

Feb. 27, 1940.

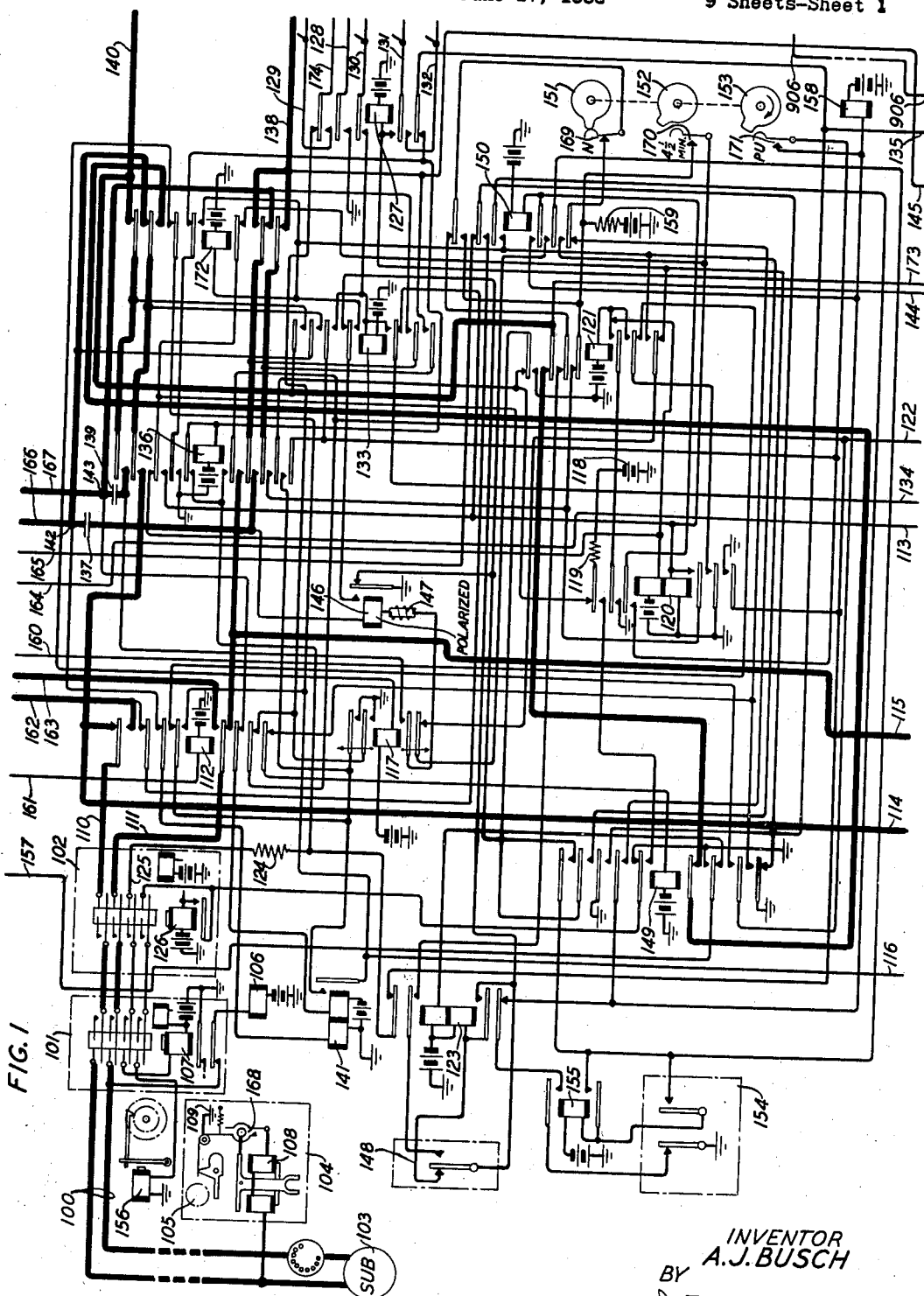
A. J. BUSCH

2,192,025

TELEPHONE SYSTEM

Filed June 17, 1938

9 Sheets-Sheet 1



INVENTOR
A. J. BUSCH
BY
M. J. McNamee
ATTORNEY

Feb. 27, 1940.

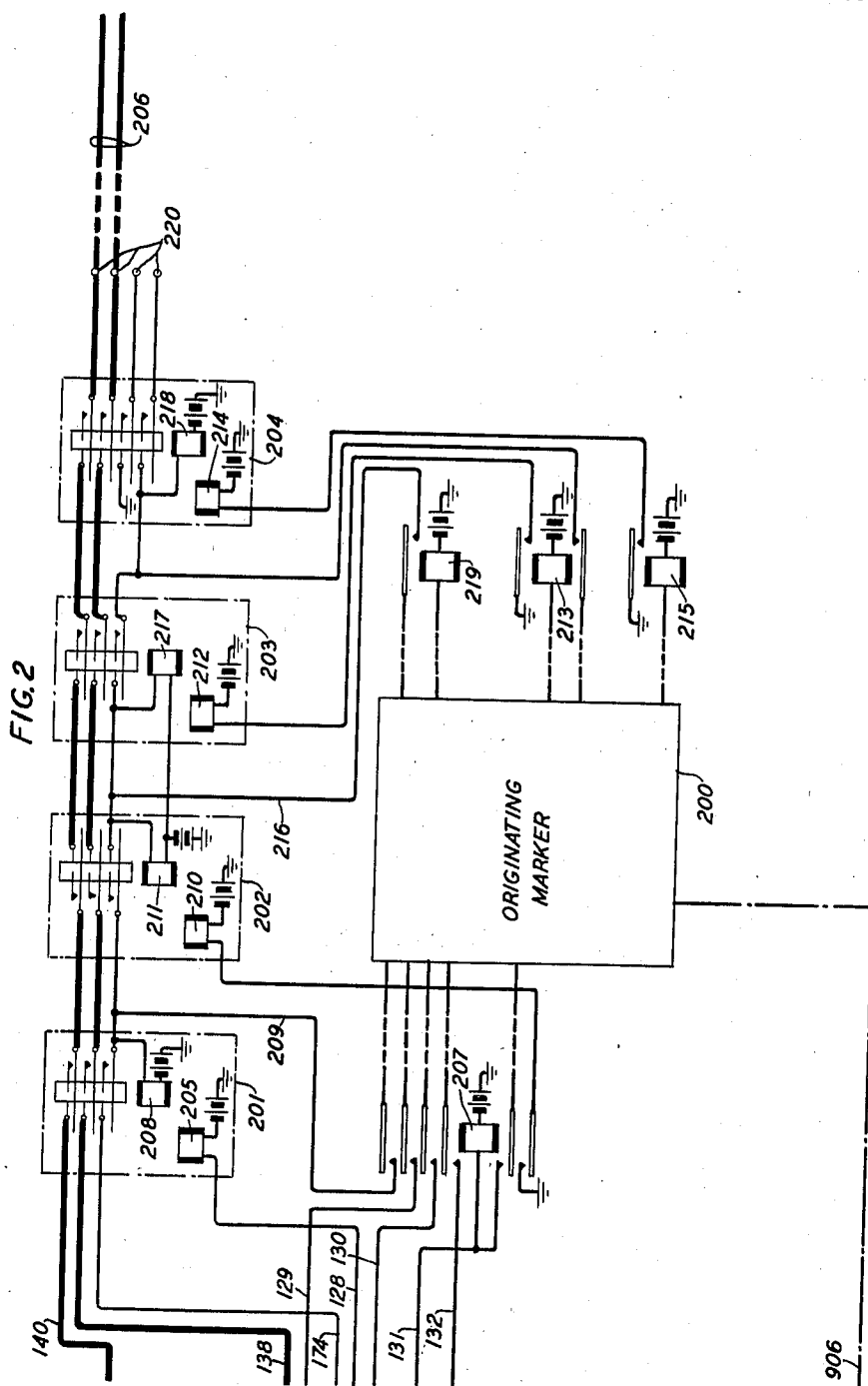
A. J. BUSCH

2,192,025

TELEPHONE SYSTEM

Filed June 17, 1938

9 Sheets-Sheet 2



INVENTOR
A. J. BUSCH
BY *M. T. McGerney*
ATTORNEY

Feb. 27, 1940.

