

Oct. 6, 1936.

C. E. GERMANTON

2,056,265

TELEPHONE SYSTEM

Filed Aug. 13, 1935

10 Sheets-Sheet 1

FIG. 1

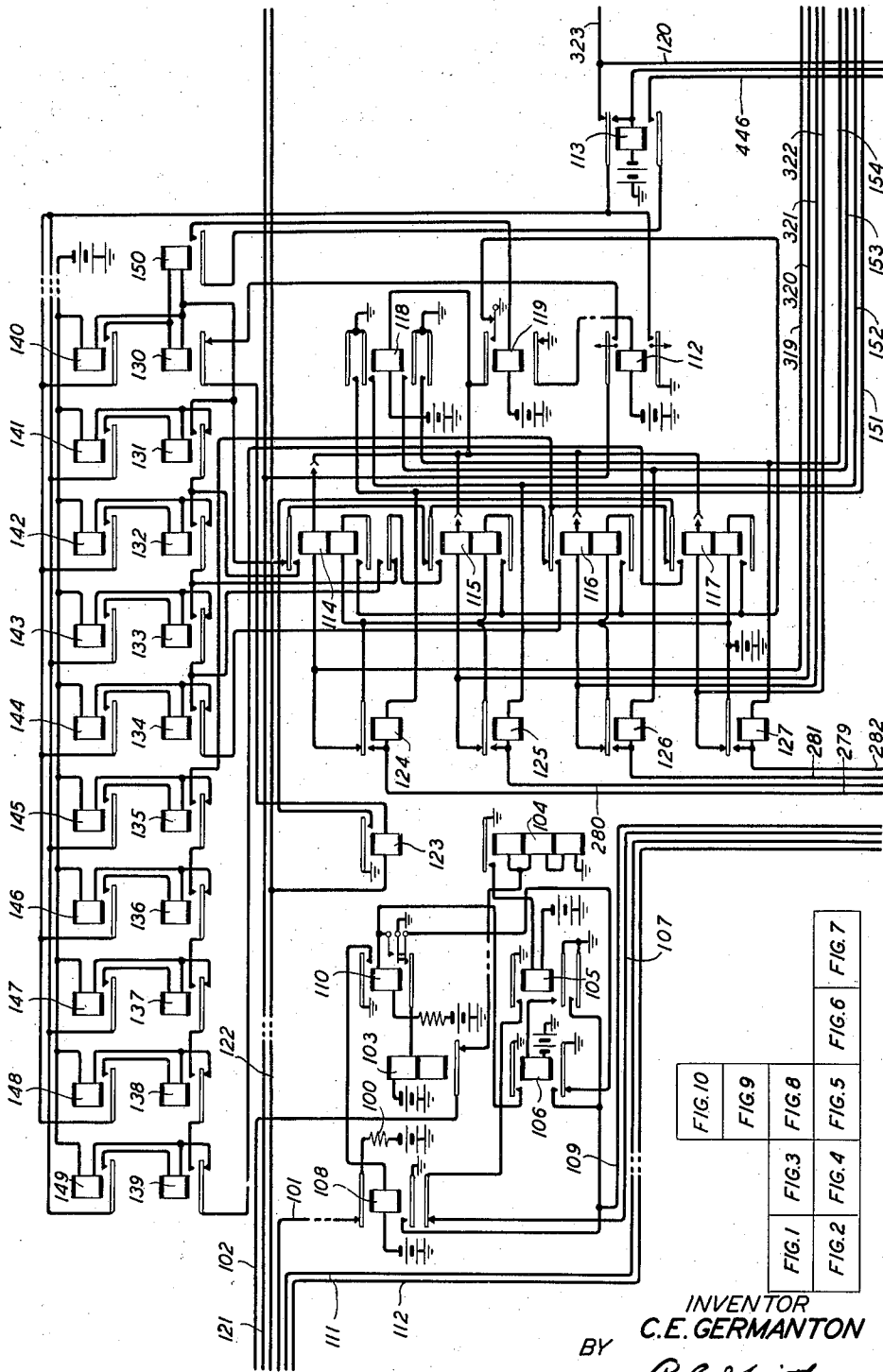


FIG. 10	FIG. 9	FIG. 8	FIG. 7
FIG. 1	FIG. 3	FIG. 5	FIG. 6
FIG. 2	FIG. 4	FIG. 5	FIG. 7

INVENTOR
C. E. GERMANTON

BY

B. C. Smith

ATTORNEY

Oct. 6, 1936.

C. E. GERMANTON

2,056,265

TELEPHONE SYSTEM

Filed Aug. 13, 1935

10 Sheets-Sheet 2

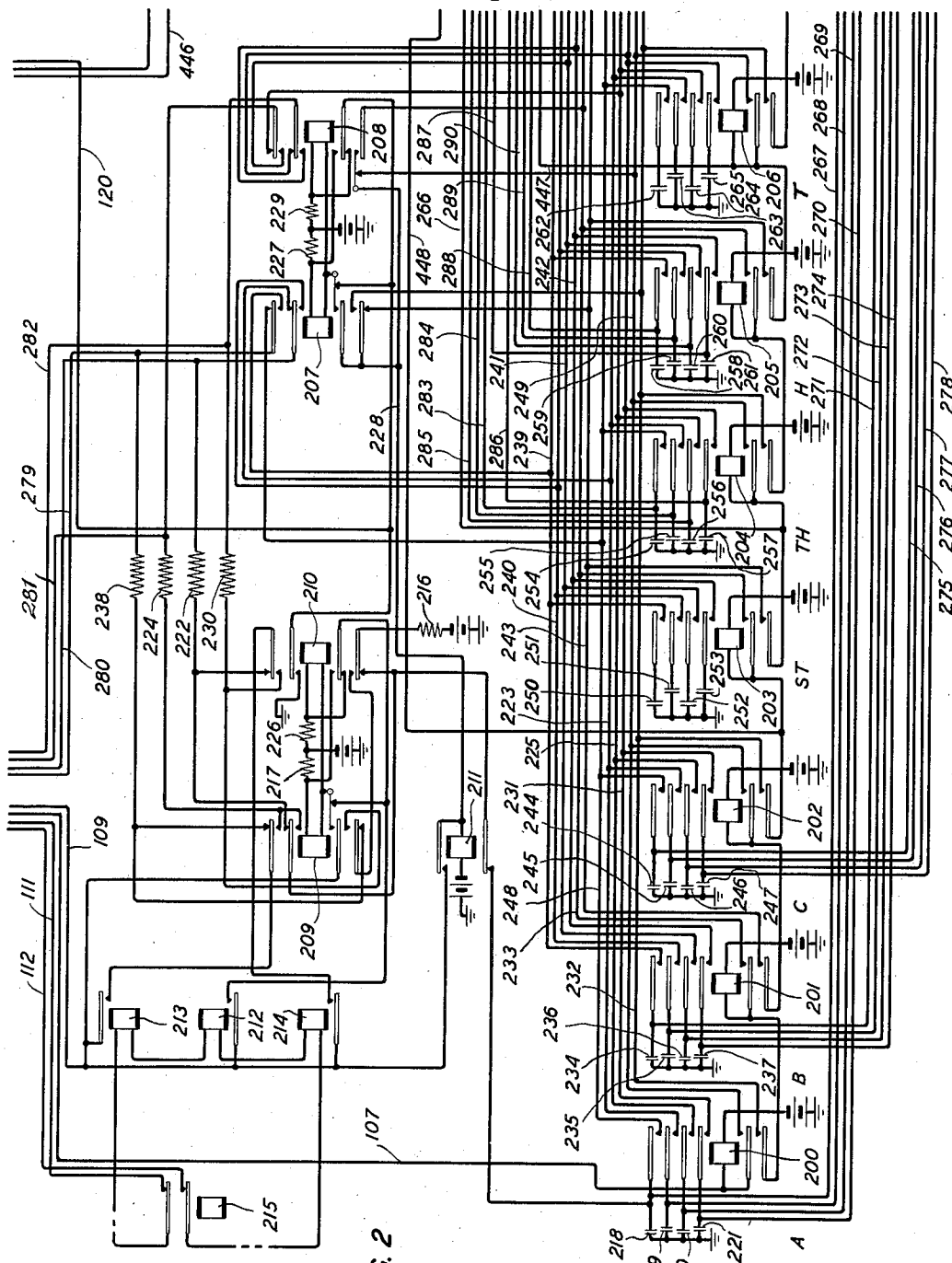


FIG. 2

INVENTOR
C. E. GERMANTON
BY
P. C. Smith
ATTORNEY

Oct. 6, 1936.

C. E. GERMANTON

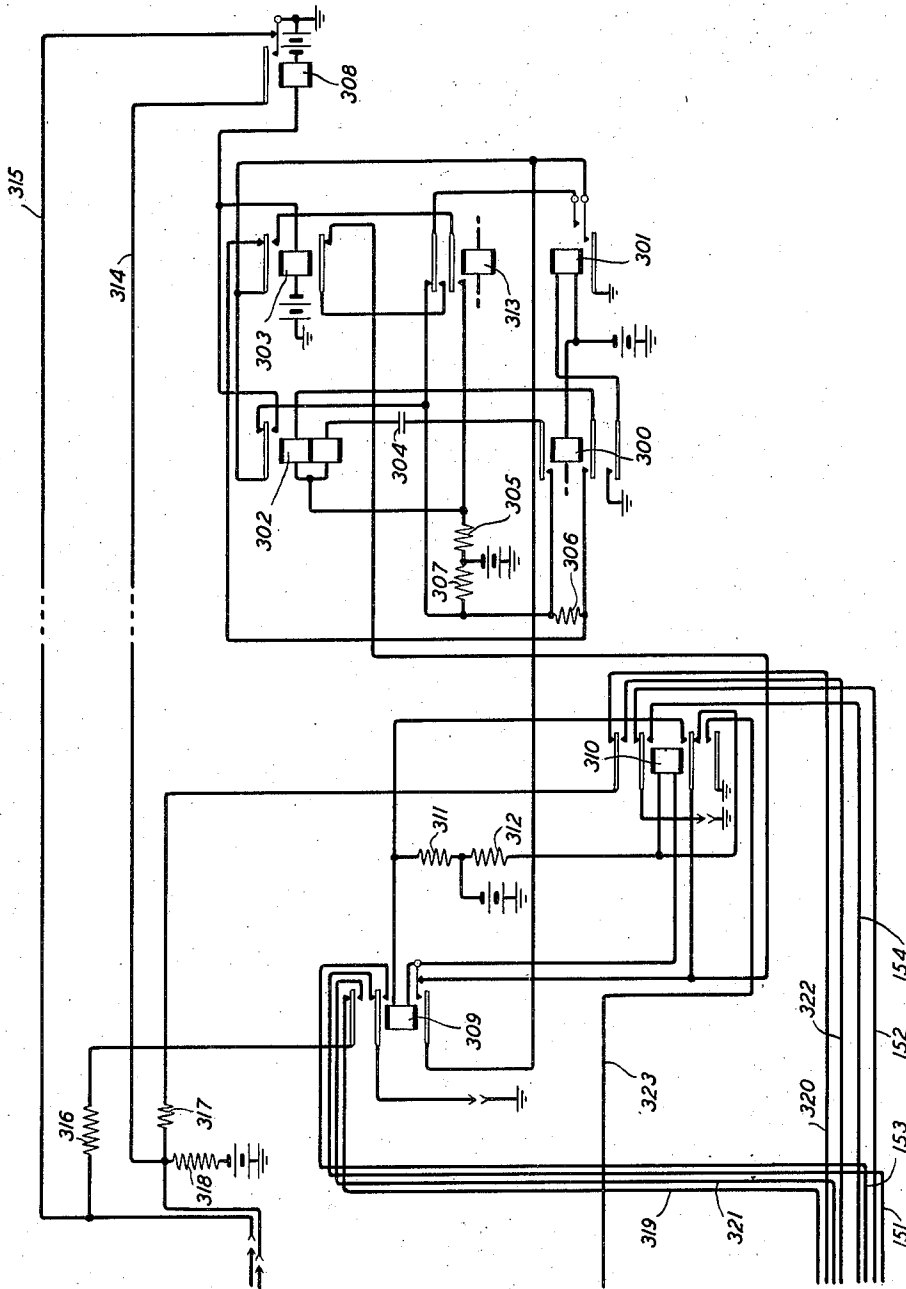
2,056,265

TELEPHONE SYSTEM

Filed Aug. 13, 1935

10 Sheets-Sheet 3

FIG. 3



INVENTOR
C. E. GERMANTON
BY *P. C. Smith*
ATTORNEY

Oct. 6, 1936.

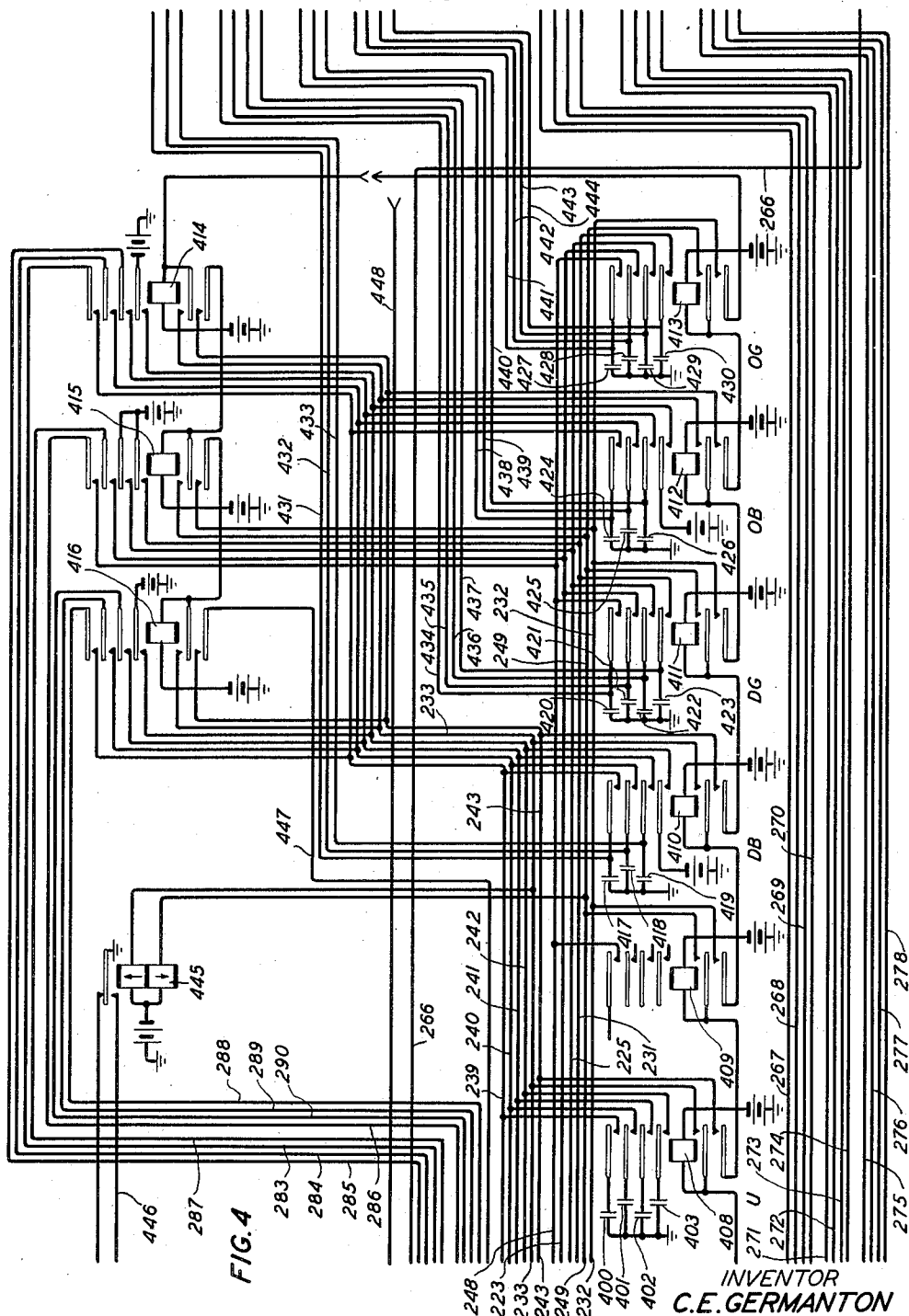
C. E. GERMANTON

2,056,265

TELEPHONE SYSTEM

Filed Aug. 13, 1935

10 Sheets-Sheet 4



INVENTOR
C. E. GERMANTON
BY
P. C. Smith

ATTORNEY

Oct. 6, 1936.

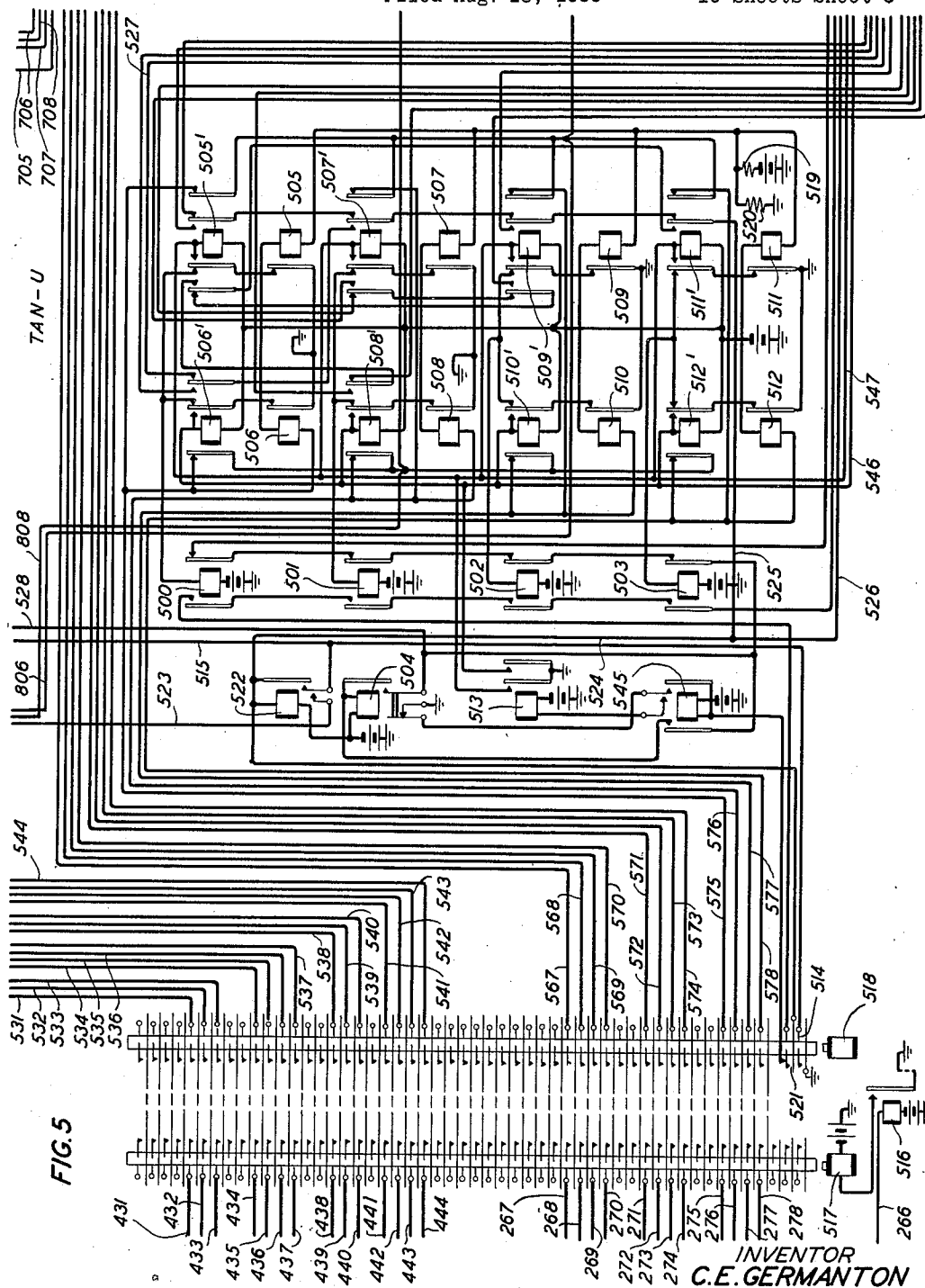
C. E. GERMANTON

2,056,265

TELEPHONE SYSTEM

Filed Aug. 13, 1935

10 Sheets-Sheet 5



Oct. 6, 1936.

