

Aug. 16, 1938.

T. L. DIMOND

2,126,875

SELECTION CONTROLLING APPARATUS FOR TELEPHONE SYSTEMS

Filed Nov. 26, 1937

3 Sheets-Sheet 1

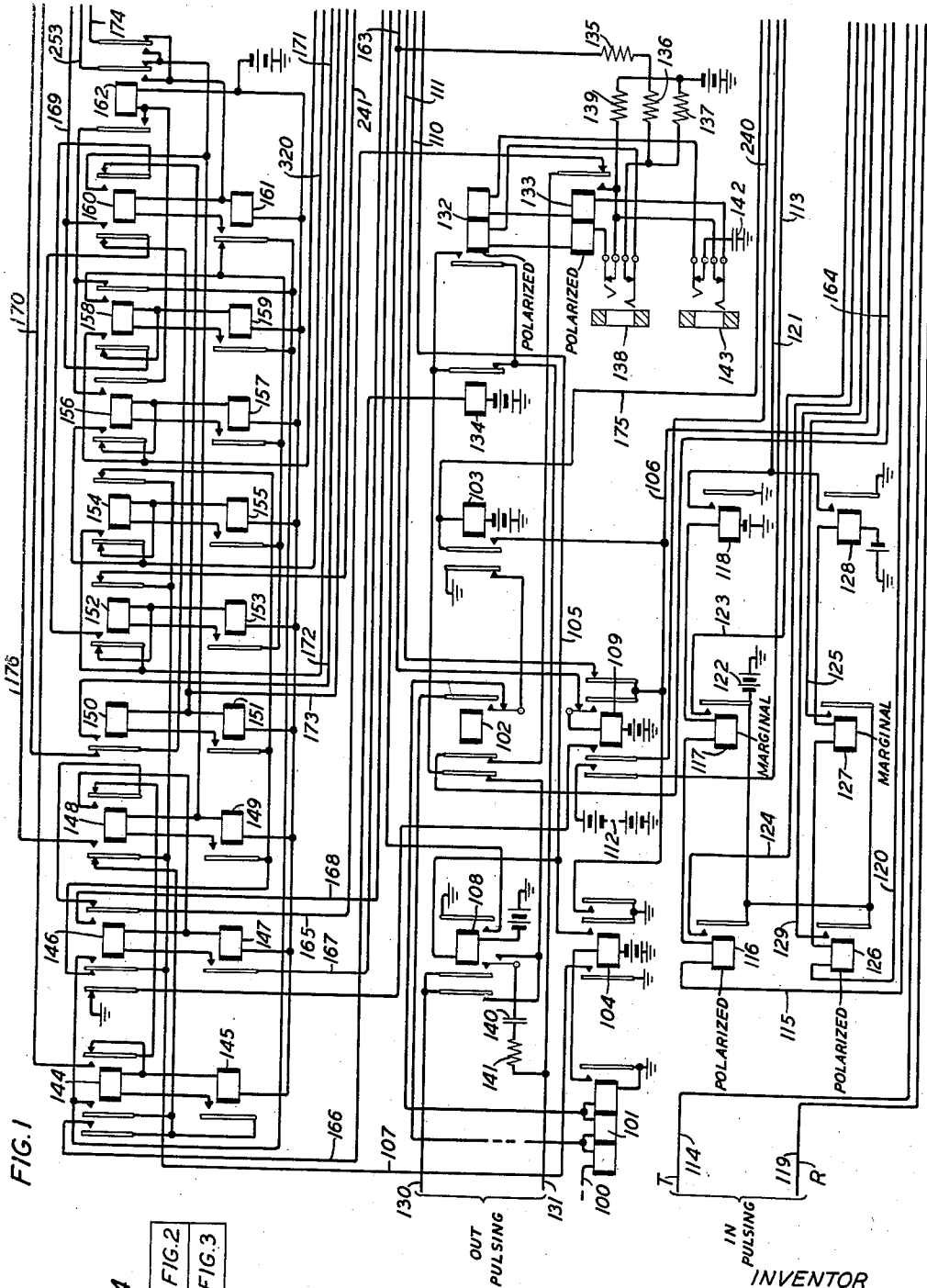


FIG. 4

FIG. 1	FIG. 2	FIG. 3
--------	--------	--------

INVENTOR
T. L. DIMOND
BY
P. C. Smith

ATTORNEY

Aug. 16, 1938.

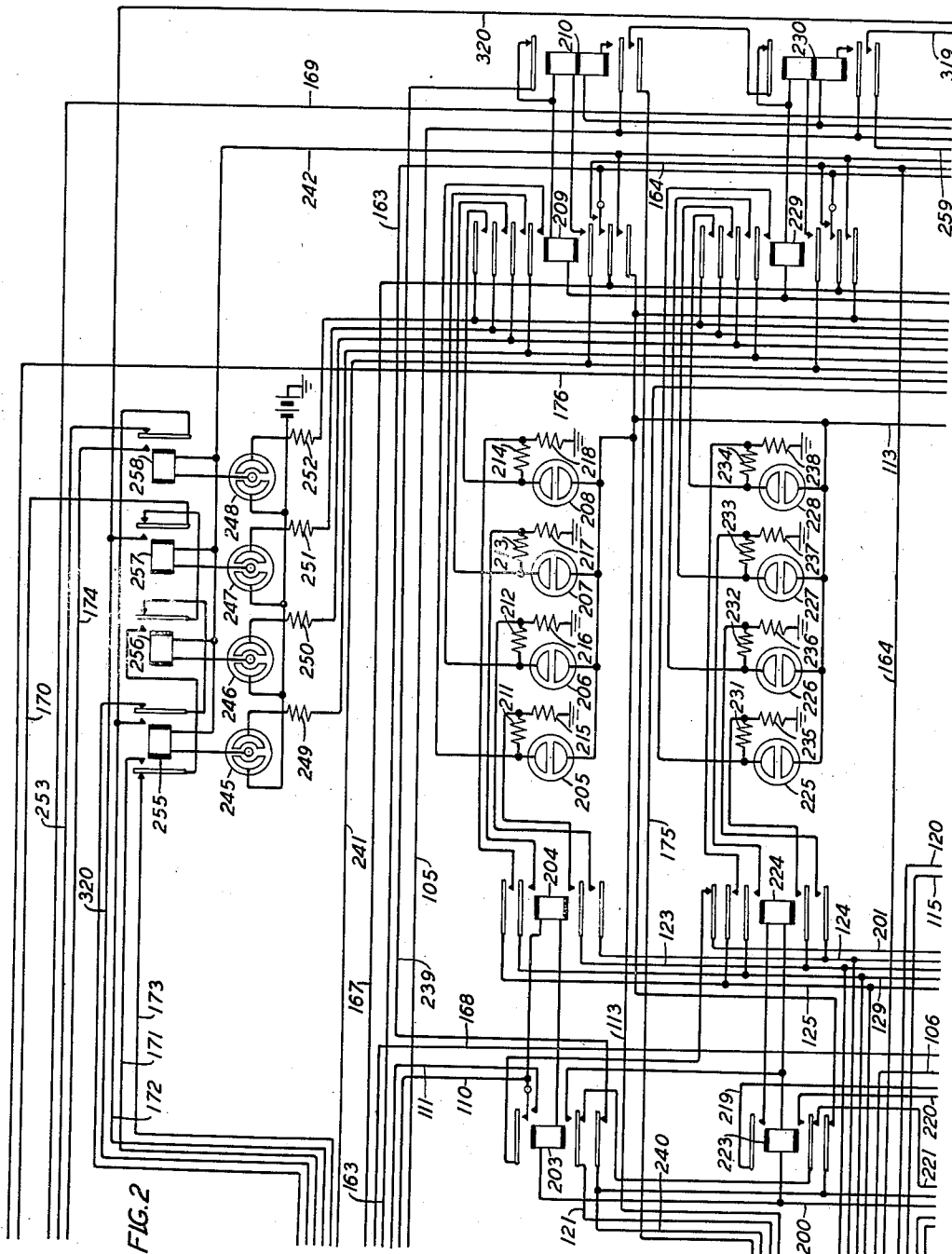
T. L. DIMOND

2,126,875

SELECTION CONTROLLING APPARATUS FOR TELEPHONE SYSTEMS

Filed Nov. 26, 1937

3 Sheets-Sheet 2



INVENTOR
T. L. DIMOND
BY
P. C. Smith

ATTORNEY

Aug. 16, 1938.