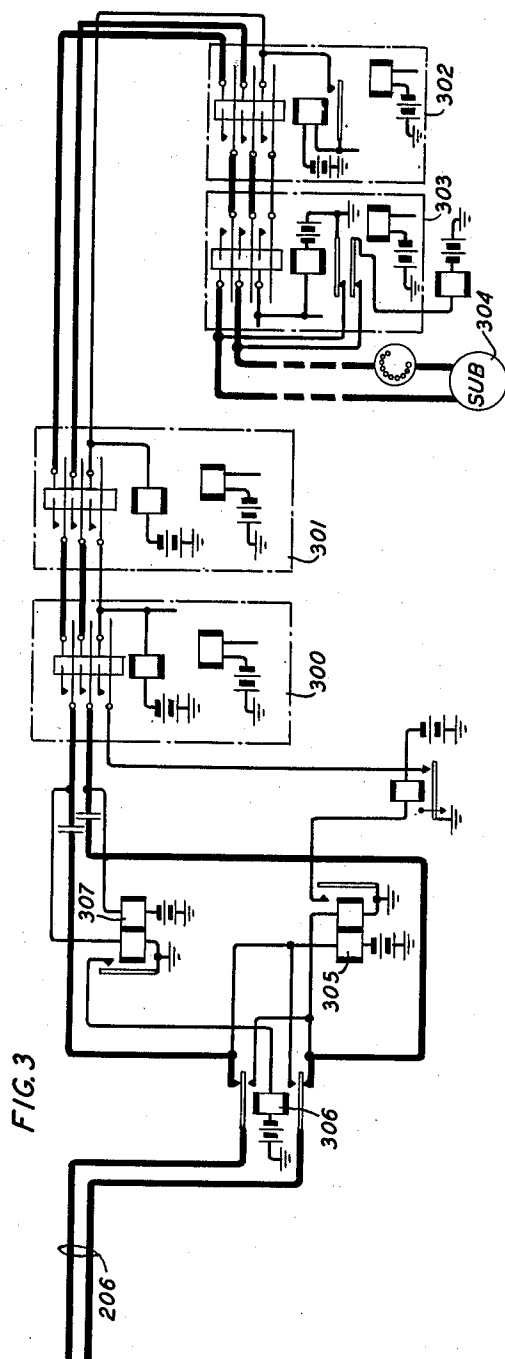
A. J. BUSCH

2,192,025

TELEPHONE SYSTEM

Filed June 17, 1938

9 Sheets-Sheet 3



INVENTOR
BY A.J. BUSCH
M. J. McJannet
ATTORNEY

Feb. 27, 1940.

A. J. BUSCH

2,192,025

TELEPHONE SYSTEM

Filed June 17, 1938

9 Sheets-Sheet 4

FIG. 4

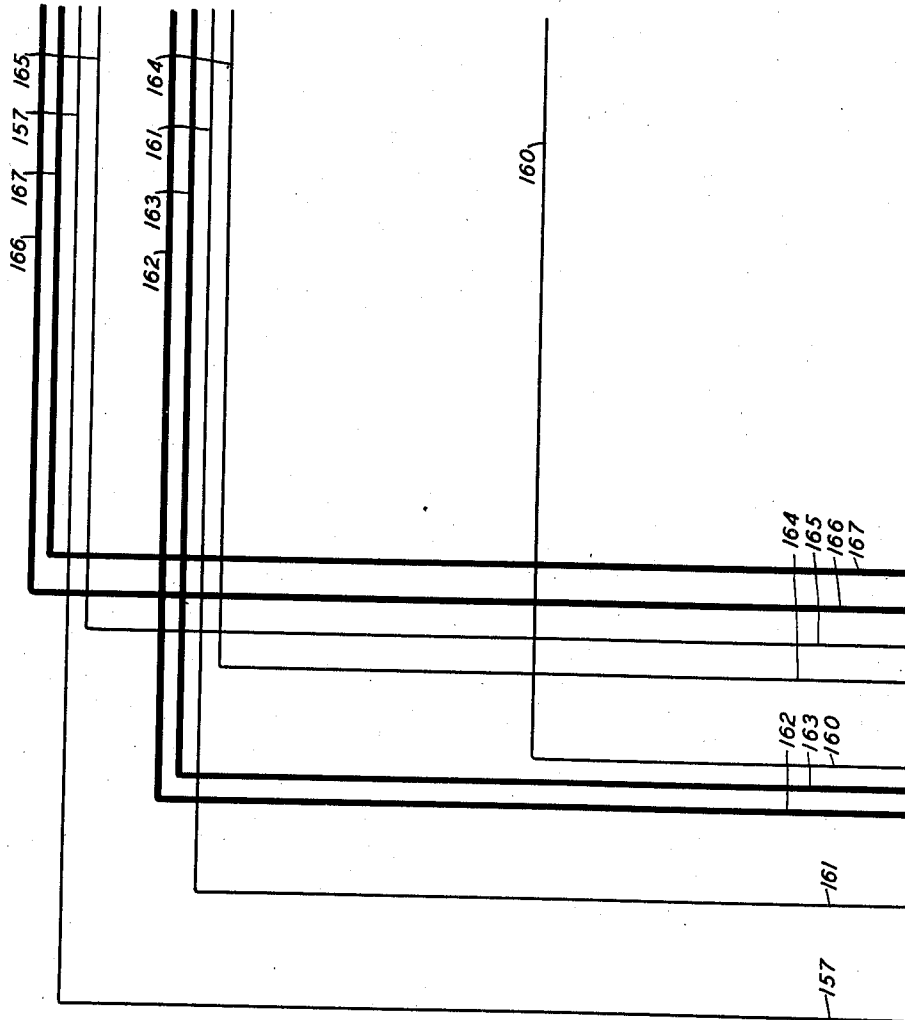


FIG. 4	FIG. 5	FIG. 6	FIG. 7	FIG. 8
FIG. 1	FIG. 2	FIG. 3		
FIG. 9				

FIG. 10

INVENTOR
A. J. BUSCH
BY *M. S. McJannet*
ATTORNEY

Feb. 27, 1940.

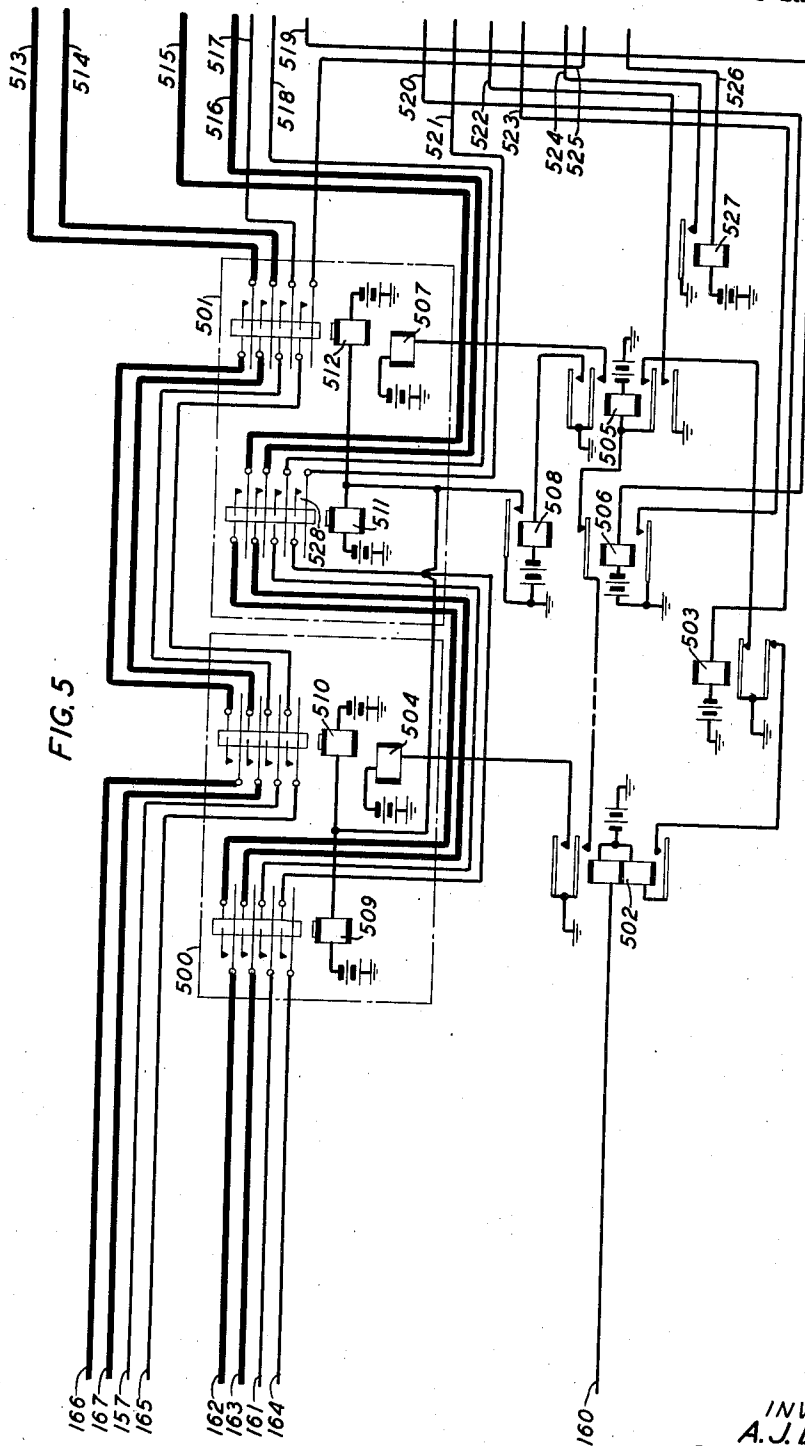
A. J. BUSCH

2,192,025

TELEPHONE SYSTEM

Filed June 17, 1938

9 Sheets-Sheet 5



INVENTOR
A. J. BUSCH
BY *Wm. H. H. H. H.*
ATTORNEY

Feb. 27, 1940.