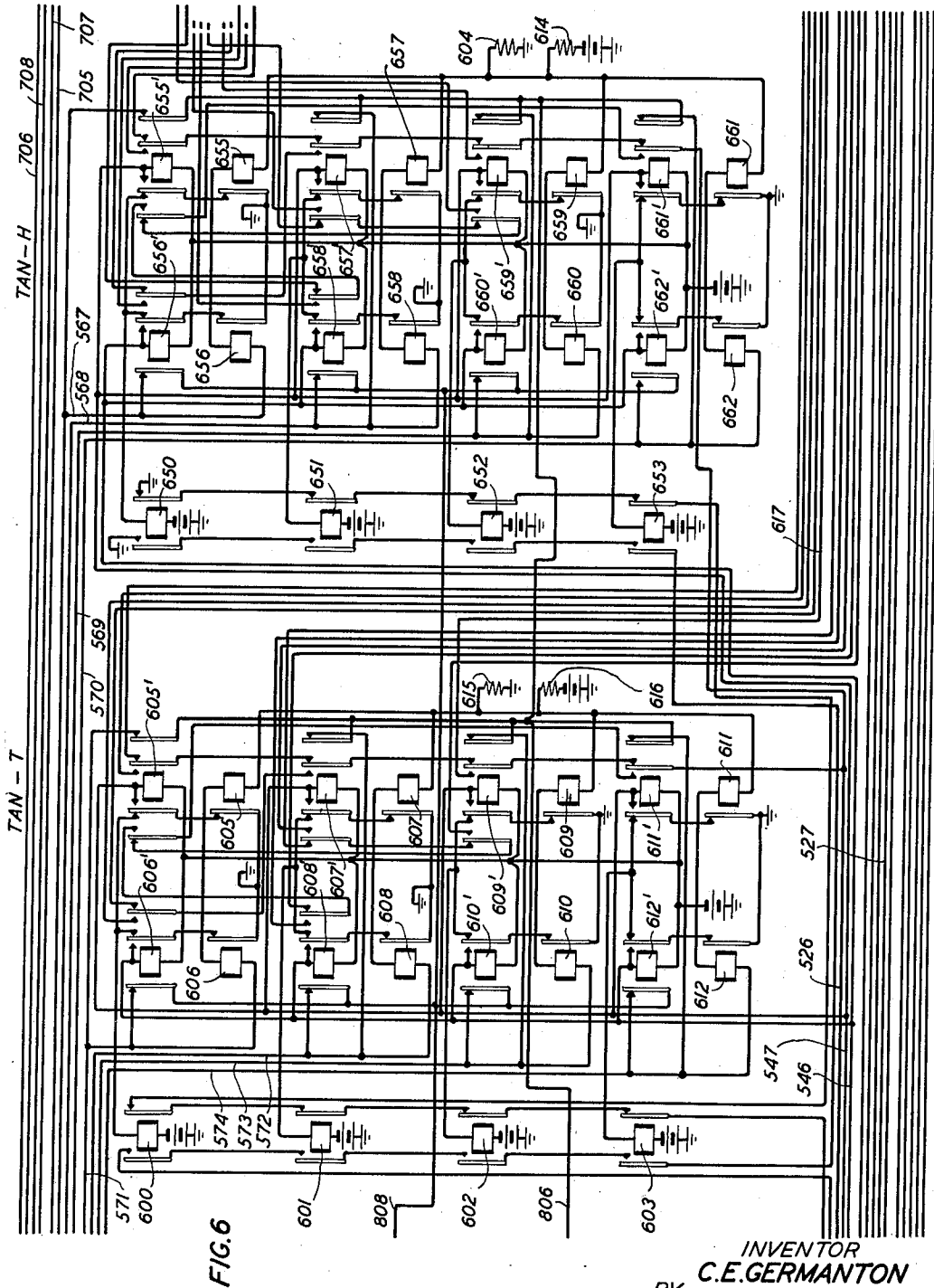
C. E. GERMANTON

2,056,265

TELEPHONE SYSTEM

Filed Aug. 13, 1935

10 Sheets-Sheet 6



INVENTOR
C. E. GERMANTON
BY
P. C. Smith

ATTORNEY

Oct. 6, 1936.

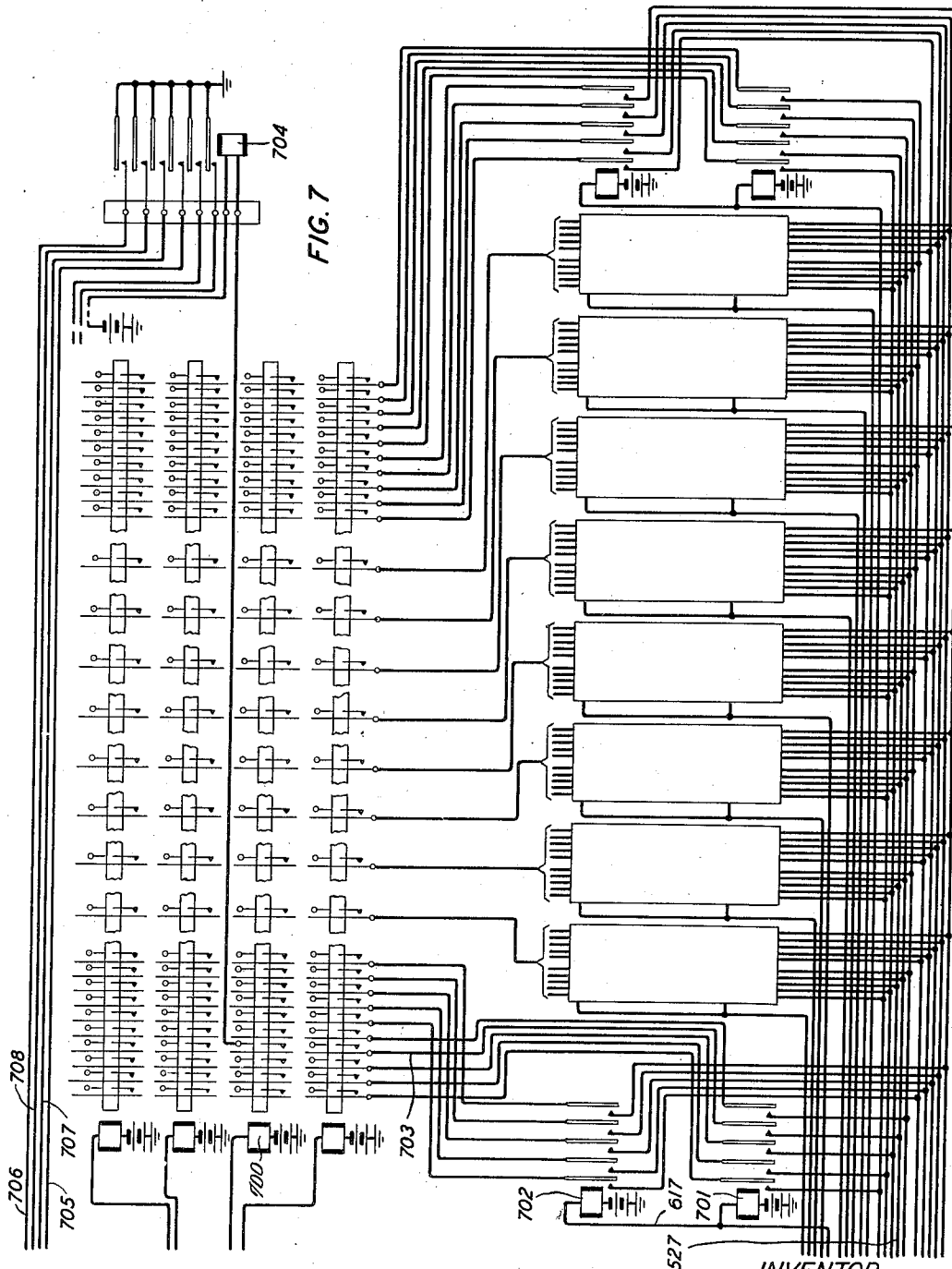
C. E. GERMANTON

2,056,265

TELEPHONE SYSTEM

Filed Aug. 13, 1935

10 Sheets-Sheet 7



INVENTOR
C. E. GERMANTON
BY *P. C. Smith*

ATTORNEY

Oct. 6, 1936.

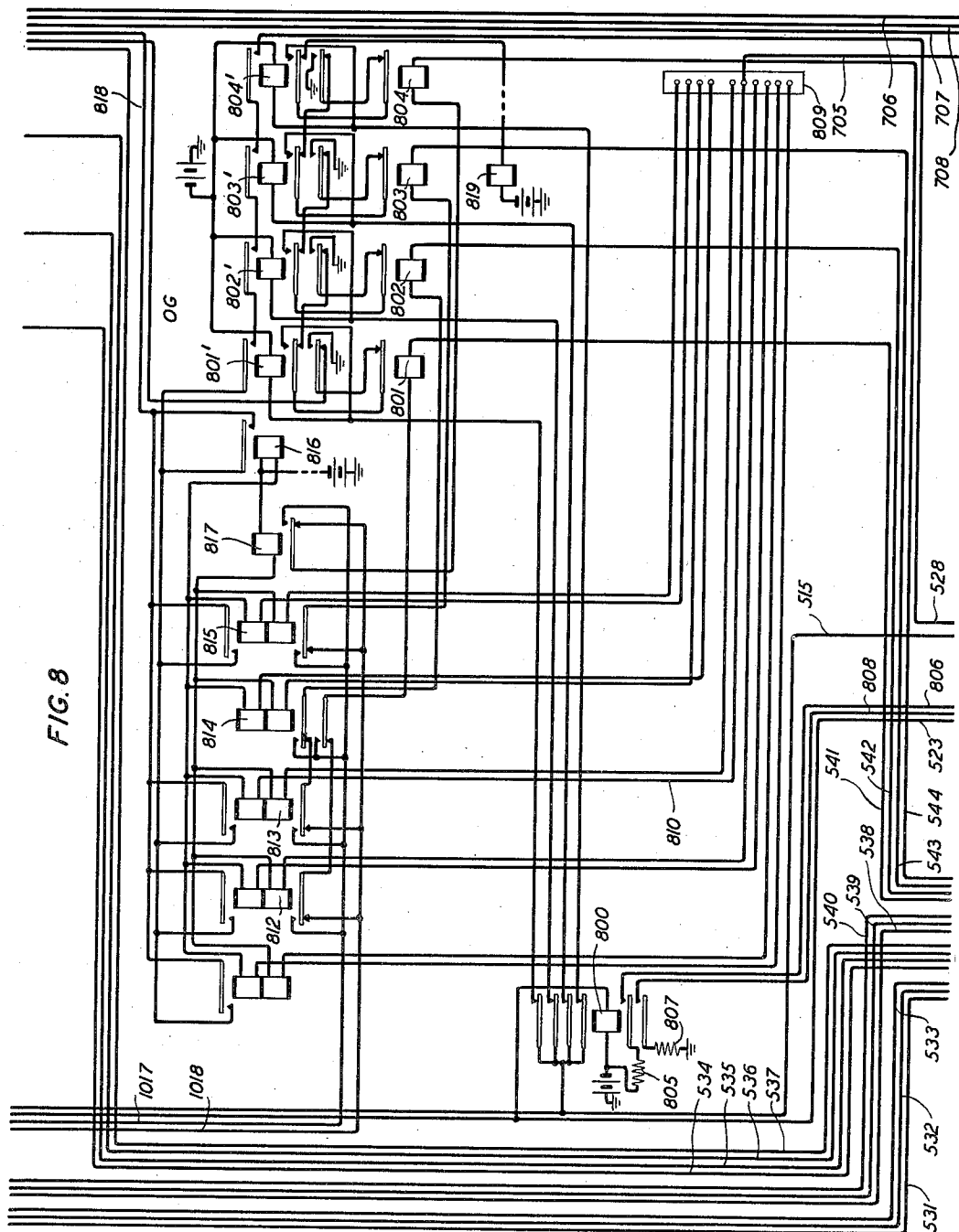
C. E. GERMANTON

2,056,265

TELEPHONE SYSTEM

Filed Aug. 13, 1935

10 Sheets-Sheet 8



INVENTOR
BY C. E. GERMANTON
P. C. Smith

ATTORNEY

2,056,265

Filed Aug. 13, 1935

10 Sheets-Sheet 9



Oct. 6, 1936.

C. E. GERMANTON

2,056,265

TELEPHONE SYSTEM

Filed Aug. 13, 1935

10 Sheets-Sheet 10

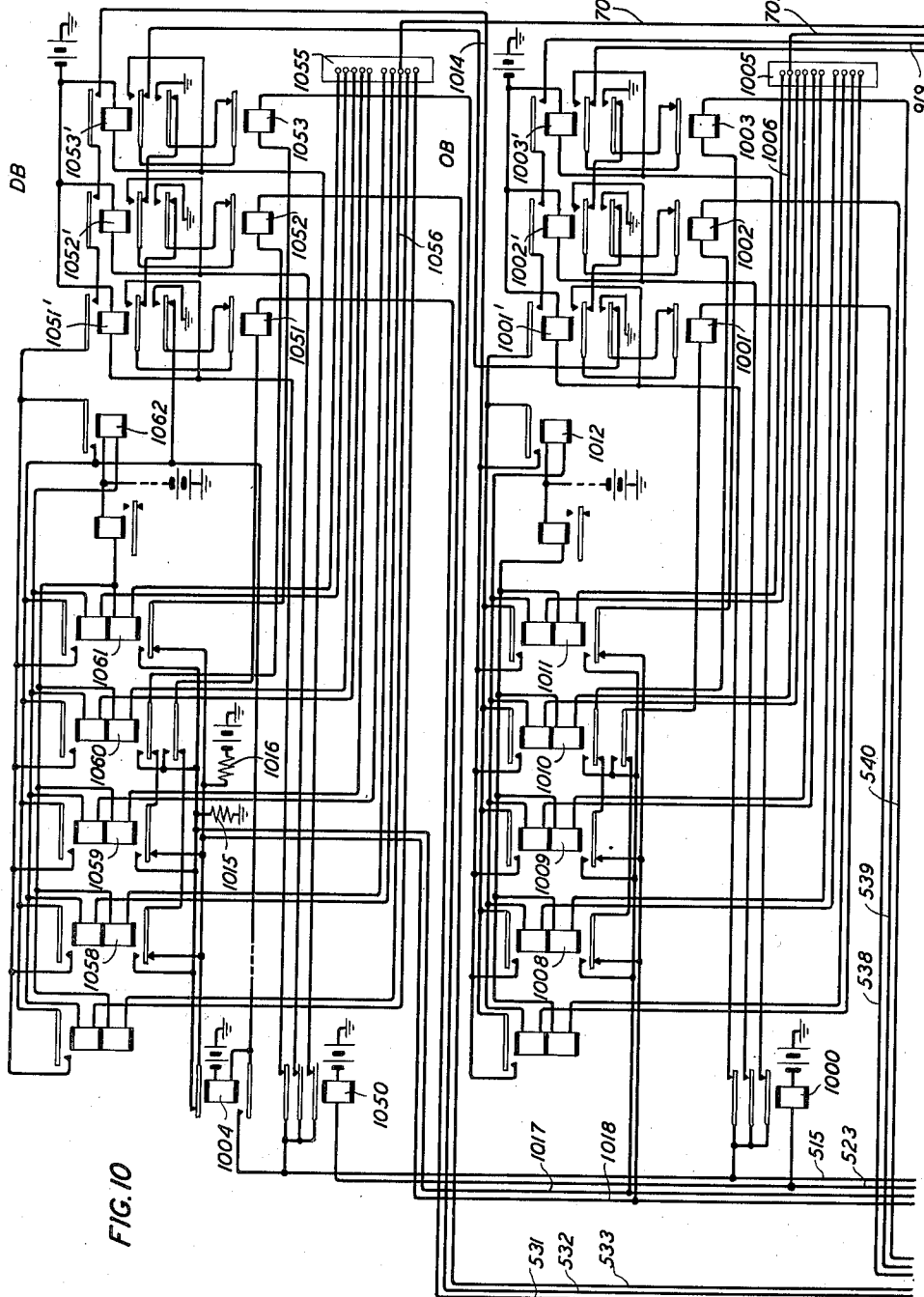


FIG. 10

INVENTOR
C. E. GERMANTON
BY
P. C. Smith

ATTORNEY

UNITED STATES PATENT OFFICE

2,056,265

TELEPHONE SYSTEM

Charles E. Germanton, Brooklyn, N. Y., assignor
to Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

Application August 13, 1935, Serial No. 35,917

17 Claims. (Cl. 179—18)

This invention relates to telephone systems and more particularly to senders in which series of impulses indicative of the designations of subscribers' lines are registered for the purpose of controlling the extension of connections to such lines.

