Sept. 17, 1940. H. C. CAVERLY 2,214,809

TELEPHONE SYSTEM

Filed Aug. 23, 1939 16 Sheets-Sheet 1

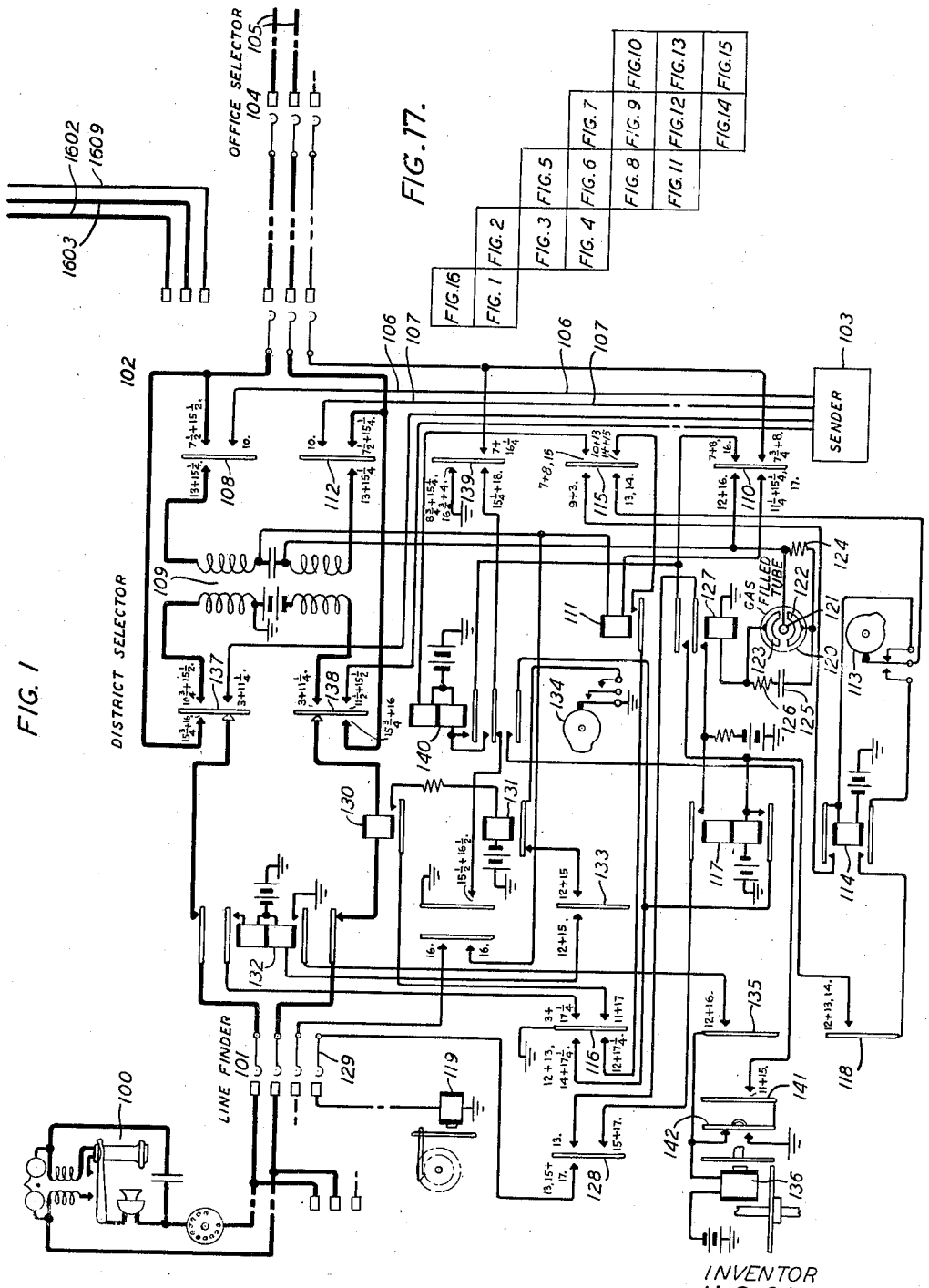


FIG. 1

INVENTOR
H. C. CAVERLY
BY
R. C. Smith
ATTORNEY

Sept. 17, 1940. H. C. CAVERLY 2,214,809

TELEPHONE SYSTEM

Filed Aug. 23, 1939 16 Sheets-Sheet 2

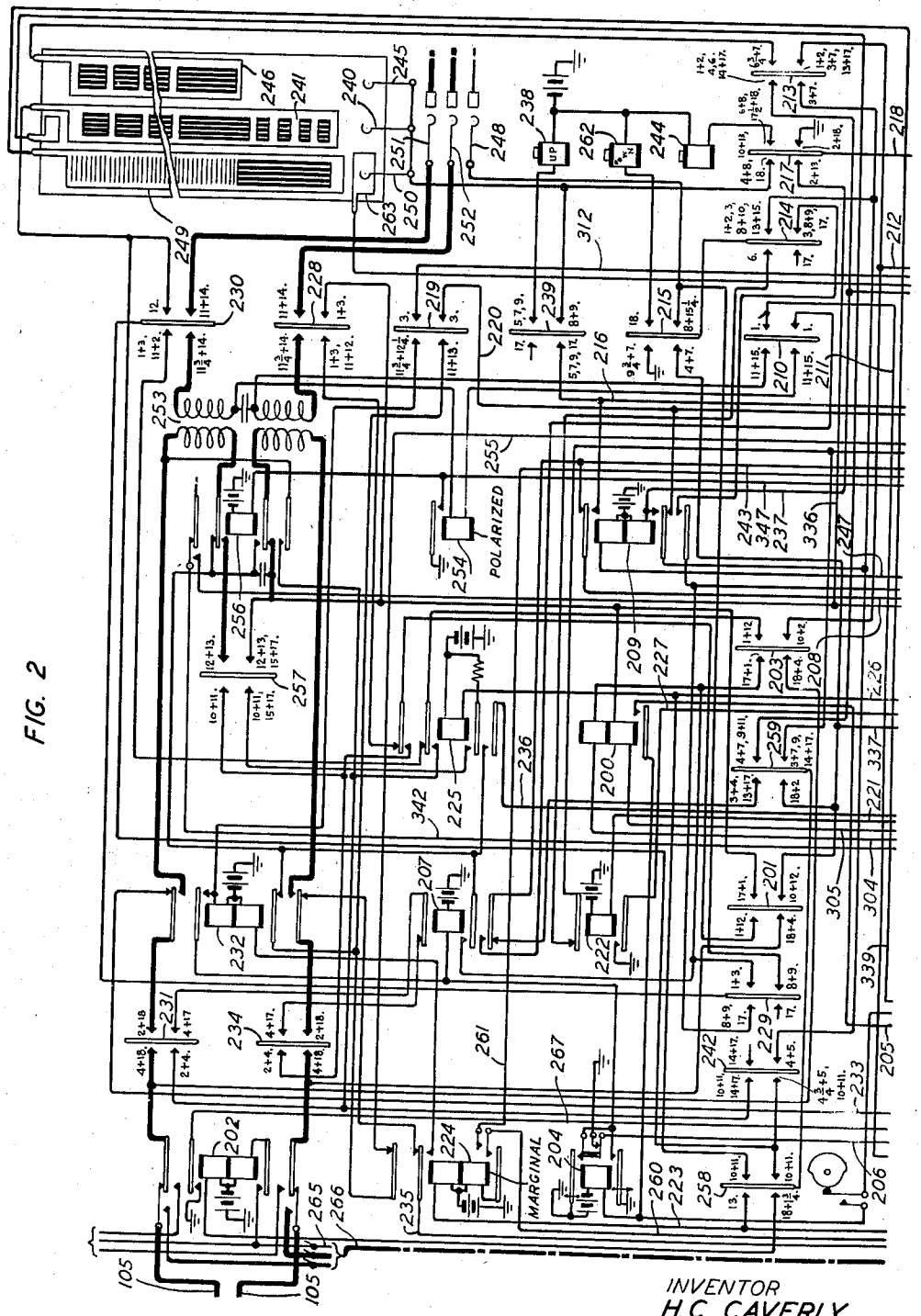


FIG. 2

INVENTOR
H. C. CAVERLY
BY
P. C. Smith
ATTORNEY

Sept. 17, 1940. H. C. CAVERLY 2,214,809

TELEPHONE SYSTEM

Filed Aug. 23, 1939 16 Sheets-Sheet 3

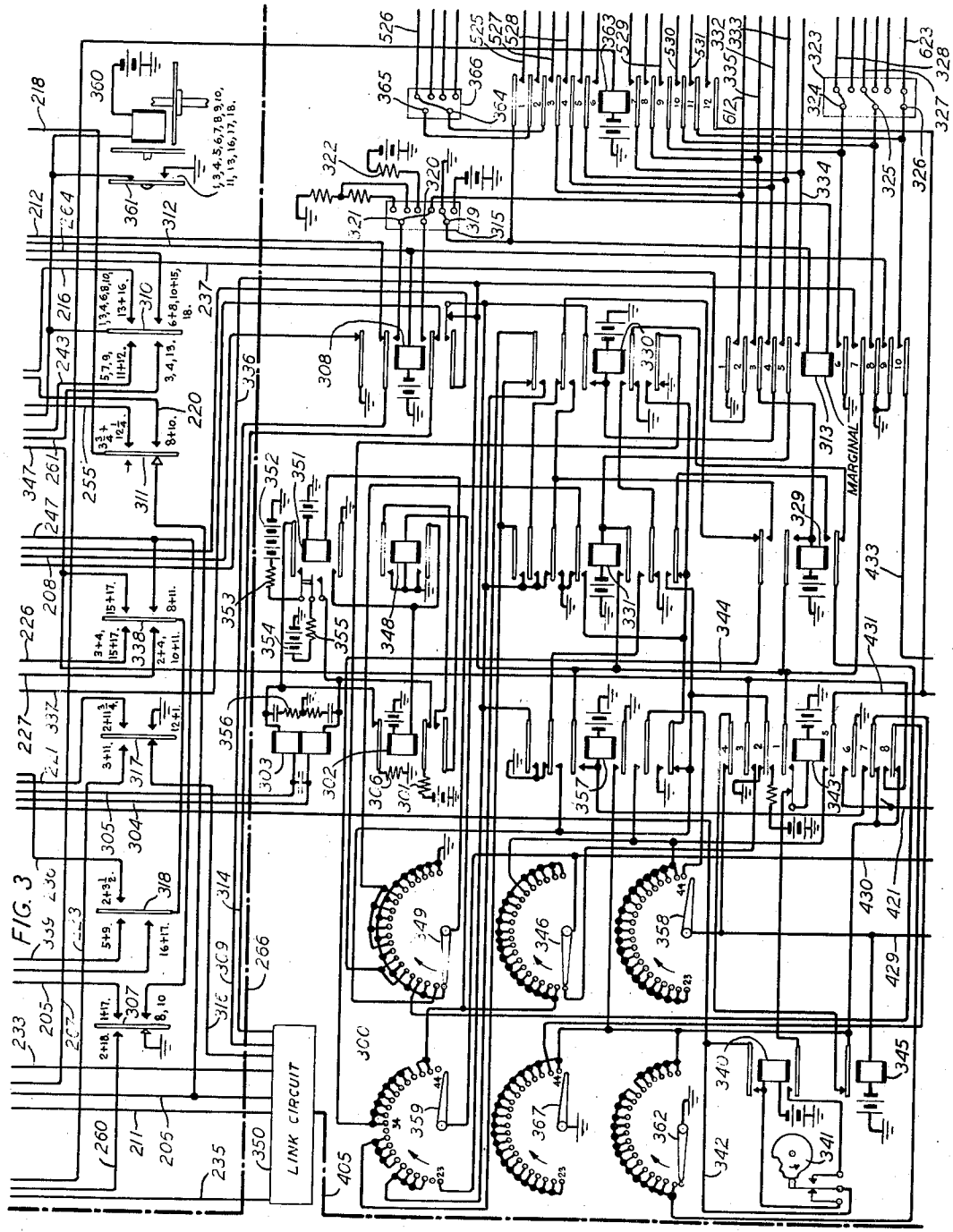


FIG. 3

INVENTOR
H. C. CAVERLY
BY
P. C. Smith
ATTORNEY

Sept. 17, 1940. H. C. CAVERLY 2,214,809

TELEPHONE SYSTEM

Filed Aug. 23, 1939 16 Sheets-Sheet 4

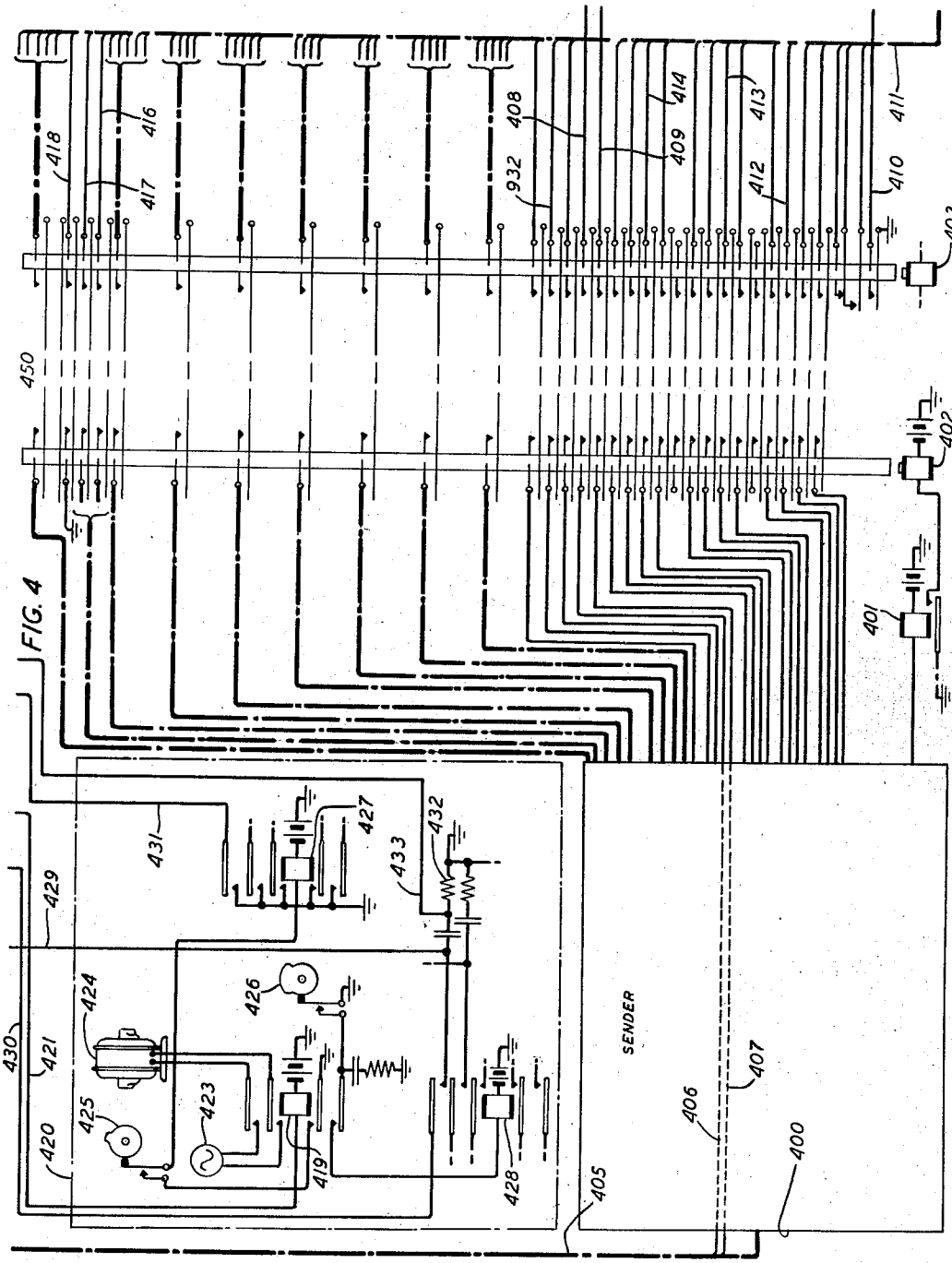


FIG. 4

INVENTOR
H.C. CAVERLY

BY
P. C. Smith

ATTORNEY

Sept. 17, 1940. H. C. CAVERLY 2,214,809

TELEPHONE SYSTEM

Filed Aug. 23, 1939 16 Sheets-Sheet 5

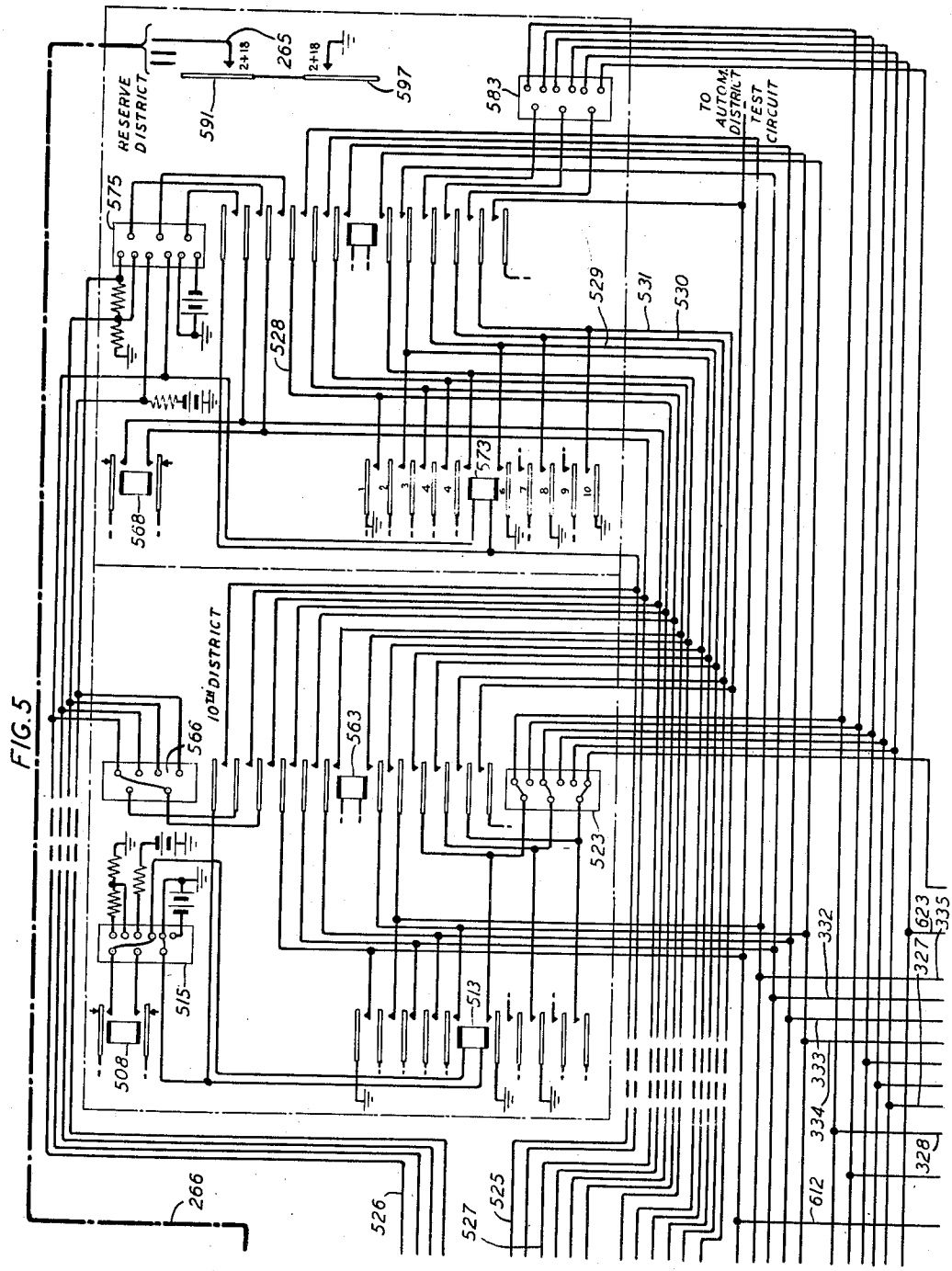


FIG. 5

INVENTOR
H. C. CAVERLY

BY
P. C. Smith

ATTORNEY

Sept. 17, 1940. H. C. CAVERLY 2,214,809

TELEPHONE SYSTEM

Filed Aug. 23, 1939 16 Sheets-Sheet 6

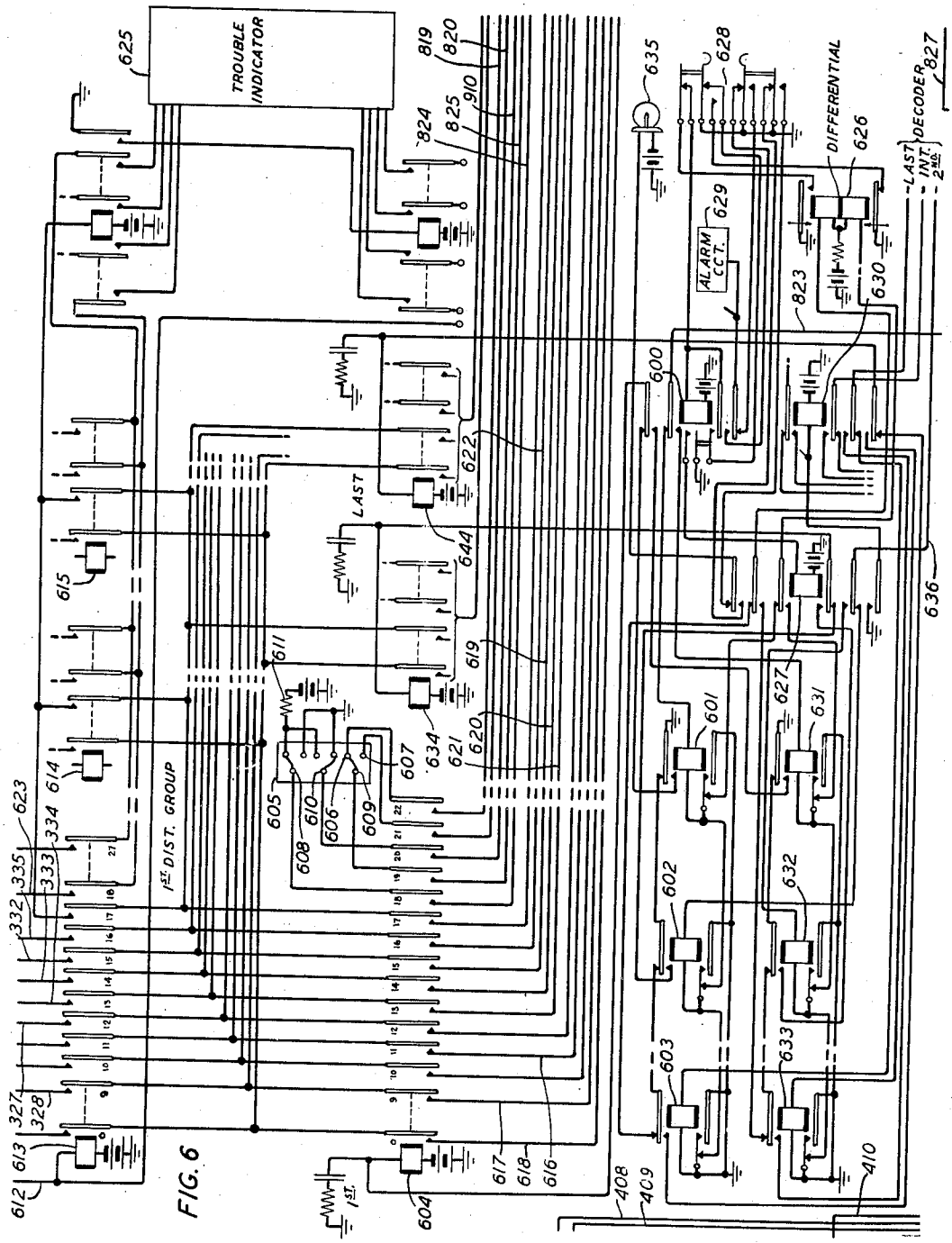


FIG. 6

INVENTOR
H. C. CAVERLY

BY
P. C. Smith

ATTORNEY

Sept. 17, 1940. H. C. CAVERLY 2,214,809

TELEPHONE SYSTEM

Filed Aug. 23, 1939 16 Sheets-Sheet 7

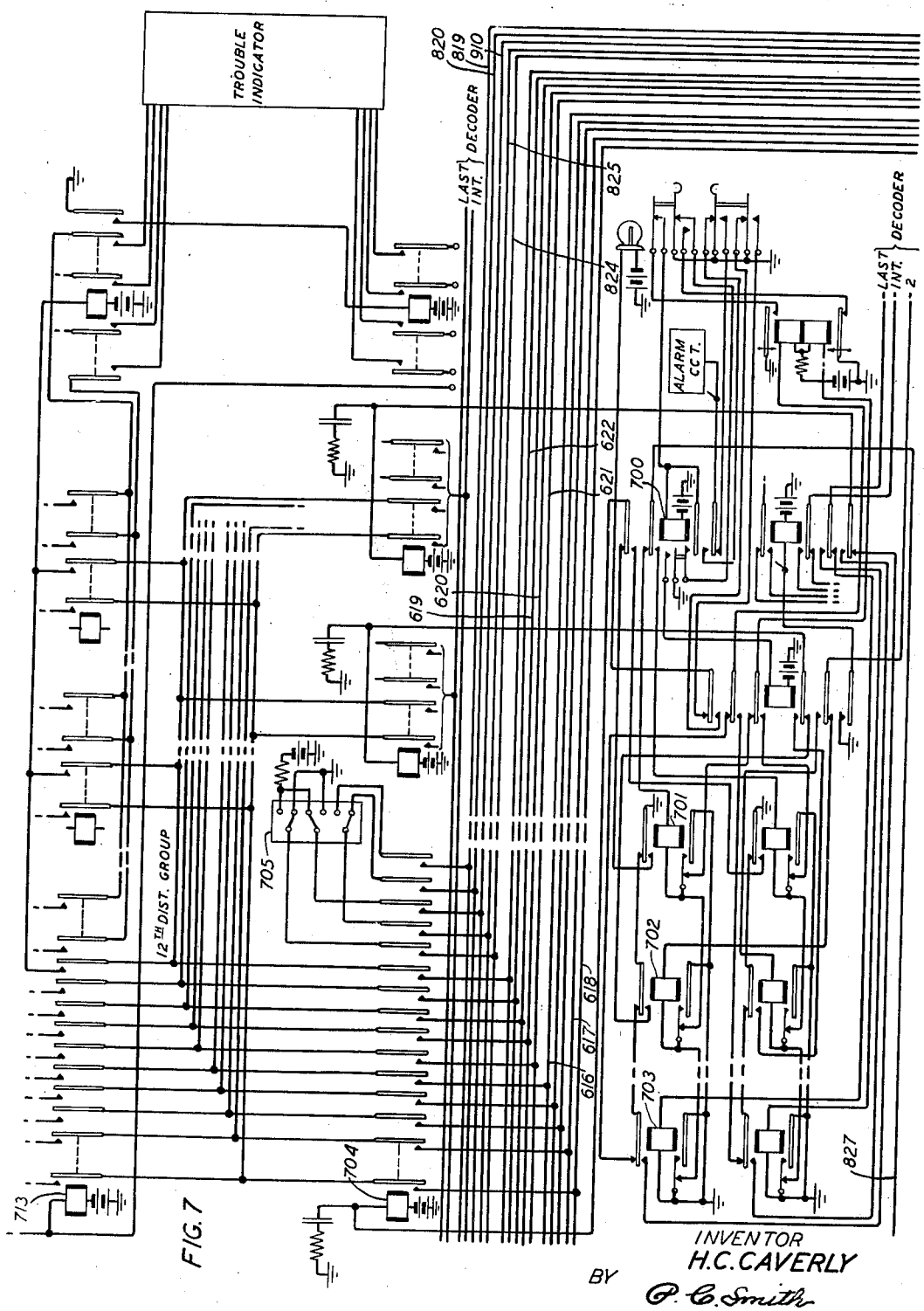


FIG. 7

INVENTOR
H.C. CAVERLY

BY
P. C. Smith

ATTORNEY

Sept. 17, 1940. H. C. CAVERLY 2,214,809

TELEPHONE SYSTEM

Filed Aug. 23, 1939 16 Sheets-Sheet 8

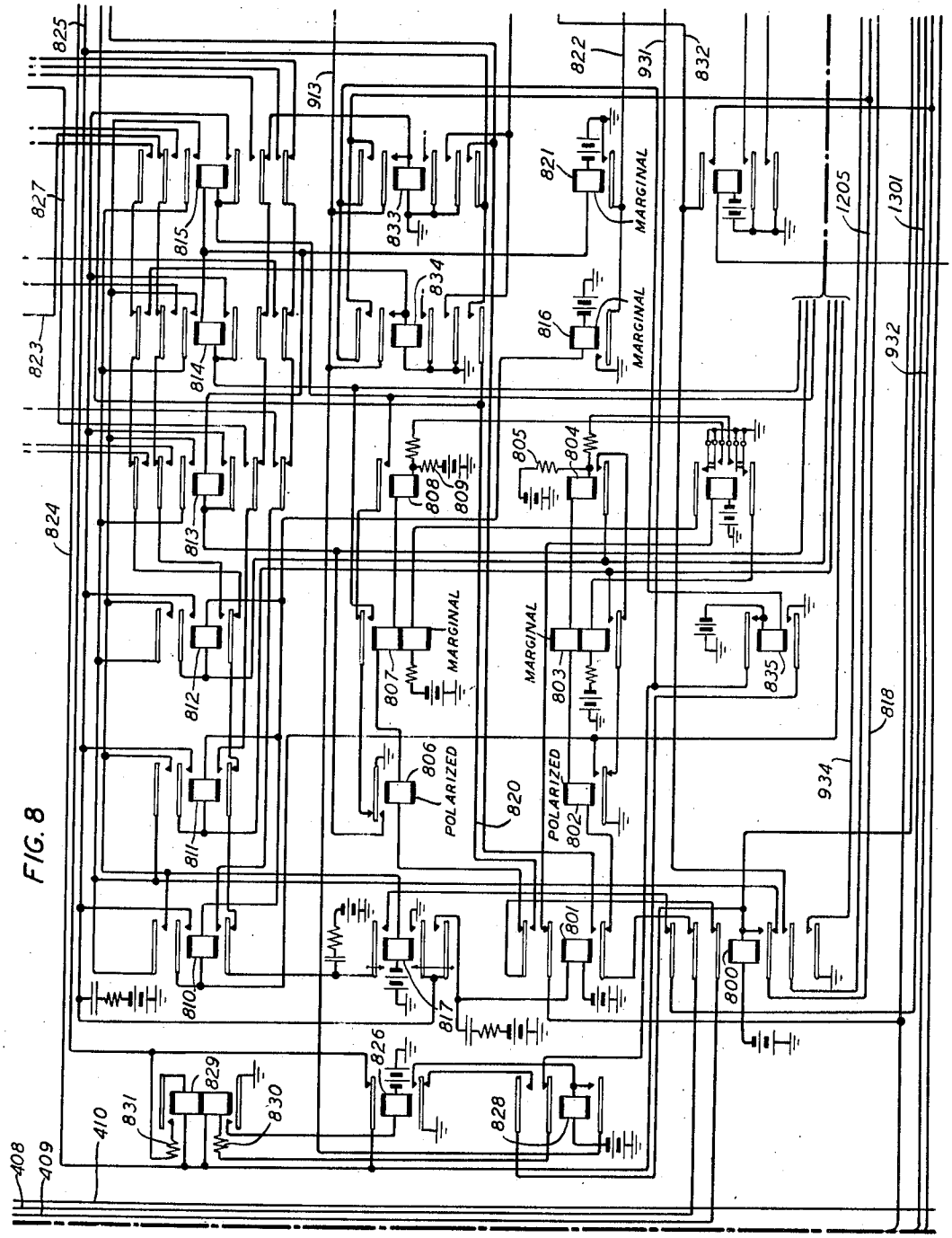


FIG. 8

INVENTOR
H.C. CAVERLY

BY P. C. Smith

ATTORNEY

Sept. 17, 1940. H. C. CAVERLY 2,214,809

TELEPHONE SYSTEM

Filed Aug. 23, 1939 16 Sheets-Sheet 9

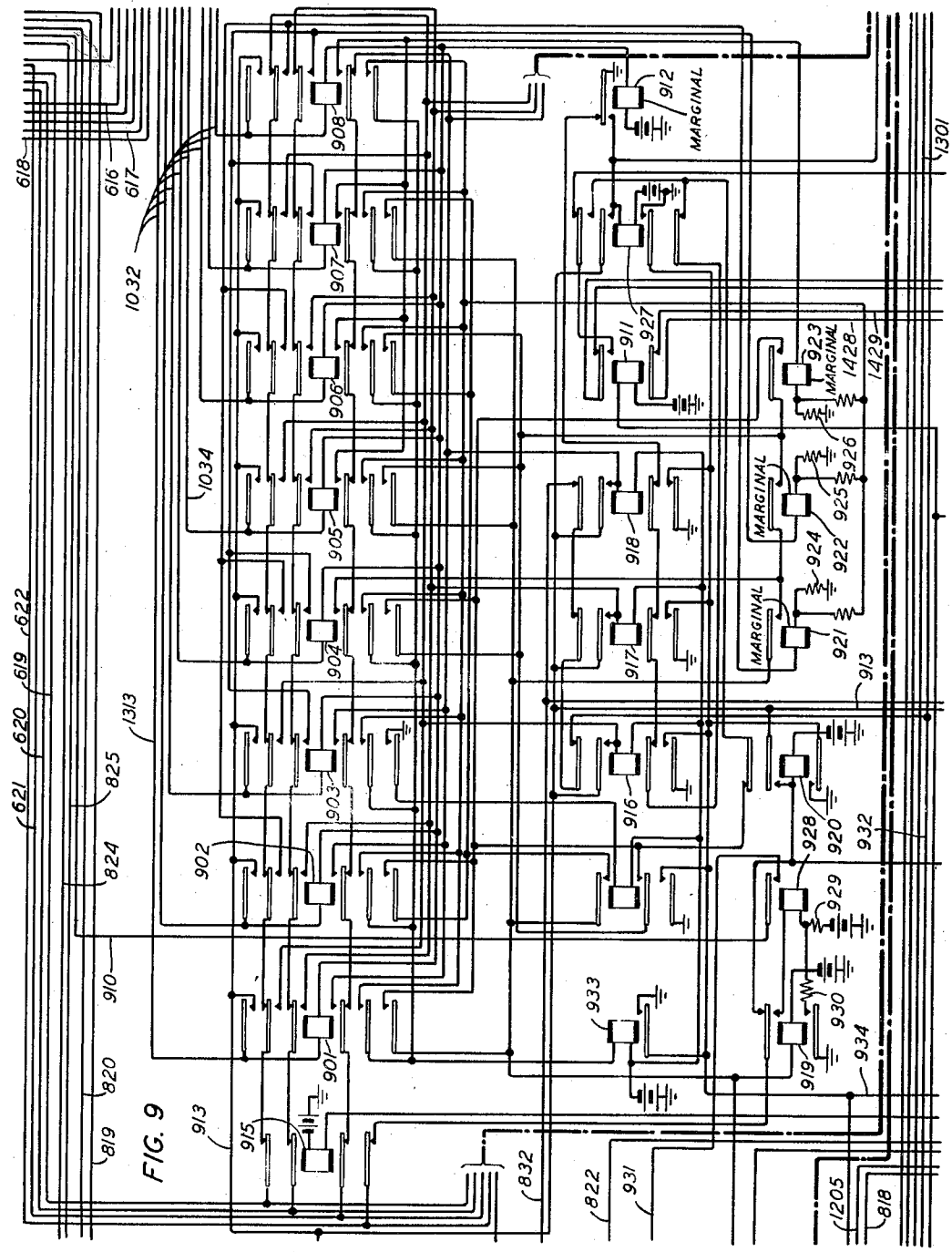


FIG. 9

INVENTOR
H. C. CAVERLY

BY
P. C. Smith

ATTORNEY

Sept. 17, 1940. H. C. CAVERLY 2,214,809

TELEPHONE SYSTEM

Filed Aug. 23, 1939 16 Sheets-Sheet 10

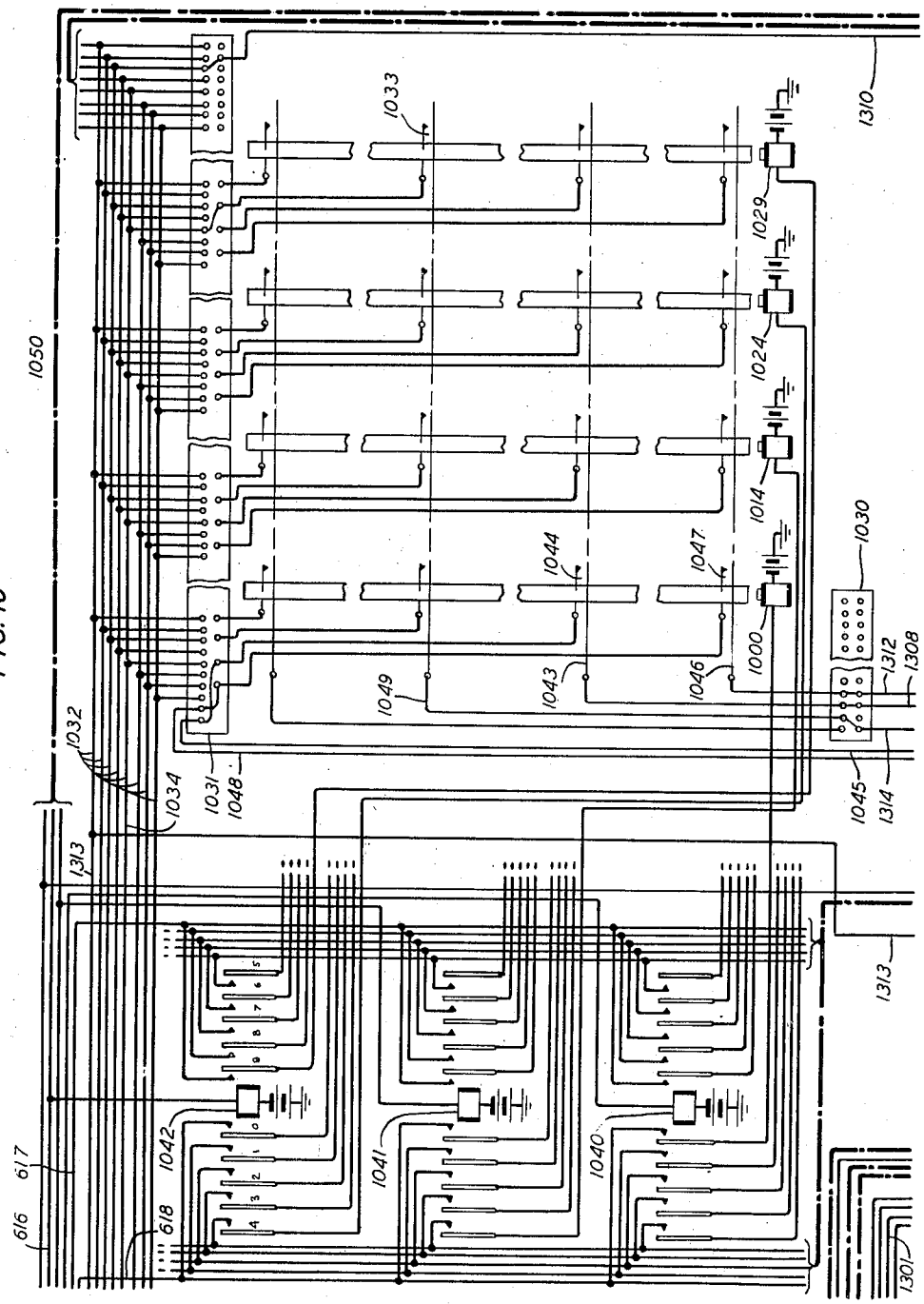


FIG. 10

INVENTOR
H.C. CAVERLY
BY
P. C. Smith
ATTORNEY

Sept. 17, 1940. H. C. CAVERLY 2,214,809

TELEPHONE SYSTEM

Filed Aug. 23, 1939 16 Sheets-Sheet 11

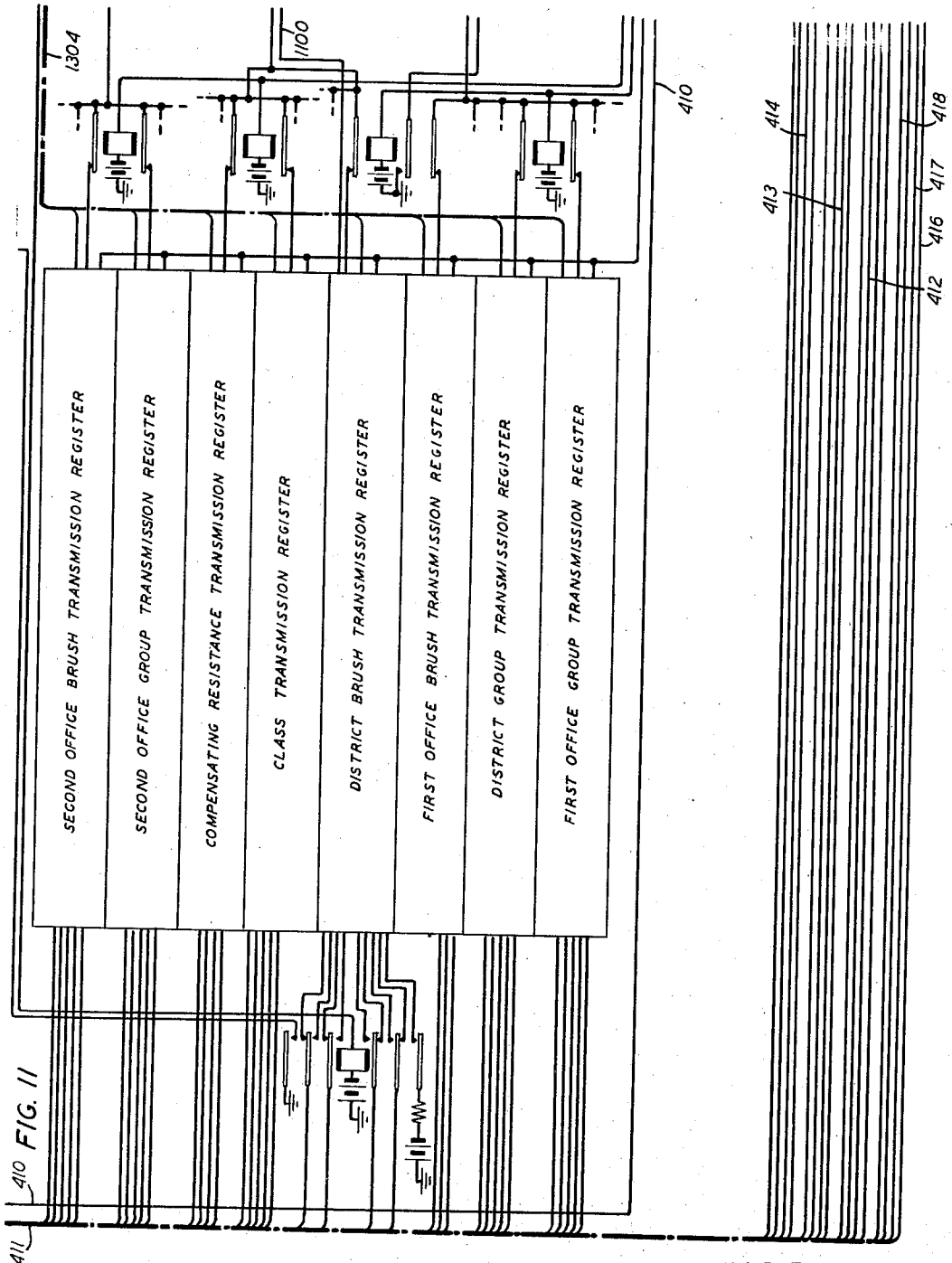


FIG. 11

INVENTOR
H. C. CAVERLY

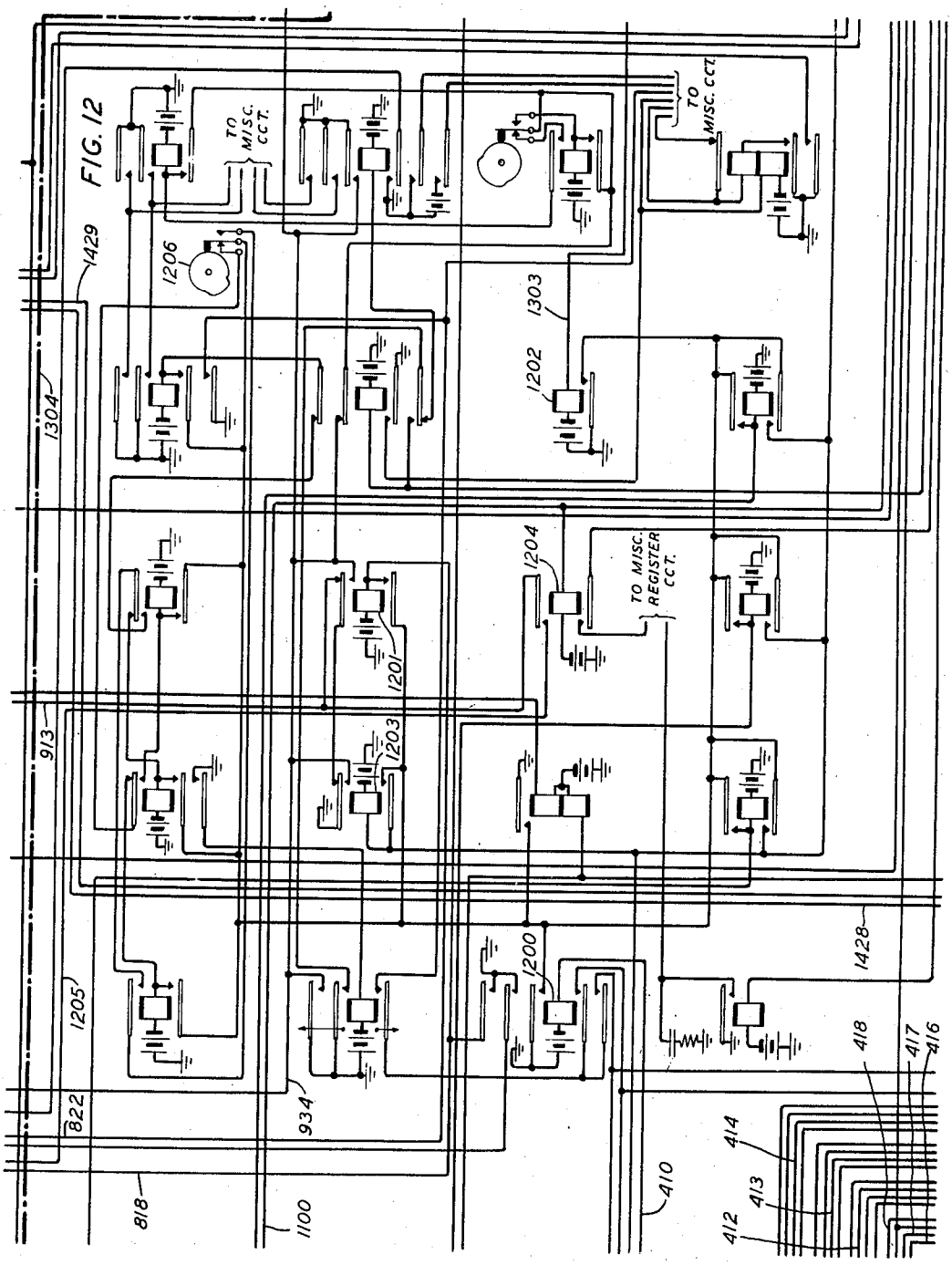
BY P. C. Smith

ATTORNEY

Sept. 17, 1940. H. C. CAVERLY 2,214,809

TELEPHONE SYSTEM

Filed Aug. 23, 1939 16 Sheets-Sheet 12



INVENTOR
H.C. CAVERLY

BY
P. C. Smith

ATTORNEY

Sept. 17, 1940. H. C. CAVERLY 2,214,809

TELEPHONE SYSTEM

Filed Aug. 23, 1939 16 Sheets-Sheet 13

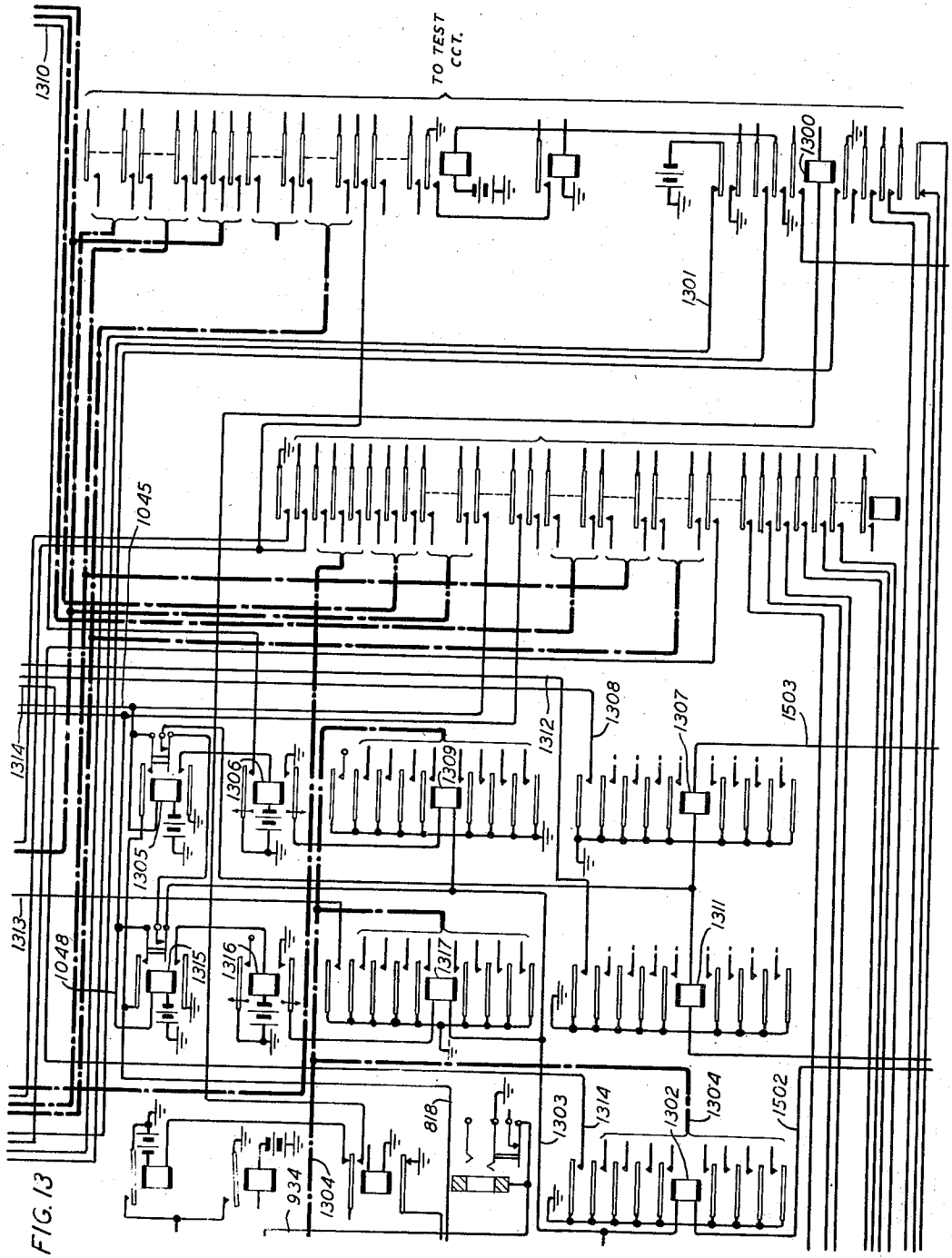


FIG. 13

INVENTOR
H. C. CAVERLY

BY P. C. Smith

ATTORNEY

Sept. 17, 1940. H. C. CAVERLY 2,214,809

TELEPHONE SYSTEM

Filed Aug. 23, 1939 16 Sheets-Sheet 14

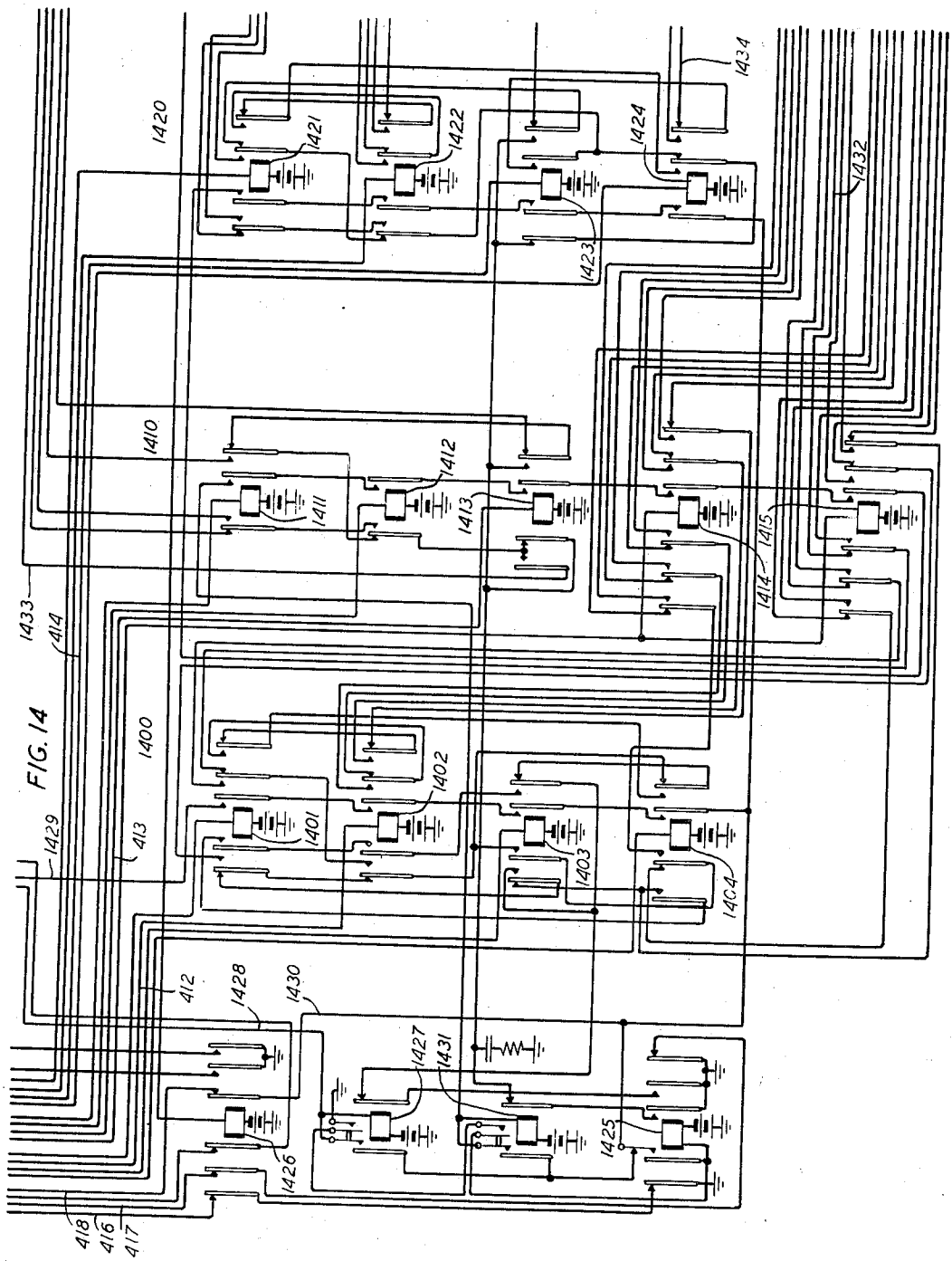


FIG. 14

INVENTOR
H. C. CAVERLY

BY P. C. Smith

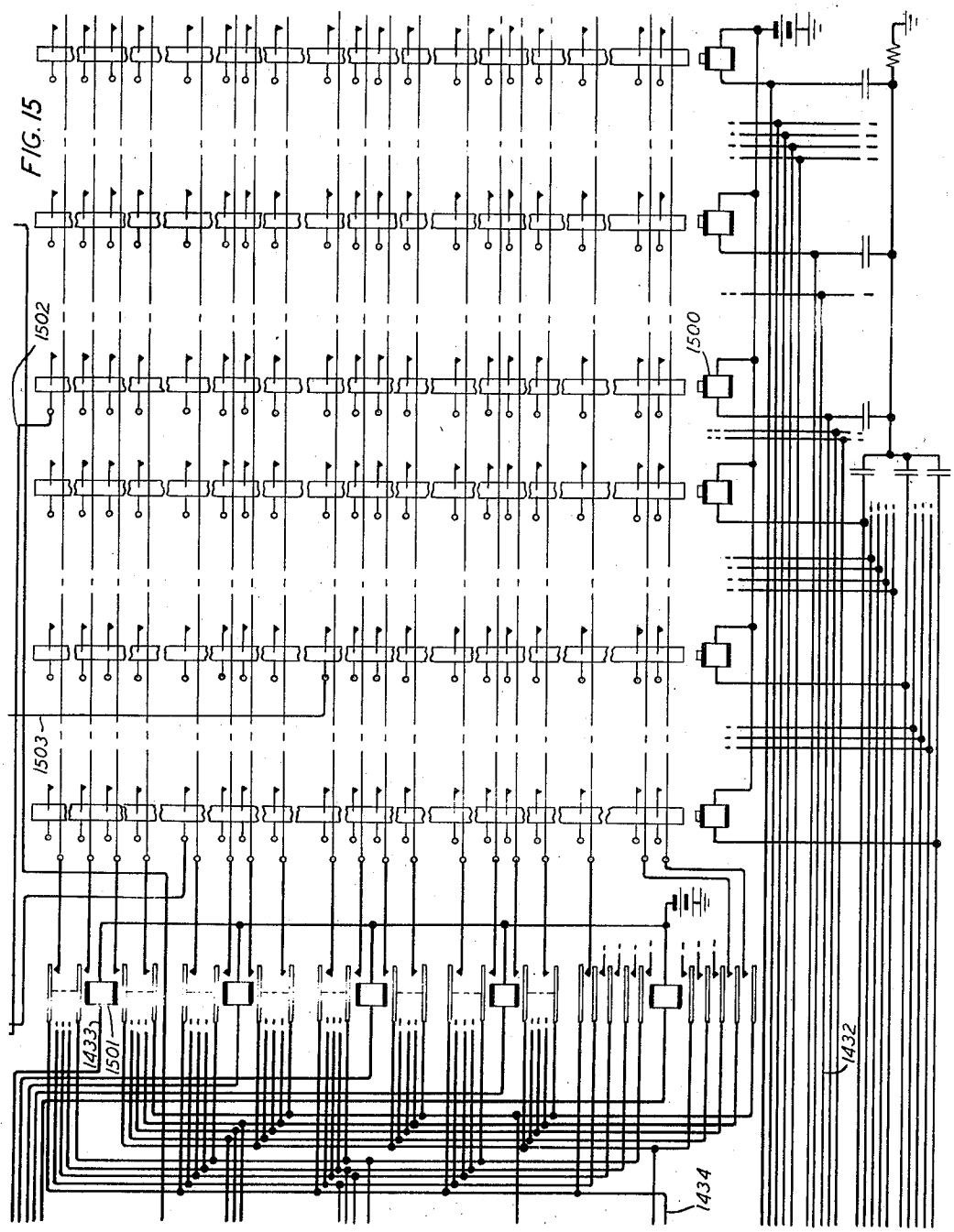
ATTORNEY

Sept. 17, 1940. H. C. CAVERLY 2,214,809

TELEPHONE SYSTEM

Filed Aug. 23, 1939 16 Sheets-Sheet 15

FIG. 15



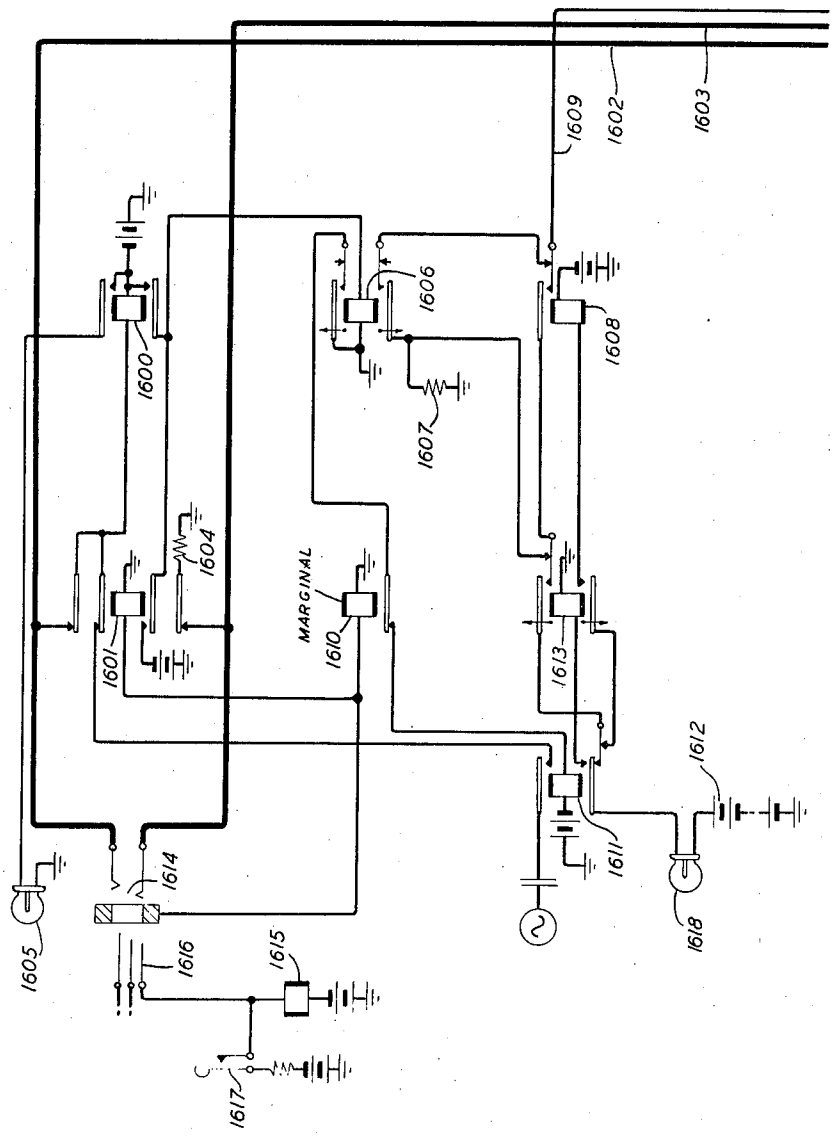
INVENTOR
H. C. CAVERLY
BY
P. C. Smith
ATTORNEY

Sept. 17, 1940. H. C. CAVERLY 2,214,809

TELEPHONE SYSTEM

Filed Aug. 23, 1939 16 Sheets-Sheet 16

FIG. 16



INVENTOR
H. C. CAVERLY

BY P. C. Smith

ATTORNEY

Patented Sept. 17, 1940 2,214,809

UNITED STATES PATENT OFFICE

2,214,809

TELEPHONE SYSTEM

Harry C. Caverly, East Orange, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application August 23, 1939, Serial No. 291,483

18 Claims. (Cl. 179—7.1)

This invention relates to telephone systems and more particularly to systems in which a charge is automatically made for each completed call in accordance with the relative location of the calling and called lines within the exchange area and in accordance with the elapsed conversational period.

