current, an amplifier 21 normally connected to the line L for amplifying incoming dial impulses, a filter 22 which passes 1500 cycle dialing current, a filter 23 which passes 600 cycle talking current, a rectifier 24 for the 1500 cycle current, a rectifier 25 for the 600

cycle current and a polarized impulse relay 26, the upper winding of which is connected for energization by the rectified 1500 cycle current, the middle winding of which is connected for energization by the rectified 600 cycle current, and the lower winding of which is connected in a local circuit to bias the relay so that its contacts are normally held in the position shown in the drawing. A biasing spring may be used in place of the biasing winding. The upper and middle windings of relay 26 are so connected as to be in electromagnetic opposition to each other so that the relay will not respond to 600 cycle talking current or to both 1500 cycle signaling current and 600 cycle talking current together if a subscriber dials while the line is being used for talking. Relay 26 is a sensitive relay which, with the talking key normal, responds to the impulses created by the operation of the dial at any other station providing the line is not then being used for talking. The station equipment also includes a selector which comprises an auxiliary impulse relay 28, a slow-to-release relay 31, control relays 35 and 38, a signal relay 39, and a series of three-element cold-cathode gas-filled tubes numbered T—0 to T—18 inclusive for operation under the control of the impulse relay 26. A bell 40 is controlled by the signal relay 39.

The energy for operating the selector relays and tubes is derived from a battery 50 in combination with resistors 41 to 47 inclusive and two three-element gas-filled tubes 51 and 52. The negative pole of battery 50 is connected to ground. The battery 50 is of the required voltage to operate tubes 51 and 52 and the tubes produce the voltage required for operating the impulse counting tubes T—0 to T—18 inclusive. For instance, the battery voltage required for operating tubes 51 and 52 may be from 175 to 225 volts, the potential thus obtained from the tubes for operating the impulse counting tubes being from 140 to 150 volts. The current through tubes 51 and 52 increases if the battery voltage increases and decreases if the battery voltage decreases, the drop in potential in resistor 44 being effective to compensate for any change in battery voltage. Resistors 45 and 46 constitute a potentiometer which supplies the required potential, for instance 50 volts, for operating relay 28 in response to each operation of relay 26 and for raising the potential of the grids of the counting tubes to cause their successive energization as hereinafter described. While the tubes 51 and 52 and the associated resistors constitute a reliable arrangement for controlling the potential impressed on tubes T—0 to T—18 inclusive, any other arrangement for supplying the required operating potentials may be substituted for the arrangement shown.

Each of the gas-filled tubes may be similar to the tube disclosed in Patent No. 1,784,869 granted to F. Gray, December 16, 1930. The impulse counting tubes T—5 to T—16, inclusive, and the associated condensers and resistors are not shown in the drawing but are represented by the broken lines between tubes T—4 and T—17. The plate or anode of tube T—0 is permanently connected over conductor 53 through resistors 47 and 44 to the positive pole of battery 50; and the anode of each of tubes T—1 to T—18 inclusive, is connected over conductor 54, through the back contact of relay 35, through resistors 47 and 44 to the positive pole of battery 50. The grid or control element of tube T—0 is permanently connected through the grid resistor GR—0 and resistor 37 to ground and through resistors GR—0 and 36 to the front contact of relay 35; the grid of each of tubes T—1 to T—18 inclusive, is connected through the associated one of grid resistors GR—1 to GR—18 inclusive, to the cathode of the preceding tube and through the associated one of grid condensers GC—1 to GC—18 over conductor 27, in parallel with the winding of relay 28, to the contacts of impulse relay 26. The cathode of tube T—0 is connected to ground through resistor CR—0, the cathode of tube T—17 is connected to ground through the windings of control relays 39 and 38 in series, the cathode of tube T—18 is connected to ground through a resistor CR—18, the cathode of each of the remaining tubes are connected to ground either through an associated resistor similar to resistors CR—0 and CR—18 or to ground through such a resistor in series with the winding of the control relay 38 depending upon the particular code assigned to the station at which the selector is located. To illustrate, the cathode of tube T—2 at station C is connected to ground through the resistor CR—2 and the cathode of tube T—3 is connected to ground through resistor CR—3 in series with the winding of relay 38.

The codes assigned to the various stations consist of two or more digits, the total number of units in each code being 17. For instance, the code 395 may be assigned to station C. In this case, the cathode of tubes T—3 and T—12 are connected through resistors CR—3 and CR—12 respectively to the winding of control relay 38 so that the progressive energization of the impulse counting tubes, as hereinafter described, will not be interrupted if the incoming impulses correspond to the code 395. Each of tubes T—3 and T—12 are thus locked operated if energized by the last impulse of a series to obtain the same locking effect as is obtained by the pegs in a selector of the type disclosed in Patent No. 1,343,256, granted to J. C. Field, June 15, 1920. The selectors at the other stations in the system are arranged in like manner by the connection of the cathode element of each of the impulse counting tubes T—2 to T—16 inclusive either to ground through a resistor alone or to ground through a resistor in series with control relay 38 according to the particular code assigned to the station in question.