In large multi-office exchange areas register senders are employed in the several offices for controlling the setting of automatic switches for extending connections to other offices and to subscribers' lines terminating in the originating office or in the other offices. Such senders are equipped either with step-by-step register switches responsive to dialed impulses or with registers of the relay type for recording the designations of desired connections and with mechanism responsive in accordance with the registered information for controlling the establishment of connections. In senders of the type employing registers of the relay type, each register for registering a digit of a designation comprises four or more relays and since it is usually necessary to register three digits for identifying the office in which a desired line terminates, four digits to identify the number of the line and for party lines an identifying party letter, eight registers are necessary involving at least thirty-two relays. Further, in systems employing senders of the decoder type as in the well-known panel system, each sender must have additional registers to record information for setting selector switches to extend a connection to another office of the exchange area in accordance with the translation made by the decoder of the office identifying digits registered in the sender. In the panel system four such registers are employed in the decoder sender each having at least four relays or a total of sixteen relays. Thus, a sender of this type employs at least forty-eight register relays. Typical senders of this character are disclosed in Patent No. 1,862,549 granted June 14, 1932 to R. Raymond et al., showing a local office sender and in Patent No. 1,840,132 granted January 5, 1932 to T. H. Roberts, showing a tandem office sender.

The object of the present invention is to reduce the initial cost, maintenance, current drain and required floor space of register senders by employing condensers as registers, replacing the register relays heretofore employed, whereby a considerable economy is realized.

In accordance with the present invention this object is attained in a tandem decoder sender of the type disclosed in the patent to Roberts, hereinafter referred to, in the following manner: In

the tandem sender the designations identifying a desired line are received therein as series of impulses in accordance with the well-known call indicator code characters. These impulses are received by three relays, one of which responds to impulses of either light or heavy positive potential, a second of which responds to impulses of either light or heavy negative potential and a third of which is marginal and responds only to heavy impulses of either positive or negative potential. Associated with these relays are two other relays of the well-known W and Z type which selectively place the condensers of groups of condensers functioning as receiving registers, in a charged or uncharged condition in accordance with the codes of received impulses. Each register for registering the code impulses comprises four condensers, the first of which will be charged and remain charged if the first impulse of a code is blank, but will be discharged if the first impulse is positive, the second of which will be charged and remain charged if the second impulse is light negative, but will be discharged if the second impulse is heavy negative, the third of which will be charged and remain charged if the third impulse is blank, but will be discharged if the third impulse is positive and the fourth of which will be charged and remain charged if the fourth impulse is light negative, but will be discharged if the fourth impulse is heavy negative. Eight condenser registers are provided for registering in the order of their reception the series of code impulses designating the three office code digits, the stations letter and the thousands, hundreds, tens and units numerical digits of the line designations.

In order that the condenser registers may be associated successively and in the proper order with the impulse receiving relays, a so-called "walking" or sequence circuit is provided which comprises a second pair of W and Z relays and a train of relays, one individual to each register. This sequence circuit is controlled by the first pair of W and Z relays.

As soon as the office code digits have become registered a decoder is associated with the sender in the usual manner for the purpose of translating the office code digits into the proper routing information for routing the call to an office from which the desired line may be reached. To accomplish this, it is necessary to transfer the office code registrations to registers in the decoder, make the necessary translation in the decoder and then retransmit the translated routing information to registers in the sender which may then

be effective to direct the sender in its control of selector switches to trunk the call to another office of the exchange area. In accordance with the present invention these routing or transmitting registers of the sender are also of the condenser type, four such registers being supplied for controlling district brush and group and office brush and group selections.

Thus, upon the association of a decoder with a sender receiving paths must be established from the condensers comprising the three office code registers to the receiving registers of the decoder and transmitting paths must be established from the decoder to the transmitting registers of the sender and a check made to determine if these paths are all in efficient working or operative condition. A check is first made to determine if the receiving paths are all properly established and coincidentally the office code registrations are transferred over these paths to the receiving registers of the decoder. For the purpose of making the check of each path and the transfer thereof of the registration condition of the particular register condenser of the sender associated therewith, a group of relays is provided in the decoder for each receiving path.

Each group of relays comprises two oppositely polarized relays connected to the associated receiving path through a potentiometer, one of which will operate if the register condenser in which the sender end of the path terminates, is in a charged condition and the other of which will operate if the condenser is in an uncharged condition. Thus, one or the other of these relays will operate if the path is in an operative condition and will thus afford a check on the condition of the path. Associated with these relays are two other relays whose operated or unoperated condition is controlled by the first relays and which serve as a register to register the registering condition of the condenser. These four relays function together to control a fifth relay which serves as a check relay to indicate the operative condition of the path, being operated only if the path is operative and to check for crosses with battery or ground.

Three main groups of these groups of relays are provided corresponding to the three office code registers of the sender, one main group of four groups serving to check the four receiving paths extending from the four condensers of the first office code register and to register the first code digit in the decoder, a second main group of four groups serving to check the four receiving paths extending from the four condensers of the second office code register and to register the second code digit in the decoder, and a third main group of four groups serving to check the four receiving paths extending from the four condensers of the third office code register and to register the third code digit in the decoder.

If all of the check relays of these groups are operated indicating that all receiving paths are operative and that the office code registrations have been registered in the decoder, the decoder then proceeds in the usual manner to translate the registrations by operating a route relay and by setting transmitting register relays of the decoder. The transmitting paths extending from the decoder to the condensers of the selection registers of the sender are now checked and the information registered on the selection registers of the decoder is transmitted to the selection registers of the sender. Each transmitting path was extended through one of the condensers of

the selection registers in the sender, through the winding of a check relay and to the mid-point of a potentiometer upon the association of the decoder with a sender so that each condenser of the selection registers was thus charged to an intermediate potential if the transmitting path was intact. Therefore, when the check of the transmitting path is started, the potential on all transmitting paths at the decoder is changed from the intermediate potential to either ground or increased battery potential in accordance with the operated or unoperated condition of the selection register relays of the decoder and if a transmitting path is in an operative condition the check relay therein should operate either by the discharge therethrough of the partially charged condenser connected therewith at the sender or by the further charging of such condenser therethrough. Thus, at the end of the checking operation the condensers of the selection registers of the sender will have been placed in a charged or discharged condition in accordance with the setting of the selection registers of the decoder if all transmitting paths are in an operative condition and all check relays will have operated to close a circuit for disconnecting the decoder from the sender. The sender now has registered therein all of the information required for completing the call.

The sender may now proceed to establish the desired connection. If the connection may be completed either in the tandem office or in another local office by the setting of selector switches, the sender proceeds to cause the setting of a district selector or both the district selector and an office selector in accordance with the setting of its selection registers and the setting of an incoming selector and a final selector in accordance with the setting of the thousands, hundreds, tens and units receiving registers. The usual revertive impulsing control circuit including a stepping relay and counting relays is employed for this purpose, but as the sender registers comprise condensers rather than relays, the registrations are successively transferred in the proper order to a secondary register comprising a group of four registering relays which in the usual manner control the counting relays during each selection control.

The relays of the secondary register are associated with a group of four charge detecting relays which are successively associated with a group of condenser registers by the previously mentioned sequence circuit. Upon the association of the detecting relays with each group of condensers they are selectively operated by the discharge of the charged condensers of the group therethrough and in turn selectively determine the operated or unoperated condition of the relays of the secondary register whereby the secondary register reregisters the digits or information previously registered on the condenser register at the time associated therewith. Thus, during the establishment of a full mechanical connection the secondary register assumes successively the district brush and group and office brush and group registrations registered on the selection registers and the incoming brush and group, final brush, tens and units registrations previously registered on the thousands, hundreds, tens and units receiving registers and controls revertive impulsing in accordance therewith.

If the desired connection is to be terminated in a manual office or extended through a manual tandem office, it is necessary first to control the

lowing code will be transmitted from the sender in the originating office:

5	C	2	-----	Heavy negative.	-----	Light negative
	H	4	-----	Light negative.	Positive	Do.
10		3	Positive	Heavy negative.	-----	Do.
		0	-----	Light negative.	-----	Do.
		5	-----	Heavy negative.	-----	Heavy negative.
		6	Positive	Light negative.	-----	Do.
		7	-----	Heavy negative.	-----	Do.
		8	Positive	Heavy negative.	-----	Do.

Registration of call designation

The first code impulse which, as shown above, is a heavy negative causes the operation of relays 212 and 214. Relay 212 in operating connects ground from conductor 109 over its front contact, inner lower normal contacts and winding of relay 209, resistance 217 to battery. Relay 209 operates and locks over its inner lower alternate contacts to ground on conductor 109. With relay 209 operated a charging circuit for condenser 220 is established from battery through resistance 216, lower back contact of relay 210, inner upper front contact of relay 209, resistance 224, upper back contact of relay 208, conductor 225, next-to-inner upper contact of relay 200 to ground through condenser 220. Relay 209 also closes a circuit from battery through resistance 226, winding of relay 210, inner lower alternate contacts of relay 209 to ground on conductor 109 to prepare relay 210 for operation. Relay 210 is prevented from operating at this time by ground connected over the contacts of relay 212, the inner lower back contact of relay 210 to resistance 226 in shunt of the winding of relay 210.

Relay 214 upon operating closes a circuit from ground on conductor 109 over its contact, the upper back contact of relay 210 through resistance 222, thence as traced to ground through the previously charged condenser 219 causing the condenser to immediately discharge. When the impulse terminates relays 212 and 214 release, relay 212 removing the shunt from around the winding of relay 210 which now operates. With relay 210 operated a circuit is closed from battery through resistance 227, the winding and inner lower normal contacts of relay 207 to ground at the inner upper contact of relay 210. Relay 207 operates and locks over its inner lower alternate contacts to ground on conductor 228 supplied from conductor 109 over the front contact of relay 211, and prepares an operating circuit for relay 208 extending from battery through resistance 229, winding of relay 208, inner lower alternate contacts of relay 207 to ground on conductor 228. Relay 208, however, is prevented from operating at this time by ground connected over the inner upper front contact of relay 210 and the inner lower back contact of relay 209 to resistance 229 in shunt of the winding of relay 208. Relay 207 upon operating closes an operating circuit for transfer relay 201 which may be traced from battery through the winding of relay 201, lower contact of transfer relay 200, conductor 232, lower front contact of relay 207 to ground on conductor 228. Relay 210 upon operating also closes a charging circuit for condenser 221 extending from battery through resistance 216, lower front contact of relay 210, lower front contact of relay 209, resistance 230, inner upper

back contact of relay 208, conductor 231, inner upper contact of relay 200 to ground through condenser 221.

The next impulse received is light negative and therefore relay 212 operates alone and closes a circuit from ground on conductor 109 over its contact, inner lower front contact of relay 210 to resistance 217 in shunt of the winding of relay 209 which now releases. The inner lower contact of relay 209 being of the continuity type, relay 210 does not release upon the release of relay 209, but is held operated over the inner lower normal contacts of relay 209 and the contacts of relay 212 to ground on conductor 109 until the impulse terminates. With relay 209 released and relays 210, 207 and 201 operated a charging circuit is established for condenser 234 extending from battery through resistance 216, lower front contact of relay 210, lower back contact of relay 209, resistance 238, upper front contact of relay 207, conductor 239, upper contact of transfer relay 201 to ground through condenser 234.

When relay 210 releases upon the termination of the impulse, relay 208 operates and at its lower normal contacts opens the locking circuit of transfer relay 200 which now releases. At its lower alternate contacts relay 210 establishes a locking circuit for transfer relay 201 extending from battery through the winding and inner lower contact of relay 201, conductor 233, the alternate contacts of relay 208 to ground on conductor 228. Since the lower contacts of relay 208 are of the continuity type, the locking circuit of relay 201 is closed prior to the opening of the locking circuit of relay 200 and the consequent opening of the operating circuit of relay 201. Relay 210 upon releasing also establishes a charging circuit for condenser 235 extending from battery through resistance 216, lower back contact of relay 210, inner upper back contact of relay 209, resistance 222, inner upper front contact of relay 207, conductor 240, next-to-upper contact of transfer relay 201 through condenser 235 to ground.

Prior to and during the first series of code impulses condensers 218 to 221, inclusive, 234 and 235 were successively charged and condenser 219 was discharged to register the first code letter C.

During the reception of the first impulse of the second code letter H, relay 212 is operated alone and as described, causes the operation of relay 209. Relay 209 upon operating establishes a charging circuit for condenser 236 extending from battery through resistance 216, lower back contact of relay 210, inner upper front contact of relay 209 through resistance 224, upper front contact of relay 208, conductor 241, next-to-inner contact of relay 201 to ground through condenser 236. At the end of the impulse relay 210 is also operated closing a charging circuit for condenser 237 extending from battery through resistance 216, lower front contacts of relays 210 and 209, resistance 230, inner upper front contact of relay 208, conductor 242, inner upper contact of relay 201 to ground through condenser 237. Relay 210 also connects ground over its inner upper contact, the inner lower front contact of relay 208 to resistance 227 in shunt of the winding of relay 207 which now releases. Since the inner lower contacts of relay 207 are of the continuity type, relay 208 does not release at this time, but is held operated over the inner lower normal contacts of relay 207 to ground at the inner upper contact of relay 210. Relay 207 upon releasing establishes an operating circuit for transfer relay 202 which may be traced from battery through the winding of

setting of either a district selector or both a district selector and an office selector to trunk the call to such office and to then transmit by codes of call indicator impulses information necessary to enable the operator at such office to complete or further extend the connection. To extend the connection to the distant manual office the sender functions as previously described to revertively control the setting of district and office selectors in accordance with the setting of the selection registers of the sender. For the transmission of call indicator impulses to the selected manual office the usual standard call indicator impulse generator is employed, the codes of impulses transmitted thereby being determined by the charge detecting relays which are selectively operated through their association with successive receiving registers. The same sequence circuit is employed for associating the detecting relays with successive registers.

For example, if the connection is made to a manual tandem office it is necessary to retransmit by codes of impulses the entire office code, station and numerical designations of the wanted line and thus the three office code, stations, thousands, hundreds, tens and units registers are successively associated with the detecting relays in the order named. If, however, the connection is to be made to a manual terminating office it is not necessary to retransmit the office code designation and therefore, following the selection of the office the stations, thousands, hundreds, tens and units registrations are retransmitted.

Although for the purposes of illustration the novel features of the invention have been disclosed as applied to the decoder sender of a panel type system, it will be obvious that the invention is equally applicable to systems of the step-by-step type in which directive impulses are transmitted from a sender for controlling step-by-step switches, or to systems of the cross-bar type, since in its broad aspect, the invention relates primarily to registration of incoming impulses on registers comprising condensers and to the utilization of the charged or uncharged condition of the condensers of the registers to control selective operations. It will also be evident that while the selective placing of the condensers of a register in a charged or uncharged condition has, for the purposes of illustration, been disclosed as under the control of call indicator impulse responsive means, any other well-known form of impulse responsive means could equally well be employed.

For a clearer understanding of the invention reference may be had to the following detailed description taken in connection with the accompanying drawings in which:

Figs. 1 to 4, inclusive, show as much of a tandem sender as is considered necessary to an understanding of the invention; Fig. 1 showing the counting relays, stepping relay and out-pulsing control relays; Figs. 2 and 3 showing the impulse receiving and registering equipment and Fig. 4 showing the call indicator impulser;

Figs. 5 to 10, inclusive, show as much of a decoder as is considered necessary to an understanding of the invention; Fig. 5 showing schematically a portion of the decoder connector and one of the code registers; Fig. 6 showing the remaining two code registers; Fig. 7 showing the translation equipment and one of the route relays; Fig. 8 showing the office group selection

register; Fig. 9 showing the district group selection register and Fig. 10 showing the district and office brush selection registers; and

Fig. 11 is a diagram showing the manner in which the figures should be arranged to completely disclose the invention.

It is believed that the invention will be best understood through the detailed description of the establishment of typical connections. Since, however, the invention is chiefly concerned with the sender and decoder the trunking facilities over which a call is directed to the tandem sender and over which the sender controls the further extension of connections, are not disclosed herein. For such trunking facilities reference may be had to Patent No. 1,840,132 hereinbefore referred to. It will therefore be assumed that a call is incoming to the tandem office and that a link circuit, not shown, tests for an idle sender.

An idle sender is characterized by battery through a resistance, such as resistance 100, connected to test conductor 101. Assuming that the sender shown is the first idle sender, when the sender-finder of the link tests conductor 101, the sender-finder is arrested in its hunting movement and the sequence switch of the link is advanced in the usual manner whereupon a circuit is established over conductor 102, back contact of relay 103, windings of relay 104 to ground. Relay 104 operates, in turn operating relays 105 and 106. Relay 105 establishes an operating circuit for transfer relay 200 which extends from battery through the winding of relay 200, over conductor 107, the back contact of relay 108 to ground at the upper front contact of relay 105. Relay 200 operates and extends its operating ground over its inner lower front contact, conductor 249, the lower normal contact of relay 208 to battery through the winding of relay 211. Relay 211 operates establishing a locking circuit for itself and for relay 200 over its front contact, conductor 109 to ground at the lower front contact of relay 105. Prior to the operation of relay 211, condenser 218, associated with relay 200, is charged in a circuit from battery through resistance 216, lower back contact of relay 210, back contact of relay 211 through condenser 218 to ground. As soon as relay 200 operates a charging circuit for condenser 219 is established from battery through resistance 216, lower back contact of relay 210, inner upper back contact of relay 209, resistance 222, inner upper back contact of relay 207, conductor 223, next-to-upper contact of relay 200 to ground through condenser 219.

Relay 106 upon operating causes the operation of relay 110 which locks and closes the operating circuit of relay 108. Relay 108 upon operating opens the initial operating circuit of relay 200, connects ground to conductor 109 and disconnects battery through resistance 100 from conductor 101 thereby advancing the sequence switch of the link circuit. An in-pulsing circuit is now prepared in the usual manner from the sender in the originating office through the link circuit, over conductor 111, back contact of relay 215, windings of relays 212, 213 and 214 in series, back contact of relay 215, conductor 112, through the link circuit back to the sender of the originating office.

Relay 212 is polarized to respond to negative impulses, relay 213 is polarized to respond to positive impulses and relay 214 is marginal so that it responds to heavy impulses of either positive or negative polarity. Assuming that the desired subscriber's number is Chelsea 3-5678, the fol-

relay 202, the lower front contact of relay 201, conductor 243, the lower back contact of relay 207 to ground on conductor 228.

The second impulse is positive causing the operation of relay 213 and the closure of a circuit from ground on conductor 109, contact of relay 213, upper front contact of relay 209 through resistance 224, upper front contact of relay 208, conductor 241, thence as traced through condenser 236 to ground causing this condenser to discharge. The third impulse is light negative causing the operation of relay 212 alone. Relay 212 upon operating causes the release of relay 209 which establishes a charging circuit for condenser 244 extending from battery through resistance 216, lower front contact of relay 210, lower back contact of relay 209, resistance 238, upper back contact of relay 207, conductor 248, upper contact of transfer relay 202 through condenser 244 to ground. Upon the cessation of this impulse relay 212 releases in turn releasing relay 210. With relay 210 released a charging circuit is established for condenser 245 extending from battery through resistance 216, lower back contact of relay 210, inner upper back contact of relay 209, resistance 222, inner upper back contact of relay 207, conductor 223, next-to-upper contact of relay 202 to ground through condenser 245.