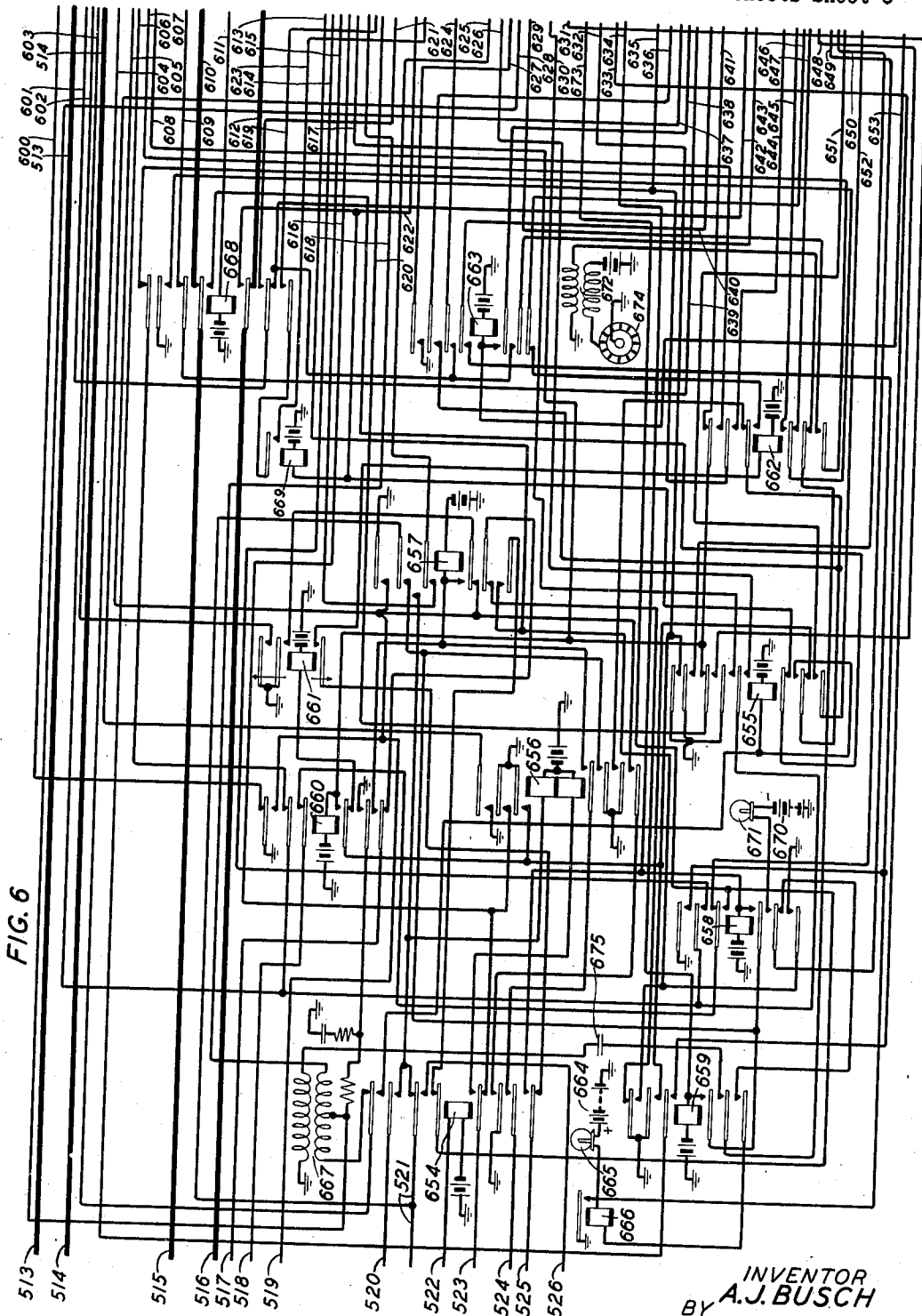
A. J. BUSCH

2,192,025

TELEPHONE SYSTEM

Filed June 17, 1938

9 Sheets-Sheet 6



INVENTOR
BY A. J. BUSCH
MR. McKenney
ATTORNEY

Feb. 27, 1940.