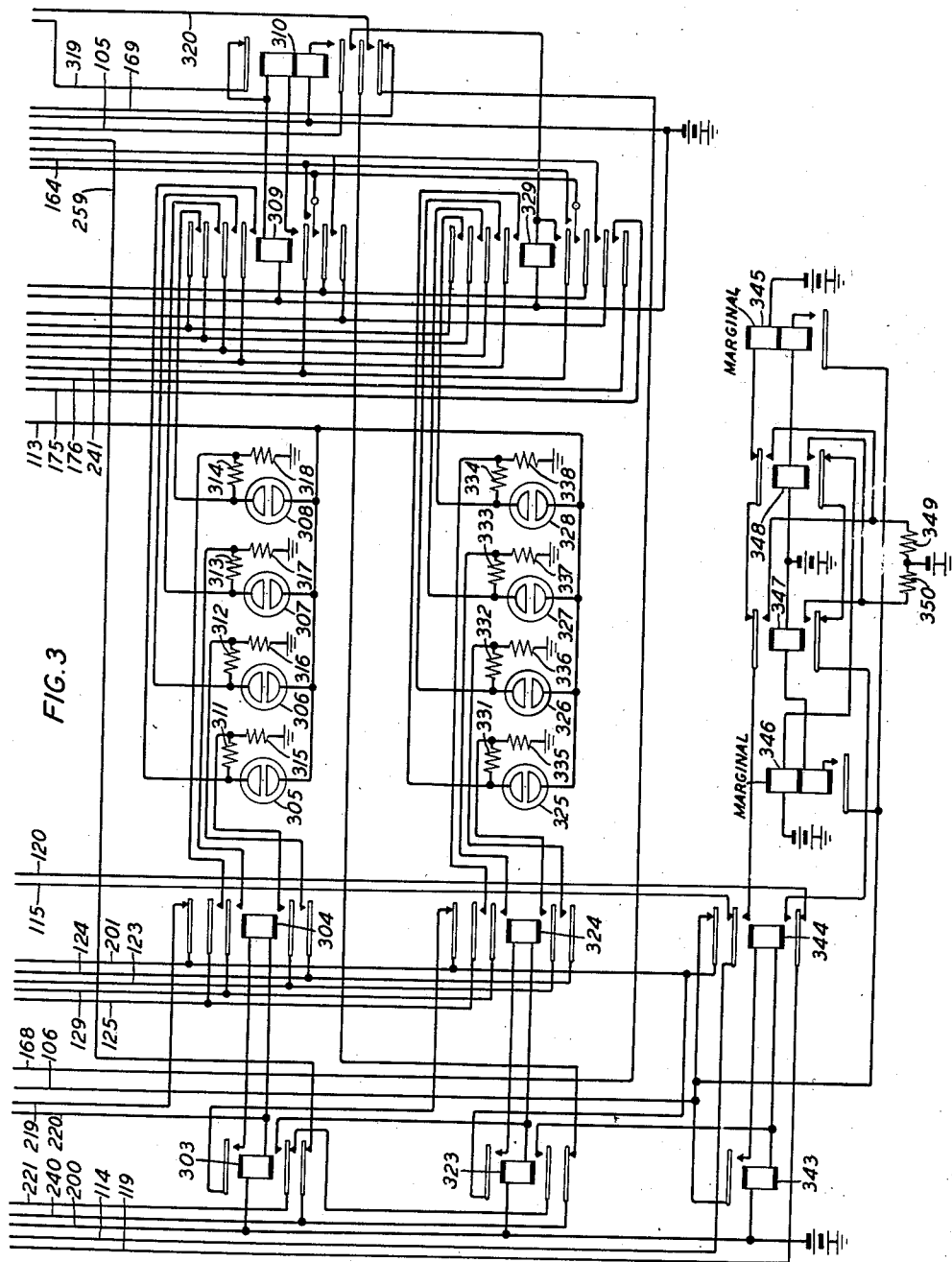
T. L. DIMOND

2,126,875

SELECTION CONTROLLING APPARATUS FOR TELEPHONE SYSTEMS

Filed Nov. 26, 1937

3 Sheets-Sheet 3



INVENTOR
T. L. DIMOND
BY
P. C. Smith

ATTORNEY

UNITED STATES PATENT OFFICE

2,126,875

SELECTION CONTROLLING APPARATUS FOR
TELEPHONE SYSTEMS

Thomas L. Dimond, Rutherford, N. J., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application November 26, 1937, Serial No. 176,557

11 Claims. (Cl. 179—90)

This invention relates to telephone exchange systems and more particularly to a sender for controlling the setting of selector switches in accordance with digit registrations.

Heretofore senders for controlling the setting of selector switches have been provided with register switches of the step-by-step type or groups of register relays for registering the digits of wanted line designations which are successively set by series of digit impulses dialed by a calling subscriber or by series of code impulses keyed by an operator. The present invention relates to a sender of this general type in which groups of gas-filled tubes are employed as registers in lieu of groups of relays whereby the cost of the sender is reduced, the circuits of the sender are simplified and the registration response is rendered more sensitive and faster.

In accordance with the present invention a group of cold cathode tubes is employed to register each digit of a line designation, there being a group of tubes for each digit to be registered.

For convenience of illustration, the invention has been disclosed in connection with a key pulsing sender of the type disclosed in Patent 1,916,760 granted July 4, 1933 to I. H. Henry, for enabling an operator to complete connections to subscribers' lines terminating in an office equipped with selector switches of the step-by-step type. The invention is not, however, to be considered as limited to senders of the key pulsing type or to the control of step-by-step switches, but could with slight modification be made applicable to receive digit series dialed directly by subscribers, or to receive series of code impulses transmitted thereto from another sender and to control the setting of any known type of selector switches such as the switches used in the well-known panel type or cross-bar type systems.

The groups of tubes are associated in succession by steering-in relays with impulse recording relays which are responsive to the series of impulses incoming to the sender. Each group of tubes comprises four two-element cold cathode gas-filled tubes, the cathode of each tube having a positive potential connected thereto upon the seizure of the sender, the control cathode or control electrode of each tube being connected through a high resistance to ground and the midpoint of the resistances being connected to the front contacts of the steering-in relay associated with the group of tubes. While tubes of the cold cathode type have been disclosed, it will be apparent to those skilled in the art that tubes of the hot cathode type could equally well be used.

When the control electrodes of a group of tubes have been connected over contacts of the associated steering-in relay with the recording conductors extending to the contacts of the impulse recording relays, the tubes may be rendered conducting singly or in combination by the application of negative potential of the value required by the connection of such potential to the recording conductors through the selective operation of the recording relays in response to an impulse code incoming to the sender, in the present instance, by the keying of a digit by the operator.

In response to successive impulse codes, the steering-in relays are operated in the usual manner to associate successive groups of tubes with the recording conductors so that successively keyed or dialed digits of a line number may be successively registered by the groups of tubes.

For controlling the transmission of series of outgoing impulses for setting selector switches in accordance with the registrations set up in the groups of registering tubes, a group of three-element cold cathode gas-filled decoding tubes is provided. It is to be understood, however, that the decoding tubes might be of the hot cathode type. Each of the decoding tubes is provided with an anode, a cathode and a control cathode or control electrode. The anode of each of these tubes is connectible through the winding of a decoder register relay to a source of positive potential and the cathode of each tube is connected to a source of negative potential. The control electrode of each of these tubes is connected to a bus-bar. The bus-bars to which the control electrodes of these tubes are connected may be connected successively to the control electrodes of the several groups of register tubes by a chain of steering-out relays.

The groups of decoder register relays are employed to control out pulsing in the usual manner, being set by the decoder tubes successively from the register tubes to control out pulsing in accordance with the registrations set up in the groups of register tubes.

If, for example, it be assumed that the first group of register tubes has been set to register the digit 1 by rendering only the first tube of the group conducting and that the second group of register tubes has been set to register the digit 3 by rendering only the first and second tubes of the second group conducting, when now the decoder tubes are connected to the first group of register tubes by the operation of the first of the chain of steering-out relays, only the first decoder tube will fire or become conducting since

it will be the only one of the decoder tubes which will have positive potential of a sufficient value applied to its control electrode through a conducting register tube, that is, the first register tube. The first decoder tube upon firing will operate the associated decoder register relay to control out pulsing for the first registered digit 1.