In large exchange areas having several offices, some of which may be located at quite distant points in the area, it is desirable that means be provided whereby a calling subscriber may be charged differently for calls to offices which are most remotely located from the office in which the calling line terminates than for calls to offices which are not so remotely located, since to reach such remotely located offices, longer trunks and more switching equipment are required necessitating greater installation and maintenance costs. Furthermore, if such equipment is held in service on any call for long conversational periods, it is more equitable to the operating telephone company that the charges be also based on the length of the conversational period.

Heretofore, it has been proposed as disclosed in Patent 1,837,206, granted December 22, 1931, to Collis, to control the charging for calls on a zone and elapsed conversational period basis in small office areas by providing the district selector circuits of all offices with equipment for timing the duration of calls and with equipment for controlling the subscriber's message registers during the conversational period in accordance with the duration of the call and in accordance with the zone of the exchange area in which a call has been terminated. The addition of this equipment to every district selector in a large exchange area would be very expensive.

It is the usual practice in large exchange areas, in order to reduce the expense of installation which would be incurred if direct interoffice trunks were provided between all offices of the area, to provide tandem offices located in different portions of the area to which relatively short trunks from nearby offices are extended and from which outgoing trunks extend to other offices and through which calls may be trunked from one portion of the area to another. Since it is possible to trunk all interzone calls in this type of exchange system through the tandem offices, it then becomes possible to provide call charging facilities on a zone and elapsed conversational time basis by locating the timing and zoning equipment in such tandem offices and to transmit message register control impulses as determined by such tandem office equipment over the trunk incoming from the originating office to relatively inexpensive equipment in the district selector circuits of the originating office for controlling the subscriber's message register.

It is therefore the object of the present invention to provide means for charging calls on a zone and elapsed conversational period basis in large exchange areas which is economical to install, operate and maintain.

This object is attained by the provision of timing and zone charging equipment associated with the district selector of the tandem office in which each trunk incoming from an originating office terminates, which equipment is operable in accordance with the duration of the call established over the trunk and in accordance with the zone of the exchange area in which both the calling and called lines terminate and which is instrumental in transmitting message register control impulses over the talking conductors of the interoffice trunk during the conversation to the district selector circuit in the originating office. The district selector circuit of the originating office is provided with a gas-filled tube which is responsive to the message register control impulses and in turn controls the message register of the calling line.