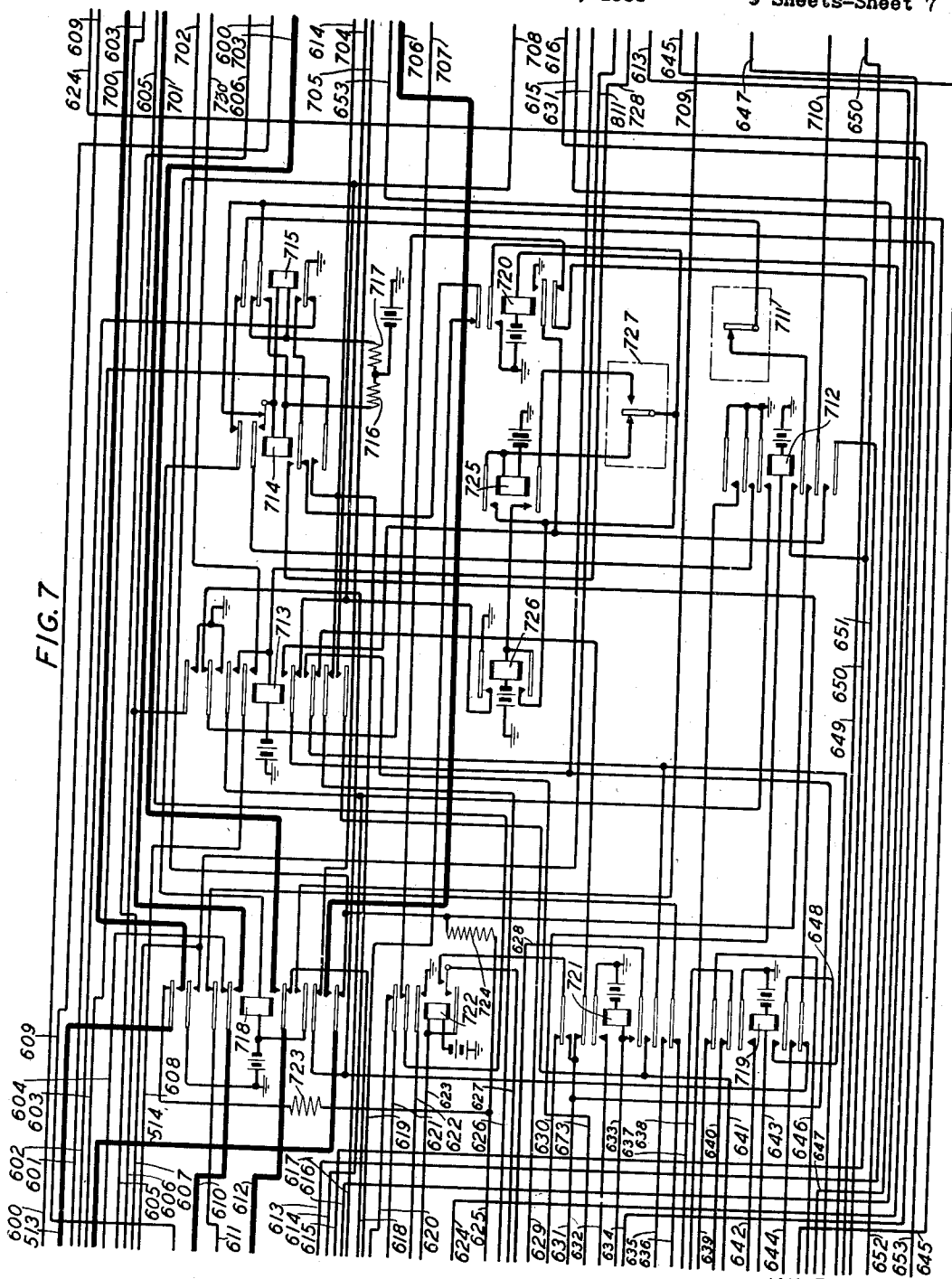
A. J. BUSCH

2,192,025

TELEPHONE SYSTEM

Filed June 17, 1938

9 Sheets-Sheet 7



INVENTOR
BY A. J. BUSCH

W. R. McKenney
ATTORNEY

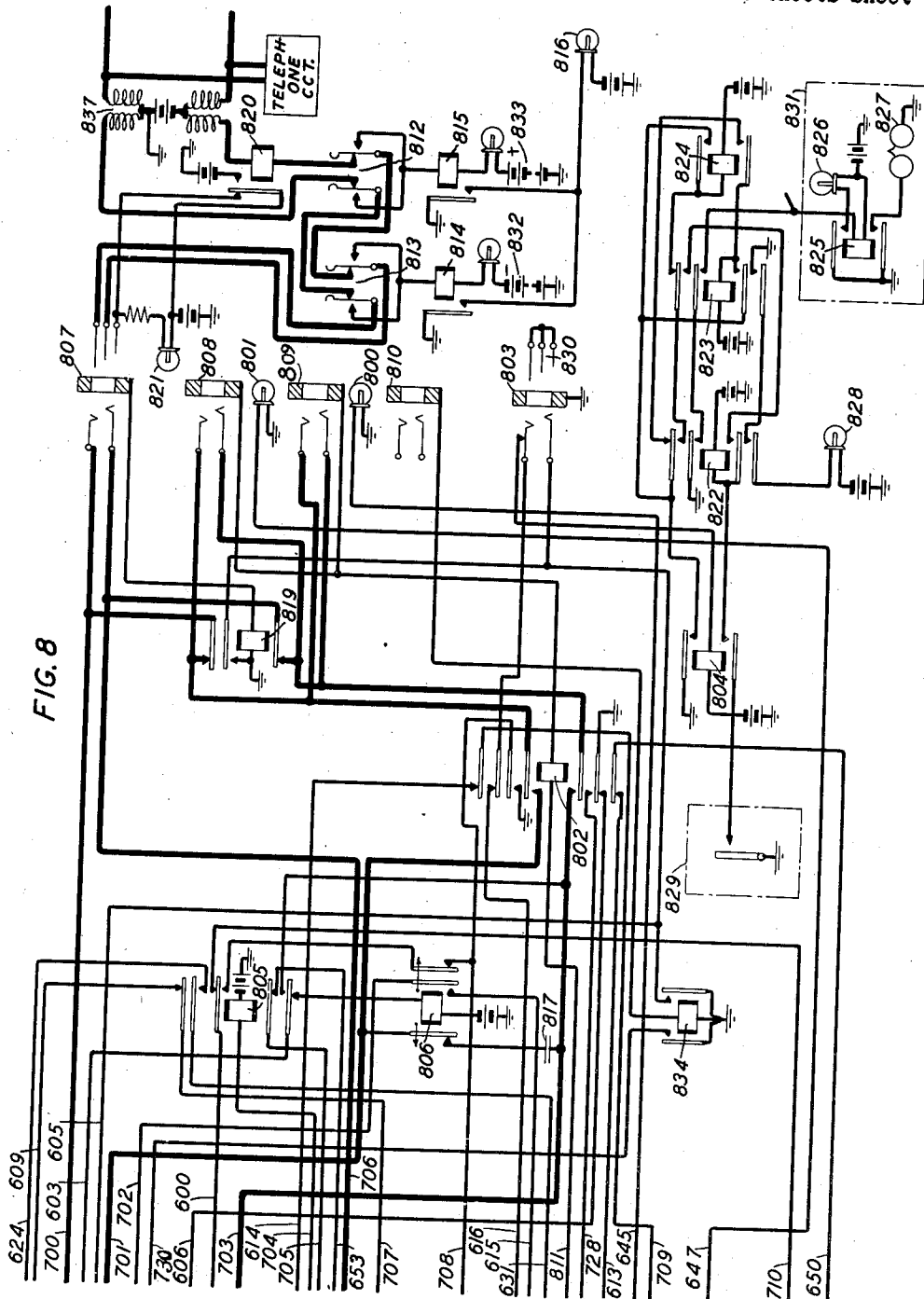
Feb. 27, 1940.

A. J. BUSCH
TELEPHONE SYSTEM

2,192,025

Filed June 17, 1938

9 Sheets-Sheet 8



INVENTOR
A. J. BUSCH

BY
M. R. McJannet
ATTORNEY

Feb. 27, 1940.

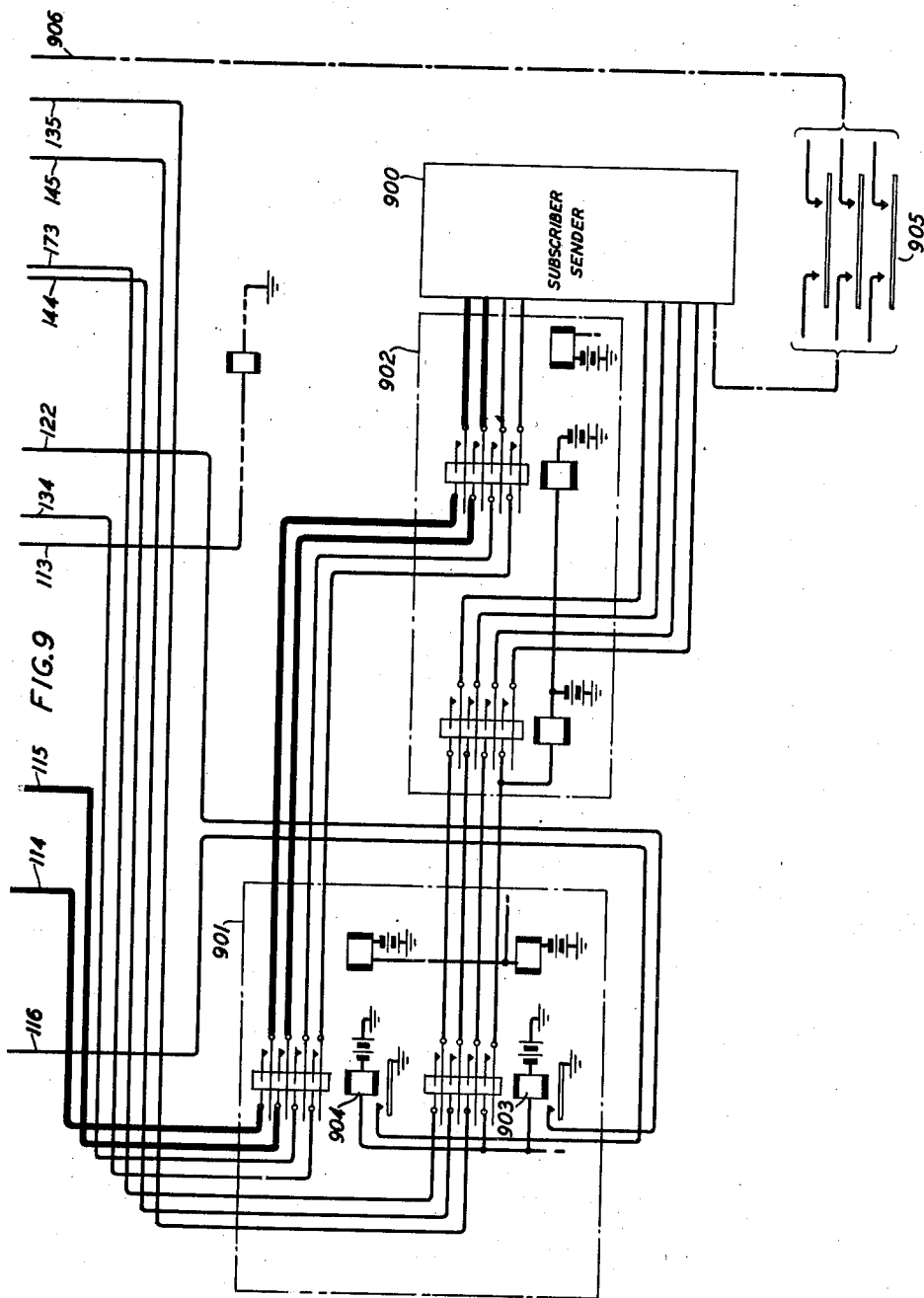
A. J. BUSCH

2,192,025

TELEPHONE SYSTEM

Filed June 17, 1938

9 Sheets-Sheet 9



INVENTOR
A. J. BUSCH
BY
M. T. McManey
ATTORNEY

UNITED STATES PATENT OFFICE

2,192,025

TELEPHONE SYSTEM

Aloysius J. Busch, Madison, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application June 17, 1938, Serial No. 214,348

10 Claims. (Cl. 179—6.31)

This invention relates to telephone systems and particularly to systems in which automatic switching equipment is employed for establishing connections.