When all of the connections between the various elements of the selector at station C are first completed, the tubes 51 and 52 are immediately energized. It is also necessary to initially energize tube T—0 to condition tube T—1 for response to the first impulse of any code of impulses which may be received over line L. The initial energization of tube T—0 may be obtained by transmitting a preliminary impulse over the line to cause the operation of relays 26, 28, 31 and 35, as hereinafter described, or may be obtained by a manual operation of the armature of relay 35 so as to momentarily close its front contact. In either case, upon closure of the front contact of relay 35, the drop in potential through resistor 37 raises the potential of the grid element of tube T—0 to permit ionization of the gas and thus complete the anode-cathode circuit. Once energized, tube T—0 remains energized until tube T—1 is energized in response to an incoming impulse. There is a drop in potential from the anode to the cathode and a sufficient drop in potential in resistor CR—0 to render the grid of tube T—1 substantially higher in potential than the grid of each

of tubes T—2 to T—18 inclusive, condensers GC—1 and C—1 both being charged by the drop in potential in resistor CR—0.

Assume now that the code 395 is dialed at some other station of the system, that dial impulses of 1500 cycle current are transmitted over line L, are amplified in amplifier 19, are passed through filter 22 and rectified by rectifier 24 to cause the alternate operation and release of relay 26. Each operation and release of relay 26 causes a corresponding operation and release of relay 28. The operation of relay 28 in response to the first impulse of a series closes a circuit for operating relay 31. Relay 31, being slow in releasing, remains operated until all of the impulses in this series have been received. Condenser 30 and resistor 32 help to hold relay 31 operated after each release of relay 28. The operation of relay 31 closes a short-circuit around condenser 34 and relay 35 so that condenser 34 discharges through the winding of relay 35. Relay 35, being polarized, is operatively unaffected by this discharge current. Upon the first operation of relay 26 the potential of the grid of each of tubes T—1 to T—18, inclusive, is raised by the amount of the potential drop across relay 26. The grid of tube T—1 thus becomes positive with respect to the cathode by an amount equal to the drop in potential in resistor CR—0 plus the drop in potential in relay 28, a difference which is sufficient to cause ionization of the gas and thus complete the anode-cathode circuit. But the grid of each of tubes T—2 to T—18 inclusive, is then positive with respect to the cathode by an amount equal only to the drop in potential in relay 28, which amount is insufficient to cause ionization of the gas in any of these tubes. Upon energization of tube T—1 there is a drop in potential between the anode and cathode and a drop in potential through resistor CR—1 which is about equal to the drop in potential through resistor CR—0. The potential of the cathode of tube T—0 is thereby temporarily raised due to the discharge of condenser C—1 through resistor CR—1 sufficiently to cause the deenergization of tube T—0 and tube T—0 remains deenergized until its grid element is again connected to conductor 53 by the operation of relay 35. With tube T—1 energized the grid of tube T—2 becomes positive with respect to the cathode of this tube by an amount equal to the drop in potential in resistor CR—1 so as to condition tube T—2 for energization in response to the second impulse of the series, condensers GC—2 and C—2 being charged by the drop in potential in resistor CR—1. In response to the second impulse of the series, tube T—2 is energized and tube T—1 extinguished in the same manner that tube T—1 was energized and tube T—0 extinguished in response to the first impulse of the series. Tube T—3 is thereby conditioned for operation in response to the third and last impulse of the series created by the dialing of the first digit of the code assigned to station C. Upon energization of tube T—3, relay 38 is operated by the anode-cathode current. The operation of relay 38 closes a circuit for maintaining the short-circuit around condenser 34 and relay 35; so that, although the continued release of relay 26 after responding to the third and last impulse of the first series is effective to cause the release of relay 31, the control relay 35 does not operate to cause the reenergization of tube T—0. With tube T—3 energized, tube T—4 is conditioned for energization. When relay 26 operates in response to the first impulse of the second series, relays 28 and 31 are reoperated, tube T—4 is energized and tube T—3 extinguished. Tubes T—5 to T—12 inclusive, are thereupon successively energized in response to the succeeding impulses of the second series, tubes T—4 to T—11 inclusive, being successively extinguished. Although relay 38 releases when tube T—3 is extinguished, relay 31 maintains condenser 34 and relay 35 short-circuited while the second series of impulses are being received; and relay 38 is reoperated by the energization of tube T—12 in response to the last impulse of the series. The operation of relay 26 in response to the first impulse of the third and last series causes the reoperation of relays 28 and 31 and the energization of tube T—13. The deenergization of tube T—12 causes the release of relay 38 but relay 31 maintains condenser 34 and relay 35 short-circuited while the last series of impulses are being received. Tubes T—14 to T—17 are energized successively in response to the remaining impulses of the last series, tubes T—13 to T—16 being successively deenergized. Upon energization of tube T—17 in response to the last impulse, relays 39 and 38 are both energized in the anode-cathode circuit. Relay 38 maintains the short-circuit around condenser 34 and relay 35 and, as soon as relay 31 releases, a circuit is closed for operating the signal 40.