In the application of message register control from the tandem office, it becomes necessary in determining the charge to be applied for any call extending through the tandem office that the zones in which both the calling and called lines terminate be ascertained, otherwise higher charging rates would be applied to calls established through the tandem office than would be the case were such calls established over direct trunks. Therefore, in accordance with the invention, the zone of the called subscriber is determined by the route relay of the decoder associated with the tandem office sender, which relay is selected by the office code digits registered in the usual manner in the decoder, for example as disclosed in Patent 1,840,132, granted January 5, 1932, to T. H. Roberts. The zone or dialing area in which the calling line is terminated is determined by the particular interoffice trunk over which the connection is extended to the tandem office and the zone classification thereof is transmitted to the decoder and registered therein by a group of relays. These relays in combination with the operated route relay determine the charging rate to be applied for any call by operating one of a plurality of rate register relays in the decoder. These rate register relays are then instrumental in selectively operating one or more rate relays in the zone and call duration equipment associated with the tandem district and interoffice trunk employed in the connection.

Since the link circuit which is employed in the tandem office for associating the tandem district selector in which the incoming interoffice trunk

terminates with an idle sender and decoder, does not afford sufficient circuit paths to the decoder for transmitting from the district selector to the decoder the necessary information for registering in the decoder the dialing area or zone in which the calling line is located and for transmitting information from the decoder to the district selector concerning the charge rate to be applied for the call, a district group connector is provided for establishing additional circuit paths from the decoder to the district selector. This connector comprises a plurality of district group relays one for each group of one hundred districts or a maximum of twelve and ten subgroup relays for each group relay or one relay for each subgroup of ten districts. A set of twelve district group relays is provided for each decoder and lock-out circuits are provided for preventing more than one decoder from obtaining access at any time to the same district group. For connecting a decoder with the same district selector which has been associated with an idle sender through the usual sender link, provision is made in the district to transmit signals of the well-known key pulsing character over the fundamental tip and ring conductors extended through the sender and decoder connector to registering relays in the decoder. These signals are instrumental in registering in the decoder the identification of the group of one hundred districts in which the district connected to the sender is located, the registration then being effective to operate the appropriate one of the district group relays of the district connector. If the proper group relay is operated, a signal is sent back over the fundamental circuit conductors to indicate to the district that the proper group relay of the district connector has been operated, whereupon the subgroup relay in the district connector corresponding to the subgroup in which the calling district is located is operated from the district. Circuit paths are now extended from the zone and call duration equipment of the tandem district to the decoder over which the zone indication of the calling office is transmitted to the decoder and over which the rate relays of the equipment are selectively operated from the decoder.