As soon as out pulsing is completed for the first registered digit, the first steering-out relay is released, the conducting decoder tube and operated decoder register relay are restored and the second steering-out relay is operated to associate the decoder tubes with the second group of register tubes upon which the second digit has been registered. With the assumption that the first two tubes of the second group of register tubes have been rendered conducting to register the digit 3, the first two decoder register relays will fire to operate the first two decoder tubes which will have positive potential of a sufficient value applied to their control electrodes through the first and second conducting register tubes of the second group of register tubes. The reoperation of the decoder register relays will now control out pulsing for the second registered digit. Other digits of any required number may be registered and out pulsing controlled in accordance therewith in the same manner. To simplify the disclosure it will be assumed that it will be necessary to register line designations having a maximum of four digits.

Having given a general description of the invention and the mode of its operation, it is believed that a better understanding thereof may be had from the following detailed description taken in connection with the accompanying drawings in which:

Fig. 1 shows recording relays for receiving incoming series of impulses transmitted in accordance with the digital values of the digits of line designations, out pulsing and counting relays for controlling the setting of selector switches and other control relays;

Fig. 2 shows the decoder tubes and associated decoder register relays, two groups of register tubes and associated steering-in and steering-out relays;

Fig. 3 shows other groups of register tubes and associated steering-in and steering-out relays; and

Fig. 4 is a diagram showing how Figs. 1, 2 and 3 should be arranged to fully disclose the invention.

Referring now to the drawings only such parts of a sender of the key pulsing type disclosed in the aforementioned patent to Henry have been illustrated as are considered necessary to a full disclosure of the present invention.

It will be assumed that an operator, desiring to complete a connection with a line terminating in a step-by-step office whose directory number is "1379", plugs into the jack of a trunk (not shown) extending toward the office in which the desired line terminates. It will be further assumed that the sender disclosed is idle and thereupon becomes associated with the trunk circuit through a link circuit in the manner fully described and disclosed in the Henry patent. Upon the seizure of the sender ground is applied to conductor 100 whereupon relay 101 operates in a circuit through its left and middle windings, right normal contacts of relay 102 to ground at the back contact of relay 103 and in operating establishes an obvious circuit for relay 104. Relay 104 upon operating connects ground to conductors

105, 106 and 107. Upon the connection of ground to conductor 105 an obvious operating circuit is established for relay 108 and upon the connection of ground to conductor 106, a circuit is established therefrom over the outer right back contact of relay 109, conductor 110, winding of steering-in relay 204, winding of transfer relay 203, conductor 200 to battery and ground.

Relays 203 and 204 operate and lock in a circuit from battery through their windings in series, the outer upper front contact of relay 203, the upper back contact of steering-in relay 224, conductor 201, the upper back contact of relay 344 to ground on conductor 106 and a circuit is established from ground on conductor 110 over the inner upper front contacts of relay 203, conductor 111 and the right normal contacts and winding of relay 109 to battery and ground. Relay 109 thereupon operates, locks over its right alternate contacts to ground on conductor 106 and opens the initial operating circuit of relays 203 and 204. At its outer left contact, relay 109 connects the source 112 of 90-volt positive potential to conductor 113 and thence to the lower cathodes of each of the register tubes 205, 206, etc.

Upon the seizure of the sender impulsing circuits are also established from the tip conductor 114 over the inner upper back contact of relay 344, conductor 115, thence in series through the windings of polarized recording relay 116, marginal recording relay 117 and sensitive recording relay 118 to 24-volt battery and ground, and from ring conductor 119 over the lower back contact of relay 344, conductor 120, thence in series through the windings of polarized recording relay 126, marginal recording relay 127 and sensitive recording relay 128 to 24-volt battery and ground.

It has been assumed that the first digit of the designation of the desired line is 1. When, therefore, the operator keys this digit, ground through a low resistance is applied to impulse conductor 114 whereupon sufficient current flows through the windings of relays 116, 117 and 118 to cause the operation of both the marginal relay 117 and the sensitive relay 118, but polarized relay 116 does not receive current in the proper direction through its winding to cause its operation. With transfer relay 203 operated, the operation of relay 118 establishes a circuit from ground over its contact, conductor 121, inner lower front contact of relay 203, winding of transfer relay 223 to battery and ground over conductor 200. Relay 223 thereupon operates and locks through the winding of steering-in relay 224, upper front contact of relay 223, conductor 219, upper back contact of steering-in relay 304, conductor 201, upper back contact of steering-in relay 344 to ground on conductor 106, but steering-in relay 224 being shunted so long as relay 118 remains operated, does not operate at this time. Recording relay 117 upon operating closes a circuit extending from the negative terminal of the 45-volt grounded battery 122, over conductor 123, the inner lower front contact of steering-in relay 204 through resistance 215 to ground and through resistance 211 to the upper or control electrode of tube 205 of the first digit register. With 90-volt positive potential applied to the lower cathode and 45-volt negative potential applied to the upper cathode of tube 205, this tube ionizes and becomes conducting, the ionization of the tube continuing after the subsequent release of relay 117 in a circuit from the source of 90-volt positive potential 112 applied to its lower cathode, through the tube to the upper cathode and thence

to ground through resistances 211 and 215 in series.

When the operator releases the digit key at her key-set, recording relays 117 and 118 release, relay 118 upon releasing removing the shunt from around the winding of steering-in relay 224 whereupon relay 224 operates in the locking circuit of relay 223, opening at its back contact the locking circuit of transfer relay 203 and steering-in relay 204, causing these relays to release. Relay 224 upon operating connects the recording conductors extending from the contacts of recording relays 117, 116, 126 and 127 to the control electrodes of the tubes 225 to 228, respectively, and relay 204 upon releasing disconnects the recording conductors from the control electrodes of the tubes 205 to 208, inclusive.

When the operator depresses the key of her key-set to register the second digit 3, 48-volt battery is connected through a low resistance to conductor 114 and a circuit is established as traced through the windings of recording relays 116, 117 and 118 in series to the 24-volt battery and ground. The direction of current flowing through the windings of these relays is such as to operate the polarized relay 116 and since a low resistance has been included in the circuit, relays 117 and 118 also operate. Relay 118 upon operating with transfer relay 203 released and transfer relay 223 operated, completes a circuit from ground over the front contact of relay 118, conductor 121, inner lower back contact of relay 203, inner lower front contact of relay 223, conductor 220, winding of transfer relay 303 to battery on conductor 206. Relay 303 operates and locks in a circuit from battery through its winding and the winding of steering-in relay 304, upper front contact of relay 303, upper back contact of steering-in relay 324, upper back contact of relay 344 to ground on conductor 106, but relay 304 being shunted so long as relay 118 remains operated, does not operate at this time. Recording relay 117 upon operating closes a circuit extending from the negative terminal of the 45-volt battery 122, over conductor 123, the inner lower front contact of steering-in relay 224, through resistance 235 to ground and through resistance 231 to the upper or control electrode of tube 225 of the second digit register. Recording relay 116 upon operating closes a circuit extending from the negative terminal of the 45-volt battery 122, over conductor 124, the lower front contact of relay 224 through resistance 236 to ground and through resistance 232 to the upper or control electrode of tube 226 of the second digit register. Since tubes 225 and 226 have 90-volt positive potential connected to their lower cathodes, they both ionize and become conducting and remain conducting after the subsequent release of recording relays 116 and 117.

When the operator releases the depressed key, recording relays 116, 117 and 118 release, relay 118 upon releasing opening the shunt around the winding of steering-in relay 304 whereupon relay 304 operates in the locking circuit of relay 303, opening at its back contact the locking circuit of transfer relay 223 and steering-in relay 224 causing these relays to release. Relay 304 upon operating connects the recording conductors extending from the contacts of recording relays 117, 116, 126 and 127 to the control electrodes of the tubes 305 to 308, respectively, and relay 224 upon releasing disconnects the recording conductors from the control electrodes of the tubes 225 to 228, inclusive.

In response to the operation of a key of the operator's key-set to register the third digit 7, 48-volt battery is connected through a high resistance to conductor 114 with the result that current flows through the windings of relays 116, 117 and 118 in such a direction as to cause the energization of polarized relay 116 and since a high resistance has been included in the impulsing circuit, marginal relay 117 does not operate, but sensitive relay 118 does operate. The operated key also connects ground through a low resistance to conductor 119 thereby completing a circuit as traced through the windings of recording relays 126, 127 and 128 to 24-volt battery and ground. The direction of current flowing over this circuit is not such as will operate the polarized relay 126, but due to the inclusion of a low resistance, both marginal relay 127 and sensitive relay 128 operate.