Relay 210 upon releasing also opens the holding circuit of relay 208 which now releases and at its lower continuity contacts first closes a holding circuit for transfer relay 202 extending from battery through the winding and inner lower front contact of relay 202, conductor 249, lower normal contacts of relay 208 to ground on conductor 228 and then opens the previously traced holding circuit of transfer relay 201 which now releases. During the pulsing for the second code letter H, condensers 236, 237, 244 and 245 have been successively charged and condenser 236 has become discharged.

The first impulse of the third code digit 3 is positive and relay 213 therefore operates and closes a circuit for discharging the previously charged condenser 244 which may be traced from ground on conductor 109, contact of relay 213, upper back contact of relay 209, through resistance 238, upper back contact of relay 207, conductor 248, upper contact of relay 202, through condenser 244 to ground. The second impulse which is heavy negative causes the operation of relays 212 and 214 as before described. Relay 214 closes a circuit for discharging the previously charged condenser 245 which may be traced from ground on conductor 109, contact of relay 214, upper back contact of relay 210, through resistance 222, inner upper back contact of relay 207, conductor 223, the next-to-upper contact of relay 202 through condenser 245 to ground. Relay 212 upon operating causes the operation of relay 209, as previously described, and the establishment of a charging circuit for condenser 246 which may be traced from battery through resistance 216, the lower back contact of relay 210, the inner upper front contact of relay 209, resistance 224, the upper back contact of relay 208, conductor 225 the next-to-inner upper contact of relay 202, condenser 246 to ground.

Upon the cessation of the second impulse relay 212 releases and relay 210 operates in turn operating relay 207 as previously described. Relay 210 upon operating also closes a charging circuit for condenser 247 extending from battery through resistance 216, lower front contacts of relays 210 and 209, through resistance 230, inner

upper back contact of relay 208, conductor 231, inner upper contact of relay 202, condenser 247 to ground. Relay 207 upon operating opens the initial operating circuit of relay 202 and at its lower front contact closes the operating circuit of transfer relay 203 which may be traced from battery through the winding of relay 203, lower front contact of relay 202, conductor 232, lower front contact of relay 207 to ground on conductor 228.

The third impulse is light negative and therefore only relay 212 operates in turn releasing relay 209. A charging circuit is now established for condenser 250 which may be traced from battery through resistance 216, lower front contact of relay 210, lower back contact of relay 209, resistance 230, upper front contact of relay 207, conductor 239, upper contact of relay 203 to ground through condenser 250. Upon the termination of this impulse relay 210 releases followed by the operation of relay 208 as previously described. Relay 210 upon releasing closes the charging circuit for condenser 251 extending from battery through resistance 216, lower back contact of relay 210, inner upper back contact of relay 209, resistance 222, inner upper front contact of relay 207, conductor 240, next-to-upper contact of relay 203 to ground through condenser 251. Relay 208 upon operating at its lower continuity contacts first closes the locking circuit of transfer relay 203 extending from battery through the winding and inner lower contact of relay 203, conductor 233, alternate contacts of relay 208 to ground on conductor 228 and then opens the locking circuit of transfer relay 202 which now releases. Thus, during the pulsing for the third code digit 3, condensers 246, 247, 250 and 251 have been successively charged and condensers 244 and 245 have been discharged.

Assuming that the called subscriber's number includes no stations digit, the next digit received will consist of two light negative impulses which are equivalent to the digit zero. In response to the first impulse relay 212 operates in turn operating relay 209 which closes a charging circuit for condenser 252 which may be traced from battery through resistance 216, lower back contact of relay 210, inner upper front contact of relay 209, resistance 224, upper front contact of relay 208, conductor 241, next-to-inner upper contact of relay 203, through condenser 252 to ground. Upon the termination of this impulse, relay 210 operates followed by the release of relay 207. Relay 210 upon operating closes a charging circuit for condenser 253 which may be traced from battery through resistance 216, lower front contact of relay 210, lower front contact of relay 209, resistance 230, inner upper front contact of relay 208, conductor 242, inner upper contact of relay 203 through condenser 253 to ground. Relay 207 upon releasing opens the initial operating circuit of transfer relay 203 and at its lower back contact closes an operating circuit for transfer relay 204 extending from battery, winding of relay 204, lower contact of relay 203, conductor 243, lower back contact of relay 207 to ground on conductor 228.

In response to the second impulse, relay 212 again operates in turn releasing relay 209 which closes a charging path for condenser 254 extending from battery through resistance 216, lower front contact of relay 210, lower back contact of relay 209, resistance 238, upper back contact of relay 207, conductor 248, upper contact of relay 204 through condenser 254 to ground. Upon

the termination of the second impulse, relay 210 releases in turn releasing relay 208. Relay 210 upon releasing establishes a charging circuit for condenser 255 extending from battery through resistance 216, lower back contact of relay 210, inner upper back contact of relay 209, resistance 222, inner upper back contact of relay 207, conductor 223, next-to-upper contact of relay 204, through condenser 255 to ground. Relay 208 upon releasing at its continuity contacts first closes the locking circuit of transfer relay 204 extending from battery through the winding and inner lower contact of relay 204, conductor 249, alternate contacts of relay 208 to ground on conductor 228 and then opens the locking circuit of transfer relay 203 which now releases. Thus, during the transmission of impulses for the station's digit zero, condensers 252, 253, 254 and 255 were successively charged and all condensers 250 and 253, inclusive, constituting the station's register were left charged.

The remaining digits are recorded in a manner similar to that described. The thousands digit 5 is recorded on the condensers of the group including condensers 254 to 257, inclusive, by fully charging these condensers and then discharging condensers 255 and 257. The hundreds digit 6 is recorded on the condensers of the group including condensers 258 to 261, inclusive, by fully charging these condensers and then discharging condensers 258 and 261. The tens digit 7 is recorded on the condensers of the group including condensers 262 to 265, inclusive, by fully charging these condensers and then discharging condensers 263 and 265. The units digit 8 is recorded on the condensers of the group including condensers 400 to 403, inclusive, by fully charging these condensers and then discharging condensers 400, 401 and 403.

Thus, at the termination of the transmission of the units digit impulses, relays 207, 208, 209 and 210 are all deenergized and transfer relay 409 is operated, all preceding transfer relays 200 to 206, inclusive, and 408 having been released in the manner previously described. During the reception of the heavy positive pulse, relays 207 and 208 operate in succession in the manner previously described. Relay 207 upon operating closes the operating circuit for transfer relay 410 extending from ground on conductor 228, lower front contact of relay 207, conductor 232, lower front contact of relay 409, winding of relay 410 to battery. Upon the operation of relay 208 the locking circuit of relay 410 is first closed followed by the opening of the locking circuit of relay 409 which now releases. The heavy positive pulse may be employed in the usual manner to cause the operation of relay 215 to transfer the impulsing circuit from the relays 212, 213 and 214 to a holding circuit.

Transfer of office designation to the decoder

When transfer relay 204 operated during the recording of the station's digit, a circuit was also established in parallel with the winding thereof over conductor 266 to battery through the winding of decoder connector start relay 516. In the well-known manner relay 516 establishes the circuit of multi-contact relay 517 which is individual to the sender. In the well-known manner relay 518 which is individual to the decoder of Figs. 5 to 10, inclusive, is operated. The operation of relays 517 and 518 now connects the receiving and transmitting conductors of the sender to the

corresponding receiving and transmitting conductors of the decoder.

Prior to the seizure of the decoder relay 504 should be locked operated and relay 513 should be released in a manner to be hereinafter described, indicating that the prime relays 505' to 512', inclusive, of the tandem units receiving register, 605' to 612', inclusive, of the tandem tens receiving register and 655' to 662', inclusive, of the tandem hundreds receiving register are locked operated under the control of their associated polarized relays 505 to 512, inclusive, 605 to 612, inclusive, and 655 to 662, inclusive.

Upon the seizure of the decoder the receiving conductors are extended from the groups of condensers comprising the A, B and C code registers of the sender upon which the office code letters have been recorded, through the windings of the polarized relays of the receiving registers of the decoder to ground through a resistance, and also to battery through a resistance, and the transmitting conductors are extended from the groups of condensers comprising the district brush and group and office brush and group selection registers of the sender through the windings of the test relays 801 to 804, inclusive, of the office group register of the decoder, 901 to 904, inclusive, of the district group register, 1001 to 1003, inclusive, of the office brush register and 1051 to 1053, inclusive, of the district brush register.

At off-normal contact 514 ground is connected to conductor 515, thence over back contacts of relay 800 through the windings of relays 801' to 804', inclusive, of the office group register to battery, over back contacts of relay 900 through the windings of relays 901' to 904', inclusive, of the district group register to battery, over back contacts of relay 1000 through the windings of relays 1001' to 1003', inclusive, of the office brush register to battery, and over back contacts of relay 1050 through the windings of relays 1051' to 1053', inclusive, of the district brush register to battery. These relays operate and lock under the control of their associated relays. For example, relay 801' locks in a circuit from battery through its winding and inner lower front contact, back contact of relay 801 to ground at the lower front contact of relay 801'. The decoder is now conditioned to receive the office code record from the sender, to decode it and transfer the decoded information back to the sender.

It will be recalled that in recording the code letter C, condensers 218 to 221, inclusive, were all charged and then condenser 219 was discharged. With the receiving conductors extended to the decoder, condenser 218 now discharges in a circuit from ground therethrough, conductors 267 and 567, windings of polarized relays 655 and 656 in series, resistance 604 to ground causing relay 655 to momentarily operate. Relay 656 does not operate since the discharge current from condenser 218 through its winding is not in the proper direction. Condenser 219 charges in a circuit from ground therethrough, conductors 268 and 568, windings of polarized relays 657 and 658 in series, resistance 614 to battery causing relay 658 to momentarily operate. The charging current is not, however, in the proper direction to operate relay 657. Condenser 220 discharges in a circuit from ground therethrough, conductors 269 and 569, windings of polarized relays 659 and 660 in series, resistance 604 to ground causing relay 659 to momentarily operate. The discharge current is not, however, in the proper direction to operate relay 660. Condenser 221 discharges

in a circuit from ground therethrough over conductors 270 and 570, windings of polarized relays 661 and 662 in series, resistance 604 to ground causing relay 661 to momentarily operate. The discharge current is not, however, in the proper direction to operate relay 661.

If the four receiving circuits just traced are operative and relays 655, 658, 659 and 661 operate as described, the locking circuits of the associated prime relays 655', 658', 659' and 661' are opened at the back contacts of relays 655, 658, 659 and 661. Relay 655' thereupon releases and as soon as relay 655 releases, which it does as soon as the discharge current from condenser 218 through its winding ceases, closes a circuit for relay 650 extending from battery, winding of relay 650, left back contacts of relays 655' and 658' to ground. Relay 658' releases upon the operation of relay 658 and as soon as relay 658 again releases when the charging current through its winding and condenser 219 ceases, closes a circuit for relay 651 extending from battery, winding of relay 651, right back contacts of relays 658' and 658 to ground. In a similar manner relays 652 and 653 are operated upon the release of relays 659' and 659 and 661' and 661, respectively. The operation of relays 650 to 653, inclusive, is indicative that the recorded A code letter registration has been transferred to the tandem hundreds receiving register of the decoder. The operated condition of relays 656', 660' and 662' and the release of relay 658' records the tandem hundreds code letter C.

It will be recalled that in recording the B code letter H condensers 234 to 237, inclusive, were all charged and then condenser 236 was discharged. With the receiving conductors extended to the decoder, condenser 234 now discharges in a circuit from ground therethrough, conductors 271 and 571, windings of polarized relays 605 and 606 in series, resistance 615 to ground causing relay 605 to momentarily operate. Relay 606 does not operate since the discharge current from condenser 234 through its winding is not in the proper direction. Condenser 235 discharges in a circuit from ground therethrough, conductors 272 and 572, windings of polarized relays 607 and 608 in series, resistance 615 to ground causing relay 607 to momentarily operate. Relay 608 does not operate since the current through its winding is not in the proper direction. Condenser 236 charges in a circuit from ground therethrough over conductors 273 and 573, windings of polarized relays 609 and 610 in series, resistance 616 to battery causing relay 610 to momentarily operate. Relay 609 does not operate since the charging current through its winding is not in the proper direction. Condenser 237 discharges in a circuit from ground therethrough, conductors 274 and 574, windings of polarized relays 611 and 612 in series, resistance 615 to ground causing relay 611 to momentarily operate. Relay 612 does not operate since the discharge current through its winding is not in the proper direction.

If the four receiving circuits just traced are operative, relays 605, 607, 610 and 611 operate, as described, and the locking circuits of the associated prime relays 605', 607', 610' and 611' are opened at their back contacts. Relays 609 to 603 should now operate in circuits extending over back contacts of relay 605', 607', 610' and 611' and back contacts of relays 605, 607, 610 and 611 as soon as the latter relays release after their momentary operation. The operation of

relays 600 to 603, inclusive, is indicative that the recorded B code letter registration has been transferred to the tandem tens receiving register of the decoder. The operated condition of the prime relays 606', 608' and 612' and the release of relay 610' records the tandem tens code letter H.

In recording the C code digit 3, condensers 244 to 247, inclusive, were all charged and then condensers 244 and 245 were discharged. With the receiving conductors extended to the decoder, condenser 244 now charges in a circuit from ground therethrough, conductors 275 and 575, windings of polarized relays 505 and 506 in series, resistance 519 to battery causing relay 506 to momentarily operate. Relay 505 does not operate since the charging current through its winding is not in the proper direction. Condenser 245 charges in a circuit from ground therethrough over conductors 276 and 576, windings of polarized relays 507 and 508 in series, resistance 519 to battery causing relay 508 to momentarily operate. Relay 507 does not operate since the charging current through its winding is not in the proper direction. Condenser 246 discharges in a circuit from ground therethrough, conductors 277 and 577, windings of polarized relays 509 and 510 in series, resistance 520 to ground causing relay 509 to momentarily operate. Relay 510 does not operate since the discharging current from condenser 246 through its winding is not in the proper direction. Condenser 247 discharges in a circuit from ground therethrough over conductors 278 and 578, windings of polarized relays 511 and 512 in series, resistance 520 to ground causing relay 511 to momentarily operate. Relay 512 does not operate since the discharge current from condenser 247 through its winding is not in the proper direction.

If the four receiving circuits just traced are operative and relays 506, 508, 509 and 511 operate as described, the locking circuits of the associated prime relays 506', 508', 509' and 511' are opened at their back contacts. Relays 500 to 503 should now operate in circuits extending over the back contacts of relays 506', 508', 509' and 511' and back contacts of relays 506, 508, 509 and 511 as soon as these relays release after their momentary operation. The operation of relays 500 to 503, inclusive, is indicative that the recorded C code digit registration has been transferred to the tandem units receiving register of the decoder. The released condition of relays 506' and 508' and the operated condition of relays 510' and 512' records the tandem units code digit 3.

If relays 500 to 503, inclusive, 600 to 603, inclusive, and 650 to 653, inclusive, are all operated indicating that no receiving conductor was open, crossed with battery or ground, or that no condenser was broken down or leaking excessively, the locking circuit of relay 504 extending over the serially connected back contacts of these relays is opened thereby releasing relay 504. A circuit is now established from ground at the front contact of relay 650 serially through the contacts of the others of these relays, off-normal contact 521, winding of relay 522 to battery. Relay 522 operates and locks to off-normal ground on conductor 515 and extends ground from conductor 515 to conductor 524 and thence by branch 525 to the inner right armature of relay 511' and by branch 526 to the inner right armatures of relays 611' and 661'. Three circuits are now closed as determined by the operated

and unoperated condition of the prime relays of the tandem hundreds, tandem tens and tandem units registers of the decoder. The first of these circuits extends from ground on conductor 526 over the inner right back contact of relay 661', inner right back contact of relay 659', inner right front contact of relay 657', outer right front contact of relay 656', winding of relay 700 to battery operating multi-contact relay 700. A second of these circuits extends from ground on conductor 526, inner right back contact of relay 611', inner right front contact of relay 609', conductor 617, windings of relays 701 and 702 in parallel to battery. The third of these circuits extends from ground on conductor 525, inner right back contact of relay 511', inner right back contact of relay 509', inner right front contact of relay 507', outer right back contact of relay 506', conductor 527, next-to-outer contact of relay 701, conductor 703, contact of relay 700, winding of route relay 704 to battery. Route relay 704 upon operating prepares circuits for setting the selection registers shown in part in Figs. 8, 9 and 10 as will be hereinafter described.

Relay 522 upon operating also establishes a circuit from ground on conductor 515, over conductor 523, thence in parallel through the windings of relays 800, 900, 1000 and 1050 to battery. These relays now operate opening the initial operating circuits of relays 801' to 804', inclusive; 901' to 904', inclusive; 1001' to 1003', inclusive; and 1051' to 1053', inclusive. These relays, however, being locked do not release. At its front contacts relay 800 connects battery through resistance 805 to conductor 806 and ground through resistance 807 to conductor 808 for the purpose of restoring the condensers of the A, B and C code registers of the sender to the condition in which they were prior to the transference of the registrations therefrom to the receiving registers of the decoder and for the purpose of reoperating the same polarized relays of the receiving registers of the decoder as previously operated. This is done as a further check on the correct functioning of the decoder.

For reconditioning the condensers of the A code register of the sender the following circuits are established: From ground on conductor 808 over the left back contact of relay 658' through the winding of relay 658 and resistance 614 to battery and over conductor 568, thence as traced to ground through condenser 219, thus discharging this condenser and operating relay 658; from battery on conductor 806, over the outer right back contacts of relays 655', 659' and 661', through the windings of relays 655, 659 and 661 and resistance 604 to ground and over conductors 567, 569 and 570, thence as traced to ground through condensers 218, 220 and 221 thus recharging these condensers and operating relays 655, 659 and 661.

For reconditioning the condensers of the B code register of the sender the following circuits are established: From ground on conductor 898 over the left back contact of relay 610' through the winding of relay 610 and resistance 616 to battery and over conductor 573, thence as traced to ground through condenser 236 thus discharging this condenser and operating relay 610; from battery on conductor 806 over the outer right back contacts of relays 605', 607' and 611' through the windings of relays 605, 607 and 611 and resistance 615 to ground and over conductors 571, 572 and 574, thence as traced to ground through condensers 234, 235 and 237 thus re-

charging these condensers and operating relays 605, 607 and 611.