5 It has been the practice heretofore in automatic telephone systems to provide common controlling mechanisms at the central office for the purpose of collecting at periodic intervals during a telephone conversation the coins that
10 are deposited by the calling party at a coin substation. Since these controlling mechanisms are common to a number of trunk circuits in the central office, and since their service is required only for a short interval of time while the deposited coin is being collected, the usual arrangement is to connect an idle one of these mechanisms to any one of the trunks having a call
15 thereon which has progressed to the point where the deposited coin should be collected and thereafter to restore the mechanism to normal in order that it may be taken in use by any other trunk having a call thereon that requires similar treatment. In addition to these periodic coin collecting operations it is also the practice in
20 systems of this kind to make tests of the calling coin line at regular intervals to determine that the calling patron has deposited a coin entitling him to another interval of conversation. In the past, the testing devices for testing the calling line to determine whether the coin has been deposited have been associated individually with the trunk circuits over which the conversational connections are established. Moreover, it has
25 been necessary to provide individual connecting circuits, such as operators' jacks, for each of the trunk circuits in order that a monitoring operator could make connection with any one of the trunks having a call thereon in the event that the testing mechanism discovers that the
30 calling patron has failed to deposit a coin for the next periodic interval of conversation.

The objects of the present invention are to simplify the equipment used in these systems by
35 combining in a single controlling mechanism the function of testing for a deposited coin and the function of disposing of the coin; to obtain a more reliable test for the presence of the coins deposited by the calling patron; to simplify the equipment necessary for monitoring on the established connections; and to secure other improvements in systems of this general character.

A feature of the present invention is a system in which a plurality of coin-control mechanisms
40 are provided in common to the conversational

trunks in the central office, and in which any particular one of the trunks having a call thereon, established from a coin substation, seizes an idle one of the control mechanisms for a brief interval near the end of each overtime
5 period of conversation and again seizes an idle one of these mechanisms for a brief interval at the end of each such overtime period. When the control mechanism is connected to the trunk near the expiration of the conversational period,
10 it proceeds to collect the coin that was previously deposited at the calling substation in payment for the conversational period. At this time the control mechanism also transmits a warning tone to the calling party, advising him that the conversational period is about to expire and that he should deposit a new coin if he wishes to continue. On its subsequent connection to the conversational circuit, namely, at the end
15 of the full conversational period, the control mechanism makes a test of the calling line to determine whether the calling party has deposited a new coin for the next period. If the mechanism fails to find the coin when it attempts to collect on its first association with the circuit
20 near the end of the conversational period, the monitoring operator is signaled and she makes connection with the calling line, by way of a jack circuit which is individual to the control mechanism, and challenges the calling party, requesting him to deposit a coin. When he does so, she immediately collects the coin and withdraws from the connection. If the coin control
25 mechanism fails to find a coin when it tests the line at the end of any conversational period, it signals the monitoring operator, and she makes connection with the calling line and requests the calling party to deposit a coin in payment for the next conversational period. When he deposits the new coin or advises the operator that he has already done so, she withdraws from the connection.

Another feature of the invention is an arrangement whereby the control mechanism makes a
30 retest of the calling line for the presence of a coin after the monitoring operator withdraws from the connection following her request to the calling party to deposit a new coin for the next conversational period. If on retest the control
35 mechanism finds that a coin has been deposited, the mechanism is disconnected and returns to common use; but, if the retest shows no coin is present, the mechanism again signals the monitoring operator, and she returns to the con-
40

nection and requests the calling party to deposit the coin. And on each withdrawal of the monitoring operator the control mechanism tests the line for the presence of the coin and will not retire from the connection until this test has been satisfied.

A further feature of the invention is the provision whereby the monitoring operator obtains connection to any calling coin line by means of connecting circuits, such as jacks, which are individual to the common control mechanisms. The control mechanism is always associated with the individual subscriber's line at the time the monitoring operator's service is required, and by giving her access to the lines by way of these common mechanisms rather than by way of connecting circuits individual to the central office trunks, a considerable economy is effected in the equipment required, and a concentration of the operators' connecting circuits is also obtained.

These and other features of the invention will be discussed more fully in detail in the following description and will also be set forth in the appended claims.

Referring to the drawings which accompany the detailed specification:

Fig. 1 shows a district junctor circuit arranged to function with a coin-control circuit and connected conventionally with a coin-box subscriber station by a line link and group control circuit consisting essentially of cross-bar switches:

Fig. 2 shows in abbreviated schematic form the connection of the district junctor of Fig. 1 to a district link frame and thence through an office link frame to an outgoing trunk;

Fig. 3 shows in an abbreviated form the termination of the trunk of Fig. 2 and its connection, through the cross-bar switches of incoming link and line link circuits, to a called subscriber's line;

Fig. 4 shows the conductors connecting Fig. 1 with Fig. 5;

Fig. 5 is an abridged form of a link and control circuit to illustrate means whereby a connection between the district junctor of Fig. 1 and the coin-control circuit of Figs. 6, 7 and 8 may be established;

Figs. 6, 7 and 8 placed together in order from left to right illustrate the coin-control circuit; arranged according to this invention;

Fig. 9 illustrates in an abbreviated schematic manner the connection of the district junctor of Fig. 1 through a subscriber sender link and control circuit to a subscriber sender circuit, conventionally represented by a box; and

Fig. 10 is a block diagram showing the manner in which the several figures of the drawings, should be arranged to show a complete system.

General description

The invention is illustrated in an automatic telephone system in which automatic switches of the cross-bar type are used as the medium for extending connections from subscribers' lines over trunks to other subscribers' lines. These cross-bar switching mechanisms are controlled by register senders at the central office, which receive the designations from the calling subscribers' dials, and by decoder markers. These markers are connectable to the senders for receiving information from the senders and are connectable to the proper switch frames for the purpose of testing the outgoing trunks and for testing the connecting links and for operating the magnets of the cross-bar switches to establish the connections.

While the system disclosed is not limited to the use of cross-bar switches of any particular type, reference may be had to the patent to Reynolds 2,021,329 of November 19, 1935, for an understanding of the construction and operation of a switch suitable for use in such systems. Because of the complicated nature of these systems, and since it is not necessary to an understanding of the invention that the system in all of its details be disclosed, much of the circuits and equipment has been eliminated in the present disclosure for the sake of simplicity. And in the following descriptions reference will be made to numerous operations which are not fully disclosed in all of their details. Wherever such references occur it will be understood that the circuits and equipment so referred to are already known and in particular reference is here made to the following for a detailed disclosure of operations and equipment referred to herein but not specifically disclosed: Carpenter Patent 2,093,117 of September 14, 1937; and Carpenter application Serial No. 214,356, filed June 17, 1938.

The subscribers' lines, such as line 100, are connected to verticals of the primary cross-bar switches indicated conventionally by the apparatus in the box 101 and thence extended through secondary switches, such as switch 102, to district junctor circuits. The connections to the district junctor circuits are effected by means of a line link and group control circuit and a subscriber sender link and control circuit. The circuit details (not shown) whereby these connections to the district junctor circuits are effected may be the same as in Carpenter Patent 2,093,117, and Carpenter application Serial No. 214,356, above mentioned.

When the connection to the district junctor, which is one of a group of similar junctors, not shown, is established as above outlined, the subscriber sender 900, through a link circuit represented in abbreviated form by primary and secondary cross-bar switches 901 and 902, functions in association with a marker circuit, indicated by a box 200, to establish connection to an outgoing trunk 206, in accordance with the office code dialed at calling station 103 and recorded by sender 900. This connection is established through district frame cross-bar switches 201 and 202 and office frame switches 203 and 204.