The operation of relays 118 and 128 connects ground to conductor 121 thereby completing a circuit over the inner lower back contacts of transfer relays 203 and 223, conductor 221, inner lower front contact of transfer relay 303, winding of transfer relay 323 to battery on conductor 200. Relay 323 operates and locks in a circuit from battery through its winding and the winding of steering-in relay 324, upper front contact of relay 323, upper back contact of relay 344 to ground on conductor 106, but relay 324 being shunted so long as relays 118 and 128 remain operated, does not operate at this time. The operation of polarized recording relay 116 closes a circuit from the negative terminal of 45-volt battery 122, over conductor 124, the lower front contact of steering-in relay 304, through resistance 316 to ground and through resistance 312 to the upper or control electrode of tube 306 of the third digit register. Recording relay 127 upon operating closes a circuit from the negative terminal of 45-volt battery 122, over conductor 125, the outer upper front contact of steering-in relay 304, through resistance 318 to ground and through resistance 314 to the upper or control electrode of tube 308 of the third digit register. Since tubes 306 and 308 have 90-volt positive potential connected to their lower cathodes they both ionize and become conducting and remain conducting after the subsequent release of recording relays 116 and 127.

When the operator releases the digit key, recording relays 116, 118, 127 and 128 release, relays 118 and 128 upon releasing opening the shunt around the winding of steering-in relay 324 whereupon relay 324 operates in the locking circuit of relay 323, opening at its back contact the locking circuit of transfer relay 303 and steering-in relay 304, causing these relays to release. Relay 324 upon operating connects the recording conductors extending from the contacts of recording relays 117, 116, 126 and 127 to the control electrodes of the tubes 325 to 328, respectively, and relay 304 upon releasing disconnects the recording conductors from the control electrodes of the tubes 305 to 308, inclusive.

In response to the operation of a key of the operator's key-set to register the last digit 9, 48-volt battery through a low resistance is connected to conductor 119 with the result that current flows through the windings of recording relays 126, 127 and 128 in such a direction as to cause the energization of polarized relay 126 and since a low resistance has been included in the impulsing circuit, both the marginal relay 127 and the sensitive relay 128 also operate. The oper-

ated key also connects ground through a high resistance to conductor 114 thereby completing a circuit, as traced, through the windings of recording relays 116, 117 and 118 to 24-volt battery and ground. The direction of current flowing over this circuit is not such as will operate the polarized relay 116 and due to the inclusion of a high resistance, marginal relay 117 does not operate, but sensitive relay 118 does operate.

The operation of relays 118 and 128 connects ground to conductor 121 thereby completing a circuit over the inner lower back contacts of transfer relays 203 and 223, conductor 221, inner lower back contact of transfer relay 303, inner lower front contact of transfer relay 323 to battery through the winding of transfer relay 343. Relay 343 operates and locks in a circuit from battery through its winding and the winding of relay 344, upper front contact of relay 343 to ground on conductor 106, but relay 344 being shunted so long as relays 118 and 128 remain operated, does not operate at this time. The operation of polarized recording relay 126 closes a circuit from the negative terminal of 45-volt battery 122, over conductor 129, the inner upper front contact of steering-in relay 324, through resistance 337 to ground and through resistance 333 to the upper or control electrode of tube 327 of the fourth digit register. Recording relay 127 upon operating closes a circuit from the negative terminal of 45-volt battery 122, over conductor 125, the outer upper front contact of steering-in relay 324, through resistance 338 to ground and through resistance 334 to the upper or control electrode of tube 328 of the fourth digit register. Since tubes 327 and 328 have 90-volt positive potential connected to their lower cathodes, they both ionize and become conducting and remain conducting after the subsequent release of recording relays 126 and 127.

When the operator releases the digit key, recording relays 118, 126, 127 and 128 release, relays 118 and 128 upon releasing opening the shunt around the winding of relay 344 whereupon relay 344 operates in the locking circuit of transfer relay 343 opening at its upper back contact the locking circuit of transfer relay 323 and steering-in relay 324 causing these relays to release. Relay 324 upon releasing disconnects the recording conductors extending from the contacts of recording relays 116, 117, 126 and 127 to the control electrodes of tubes 325 to 328, inclusive. Relay 344 upon operating also at its inner upper and inner lower back contacts disconnects the impulsing conductors 114 and 119 from the windings of the recording relays 116, 117, 118, 126, 127 and 128 and connects these conductors over its inner upper and inner lower front contacts to 48-volt battery through the upper windings of relays 345 and 346, respectively. The circuit from impulsing conductor 114 may now be traced over the inner upper front contact of relay 344, upper back contacts of relays 347 and 348, through the upper winding of relay 345 to battery and the circuit from conductor 119 may be traced over the lower front contact of relay 344, lower back contacts of relays 347 and 348, through the upper winding of relay 346 to battery.

At the key-set two polarized relays whose windings are connected at this time to the impulsing conductors 114 and 119 operate as described fully in the Henry patent, but relays 345 and 346 being marginally wound do not operate. Upon the operation of both polarized relays at the key-set, direct ground is connected to impulsing conductor 114 whereupon relay 345 operates locking in a cir-

cuit from battery through the winding of relay 348, the lower winding and front contact of relay 345 to ground on conductor 106. Relay 348 operates in this locking circuit, opening at its back contacts the operating circuits previously traced through the upper windings of relays 345 and 346 and at its front contacts connects 24-volt battery through resistances 349 and 350 over the back contacts of relay 347 and the front contacts of relay 344 to the impulsing conductors 114 and 119. The operator's key-set circuit is now released in the manner described in the Henry patent.

It will be recalled that upon the seizure of the sender relay 108 operated. Upon operating it establishes an operating circuit for the polarized impulse generating relays 132 and 133 extending from ground over its right front contact conductor 163, through resistances 135 and 136 and thence in parallel through resistance 137 and over the lower normal contacts of jack 138, left windings of relays 132 and 133, upper normal contacts of jack 138 and resistance 139 to battery, and relays 132 and 133 both operate. At this time the out-pulsing loop is established from conductor 130, left front contacts of relay 108, outer left back contact of relay 102, back contacts of relay 134 and front contacts of relay 132 in parallel, until relay 134 operates at the end of the synchronizing impulse as will be later described, to conductor 131. Relay 108 also at its outer left contacts switches the condenser 140 and resistance 141 across the impulsing conductors 130 and 131. At this time condenser 142 associated with the impulse generating relays 132 and 133 is also charged in a circuit extending from ground through condenser 142, the upper normal contacts of jack 143, through the right windings of relays 132 and 133, the lower normal contacts of jack 143, resistance 139 to battery and ground.

As soon as the first digit keyed by the operator has been registered in the first group of register tubes and transfer relay 203 has released, with relay 109 operated, a circuit is established for steering-out relay 209 which may be traced from battery through the winding of relay 209, the upper back contact of transfer relay 210, conductor 239, the lower back contact of transfer relay 203, conductor 240, inner left front contact of relay 109 to ground at the outer left back contact of counting relay 146. Relay 209 upon operating locks through its winding and the upper winding of relay 210, inner lower front contact of relay 209, conductor 241, right back contact of counting relay 152 to ground on conductor 107, but relay 210 being shunted does not operate at this time. Relay 209 also connects the upper or control electrodes of the tubes 205 to 208, inclusive, of the first tube register, over its four upper front contacts through resistances 249 to 252, inclusive, to the right or control electrodes of the decoder tubes 245 to 248, respectively. At its lowermost front contact relay 209 connects 90-volt positive potential applied from battery 112 to conductor 113, thence over conductor 242 and through the windings of decoder register relays 255 to 258, inclusive, in parallel to the anodes of decoder tubes 245 to 248, inclusive, and establishes a circuit from ground over the right front contact of relay 108, conductor 163, middle lower front contacts of relay 209, conductor 164, inner left back contact of relay 102, front contact of relay 133, upper contacts of jack 138, left windings of relays 132 and 133, 75

lower contacts of jack 133 to battery through resistance 137 and in parallel with the left windings of relays 132 and 133 to battery through resistance 139. When ground is applied to conductor 164, the left windings of relays 132 and 133 become shunted, but relays 132 and 133 do not release immediately because the discharge current from condenser 142, which was normally charged, now flows in a circuit previously traced therefrom through the right windings of relays 132 and 133, over the front contact of relay 133 to ground on conductor 163 and holds the relays operated. When the discharge current from condenser 142 decays to a certain point the left windings of relays 132 and 133 become controlling and the relays 132 and 133 both release.