The zone and call duration equipment of the tandem district comprises means for transmitting the district group identification signals to the decoder during the time that the sender registers are being set to record the called line number, means for recording the fact that the decoder has operated the proper group relay of the district connector and for operating the proper subgroup relay of the district connector, means for transmitting signals to the decoder through the district connector for registering in the decoder the zone from which the call has originated, register relays for registering the charge rate for the particular call as transmitted thereto through the district connector from the decoder and a step-by-step switch for controlling the transmission of message register control impulses back over the interoffice trunk for operating the calling subscriber's message register in accordance with the rate registration set up by the rate relays. This switch is started to function upon the response of the called subscriber and during the first half of its first revolution transmits from one to eight impulses dependent upon the charge rate to be applied as registered by the rate relays. During the second half of its first revolution different intervals are measured for the initial period of conversation dependent upon the charge rate registered by the rate relays. Just prior to the completion of its first revolution an overtime relay is operated and thereafter upon each following complete revolution of the switch message register impulses are first transmitted in accordance with the charge rate to be applied as registered by the rate relays for charging for an overtime period and then an overtime period is measured also dependent upon the condition of the rate relays.

In some instances the calling subscriber may desire the assistance of an operator in establishing a desired connection and in accordance with the usual practice dials zero whereupon the connection is established at the originating office to a trunk extending to an "A" operator's position. The operator thereupon completes the desired connection. To enable the operator to charge the calling subscriber for the call in accordance with the zoning of the calling and called lines and in accordance with the elapsed time of the conversation, the trunk extending to the operator's position is provided with equipment responsive to a charging key in the operator's cord circuit for controlling the charging equipment of the originating district selector.

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

Fig. 1 shows schematically the equipment of an originating office including the line of a calling subscriber, a line finder, such portions of a district selector circuit as are necessary to an understanding of the invention, an office selector by means of which a call may be extended to any other office of the exchange area, and the outgoing end of an interoffice trunk extending to a tandem office;

Fig. 2 shows a district selector at the tandem office in which the interoffice trunk terminates and which has access to other selectors for completing a desired connection;

Fig. 3 shows the message register control equipment appertaining to the district selector of Fig. 2;

Fig. 4 shows one of the senders of the tandem office indicated by the box and a schematic representation of the decoder-connector by means of which the sender may be associated with a decoder such as is illustrated in Figs. 8 to 15, inclusive;

Fig. 5 shows schematically equipment of other tandem district selectors;

Figs. 6 and 7 taken together illustrate a district group connector for connecting any one of a plurality of tandem district selectors with that one of a plurality of decoders which has been taken for use on a call incoming to a tandem district selector;

Figs. 8 to 15 taken together illustrate such portions of one of the decoders as are necessary to an understanding of the invention;

Fig. 16 shows a trunk extending to an "A" operator's position and the call charging equipment of an operator's cord circuit; and,

Fig. 17 is a chart indicating the manner in which the several figures of the drawings should be arranged to fully disclose the invention.

The invention has been embodied in a local district selector circuit of the type disclosed in Patent 1,567,072, granted to W. H. Matthies on December 29, 1925, and in tandem office circuits of the type disclosed in Patent 1,840,132, granted

January 5, 1932, to T. H. Roberts, above referred to.

ESTABLISHMENT OF CONNECTION TO THE TANDEM OFFICE

It will be assumed that the subscriber at substation 100 initiates a call by removing his receiver from the switchhook whereupon an idle line finder 101 associated with a district selector 102 is started to hunt for and seize the calling line. Thereafter the line-finder, district-selector link 101—102 becomes associated in the well-known manner with an idle sender 103 as, for example, over a link circuit such as is disclosed in the patent to Matthies above referred to. The calling subscriber upon receiving a dial tone from the sender then proceeds to dial the office code and numerical designations of the wanted line resulting in the registration of such designations in the sender. It will be assumed that the desired line terminates in a distant office of the exchange area and that, therefore, in response to the registration of the office code designations of the wanted line number, the sender proceeds to set the district selector 102 and the office selector 104 to select an idle trunk such as 105 extending to a tandem office through which the desired line may be reached.

Upon the seizure of the idle trunk, a relay is connected across the tip and ring fundamental circuit conductors 106 and 107 at the sender 103 completing a circuit from the district selector at the tandem office which may be traced from battery through resistance 301, lower back contact of relay 302, lower winding of retard coil 303, conductor 304, upper winding of relay 200, left contacts of cam 203, upper normal contacts of relay 202, tip conductor of the interoffice trunk, through the sender, thence over the ring conductor of the trunk, lower normal contacts of relay 202, lower left and upper right contacts of cam 201, lower winding of relay 200, conductor 305, upper winding of retard coil 303, upper back contact of relay 302, through resistance 306 to ground. Relay 200 operates, closing a circuit from battery through the winding of relay 204, contact of relay 200, conductor 205 to ground over the upper right contact of cam 307. Incidentally, it may be stated that the sequence switch cams disclosed in both Figs. 2 and 3 are controlled by the sequence switch magnet 360 disclosed in Fig. 3. Relay 204 upon operating disconnects ground from conductor 206 to mark the district selector as calling to the district finder of the link circuit indicated by the small box 350 in Fig. 3 and closes an obvious operating circuit for relay 207. Relay 207 upon operating connects ground from the upper back contact of relay 308, over conductor 208, upper back contact of relay 209, lower front contact of relay 207, right contacts of cam 210 to start conductor 211 for starting an idle link circuit to select the calling district selector as identified by the removal of ground from conductor 206 and to select an idle sender. The operation of the link circuit to accomplish these functions is fully described in the patent to Roberts hereinbefore referred to.

As soon as the district selector circuit has been found, ground is connected to conductor 309 at the link circuit thereby completing a circuit from such conductor over the inner upper back contact of relay 308, conductor 212, lower right and upper left contacts of cam 213 through the lower winding of relay 209 to battery. Relay 209 upon operating locks over its inner lower front contact, the upper right contact of cam 214 and the upper left contact of cam 215 to ground; disconnects ground from the start conductor 211 and establishes a circuit from ground over conductor 208, upper front contact of relay 209, conductor 216, upper right contact of cam 310, through the winding of sequence switch magnet 360 to battery, whereby the sequence switch is advanced into position 3 under the control of its master cam 361. After it leaves position 1, the lower winding of relay 200 is connected over the lower contacts of cam 228, the upper back contact of relay 225 and the left contacts of cam 201 to the ring conductor of the interoffice trunk and the upper winding is connected over the upper right contact of cam 229, the upper left contact of cam 230, the inner upper back contact of relay 225, and the upper right and lower left contacts of cam 203 to the tip conductor of the trunk whereby relay 200 is maintained operated until after the sequence switch leaves position 3. Upon reaching position 2, ground is connected over the lower right contact of cam 217, conductor 218 and the left contact of cam 311 to conductor 206, to prevent the selection of the district selector by any other district finder and when the sequence switch leaves position 2, the locking circuit of relay 209 is opened and relay 209 releases. When the sequence switch reaches position 3, relay 308 operates in a circuit from battery through its winding, conductor 312, right contacts of cam 219, conductor 220, lower back contact of relay 209, upper right contact of cam 214, to ground at the upper left contact of cam 215; removes ground from the upper armature of relay 209, and connects the winding of relay 313 over either its inner lower or upper front contacts and conductors 309 or 314 through the link circuit to the sender 400 of Fig. 4, as soon as the sender is selected by the link circuit, as determined by the cross-connections of the cross-connecting block 315, and connects one of several different combinations of high or low resistance battery or ground to conductor 309 or 314 as determined by the cross-connections of the cross-connecting block 315 to indicate to the decoder the group of one hundred districts in which the calling district is located as will be later described.

When the sender has been found, it connects medium resistance to ground through the link circuit to conductor 316 thence over the upper right contact of cam 317, conductor 221, through the winding of relay 222 to battery and over the upper left contact of cam 317 and conductor 223 through the upper winding of relay 224 to battery. Relay 222 operates but relay 224 being marginal does not operate at this time. Relay 222 upon operating establishes the circuit of relay 225 extending from battery through the winding of relay 225, conductor 226, the left contacts of cam 336, conductor 227, contact of relay 222 to ground whereupon relay 225 operates, at its upper back contacts disconnects the windings of relay 200 from the trunk conductors and connects the trunk conductors over its upper front contacts through the link circuit to the sender, the tip conductor of the trunk being connected as previously described to the inner upper armature of relay 225, thence over the front contact thereof, the lower left and upper right contacts of cam 231, upper back contact of relay 232, conductor 233, thence through the link to the sender and the ring conductor of the trunk being connected as previously described to the upper armature of relay 225, thence over the front

contact thereof, the upper left and lower right contacts of cam 234, lower back contact of relay 232, inner upper back contact of relay 224, conductor 235, thence through the link to the sender. Relay 200 is now held operated under the control of relay 222 in a circuit extending from battery as traced through the upper winding of relay 200, inner lower front contact of relay 207, lower front contact of relay 225, conductor 236, right contact of cam 318, lower left contact of cam 338, conductor 227 to ground at the front contact of relay 222.

The disconnection of the windings of relay 200 from the trunk conductors is a signal to the sender 103 of the originating office to commence the transmission of pulse code impulses to the tandem sender 400 to transfer the office code and numerical designations of the wanted line registered therein to registers of the tandem sender. As soon thereafter as the office code has been transferred to the office code registers of the tandem sender, the tandem sender operates relay 401 which in turn operates the multicontact relay 402 individual to the sender of the decoder-connector 450 after which the multicontact relay 403 of the decoder-connector individual to an idle decoder, assumed to be the decoder disclosed in Figs. 8 to 15, inclusive, is operated. With relays 402 and 403 both operated, a plurality of control paths are established between the sender 400 and the decoder in the manner fully described in the Roberts patent hereinbefore referred to. Upon the connection of the sender to the decoder, the operation of relay 403 connects ground to conductor 410 thereby operating the decoder start relay 1200. Conductors 309 and 314 are now extended through the link circuit and over conductors 406 and 407 included in the cable 405 extending from the link circuit 350 to the sender 400, thence over contacts of relays 402 and 403 of the decoder-connector to conductors 408 and 409. Fundamental tip conductor 408 is further extended over the middle upper back contact of relay 800, lower back contact of relay 801 and thence serially through the winding of polarized relay 802, upper winding of marginal relay 803, winding of relay 804, resistance 805 to battery and fundamental ring conductor 409 is further extended over the inner upper back contact of relay 800, upper back contact of relay 801, winding of polarized relay 806, upper winding of marginal relay 807, winding of relay 808 through resistance 809 to battery.

ASSOCIATION OF TANDEM DISTRICT WITH SEIZED DECODER

It will be recalled that at the tandem district selector, relay 308 upon operating connected a combination of high or low resistance battery or ground to either or both of the fundamental tip and ring conductors 309 and 314 dependent on the cross-connections on the block 315 for identifying the group of one hundred tandem district selectors in which the calling tandem district is located. The cross-connections may be made from full battery or ground to terminal 319 of the block which is connected to one terminal of the winding of relay 313; from high resistance battery or high or low resistance ground to ring terminal 320 which is connected by relay 308 to the fundamental ring conductor 314 or high resistance battery or high or low resistance ground to tip terminal 321 which is connected by relay 308 to the fundamental tip conductor 309 and the other terminal of the winding of relay 313 may be connected to either terminal 320 or 321 to identify twelve groups of districts in accordance with the following table:

Table I

Hundred districts	Terminal 319	Terminal 321 fundamental tip	Terminal 320 fundamental ring
1st group	Ground	Relay 313.	
2nd group	do		Relay 313.
3rd group	Battery	Relay 313.	
4th group	do		Relay 313.
5th group	Ground	Relay 313	High resistance battery.
6th group	do	High resistance battery.	Relay 313.
7th group	Battery	Relay 313	Low resistance ground.
8th group	do	High resistance battery.	Relay 313.
9th group	Ground	Relay 313	Low resistance ground.
10th group	do	Low resistance ground.	Relay 313.
11th group	Battery	Relay 313	Low resistance ground.
12th group	do	Low resistance ground.	Relay 313.

In the decoder relays 802, 803 and 804 selectively respond to different ground and battery conditions applied to the fundamental tip conductor 309 at the district and thence to the fundamental tip conductor 408 and selectively control the register relays 810 to 812, inclusive, and relays 806, 807 and 808 selectively respond to different ground and battery conditions applied to the fundamental ring conductor 314 at the district and thence to the fundamental ring conductor 409 and selectively control the register relays 813 to 815, inclusive, in accordance with the following table:

Table II

District group indication	Circuit condition on tip 408	Circuit condition on ring 409	Pulse relays operated	Register relays operated
1st group	High resistance ground		804	812
2nd group		High resistance ground	808	815
3rd group	High resistance battery		802, 804	810
4th group		High resistance battery	806, 808	813
5th group	High resistance ground	do	804, 806, 808	812, 813
6th group	High resistance battery	High resistance ground	802, 804, 808	810, 815
7th group	High resistance ground	do	804, 808	812, 815
8th group	High resistance battery	High resistance battery	802, 804, 806, 808	810, 813
9th group	High resistance ground	Low resistance ground	804, 807, 808	812, 814
10th group	Low resistance ground	High resistance ground	803, 804, 808	811, 815
11th group	High resistance battery	Low resistance ground	802, 804, 807, 808	810, 814
12th group	Low resistance ground	High resistance battery	803, 804, 806, 808	811, 813

The winding of relay 313 of the tandem district selector is always connected to either the tip conductor 408 or the ring conductor 409 to introduce a high resistance ground or battery condition dependent on the cross-connection at the distributing block 315 at the district selector.

It will be assumed that the calling district is located in the first group of one hundred districts

and that in accordance with Table I, the winding of relay 313 is connected between ground and the tip terminal 321 of the cross-connecting block thus applying a high resistance ground condition to the ring conductor 408 and that the ring terminal 320 of the block is unconnected. Under this condition no circuit is established over the fundamental ring conductor but a circuit is established from ground over terminal 319, winding of relay 313, terminal 321, thence as traced serially through the windings of relays 802, 803 and 804 and resistance 805 to battery. Polarized relay 802 does not receive current in the proper direction to cause its operation at this time and due to the inclusion of the high resistance winding of relay 313, marginal relay 803 also does not operate but relay 804 operates and establishes a circuit from ground over the back contacts of relays 802 and 803, front contacts of relay 804, winding of relay 812 to battery through the winding of relay 816. Relays 313 and 816 being marginal do not operate but relay 812 operates and establishes a circuit extending from battery through the winding of relay 817, upper contact of relay 812, inner lower back contact of relay 800, conductor 818 to ground at the upper front contact of decoder start relay 1200 which operated upon the seizure of the decoder. Marginal relay 816 is provided in the operating circuits of register relays 810 to 812, inclusive, and marginal relay 821 is provided in the operating circuits of register relays 813 to 815, inclusive, so that should more than one of each of these groups of relays be falsely operated at the same time, and either or both of relays 816 and 821 be thereby operated, a circuit will be established over conductor 822 for blocking relay 1201 which will operate to block the call. With relay 817 operated, a locking circuit for register relay 812 is now established from battery through the winding of relay 816, winding and inner upper front contact of relay 812 to ground at the inner lower front contact of relay 817. Relay 817 upon operating also establishes an obvious operating circuit for relay 801 which disconnects the pulse responsive relays 802 to 804, inclusive, and 806 to 808, inclusive, from the tip and ring conductors 408 and 409 and connects these conductors to conductors 819 and 820, respectively, extending to the district group connector disclosed in Figs. 6 and 7.

With register relay 812 operated, indicating that the calling district is located in the first hundreds group, a start circuit is established from battery, over the upper back contact of relay 1300, conductor 1301, upper back contact of relay 800, upper front contact of relay 817, lower back contacts of register relays 810 and 811, lower front contact of register relay 812, middle upper back contacts of register relays 813 to 815, inclusive, conductor 823, inner upper back contact of relay 600, winding of relay 601, lower normal contacts of other chain connected relays such as 602 and 603 to ground, it being assumed that the first hundreds group section of the district group connector is not at the time allocated to the use of another decoder. Relay 601 upon operating locks over its lower alternate contacts to ground and establishes a circuit from ground over its upper contact, the upper back contacts of relay 600 to battery through the winding of multicontact relay 604 which is allocated to the first decoder assumed to be seized for use on the connection.

At the district group connector there is one regular preference relay such as 601, one emergency preference relay such as 631 and one multicontact relay such as 604 for each one hundred group of district selectors per decoder. Relays 602, 632, and 634 are individual to a second decoder and relays 603, 633 and 644 are individual to the last decoder.

Because of the chain operating circuit, relay 603 being nearest the operating ground has first preference in operating, but again due to the chain arrangement relay 601 has the preference in operating the corresponding multicontact relay 604. When all of the regular decoder relays 601, 602 and 603 are normal, a circuit is closed from battery through the lower winding of relay 626, inner upper back contact of transfer relay 627 and the lower normal contacts of relays 601, 602 and 603 to ground and a circuit is established from battery through the upper winding of relay 626, middle upper back contact of relay 627 and the upper back contacts of relays 603, 602 and 601 to ground. Relay 626, being differentially wound, does not operate as long as the chain circuits are either both open or both closed. This relay is slow to operate to prevent an undesirable operation thereof due to differences in contact transfer time of relays 601, 602 and 603. If, however, one chain remains open while the other chain remains closed, relay 626 operates, closing a circuit over its upper contact, upper normal contacts of key 628 to battery through the winding of relay 600 which operates, locks over its next-to-inner lower contacts to ground over the inner upper normal contacts of key 628; closes at its lower front contact a circuit extending from ground over the inner lower normal contacts of key 628 to the alarm circuit 629 and closes an obvious circuit for transfer relay 627 which in turn closes an obvious circuit for transfer relay 630. Relay 627 upon operating closes a circuit for trouble lamp 635 extending from battery through the lamp over the upper front contact of relay 627 to ground at the lower normal contact of key 628. Transfer relays 600, 627 and 630 also transfer the start, chain and other control circuits to the emergency relays 631, 632 and 633. If the chain circuits through contacts of these latter relays are intact, relay 626 will now release.

When key 628 is now operated, lamp 635 is extinguished, alarm 629 is silenced and a new locking circuit for relay 600 is established from battery through its winding over its next-to-inner lower contact, inner upper alternate contacts of key 628 to ground at the back contact of relay 626 and relay 600 maintains relays 627 and 630 operated. If trouble now occurs and relay 626 reoperates due to one chain circuit over contacts of relays 631, 632 and 633 remaining closed while the other chain circuit remains open, it will open the locking circuit of relay 600 which will release, in turn releasing relays 627 and 630 and the circuits of lamp 635 and alarm 629 will be again closed, the circuit of lamp 635 extending over the upper back contact of relay 627 to ground at the lower alternate contact of key 628 and the circuit of alarm 629 extending over the lower back contact of relay 600 to ground at the inner lower alternate contact of key 628. With transfer relays 600, 627 and 630 released, the start, chain and other control circuits become transferred back to the regular relays 601, 602 and 603.

Had the second decoder been seized for service by the sender, then with the register relay of such decoder corresponding to relay 812 operated, battery would have been applied to start conductor 636 completing a circuit over the lower back contact of relay 627 through the winding of relay

602 and lower normal contacts of relays including relay 603 to ground and relay 602 upon operating would have closed a circuit from ground over the upper back contact of relay 601, upper front contact of relay 602, inner lower back contact of relay 627 to battery through the winding of multicontact relay 634, allocated to such second decoder. Similar start circuits for other decoders extend through windings of other relays beyond relay 602 and including relay 603 which upon operating control circuits for other multicontact relays such as 644.

Circuits similar to those of Fig. 6 are provided for each hundreds group section of the district group connector which function in the same manner, those of the twelfth hundreds group being disclosed in Fig. 7.

Relay 604 upon operating prepares circuits extending to the decoder for use in transferring calling office zone information from the tandem district of the first hundreds group to the decoder and for transferring charge rate information from the decoder to such group of districts as will hereinafter be described. Relay 604 also connects the tip and ring conductors 819 and 820 and the conductors 824, 825 and 910 to terminals 606 to 610, respectively, of the cross-connecting block 605. A similar cross-connecting block is provided in each one hundred group section of the district group connector, the block for the twelfth section being designated 705 in Fig. 7. The terminals in each block are cross-connected differently in accordance with the following table to identify the several one hundred groups of districts as a check back to a calling district selector that the proper group has been selected in response to the identification transmitted to the decoder:

Table III

District group	Terminals 609, 709, etc., strapped to—	Terminals 608, 708, etc., strapped to—	Terminals 610, 710, etc., strapped to—
1st group	Terminal 606	Low resistance battery.	Ground.
2nd group	Terminal 607	do	Do.
3rd group	Terminal 606	Ground	Low resistance battery.
4th group	Terminal 607	do	Do.
5th group	Terminal 606	Low resistance battery.	Ground.
6th group	Terminal 607	do	Do.
7th group	Terminal 606	do	Do.
8th group	Terminal 607	Ground	Low resistance battery.
9th group	Terminal 606	Low resistance battery.	Ground.
10th group	Terminal 607	do	Do.
11th group	Terminal 606	Ground	Low resistance battery.
12th group	Terminal 607	do	Do.

Since as assumed the calling district is located in the first hundreds group and therefore direct ground through relay 313 at the district selector was connected to the tip conductor 309 and thence as traced to tip conductor 408, the circuit of relay 313 should now be completed assuming that the decoder has functioned properly to operate the multicontact reay 604 allocated to the first hundreds group section of the district group connector. Under this assumption, this circuit is now completed over the middle upper back contact of relay 800, lower front contact of relay 801, conductor 819, No. 22 contact of relay 604, strapped terminals 606 and 609 of block 605, No. 19 contact of relay 604, conductor 825, upper back contact of relay 826, conductor 824, No. 18 contact of relay 604, terminal 608, strapped to battery through resistance 611.

IDENTIFICATION OF CALLING ZONE TO DECODER

Relay 313 thereupon operates; at its No. 1 contact establishes a circuit extending from ground over conductor 612 to battery through the winding of subgroup relay 613 of the district group connector which identifies the subgroup of ten districts in which the calling district is located; at its No. 9 contact establishes a holding circuit for relay 303 after relay 209 has operated and over its Nos. 6, 8 and 10 contacts connects ground to the left terminals of distributing block 323. The upper left terminal 324 is strapped to one of ten upper right units terminals on the block, the first and tenth of which are shown, and the terminal 325 is strapped to one of the next three lower right tens terminals to indicate the calling area from which the district was seized and thus the calling zone of the calling line and the terminal 326 is strapped to one of ten lower right terminals of which only one is shown to identify the calling district in case a trouble indicator is called in on a stuck connection. By this strapping of the terminals 325 and 324 to any one of the tens and units terminals of the block, the district may be identified as having been reached from any one of thirty calling zones or classes. These tens and units terminals are connected by groups of conductors through contacts of the district subgroup relay 613 and contacts of the hundreds group relay 604 of the district connector to the charge rate indicator 1050 of the decoder disclosed in Fig. 10.