For reconditioning the condensers of the C code register of the sender the following circuits are established: From ground on conductor 808 over the left back contacts of relays 506' and 508' through the windings of relays 506 and 508 and resistance 519 to battery and over conductors 575 and 576, thence as traced to ground through condensers 244 and 245 thus discharging these condensers and operating relays 506 and 508; from battery on conductor 806 over the outer right back contacts of relays 509' and 511', through the windings of relays 509 and 511 and resistance 520 to ground and over conductors 577 and 578, thence as traced to ground through condensers 246 and 247 thus recharging these condensers and operating relays 509 and 511.

Since relays 506, 508, 509, 511, 605, 607, 610, 611, 655, 658, 659 and 661 are all operated at the same time and open the circuits over which relays 500 to 503, 600 to 603 and 650 to 653 have been held operated, these latter relays all release and establish the chain circuit from ground at the right back contact of relay 650 over the right back contacts of these relays to conductor 528, which circuit is completed through the winding of relay 1004 if the selection registers of Figs. 8 to 10, inclusive, have already functioned.

It will be recalled that as a result of the transference of the office code registration to the receiving registers of the decoder, the route relay 704 was operated. It will be assumed that the operation of this relay is indicative that the call should be routed to a full mechanical office over a district and an office selector and that therefore the following circuits are established by relay 704 for relays of the selection registers of the decoder: (1) from ground over conductor 705, distributing frame 809, conductor 810, upper winding of office group register relay 813, winding of relay 816 to battery. Relays 813 and 816 both operate; (2) from ground over conductor 706, distributing frame 905, conductor 906, lower winding of district group register relay 910, winding of relay 917 to battery. Relays 910 and 917 both operate; (3) from ground over conductor 707, distributing frame 1005, conductor 1006, upper winding of office brush register relay 1011, winding of relay 1012 to battery. Relays 1011 and 1012 both operate; (4) from ground over conductor 708, distributing frame 1055, conductor 1056, upper winding of district brush register relay 1058, winding of relay 1062 to battery. Relays 1058 and 1062 both operate. Relay 706 would also establish circuits for the relays of the usual class and compensating resistance registers. As these registers function in the usual manner they have been omitted from the present disclosure.

Setting selection registers of the sender

As soon as the selection registers receive their settings from the route relay 704, if at that time ground has been connected to conductor 528 as previously described, a circuit is established from this conductor, upper front contacts of relays 801' to 804', inclusive, upper contacts of relay 813, conductor 818, upper front contacts of relays 901' to 904', inclusive, upper front contact of relay 910, conductor 919, upper front contacts of relays 1001' to 1003', inclusive, upper contacts of relay 1011, conductor 1014, upper front contacts of relays 1051' to 1053', inclusive, upper contacts of relay 1058, thence in a chain circuit through contacts of relays of the compensating resistance

and class registers, not shown, to battery through the winding of relay 1004. Relay 1004 operates and locks over its lower front contact to ground on conductor 515 and at its upper contact opens a potentiometer circuit including resistances 1015 and 1016, thus changing the potential on all of the transmitting conductors extending from the decoder to the condensers of the selection control registers of the sender from an intermediate potential, which was applied thereto immediately upon the connection of the decoder with the sender, to either battery or ground potential dependent upon the operated or non-operated condition of the selection register relays. Thus, for example, immediately following the seizure of the decoder, intermediate potential was applied from the midpoint of the potentiometer (grounded battery through resistance 1016, back contact of relay 1004, resistance 1015 to ground), back contact of relay 1058, lower back contact of relay 1060, winding of relay 1051, conductors 531 and 431 through condenser 417 to ground thus charging condenser 417 to the intermediate potential. In a similar manner the remaining condensers 418 to 430, inclusive, of the selection control registers are charged to the intermediate potential.

When relay 1004 operates as previously described with relay 1058 of the district brush register operated and the other relays 1059, 1060 and 1061 of this register unoperated, the following circuit conditions over the transmitting conductors extending from the district brush register of the decoder to the district brush register of the sender are effective: From ground through resistance 1015, front contact of relay 1058, lower back contact of relay 1060, winding of relay 1051, conductors 531 and 431 through condenser 417 to ground resulting in the discharge of condenser 417 and the momentary operation of relay 1051; from battery through resistance 1016, back contact of relay 1059, inner lower back contact of relay 1060, winding of relay 1052, conductors 532 and 432 through condenser 418 to ground resulting in the further charging of condenser 418 and the momentary operation of relay 1052; from battery through resistance 1016, back contact of relay 1061, winding of relay 1053, conductors 533 and 433 through condenser 419 to ground resulting in the further charging of condenser 419 and the momentary operation of relay 1053. The momentary operation of relays 1051, 1052 and 1053 releases relays 1051', 1052' and 1053', respectively. The district brush registration has now been recorded in the sender by the discharged condition of condenser 417 and the charged condition of condensers 418 and 419.

It will be recalled that relay 910 of the district group register was operated and that the other register relays of this register were unoperated. Following the operation of relay 1004 the following circuit conditions over the transmitting conductors extending from the district group register of the decoder to the district group register of the sender are effective: From ground through resistance 1015 over conductor 1017, lower front contact of relay 910, lower back contact of relay 913, back contact of relay 915, winding of relay 901, conductors 534 and 434 through condenser 420 to ground resulting in the discharge of condenser 420 and the momentary operation of relay 901; from ground through resistance 1015 over conductor 1017, inner lower front contact of relay 910, lower back contact of relay 914, inner lower back contact of relay 920, winding of relay 902, conductors 535 and 435

through condenser 421 to ground resulting in the discharge of condenser 421 and the momentary operation of relay 902; from battery through resistance 1016 over conductor 1018, back contact of relay 911, lower back contact of relay 916, winding of relay 903, conductors 536 and 436 through condenser 422 to ground resulting in the further charging of condenser 422 and the momentary operation of relay 903; from battery through resistance 1016 over conductor 1018, back contact of relay 912, inner lower back contacts of relays 913 and 914, lower back contact of relay 923, inner lower back contact of relay 916, winding of relay 904, conductors 537 and 437, condenser 423 to ground resulting in the further charging of condenser 423 and the momentary operation of relay 904. The momentary operation of relays 901 to 904, inclusive, releases relays 901' to 904', inclusive. The district group registration has now been recorded in the sender by the discharged condition of condensers 420 and 421 and the charged condition of condensers 422 and 423.

Since relay 1011 of the office brush register was operated and the remaining register relays of the register are unoperated the following circuit conditions over the transmitting conductors extending from the office brush register of the decoder to the office brush register of the sender are effective following the operation of relay 1004: From battery through resistance 1016 over conductor 1018, back contact of relay 1008, lower back contact of relay 1010, winding of relay 1001, conductors 538 and 438 through condenser 424 to ground resulting in the further charging of condenser 424 and the momentary operation of relay 1001; from battery through resistance 1016, over conductor 1018, back contact of relay 1009, inner lower back contact of relay 1010, winding of relay 1002, conductors 539 and 439 through condenser 425 to ground resulting in the further charging of condenser 425 and the momentary operation of relay 1002; from ground through resistance 1015 over conductor 1017, lower front contact of relay 1011, winding of relay 1003, conductors 540 and 440 through condenser 426 to ground resulting in the discharge of condenser 426 and the momentary operation of relay 1003. The operation of relays 1001 to 1003, inclusive, releases relays 1001' to 1003', inclusive. The office brush registration has now been recorded in the sender by the charged condition of condensers 424 and 425 and the discharged condition of condenser 426.

Since relay 813 of the office group register was operated and the remaining register relays of this register are unoperated, the following circuit conditions over the transmitting conductors extending from the office group register of the decoder to the office group register of the sender are effective following the operation of relay 1004: From battery through resistance 1016 over conductor 1018, back contact of relay 812, lower back contact of relay 814, winding of relay 801, conductors 541 and 441 through condenser 427 to ground resulting in the further charging of condenser 427 and the momentary operation of relay 801; from ground through resistance 1015 over conductor 1017, lower front contact of relay 813, inner lower back contact of relay 814, winding of relay 802, conductors 542 and 442 through condenser 428 to ground resulting in the discharge of condenser 428 and the momentary operation of relay 802; from battery through resistance 1016 over conductor 1018, back contact of relay

815, winding of relay 803, conductors 543 and 443 through condenser 429 to ground resulting in the further charging of condenser 429 and the momentary operation of relay 803; from battery through resistance 1016 over conductor 1018, back contact of relay 817, winding of relay 804, conductors 544 and 444 through condenser 430 resulting in the further charging of condenser 430 and the momentary operation of relay 804. The operation of relays 801 to 804, inclusive, releases relays 801' to 804', inclusive. The office group registration has now been recorded in the sender by the discharged condition of condenser 428 and the charged condition of condensers 427, 429 and 430.

When all of the relays 801' to 804', inclusive, 901' to 904', inclusive, 1001' to 1003', inclusive, and 1051' to 1053', inclusive, have been released, a circuit is closed from ground on conductor 515, front contact of relay 1004, lower back contact of relay 1051', back contact of relay 1051', inner lower back contact of relay 1051', and in a similar manner over back contacts of the other transmitting relays and finally to battery through the winding of decoder disconnect relay 819. Had there been an open, cross with battery or ground, breakdown or excessive leakage on a condenser, the circuit of relay 819 would not have been effective and a trouble release alarm signal would be sent in the usual manner. When relay 819 operates causing the release of the decoder connector, all of the transmitting and receiving conductors are opened and relays 522, 800, 900, 1000, 1004 and 1050 release. When relay 800 releases and removes battery and ground from conductors 806 and 808 the polarized relays, which operated as previously described during the reconditioning of the code registers of the sender, are released causing the operation of all relays 500 to 503, inclusive, 600 to 603, inclusive, and 650 to 653, inclusive. For example, upon the release of polarized relay 506, relay 500 operates in a circuit from battery through its winding, inner right back contact of relay 506' and the back contact of relay 506 to ground. With these relays all operated a chain circuit is closed from ground over their front contacts, the normally closed contacts of contact set 521, winding of relay 545 to battery. Relay 545 operates and locks over its outer front contact to ground at the normal contacts of relay 504 and extends its own operating ground through the winding of relay 513 which also operates. Relay 513 upon operating connects ground to conductors 546 and 547 causing the operation of all of the prime relays of the receiving registers of the decoder, these relays locking under the control of their associated polarized relays. For example, relay 505' locks in a circuit from battery through its winding and inner left front contact, back contact of relay 505 to ground. With the prime relays all operated, relays 500 to 503, inclusive, 600 to 603, inclusive, and 650 to 653, inclusive, release closing a chain circuit from ground over their back contacts, left front contact of relay 545, winding of relay 504 to battery. Relay 504 upon operating first locks over its front contact to ground supplied over this chain circuit and then opens the locking circuit of relay 545 which now releases in turn releasing relay 513. The remaining operated apparatus of the decoder is released in the usual manner and the decoder is now in condition for serving the next call.

Establishment of full mechanical call

It will be assumed that with the complete in-

formation for controlling the establishment of the connection now registered in the sender, relay 119 is operated and then released. Upon operating it closes the circuit of relay 118 and, since it will be assumed that the registered information concerns a full mechanical connection, operating circuits are also closed through the upper winding of selection control relay 114, the upper back contact of relay 124 to battery. Similar circuits are closed for the selection control relays 115, 116 and 117. These relays will operate, relay 118 preparing operating circuits for relays 124 to 127, inclusive. With the transfer relay 410 operated, as previously described, the following circuits are now effective: (1) From ground through condenser 417, the upper contact of relay 410, conductor 239, upper front contact of relay 207, conductor 279, winding of relay 124 to ground at the upper contact of relay 118, but without effect as condenser 417 is uncharged; (2) from ground through condenser 418, next-to-upper contact of relay 410, conductor 240, inner upper front contact of relay 207, conductor 280, winding of relay 125 to ground at the upper inner contact of relay 118. Since condenser 418 is in a charged condition it will now discharge operating relay 125 which locks to battery over its front contact and at its back contact opens the operating circuit of relay 115 which releases; (3) from ground through condenser 419, next-to-inner upper contact of relay 410, conductor 241, upper front contact of relay 208, conductor 281, winding of relay 126 to ground at the inner lower front contact of relay 118. Since condenser 419 is in a charged condition, it will now discharge operating relay 126 which locks to battery over its front contact and at its back contact opens the operating circuit of relay 116 which releases; (4) from battery over the inner upper contact of relay 410, conductor 242, inner upper front contact of relay 208, conductor 282, winding of relay 127 to ground at the lower contact of relay 118. Relay 127 operates, locks over its front contact and at its back contact opens the circuit of relay 117 which now releases.

As soon as relay 119 releases, locking circuits are first established for all operated relays 114 to 117, inclusive, and then the initial operating circuits of these relays and relay 118 are opened. Relay 118 releases followed by the release of any operated relays 124 to 127, inclusive. As the result of these operations relay 114 remains operated upon the release of relay 119 and the remaining selection control relays are unoperated. The release of relay 119 establishes the operating circuit of relay 112 which supplies locking ground to the counting relays and closes the fundamental circuit which may be traced in part from conductor 121 over the upper contact of relay 112, lower back contact of counting relay 130, winding of stepping relay 123, conductor 122 thence through the winding of the control relay of the district selector (not shown). The control relay of the district selector and the stepping relay of the sender both operate over this circuit.

The control relay of the district selector starts the brush selection movement of the selector switch shaft in the well-known manner, and relay 123 establishes a circuit from ground, upper back contacts of selection control relays 117, 116 and 115, upper front contact of relay 114, lower back contact of counting relay 131, winding of relay 141 to battery. Relay 141 operates and locks in series with relay 131, over the front contact of relay 141 to ground at the front contact

of relay 112, but relay 131 does not operate in this locking circuit. As the selector switch advances, the stepping relay 123 is intermittently shunted down and upon its first release, removes the shunt from the operating circuit of relay 131 which operates. On the next operation of relay 123, relay 140 operates, locking in a circuit through the windings of relays 130 and 150 and its own front contact. On the next shunting down of relay 123, relays 130 and 150 operate, relay 130 opening the fundamental circuit to arrest further advance of the district selector shaft in its brush selection movement. The selector switch has now been set to trip its No. 1 brush set.

At the time relay 112 operated it closed a circuit from ground over the upper back contact of relay 113, conductor 120, inner lower front contact of relay 208 to a point between resistance 227 and the winding of relay 207 thereby shunting down relay 207 which releases and establishes a circuit from ground on conductor 228 over its lower back contact, conductor 243, lower front contact of relay 410 to battery through the winding of transfer relay 411. With relay 208 still operated a circuit is closed from ground on conductor 228, lower alternate contacts of relay 208, conductor 233, upper winding of differential relay 445 to battery. A second circuit is closed upon the release of relay 207 and the operation of transfer relay 411 from ground on conductor 228, lower back contact of relay 207, conductor 243, lower front contact of relay 410, inner lower front contact of relay 411, conductor 249, lower winding of relay 445 to battery. Since both windings of relay 445 are now energized, this relay releases and establishes the operating circuit for relay 113 which locks over its upper front contact to ground at the lower contact of relay 112 and at its upper back contact opens the locking circuit of relay 208. Relay 208 upon releasing first establishes a locking circuit for transfer relay 411 extending from ground over the lower alternate contacts of relay 208, conductor 249, inner lower front contact and winding of relay 411 to battery and then opens the locking circuit of transfer relay 410. Relay 410 now releases.

When relay 208 releases the previously traced circuit through the upper winding of relay 445 is opened and a new circuit is established from ground on conductor 228, lower normal contacts of relay 208, conductor 249, lower winding of relay 445 to battery. Relay 445 now operates and with relay 113 operated establishes a circuit from ground at its front contact, conductor 446, lower contact of relay 113, contact of counting relay 150, winding of relay 119 to battery. Relay 119 upon operating releases the operated selection control relay 114, causes the operation of all of the selective control relays 114 to 117, inclusive, and the operation of relay 118.

With relay 118 operated, four circuits are closed as follows: (1) From ground through condenser 420, upper contact of relay 411, conductor 248, upper back contact of relay 207, conductor 219, winding of relay 124 to ground, but without effect as condenser 420 is uncharged; (2) from ground through condenser 421, next-to-upper contact of relay 411, conductor 223, inner upper back contact of relay 207, conductor 280, winding of relay 125 to ground, but without effect as condenser 421 is uncharged; (3) from ground through condenser 422, next-to-inner upper contact of relay 411, conductor 225, upper back contact of relay 208, conductor 281, winding of relay 126 to ground thus discharging

condenser 422 and operating relay 126 which locks and releases relay 116; (4) from ground through condenser 423, inner upper contact of relay 411, conductor 231, inner upper back contact of relay 208, conductor 282, winding of relay 127 to ground thus discharging condenser 422 and operating relay 127 which locks and releases relay 117.

Relay 119 upon operating also releases relay 112 which after an interval, as determined by its slow-releasing characteristic, opens the locking circuit of relay 113, the locking circuits of the operated counting relays and opens the fundamental circuit. Upon the release of counting relay 150 and relay 113, relay 119 releases, first closing locking circuits for the operated selection control relays 114 and 115 and then opening the operating circuits of all of the selection control relays and of relay 118. Upon the release of relay 118 the operated relays 126 and 127 release. Relay 119 upon releasing also reoperates relay 112 which prepares the locking circuits of the counting relays and recloses the fundamental circuit preparatory to controlling the group selection movement of the district selector. Upon the closure of the fundamental circuit stepping relay 123 operates, and since selection control relays 114 and 115 are operated, closes a circuit from ground over its contact, the upper back contacts of relays 117 and 118, the upper front contact of relay 115, the lower front contact of relay 114, the lower back contact of counting relay 133, winding of relay 143 to battery. In the well-known manner counting relays 133, 142, 132, 141, 131, 140, 130 and 150 operate in succession during the group selection movement of the district selector. The second brush set of the district selector has now been tripped and positioned on the lowermost set of terminals of the fourth group of the No. 1 brush group from which position it is advanced in a trunk hunting movement.

Relay 112 upon operating also establishes a circuit from ground at its lower contact, upper back contact of relay 113, conductor 120, inner lower normal contacts and winding of relay 207, resistance 227 to battery. Relay 207 operates and locks over its inner lower alternate contacts to ground on conductor 228, prepares the operating circuit of relay 208, opens the initial operating circuit of transfer relay 411 and at its lower front contact establishes the operating circuit of transfer relay 412 extending from ground on conductor 228, lower front contact of relay 207, conductor 232, lower front contact of relay 411, winding of transfer relay 412 to battery. With relay 207 and both transfer relays 410 and 411 operated, a circuit is established from ground on conductor 228, lower front contact of relay 207, conductor 232, lower front contact of relay 411, inner lower front contact of relay 412, conductor 233, upper winding of relay 445 to battery and, since the circuit through the lower winding of this relay over the lower normal contacts of relay 208 is still effective, relay 445 releases causing the operation of relay 113 which locks under the control of relay 112 and at its upper back contact removes ground from conductor 120 thus permitting the operation of relay 208. Relay 208 upon operating first establishes a locking circuit for transfer relay 412, extending from ground on conductor 228, lower alternate contacts of relay 208, conductor 233, inner lower front contact and winding of relay 412 to battery and in parallel from conductor 233 through the upper winding of relay 445 to battery, and then opens the previously traced

locking circuit of relay 411 which then releases and the previously traced circuit through the lower winding of relay 445. Relay 445 now operates.