Upon operation of the talking key, or removal of the receiver from the receiver hook, to answer the call, the telephone set is connected to line L; and the short-circuit around condenser 34 and relay 35 is opened at the uppermost contact of the key so that the condenser is charged in series with resistor 33 and the winding of relay 35, thereby causing the temporary operation of polarized relay 35. Relay 35 opens the connection between battery 50 and conductor 54 thereby extinguishing tube T—17 and releasing relays 38 and 39. The release of relay 39 silences the bell 40. The operation of relay 35 also connects the grid of tube T—0 through resistor 36 to conductor 53 thereby causing the reenergization of tube T—0. When relay 35 releases, battery is again connected over conductor 54 to the anodes of tubes T—1 to T—18 inclusive. When conversation is completed, the talking key is restored to normal, or receiver replaced on the receiver hook, the energization of tube T—0 having conditioned tube T—1 for operation in response to the first impulse of the next code which is transmitted over line L.

If a code assigned to some other station is dialed, and the last impulse of the series corresponding to the first digit causes the operation of a tube other than tube T—3, relay 38 is not operated and the release of relay 31 at the end of the series, causes the operation of relay 35, thereby extinguishing the tube corresponding to the last impulse of the series. The operation of relay 35 also causes the reenergization of tube T—0 thereby conditioning tube T—1 for response to the first impulse of the second digit. If the first digit of this other code is 3, then relay 38 is operated when tube T—3 energizes and the second series of impulses will continue the successive operation of the counting tubes beginning with tube T—4. If the first digit is 3 and the second digit is any other than 9, the tube energized in response to the last impulse of the second digit will be deenergized when relay 31 releases.

If tube T—3 or tube T—13 is energized by the last impulse of the code for some other station,

this tube and relay 38 will remain energized since the call is not answered at station C. To restore the selectors at station C and all stations other than the calling and called stations, the calling subscriber may dial a digit, for instance the digit 1, to cause the energization of the next tube in each of these selectors. The tube T—3 or T—13 and relay 38 will thus be deenergized and when relay 31 releases the selector at station C will be restored to normal. The arrangement might be such that a restoring impulse is transmitted whenever the talking key is restored or the receiver replaced on the receiver hook. If more than seventeen impulses are received without the selector being reset by the operation of relay 35, tube T—18 responds to the eighteenth impulse, thereby causing the deenergization of tube T—17 and release of relay 39. The further operation of relay 26 will cause no further operation of the selector, the release of relay 31 at the end of the series being effective to cause the operation of relay 35 and the resetting of the selector.

It is, therefore, apparent that the selectors at all stations of the system will respond to all impulses transmitted over the line L, but that the selector at each of the stations will be operatively effective to close the local signal circuit only in response to the particular code assigned to that station.

What is claimed is:

1. A selective switching device comprising a plurality of ionic tubes, signal receiving means for response to signal impulses corresponding to a plurality of digits, a signaling circuit, and control means whereby the tubes are operated successively to close said signaling circuit only if the operative response of said impulse receiving means corresponds to one particular combination of digits.

2. In a signaling system, a plurality of interconnected stations, means for transmitting signal impulses corresponding to a plurality of digits to all of the stations simultaneously, a selective switching device comprising signal receiving means and a plurality of ionic tubes at each station, and a signaling circuit at each station, each of said selective switching devices being arranged to respond to all impulses transmitted and to close the associated signaling circuit in response to signal impulses corresponding to a different combination of digits.

3. In combination, an impulse relay for responding to series of impulses, a series of three-element gas-filled tubes, setting means for conditioning the first of said tubes for energization in response to the first of a series of operations of said impulse relay, means rendered effective upon energization of each of said tubes in response to an operation of said impulse relay for conditioning the next of said tubes for energization in response to the next operation of said impulse relay, means rendered effective upon energization of each of said tubes in response to an operation of said impulse relay for causing the deenergization of the preceding one of said tubes, control means effective at the end of a series of operations of said impulse relay for causing the deenergization of the tube energized in response to the last operation of said impulse relay and for operating said setting means, means comprising a relay connected for operation upon energization of a first particular one of said tubes in response to the last of a series of operations of said impulse relay for preventing the operation of said control means, and a signal relay connected for operation only upon energization of a second particular one of said tubes.