When relay 133 releases, the ground is removed from its front contact and current now flows through the left windings of relays 132 and 133, thus tending to operate the relays. They do not operate immediately, however, because the charging current for condenser 142 now flowing through the right windings of these relays prevents them from doing so until after the charging current has decayed to a sufficiently low value. This pulsing action continues until ground is removed from the armature of relay 133 by the release of steering-out relay 209 following the transmission of impulses for the first registered digit; by the release of steering-out relay 229 following the transmission of impulses for the second digit; by the release of steering-out relay 309 following the transmission of impulses for the third digit; by the release of steering-out relay 329 following the transmission of impulses for the fourth or last digit and the timing for trunk hunting between the transmission of digits has been allowed.

Upon the first release of relay 133, a circuit is established from ground on conductor 163, over the back contact of relay 133, conductor 165, right back contact of counting relay 146, right back contact of counting relay 148, right back contact of counting relay 144, winding of counting relay 145 to battery. Relay 145 upon operating locks through the winding of relay 144, front contact of relay 145, left back contact of counting relay 148 to ground on conductor 107, but relay 144 being shunted does not operate until relay 133 again operates. Upon the next operation of relay 133, relay 144 operates and extends ground from conductor 107, over the left back contact of relay 148, inner left contact of relay 144 to the armatures of counting relays 159 and 161 for affording locking ground for these relays, over the back contact of relay 161 to the armatures of counting relays 153, 155 and 157 for locking these relays when operated and at its outer left contact connects ground from conductor 107 over conductor 166 to battery through the winding of relay 134. Relay 134 upon operating opens one point in the out-pulsing circuit thus placing this circuit under the control of impulsing relay 132. The first impulse generated by the release of relay 132 is thus absorbed by relays 144 and 145, succeeding impulses transmitted by the successive operation and release of relay 132 being effective to cause the vertical stepping of the first selector switch in the well-known manner so long as relay 134 remains operated.

When steering-out relay 209 operated as previously described, to connect the control electrodes of tubes 205 to 208, inclusive, to the control electrodes of the decoder tubes, since only tube 205 was in a conducting condition as as-

sumed to register the first digit 1, 90-volt breakdown potential was applied to the control electrode of decoder tube 245 over a circuit extending from battery 112, over conductor 113, through the tube 205, inner upper front contact of relay 209, resistance 249 to the right or control electrode of tube 245 and since the left cathode of this tube is connected to a source of 45-volt negative potential, the tube ionizes and establishes a conductive path therethrough from the 90-volt positive battery 112, now connected to conductor 242, through the winding of decoder register relay 255 to the anode of tube 245, thence through the tube to the left cathode thereof and to the source of 45-volt negative potential. Register relay 255 thereupon operates. Since the other register tubes 206 to 208, inclusive, were assumed to be in a non-conducting condition, the other decoder tubes 246 to 248, inclusive, will not fire and consequently decoder register relays 256 to 258, inclusive, remain unoperated. With decoder register relay 255 operated and relays 256, 257 and 258 unoperated, a registration is set up for the first registered digit 1.

When impulsing relays 132 and 133 again release, relay 132 opens the out-pulsing circuit and relay 133 at its back contact connects ground over conductor 165, right back contact of counting relay 146, right back contact of counting relay 148, right front contact of counting relay 144, left back contact of counting relay 160, back contact of counting relay 150, conductor 170, back contact of register relay 257, back contact of register relay 256, right front contact of register relay 255, back contact of register relay 258, conductor 253, inner right back contact of counting relay 162, winding of counting relay 149 to battery. Relay 149 operates and locks through the winding of relay 148, front contact of relay 149, right back contact of relay 154 to ground on conductor 107, but relay 148 does not operate in this locking circuit being shunted by ground over the back contact of relay 133. When relay 133 again operates, this shunt is removed and relay 148 operates, opening the locking circuits of relays 144 and 145 which now release in turn releasing relay 134. When relay 134 releases it shunts the contacts of impulsing relay 132 and the further operation of relays 132 and 133 is rendered ineffective to transmit impulses to the first selector switch. A single impulse has thus been transmitted.

The impulses generated by the operation of relay 133 are still effective and upon the next release of relay 133, a circuit is established from ground over its back contact, conductor 165, right back contact of counting relay 146, right front contact of counting relay 148, winding of counting relay 147 to battery. Relay 147 operates and locks through the winding of relay 146, front contact of relay 147, conductor 167, middle lower front contacts of steering-out relay 209 to ground on conductor 163. Relay 146 operates in this locking circuit upon the next operation of relay 133, opening at its outer left back contact the shunt around transfer relay 210 which now operates in the locking circuit of relay 209. The operation of counting relays 146 and 147 begins a 0.6 second timing interval to permit the first selector switch to hunt for an idle trunk in the first level of its bank to which its brushes have been raised.

Upon the next release of relay 133 ground is extended over its back contact, conductor 165, right front contact of relay 146, conductor 168, 75

lower back contact of transfer relay 310, conductor 169, left back contact of counting relay 158, winding of counting relay 159 to battery. Relay 159 operates and locks through the winding of relay 158, front contact of relay 159, inner left front contact of counting relay 146 to ground on conductor 107 and on the next energization of relay 133, relay 158 operates in this locking circuit. With relay 158 operated, upon the next release of relay 133 the operating circuit previously traced to the left armature of relay 158 is extended over the front contact thereof, left back contact of counting relay 156 to battery through the winding of counting relay 157. Relay 157 now operates, locking through the winding of relay 156 and its own front contact, over the back contact of counting relay 161 and the inner left front contact of relay 146 to ground on conductor 107. On the next operation of relay 133, relay 156 operates in this locking circuit. On the next release of relay 133, the circuit over which relay 157 was operated is extended over the left front contact of relay 156, left back contact of counting relay 154 to battery through the winding of counting relay 155 which operates and locks through the winding of relay 154 and its own front contact, back contact of relay 161 and inner left front contact of relay 146 to ground on conductor 107. On the next operation of relay 133, relay 154 operates in this locking circuit and at its right back contact opens the locking circuit of counting relays 148 and 149 which release. On the next release of relay 133, the circuit over which relay 155 was operated is extended over the left front contact of relay 154, left back contact of counting relay 152 to battery through the winding of counting relay 153 which operates and locks through the winding of relay 152 and its own front contact, back contact of relay 161 and inner left front contact of relay 146 to ground on conductor 107. On the next operation of relay 133, relay 152 operates in the locking circuit of relay 153 and at its right back contact opens the locking circuit of steering-out relay 209 which releases, transfer relay 210 being held energized over its lower winding and inner lower front contact to ground on conductor 105. Relay 209 upon releasing opens the locking circuit of counting relays 146 and 147 which now release in turn opening the locking circuits of relays 152 to 159, inclusive, which release. Relay 209 upon releasing also disconnects the 90-volt source 112 of positive potential from the anode of decoder tube 245, restoring this tube and releasing the operated decoder register relay 255 and disconnects the control electrodes of tubes 205 to 208, inclusive, from the control electrodes of the decoder tubes 245 to 248, inclusive.

If the second digit has now been registered in the tubes of the second tube register and transfer relay 223 has become deenergized, with transfer relay 210 operated, a circuit is closed for steering-out relay 229 extending from battery, winding of relay 229, upper back contact of transfer relay 230, lower front contact of transfer relay 210, lower back contact of transfer relay 223, conductor 240, inner left front contact of relay 109 to ground at the outer left back contact of counting relay 146. Relay 229 operates and locks through the upper winding of transfer relay 230, inner lower front contact of relay 229, conductor 241, right back contact of counting relay 152 to ground on conductor 107, but relay 230 does not operate in this locking circuit.

When impulsing relay 133 next releases and

closes its back contact, a circuit is closed from ground on conductor 163 over the middle lower front contacts of relay 229, conductor 164, inner left back contact of relay 102 to the armature of relay 133, thence over conductor 155, back contacts of counting relays 146, 148 and 144 to battery through the winding of counting relay 145. Relay 145 operates and locks through the winding of relay 144, front contact of relay 145, left back contact of relay 148 to ground on conductor 107, relay 144 operating on the next operation of relay 133 in this locking circuit and again causing the operation of relay 134 which, as before described, opens the shunt around the contacts of impulsing relay 132. This terminates the 0.6 second timing interval following the transmission of the first digit series.