5 With relay 113 operated, relay 445 now closes the previously traced circuit for relay 119 which operates opening the locking circuits of the selection control relays 114 and 115, causing the operation of all of the selection control relays 114 to 117, inclusive, and the operation of relay 118. 10 Relay 118 upon operating closes four circuits as follows: (1) From ground through condenser 424, upper contact of relay 412, conductor 239, upper front contact of relay 207, conductor 279, 15 winding of relay 124 to ground thus discharging condenser 424 and operating relay 124 which locks and releases relay 114; (2) from ground through condenser 425, next-to-upper contact of relay 412, conductor 240, next-to-upper front contact 20 of relay 207, conductor 280, winding of relay 125 to ground thus discharging condenser 425 and operating relay 125 which locks and releases relay 115; (3) from ground through condenser 426, next-to-inner upper contact of relay 412, conductor 241, upper front contact of relay 208, conductor 281, winding of relay 126 to ground but without effect as condenser 426 is uncharged; (4) from battery, inner upper contact of relay 412, conductor 242, inner upper front contact of 30 relay 208, conductor 282, winding of relay 127 to ground operating relay 127 which locks and releases relay 117. Selection control relay 116 is now operated and the remaining selection control relays 114, 115 and 117 are released.

35 Relay 119 upon operating also releases relay 112 which after an interval opens the locking circuit of relay 113, the locking circuits of the operated counting relays and opens the fundamental circuit. Upon the release of counting relay 150 and relay 113, relay 119 releases first closing the locking circuit of selection control relay 116 and then opening the operating circuits of all of the selection control relays and of relay 118. Upon the release of relay 118 the operated 40 relays 124, 125 and 127 release. Relay 119 upon releasing also reoperates relay 112 which prepares the locking circuits of the counting relays and recloses the fundamental circuit preparatory to controlling the brush selection movement of the office selector. Upon the closure of the fundamental circuit stepping relay 123 operates and since selection control relay 116 only is operated, closes a circuit from ground over its contact, the upper back contact of relay 117, the upper front 45 contact of relay 116, the lower back contact of counting relay 134, winding of counting relay 144 to battery. In the well-known manner the counting relays are operated in succession during the brush selection movement of the office selector until relays 130 and 150 operate at which 50 time the office selector will have been positioned preparatory to tripping the fifth of its brush sets.

Relay 112 upon operating also establishes a circuit from ground over its lower contact, upper back contact of relay 113, conductor 120, inner lower front contact of relay 208 to resistance 227 thus causing the release of relay 207. Relay 208 is now locked over the inner lower normal contacts of relay 207 to ground on conductor 120. 70 Relay 207 upon releasing closes the operating circuit of transfer relay 413 from ground on conductor 228 over the lower back contact of relay 207, conductor 243, lower front contact of relay 412, winding of relay 413 to battery. Relay 413 75 upon operating extends its operating ground over

its inner lower front contact to battery through the lower winding of relay 445 which now differentially releases and causes the operation and locking of relay 113. Relay 113 upon operating 5 removes holding ground from conductor 120 thus releasing relay 208. Relay 208 upon releasing first establishes a locking circuit for transfer relay 413 extending from ground over the lower alternate contacts of relay 208, conductor 249, inner lower front contact and winding of relay 413 10 to battery and in parallel to battery through the lower winding of relay 445 and then opens the locking circuit of transfer relay 412 which now releases and the circuit through the upper winding of relay 445. Relay 445 now operates and 15 with relay 113 operated establishes the circuit of relay 119 which now operates opening the locking circuit of the operated selection control relay 116 and causing the operation of all the selection control relays 114, 115, 116 and 117 and the operation 20 of relay 118.

With relay 118 operated four circuits are closed as follows: (1) From ground through condenser 427, upper contact of relay 413, conductor 248, upper back contact of relay 207, conductor 279, 25 winding of relay 124 to ground thus discharging condenser 427 and operating relay 124 which locks and releases relay 114; (2) from ground through condenser 428, next-to-upper contact of relay 413, conductor 223, inner upper back contact of relay 207, conductor 280, winding of relay 125 to ground, but without effect as condenser 428 is uncharged; (3) from ground through condenser 429, next-to-inner upper contact of relay 413, conductor 225, upper back contact of relay 30 208, conductor 281, winding of relay 126 to ground thus discharging condenser 429 and operating relay 126 which locks and releases relay 116; (4) from ground through condenser 430, inner upper contact of relay 413, conductor 231, inner upper back contact of relay 208, conductor 282, winding of relay 127 to ground thus discharging condenser 430 and operating relay 127 which locks and releases relay 117. Selection control relay 115 is now operated and control 45 relays 114, 116 and 117 are released.

Relay 119 upon operating also releases relay 112 which after an interval opens the locking circuit of relay 113, the locking circuits of the operated counting relays and opens the fundamental circuit. Upon the release of counting relay 150 and relay 113, relay 119 releases first closing a locking circuit for the operated selection control relay 115 and then opening the operating circuits of all of the selection control relays and of relay 118. Upon the release of relay 118 the operated relays 124, 126 and 127 release. Relay 119 upon releasing also reoperates relay 112 which prepares the locking circuits for the counting relays and recloses the fundamental circuit preparatory to controlling the group selection movement of the office selector. Upon the closure of the fundamental circuit stepping relay 123 operates and, since selection control relay 115 is operated, closes a circuit from ground over its contact, the upper back contacts of relays 117 and 116, the upper front contact of relay 115, the lower back contact of relay 114, the lower back contact of counting relay 132, winding of relay 142 to battery. As the office selector advances 70 in its group selection movement, counting relays 142, 132, 141, 131, 140, 130 and 150 operate in the well-known manner. The fifth brush set of the office selector will now have been tripped and positioned on the first terminal set of its third 75

group from which position it is then advanced in a trunk hunting movement.

Relay 112 upon operating also establishes a circuit from ground at its lower contact, upper back contact of relay 113, conductor 120, inner lower normal contacts and winding of relay 207, resistance 227 to battery. Relay 207 operates, locks over its inner lower alternate contacts to ground on conductor 228, prepares the operating circuit of relay 208, opens the initial operating circuit of transfer relay 413 and at its lower front contact establishes the operating circuit of transfer relay 414 which may be traced from ground on conductor 228, lower front contact of relay 207, conductor 232, lower front contact of relay 413, winding of transfer relay 414 to battery and as soon as relay 414 operates extends its operating circuit over its inner lower front contact, conductor 233 to battery through the upper winding of relay 445. Since at this time the lower winding of relay 445 is energized in a circuit over conductor 249 and the lower normal contacts of relay 208, relay 445 releases causing the operation and locking of relay 113 which at its upper contact removes ground from conductor 120. Relay 208 now operates first establishing a locking circuit for transfer relay 414 extending from ground on conductor 228, lower alternate contacts of relay 208, conductor 233, inner lower front contact and winding of relay 414 to battery and in parallel from conductor 233 through the upper winding of relay 445 to battery and then opens the previously traced locking circuit of relay 413, which then releases, and the previously traced circuit through the lower winding of relay 445. Relay 445 now operates.

With relay 113 operated, relay 445 now closes the previously traced circuit for relay 119 which operates, opening the locking circuit of selection control relay 115, causing the operation of all the selection control relays and the operation of relay 118. Relay 118 upon operating closes four circuits as follows: (1) From ground through condenser 254 of the thousands register, conductor 283, upper contact of relay 414, conductor 239, upper front contact of relay 207, conductor 279, winding of relay 124 to ground thus discharging condenser 254 and operating relay 124 which locks and releases relay 114; (2) from ground through condenser 255, conductor 284, next-to-upper contact of relay 414, conductor 240, next-to-upper front contact of relay 207, conductor 280, winding of relay 125 to ground, but without effect as condenser 255 is uncharged; (3) from ground through condenser 256, conductor 285, next-to-inner upper front contact of relay 414, conductor 241, upper front contact of relay 208, conductor 281, winding of relay 126 to ground thus discharging condenser 256 and operating relay 126 which locks and releases relay 116; (4) from battery, inner upper contact of relay 414, conductor 242, inner upper front contact of relay 208, conductor 282, winding of relay 127 to ground operating relay 127 which locks and releases relay 117. Selection control relay 115 is now operated and control relays 114, 115 and 117 are released.

Relay 119 upon operating also releases relay 112 which after an interval opens the locking circuit of relay 113, the locking circuits of the operated counting relays and opens the fundamental circuit. When counting relay 150 releases, relay 119 releases, first closing the locking circuit of selection control relay 115 and then opening the operating circuits of all of the selection control

relays and of relay 118. Upon the release of relay 118 the operated relays 124, 126 and 127 release. Relay 119 upon releasing also reoperates relay 112 which prepares the locking circuits of the counting relays and recloses the fundamental circuit preparatory to controlling the brush selection movement of the incoming selector. Upon the closure of the fundamental circuit stepping relay 123 operates and since selection control relay 115 is operated, closes a circuit from ground over its contact, the upper back contacts of relays 117 and 116, the upper front contact of relay 115, the lower back contact of relay 114, the lower back contact of counting relay 132 to battery through the winding of counting relay 142. In the well-known manner, as the brush shaft of the incoming selector is advanced, the successive counting relays are operated by the intermittent operation and release of stepping relay 123 until relays 130 and 150 operate at which time the brush shaft of the incoming selector will have been positioned preparatory to tripping the third brush set.

Relay 112 upon operating also establishes a circuit from ground over its lower contact, upper back contact of relay 113, conductor 120, inner lower front contact of relay 208 to resistance 227 thus causing the release of relay 207. Relay 208 remains locked to ground on conductor 120. Relay 207 upon releasing closes the operating circuit of transfer relay 415 from ground on conductor 228 over the lower back contact of relay 207, conductor 243, lower front contact of relay 414, winding of relay 415 to battery. Relay 415 upon operating extends this operating ground over its inner lower front contact through the lower winding of relay 445 to battery and relay 445 now releases and causes the operation of relay 113. Relay 113 upon operating removes ground from conductor 120 thus releasing relay 208. Relay 208 upon releasing first establishes a locking circuit for transfer relay 415 extending from ground over the lower alternate contacts of relay 208, conductor 249, inner lower front contact and winding of relay 415 to battery and in parallel to battery through the lower winding of relay 445 and then opens the locking circuit of transfer relay 414, which now releases, and the circuit through the upper winding of relay 445. Relay 445 operates and with relay 113 operated establishes the circuit of relay 119 which now operates opening the locking circuit of relay 115 and causing the operation of all of the selection control relays 114 to 117, inclusive and of relay 118.

With relay 118 operated four circuits are closed as follows: (1) From ground through condenser 257 of the thousands register, conductor 286, upper contact of relay 415, conductor 248, upper back contact of relay 207, conductor 279, winding of relay 124, to ground, but without effect since condenser 257 is uncharged; (2) from ground through condenser 261 of the hundreds register, conductor 287, next-to-upper contact of relay 415, conductor 223, inner upper back contact of relay 207, conductor 280, winding of relay 125 to ground, but without effect as condenser 261 is uncharged; (3) from battery over the next-to-inner upper front contact of relay 415, conductor 225, upper back contact of relay 208, conductor 281, winding of relay 126 to ground thus operating relay 126 which locks and releases relay 116; (4) from battery over the inner upper contact of relay 415, conductor 231, inner upper back contact of relay 208, conductor 282, winding of relay 127 to ground thus operating relay 127 which locks and releases

relay 117. Selection control relays 114 and 115 are now operated and relays 116 and 117 are released.

Relay 119 upon operating also releases relay 112 which after an interval opens the locking circuit of relay 113, the locking circuits of the operated counting relays and opens the fundamental circuit. Upon the release of counting relay 150 and relay 113, relay 119 releases first closing locking circuits for selection control relays 114 and 115 and then opening the operating circuits of all of the selection control relays and of relay 118. Upon the release of relay 118 the operated relays 126 and 127 release. Relay 119 also reoperates relay 112 which prepares the locking circuits for the counting relays and recloses the fundamental circuit preparatory to controlling the group selection movement of the incoming selector. Upon the closure of the fundamental circuit stepping relay 123 operates and since selection control relays 114 and 115 are both operated, closes a circuit from ground over its contact, the upper back contacts of relays 116 and 117, the upper front contact of relay 115, the lower front contact of relay 114, the lower back contact of counting relay 133 to battery through the winding of relay 143. As the incoming selector advances in its group selection movement the counting relays operate in the well-known manner until, when counting relays 130 and 150 operate, the incoming selector will have been advanced to trip the selected third set of brushes and to position them on the first terminal set of the fourth group from which position it is advanced in a trunk hunting movement.

Relay 112 upon operating also establishes a circuit from ground at its lower contact, upper back contact of relay 113, conductor 120, inner lower normal contacts and winding of relay 207, resistance 227 to battery. Relay 207 operates and locks over its inner lower alternate contacts to ground on conductor 228, prepares the operating circuit of relay 208, opens the initial operating circuit of transfer relay 415 and at its lower front contact establishes the operating circuit of transfer relay 416 extending from ground on conductor 228, alternate contacts of relay 207, conductor 232, lower contact of relay 415, winding of relay 416 to battery and as soon as relay 416 operates, extends this operating circuit over its inner lower contact, conductor 233 through the upper winding of relay 445 to battery. Since at this time the lower winding of relay 445 is energized in a circuit over conductor 249 and the lower normal contacts of relay 208, relay 445 releases causing the operation and locking of relay 113 which at its upper contact removes ground from conductor 120. Relay 208 now operates, first establishing a locking circuit for transfer relay 416 extending from ground on conductor 228, lower alternate contacts of relay 208, conductor 233, inner lower front contact and winding of relay 416 to battery and in parallel from conductor 233 through the upper winding of relay 445 to battery, and then opens the previously traced locking circuit of relay 415, which then releases, and the previously traced circuit through the lower winding of relay 445. Relay 445 now releases.

With relay 113 operated relay 445 now closes the previously traced circuit of relay 119 which operates opening the locking circuits of selection control relays 114 and 115, causing the operation of all of the selection control relays 114 to 117, inclusive and the operation of relay 118. Relay 118 upon operating closes four circuits as follows:

(1) From ground through condenser 258 of the hundreds register, conductor 288, upper contact of relay 416, conductor 239, upper front contact of relay 207, conductor 279, winding of relay 124 to ground, but without effect since the conductor 258 is uncharged; (2) from ground through condenser 259, conductor 289, next-to-upper contact of relay 416, conductor 240, next-to-upper front contact of relay 207, conductor 280, winding of relay 125 to ground thus discharging condenser 259 and operating relay 125 which locks and releases relay 115; (3) from ground through condenser 260, conductor 290, next-to-inner upper contact of relay 416, conductor 241, upper front contact of relay 208, conductor 281, winding of relay 126 to ground thus discharging condenser 260 and operating relay 126 which locks and releases relay 116; (4) from battery, inner upper contact of relay 416, conductor 242, inner upper front contact of relay 208, conductor 282, winding of relay 127 to ground operating relay 127 which locks and releases relay 117. Selection control relay 114 is now operated and relays 115, 116 and 117 are released.

Relay 119 upon operating also releases relay 112 which after an interval opens the locking circuit of relay 113, the locking circuits of the operated counting relays and opens the fundamental circuit. When counting relay 150 releases with relay 113 released, relay 119 releases thus closing the locking circuit of selection control relay 114 and then opening the operating circuits of all of the selection control relays and of relay 118. Upon the release of relay 118 the operated relays 125, 126 and 127 release. Relay 119 upon releasing also reoperates relay 112 which prepares the locking circuits of the counting relays and recloses the fundamental circuit preparatory to controlling the brush selection movement of the final selector. Upon the closure of the fundamental circuit stepping relay 123 operates and with selection control relay 114 operated, closes a circuit from ground over its contact, the upper back contacts of relays 117, 116 and 115, the upper front contact of relay 114, the back contact of counting relay 131 to battery through the winding of relay 141. In the well-known manner as the brush shaft of the final selector is advanced, successive counting relays are operated by the intermittent operation and release of stepping relay 123 until relays 130 and 150 operate, at which time the brush shaft of the final selector will have been positioned preparatory to tripping the second brush set.

Relay 112 upon operating also establishes a circuit from ground over its lower contact, upper back contact of relay 113, conductor 120, inner lower front contact of relay 208 to resistance 227 thus causing the release of relay 207, relay 208 remaining locked to ground on conductor 120. Relay 207 upon releasing closes the operating circuit of transfer relay 206 extending from ground on conductor 228 over the lower back contact of relay 207, conductor 243, lower front contact of relay 416, conductor 447, winding of relay 206 to battery. Relay 206 upon operating extends the operating ground over its inner lower front contact through the lower winding of relay 445 to battery and relay 445 now releases to cause the operation of relay 113. Relay 113 upon operating removes ground from conductor 120 thus releasing relay 208. Relay 208 upon releasing first establishes a locking circuit for transfer relay 206 extending from ground over the lower alternate contacts of relay 208, conductor 249, 75

inner lower front contact and winding of relay 206 to battery and in parallel to battery through the lower winding of relay 445 and then opens the locking circuit of transfer relay 416, which now releases, and the circuit through the upper winding of relay 445. Relay 445 operates and with relay 113 operated establishes the circuit of relay 119 which operates opening the locking circuit of selection control relay 114 and causing the operation of all of the selection control relays and of relay 118.

With relay 118 operated four circuits are closed as follows: (1) From ground through condenser 262 of the tens register, upper contact of relay 206, conductor 243, upper back contact of relay 207, conductor 279, winding of relay 124 to ground causing the discharge of condenser 262 and the operation of relay 124 which locks and releases relay 114; (2) from ground through condenser 263, next-to-upper contact of relay 206, conductor 223, inner upper back contact of relay 207, conductor 280, winding of relay 125 to ground, but without effect since condenser 263 is uncharged; (3) from ground through condenser 264, next-to-inner upper contact of relay 206, conductor 225, upper back contact of relay 208, conductor 281, winding of relay 126 to ground thus discharging condenser 264 and operating relay 126 which locks and releases relay 116; (4) from ground through condenser 265, inner upper contact of relay 206, conductor 231, inner upper back contact of relay 208, conductor 282, winding of relay 127 to ground, but without effect since condenser 265 is uncharged. Selection control relays 115 and 117 are now operated and relays 114 and 116 are released.