In Fig. 5 a portion of the apparatus of the tenth district in the subgroup in which the district shown in Figs. 2 and 3 is located has been illustrated, relay 508 thereof functioning in connection with the cross-connection block 515 to cause the decoder to operate the district group relay 604 of the district connector and to cause the operation of relay 513 which upon operating will cause the operation of subgroup relay 613 of the district connector and will in conjunction with the associated cross-connection block 523 selectively establish circuits over the groups of tens and units conductors through contacts of relays 604 and 613 of the district connector to the charge rate indicator 1050 of the decoder.

Had the calling district been located in some other tens subgroup of the first hundreds group, then some other subgroup relay, such as relay 614 or 615 of Fig. 6, of the district connector would be operated following the operation of group relay 604 as previously described. If the calling district had been located in some other hundreds group, another one of the district group relays corresponding to relay 604 would have been operated followed by the operation of a subgroup relay corresponding to relay 613 of the ten districts in which such district is located. For example, if the calling district were assumed to be the twelfth hundreds group and in the first tens subgroup thereof, group identification relays 811 and 813 of the decoder would have been operated in accordance with Tables I and II, resulting in the establishment of a circuit over start conductor 827, the upper back contact of relay 700, winding of relay 701, normal contacts of relays 702 and 703 to ground, thereby causing the operation of relay 701 followed by the operation of group relay 704. Following the operation of relay 704, the relay of such calling district corresponding to relay 313 would be operated to cause the operation of tens subgroup relay 713 and the extension of the cir-

cuit paths from such district over contacts of relays 713 and 704 to the decoder.

Returning to a further consideration of the operations incident to the seizure of the tandem district selector of Figs. 2 and 3, it will be assumed that the terminals of cross-connecting block 323 are strapped to identify the district as having been seized from an originating office located in the twenty-ninth calling zone of the exchange area. Therefore upon the operation of relay 313 as previously described, a circuit is established from ground over the No. 8 contacts thereof, strapped terminals of block 323, conductor 327, No. 12 contacts of relays 613 and 604, conductor 616, winding of tens register relay 1042 to battery thereby operating this relay, whereupon a further circuit is established from ground over the No. 6 contacts of relay 313, strapped terminals of block 323, conductor 328, No. 9 contacts of relays 613 and 604, conductor 617, No. 9 contact of relay 1042 to battery through the winding of multicontact relay 1029. To register the thirty zones or classes requiring different charging conditions to terminating zones, thirty such multicontact relays are provided, only four of which, 1000, 1014, 1024 and 1029, are disclosed. Any one of these relays may be operated through the operation of one of the three tens registering relays 1040, 1041 or 1042 in response to the connection of ground to its operating circuit at a district selector and by the connection of ground at the district selector to one of the ten units conductors such as 617 and 618 multipled to the contacts of the relays 1040, 1041 and 1042.

Relay 313 also establishes a circuit for identifying the calling district selector to the trouble indicator 625 which serves the subgroup of ten districts in which the calling district is located, which may be traced from ground through resistance 432, conductor 433, No. 10 contact of relay 313, terminal 326 strapped to one of ten conductors such as 623 extending over Nos. 18 to 27 contacts of relay 613 to the trouble indicator 625.

Identification of Called Zone to Decoder

In the meantime the tandem sender has been receiving code impulses from the originating sender 103 with respect to the numerical digits of the wanted line, has registered this information and has proceeded to transfer the registered office code digits to the office code registers of the decoder designated 1400, 1410 and 1420 in Fig. 14. The settings of these registers are translated to operate additional sets of relays disclosed in Fig. 15 to mark a point to identify the routing indicated by operating a corresponding route relay, several of which are shown in Fig. 13. The operated route relay in turn sets a group of outgoing or transmitting registers disclosed in Fig. 11 which control the settings of the selection control registers of the sender in a manner fully set forth in the patent to Roberts hereinbefore referred to. As soon as the decoder was connected to the sender over the decoder connector 450 as previously described, circuits were established over contacts of the office code register relays of the sender to the windings of the corresponding relays of the incoming registers 1400, 1410 and 1420 of the decoder over the cable of conductors 411.

It will be assumed that the calling subscriber has dialed the called subscriber's number, CHelsea 4–5678, and that therefore the code registers of the sender have been so set as to establish the following circuits for operating the incoming registers of the decoder; conductor 412, winding of relay 1402 to battery; conductor 413, winding of relay 1413 to battery and conductor 414, winding of relay 1423 to battery. Relays 1402, 1413 and 1423 thereupon operate. At the same time ground is applied from the left back contact of relay 1425 over the left back contact of relay 1426, conductor 416, through the decoder-connector to the sender and over the right back contact of relay 1425 and the middle left back contact of relay 1426, conductor 417, through the decoder-connector to the sender. These circuits are extended at the sender over back contacts of unoperated office code register relays to the windings of corresponding relays of the incoming registers 1400, 1410 and 1420 of the decoder. Therefore all of the register relays of the decoder are operated if the conductors connecting the register relays of the office code registers of the sender with the incoming register relays of the decoder are unbroken. With all of the incoming register relays of the decoder now operated, a circuit is established from battery through the winding of relay 1427, conductor 1428, lower back contact of relay 911, conductor 1429, inner right front contacts of register relays 1401 to 1404, inclusive, conductor 1430, inner right back contact of relay 1426, conductor 418, through the decoder-connector to ground and a circuit is established from battery through the winding of relay 1431, innermost right front contacts of register relays 1411 to 1415, inclusive, inner left front contacts of register relays 1421 to 1424, inclusive, conductor 1430 and thence as traced to ground at the decoder-connector. Relays 1427 and 1431 thereupon operate and lock over their left front contacts and the inner left normal contacts of relay 1425 to ground on conductor 1430 and establish an obvious circuit for relay 1425 which operates, locks to ground on conductor 1430, opens the locking circuits of relays 1427 and 1431 and disconnects ground from conductors 416 and 417, releasing all register relays of the incoming registers of the decoder except those which correspond to operated register relays of the sender. As soon as any relay of each incoming register releases, relays 1427 and 1431 release.

With relays 1427 and 1431 released and relay 1425 operated, circuits are established over contacts of the operated relays of the incoming registers of the decoder for operating the translating relays of the decoder. The first of these circuits is established from ground at the outer right front contact of relay 1425, right back contact of relay 1427, right back contact of register relay 1403, right back contact of register relay 1404, outer left front contact of register relay 1402, inner right back contact of register relay 1401, inner left back contact of register relay 1415, conductor 1432, winding of multicontact relay 1500 to battery; the second of these circuits is established from ground at the inner right front contact of relay 1425, right back contact of relay 1431, outer right front contact of register relay 1413, right back contact of register relay 1411, left back contact of register relay 1412, left front contact of register relay 1413, conductor 1433, winding of relay 1501 to battery and the third of these circuits is established from ground at the inner right front contact of relay 1425, right back contact of relay 1431, right front contact of register relay 1423, inner right back contact of register relay 1421, left back contact of register relay 1422, inner right front contact of

register relay 1423, outer right back contact of register relay 1424, conductor 1434, to the upper armature of relay 1501. With relays 1500 and 1501 both operated, the third circuit is extended over the upper front contacts of relays 1501 and 1500, conductor 1502, winding of route relay 1302, conductor 1303 through the winding of relay 1202 to battery. Relay 1202 upon operating connects ground to the armature of timing interrupter 1206 to start the timing operation to sound an alarm in case the circuit of route relay 1302 becomes permanently grounded.

Since there are twenty relays in the horizontal group containing relay 1500, of which only six are illustrated, and five relays in the vertical group containing the relay 1501 and each of the latter relays has ten contacts, it is possible to select any one of one thousand code points in the contact field of Fig. 15, by the selective operation of one relay in each group and the selection of one of the contacts of the operated relay in the vertical group to thereby operate any one of one thousand route relays such as 1302. A separate route relay for each code point is not, however, necessary but only as many as are required to give the sender the distinctive information necessary for establishing calls to all destinations which may be reached. The several code points which would give the sender the same information are cross-connected to the same route relay as, for example, all cross-points which correspond to all unused office codes.

Each route relay such as 1302 controls the transmission of information to the sender for the selection of the proper trunk group outgoing from the tandem office for extending the call to a particular terminating office, for the determination of the class of the call and for the determination of the compensating resistance to be employed in the fundamental circuit over which the establishment of the connection is controlled by the sender. This information is transmitted by the route relay 1302 by grounding a selection of conductors extending through the cable 1304 to the outgoing or transmission registers of the decoder illustrated by the boxes of Fig. 11 and these registers then proceed to transmit this information over conductors extending through cable 411 and over contacts of the decoder-connector 450 to the selection controlling registers of the sender 400. The sender selection controlling registers are thereby selectively set preparatory to the setting of the district selector of Figs. 2 and 3 and office selectors, if required, to select a trunk outgoing from the tandem office and terminating in the office in which the wanted line terminates, in the case assumed, in the CHelsea 4 office. These operations are performed in the manner fully set forth in the Roberts patent hereinbefore referred to.

In addition the route relay connects ground to one of ninety-nine horizontal multiples of the relays 1000 to 1029, inclusive, of the rate indicator 1050 disclosed in Fig. 10 for registering therein one of ninety-nine possible called zones into which a call may be extended. For example, route relay 1302 connects ground over its upper front contact, conductor 1314, cross-connection block 1030 to horizontal multiple 1049. The decoder is arranged to register a maximum of eight charging rates which are jointly determined by the operated condition of one of the thirty calling zone identifying relays 1000 to 1029 of the rate indicator 1050 as previously described and by the grounded one of the ninety-nine horizontal called zone identifying conductors such as 1049 through the cross-connections from the front contacts of relays 1000 to 1029 over the cross-connection block 1031 to eight rate conductors in the group 1032 which are connected to rate register relays 901 to 908, inclusive. These rate register relays are in turn instrumental in selectively establishing circuits over three circuit paths extending from their contacts through the district group connector to the windings of three rate register relays 329, 330 and 331 in the tandem district in accordance with the following table:

Table IV

Decoder rate relay operated	District rate relays operated	Impulses to be transmitted from the tandem district for initial conversational period
901	None	One.
902	329	Two.
903	330	Three.
904	329, 330	Four.
905	331	Five.
906	329, 331	Six.
907	330, 331	Seven.
908	329, 330, 331	Eight.

It will be recalled that relay 313 at the tandem district selector was operated following the connection of the decoder with the district selector by the operation of the district group connector and in addition to establishing circuits for registering in the decoder information relative to the zone of the calling office established the three circuit paths above referred to as follows: (1) from battery through the winding of relay 329, No. 3 contact of relay 313, conductor 332, No. 15 contacts of relays 613 and 604 of the district group connector, conductor 619, upper back contacts of relays 915 and 901 to 908, inclusive, winding of relay 916 to battery; (2) from battery through the winding of relay 330, No. 4 contact of relay 313, conductor 333, No. 14 contacts of relays 613 and 604, conductor 620, inner upper back contacts of relays 915 and 901 to 908, inclusive, winding of relay 917 to battery; and (3) from battery through the winding of relay 331, No. 5 contact of relay 313, conductor 334, No. 13 contacts of relays 613 and 604, conductor 621, inner lower back contacts of relays 915 and 901 to 908, inclusive, winding of relay 918 to battery. A fourth circuit was also established from battery through the lower winding of relay 209, conductor 237, No. 2 contact of relay 313, conductor 335, No. 16 contacts of relays 613 and 604, conductor 622, lower back contact of relay 915, back contact of relay 919, winding of relay 920 to battery. Since the rate relays 329, 330 and 331 and relay 209 of the district selector are connected to battery, relays 916, 917, 918 and 920 should not operate at this time, but should any of the above-traced circuit paths be falsely grounded, one of the latter relays will operate and lock over conductor 913, back of relay 1201 and back contact of relay 1203 to ground and will provide a trouble release signal as later described.

Establishment of Charge Rate Registration in the Decoder

As previously described, relay 1029 of the decoder rate indicator 1050 was assumed to have been operated and therefore upon the operation of route relay 1302, ground is connected over contact 1033 of relay 1029 to a lower terminal

of block 1031 which it will be assumed is cross-connected to rate conductor 1034, establishing a circuit through the winding of rate register relay 905 and the winding of relay 912 to battery. Relay 905 operates and locks over its upper front contact to ground on conductor 913, but relay 912 being marginal does not operate. Relay 912 operates only if more than one of the register relays 901 to 908, inclusive, should be simultaneously operated by reason of false grounds or crosses on their operating circuits to perform functions later described.

TRANSFER OF CHARGE RATE REGISTRATION TO TANDEM DISTRICT

With register relay 905 operated, the circuit path previously traced from battery through the winding of register relay 331 at the tandem district selector over conductor 621, the inner lower back contact of relay 915 and the inner lower back contacts of relays 901 to 904, inclusive, is extended over the inner lower front contact of relay 905 through the winding of relay 923 and resistance 926 to ground. Relay 923 being marginal does not operate, but relay 331 operates and locks over its inner lower front contact, conductor 344, the No. 7 contact of relay 313, conductor 336 to ground over the lower contacts of cam 217. At its middle upper front contact relay 905 extends conductor 619 over the upper back contacts of relays 915 and 901 to 904, inclusive, through the winding of relay 916 to battery and at its inner upper front contact extends conductor 620 over the inner upper back contacts of relays 915 and 901 to 904, inclusive, through the winding of relay 917 to battery to again check the unused circuit paths 619 and 620 for false grounds or crosses with the circuit path 621 being used and establishes a circuit extending from battery through the winding of relay 933, middle lower front contact of relay 905 to ground through a resistance and relay 933 operates to apply ground to conductor 934 to prevent the decoder from being selected for use by another sender.

When the register relay 331 at the district selector operates and locks, the locking ground applied to its operating circuit now causes the operation of marginal relay 923 in the decoder as a check that the register relay has operated. The contacts of relay 923 are now effective, but the contacts of the other marginal relays 921 and 922 which should not be operated under the rate condition assumed are shunted by the lower contacts of register relay 905. With relay 923 operated, the circuit of relay 919 is now established from battery through its winding over the lower front contact of relay 905, the contacts of relay 923, back contact of relay 920, lower back contact of relay 927, inner lower back contacts of relays 916, 917 and 918 to ground at the back contact of relay 912 and relay 919 operates, transferring the circuit previously traced from battery through the winding of relay 209 at the district selector from the winding of relay 920 through the winding of relay 928 and resistance 929 to battery and through resistance 930 to ground at the lower contact of relay 919. Relay 928 does not operate in this circuit but relay 209 operates and locks over its inner lower front contact, the upper right contact of cam 214 to ground at the upper left contact of cam 215. With this locking ground applied to the operating circuit of relay 209, relay 928 at the decoder now operates and establishes a circuit for relay 829 indicating that the registration functions of the decoder have been completed. This circuit may be traced from ground, strapped terminal 610 of connecting block 605 at the district group connector over the No. 20 contact of relay 604, conductor 910, contact of relay 928, conductor 931, back contact of relay 828, resistance 830, lower winding of relay 829, conductor 824, No. 18 contact of relay 604, terminal 608 of block 605 strapped through resistance 611 to battery.

Relay 829 upon operating connects its upper winding through resistance 831 over its upper contact across the upper back contact of relay 826 and over its lower front contact, establishes an obvious circuit for relay 826, which upon operating establishes an obvious circuit for relay 828, which in turn operates and locks over its lower front contact to ground on conductor 913. At its upper back contact, relay 826 opens the shunt around the upper winding of relay 829 whereby the circuit previously traced for relay 313 of the district selector now extends from ground through the winding of relay 313, thence as traced to conductor 819, No. 22 contact of relay 604, strapped terminals 606 and 609 of block 605, No. 19 contact of relay 604, conductor 825, resistance 831, upper contact and winding of relay 829, conductor 824, No. 18 contact of relay 604 through resistance 611 to battery. Relay 829 is held operated over this circuit after its initial operating circuit is opened at the upper back contact of relay 828 but the inclusion of the added resistance 831 and the upper winding of relay 829 causes relay 313 at the district selector to release, in turn releasing district connector relay 613 and opening all circuit paths extending through the district group connector to the decoder and opening the locking circuit of relay 308. Since the operating circuit of relay 209 was opened upon the operation of relay 209 as previously described, relay 308 now releases in turn opening the holding circuit of relay 829 which now releases in turn releasing relay 826. With relay 826 now released and relay 828 operated, a circuit is established from ground over the lower back contact of relay 826, the upper front contact of relay 828 and winding of release relay 800 to battery, which relay locks over its inner lower front contact to ground connected to conductor 818 by the decoder start relay 1200.

As soon as the outgoing transmission registers of Fig. 11 have functioned, a chain circuit from ground is connected over conductor 1100 through the winding of relay 1204 to battery, whereupon relay 1204 operates and with relay 800 operated, connects ground from the back contact of relay 1203, upper back contact of relay 1201, upper contact of relay 1204, conductor 1205, middle lower front contact of relay 800, conductor 832, upper back contacts of relays 918, 917 and 916, conductor 932 over contacts of the decoder-connector 450 to the sender 400. The sender thereupon proceeds to function to control the extension of the connection in accordance with the information transferred thereto from the outgoing registers of the decoder and to release the decoder-connector 450 and thereby release the decoder.

The operation of relay 800 opens the circuit of relay 817 which thereupon releases in turn removing battery from the start lead 823 to release relay 601, which in turn releases relay 604 of the district group connector. Relay 817 upon releasing also removes locking ground from the operated register relays, in the case assumed, re-

lay 812 which releases. The remaining operated relays of the decoder are released upon the release of the decoder-connector. Should the operated rate register relay of the decoder fail to release, in the case assumed, relay 905, relay 933 will remain operated to hold ground on conductor 934 to thereby mark the decoder against reassignment.

EXTENSION OF CONNECTION TO CALLED OFFICE

At the tandem district selector following the operation of relay 209, and the release of relay 308, a circuit is established from ground at the upper back contact of relay 308, conductor 208, upper front contact of relay 209, conductor 216, upper right contact of cam 310 through the winding of the magnet of sequence switch 360, whereupon the sequence switch is advanced into position 4, relay 209 releasing as soon as the sequence switch leaves position 3 since the locking circuit thereof is opened at the upper right contact of cam 214. After relays 313 and 308 release, the operated rate register relay 331 is maintained operated over a locking circuit extending over its inner lower front contact, conductor 344, the lower normal contacts of relay 308, conductor 336 to ground over the lower contacts of cam 217.

With the sequence switch in position 4, the fundamental tip conductor 309 extending to the sender 400 is connected over the inner upper back contact of relay 308, conductor 212, the lower right and upper left contacts of cam 213 through the lower winding of relay 209 to battery and the fundamental ring conductor 314 is connected over the inner lower back contact of relay 308, conductor 337 to ground over the left contacts of cam 215 and since at this time the stepping relay of the sender is bridged across these conductors, relay 209 operates, locks over its inner lower front contact and the lower contacts of cam 213 over the fundamental circuit and establishes a circuit from ground at the upper back contact of relay 308, conductor 208, upper front contact of relay 209, conductor 216, upper right contact of cam 310, through the magnet winding of sequence switch 360 for advancing the sequence switch into position 5. When the sequence switch leaves position 4, the circuit of relay 225 is opened and relay 225 releases and opens the local holding circuit for relay 200, but relay 200 is now maintained operated in a circuit from battery, through its upper winding, inner lower front contact of relay 207, inner lower back contact of relay 232, upper back contact of relay 224, conductor 255, upper contact of cam 311, conductor 218 to ground at the lower right contact of cam 217. In position 5, the circuit of up-drive magnet 238 is established from battery through the winding of magnet 238, upper right and lower left contacts of cam 239, upper front contact of relay 209, to ground on conductor 208 and magnet 238 energizes to drive the elevator rod of the district selector in its brush selection movement. As it moves upwardly, a circuit is intermittently established from ground over the lower right and upper left contacts of cam 217, commutator brush 240, conducting segments of commutator strip 241, lower contacts of cam 242, over the lower front contact and lower winding of relay 209 to battery. This circuit holds relay 209 operated but intermittently shunts the winding of the stepping relay of the sender.

When the sender has thus received sufficient shunting impulses to satisfy its district brush registration, the fundamental circuit is opened at the sender in the well-known manner, whereupon relay 209 releases in turn releasing the up-drive magnet to arrest the brush selection movement and establishes a circuit from ground on conductor 208 over its upper back contact, conductor 243, the upper left contact of cam 310, through the magnet winding of sequence switch 360 for advancing the sequence switch into position 6. In position 6 the circuit of trip magnet 244 is established from battery through the winding of this magnet to ground over the right contacts of cam 217 preparatory to tripping the selected set of the selector brushes upon the subsequent group selection movement of the elevator rod of the switch.

The fundamental circuit previously traced is now closed at the sender resulting in the reoperation of relay 209 which locks to the fundamental circuit and over its upper front contact establishes the previously traced circuit for the magnet of sequence switch 360 which now advances into position 7. With the sequence switch in position 7 and relay 209 operated, the previously traced circuit for up-drive magnet 238 is established and the elevator rod is advanced in a group selection movement. During the initial portion of this movement with the trip magnet 244 operated the selected brush set is tripped. As the elevator rod continues in its upward movement commutator brush 245 engages segments of commutator strip 246 and a circuit is intermittently established from ground over the lower right and upper left contacts of cam 217, brush 245, commutator strip 246, upper right and lower left contacts of cam 213, lower front contact and lower winding of relay 209 to battery. This circuit holds relay 209 operated but intermittently shunts down the stepping relay of the sender.

When the sender has thus received sufficient shunting impulses to satisfy its district group registration, the fundamental circuit is opened at the sender and relay 209 releases, in turn releasing the up-drive magnet 238 and establishing over its upper back contact the previously traced circuit for the magnet of sequence switch 360 which, upon operating, advances the sequence switch into position 8. Relay 209 is now operated in a local circuit from battery through its upper winding, over conductor 247 and lower contacts of cam 307 to ground and advances the sequence switch into position 9. In this position the up-drive magnet 238 is again operated. Relay 209 is held operated in position 9 only provided the first outgoing trunk in the group on which the brushes of the district selector have been positioned is busy. The holding circuit for relay 209 extends from battery through its lower winding and inner lower front contact, upper right contact of cam 214, lower right contact of cam 215 to the sleeve brush 248 to which ground will be connected from the sleeve terminal of the first trunk upon which it is resting if the trunk is busy. Relay 209 is held operated as the sleeve brush 248 passes from terminal to terminal by a circuit extending from battery through its upper winding, conductor 247, lower right contact of cam 338, upper left contact of cam 318, conductor 339, segments of commutator strip 249, brush 250, lower contacts of cam 239, upper front contact of relay 209, conductor 208 to ground at the upper back contact of relay 208. This assures the stopping of the brushes on the

first idle set of terminals. When an idle trunk has been found, relay 209 releases advancing the sequence switch to position 10. As soon as relay 209 releases ground is connected to the sleeve brush 248 over the lower right contact of cam 215, the upper right contact of cam 214, the lower back contact of relay 209, conductor 220, lower right contact of cam 311, conductor 218 to ground at the lower right contact of cam 217. As soon as the sequence switch reaches position 9¾ direct ground is connected to sleeve brush 248 over the lower right and upper left contacts of cam 215. In position 10 relay 209 is operated in a circuit from battery through its upper winding, conductor 247 to ground over the lower contacts of cam 307 and establishes a locking circuit through its upper winding, conductor 247, lower contacts of cam 338, conductor 227, to ground at the front contact of relay 222 which holds relay 209 operated after the sequence switch has advanced into position 11 following the operation of relay 209.