When the outgoing trunk 206 is thus seized a connection is established through an incoming link and connector circuit consisting of cross-bar switches 300 and 301, and line link circuit consisting of cross-bar switches 302 and 303, to the line of the called subscriber station 304. After the subscriber of station 304 answers, this condition is registered in the district junctor of Fig. 1.

The district junctor of Fig. 1 has common access to a group of coin-control circuits, one of which is shown by Figs. 6, 7 and 8. The connection to a selected coin-control circuit is made by means of the link and control circuit of Fig. 5, which consists essentially of primary and secondary cross-bar switches 500 and 501. This link and the associated control circuit, whereby a calling district junctor is connected to an idle coin control circuit, are not shown in full detail since they are well known and may be essentially the same as those shown in Carpenter Patent 2,093,117, and Carpenter application Serial No. 214,356, above mentioned.

The district junctor circuit of Fig. 1 is arranged to summon the control circuit of Figs. 6, 7 and 8 when required as follows: (a) to collect a coin, 75

after a completed connection, immediately after the calling party has disconnected; (b) to collect a coin during conversation at the end of a predetermined interval; (c) to return a coin after an incompleted connection immediately after the calling party disconnects or for a free call; (d) to test for the presence of an additional coin at the beginning of an overtime period, and, in case no coin is found, to summon an operator for overtime monitoring on the connection. In the case of condition (a), before mentioned, the coin control circuit makes a test to determine the presence or non-presence of a coin in the coin box 104 and to determine whether or not the coin box 104 has been properly cleared after the application of coin-collect current. For either of these conditions lamp 800 is flashed to inform an operator of the failure to collect the coin. For condition (b), should the coin-control circuit fail to find a coin, lamp 801 is immediately flashed to inform the operator of this condition. For condition (c), lamp 800 is lighted steadily if the coin box is not properly cleared after the application of coin return current. For condition (d), the operator is summoned by the steady lighting of lamp 801, if the test indicates no coin is present.

Detailed description of operation

The operation of the system will now be described in detail, and for this purpose let it be assumed that the calling party of station 103 initiates a call by depositing a coin 105 in coin box 104 and by actuating the telephone switch of station 103. A circuit is thereby closed for operating line relay 106, which circuit may be traced from battery through the winding of relay 106, lowermost contacts of cross-bar switch hold magnet 107, over ring conductor of line 100, through the switch contacts of station 103 and the winding and associated contacts 108 of coin collector magnet 108 to ground 109. Line relay 106 functions in cooperation with the line link and group control circuit of Fig. 1 and the subscriber sender link and control and subscriber sender circuits of Fig. 9 to effect the selection of an idle district junctor circuit, and an idle line link extending thereto. The idle condition of the district junctor circuit is indicated by the presence of battery on busy test lead 113. The circuit details, whereby this is accomplished are shown by the aforesaid patent application of W. W. Carpenter, Serial No. 214,356, filed June 17, 1938.

The selection before stated having been made, cross-bar switch contacts of the primary switch 101, and of the secondary switch 102, are closed, extending the conductors of line 100 to conductors 110 and 111, which terminate respectively on the upper outermost, and lower innermost break contacts of relay 112, through which contacts connection is made over conductors 114 and 115, through the cross-bar switch contacts of the sender link and control circuit, represented diagrammatically by boxes 901 and 902, to subscriber sender 900. Dial tone is now furnished over these conductors as an indication to the party of station 103 that dialing may now be started. Ground is also connected at this time by the hold magnet 904 of the subscriber sender link and control circuit to conductor 116 and thereby is operated relay 117. The operating circuit may be traced from battery through the winding of relay 117, upper next-to-innermost break contacts of relay 112 to ground on conductor 116. Relay 117 in operating performs no useful function at this

time, except to disconnect busy test battery 118 from test conductor 113, this circuit being traced from battery 118, through resistance 119, upper outermost break contacts of relays 120 and 121, and lower outer break contacts of relay 117 to conductor 113. This disconnection of battery 118 makes the district junctor test busy to the sender link and control circuit on subsequent calls. Hold magnet 903 of the sender link and control circuit also connects ground to conductor 122, which is extended through upper outer break contacts of relay 123 and resistance 124 to sleeve conductor 125, thereby supplying a holding ground for the line link hold magnets 107 and 126, while the sender 900 is connected to the district junctor circuit.

While the connection is being established from the calling line 100 to the sender circuit 900 the subscriber sender link and control circuit of Fig. 9 is momentarily connected to sender circuit 900 and during this momentary interval sender circuit 900 is furnished with the class of service information of line 100 and also is informed of the number of the district link and connector frame associated with the district junctor circuit to which sender 900 is connected. The line link and group control circuit and the subscriber sender link and control circuit are used only momentarily to connect line 100 to an idle district junctor circuit and a subscriber sender circuit and are then released to serve other calls but the connections through the cross-bar switches 101, 102, 901 and 902 which these circuits have established are held by the subscriber sender circuit 900 under control of the calling subscriber. After the office code has been dialed, sender 900 connects to the originating marker circuit 200, by means of a connector circuit 905, over a group of conductors represented by the broken line 906. The sender circuit 900 registers in the marker circuit 200 the office code, the class of service information of the calling line 100, and the number of the district link and connector frame serving the district junctor circuit involved in the call. The marker 200 then furnishes the sender 900 with the necessary information which it requires to control the progress of the call. Marker 200 then selects an office link and connector frame on which the desired trunk 206, leading to the called destination, appears, connects itself thereto and also to the district link and connector frame that is associated with the district junctor circuit involved in the call. After this has been successfully accomplished, marker 200 connects ground to a conductor which is extended through connector 905, sender 900, and the sender link circuit consisting of switches 901 and 902 to conductor 173, thereby operating district junctor relay 127. Relay 127 in operating connects ground with its upper next-to-innermost contacts to conductor 128, thereby operating select magnet 205 of the primary switch 201 of the district link and connector frame serving the district junctor of Fig. 1, and connects ground with its lower inner contacts to conductor 131, thereby operating relay 207, which is common to a group of district junctors served by the primary switch represented by the box 201. The operation of relay 207 extends conductors 129, 130, 131, 132 and 209 through contacts of a marker connector relay to the marker circuit 200 selected for handling the call being established. This connector relay which is not shown, being indicated only by broken lines, is individual to the marker circuit 200 and is operated each time

that marker 200 is selected for service in establishing a connection to the district frame represented by Fig. 2. Conductor 129 is used by marker 200 to determine when the primary switch 201 has operated from ground supplied by the marker over conductor 209. This is effected by the extension of the aforesaid ground through lowermost primary switch contacts associated with magnet 208, over conductor 174, through upper outermost make contacts of relay 127, over conductor 129, through upper next-to-outermost make contacts of relay 207, and contacts of the aforesaid marker connector relay, not shown, to marker 200. Conductor 130 is grounded by marker 200 through upper next-to-innermost contacts of relay 207, to operate relay 133, through upper innermost contacts of relay 127, for calls to an operator. Conductor 131 is used by the marker 200 to hold relay 127 operated, through its lower innermost contacts, until the marker 200 releases, as hereinafter described, and conductor 132 through lower outermost make contacts of relay 127 to give the sender 900 a trouble release signal if a trouble condition has been encountered by marker 200 in establishing the connection. If relay 133 is operated it will lock through its lower innermost make contacts to ground supplied by sender 900 over conductor 134.

Marker 200 now establishes the connection through the district and office switches to trunk 206. Select magnet 219 of secondary district switch 202 is operated by ground on the lower outer contacts of relay 207. Select magnet 212 of the primary office switch 203 is operated by ground on the upper contacts of relay 213, and select magnet 214 of the secondary switch by ground on the contacts of relay 215, both of which relays are operated by marker 200. The link between the secondary district and primary office switches is established when relay 219 is operated by marker 200 and operates hold magnets 211 and 217 from ground over conductor 216. The link between the primary and secondary switches of the office frame is completed, when hold magnet 218 is operated from ground in the marker through lower contacts of relay 213.

After the marker 200 has established connection with the trunk 206 as before described, it releases relay 127 by removing ground from the winding of relay 207. Relay 127 releases and closes the sleeve conductor 174 through to ground on the upper inner make contacts of relay 117. Marker 200 tests for this ground and if it finds this ground disconnects. Relay 117 was operated over conductor 116 when the sender link and control circuit connected sender 900 to the district junctor of Fig. 1. Relay 127 in releasing opens conductors 128, 129, 130, 131 and 132 to the district link and connector circuit and connects conductor 135, with its lower outermost break contacts, to the winding of relay 136 so that the sender can operate this relay later.