Relay 119 upon operating also releases relay 112 which after an interval opens the locking circuit of relay 113, the locking circuits of the operated counting relays and opens the fundamental circuit. Upon the release of counting relay 150 and relay 113, relay 119 releases first closing a locking circuit for selection control relays 115 and 117 and then opening the operating circuits of all of the selection control relays and of relay 118. Upon the release of relay 118 the operated relays 124 and 126 release. Relay 119 also reoperates relay 112 which prepares the locking circuits for the counting relays and recloses the fundamental circuit preparatory to controlling final tens selection. Upon the closure of the fundamental circuit, stepping relay 123 operates and since selection control relays 115 and 117 are both operated, closes a circuit from ground over its contact, the upper front contact of relay 117, the lower back contact of counting relay 139, winding of relay 149 to battery. As the final selector advances in its tens selection movement, counting relays 149, 139, 148, 138, 147, 137, 146, 136, 145, 135 operate in succession, relay 135 upon operating extending the counting relay operating circuit over the upper back contact of relay 116, upper front contact of relay 115, lower back contact of relay 114, back contact of counting relay 132 to battery through the winding of relay 142. Counting relays 142, 132, 141, 131, 140, 130 and 150 now operate in succession. When relays 130 and 150 operate the brush shaft of the final selector will have advanced to trip its second brush set and position this set of brushes at the beginning of the eighth group.

Relay 112 upon operating also establishes a circuit from ground at its lower contact, upper back contact of relay 113, conductor 120, inner

lower normal contacts and winding of relay 207, resistance 227 to battery. Relay 207 operates, locks over its inner lower alternate contacts to ground on conductor 228, prepares the operating circuit of relay 208, opens the initial operating circuit of transfer relay 206 and at its lower front contact establishes an operating circuit for transfer relay 408 extending from ground on conductor 228, lower front contact of relay 207, conductor 232, lower front contact of relay 206, winding of relay 408 to battery. As soon as relay 408 operates this operating circuit is extended over its inner lower front contact and conductor 233 through the upper winding of relay 445 to battery. Since at this time the lower winding of relay 445 is energized in a circuit over conductor 249 and the lower normal contacts of relay 208, relay 445 releases causing the operation and locking of relay 113 which at its upper contact removes ground from conductor 120. Relay 208 now operates first establishing a locking circuit for transfer relay 408 extending from ground on conductor 228, lower alternate contacts of relay 208, conductor 233, inner lower front contact and winding of relay 408 to battery and in parallel from conductor 233 through the upper winding of relay 445 to battery and then opens the previously traced locking circuit of relay 206, which then releases, and the previously traced circuit through the lower winding of relay 445. Relay 445 now releases.

With relay 113 operated relay 445 now closes the previously traced circuit of relay 119 which operates opening the locking circuits of selection control relays 115 and 117 and causing the operation of all of the selection control relays and the operation of relay 118. Relay 118 upon operating closes four circuits as follows: (1) From ground through condenser 400 of the units register, upper contact of relay 408, conductor 239, upper front contact of relay 207, conductor 279, winding of relay 124 to ground, but without effect since condenser 400 is uncharged; (2) from ground through condenser 401, next-to-upper contact of relay 408, conductor 240, next-to-upper front contact of relay 207, conductor 280, winding of relay 125 to ground, but without effect since condenser 401 is uncharged; (3) from ground through condenser 402, next-to-inner upper contact of relay 408, conductor 241, upper front contact of relay 208, conductor 281, winding of relay 126 to ground thus discharging condenser 402 and operating relay 126 which locks and releases relay 116; (4) from ground through condenser 403, inner upper contact of relay 408, conductor 242, inner upper front contact of relay 208, conductor 282, winding of relay 127 to ground, but without effect since condenser 403 is uncharged. Selection control relays 114, 115 and 117 are now operated and relay 115 is released.

Relay 119 upon operating also releases relay 112 which after an interval opens the locking circuit of relay 113, the locking circuits of the operated counting relays and opens the fundamental circuit. When counting relay 150 releases, relay 119 releases first closing the locking circuits of relays 114, 115 and 117, and then opening the operating circuits of all of the selection control relays and of relay 118. Upon the release of relay 118 the operated relay 126 releases. Relay 119 upon releasing also reoperates relay 112 which prepares the locking circuits of the counting relays and recloses the fundamental circuit preparatory to controlling the

final units selection. Upon the closure of the fundamental circuit, stepping relay 123 operates and with selection control relay 114 operated, closes a circuit from ground over its contact, the upper front contact of relay 117, the back contact of counting relay 139 to battery through relay 149. In the well-known manner the counting relays are operated until upon the operation of relay 135 the control circuit is extended over the front contact of relay 135, the upper back contact of relay 116, the upper front contact of relay 115, the lower front contact of relay 114, the back contact of counting relay 133 to battery through relay 143. Relay 143 and the remaining counting relays, including relays 130 and 150, now operate in succession at which time the tripped brush set of the final selector will have been positioned on the terminal of the desired line whose number was assumed to be 5678.

Since the remaining functions of the sender in completing the connection and in restoring for use on a subsequent call are performed in the usual manner, a description thereof herein is deemed unnecessary.

Call to manual call indicator office

Having now described how the sender and decoder function to control the extension of a connection to a full mechanical office, the extension of another type of call, that is to a manual office equipped with call indicator equipment, will be described. To simplify the description it will be assumed that the same number, Chelsea 3—5678, is recorded on the condenser registers of the sender and that the code designation CH 3 is transmitted to the decoder, decoded and registered on the selection control registers of the sender in the manner previously described, but that the sender is now informed that the call is of the call indicator class. Following the transfer to the sender of complete information for controlling the connection, the district and office selectors are set in the manner previously described thereby routing the connection to the Chelsea 3 office now assumed to be a manual terminating office.

As previously described at the end of office group selection, relay 207 is operated and since the call is of the call indicator type, the circuit of transfer relay 203 is established from ground on conductor 228, lower front contact of relay 207, conductor 232, lower contact of transfer relay 413, conductor 448 to battery through the winding of transfer relay 203. As soon as relay 203 operates, relay 445 releases and relay 208 then operates first locking transfer relay 203 over a circuit extending from ground, lower alternate contacts of relay 208, conductor 233, inner lower contact and winding of relay 203 to battery and in parallel through the upper winding of relay 445 to battery and then opens the previously traced locking circuit of transfer relay 413, which now releases, and the previously traced circuit through the lower winding of relay 445. Relay 445 now operates, but without effect.

With transfer relay 203 now operated a circuit is established from ground through condenser 250 of the stations register, upper contact of relay 203, conductor 239, upper front contact of relay 207, conductor 279, winding of relay 124, conductor 151, inner upper back contact of relay 309 to ground thus discharging condenser 250 and operating relay 124 which locks from battery over its front contact to ground at the back contact of relay 309. A second circuit is also established

from ground through condenser 251, next-to-upper contact of relay 203, conductor 240, next-to-upper front contact of relay 297, conductor 280, winding of relay 125, conductor 152, inner upper back contact of relay 310 to ground thus discharging condenser 251 and operating relay 125 which locks from battery over its front contact to ground at the back contact of relay 310.

As soon as the office group selection has been completed and the selector has made connection with an idle trunk extending to the wanted manual office, the fundamental circuit including conductors 121 and 122 is extended to the sender and in the manner fully described in the application of R. Raymond, Serial No. 27,340, filed June 19, 1935, relays 300 and 301 are operated. Relay 302 is a non-biased, condenser timed, polarized relay which closes its front contact when energized in one direction, closes its back contact when energized in the opposite direction and leaves either contact closed when not energized. When current is first passed through its upper winding in either direction its force is neutralized by an opposing current through the lower winding caused by the discharge of the timing condenser 304 and its recharge in the opposite sense. When the condenser has been discharged and recharged, current ceases to flow in the lower winding and the upper winding causes the armature to move from one contact to the other. The alternate back and forth movement of the armature can be retarded, as desired, by selecting the proper capacity for condenser 304 and values for resistances 305 and 307. Both ends of both windings are normally connected to battery, the left ends in common through resistance 305. The right end of the upper winding is connected over the lower front contact of relay 300, resistance 306, resistance 307 to battery while the right end of the lower winding is connected through condenser 304, the upper front contact of relay 303, through resistance 307 to battery. By shunting one or the other battery connection with ground, current is caused to flow through the upper winding in one direction or in the other and in the lower winding always in the opposing direction. With relays 302 and 303 normal, resistance 306 is shunted over the back contacts thereof and with either relay operated this resistance is introduced in series with the upper winding of relay 302 to delay the closure of its back contact and to thus equalize alternate impulses.

When relay 301 operates it connects ground to the armature of relay 302 and to the upper armature of relay 303 thereby connecting ground over the back contacts of these armatures in shunt of battery through resistance 307. Relay 302 therefore closes its front contact extending ground to the winding of relay 303. Since relay 313 has not operated the operation of relay 303 is ineffective to release relay 302 and relays 302 and 303 remain operated ready to start pulsing.

When the operator assigns the trunk by the operation of her assignment key, relay 313 also operates removing the shunt from battery through resistance 307 and connecting the upper front contact of relay 303 over its inner front contact in shunt of battery through resistance 305 thereby starting relays 302 and 303 to pulsing. Relay 302 opens its front contact releasing relay 303 which closes a circuit which may be traced from ground at the front contact of relay 301, front contact of relay 313, back contact of relay 303, inner lower normal contacts and winding of relay 309, resistance 311 to battery and through

the winding of relay 310, resistance 312 to battery. Relay 309 operates and locks over its inner lower alternate contacts to ground at the front contact of relay 301, but the winding of relay 310 being shunted over its inner lower back contact does not operate. When relay 303 next operates the shunt around the winding of relay 310 is opened and relay 310 operates. On the next release of relay 303 it extends ground over the inner lower front contact of relay 310 to resistance 311 in shunt of the winding of relay 309. Relay 309 releases, but relay 310 is held operated over the inner lower continuity contacts of relay 309, first to the locking ground of relay 309 and then to ground over the back contact of relay 303. When relay 303 again operates, relay 310 releases. Relays 309 and 310 repeat this cycle of operations under the control of relay 303 until the designation has been completely transmitted. Each complete cycle generates four impulses.

Relay 308 operates in parallel with relay 303 being operated for the odd impulses and released for the even impulses and serves to alternately connect ground over conductor 314 and thence to the fundamental ring conductor 122 for the odd impulses and ground over conductor 315 and thence to the tip fundamental conductor 121 for the even impulses.

During the initial impulse period immediately following the response of the operator at which time relays 303 and 308 are operated and relays 309 and 310 are released, the tip fundamental conductor 121 is extended through resistance 316, upper back contact of relay 309, conductor 319 to the back contact of relay 124 and the ring fundamental conductor is extended over conductor 314 to ground at the alternate contacts of relay 303. It will be recalled that relay 124 was operated and locked due to the charged condition of the stations register condenser 250 and that therefore the fundamental loop is not closed resulting in a blank impulse.

With relay 309 operated and relays 308 and 310 released during the second impulse period, the tip fundamental conductor is connected to ground at the normal contacts of relay 308 and the ring fundamental conductor is extended through high resistance 318 to battery and in a parallel branch through low resistance 317, the upper back contact of relay 310, conductor 320 to the upper back contact of relay 125. It will be recalled that relay 125 was operated and locked due to the charged condition of condenser 251 and that therefore this branch is ineffective. Since only the high resistance 318 is included in the fundamental loop, a light negative impulse is transmitted. Relay 309 upon operating also establishes a circuit from ground through the stations register condenser 252, next-to-inner contact of relay 203, conductor 241, upper front contact of relay 208, conductor 281, winding of relay 126, conductor 153, inner upper front contact of relay 309 to ground, thus discharging condenser 252 and operating relay 126 which locks from battery over its front contact to ground at the front contact of relay 309. At its inner upper back contact relay 309 opens the locking circuit of relay 124 which now releases.

With relays 308, 309 and 310 operated during the third impulse period, the ring fundamental conductor is connected to ground at the alternate contacts of relay 308 and the tip fundamental conductor is connected through resistance 316, the upper front contact of relay 309, conductor 321 to the upper back contact of relay 126, but

since relay 126 was operated due to the charged condition of stations register condenser 252 the fundamental loop is not closed resulting in a blank impulse. With relay 310 operated the locking circuit of relay 125 is opened at the inner upper back contact of relay 310 and a circuit is established from ground through condenser 253, inner and upper contact of relay 203, conductor 242, inner upper front contact of relay 208, conductor 282, winding of relay 127, conductor 154 to ground at the inner upper front contact of relay 310 thus discharging condenser 253 and operating relay 127 which locks from battery over its front contact to ground at the front contact of relay 310.

With relays 308 and 309 released and relay 310 operated during the fourth impulse period, the tip fundamental conductor is connected to ground at the normal contacts of relay 308 and the ring fundamental conductor is extended through high resistance 318 to battery and in a parallel branch through low resistance 317, upper front contact of relay 310, conductor 322 to the upper back contact of relay 127. Since, however, relay 127 is operated this branch is ineffective and, with only high resistance 318 included in the fundamental loop, a light negative impulse is transmitted. Thus, during the first four impulse periods a code of two light negative impulses has been transmitted to record at the operator's position the stations digit zero.

During the third impulse period, when relay 310 operated, a circuit was established from ground at its lower front contact over conductors 323 and 120, the inner lower front contact of relay 208 through resistance 227 in shunt of the winding of relay 207 resulting in the release of relay 207, relay 208 remaining locked after the release of relay 207 over the inner normal contacts of relay 207, conductors 120 and 323 to ground at the front contact of relay 310. Relay 207 upon releasing establishes a circuit from ground on conductor 228, over its lower back contact, conductor 243, the lower front contact of relay 203 to battery through the winding of transfer relay 204. Therefore, when relay 309 releases during the fourth impulse period, a circuit is established from ground through condenser 254 of the thousands register, upper contact of relay 204, conductor 248, upper back contact of relay 207, conductor 279, winding of relay 124, conductor 151, inner upper back contact of relay 309 to ground causing the discharge of condenser 254 and the operation of relay 124 which locks from battery over its front contact to ground over the back contact of relay 309. At its inner front contact relay 309 opens the locking circuit of relay 126 which releases.

During the fifth impulse period, with relays 309 and 310 both released and relay 308 operated, the ring fundamental conductor is connected to ground over the alternate contacts of relay 308 and the tip fundamental conductor is extended through resistance 316, upper back contact of relay 309, conductor 319 to the back contact of relay 124, but since relay 124 is at the time operating the fundamental loop is not closed resulting in a blank impulse. A circuit is also established from ground through condenser 255, next-to-upper contact of relay 204, conductor 223, upper inner back contact of relay 207, conductor 280, winding of relay 125, conductor 152, upper inner back contact of relay 310 to ground and since condenser 255 is uncharged, relay 125 does not operate. With relay 310 released, ground is

removed from conductor 323 resulting in the release of relay 208. Relay 208 upon releasing, first establishes a locking circuit for transfer relay 204 extending from ground over the lower alternate contacts of relay 208, conductor 249, inner lower front contact and winding of relay 204 to battery and then opens the locking circuit of transfer relay 203 which now releases. With relay 310 released the locking circuit of relay 127 is opened and relay 127 releases.

During the sixth impulse period, with relay 309 operated and relays 308 and 310 released, the tip fundamental conductor is connected to ground at the normal contacts of relay 308 and the ring fundamental conductor is extended through high resistance 318 to battery and in a parallel branch through low resistance 317, upper back contact of relay 310, conductor 320, back contact of relay 125 to battery. Since both resistances 317 and 318 are connected in parallel into the fundamental loop a heavy negative impulse is transmitted. Relay 309 upon operating also establishes a circuit from ground through condenser 256, next-to-inner upper contact of relay 204, conductor 225, upper back contact of relay 208, conductor 281, winding of relay 126, conductor 153, inner upper front contact of relay 309 to ground resulting in the discharge of condenser 256 and the operation of relay 126 which locks from battery over its front contact to ground over the front contact of relay 309. Relay 309 operated, opens the locking circuit of relay 124 which releases.

During the seventh impulse period, with relays 308, 309 and 310 operated the ring fundamental conductor is connected to ground at the alternate contacts of relay 308 and the tip fundamental conductor is connected through resistance 316, the upper front contact of relay 309, conductor 321 to the upper back contact of relay 126, but since relay 126 is operated the fundamental loop is not closed resulting in a blank impulse. With relay 310 operated a circuit is established from ground through condenser 257, inner upper contact of relay 204, conductor 231, inner upper back contact of relay 208, conductor 282, winding of relay 127, conductor 154 to ground at the inner upper front contact of relay 310, but since condenser 257 is uncharged this circuit is ineffective. At its lower front contact relay 310 connects ground to conductor 323 resulting in the operation and locking of relay 207 and the preparation of the operating circuit of relay 208. Upon closing its lower front contact relay 207 establishes the operating circuit of transfer relay 205 extending from ground on conductor 228, lower front contact of relay 207, conductor 232, lower front contact of relay 204 to battery through the winding of relay 205.

With relays 308 and 309 released and relay 310 operated during the eighth impulse period, the tip fundamental conductor is connected to ground at the normal contacts of relay 308 and the ring fundamental conductor is extended through high resistance 318 to battery and in a parallel branch through low resistance 317, upper front contact of relay 310, conductor 322 over the upper back contact of relay 127, which is not operated, to battery. Since both resistances 317 and 318 are connected in parallel into the fundamental loop, a heavy negative impulse is transmitted. Thus during the second four impulse periods a code of two heavy negative impulses has been transmitted to record at the operator's position the thousands digit 5. With re-

lay 309 released, the locking circuit of relay 126 is opened at the inner upper front contact of relay 309 releasing relay 126, and a circuit is established from ground through condenser 258 of the hundreds register, upper contact of relay 205, conductor 239, upper front contact of relay 207, conductor 279, winding of relay 124, conductor 151, inner upper back contact of relay 309 to ground, but since condenser 258 is uncharged this circuit is ineffective.

During the ninth impulse period, with relays 309 and 310 both released and relay 308 operated, the ring fundamental conductor is connected to ground over the alternate contacts of relay 308 and the tip fundamental conductor is extended through resistance 316, upper back contact of relay 309, conductor 319, over the back contact of relay 124 to battery thus completing the fundamental loop to transmit a positive impulse. The release of relay 310 closes a circuit from ground through condenser 259, next-to-upper contact of relay 205, conductor 240, inner upper front contact of relay 207, conductor 280, winding of relay 125, conductor 152, inner upper back contact of relay 310 to ground thus discharging condenser 259 and operating relay 125 which locks from battery over its front contact to ground over the inner upper back contact of relay 310. At its lower contact relay 310 removes ground from conductor 223 whereupon relay 208 operates, first establishing the locking circuit to transfer relay 205 and then opening the locking circuit of transfer relay 204 which now releases.