In position 11 the fundamental circuit from the sender is extended from fundamental tip conductor 309, over the inner upper back contact of relay 308, conductor 212, right contacts of cam 203, inner upper back contact of relay 225, upper left and lower right contacts of cam 230, thence over the tip brush 251 to the tip of the outgoing trunk and from fundamental ring conductor 314 over the inner lower back contact of relay 308, conductor 337, lower right and upper left contacts of cam 201, upper back contact of relay 225, lower left and upper right contacts of cam 228, thence over the ring brush 252 to the ring of the trunk. The succeeding selectors (not shown) are now controlled in the well-known manner to complete the connection to the wanted line. After these selections have been completed the sender increases the resistance in the circuit of relay 222 which thereupon releases and in turn releases relay 209. Relay 209 upon releasing closes a circuit from ground on conductor 208 over its upper back contact, conductor 243, the upper left contact of cam 310 through the magnet of sequence switch 360 for advancing the sequence switch into position 13. As the sequence switch passes into position 12 ground is connected over the lower contacts of cam 317 and conductor 316 to the link circuit 350 to insure proper operation of the sender 400 and to cause the sender and sender link circuit 350 to disconnect.

With the sequence switch in position 13 the fundamental circuit previously traced is disconnected and the tip brush 251 is connected over the lower contacts of cam 230, upper right winding of repeating coil 253, winding of polarized relay 254, left contacts of cam 210, lower right winding of coil 253, upper contacts of cam 228 to the ring brush 252. The tip and ring conductors of the trunk are connected to battery and ground at the incoming selector but the direction of current flowing is such that relay 254 does not operate. When the sequence switch reaches position 11¾ a circuit is closed from battery through the upper winding of relay 232, left contacts of cam 219, upper back contact of relay 224, conductor 255, upper contact of cam 311, conductor 218 to ground at the lower right contact of cam 217. Relay 232 operates and locks over its inner upper front contact to ground at the lower front contact of relay 204, opens at its inner lower back contact the locking circuit of relay 200, disconnects the tip and ring conductors of the incoming trunk 105 from the sender at its upper and lower back contacts and establishes a circuit from battery through resistance 301, lower back contact of relay 302, lower winding of retard coil 303, conductor 304, upper winding of relay 200, inner lower front contact of relay 207, upper back contact of relay 256, upper left winding of repeating coil 253, upper front contact of relay 232, upper contacts of cam 231, upper back contact of relay 202, tip conductor of tandem trunk 105, over the tip brushes of selectors 104 and 102 in the originating office, upper contacts of cam 108 of the district selector sequence switch, which was advanced into the talking position 13 following the completion of the transfer of information from the originating sender to the tandem sender, upper right winding of repeating coil 109, winding of polarized relay 111, left contacts of cam 110, lower right winding of repeating coil 109, lower contacts of cam 112, ring brushes of selectors 102 and 104, ring conductor of trunk 105, lower back contact of relay 202, lower contacts of cam 234, lower front contact of relay 232, lower left winding of repeating coil 253, lower back contact of relay 256, lower winding of relay 200, conductor 305, upper winding of retard coil 303, upper back contact of relay 302, through resistance 306 to ground. Relay 200 reoperates in this circuit, in turn holding relays 204 and 207 operated but the current flowing through the winding of polarized relay 111 at the originating district selector is not in such a direction as to cause its operation.

Response of Called Subscriber and Call Charging

When the called subscriber answers battery is reversed through the winding of polarized relay 254 which operates, in turn establishing an obvious circuit for relay 256. Relay 256 upon operating reverses the direction of current flowing over the trunk toward the originating office whereupon relay 111 operates. As soon thereafter as interrupter 113 closes its right contacts a circuit is established from battery through the winding of relay 114, right contacts of the interrupter, lower contacts of cam 115, contacts of relay 111 to ground over the lower left contact of cam 116. Relay 114 operates, locks over its upper contact, the upper left and lower right contacts of cam 115 and thence as traced to ground at cam 116 and establishes a circuit for relay 117 which is effective as soon as interrupter 113 closes its left contacts which may be traced from battery through the lower winding of relay 117, contact of cam 118, lower contact of relay 114, left contacts of interrupter 113, lower contacts of cam 115, front contact of relay 111 to ground over the lower left contact of cam 116. Relay 117 operates and locks over its lower front contact and the upper left contact of cam 116 to ground and at its upper contact prepares a circuit for operating the calling subscriber's message register 119.

At the tandem district selector relay 256 upon operating establishes an operating circuit for relay 340 as soon thereafter as interrupter 341 closes its left contacts, which circuit may be traced from battery, winding of relay 340, left contacts of interrupter 341, conductor 342, upper contacts of relay 256, conductor 336, to ground over the lower contacts of cam 217. Relay 340 upon operating locks over its upper contact to its operating circuit independent of the interrupter contacts and two seconds later when the interrupter 341 closes its right contacts estab-

lishes a circuit from ground on conductor 342 over the right contacts of interrupter 341, lower contacts of relay 340, inner upper normal contacts and winding of relay 343 to battery. Relay 343 then operates and locks over its inner upper alternate contacts to ground over conductor 344, the lower normal contacts of relay 308, conductor 336, and the lower contacts of cam 217. Relay 343 upon operating causes the operation of start relay 419 of the timing and interrupter circuit 420 which is common to five tandem district circuits, over a circuit from battery through the winding of relay 419, conductor 421 to ground over the No. 6 contact of relay 343; at its No. 2 contact prepares a circuit for transmitting charging impulses to the district selector of the originating office as will be later described and over its No. 3 contact prepares a circuit for advancing the timing switch 300 out of position 1 into position 2.

Start relay 419 upon operating establishes a circuit from a source 423 of commercial alternating current through the timing motor 424 which drives two interrupter cams 425 and 426 and establishes obvious circuits through the contacts thereof to the windings of relays 427 and 428 respectively. The contacts of interrupter 426 are so operated as to close every .6 second and therefore relay 428 operates and releases at .6-second intervals and the contacts of interrupter 425 are so operated as to close every 15 seconds and therefore relay 427 is operated and released at 15-second intervals. Upon the first operation of relay 428 after the operation of relay 343, the previously mentioned circuit for advancing the timing switch 300 into position 2 may be traced from battery through the winding of stepping magnet 345, conductor 429, upper contacts of relay 428, conductor 430, brush 346 and the No. 1 terminal of the arc with which it is associated, the No. 3 contacts of relay 343, conductor 347 to ground at the contacts of relay 254. Magnet 345 operates in this circuit and upon its release when relay 428 releases following the next opening of the contacts of interrupter 426 the brushes of switch 300 advance one step.

With the brushes of the switch in engagement with the No. 2 terminals of their arcs, a circuit is established from ground through the winding of relay 348, brush 349, the No. 2 terminal of the arc with which it is associated to battery over the No. 2 front contact of relay 343. Relay 348 upon operating establishes an obvious circuit for relay 302 which operates, disconnecting battery and ground applied as previously described through the windings of retard coil 303 and relay 200 over the loop of the interoffice trunk 105 through the winding of relay 111 at the originating district selector and establishing a circuit from battery through the winding of relay 351, lower front contacts of relay 302 and upper contacts of relay 348 to ground. Relay 351 upon operating establishes at its lower front contact a holding circuit for relay 302. At its upper contact it connects the positive terminal of 165-volt battery 352 through resistance 353, through the upper winding of retard coil 303, conductor 305, lower winding of relay 200, right contacts of cam 257, inner upper front contact of relay 256, upper left winding of repeating coil 253, thence as traced over the tip conductor of the trunk 105 to the originating district selector, and thence over the upper contacts of cam 108, through the upper right winding of repeating coil 109, through the winding of relay 111 and left contacts of cam 110 to the anode 121 of gas-filled tube 120, and through high resistance 124, condenser 125, low resistance 126, and winding of relay 127 to ground. At its inner upper contact, relay 351 connects the positive terminal of 130-volt battery 354, through resistance 355, the lower winding of retard 303, conductor 304, upper winding of relay 200, lower front contact of relay 207, inner lower front contact of relay 256, lower left winding of repeating coil 253, thence as traced over the ring conductor of trunk 105, over the lower contacts of cam 112, lower right winding of repeating coil 109 to the anode 121 of tube 120, and through resistance 124, condenser 125, resistance 126 and winding of relay 127 to ground. It will be noted that the operation of relay 351 has thus established a simplex circuit over the talking conductors of trunk 105 to the tube 120, the difference in the battery potential applied to the two sides of this circuit compensating for the resistance of relay 111 which is included in the tip side of the circuit. During the change-over from loop operation to simplex operation through the operation of relay 302 followed by the operation of relay 351, relays 200 and 111 are prevented from releasing by the loop between conductors 304 and 305 through the windings of retard coil 303, and the condenser and resistance network 356 bridged across the windings of the retard coil and after relay 351 has operated these relays are prevented from releasing by the loop established from conductor 304 through the lower winding of retard coil 303, the inner upper contact of relay 351, resistance 355, battery 354, through ground, battery 352, resistance 353, the upper contacts of relay 351, through the upper winding of retard coil 303 to conductor 304, the difference of potential of the batteries 352 and 351 causing a current flow over the loop including the windings of relays 200 and 111 in such a direction as to maintain these relays operated. Since the conductors of trunk 105 are connected to the sources of charging potential supplied by batteries 352 and 354 in simplex, there is no disturbance of the conversation which is at the time being conducted over the trunk and any acoustic disturbances which might arise during the change-over from loop to simplex operation are prevented by the resistance condenser bridge 356.

At the originating district selector the application of positive potential to one terminal of condenser 125, the other terminal of which is connected to ground through resistance 126 and the winding of relay 127, causes the condenser to become charged but relay 127 does not operate in response to such charging current. If the charging potential is applied for a sufficient interval, the condenser reaches a potential equal to the breakdown potential of the gas-filled tube 120 whereupon it discharges across the gap between the cathodes 122 and 123 and the tube then fires across the gap between its anode 121 to which high positive potential is applied from the batteries 352 and 354 and the cathode 123 thus operating relay 127. Relay 127 now remains operated so long as positive potential is applied to the anode 121 and establishes a circuit from battery over its inner contacts, the upper contacts of cam 128, the brush 129 of the line finder 101 to ground through the winding of the message register 119 of the calling line. The message register is thus operated to make a charge for one unit of conversation.

The condenser 125 and resistance 126 are con-

nected across the cathodes of tube 120 to time the operation of the tube to prevent the firing thereof and the consequent operation of the calling subscriber's message register on short applications of high positive potential over the trunk 105 which might result from inductive disturbances from power lines or from the application of ringing current to the trunk by a maintenance man for testing purposes. Such impulses being of alternating character the condenser will not become charged to a sufficient potential to cause the tube to break down.

Upon the next operation and release of relay 428 switch 300 is advanced from position 2 into position 3 over a circuit extending from battery through the winding of magnet 345, conductor 429, contacts of relay 428, conductor 430, No. 2 terminal of the arc associated with brush 346, to ground on conductor 336, and upon leaving position 2, relay 348 releases followed first by the release of relay 351, and then by the release of relay 302. Relay 351 upon releasing removes the batteries 352 and 354 from connection with the conductors of trunk 105 thereby extinguishing the tube 120 and relay 302 upon operating then reestablishes the supervisory loop over the trunk 105 through resistance 301 to talking battery and through resistance 306 to ground. From position 3 switch 300 is then stepped to position 17 under the control of relay 428 over the circuit just traced, its brushes remaining on each terminal for .6 second. Positions 4, 6, 8, 10, 12, 14 and 16 of the arc associated with brush 349 are also charging positions and the circuit for relay 348 will be closed in such positions, dependent on the operated or unoperated condition of the charge rate relays 329, 330 and 331.

If none of the rate register relays have been operated indicating that but one charge should be made for the initial period, no effective circuit for operating relay 348 will be closed as switch 300 advances to position 17, since in position 4 of brush 349 the circuit from the winding of relay 348 will extend over the lower back contact of relay 329 to ground at the inner lower back contact of relay 330; in positions 6 and 8, the circuit will extend to ground at the lower back contact of relay 330 and in positions 10, 12, 14 and 16 the circuit will extend to ground over the inner upper back contact of relay 331. The subscriber's register has thus been operated but once.

If only rate register relay 329 is operated indicating that two charges should be made then when the switch reaches position 4, the circuit for relay 348 will be extended over brush 349, the lower front contact of relay 329, the lower back contact of relay 331, the lower back contact of relay 357, to battery over the No. 2 contact of relay 343 and relay 348 will operate to cause a second operation of the subscriber's message register in the manner previously described. In positions 6 and 8 the circuit of relay 348 will be extended over brush 349 and the lower back contact of relay 330 to ground and in positions 10, 12, 14 and 16 the circuit will extend to ground over the inner upper back contact of relay 331 and relay 348 will therefore not operate. The subscriber's message register is thus operated a total of two times.

If only rate register relay 330 is operated indicating that three charges should be made then when the switch reaches position 4, the circuit for relay 348 will be extended over brush 349, the lower back contact of relay 329, the inner lower front contact of relay 330 to ground over the middle lower back contact of relay 331 and relay 348 will not operate. In positions 6 and 8, however, the circuit of relay 348 over brush 349, the lower front contact of relay 330, the lower back contact of relay 337 to battery over the No. 2 contact of relay 343 is effective and relay 348 will operate twice to cause a second and a third operation of the subscriber's message register. In positions 10, 12, 14 and 16 the circuit for relay 348 will extend over brush 349 to ground at the inner upper back contact of relay 331 and relay 348 will not operate. The subscriber's message register is thus operated a total of three times.

If rate register relays 329 and 330 are both operated indicating that four charges should be made then when the switch reaches position 4 the circuit for relay 348 is extended over brush 349, the lower front contact of relay 329, the lower back contact of relay 331, the lower back contact of relay 357 to battery over the No. 2 contact of relay 343 and relay 348 operates to cause an operation of the subscriber's message register. In positions 6 and 8 the circuit of relay 348 is extended over brush 349, the outer lower front contact of relay 330, the lower back contact of relay 357, to battery over the No. 2 contact of relay 343 and relay 348 operates twice to cause a third and a fourth operation of the subscriber's message register. In positions 10, 12, 14 and 16 the circuit of relay 348 is ineffective since it extends over brush 349 and the inner upper back contact of relay 331 to ground. The subscriber's message register is thus operated a total of four times.

If only rate register relay 331 is operated indicating that five charges should be made and this is the condition assumed for the established connection, then when the switch passes through positions 4, 6 and 8 no effective circuit is established for relay 348 since in position 4 this circuit is extended over the lower back contact of relay 329 and the inner lower back contact of relay 330 to ground, and in positions 6 and 8 is extended to ground over the lower back contact of relay 330. However, in positions 10, 12, 14 and 16 an effective circuit is established over the inner upper front contact of relay 331, the lower back contact of relay 357 to battery over the No. 2 contact of relay 343 and relay 348 is operated four times to operate the subscriber's circuit register 119 four additional times, or a total of five times.

If rate register relays 329 and 331 had both been operated indicating that six charges should be made then when switch 300 passes through position 4 the circuit for relay 348 is effectively extended over the lower front contact of relay 329, the lower front contact of relay 331 to battery at the No. 2 contact of relay 343 thus causing a second operation of the subscriber's message register. In passing through positions 6 and 8 no effective circuit is established for relay 348 since it extends to ground at the lower back contact of relay 330 but in positions 10, 12, 14 and 16 the circuit of relay 348 is extended over the inner upper front contact of relay 331, the lower back contact of relay 357 to battery over the No. 2 contact of relay 343 and relay 348 operates four times thus causing four more operations of the subscriber's message register or a total of six operations.

If rate register relays 330 and 331 had both been operated indicating that seven charges should be made then no effective circuit for relay 348 is established as the switch passes through position 4 since this circuit extends over the lower back contact of relay 329, the inner lower front contact of relay 330, the middle lower front contact of relay 331 to ground at the upper back contact of relay 357. However, in positions 6, 8, 10, 12, 14 and 16 effective circuits for relay 348 are established, in positions 6 and 8 over the lower front contact of relay 330, the lower back contact of relay 357 to battery at the No. 2 contacts of relay 343 and in positions 10, 12, 14 and 16 over the inner upper front contact of relay 331, the lower back contact of relay 357 to battery over the No. 2 contact of relay 343 and relay 348 is thus operated six times thus causing six additional operations of the subscriber's message register or a total of seven operations.

If rate register relays 329, 330 and 331 had all been operated indicating that eight charges should be made then effective circuits for relay 348 would be established as the switch passes through positions 4, 6, 8, 10, 12, 14 and 16, in position 4 over the lower front contact of relay 329, the lower front contact of relay 331 to battery at the No. 2 contact of relay 343, in positions 6 and 8 over the lower front contact of relay 330, the lower back contact of relay 357 to battery at the No. 2 contact of relay 343 and in positions 10, 12, 14 and 16 over the inner upper front contact of relay 331, the inner lower back contact of relay 357 to battery at the No. 2 contact of relay 343 and relay 348 is thus operated seven times thus causing seven additional operations of the subscriber's message register or a total of eight operations.

Upon reaching position 17 switch 300 is stepped into position 18 over a circuit extending from battery through the winding of magnet 345, conductor 429, contact of relay 428, conductor 430, brush 346 and the No. 17 terminal of its arc, the No. 5 contact of relay 343, conductor 431, upper contact of relay 427 to ground as soon as relay 427 becomes operated by the closure and opening of the contacts of interrupter 425 to measure one 15-seconds interval. In positions 18 to 22 the previously traced circuit of magnet 345 extending over brush 346 and the strapped terminals 18 to 22, inclusive, of its arc through the contacts of relay 428 is closed and the switch wipers are advanced at .6-second intervals. From position 23 through position 41 into position 42 the switch is stepped at 15-second intervals under the control of relay 427 over a circuit extending from battery through the winding of magnet 345, brush 358, strapped terminals of its arc, No. 5 terminals of relay 343, conductor 431 to ground over the contacts of relay 427 thereby counting nineteen additional intervals or a total initial interval of 28.5 to 300 seconds. Upon reaching position 42 the switch is advanced rapidly into position 44 under the control of relay 428, over a circuit extending from battery through the winding of magnet 345, conductor 429, contact of relay 428, conductor 430, brush 359 and the Nos. 42 and 43 terminals of its bank to ground on conductor 336.

For charges of over five for the initial interval the conversational period is shortened to three minutes; for example, if rate register relays 329 and 331 had been operated to cause six charges to be made for the initial period, switch 300 is advanced at 15-second intervals from position 23 to position 34 under the control of relay 427 as previously described and is then advanced rapidly into position 42 by a circuit extending from battery through the winding of magnet 345, conductor 429, contacts of relay 428, conductor 430, brush 359 and the Nos. 34 to 42 terminals of its arc, upper front contact of relay 329, next-to-inner upper front contact of relay 331 to ground. Had rate register relays 330 and 331 been operated to cause seven charges to be made for the initial period, switch 300 is advanced at 15-second intervals from position 23 to position 34 under the control of relay 427 and is then advanced rapidly into position 42 by a circuit extending from battery through the winding of magnet 345, thence as traced to brush 359, over the Nos. 34 to 42 terminals of its arc, the upper back contact of relay 329, the middle upper front contact of relay 330 and the next-to-inner upper front contact of relay 331 to ground. Had rate register relays 329, 330 and 331 been operated to cause eight charges to be made for the initial period, switch 300 is advanced at 15-second intervals from position 23 to position 34 as previously described and is then advanced rapidly into position 42 by a circuit extending from battery through the winding of magnet 345, thence as traced to brush 359 over the Nos. 34 to 42 terminals of its arc, the upper front contact of relay 329, and the next-to-inner upper front contact of relay 331 to ground. From position 42 the switch is advanced into position 44 as previously described.

In passing through position 43 a circuit is established from battery through the winding of overtime relay 357, the No. 7 contact of relay 343, the No. 43 terminal of the arc associated with brush 361 to ground. Relay 357 upon operating locks over its inner upper front contact to ground on conductor 344 and closes a circuit from battery through the winding of magnet 345, brush 358 and the No. 44 terminal of its arc, the middle lower front contact of relay 357, the No. 5 contact of relay 343, conductor 431 to ground over the contact of relay 427 so that the switch is advanced into position 1 under control of the 15-second interrupter 425 thereby counting a further interval of 15 seconds. Thus in advancing from position 23 into its normal position 1 the switch has counted an interval of 300 to 315 seconds, or a maximum of 5 minutes if the charging rate was five charges or less and an interval of 180 to 195 seconds or a maximum of 3 minutes if the charging rate was over five charges.

If the conversation is still continuing when the switch reaches position 1 and relay 343 is still operated, the switch is started on a second revolution and advances into position 17 as previously described, and relay 348 is operated as the switch passes through position 2 as previously described to cause one additional operation of the calling subscriber's message register for the overtime period. When it reaches position 4 relay 348 will be operated once again only if the relays 329 and 331 or 330 and 331 or 329, 330 and 331 are operated, indicating that a second charge should be made for the overtime period, the circuits extending from brush 349 over the lower front contact of relay 329, the lower front contact of relay 331 to battery at the No. 2 contact of relay 343 if relays 329 and 330 were operated; from brush 349 over the lower back contact of relay 329, the inner lower front contact of relay 330, the middle lower front contact of relay 331, the middle upper

front contact of relay 357 to battery at the No. 2 contact of relay 343 if relays 330 and 331 were operated and from brush 349 over the lower front contact of relay 329, the lower front contact of relay 331 to battery at the No. 2 contact of relay 343 if relays 329, 330 and 331 operated. If relays 329, 330 and 331 were operated singly, or relays 329 and 330 were operated together, no effective circuit would be established at this time since the circuit from brush 349 would be extended over the lower front contact of relay 329, the lower back contact of relay 331 to ground at the lower front contact of relay 357, with only relay 329 operated; from brush 349 over the lower back contact of relay 329, the inner lower front contact of relay 330 to ground at the middle lower back contact of relay 331 with only relay 330 operated; from brush 349 over the lower back contact of relay 329, to ground over the inner lower back contact of relay 330 with only relay 331 operated and from brush 349 over the lower front contact of relay 329, the lower back contact of relay 331 to ground at the lower front contact of relay 357 with relays 329 and 330 both operated.