4. In combination, an impulse relay for responding to series of impulses, a series of three-element gas-filled tubes, means rendered effective upon energization of each of said tubes except the last for conditioning the next of said tubes for operation in response to the next operation of said impulse relay, means rendered effective upon energization of each of said tubes except the first for causing the deenergization of the preceding one of said tubes, setting means comprising a relay for causing the deenergization of said tubes other than the first and for causing the energization of the first of said tubes, a control relay connected for operation upon energization of a certain one other than the first or last of said tubes, and a signal relay connected for operation only upon energization of the penultimate one of said tubes.

5. In combination, an impulse relay for responding to series of impulses, a slow-to-release relay operated in response to the first operation of a series of operations of said impulse relay and remaining operated during the response of said impulse relay to the succeeding impulses in the series, a series of three-element gas-filled tubes, means rendered effective upon energization of each of said tubes except the last for conditioning the next of said tubes for operation in response to the next operation of said impulse relay, means rendered effective upon energization of each of said tubes except the first for causing the deenergization of the preceding one of said tubes, setting means rendered operatively effective by the release of said slow-to-release relay at the end of a series of impulses for causing the deenergization of said tubes other than the first and for causing the energization of the first of said tubes, a control relay connected for operation upon energization of a certain one other than the first or last of said tubes, and a signal relay connected for operation only upon energization of the penultimate one of said tubes, said control relay being effective while operated to prevent the operation of said setting means.

6. In a combination according to claim 5, a signal controlled by said signal relay.

7. In a combination according to claim 5, a signal controlled by said signal relay, and a switch for causing the release of said control and signal relays.

8. In combination, an impulse relay for responding to series of impulses, a series of three-element gas-filled tubes, setting means for conditioning the first of said tubes for energization in response to the first of a series of operations of said impulse relay, means rendered effective upon energization of each of said tubes in response to an operation of said impulse relay for conditioning the next of said tubes for energization in response to the next operation of said impulse relay, means rendered effective upon energization of each of said tubes in response to an operation of said impulse relay for causing the deenergization of the preceding one of said tubes, control means effective at the end of a series of operations of said impulse relay for causing the deenergization of the tube energized in response to the last operation of said impulse relay and for operating said setting means, means comprising a relay connected for operation upon energization of a first particular one of said tubes in response to the last of a first series of operations of said impulse relay and upon

energization of a second particular one of said tubes in response to the last of a second series of operations of said impulse relay for preventing the operation of said control means, and a signal relay connected for operation only upon energization of said second particular one of said tubes.

9. In combination, an impulse relay for responding to series of impulses, a series of three-element gas-filled tubes, setting means for conditioning the first of said tubes for energization in response to the first of a series of operations of said impulse relay, means rendered effective upon energization of each of said tubes in response to an operation of said impulse relay for conditioning the next of said tubes for energization in response to the next operation of said impulse relay, means rendered effective upon energization of each of said tubes in response to an operation of said impulse relay for causing the deenergization of the preceding one of said tubes, control means effective at the end of a series of operations of said impulse relay for causing the deenergization of the tube energized in response to the last operation of said impulse relay and for operating said setting means, means comprising a relay connected for operation upon energization of a first particular one of said tubes in response to the last of a first series of operations of said impulse relay and upon energization of a second particular one of said tubes in response to the last of a second series of operations of said impulse relay and upon energization of a third particular one of said tubes in response to the last of a third series of operations of said impulse relay for preventing the operation of said control means, and a signal relay connected for operation only upon energization of said third particular one of said tubes.

10. In combination, an impulse relay for responding to series of impulses, a series of three-element gas-filled tubes, means rendered effective upon energization of each of said tubes except the last for conditioning the next of said tubes for operation in response to the next operation of said impulse relay, means rendered effective upon energization of each of said tubes except the first for causing the deenergization of the preceding one of said tubes, setting means comprising a relay for causing the deenergization of said tubes other than the first and for causing the energization of the first of said tubes, a control relay connected for operation upon energization of certain of said tubes other than the first or last of said tubes, and a signal relay connected for operation only upon energization of the penultimate one of said tubes.

11. In combination, an impulse relay for responding to series of impulses, a series of three-element gas-filled tubes, means rendered effective upon energization of each of said tubes except the last for conditioning the next of said tubes for operation in response to the next operation of said impulse relay, means rendered effective upon energization of each of said tubes except the first for causing the deenergization of the preceding one of said tubes, setting means comprising a relay for causing the deenergization of said tubes other than the first and for causing the energization of the first of said tubes, a control relay connected for operation upon energization of certain of said tubes other than the first or last of said tubes and connected for operation upon energization of the penultimate one of said tubes, and a signal relay connected for operation only upon energization of the penultimate one of said tubes.

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