Steering-out relay 229 upon operating connects 90-volt positive potential from conductor 113 over its lowermost contact and conductor 242, thence through the windings of the decoder register relays to the anodes of the decoder tubes and over its upper four contacts connects the control electrodes of tubes 225 to 228, inclusive, of the second tube register to the control electrodes of the decoder tubes 245 to 248, respectively. It having been assumed that tubes 225 and 226 have been rendered conducting to register the second digit 3, decoder tubes 245 and 246 now ionize and the decoder register relays 255 and 256 operate over the discharge paths through these tubes.

With counting relay 144 operating, on the next release of relays 132 and 133, the out-pulsing loop is opened at the contacts of relay 132 since relay 134 is now operated, and the circuit from ground over the back contact of relay 133 is extended over conductor 165, back contacts of counting relays 146 and 148, right front contact of counting relay 144, left back contact of counting relay 160, left back contact of counting relay 150, conductor 170, back contact of register relay 257, front contact of register relay 256, left front contacts of register relay 255, conductor 171, left back contact of counting relay 152 to battery through the winding of counting relay 153. Relay 153 operates and locks through the winding of relay 152, its own front contact, back contact of relay 161, inner left front contact of relay 144, left back contact of relay 148 to ground on conductor 107, but relay 152 being shunted at the back contact of relay 133 does not operate at this time. On the next operation of relays 132 and 133, the out-pulsing loop is closed at the contact of relay 132 and the shunt of counting relay 152 is opened at the back contact of relay 133 and relay 152 now operates in the locking circuit of relay 153. Relay 152 at its right back contact opens the locking circuit of steering-out relay 229, but relay 229 is maintained operated over its initial operating circuit previously traced. On the next release of relays 132 and 133, the out-pulsing loop is again opened and the previously traced circuit from ground over the back contact of relay 133 is now extended over the front contact of counting relay 152, right back contact of counting relay 160 to battery through the winding of counting relay 151. Relay 151 operates and locks through the winding of relay 150, its own front contact, inner left back contact of relay 146 to ground on conductor 107, but relay 150 being shunted at the back contact of relay 133 does not operate. On the next operation of relays 132 and 133 the out-pulsing loop is again closed and the shunt of

counting relay 150 is opened whereupon it energizes. On the next release of relays 132 and 133 the out-pulsing loop is again opened and the previously traced circuit from ground over the back contact of relay 133 is now extended over the front contact of counting relay 150, conductor 172, back contact of register relay 258, conductor 253, inner right back contact of counting relay 162, winding of counting relay 149 to battery. Relay 149 operates and locks through the winding of relay 148, its own front contact, left back contact of relay 146 to ground on conductor 107, but being shunted at the back contact of relay 133, relay 148 does not operate. On the next operation of relays 132 and 133 the out-pulsing loop is again closed and the shunt is removed at the back contact of relay 133 from around the winding of counting relay 148 which now operates, opening the locking circuit of relays 144 and 145 which release in turn releasing relay 134 and releasing counting relays 152 and 153, relay 152 again restoring the locking circuit of steering-out relay 229. When relay 134 released, the further operation of relays 132 and 133 is rendered ineffective to transmit impulses over the out-pulsing loop since the contacts of relay 132 are now shunted by the normal contacts of relay 134. The second selector has now been stepped three steps vertically.

On the next release of relays 132 and 133, the circuit from ground over the back contact of relay 133 is extended as traced over conductor 165, right back contact of counting relay 146, right front contact of counting relay 148 to battery through the winding of counting relay 147. Relay 147 operates and locks through the winding of relay 146, its own front contact, conductor 167, middle lower front contacts of steering-out relay 229 to ground on conductor 163 and relay 146 operates in this locking circuit upon the next operation of relay 133, opening at its outer left back contact the shunt around the winding of transfer relay 230 which operates in the locking circuit of relay 229 and opening at its inner left back contact the locking circuits of counting relays 148 to 151, inclusive. The operation of relays 146 and 147 begins a 0.6 second timing interval to permit the second selector to trunk hunt.

Upon the next release of relay 133, ground is extended over its back contact, conductor 165, right front contact of relay 146, conductor 168, lower back contact of transfer relay 310, conductor 169, left back contact of counting relay 158 to battery through the winding of counting relay 159. In the manner previously described, upon the continued release and operation of relay 133, counting relays 159, 158, 157, 156, 155, 154, 153 and 152 operate in succession. Relay 152 upon operating opens at its right back contact the locking circuit of steering-out relay 229 which now releases, but transfer relay 230 remains locked over its lower winding and inner lower front contact to ground on conductor 105. Relay 229 upon releasing opens the locking circuit of counting relays 146 and 147 which now release, opening the locking circuits of counting relays 152 to 159, inclusive, which also release. Relay 229 upon releasing also disconnects the 90-volt source 112 of positive potential from the anodes of the decoder tubes 245 and 246 restoring them and releasing the operated decoder register relays 255 and 256 and disconnects the control electrodes of tubes 225 to 228, inclusive,

from the control electrodes of decoder tubes 245 to 248, inclusive.

If the third digit has now been registered in the tubes of the third tube register and transfer relay 303 has become deenergized, with transfer relay 230 operated, a circuit is closed for steering-out relay 309 extending from battery, through the winding of relay 309, upper back contact of transfer relay 310, conductor 319, lower front contact of transfer relay 230, conductor 259, lower back contact of transfer relay 303, conductor 240, inner left front contact of relay 109 to ground at the outer left back contact of counting relay 146. Relay 309 operates and locks through the upper winding of transfer relay 310, inner lower front contact of relay 309, conductor 241, right back contact of counting relay 152 to ground on conductor 107, but relay 230 does not operate in this locking circuit. When impulsing relay 133 next releases and closes its back contact, a circuit is closed from ground on conductor 163, middle lower front contacts of relay 309, conductor 164, inner left back contact of relay 102 to the armature of relay 133, thence over conductor 165, back contacts of counting relays 146, 148 and 144 to battery through the winding of counting relay 145. Relay 145 operates and locks through the winding of relay 144, front contact of relay 145, left back contact of counting relay 148 to ground on conductor 107, relay 144 operating on the next operation of relay 133 in this locking circuit and again causing the operation of relay 134 which, as before described, opens the shunt around the contacts of impulsing relay 132. This terminates the 0.6 second timing interval following the transmission of the second digit series.

Steering-out relay 309 upon operating connects 90-volt positive battery from conductor 113, over its lowermost contact and conductor 242, thence through the windings of the decoder register relays to the anodes of the decoder tubes and over its upper four contacts connects the control electrodes of tubes 305 to 308, inclusive, of the third tube register to the control electrodes of the decoder tubes 245 to 248, respectively. It having been assumed that tubes 306 and 308 have been rendered conducting to register the third digit 7, decoder tubes 245 and 248 now ionize and the decoder register relays 256 and 258 operate over the discharge paths through these tubes.

With counting relay 144 operated, on the next release of relays 132 and 133, the out-pulsing loop is opened at the contacts of relay 132, since relay 134 is now operated, and the circuit from ground over the back contact of relay 133 is extended over conductor 165, back contacts of relays 146 and 148, right front contact of relay 144, left back contact of relay 160, left back contact of relay 150, conductor 170, back contact of register relay 257, front contact of register relay 256, left back contact of register relay 255, conductor 173, winding of counting relay 151 to battery. Relay 151 operates and locks through the winding of relay 150, front contact of relay 151, inner left back contact of relay 146 to ground on conductor 107, but relay 150 being shunted does not operate. On the next operation of relays 132 and 133, the out-pulsing loop to the connector switch is closed at the contacts of relay 132 and the shunt of relay 150 is opened at the back contact of relay 133 and relay 150 operates.