As the switch passes through positions 6 and 8 no effective circuit for relay 348 is established under any condition of relays 329, 330 and 331, since if relay 330 is not operated brush 349 is connected to ground at the lower back contact and if it is operated alone or in combination with relays 329 and 331 brush 349 is connected over its lower front contact to ground at the lower front contact of overtime relay 357. As the switch passes through positions 10, 12, 14 and 16 no effective circuit for relay 348 is established since, if relay 331 is not operated, brush 349 is connected over its inner upper back contact to ground, and if it is operated alone or in combination with relays 329 and 330 brush 349 is connected over its inner upper front contact to ground at the lower front contact of relay 357. Thus for the overtime period a single charge is made if rate register relays 329 or 330 or 331, or 329 and 330 have been operated and two charges are made if relays 329 and 331 or 330 and 331 or 329, 330 and 331 have been operated.

When the switch reaches position 17 it is advanced under the control of relay 427 into position 18 to measure one 15-second overtime interval and is then advanced from position 18 into position 23 under the control of relay 428 as previously described. Upon reaching position 23 it is advanced at once into position 24 under the control of relay 428 over a circuit extending from battery through the winding of magnet 345, conductor 429, contacts of relay 428, conductor 430, brush 359 and the No. 23 terminal of its arc to ground at the upper front contact of overtime relay 357. From position 23 it is advanced step by step under the control of relay 427 over a circuit extending from battery through the winding of magnet 345, brush 358, No. 5 contact of relay 343, conductor 431 to ground at the contacts of relay 427 to measure additional 15-second intervals. If none of the rate relays 329, 330 and 331 are at the time operated, it will continue to advance into position 42 thus measuring nineteen 15-second intervals and upon reaching position 42 will be rapidly advanced into position 44 under the control of relay 428 from which position it is advanced to position 1 under the control of relay 427 in a circuit from battery through the winding of magnet 345, brush 358 and the No. 44 terminal of its bank, the middle lower front contact of relay 357, the No. 5 contact of relay 343 to ground at the contact of relay 427 thus measuring an additional 15-second interval. Thus at least twenty 15-second intervals have been measured or a 5-minute interval.

If the rate register relay 329 had been operated alone then when the switch reached position 34 after having measured eleven 15-minute intervals, it would have been rapidly advanced to position 42 under the control of relay 428 over a circuit from battery, winding of magnet 345, conductor 429, contact of relay 428, conductor 430, brush 359, Nos. 34 to 41 terminals of its arc, upper front contact of relay 329, next-to-inner upper back contact of relay 331, to ground at the upper front contact of relay 357 from which position it would have advanced to position 1, as previously described, measuring one additional 15-second interval. In this case a total of twelve intervals would have been measured or an elapsed time of three minutes.

If the rate register relay 330 had been operated alone or relays 329 and 330 been operated together then when the switch reached position 25 after having measured two 15-second intervals it would have been rapidly advanced into position 29 under the control of relay 428 over a circuit extending from battery through the winding of magnet 345 thence as traced to brush 359, Nos. 25 to 28 terminals of its arc, upper front contact of relay 330 to ground at the upper front contact of relay 357 from which position it would have been advanced into position 34 under the control of relay 427 as previously described to measure five additional 15-second intervals. From position 34 it would then have advanced rapidly into position 42 under the control of relay 428 in the circuit previously traced from the winding of magnet 345 to brush 359 thence over the Nos. 34 to 41 terminals of its arc, upper back contact of relay 329, middle upper front contact of relay 330, next-to-inner upper back contact of relay 331 to ground at the upper back contact of relay 357 from which position it would have been advanced into position 1 as previously described, measuring an additional 15-second interval. In this case a total of eight intervals would have been measured or an elapsed time of two minutes.

Had rate relay 331 been operated alone or together with relay 329 then when the switch reached position 25 after having measured two 15-second intervals, it would have been rapidly advanced into position 29 under the control of relay 428 over a circuit extending from battery through the winding of magnet 345, thence as traced to brush 359, Nos. 25 to 28 terminals of its arc, upper back contact of relay 330, upper front contact of relay 331 to ground at the upper front contact of relay 357 from which position it would have advanced rapidly into position 33 under the control of relay 428 over a circuit from battery through the winding of magnet 345 thence as traced to brush 359, Nos. 29 to 32 terminals of its arc, upper front contact of relay 331 to ground at the upper front contact of relay 357. From position 33 it would then have advanced to position 34 under the control of relay 427 by the circuit from battery through the winding of magnet 345, brush 358 and the No. 33 terminal of its arc, No. 5 contact of relay 343 to ground at the contact of relay 427 to measure an additional 15-second interval. From position 34 it would have then

advanced rapidly into position 42 under the control of relay **428** in the circuit previously traced from the winding of magnet **345** to brush **359**, thence over the Nos. 34 to 41 terminals of its arc, upper back contact of relay **329** if relay **331** had been operated alone, middle upper back contact of relay **330**, next-to-upper front contact of relay **331** to ground at the upper front contact of relay **357**, or if both relays **329** and **331** had been operated over the upper front contact of relay **329** to ground at the next-to-inner upper front contact of relay **331**. From position **42** the switch would then have advanced to position 1 as previously described measuring an additional 15-second interval. In this case a total of four intervals would have been measured or an elapsed time of one minute.

Had rate relays **330** and **331** or relays **329**, **330** and **331** been operated, then when the switch reached position 25 after having measured two 15-second intervals, it would have been rapidly advanced into position 29 under the control of relay **428**, over a circuit extending from battery through the winding of magnet **345**, thence as traced to brush **359**, Nos. 25 to 28 terminals of its arc, upper front contact of relay **330** to ground at the upper front contact of relay **357** from which position it would have rapidly advanced into position **33** under the control of relay **428** over the circuit extending as traced from battery through the winding of magnet **345** to brush **359**, Nos. 29 to 32 terminals of its arc, upper front contact of relay **331** to ground at the upper front contact of relay **357**. From position 33 it would then have advanced to position 34 under the control of relay **427** as previously described to measure an additional 15-second interval. From position 34 it would then have advanced rapidly into position 42 under the control of relay **428** in the circuit previously traced from the winding of magnet **345** to brush **359**, thence over the Nos. 34 to 41 terminals of its arc, upper back contact of relay **329** if relays **330** and **331** only had been operated, middle upper front contact of relay **330** to ground at the next-to-inner upper front contact of relay **331**, or if relay **329** had been operated together with relays **330** and **331** over the upper front contact of relay **329** to ground at the next-to-inner upper front contact of relay **331**. From position **42** the switch would then have advanced to position 1 as previously described measuring an additional 15-second interval. In this case a total of four intervals would have been measured or an elapsed time of one minute.

Upon reaching position 1 after having measured the first overtime interval the switch **300** starts upon a third revolution if the conversation over the established connection continues and in the manner previously described controls charging for an additional overtime interval and measures that interval in accordance with the charge rate to be applied as indicated by the operated or non-operated condition of rate register relays **329**, **330** and **331**.

To recapitulate the charges applied for both initial and overtime periods and the measurement of such periods in accordance with the relative positions of the calling and called offices in the exchange area indicated by the condition of the charge rate register relays **329**, **330** and **331** as hereinbefore described, are made in accordance with the following table:

Table V

Rate relays operated	Initial period, charges made	Initial period, duration measured	Overtime period, charges made	Overtime period, duration measured
		Minutes		*Minutes*
None	1	5	1	5
329	2	5	1	3
330	3	5	1	2
329-330	4	5	1	2
331	5	5	1	1
329-331	6	3	2	1
330-331	7	3	2	1
329-330-331	8	3	2	1

When the called subscriber hangs up upon the termination of the conversation, relay **254** releases in turn releasing relay **256** provided the switch **300** is not at the time in one of its charge controlling positions 2 to 16. If the switch is in one of these positions relay **256** is held operated over a circuit extending through its winding over conductor **347**, the No. 8 front contact of relay **343**, the Nos. 2 to 16 terminals of the arc associated with brush **362** over brush **362** to ground. As soon thereafter as switch **300** passes beyond position 16 relay **256** releases and reverses the direction of current flowing over the tandem trunk **105** through the winding of polarized relay **111** of the district selector in the originating office and relay **111** thereupon releases. In addition, relay **256** releases relay **340** by removing ground from conductor **342**.

RELEASE OF CONNECTION

When the calling subscriber disconnects, supervisory relay **130** releases, in turn releasing relay **131** which was held operated over the right contacts of cam **116** during the conversational period. Relay **131** upon releasing establishes a circuit from battery through the lower winding of relay **132**, the contacts of cam **133**, back contact of relay **131** to ground as soon thereafter as interrupter **134** closes its contacts and relay **132** operates and locks over its upper winding and upper front contact to ground at the upper right contact of cam **116** and closes at its lower front contact a circuit extending over the contact of cam **135** through the winding of sequence switch magnet **136** for advancing the sequence switch out of the talking position into position 17 in which position, with relay **117** operated as previously described, a circuit is established from battery over the upper contact of relay **117**, the lower right and left contacts of cam **128**, brush **129**, through the subscriber's message register **119** for operating the message register once. It is thus apparent that for all calls extended through the tandem office the calling subscriber's message register is operated once upon the termination of the conversation in addition to the operations which have been made during the conversation. In this connection it may be observed that had a connection local to the originating office been made but a single charge would have been made as just described upon the termination of the connection.

From position 17 the sequence switch **136** is advanced in the well-known manner into position **18**. The district selector **102** circuits are restored to normal condition in the well-known manner. When the district selector restores, the office selector **104** restores in the well-known manner and the connection to the tandem trunk **105** is opened, resulting in the release of relay **200** at the tandem district selector followed by the release of relays **204**, **207** and **232**. With re-

lay 207 released a circuit is closed from battery through the upper winding of relay 224, upper left contact of cam 258, upper left contact of cam 259, lower back contact of relay 207, upper back contact of relay 209, conductor 208 to ground at the upper back contact of relay 308. Relay 224 upon operating locks through its lower winding and outer lower front contact over conductor 260 to ground at the left contacts of cam 307 and applies its locking ground over its inner lower front contact, conductor 261, lower left contact of cam 310 to battery through the winding of the magnet of sequence switch 360 for advancing the sequence switch into position 16, from which position it is advanced into position 18 over a circuit from ground on conductor 208, upper back contact of relay 209, lower back contact of relay 207, upper left and lower right contacts of cam 259 through the magnet winding of the sequence switch 360 to battery.

When the sequence switch leaves position 13, ground is removed from conductor 336 thereby releasing relays 343, 357 and relays 329, 330 and 331 if operated. Relay 343, upon releasing, disconnects the timing and interrupter circuit 420 thereby releasing relay 419 and stopping the operation of the motor 424 and relays 427 and 428, if no other district is using the timing circuit at the time; disconnects battery at its No. 2 contact to prevent further charging operations of relay 351 during the restoration of the switch 300, and establishes a circuit for restoring the switch 300 to normal. If the switch is in positions 2 to 16 at the time, this circuit extends from battery through the winding of magnet 345, No. 4 back contact of relay 343, interrupter contacts of magnet 345, No. 8 back contact of relay 343, Nos. 2 to 16 terminals of the arc associated with brush 362 over brush 362 to ground whereby the switch is advanced to position 17. From position 17 it is then advanced to position 23 over a circuit extending from battery, winding of magnet 345, No. 4 back contact of relay 343, interrupter contacts of magnet 345, Nos. 17 to 22 terminals of the arc associated with brush 362 to ground over brush 362. From position 23 the switch is then advanced to position 42 over a circuit from battery, winding of magnet 345, No. 4 back contact of relay 343, interrupter contacts of magnet 345, Nos. 23 to 41 terminals of the arc associated with brush 367 to ground over brush 367. From position 42 the switch is then advanced to position 44 over a circuit from battery, winding of magnet 345, No. 4 back contact of relay 343, interrupter contacts of magnet 345, No. 7 back contact of relay 343, No. 43 terminal of the arc associated with brush 367 to ground over brush 367, from which position it is advanced into position 1 over the circuit previously traced for advancing it through positions 23 to 42, inclusive.

With the sequence switch in position 18 a circuit is established from battery through the winding of down-drive magnet 262 and upper contacts of cam 215 whereupon the elevator rod of the district selector is driven downwardly into its normal position, the trip magnet 244 being operated during such movement in a circuit over the right contacts of cam 217 to prevent snagging the selector brushes. When the switch reaches its normal position a circuit is established from ground over the lower right and upper left contacts of cam 217, brush 250, normal segment 263 of the commutator, conductor 264, lower right contact of cam 310, through the magnet winding of sequence switch 360 to battery thus advancing the sequence switch into its normal position 1. Upon leaving position 18 the locking circuit of relay 224 is opened at the left contact of cam 307 and relay 224 releases. All apparatus of the tandem district selector is now restored to its normal condition and other selector switches which have been used in completing the connection are restored in the well-known manner.

Use of Reserve District

If the automatic district selector test circuit connects the district finder end of the link circuit 350 to the district circuit of Figs. 2 and 3 for routine testing, a reserve district which is common to a plurality of regular districts is brought into service to replace the district under test. Such a reserve district is schematically illustrated by the box in the right portion of Fig. 5. This transfer is effective only if the regular district is not found to be in any selecting position, that is, if sequence switch 360 is in position 18 or 1 and if the reserve district is not busy. Under these conditions, when the test circuit connects ground through the link circuit 350 to conductor 314, a circuit is established over the inner lower back contact of relay 308, conductor 337, lower left contact of cam 259, lower left contact of cam 258, upper winding of transfer relay 202 to battery. Relay 202 upon operating, at its outer transfer contacts disconnects the conductors of trunk 105 from the tip and ring conductors of the regular district and connects such conductors to the tip and ring conductors extending through the cable 266 to the reserve district whereby the reserve district is made effective for handling any call incoming over trunk 105 as previously described. Relay 202 at its inner upper front contact also establishes a circuit from ground over such contacts, conductor 267, to battery through the winding of relay 363 of the regular district under test which operates to prepare circuits to be later controlled by relays 568 and 573 of the reserve district, corresponding to relays 308 and 313 of the regular district which it has replaced, for giving the same trunk group and calling zone information to the decoder as would have been given by the regular district.

If now the trunk 105 is seized on a call, the reserve district will be started in the manner previously described and as soon as the sequence switch thereof leaves its normal position, a locking circuit for relay 202 will be established from battery through the lower winding and inner lower contact of relay 202, conductor 265 of cable 266, extending to the reserve district of Fig. 5 and thence to ground over contacts of cams 591 and 597 thereof corresponding to cams 311 and 217, to hold relay 202 operated until the reserve district is restored to normal, and thereafter relay 568 of the reserve district will be operated in the same manner as relay 308 of the regular district. With relay 363 of the regular district and relay 568 of the reserve district both operated, ground is connected over connecting block 315 of the regular district, No. 1 contact of relay 363, conductor 525, winding of relay 573, conductor 526 strapped to the tip terminal 364 of connecting block 366 of the regular district, No. 3 contact of relay 363, conductor 527, upper contact of relay 568 to the tip fundamental conductor extending through the link circuit by which the reserve district has been connected to an idle sender thence through such sender to the decoder whereby the same district group registration is set up in the decoder as would have

been established by the regular district which the reserve district has replaced. It is to be noted in this connection that tip and ring terminals 364 and 365 of block 366 correspond to tip and ring terminals 321 and 320 of block 315 and are similarly strapped to terminals connected to high and low resistance ground, high resistance battery and one terminal of relay 573 dependent upon the group of districts in which the regular district is located.

Thereafter upon the operation of relay 573 of the reserve district in response to the correct operation of the group relay 604 of the district group connector as previously described, the circuit of subgroup relay 613 of the district group connector is established from ground over the No. 1 contact of relay 573, conductor 528, No. 4 contact of relay 363, conductor 612 to battery through the winding of relay 613 whereupon circuit paths are established for sending calling zone information to the decoder. This information is transmitted by the operation of relay 573 over the strapped terminals of connecting block 323 in the same manner as had the regular district been used and its relay 313 been operated, ground being connected over the No. 6 contact of relay 573, conductor 529, No. 9 contact of relay 363 over terminals of block 323 to conductor 328; ground being connected over the No. 8 contact of relay 573, conductor 530, No. 10 contact of relay 363 over terminals of block 323 to conductor 327 and ground being connected over the No. 10 contact of relay 573, conductor 531, No. 11 contact of relay 363 over terminals of block 323 to conductor 623 for identifying the district to the trouble indicator serving the subgroup of districts. The connection of direct ground to conductor 623 rather than ground through resistance as would have been the case had the regular district been calling indicates to the trouble indicator that the reserve district has been substituted for a particular regular district.

At its Nos. 2 to 5 contacts relay 573 also establishes circuit paths from the control relay and the charge rate register relays of the reserve district (not shown) corresponding to relays 209, 329, 330 and 331 over the Nos. 5 to 8 contacts of relay 363 and conductors 335, 332 and 333 and 334 extending through the district group connector to the decoder whereby the proper charge rate registrations are made in the reserve district and the district circuit is prepared for subsequent operation. The reserve district then functions in the manner previously described in connection with the regular district.

Had the tenth district of the first subgroup been removed from service for testing, then assuming that the same reserve district was substituted therefor, then relay 563 of the tenth regular district would have been operated and, upon seizure of the trunk normally terminating in the tenth district, relay 568 of the reserve district would have been operated whereupon a trunk group indication in accordance with the cross-connections on block 566 would have been transmitted to the sender following which relay 573 would have operated as previously described to establish circuit paths over the contacts of relay 573 and 563 and strapped terminals of block 523 to indicate to the decoder the calling zone from which the call originated and to establish circuit paths over other contacts of relays 573 and 363 to the decoder over which the control relay and charge rate registers of the reserve district would be controlled from the decoder as previously described.

Substitute Routing

Under certain conditions it is desirable to withhold the regular routing information ordinarily conveyed by the route relay and to supply substitute routing information which takes into account or is dependent upon the zone in which the call originated and the zone to which the connection is directed. One example of this substitute routing is on connections whose length is such as to warrant the use of outgoing trunks which have special transmission characteristics. On such a call the routing is changed to direct the call to a district of a second group of districts which have access to the special trunks and the registrations received in the sender from the originating office are then transferred by call indicator pulse codes to another tandem sender which may or may not be in the same group as the first tandem sender, which becomes associated with such second district upon its seizure. Another use for substitute routing is for rerouting calls with a minimum of cross-connection changes.

When it is desired that a call be rerouted through a second district selector a pair of relays, such as 1305 and 1306, is provided for each combination of district routing and the charge rate registration which is different from any other combination. It will be assumed that on an incoming call, the decoder route relay 1307 has been operated over a circuit extending from ground applied to conductor 1503, winding of relay 1307, serially through normal contacts of all relays, such as 1305 and 1315, to battery over conductor 1303 through the winding of relay 1202. Relay 1307 upon operating establishes a circuit from ground over its upper contact, conductor 1308, cross-connecting block 1030 to horizontal multiple 1043 of indicator 1050 and, assuming that in this case relay 1090 has been operated to register the calling zone identification, over contact 1044, to a terminal of connecting block 1031 which is strapped to a terminal connected to conductor 1045, conductor 1045, winding of relay 1305 to battery. Relay 1305 upon operating locks over its upper front contact to ground on conductor 818, opens at its normal contacts the operating circuit of route relay 1307 which releases and closes at its lower contact an obvious circuit for relay 1306 which operates in turn causing the operation of rerouting route relay 1309. Route relay 1309 now functions as previously described in connection with route relay 1302 to cause the setting of the outgoing registers shown on Fig. 11 but in this case establishes a class of call registration which is effective to cause the sender to transfer registrations by pulse codes to a second tandem sender after the first district selector has been set. Relay 1306 also closes a circuit from ground over its upper contact, conductor 1310, to a terminal of block 1031 which is cross-connected to the winding of one of the rate register relays 901 to 908 to establish the proper rate setting in the first district selector. From this point the call proceeds in the manner previously described, except that the second tandem sender controls all switches beyond the first tandem district.

When the second tandem district has access to the same group of decoders as the first tandem district selector, the second district is arranged to transmit a district group identifying signal which, in the manner previously described, causes the operation of either relay 803 or 807. If relay 803 is operated it establishes the circuit of relay 811

from battery through the winding of relay 811, front contact of relay 803 to ground at the back contact of relay 802 and relay 811 upon operating establishes a circuit from ground through the winding of relay 833, middle lower back contacts of relays 815, 814, 813, lower front contact of relay 811, lower back contact of relay 810, upper front contact of relay 817, to battery on conductor 1301, or if relay 807 is operated, it establishes the circuit of relay 814 from battery through the winding of relay 814, upper front contact of relay 807 to ground at the back contact of relay 806 and relay 814 upon operating establishes a circuit from ground through the winding of relay 834, upper front contact of relay 814, upper back contact of relay 813, lower back contacts of relays 812, 811 and 810, upper front contact of relay 817 to battery on conductor 1301. With either relay 833 or relay 834 operated, the circuit of relay 835 is established from battery through its winding, the upper front contact of either relay 833 or 834 to ground on conductor 1205 and relay 835 operates to in turn operate relays 829, 826, 828 and 800 which function as previously described to prepare for the release of the decoder. In this case no calling zone registration is made in the decoder.

When a code is dialed by a subscriber in certain originating zones but which are restricted to other originating zones and may require rerouting, the operation of a route relay in response to the code, for example route relay 1311, will establish a circuit from ground over its upper contact, conductor 1312 strapped by cross-connecting block 1030 to horizontal multiple 1046 of the indicator 1050 and, assuming that in this case relay 1000 has been operated to register the calling zone identification, over contact 1047 to a terminal of block 1031 which is strapped to conductor 1048, thence to battery through the winding of relay 1315. Relay 1315 operates, locks over its upper front contact to ground on conductor 818, opens at its normal contacts the circuit of route relay 1311 which releases and at its lower contact closes an obvious circuit for relay 1316 which establishes an obvious circuit for rerouting relay 1317 to route the call to a vacant code trunk or any other desired trunk. In this case no charge rate relay of the group 901 to 908 will be operated by relay 1316 but the route relay 1317 will establish a circuit for relay 901 to satisfy the advance of the tandem district selector. This circuit may be traced from ground over the upper contact of relay 1317, conductor 1313, thence to battery through the winding of relay 901. Relay 901 upon operating will, in accordance with Table IV, cause the operation of no rate register relays at the tandem district selector. The connection is then established to the vacant code trunk in the usual manner.

Since the trouble features of the decoder are the same as fully described in the patent to Roberts hereinbefore referred to, and do not directly concern this invention, no detailed description thereof is believed to be necessary herein.

In some cases the calling subscriber may desire the assistance of an operator in establishing a desired connection in which event the subscriber will dial 0 and in response thereto the sender 103 will cause the setting of the brushes of the local district selector 102 upon the terminals of an idle trunk extending to the position of an "A" operator. Such a trunk is illustrated in Fig. 16. For a call of this type the sequence switch 136 of the district selector will be advanced in the well-known manner into position 15 following the seizure of the trunk whereupon a circuit will be established from battery through the winding of line relay 1600 of the trunk, upper back contact of cut-off relay 1601, tip trunk conductor 1602, tip brush of selector 102, upper contacts of cam 108, upper right winding of repeating coil 109, winding of polarized relay 111, left contacts of cam 110, lower right winding of repeating coil 109, lower contacts of cam 112, ring brush of the selector, ring trunk conductor 1603, lower back contact of relay 1601 through the non-inductive resistance 1604 to ground.