When the marker has established connection to the outgoing trunk 206, sender 900 then cooperates with the incoming apparatus of Fig. 3 to complete the call to the line of the called station 304. In connection with this incoming apparatus a terminating sender and terminating marker, not shown by Fig. 3, are provided. As soon as the connection to trunk 206 is established, a circuit is closed for operating relay 305, through break contacts of relay 306, over the established connection and over conductors 144 and 145 extending into the subscriber sender 900. The

operation of relay 305 at first closes a start lead, not shown, that causes the terminating sender aforesaid to be connected. After this the terminating sender receives from sender 900 the necessary information for completing in cooperation with the aforesaid terminating marker the connection to the line of the called station 304.

After sender 900 has completed its functions in establishing the connection, as above outlined, it connects ground to conductor 135 to operate relay 136 through lower outermost break contacts of relay 127. When relay 136 operates it locks under control of relay 172 in a circuit from battery through the winding of relay 136, upper innermost break contacts of relay 172 to ground on the upper next-to-innermost contacts of relay 136. Relay 136 in operating closes the transmission circuit to station 103. This may be traced from conductor 110, through upper outermost break contacts of relay 112, upper next-to-outermost make contacts of relay 136, upper next-to-outermost break contacts of relay 172, condenser 137, lower middle make contacts of relay 136, and lower outermost break contacts of relay 172 to conductor 138; also from conductor 111, through lower innermost break contacts of relay 112, lower next-to-innermost make contacts of relay 136, lower next-to-innermost break contacts of relay 172, condenser 139, upper outermost make contacts of relay 136, and upper outermost break contacts of relay 172 to conductor 140. Relay 136 operated also closes a holding circuit for relay 133 if this relay has been previously operated by the marker for an operator class call. Relay 136 also furnishes talking battery through the windings of relay 141 to line 100. For this purpose ground is supplied through the left winding of relay 141, upper next-to-innermost break contacts of relay 112 to junction point 142; battery is supplied through the right winding of relay 141, lower next-to-innermost break contacts of relay 112 to junction point 143.

After sender circuit 900 has completed its functions and has operated relay 136 over conductor 135 as before stated, it releases. This causes the cross-bar switches 901 and 902 of the sender link circuit of Fig. 9 to be released which opens the connection of conductors 114, 115, 134, 122, 173, 144, 145 and 135. The established connection is now placed under control of the district junctor circuit of Fig. 1. The connection is held under control of relay 117 which remains operated provided the calling subscriber station 103 is still connected to the line causing the operation of relay 141 over the line loop. Relay 141 operated holds relay 117 operated in a circuit that is traced from ground on the upper outermost contacts of relay 117, operated contacts of relay 141, upper next-to-innermost break contacts of relay 172, through winding of relay 117 to battery.

After the connection to the trunk 206 has been established, a circuit is completed for operating the bridged impedance relay 305 of the incoming trunk circuit over the loop extending to the calling district junctor of Fig. 1. This may be traced through the windings of relay 305, upper and lower break contacts of the reversing relay 306, over trunk 206, contacts of the cross-bar switches 204, 203, 202, 201, over conductors 140 and 139, outermost break contacts of relay 172, upper outermost make contacts and lower middle make contacts of relay 136, winding of polarized relay 146 and retardation coil 147 and lower inner operated make contacts of relay 117. Relay 305 75

operates in this circuit, but polarized relay 146 does not operate at this time.

When the called subscriber of station 304 answers, a circuit is closed for operating the bridged impedance relay 307, which may be traced from battery and ground through the windings of relay 307 over the tip and ring conductors and contacts of the cross-bar switches 300 and 301 of the incoming link circuit and of the cross-bar switches 302 and 303 of the line link circuit to the line leading to the called station 304. Relay 307 in operating closes an obvious circuit for operating the reversing relay 306, which in operating reverses battery and ground over trunk 206, thereby causing polarized relay 146 of the district junctor circuit of Fig. 1 to operate. Relay 146 in operating connects ground to the armature of interrupter 148, through the upper innermost break contacts of relay 133. When interrupter 148 connects ground to the lower winding of relay 123, relay 123 operates and locks to the operating ground through its lower inner make contacts. After a convenient predetermined short interval, say two seconds, interrupter 148 closes a circuit for operating a charge relay 149, through a circuit from battery through the winding of relay 149, lower outermost break contacts of relays 112 and 150, off-normal contacts 169 of interrupter cam 151, upper outermost break contacts of relay 150, upper next-to-innermost break contacts of relay 121, upper inner operated make contacts of relay 123, through the right contacts of interrupter 148 to the ground before connected by relay 146. This arrangement using the interrupter 148 insures against the possibility that charge relay 149 might operate on momentary line currents, and thereby cause the deposited coin at station 103 to be improperly collected. Relay 149 operated (a) locks under control of relay 112, in a circuit from battery through the winding of relay 149, lower outermost break contacts of relay 112 to ground on the lower outermost operated contacts of relay 149; (b) partially prepares a path for starting an automatic release circuit, to be hereinafter described by connecting to interrupter 154, with its upper outermost make contacts the break contacts of the polarized relay 146; (c) partially prepares a path, by closing its upper next-to-innermost contacts, for operating relay 172 by connecting the winding of relay 172 to the upper contacts of relay 155; (d) provides an auxiliary holding circuit for relay 136 which is required when the automatic release circuit arrangement releases the district junctor circuit by operating relay 172, this holding circuit extending from battery through the winding of relay 136, lower outermost break contacts of relay 127 to ground on the upper middle contacts of relay 149; (e) partially closes, with its upper innermost make contacts, the circuit for operating message register 156; (f) opens with its lower innermost break contacts the tip conductor of the trunk toward relay 172 so the trunk circuit will start to release when relay 172 is operated by the automatic release circuit; (g) connects ground, with its lower, next-to-innermost make contacts to conductor 157 to be used later by the coin control circuit as a signal to collect the coin deposited in the coin box 104 associated with the station 103, (h) closes a circuit for operating the magnet 158 to start timing the call. This circuit is traced from battery through the winding of magnet 158, lower next-to-outermost make contacts of relay 149, upper innermost break con-

tacts of relay 112 to ground on the upper outer make contacts of relay 117.

It is now in order to describe the operation whereby a coin deposited in coin box 104 is collected or returned; or an operator is summoned, to monitor on an overtime call, or in response to a failure of the calling party to deposit a coin or in response to a stuck coin condition.

The collection of the deposited coin due to the disconnection of the calling party, prior to the expiration of the time limit will now be discussed. When the calling party at station 103 disconnects, relay 141 releases, which in turn releases relay 117. Relay 146 releases releasing relay 123 when the called party disconnects or when relay 117 releases. When relay 117 releases it operates relay 120 in a circuit traced from ground through the lower winding of relay 120, upper middle make contacts of relay 136, upper next-to-outermost contacts of charge relay 149, lower outermost break contacts of relay 121, lower outer break contacts of relay 117, upper outermost break contacts of relay 121, lower next-to-outermost make contacts of relay 136, upper innermost contacts of relay 121 to battery through resistance 159. Relay 120 operated (a) locks through its lower innermost contacts and upper innermost break contacts of relay 121 to battery through resistance 159; (b) connects ground with its lower middle contacts, through lower middle break contacts of relay 121 to start conductor 160 to cause a coin control circuit to be connected to the district junctor circuit; (c) furnishes a holding circuit for relay 136, this holding circuit being traced from ground on the lower outermost make contacts of relay 120, through upper outermost break contacts of relay 123, and upper innermost make contacts and winding of relay 136 to battery.

When ground is connected to start conductor 160, as aforesaid, the link and control circuit of Fig. 5 functions and causes a coin control circuit, which is shown by Figs. 6, 7 and 8, to be connected. Fig. 5 is not a part of this invention, is shown only in skeleton form and only to facilitate the description of this invention. Link and control circuits of the type required for use with this invention are so designed that, when summoned for service, an idle link from a group of links is selected, and the selected link then selects an idle coin-control circuit from a group of coin-control circuits. With these selections made, the required connection between coin-control circuit and district junctor is next established. When ground is connected to start conductor 160, relay 502 operates through its upper winding and locks through its lower winding to ground on the lowermost contacts of relay 593. Ground on the upper outer contacts of relay 502 operates primary select magnet 504 of cross-bar switch 500, and ground on the upper inner contacts operates relay 585, through upper break contacts of relay 506. Relay 505 locks through its lower inner contacts to ground on the lower inner break contacts of relay 503, with its upper inner contacts it operates select magnet 507 of secondary cross-bar switch 501, and with its upper outer contacts relay 508. Relay 508 connects ground to the multiplied windings of primary hold magnets 509 and 510, and secondary hold magnets 511 and 512 and these magnets operate causing cross-bar switches 500 and 501 to operate and connect district junctor conductors 166, 167, 157, 165, 162, 163, 161 and 164 to coin-

control conductors 513, 514, 517, 525, 515, 516, 518 and 521, respectively.