During the tenth impulse period, with relay 309 operated and relays 308 and 310 released, the tip fundamental conductor is connected to ground at the normal contacts of relay 308 and the ring fundamental conductor is extended through high resistance 318 to battery and in a parallel branch through low resistance 317, upper back contact of relay 310, conductor 320 to the back contact of relay 125, but since relay 125 is operated this branch is not completed and, with only high resistance 318 included in the fundamental loop, a light negative impulse is transmitted. Relay 309 upon operating establishes a circuit from ground through condenser 260, next-to-inner upper contact of relay 205, conductor 241, upper front contact of relay 208, conductor 281, winding of relay 126, conductor 153, inner upper front contact of relay 309 to ground resulting in the discharge of condenser 260 and the operation of relay 126 which locks from battery over its front contact to ground over the front contact of relay 309.

During the eleventh impulse period with relays 308, 309 and 310 operated, the ring fundamental conductor is connected to ground at the alternate contacts of relay 308 and the tip fundamental conductor is connected through resistance 316, the upper front contact of relay 309, conductor 321 to the back contact of relay 126, but since relay 126 is operated the fundamental loop is not closed resulting in a blank impulse. With relay 310 operated the locking circuit of relay 125 is opened at its inner upper back contact thus releasing relay 125 and a circuit is established from ground through condenser 261, inner upper contact of relay 205, conductor 242, inner upper front contact of relay 208, conductor 282, winding of relay 127, conductor 154, inner upper front contact of relay 310 to ground, but without effect since condenser 261 is uncharged. Relay 310 also connects ground to conductor 323 causing the release of relay 207 which closes the op-

erating circuit of transfer relay 206 extending from ground on conductor 228, lower back contact of relay 207, conductor 243, lower front contact of relay 205 to battery through the winding of relay 206.

With relays 308 and 309 released and relay 310 operated during the twelfth impulse period, the tip fundamental conductor is connected to ground at the normal contacts of relay 308 and the ring fundamental conductor is extended through high resistance 318 to battery and in a parallel branch through low resistance 317, upper front contact of relay 310, conductor 322, back contact of relay 127 to battery. Thus both resistances 317 and 318 are introduced in parallel into the fundamental loop resulting in the transmission of a heavy negative impulse. Thus, during the third four impulse periods a code of a positive, a light negative and a heavy negative impulse has been transmitted to record at the operator's position the hundreds digit 6. With relay 309 released the locking circuit of relay 126 is opened thus releasing relay 126, and a circuit is extended from ground through condenser 262 of the tens register, upper contact of relay 206, conductor 248, upper back contact of relay 207, conductor 279, winding of relay 124, conductor 151, inner upper back contact of relay 309 to ground causing the discharge of the condenser 262 and the operation of relay 124 which locks from battery over its front contact to ground at the back contact of relay 309.

During the thirteenth impulse period, with relays 309 and 310 both released and relay 308 operated, the ring fundamental conductor is connected to ground over the alternate contacts of relay 308 and the tip fundamental conductor is extended through resistance 316, upper back contact of relay 309, conductor 319 to the back contact of relay 124, but since relay 124 is operated the fundamental loop is not closed resulting in a blank impulse. A circuit is also established from ground through condenser 263, next-to-upper contact of relay 206, conductor 223, inner upper back contact of relay 207, conductor 280, winding of relay 125, conductor 152, upper inner back contact of relay 310 to ground, but since condenser 263 is uncharged, relay 125 does not operate. With relay 310 released ground is removed from conductor 323 resulting in the release of relay 208 which first establishes a locking circuit for transfer relay 206 extending from ground over the lower alternate contacts of relay 208, conductor 249, inner lower front contact and winding of relay 206 to battery and then opens the locking circuit of transfer relay 205 which releases.

During the fourteenth impulse period, with relay 309 operated and relays 308 and 310 released, the tip fundamental conductor is connected to ground at the normal contacts of relay 308 and the ring fundamental conductor is extended through the high resistance 318 to battery and in a parallel branch through low resistance 317, upper back contact of relay 310, conductor 320, back contact of relay 125 to battery. With both resistances 317 and 318 connected in parallel into the fundamental loop a heavy negative impulse is transmitted. Relay 309 upon operating opens the locking circuit of relay 124 which releases and establishes a circuit from ground through condenser 264, next-to-inner upper contact of relay 206, conductor 225, upper back contact of relay 208, conductor 281, winding of relay 126, conductor 153, inner upper front con-

tact of relay 309 to ground resulting in the discharge of condenser 264 and the operation of relay 126 which locks from battery over its front contact to ground over the front contact of relay 309.

During the fifteenth impulse period, with relays 308, 309 and 310 operated, the ring fundamental conductor is connected to ground at the alternate contacts of relay 308 and the fundamental tip conductor is connected through resistance 316, upper front contact of relay 309, conductor 321 to the upper back contact of relay 126, but since relay 126 is operated the fundamental loop is not closed resulting in a blank impulse. With relay 310 operated a circuit is established from ground through condenser 265, inner upper contact of relay 206, inner upper back contact of relay 208, conductor 282, winding of relay 127, conductor 154 to ground at the inner upper front contact of relay 310, but since condenser 265 is uncharged this circuit is ineffective. At its lower front contact relay 310 connects ground to conductor 323 resulting in the operation and locking of relay 207 and the preparation of the locking circuit of relay 208. Upon closing its lower front contact relay 207 establishes the operating circuit of transfer relay 408 extending from ground on conductor 228, lower front contact of relay 207, conductor 232, lower front contact of relay 206 to battery through the winding of relay 408.

With relays 308 and 309 released and relay 310 operated during the sixteenth impulse period, the tip fundamental conductor is connected to ground at the normal contacts of relay 308 and the ring fundamental conductor is extended through high resistance 318 to battery and in a parallel branch through low resistance 317, the upper front contact of relay 310, conductor 322, the back contact of relay 127 to battery. Since both resistances 317 and 318 are connected in parallel into the fundamental loop a heavy negative impulse is transmitted. Thus, during the fourth four impulse periods a code of two heavy negative impulses has been transmitted to record at the operator's position the tens digit 7. With relay 309 released the locking circuit of relay 126 is opened at the inner upper front contact of relay 309 thus releasing relay 126, and a circuit is established from ground through condenser 400 of the units register, upper contact of relay 408, conductor 239, upper front contact of relay 207, conductor 279, winding of relay 124, conductor 151, inner upper back contact of relay 309 to ground, but since condenser 400 is uncharged this circuit is ineffective.

During the seventeenth impulse period, with relays 309 and 310 both released and relay 308 operated, the ring fundamental conductor is connected to ground over the alternate contacts of relay 308 and the tip fundamental conductor is extended through resistance 316, upper back contact of relay 309, conductor 319, back contact of relay 124 to battery thus completing the fundamental loop to transmit a positive impulse. The release of relay 310 closes a circuit from ground through condenser 401, next-to-upper contact of relay 408, conductor 240, inner upper front contact of relay 207, conductor 280, winding of relay 125, conductor 152, inner upper back contact of relay 310 to ground, but without effect since condenser 401 is uncharged. At its lower contact relay 310 removes ground from conductor 323 whereupon relay 208 operates first establishing the locking circuit of transfer relay 408 and

then opening the locking circuit of transfer relay 206 which then releases.

During the eighteenth impulse, with relay 309 operated and relays 308 and 310 released, the tip fundamental conductor is connected to ground at the normal contacts of relay 308 and the ring fundamental conductor is extended through high resistance 318 to battery and in a parallel branch through low resistance 317, upper back contact of relay 310, conductor 320, back contact of relay 125 to battery. Since both resistances 317 and 318 are connected in parallel into the fundamental loop a heavy negative impulse is transmitted. Relay 309 upon operating establishes a circuit from ground through condenser 402, next-to-inner upper contact of relay 408, conductor 241, upper front contact of relay 208, conductor 281, winding of relay 126, conductor 153, inner upper front contact of relay 309 to ground resulting in the discharge of condenser 402 and the operation of relay 126 which locks from battery over its front contact to ground over the front contact of relay 309.

During the nineteenth impulse period, with relays 308, 309 and 310 operated the ring fundamental conductor is connected to ground at the alternate contacts of relay 308 and the fundamental tip conductor is extended through resistance 316, the upper front contact of relay 309, conductor 321 to the back contact of relay 126, but since relay 126 is operated the fundamental loop is not closed resulting in a blank impulse. With relay 310 operated a circuit is established from ground through condenser 403, inner upper contact of relay 408, conductor 242, inner upper front contact of relay 208, conductor 282, winding of relay 127, conductor 154, inner upper front contact of relay 310 to ground, but without effect since condenser 403 is uncharged.

With relays 308 and 309 released and relay 310 operated during the twentieth impulse period, the tip fundamental conductor is connected to ground over the normal contacts of relay 308 and the ring fundamental conductor is extended through high resistance 318 to battery and in a parallel branch through low resistance 317, upper front contact of relay 310, conductor 322, back contact of relay 127 to battery. Thus, both resistances 317 and 318 are included in parallel in the fundamental loop resulting in the transmission of a heavy negative impulse. Thus, during the fifth four impulse periods a code of a positive and two heavy negative impulses is transmitted to record the units digit 8 at the operator's position.

The entire line designation has now been transmitted to the manual office and recorded on the operator's call indicator equipment. The connection is then completed and the sender dismissed in the usual manner. Had it been necessary to extend the connection through a manual tandem office to a terminating manual office then the codes of impulses transmitted would have also included codes of impulses as determined by the charged or uncharged condition of the condensers of "A", "B" and "C" office code registers.

What is claimed is:

1. In a signaling system, means responsive to series of incoming impulses, a plurality of groups of condensers, means controlled by said responsive means for selectively placing the condensers of successive groups in a charged or uncharged condition in response to successive series of impulses to register said series of impulses.

2. In a signaling system, means responsive to

series of incoming impulses, a plurality of groups of condensers, means controlled by said responsive means in response to successive series of impulses to select successive groups of said condensers and further means controlled by said responsive means for selectively placing the condensers of each selected group in a charged or uncharged condition to register said series of impulses.

3. In a signaling system, means responsive to series of incoming impulses, a plurality of groups of condensers, a relay individual to each group of condensers, means controlled by said responsive means in response to successive series of impulses to successively operate said relays to select said groups of condensers, and further means controlled by said responsive means for selectively placing the condensers of each selected group in a charged or uncharged condition to register said series of impulses.

4. In a signaling system, means responsive to series of incoming impulses, a plurality of groups of condensers, means controlled by said responsive means for selectively placing the condensers of successive groups in a charged or uncharged condition in response to successive series of impulses to register said series of impulses, a group of relays, means for successively associating said groups of condensers with said group of relays, and means operative upon the association of said relays with a group of condensers for selectively operating said relays by the discharge of the charged condensers of said group.

5. In a telephone system, means responsive to series of incoming impulses, a plurality of groups of condensers, means controlled by said responsive means for selectively placing the condensers of successive groups in a charged or uncharged condition in response to successive series of impulses to register said series of impulses, a group of relays, means for successively associating said groups of condensers with said group of relays whereby upon the association of said relays with each group of condensers said relays are selectively operated by the discharge of the charged condensers of said group, and selection controlling means controlled by said relays.

6. In a telephone system, means responsive to series of incoming impulses, a plurality of groups of condensers, means controlled by said responsive means for selectively placing the condensers of successive groups in a charged or uncharged condition in response to successive series of impulses to register said series of impulses, a group of relays, means for successively associating said groups of condensers with said group of relays whereby upon the association of said relays with each group of condensers said relays are selectively operated by the discharge of the charged condensers of said group, and impulse transmitting means controlled by said relays.

7. In a telephone system, a plurality of groups of condensers, means for selectively placing the condensers of each group in a charged or uncharged condition to register information for controlling the extension of telephone connections, a group of relays, means for successively associating said groups of condensers with said group of relays whereby upon the association of said relays with each group of condensers said relays are selectively operated by the discharge of the charged condensers of said group, and selection controlling means controlled by said relays.

8. In a telephone system, means responsive to

series of incoming impulses, a first plurality of groups of condensers, means controlled by said responsive means for selectively placing the condensers of successive groups in a charged or uncharged condition in response to successive series of impulses to register said series of impulses, a second plurality of groups of condensers, means for selectively placing the condensers of each of said latter group in a charged or uncharged condition to register information for controlling the extension of telephone connections, a group of relays, means for successively associating said latter groups of condensers and certain of said first groups of condensers in a definite order with said group of relays whereby upon the association of said relays with each group of condensers said relays are selectively operated by the discharge of the charged condensers of said group, and selection controlling means controlled by said relays.

9. In a telephone system, means responsive to series of incoming impulses, a first plurality of groups of condensers, means controlled by said responsive means for selectively placing the condensers of successive groups in a charged or uncharged condition in response to successive series of impulses to register said series of impulses, a second plurality of groups of condensers, means for selectively placing the condensers of each of said latter groups in a charged or uncharged condition to register information for controlling the extension of telephone connections, a group of relays, means for successively associating said latter groups of condensers and certain of said first groups of condensers in a definite order with said group of relays whereby upon the association of said relays with each group of condensers said relays are selectively operated by the discharge of the charged condensers of said group, and selection controlling and impulse transmitting means controlled by said relays.

10. In a telephone system, a sender including means responsive to series of incoming impulses, a first plurality of groups of condensers, means controlled by said responsive means for selectively placing the condensers of successive groups in a charged or uncharged conditions in response to successive series of impulses to register the office code and numerical digits of telephone designations, and a second plurality of groups of condensers, a decoder, means for associating said decoder with said sender, relay registers in said decoder selectively operative upon the association of said decoder with said sender by the charged or uncharged condition of the condensers of the groups upon which the office code digits are registered, translating means operable by said relay registers, and means controlled by said translating means for selectively placing the condensers of said second plurality of groups in a charged or uncharged condition to register translated designations.

11. In a telephone system, a sender including means responsive to series of incoming impulses, a first plurality of groups of condensers, means controlled by said responsive means for selectively placing the condensers of successive groups in a charged or uncharged condition in response to successive series of impulses to register the office code and numerical digits of telephone designations, and a second plurality of groups of condensers, a decoder, means for associating said decoder with said sender, relay registers in said decoder selectively operative upon the association of said decoder with said sender by the

charged or discharged condition of the condensers of the groups upon which the office code digits are registered, translating means operable by said relay registers, means controlled by said translating means for selectively placing the condensers of said second plurality of groups in a charged or uncharged condition to register translated information, and means successively controlled by groups of condensers of the first and second groups for controlling the establishment of connections.

12. In a telephone system, a sender including means responsive to series of incoming impulses, a first plurality of groups of condensers, means controlled by said responsive means for selectively placing the condensers of successive groups in a charged or uncharged condition in response to successive series of impulses to register the office code and numerical digits of telephone designations, and a second plurality of groups of condensers, a decoder, means for associating said decoder with said sender, relay registers in said decoder selectively operable upon the association of said decoder with said sender by the charged or discharged condition of the condensers of the groups upon which the office code digits are registered, translating means operable by said relay registers, means controlled by said translating means for selectively placing the condensers of said second plurality of groups in a charged or uncharged condition to register translated information, a group of selection controlling relays in said sender, means for successively associating said second groups of condensers and certain of said first groups of condensers upon which the numerical digits are registered in a definite order with said selection controlling relays whereby upon the association of said relays with each group of condensers said relays are selectively operated by the discharge of the condensers of said groups, and selection controlling means controlled by said latter relays.

13. In a telephone system, a sender including means responsive to series of incoming impulses, a first plurality of groups of condensers, means controlled by said responsive means for selectively placing the condensers of successive groups in a charged or uncharged condition in response to successive series of impulses to register the office code and numerical digits of telephone designations, and a second plurality of groups of condensers, a decoder, means for associating said decoder with said sender, relay registers in said decoder selectively operable upon the association of said decoder with said sender by the charged or uncharged condition of the condensers of the group upon which the office code digits are registered, translating means operable by said relay registers, means controlled by said translating means for selectively placing the condensers of said second plurality of groups in a charged or uncharged condition to register translated information, a group of selection controlling relays in said sender, means for successively associating said second groups of condensers and certain of said first groups of condensers in a definite order with said selection controlling relays whereby upon the association of said relays with each group of condensers said relays are selectively operated by the discharge of the condensers of said group, and selection controlling means and impulsing means controlled by said latter relays.

14. In a telephone system, a sender including means responsive to series of incoming impulses, a plurality of groups of condensers, means controlled by said responsive means for selectively placing the condensers of successive groups in a charged or uncharged condition in response to successive series of impulses to register the office code and numerical digits of telephone designations, and a second plurality of groups of condensers, a decoder, means for associating said decoder with said sender, relay registers in said decoder selectively operative upon the association of said decoder with said sender by the

trolled by said responsive means for selectively placing the condensers of successive groups in a charged or uncharged condition in response to successive series of impulses to register the office code digits of telephone designations, a decoder, 5
 a plurality of groups of receiving relays in said decoder, means for establishing a receiving path from each condenser to each group of relays respectively whereby said relays are operative, and 10
 means controlled by said relays for determining if said receiving paths are all in operative condition.

15. In a telephone system, a sender including means responsive to series of incoming impulses, a plurality of groups of condensers, means controlled by said responsive means for selectively 15
 placing the condensers of successive groups in a charged or uncharged condition in response to successive series of impulses to register the office code digits of telephone designations, a decoder, 20
 a plurality of groups of receiving relays in said decoder each comprising two oppositely polarized relays, means for establishing a receiving path from each condenser to each group of relays respectively whereby one or the other of said relays 25
 will be operative in accordance with the charged or uncharged condition of the associated condenser, and means controlled by said relays for determining if said receiving paths and condensers are in an operative condition.

30 16. In a telephone system, a sender including a

plurality of groups of condensers, a decoder, a plurality of checking relays in said decoder, means for establishing a transmitting path from each relay to each condenser respectively whereby said relays are operative, and means controlled by said relays for determining if said transmitting paths and said condensers are in operative condition. 5

17. In a telephone system, a sender including means responsive to series of incoming impulses, a first plurality of groups of condensers, means controlled by said responsive means for selectively placing the condensers of successive groups in a charged or uncharged condition in response to successive series of impulses to register the office code digits of telephone designations, and 15
 a second plurality of groups of condensers, a decoder, a plurality of groups of receiving relays, and a plurality of checking relays in said decoder, means for associating said decoder with said sender thereby establishing a receiving path 20
 from each condenser of said first group to each group of receiving relays respectively, and a transmitting path from each checking relay to each condenser of said second group respectively whereby said receiving and checking relays are 25
 operative, and means controlled by said relays for determining if said receiving and transmitting paths are all in an operative condition.

CHARLES E. GERMANTON. 30