Relay 1600 operates in this circuit but the current flowing through the winding of polarized relay 111 is not in the proper direction to cause its operation. Relay 1600 upon operating closes obvious circuits for lighting the calling lamp 1605 and for operating relay 1606. Relay 1606 upon operating connects busy ground through resistance 1607 over its front contact and the normal contacts of charging relay 1608 to the sleeve trunk conductor 1609 and at its upper front contact closes a circuit from ground over the back contact of relay 1610 to battery through the winding of relay 1611 which operates to connect a source of ringing tone current over its upper front contact and the upper back contacts of relay 1601 to the circuit previously traced through the right windings of repeating coil 109 which tone current is transmitted inductively to the calling line loop as a signal to the calling subscriber that the connection has been extended to an operator's trunk and is awaiting the response of the operator. Relay 1611 upon operating also establishes a circuit from the source 1612 of positive 120-volt current through resistance lamp 1618 over the lower front contact of relay 1611 to ground through the winding of relay 1613 thereby causing the operation of relay 1613.

When in response to the lighting of lamp 1605 the operator plugs a cord circuit into the jack 1614 of the trunk, a circuit is established from battery through the sleeve relay 1615 of the cord circuit, sleeves of plug 1616 and jack 1614, thence in parallel to ground through the winding of cut-off relay 1601 and the winding of relay 1610. Relay 1601 operates but relay 1610 being marginally wound does not operate at this time. Relay 1601 upon operating removes the winding of relay 1600 and resistance 1604 from the talking conductors of the trunk thereby releasing relay 1600, opens the ringing tone circuit at its inner upper back contacts to discontinue the ringing tone and at its front contact establishes a holding circuit for relay 1606. Relay 1606 being slow to release does not release upon the release of relay 1600 and before the holding circuit therefor is established by the operation of relay 1601. The subscriber upon noting the discontinuation of the ringing tone is apprised of the fact that the operator has responded. Talking battery is now supplied from the cord circuit to the trunk and now flows over the circuit previously traced through the winding of polarized relay 111 in such a direction as to cause its operation to establish an operating circuit for relay 140. The circuit of relay 140 extends from battery through the upper winding thereof, the right contacts of cam 115, front contact of relay 111 to ground over the lower left contact of cam 116. Relay 140 upon operating establishes a circuit from ground over the upper left contact of cam 116, lower front contact of relay 140, con-

tact of cam 141 and contact of cam 142 through the magnet winding of sequence switch 136 for advancing the sequence switch into the talking position 16.

Upon leaving position 15 the initial energizing circuit for relay 140 is opened at the right contacts of cam 115 but relay 140 is held operated over its lower winding and middle lower front contact, the lower contacts of cam 139, sleeve brush of the selector switch, sleeve conductor 1609 to ground through resistance 1607 in the trunk circuit. Upon leaving position 15¼ the previously traced circuit through the winding of relay 111 is opened at the contacts of cams 108 and 112 but when reaching position 15¾ a full metallic talking loop is extended from the tip brush of the selector over the left contacts of cam 137, the upper back contact of relay 132, over the substation loop, thence over the lower back contact of relay 132, winding of relay 130, the left contacts of cam 138 to the ring brush of the selector, the calling substation now receiving talking battery from the cord circuit.

The operator now receives information from the calling subscriber with respect to the desired connection and proceeds to establish it in the usual manner. If the call is successful and is terminated outside the local calling zone, the operator will prepare the usual ticket based upon the tariff rate for the initial and overtime periods of conversation. If, however, the call is terminated in the local zone she is enabled through the operation of a charging key 1617 associated with her cord circuit to operate the subscriber's message register once for making a single unit charge for the call. Upon the operation of key 1617 the resistance of the sleeve circuit extending as previously traced through the windings of relays 1601 and 1610 is reduced to such an extent that marginal relay 1610 responds to open the circuit of relay 1611 which thereupon releases. Since relay 1613 is slow to release it does not release immediately following the release of relay 1611 and with relay 1611 released establishes an operating circuit for charging relay 1608 extending from the 120-volt battery 1612 through resistance lamp 1618 over the lower back contact of relay 1611, the lower front contact of relay 1613 through the winding of relay 1608 to the negative terminal of the 48-volt central office battery thus causing relay 1608 to operate. Relay 1608 upon operating at its transfer contacts substitutes the source 1612 of 120-volt positive current for the trunk busying ground through resistance 1607 whereby current from the source 1612 is applied over the inner lower back contact of relay 1611, the upper transfer contacts of relay 1613, the transfer contacts of relay 1608, conductor 1609, the sleeve brush of selector switch 102, the lower contacts of cam 139, over the middle lower front contact and through the lower winding of relay 140 to the negative terminal of central office battery, thus holding relay 140 operated, and by a parallel path over the inner lower front contact of relay 140, the upper contacts of cam 110 to the anode 121 of tube 120 and through resistance 124 to the cathode 122 and through condenser 125, resistance 126 to ground through the winding of relay 127. In the manner previously described the tube 120 fires and relay 127 consequently operates and establishes a circuit for relay 117. This circuit may be traced from battery through the lower winding of relay 117, the upper contact of relay 127, the inner and middle front contacts of relay 140 thence as traced to the 120-volt source of charging potential 1612 so long as relays 1608 and 1613 remain operated, or over the alternate contacts of relay 1608 and the upper normal contacts of relay 1613 to ground through resistance 1607 after relay 1613 finally releases if the key 1617 is maintained operated, or over the normal contacts of relay 1608 and the lower contact of relay 1606 to ground through resistance 1607 if the key 1617 has been released quickly and relay 1611 has reoperated to release relay 1608. As soon as relay 1608 releases the tube 120 is extinguished.

Relay 117 upon operating over any one of the alternative circuits thus traced locks over its lower front contact to ground at the upper left contact of cam 116 and at its upper contact connects battery over the lower right and left contacts of cam 128, brush 129 of the line finder to ground through the calling subscriber's message register 119 thereby operating the message register once. The connection to the operator's position is released when the operator withdraws the plug 1616 of her cord circuit from the trunk jack 1614 in the well-known manner.

What is claimed is:

1. In a telephone system, a plurality of offices located in different zones thereof, subscribers' lines terminating in said offices each having a call charging means individual thereto, a tandem office, trunks incoming to said tandem office over which connections from subscribers' lines in originating offices are extended to said tandem office, charge controlling means individual to each of said trunks for transmitting impulses thereover for operating the call charging means of a subscriber's line in an originating office, a sender common to said trunks for controlling the extension of a connection from a calling one of said trunks to a subscriber's line in any desired office, means for connecting said sender with a calling trunk, a control device associable with said sender having means for registering the zone in which an originating office is located and means for registering the zone in which a desired office is located, and means jointly controlled by said registering means for controlling the charge controlling means individual to the calling trunk.

2. In a telephone exchange system, a plurality of offices located in different zones thereof, subscribers' lines terminating in said offices each having a call charging means individual thereto, a tandem office, trunks incoming to said tandem office over which connections from subscribers' lines in originating offices are extended to said tandem office, charge controlling means individual to each of said trunks for transmitting impulses thereover for operating the call charging means of a subscriber's line in an originating office, a sender common to said trunks for controlling the extension of a connection from a calling one of said trunks to a subscriber's line in any desired office, means for connecting said sender with a calling trunk, a control device associable with said sender having means operable from said calling trunk for registering the zone in which the originating office is located and means operable from said sender for registering the zone in which the desired office is located, and means jointly controlled by said registering means for controlling the charge controlling means of the calling trunk.

3. In a telephone exchange system, a plurality of offices located in different zones thereof, sub-

scribers' lines terminating in said offices each having a call charging means individual thereto, a tandem office, trunks incoming to said tandem office over which connections from subscribers' lines in originating offices are extended to said tandem office, charge controlling means individual to each of said trunks for transmitting impulses thereover for operating the call charging means of a subscribers' line in an originating office, a sender common to said trunks responsive to impulses designating the office code and numerical digits of the wanted line for controlling the extension of a connection from a calling one of said trunks to said line, means for connecting said sender to a calling trunk, a control device associable with said sender having register relays selectively operable from the calling trunk for registering the zone in which the originating office is located and a plurality of route relays selectively operable from said sender in accordance with the office code digits registered therein, an operated route relay being effective to control said sender in the establishment of a connection to the office in which a desired line terminates, and means jointly controlled by an operated register relay and an operated route relay for controlling the charge controlling means of the calling trunk.

4. In a telephone exchange system, a plurality of offices located in different zones thereof, subscribers' lines terminating in said offices each having a call charging means individual thereto, a tandem office, trunks incoming to said tandem office over which connections from subscribers' lines in originating offices are extended to said tandem office, said trunks being divided into groups, a sender common to said trunks for controlling the extension of a connection from a calling one of said trunks to a subscriber's line in any desired office, means for connecting said sender with a calling trunk, a control device associable with said sender having means for registering the zone in which a desired office is located, charge controlling means individual to each of said trunks for transmitting impulses thereover for operating the charging means of a subscriber's line in an originating office, means in said control device controlled from the calling trunk for registering the identification of the group in which the trunk is located, a trunk connector operable in accordance with said registration for connecting said control device with the trunk of a group at the time connected with said sender, means in said control device operable from said trunk over said trunk connector for registering the zone in which the originating office is located, and means jointly controlled by the calling and called zone registration means of said control device over said trunk connector for controlling the charge controlling means of said trunk.

5. In a telephone exchange system, a plurality of offices located in different zones thereof, subscribers' lines terminating in said offices each having a call charging means individual thereto, a tandem office, trunks incoming to said tandem office over which connections from subscribers' lines in originating offices are extended to said tandem office, said trunks being divided into groups, a sender common to said trunks for controlling the extension of a connection from a calling one of said trunks to a subscriber's line in any desired office, means for connecting said sender with a calling trunk, a control device associable with said sender having means for registering the zone in which a desired office is located, charge controlling means individual to each of said trunks for transmitting impulses thereover for operating the charging means of a subscriber's line in an originating office, means in said control device controlled from the calling trunk for registering the identification of the group in which the trunk is located, a trunk connector operable in accordance with said registration for selecting the trunk group in which the calling trunk is located, means in said calling trunk responsive if the proper trunk group has been selected for completing a connection from said trunk through said trunk connector to said control device, means in said control device operable from said trunk over said trunk connector for registering the zone in which the originating office is located and means jointly controlled by the calling and called zone registration means of said control device over said trunk connector for controlling the charge controlling means of said trunk.

6. In a telephone exchange system, a plurality of outlying offices, a tandem office, trunks incoming to said tandem office over which connections are extended from originating outlying offices to said tandem office, said trunks being divided into groups, a sender common to said trunks for controlling the extension of a connection from a calling one of said trunks to a subscriber's line in any desired outlying office, a link circuit for extending control paths between said sender and a calling trunk, a control device associable with said sender having means for registering the identification of the group in which a calling trunk is located, means in each trunk for transmitting a code of impulses through said link circuit to said control device for selectively operating said registering means and a trunk connector operable in accordance with said registration for establishing additional control paths between said control device and the calling trunk of the identified group of trunks.

7. In a telephone exchange system, a plurality of offices located in different zones thereof, subscribers' lines terminating in said offices each having a call charging means individual thereto, a tandem office, trunks incoming to said tandem office over which connections from subscribers' lines in originating offices are extended to said tandem office, a sender common to said trunks for controlling the extension of a connection from a calling one of said trunks to a subscriber's line in any desired office, means for connecting said sender with a calling trunk, a control device associable with said sender having means operable from said calling trunk for registering the zone in which the originating office is located and means operable from said sender for registering the zone in which the desired office is located, charge rate registering means in said calling trunk controlled jointly by said registering means of said control device for determining the charge to be applied for an established connection, and means in said trunk controlled by said charge rate registering means for transmitting impulses over said trunk for operating the call charging means of a subscriber's line in an originating office.

8. In a telephone exchange system, a plurality of offices located in different zones thereof, subscribers' lines terminating in said offices each having a call charging means individual thereto, a tandem office, trunks incoming to said tandem office over which connections from subscribers' lines in originating offices are extended to said tandem office, a sender common to said trunks

for controlling the extension of a connection from a calling one of said trunks to a subscriber's line in any desired office, means for connecting said sender with a calling trunk, a control device associable with said sender having means operable from said calling trunk for registering the zone in which the originating office is located and means operable from said sender for registering the zone in which the desired office is located, charge rate registering means in said calling trunk controlled jointly by said registering means of said control device for determining the charge to be applied for an established connection, and means in said trunk operative upon the response of the called subscriber and controlled by said charge rate registering means for transmitting impulses over said trunk for operating the call charging means of a subscriber's line in an originating office for the initial and overtime periods of conversation and for determining the permissible duration of such periods.

9. In a telephone exchange system, a plurality of offices located in different zones thereof, subscribers' lines terminating in said offices each having a call charging means individual thereto, a tandem office, trunks incoming to said tandem office over which connections from subscribers' lines in originating offices are extended to said tandem office, a sender common to said trunks for controlling the extension of a connection from a calling one of said trunks to a subscriber's line in any desired office, means for connecting said sender with a calling trunk, a control device associable with said sender having means operable from said calling trunk for registering the zone in which the originating office is located and means operable from said sender for registering the zone in which the desired office is located, charge rate registering means in said calling trunk controlled jointly by said registering means of said control device for determining the charge to be applied for an established connection, a switch individual to said trunk operable through an initial and one or more overtime cycles upon the response of the called subscriber, means controlled by said switch during the initial portion of each cycle thereof and in accordance with the setting of said charge rate registering means for transmitting impulses over said trunk for operating the call charging means of a subscriber's line in an originating office and means operable in accordance with the setting of said charge rate registering means for controlling the speed of advance of said switch during the latter portion of each of its cycles for determining the permissible duration of such cycles.

10. In a telephone exchange system, a plurality of offices, located in different zones thereof, subscribers' lines terminating in said offices each having a call charging means individual thereto, means in each of said offices including a gas-filled tube for controlling the call charging means of a calling line of said office, a tandem office, two-wire trunks incoming to said tandem office over which connections from subscribers' lines in originating offices are extended to said tandem office, a sender common to said trunks for controlling the extension of a connection from a calling one of said trunks to a subscriber's line in any desired office, means for connecting said sender with the calling trunk, a control device associable with said sender having means operable from said calling trunk for registering the zone in which the originating office is located and means operable from said sender for registering the zone in which the desired office is located, charge rate registering means in said calling trunk controlled jointly by said registering means of said control device for determining the charge to be applied for an established connection and means operable upon the response of the called subscriber and controlled by said charge rate registering means for transmitting impulses over the conductors of said trunk whereby the tube at the originating office is rendered conducting in response to each impulse for operating the call charging means of the calling line.

11. In a telephone exchange system, a plurality of offices, located in different zones thereof, subscribers' lines terminating in said offices, each having a call charging means individual thereto, means in each of said offices including a gas-filled tube for controlling the call charging means of a calling line of said office, a tandem office, two-wire trunks incoming to said tandem office over which connections from subscribers' lines in originating offices are extended to said tandem office, a sender common to said trunks for controlling the extension of a connection from a calling one of said trunks to a subscriber's line in any desired office, means for connecting said sender with a calling trunk, a control device associable with said sender having means operable from said calling trunk for registering the zone in which the originating office is located and means operable from said sender for registering the zone in which the desired office is located, charge rate registering means in said calling trunk controlled jointly by said registering means of said control device for determining the charge to be applied for an established connection and means operable upon the response of the called subscriber and controlled by said charge rate registering means for transmitting impulses over the conductors of said trunk connected in simplex whereby the tube at the originating office is rendered conducting in response to each impulse for operating the call charging means of the calling subscriber's line.

12. In a telephone exchange system, a plurality of offices located in different zones thereof, subscribers' lines terminating in said offices each having a call charging means individual thereto, a tandem office, trunks incoming to said tandem office over which connections from subscribers' lines in originating offices are extended to said tandem office, a sender common to said trunks for controlling the extension of a connection from a calling one of said trunks to a subscriber's line in any desired office, means for connecting said sender with a calling trunk, a control device associable with said sender having means operable from said calling trunk for registering the zone in which the originating office is located, means operable from said sender for registering the zone in which the desired office is located and means controlled jointly by said registering means for registering the charge rate to be applied for an established connection, charge rate registering means in said calling trunk operable in accordance with the setting of the charge rate registering means of said control device and means in said calling trunk controlled by the charge rate registering means thereof for transmitting impulses over said trunk for operating the call charging means of a subscriber's line in an originating office.

13. In a telephone exchange system, a plurality

of offices located in different zones thereof, subscribers' lines terminating in said offices each having a call charging means individual thereto, a tandem office, trunks incoming to said tandem office over which connections to subscribers' lines in originating offices are extended to said tandem office, a sender common to said trunks for controlling the extension of a connection from a calling one of said trunks to a subscriber's line in any desired office, means for connecting said sender with a calling trunk, a control device associable with said sender having means operable from said calling trunk for registering the zone in which the originating office is located, means operable from said sender for registering the zone in which the desired office is located and means controlled jointly by said registering means for registering the charge rate to be applied for an established connection, charge rate registering means in said calling trunk, means including a plurality of circuit paths for transferring the registration from the charge rate registering means of said control device to the charge rate registering means of said calling trunk, means for checking said circuit paths for unstandard conditions, and means in said calling trunk controlled by the charge rate registering means thereof for transmitting impulses over said trunk for operating the call charging means of a subscriber's line in an originating office.

14. In a telephone exchange system, a plurality of offices located in different zones thereof, subscribers' lines terminating in said offices each having a call charging means individual thereto, a tandem office, trunks incoming to said tandem office over which subscribers' lines in originating offices are extended to said tandem office, a sender common to said trunks for controlling the extension of a connection from a calling one of said trunks to a subscriber's line in any desired office, means for connecting said sender with a calling trunk, a control device associable with said sender having means operable from said calling trunk for registering the zone in which the originating office is located, means operable from said sender for registering the zone in which the desired office is located and means controlled jointly by said registering means for registering the charge rate to be applied for an established connection, charge rate registering means in said calling trunk means including a plurality of circuit paths for transferring the registration from the charge rate registering means in said control device to the charge rate registering means of said calling trunk, means operable prior to the transfer of said registration for checking said circuit paths for unstandard conditions, means for again checking said paths to determine if said registration has been successfully transferred and means in said calling trunk controlled by the charge rate registering means thereof for transmitting impulses over said trunk for operating the call charging means of a subscriber's line in an originating office.

15. In a telephone exchange system, a plurality of offices located in different zones thereof, subscribers' lines terminating in said offices each having a call charging means individual thereto, a tandem office, trunks incoming to said tandem office over which connections from subscribers' lines in originating offices are extended to said tandem office, charge rate registering means and impulse transmitting means controllable thereby individual to each of said trunks for transmitting impulses thereover for operating the charging means of the subscriber's line in an originating office, a sender common to said trunks responsive to impulses designating the office code and numerical digits of a wanted line for controlling the extension of a connection from a calling one of said trunks to the wanted line, means for connecting said sender to a calling trunk, a control device associable with said sender having register relays selectively operable from the calling trunk for registering the zone in which the originating office is located, a plurality of route relays selectively operable from said sender in accordance with the office code digits registered therein, said route relays being effective to control said sender in the establishment of connections and means jointly controlled by an operated register relay and an operated route relay if said route relay is indicative of a restricted code for rerouting the connection and for controlling the charge rate registering means of the calling trunk to register a no charge condition for the rerouted connection.

16. In a telephone exchange system, a plurality of offices located in different zones thereof, subscribers' lines terminating in said offices each having a call charging means individual thereto, a tandem office, trunks incoming to said tandem office over which connections from subscribers' lines in originating offices are extended to said tandem office, charge rate registering means and impulse transmitting means controllable thereby individual to each of said trunks for transmitting impulses thereover for operating the charging means of a subscriber's line in an originating office, a sender common to said trunks responsive to impulses designating the office code and numerical digits of a wanted line for controlling the extension of a connection from a calling one of said trunks to the wanted line, means for connecting said sender to a calling trunk, a control device associable with said sender having register relays selectively operable from the calling trunk for registering the zone in which the originating office is located, a plurality of route relays selectively operable from said sender in accordance with the office code digits registered therein, said route relays being effective to control said sender in the establishment of connections, means jointly controlled by an operated register relay and an operated route relay if the route relay is indicative of a restricted code for operating a reroute relay and for releasing said operated route relay and means controlled by said operated reroute relay for rerouting the connection and for controlling the charge rate registering means of the calling trunk to register a no charge condition for the rerouted connection.

17. In a telephone exchange system, a plurality of offices located in different zones thereof, subscribers' lines terminating in said offices each having a call charging means individual thereto, a tandem office, trunks incoming to said tandem office over which connections from subscribers' lines in originating offices are extended to said tandem office, charge rate registering means and impulse transmitting means controllable thereby individual to each of said trunks for transmitting impulses thereover for operating the charging means of the subscribers' lines in an originating office, a sender common to said trunks responsive to impulses designating the office code and numerical digits of a wanted line for controlling the extension of a connection from a calling one of said trunks to the wanted line, means for con-

necting said sender to a calling trunk, a control device associable with said sender having register relays selectively operable from the calling trunk for registering the zone in which the originating office is located, a plurality of route relays selectively operable from said sender in accordance with the office code digits registered therein, said route relays being effective to control said sender in the establishment of connections, means jointly controlled by an operated register relay and an operated route relay if said route relay is indicative of the office code of a non-existing office for operating a reroute relay and for releasing said operated route relay, and means controlled by said operated reroute relay for rerouting the connection to a vacant code trunk and for controlling the charge rate registering means of the calling trunk to register a no charge condition for the rerouted connection.

18. In a telephone exchange system, a plurality of offices located in different zones thereof, subscribers' lines terminating in said offices each having a call charging means individual thereto, a tandem office, trunks incoming to said tandem office over which connections from subscribers' lines in originating offices are extended to said tandem office, charge rate registering means and impulse transmitting means controllable thereby individual to each of said trunks for transmitting impulses thereover for operating the charging means of a subscriber's line in an originating office, a sender common to said trunks and responsive to impulses designating the office code and numerical digits of a wanted line for controlling the extension of a connection from a calling one of said trunks to the wanted line, means for connecting said sender to a calling trunk, a control device associable with said sender having register relays selectively operable from the calling trunk for registering the zone in which the originating office is located, a plurality of route relays selectively operable from said sender in accordance with the office code digits registered therein, said route relays being effective to control said sender in the establishment of connections, means jointly controlled by an operated register relay and an operated route relay if the rerouting of the connection is signified for operating a reroute relay and for releasing said operated route relay, and means controlled by said operated reroute relay for rerouting the connection and for controlling the charge rate registering means of the calling trunk.

HARRY C. CAVERLY.