On the next release of relays 132 and 133, the out-pulsing loop is again opened and the previously traced circuit from ground over the back contact of relay 133 is now extended over the front

contact of relay 150, conductor 172, front contact of register relay 258, conductor 174, outer right back contact of counting relay 162, winding of counting relay 161 to battery. Relay 161 operates and locks through the winding of relay 160, its own front contact, inner left front contact of relay 144, left back contact of relay 148 to ground on conductor 107, but being shunted relay 160 does not operate. On the next operation of relays 132 and 133, the out-pulsing loop is again closed and the shunt around relay 160 is opened whereupon it operates. On the next release of relays 132 and 133, the out-pulsing loop is again opened and the previously traced circuit from ground over the back contact of relay 133 is now extended over the left front contact of relay 160, left back contact of counting relay 158 to battery through the winding of counting relay 159. Relay 159 operates and locks through the winding of relay 158, its own front contact, inner left front contact of relay 144, left back contact of relay 148 to ground on conductor 107, but being shunted relay 158 does not operate. On the next operation of relays 132 and 133, the out-pulsing loop is again closed and the shunt around relay 158 is opened whereupon it operates. On the next release of relays 132 and 133, the out-pulsing loop is again opened and the previously traced circuit from ground over the back contact of relay 133 is now extended over the left front contact of relay 158, left back contact of relay 156 to battery through the winding of counting relay 157. Relay 157 operates and locks through the winding of counting relay 156, its own front contact, the right front contact of relay 158, the inner left front contact of relay 144, left back contact of relay 148 to ground on conductor 107, but being shunted relay 156 does not operate. On the next operation of relays 132 and 133, the out-pulsing loop is again closed and the shunt around relay 156 is opened whereupon it operates. On the next release of relays 132 and 133, the out-pulsing loop is again opened and the previously traced circuit from ground over the back contact of relay 133 is now extended over the left front contact of relay 156, left back contact of counting relay 154 to battery through the winding of counting relay 155 and relay 154 operates on the next operation of relays 132 and 133. In a similar manner, upon the next releases and operations of relays 132 and 133, relays 153 and 152 operate and the out-pulsing loop is opened and closed again. On the next release of relays 132 and 133, the out-pulsing loop is again opened and ground on the back contact of relay 133 is extended as traced to the left armature of relay 152, thence over the right front contact of relay 160 to battery through the winding of counting relay 149. Relay 149 operates and locks through the winding of relay 148, its own front contact, the inner left back contact of relay 146 to ground on conductor 107, but relay 148 being shunted does not operate. On the next operation of relays 132 and 133, the out-pulsing loop is again closed and the shunt is removed at the back contact of relay 133 from the winding of relay 148 which now operates, opening the locking circuits of relays 144 and 145 which release in turn releasing relay 134 and counting relays 152 to 161, inclusive. Seven impulses have now been sent to set the connector switch seven steps vertically. When relay 134 releases, the further operation of relays 132 and 133 is rendered ineffective to transmit impulses to the connector switch since the contacts of relay 132 are now shunted by the normal contacts of relay 134. When counting relay

152 operated, it opened the locking circuit of steering-out relay 309, but relay 309 was maintained operated over its initial operating circuit. Upon the release of relay 152 the locking circuit of relay 309 is reestablished.

On the next release of relay 133, a circuit from ground over its back contact is extended over conductor 165, right back contact of relay 146, right front contact of relay 148 to battery through the winding of relay 147. Relay 147 operates and locks through the winding of relay 146 and its own front contact, conductor 167, middle lower front contacts of steering-out relay 309 to ground on conductor 163 and relay 146 operates in this locking circuit upon the next operation of relay 133, opening at its outer left back contact the shunt around the winding of transfer relay 310 which now operates in the locking circuit of relay 309 and locks over its lower winding and inner lower front contact to ground on conductor 105. Relay 146 also opens at its inner left back contact the locking circuits for counting relays 148 to 151, inclusive. The operation of relays 146 and 147 begins the timing interval, which in this case will be 0.4 second, before the final series of impulses is transmitted to the connector switch.

With counting relays 146 and 147 operated, when relay 133 again releases, ground is extended over its back contact, conductor 165, right front contact of relay 146, conductor 168, lower front contact of transfer relay 310, conductor 320, left back contact of counting relay 154, to the winding of counting relay 155 to battery and relay 155 operates. Upon the next operation of relay 133, relay 154 operates. In the manner previously described, upon the next release and operation of relay 133, counting relays 153 and 152 operate in succession. Relay 152 upon operating opens at its right back contact the locking circuit of steering-out relay 309 which releases, opening the locking circuit of counting relays 146 and 147 which now release in turn opening the locking circuits of counting relays 152 to 155, inclusive which release. Relay 309 upon releasing also disconnects the 90-volt source 112 of positive potential from the anodes of the decoder tubes 246 and 248, restoring them and releasing the operated decoder register relays 256 and 258 and disconnects the control electrodes of tubes 305 to 308, inclusive, from the control electrodes of the decoder tubes 245 to 248, inclusive.

If the fourth and last digit has now been registered in the tubes of the fourth tube register and transfer relay 323 has become deenergized, with transfer relay 310 operated, a circuit is closed for steering-out relay 329 extending from battery, winding of relay 329, middle lower front contact of relay 310, lower back contact of transfer relay 323, conductor 240, inner left front contact of relay 139 to ground at the outer left back contact of counting relay 146. Relay 329 operates and locks through its inner lower front contact, conductor 241, right back contact of counting relay 152 to ground on conductor 107. When impulsing relay 133 next releases and closes its back contact a circuit is closed from ground on conductor 163, next to inner lower front contacts of relay 329, conductor 164, inner left back contact of relay 102 to the armature of relay 133, thence over conductor 165, back contacts of counting relays 146, 148 and 144 to battery through the winding of counting relay 145. Relay 145 operates and locks through the winding of relay 144, front contact of relay 145, left back contact of relay 148 to ground on con-

ductor 107, relay 144 operating on the next energization of relay 133 in this locking circuit and again causing the operation of relay 134 which, as before described, opens the shunt around the contacts of impulsing relay 132. This terminates the 0.4 second timing interval following the third digit series.

Steering-out relay 329 upon operating connects 90-volt positive potential from conductor 113 over its next to lower front contact and conductor 242, thence through the windings of the decoder register relays to the anodes of the decoder tubes and over its upper four front contacts connects the control electrodes of tubes 325 to 328, inclusive, of the fourth tube register to the control electrodes of the decoder tubes 245 to 248, respectively. It having been assumed that tubes 327 and 328 have been rendered conducting to register the fourth digit 9, decoder tubes 247 and 248 now ionize and the decoder register relays 257 and 258 operate over the discharge paths through these tubes.

With counting relay 144 operated, on the next release of relays 132 and 133, the out-pulsing loop is opened at the contacts of relay 132, since relay 134 is now operated, and the circuit from ground over the back contact of relay 133 is extended over conductor 165, back contacts of relays 146 and 148, right front contact of relay 144, left back contact of relay 160, left back contact of relay 150, conductor 170, right front contact of register relay 257, conductor 320, left back contact of counting relay 154, winding of counting relay 155 to battery. Relay 155 operates and locks through the winding of relay 154, front contact of relay 155, back contact of relay 161, inner left front contact of relay 144, left back contact of relay 148 to ground on conductor 107, but relay 154 being shunted does not operate. On the next operation of relays 132 and 133 the out-pulsing loop to the connector is closed at the contacts of relay 132 and the shunt around relay 154 is opened at the back contact of relay 133 and relay 154 then operates. In the manner previously described upon the next release and operation of relays 132 and 133 relays 153 and 152 operate and the out-pulsing loop is opened and closed again. Relay 152 upon operating extends ground from the back contact of relay 133, over the left front contact of relay 152, right back contact of relay 160 to battery through the winding of relay 151 so that upon the next release and operation of relays 132 and 133 the out-pulsing loop is opened and closed again and counting relays 151 and 150 operate and lock. Relay 152 upon operating also opens the locking circuit of steering-out relay 329, but this relay remains operated over its initial operating circuit.

With counting relay 150 operated ground on the back contact of relay 133 is extended, as traced, to the left back contact of relay 160, thence over the left front contact of relay 150, conductor 172, front contact of register relay 258, conductor 174, outer right back contact of counting relay 162, winding of counting relay 161 to battery so that upon the next release and operation of relays 132 and 133, the out-pulsing loop is again opened and closed and the counting relays 161 and 160 operate and lock. Relay 161 upon operating opens the locking circuits of counting relays 152 to 155, inclusive, at its back contact and these relays release. In the manner previously described, upon successive releases and operations of relays 132 and 133, additional impulses are transmitted

over the out-pulsing loop and counting relays 159, 158, 157, 156, 155, 154, 153, 152, 149 and 148 operate and lock in the order named. Relay 148 upon operating opens the locking circuits of relays 145 and 144 which release in turn releasing relay 134 and counting relays 152 to 161, inclusive. Nine impulses have now been transmitted to set the connector in a rotary direction to the terminals of the wanted line. When relay 134 releases, the further operation of relays 132 and 133 is rendered ineffective to transmit impulses to the connector switch since the contacts of relay 132 are now shunted by the normal contacts of relay 134. Relay 152 upon releasing recloses at its right back contact the locking circuit of steering-out relay 329.

Relay 148 upon operating also establishes a circuit for relay 103 which may be traced from battery through the winding of relay 103, conductor 175, lowermost front contact of steering-out relay 329, conductor 176, left front contact of relay 148 to ground on conductor 107. Relay 103 now operates locking over its front contact to ground on conductor 106 and at its back contact removing the shunt from around the right winding of relay 101. With the right winding of relay 101 unshunted, decreased current flows over conductor 100 to signal the link circuit (not shown) that the sender has completed its functioning and may be released. The link circuit then releases and in the manner described in the Henry patent, previously referred to, removes battery from conductor 100 thereby releasing relay 101 which in turn releases relay 104. The release of relay 104 removes ground from conductors 105, 106 and 107 thereby releasing any operated relays of the sender thus restoring the sender to its normal condition.

What is claimed is:

1. In a telephone system, a first group of tubes, a cathode and a control electrode for each of said tubes, means for selectively applying breakdown potential to the control electrodes of said tubes to selectively render said tubes conducting, a second group of tubes each having a cathode, a control electrode and an anode, a register relay connected into the cathode-anode circuit of each of said second group of tubes, and means for connecting the control electrodes of said second group of tubes to the control electrodes of said first group of tubes whereby the tubes of the second group are selectively rendered conducting in accordance with the conducting condition of said first group of tubes to selectively operate said register relays.
2. In a telephone system, a first group of tubes, a cathode and a control electrode for each of said tubes, means for selectively applying breakdown potential to the control electrodes of said tubes to selectively render said tubes conducting, means to maintain said tubes in a conducting condition after the withdrawal of said breakdown potential, a second group of tubes each having a cathode, a control electrode and an anode, a register relay connected into the cathode-anode circuit of each tube of said second group, and means for connecting the control electrodes of said second group of tubes to the control electrodes of said first group of tubes whereby the tubes of the second group are selectively rendered conducting in accordance with the conducting condition of said first group of tubes to selectively operate said register relays.
3. In a telephone system, a first group of tubes, a cathode and a control electrode for each of said tubes, a resistance network associated with the control electrode of each of said tubes, means for

selectively applying breakdown potential to the control electrodes of said tubes to selectively render said tubes conducting, means including said resistance network for maintaining said tubes in a conducting condition after the withdrawal of said breakdown potential, a second group of tubes each having a cathode, a control electrode and an anode, a register relay connected into the cathode-anode circuit of each tube of said second group, and means for connecting the control electrodes of said second group of tubes to the control electrodes of said first group of tubes whereby the tubes of the second group are selectively rendered conducting in accordance with the conducting condition of said first group of tubes to selectively operate said register relays.

4. In a telephone system, a first group of tubes, each tube having a cathode and a control electrode, means for applying positive potential to the cathodes of said tubes, recording relays responsive to digit impulses for selectively applying negative breakdown potential to the control electrodes of said tubes to selectively render said tubes conducting, means for maintaining said tubes in a conducting condition after the release of said recording relays, a second group of tubes each having a cathode, a control electrode and an anode, a register relay connected into the cathode-anode circuit of each tube of said second group, means for applying positive potential to the anodes and negative potential to the cathodes of the tubes of said second group, and means for connecting the control electrodes of said second group of tubes to the control electrodes of said first group of tubes whereby positive breakdown potential is applied to the control electrodes of tubes of said second group through such tubes of said first group as have been rendered conducting to selectively render said second group of tubes conducting for selectively operating said register relays.

5. In a telephone system, a first group of cold cathode gas-filled tubes, each tube having a cathode and a control electrode, means for applying positive potential to the cathodes of said tubes, means for selectively applying negative breakdown potential to the control electrodes of said tubes to selectively render said tubes conducting, a second group of cold cathode gas-filled tubes each having a cathode, a control electrode and an anode, a register relay connected into the cathode-anode circuit of each of said second group of tubes, means for applying positive potential to the anodes and negative potential to the cathodes of said second group of tubes, and means for connecting the control electrodes of said second group of tubes to the control electrodes of said first group of tubes whereby positive breakdown potential is applied to the control electrodes of tubes of said second group through such tubes of said first group as have been rendered conducting to selectively render said second group of tubes conducting for selectively operating said register relays.

6. In a telephone system, a plurality of groups of tubes, a cathode and a control electrode for each of said tubes, means for selectively applying breakdown potential to the control electrodes of each group of tubes in succession to selectively render tubes of each group conducting, a further group of tubes each having a cathode, a control electrode and an anode, a register relay connected into the cathode-anode circuit of each of said latter tubes, and means for connecting the control electrodes of said latter tubes to the con-

trol electrodes of said groups of tubes in succession whereby said latter tubes are selectively rendered conducting to operate their associated relays in accordance with the conducting condition of said groups of tubes.

7. In a telephone system, a plurality of groups of tubes, a cathode and a control electrode for each of said tubes, means for selectively applying breakdown potential to the control electrodes of each group of tubes in succession to selectively render tubes of each group conducting, a further group of tubes each having a cathode, a control electrode and an anode, a register relay connected into the cathode-anode circuit of each of said latter tubes, and a chain of steering-out relays for connecting the control electrodes of said latter group of tubes to the control electrodes of each of said groups of tubes in succession whereby said latter tubes are selectively rendered conducting to operate their associated relays in accordance with the conducting condition of said groups of tubes.

8. In a telephone system, a plurality of groups of tubes, a cathode and a control electrode for each of said tubes, recording relays selectively responsive to each successive series of incoming impulses, a group of recording conductors, means responsive to each operation of said relays for selectively applying potential to said conductors, steering-in relays operable in succession in response to each operation and release of said recording relays for successively connecting said group of conductors with the control electrodes of each group of tubes whereby the potential on said conductors is effective to selectively render tubes of each group conducting, a further group of tubes each having a cathode, a control electrode and an anode, a register relay connected into the cathode-anode circuit of each of said latter tubes, and a chain of steering-out relays for connecting the control electrodes of said latter group of tubes successively to the control electrodes of each of said groups of tubes whereby said latter tubes are selectively rendered conducting to operate their associated register relays in accordance with the conducting condition of said groups of tubes.

9. In a telephone system, a plurality of groups of tubes, a cathode and a control electrode for each of said tubes, means for applying positive potential to the cathodes of said tubes, means for selectively applying negative breakdown potential to the control electrodes of each group of tubes in succession to selectively render tubes of each group conducting, a further group of tubes each having a cathode, a control electrode and an anode, a register relay connected into the cathode-anode circuit of each of said latter tubes, means for applying negative potential to the cathodes of said latter tubes, a chain of steering-out relays, means for successively operating said steering-out relays, and means controlled by said steering-out relays for connecting the control electrodes of said latter tubes to the control electrodes of said groups of tubes in succession and for applying positive potential to the anodes of said latter tubes whereby positive breakdown positive potential is applied to the control electrodes of said latter tubes successively through such tubes of each of said groups as have been rendered conducting for successively and selectively operating said register relays.

10. In a register sender, a plurality of groups of tubes serving as registers, means operative in accordance with the successive series of incoming

impulses to selectively render tubes of each group conducting, a further group of tubes, a group of register relays for controlling out-pulsing series of impulses associated with and controlled by
5 said latter tubes, and means for associating said latter group of tubes with said groups of register tubes in succession whereby said latter tubes operate said register relays to control out pulsing in accordance with the registrations recorded by
10 said groups of tubes.

11. In a telephone system, a plurality of groups of tubes, a cathode and a control electrode for each of said tubes, recording relays selectively responsive to each successive series of incoming
15 impulses, a group of recording conductors, means responsive to each operation of said relays for selectively applying potential to said conductors, a chain of steering-in relays operable in succession in response to each operation and release of said

recording relays for successively connecting said groups of conductors with the control electrodes of each group of tubes whereby potential on said conductors is effective to selectively render tubes
5 in each group conducting to register said series of incoming impulses, a further group of tubes each having a cathode, a control electrode and an anode, a register relay connected into the cathode-anode circuit of each of said latter tubes
10 for controlling the transmission of outgoing series of impulses, and a chain of steering-out relays for connecting the control electrodes of said latter group of tubes to the control electrodes of each of said groups of tubes in succession
15 whereby said latter tubes are selectively rendered conducting to operate said register relays in accordance with the conducting condition of said groups of tubes.

THOMAS L. DIMOND.