When the link and control circuit of Fig. 5 establishes a connection, as before described, relay 505 connects ground with its lower outer contacts to conductor 522, thereby operating relay 554. Relay 554 operated (a) connects the winding of relay 655, with its upper outermost front contacts to conductor 604, so that this relay may operate if ground is connected to this conductor by a district junctor that requires overtime monitoring service, as will be hereinafter described; (b) connects together, with its upper next-to-innermost contacts conductors 521 and 526, thereby operating relay 527 from the operating ground supplied by relay 508 through switch contacts 528; (c) connects the upper winding of relay 656, through its upper next-to-outermost make contacts, over conductor 520 to the winding of release relay 503; (d) partially prepares, with its lower next-to-outermost make contacts, a circuit for operating relay 657 over conductor 524; (e) connects with its lower outermost make contacts, the winding of relay 658 to conductor 525, so that this relay may operate for coin-return service as will be hereinafter described.

Assuming that ground has been connected to conductor 157 by the action of the district junctor circuit of Fig. 1, as before described, thereby establishing the condition for coin collection, relay 659 operates in a circuit from battery through its winding, lower middle break contacts of relay 657, lower outermost break contacts of relay 660, over conductor 517, through associated contacts of cross-bar switches 501 and 500 to said ground on conductor 157. Relay 659 in operating, operates relay 661 in a circuit from ground on the upper middle make contacts of relay 659, through lower innermost break contacts of relay 660 to battery through the winding of relay 661. Relay 661 in operating, connects ground to conductor 519 in a circuit traced from ground on the upper inner make contacts of relay 661, through lower innermost break contacts of relay 657. This operates relay 506, which connects ground with its lower contacts to conductor 523, operating thereby relay 656 in a circuit from battery through its lower winding, lower innermost make contacts of relay 654 to said ground on conductor 523. Relay 661 also operates relay 662 in a circuit from battery through the winding of relay 662, lower make contacts of relay 661, lower outermost break contacts of relay 654, when this relay releases as hereinafter described, over conductor 525, through apparatus of Fig. 5, over conductor 165, upper middle break contacts of relay 150, to ground on the lower outermost break contacts of relay 149, when this relay releases after its locking circuit is opened by the operation of relay 112, as hereinafter described. Relay 656 in operating supplements the operating ground for relay 661 with a holding ground connected through the upper innermost contacts of relay 656 and lower innermost break contacts of relay 660. This is necessary to avoid premature disconnection of the coin-control circuit in connection with overtime monitoring as will be discussed later. Relay 656 also connects ground, with its upper middle contacts to conductor 616 and thence through upper next-to-outermost break contacts of relay 802, break contacts of jack 803 and winding of the time signal relay 804 to battery. The operation of this latter relay will be discussed hereinafter. Relay 656 also connects ground to conductor 519, through a circuit traced from ground on the lower next-

to-innermost operated make contacts of relay 654, lower outermost contacts of relay 656 to conductor 519. Relay 656 also closes a holding circuit for relay 659 which is traced from battery through the winding and lower innermost operated contacts of relay 659 to ground on the lower next-to-innermost make contacts of relay 656. Relay 656 also partially prepares, with its lower innermost contacts a circuit for operating relay 657.

When the link circuit has completed its functions as evidenced by the presence of ground on sleeve conductor 521, it operates relay 527 over conductor 526, through upper next-to-innermost make contacts of relay 654 to said ground on conductor 521. Relay 527 connects ground to conductor 524, which ground is extended through the lower next-to-outermost make contacts of relay 654, lower innermost make contacts of relay 656 to battery through the winding of relay 657 which operates. Relay 657 operated (a) connects ground to conductor 519, with its upper outermost contacts; (b) locks to ground in a circuit from battery through its winding and lower innermost make contacts to ground on the upper inner make contacts of relay 661; (c) connects ground to sleeve conductor 521, the circuit being traced from ground on the lower next-to-innermost make contacts of relay 656, through upper next-to-outermost contacts of relay 657 to conductor 521 aforesaid which thereby holds the connection of cross-bar switches 500 and 501; (d) energizes the upper winding of relay 656 in a circuit from battery through the upper winding of relay 656, upper next-to-innermost make contacts of relay 657 to ground on the lower next-to-innermost contacts of relay 656, this same ground also operating link release relay 503, through upper next-to-outermost make contacts of relay 654 over release lead 520; (e) partially prepares the operating circuit for relay 712 by connecting ground from the upper outermost make contacts of relay 659, through lower outermost make contacts of relay 657 to the upper innermost break contacts of relay 654, which connect to the winding of relay 712, over conductor 673. Relay 503 in operating releases relay 505, causing the release of relay 508, and secondary select magnet 507. As before stated, hold magnets 509, 510, 511 and 512 are held by ground on conductor 521. When ground is connected to the sleeve conductor 164, a circuit is closed for holding relay 120 of Fig. 1 through its upper winding and for operating relay 121 through its lower innermost normally closed continuity contacts. Relay 121 locks through its lower innermost make contacts to ground on the upper middle make contacts of relay 120, and disconnects with its lower middle break contacts the start lead 160 from ground on the lower middle contacts of relay 120. Relay 502 accordingly releases due to the opening of the locking circuit through its lower winding, when relay 503 operates and deenergizes the primary select magnet 504.

The release of relay 505, as before described, removes ground from conductor 522 thereby causing the release of relay 654. Relay 654 disconnects conductors 526, 529 and 524 and transfers conductor 523 from the lower winding of relay 656 to conductor 616 so that the alarm circuit will function if conductor 523 is grounded for an abnormal length of time. The release of relay 654 also closes the circuit for operating relay 712, which circuit was traced hereinbefore.

For coin-collect calls, relay 659 is operated as

described hereinbefore, and holds to ground on the lower next-to-innermost contacts of relay 656. Relay 712 operated closes the holding circuit for relay 663, which is traced from ground on the upper outermost make contacts of relay 712, over conductor 638 to the lower innermost contacts of relay 663; also the holding circuit for relay 713 which is traced from ground on the upper innermost make contacts of relay 712 to the upper next-to-innermost make contacts of relay 713; also the holding circuit for relays 714 and 715 which is traced from ground on the upper middle make contacts of relay 712 to the upper innermost make contacts of relay 714. Relay 712 connects ground to interrupter 711 over a circuit from interrupter 711, through lower innermost make contacts of relay 712, over conductor 650, through lower outermost break contacts of relay 802, over conductor 613, to ground on the upper outermost make contacts of relay 659. At the first ground closure of interrupter 711, relay 714 operates through its upper inner normally closed contacts and winding and resistance 716 to battery and locks through its upper inner make contacts to ground on the upper middle make contacts of relay 712. Relay 715 is shunted by ground connected to its winding through its upper inner break contacts and does not operate with relay 714 at this time. When ground is removed by interrupter 711 at the end of the first ground closure, relay 715 operates in a circuit from battery through resistance 717, winding of relay 715 to ground on the upper inner make contacts of relay 714. Relay 715 in operating operates relay 663 in a circuit that is traced from battery through the winding of relay 663, over conductor 653, through lower innermost break contacts of relay 805, over conductor 705, through lower next-to-outermost break contacts of relay 718, lower outer break contacts of relay 719, lower inner make contacts of relay 714 to ground on the lower make contacts of relay 715. Relay 715 also connects ground through its lower make contacts, lower inner make contacts of relay 714, lower outer break contacts of relay 719, upper next-to-outermost break contacts of relay 713, lower outer break contacts of relay 720, over conductor 649, through upper innermost break contacts of relays 658 and 660 to conductor 518; thence over conductor 518, through the contacts of cross-bar switches 501 and 500 to conductor 161 and the winding of relay 112, which operates. Relay 663 operated (a) locks over conductor 638 to ground on the upper outermost contacts of relay 712; (b) partially prepares a circuit for operating relay 719 over conductor 643 by closing its lower middle contacts; (c) connects coin-collect battery 664, through resistance lamp 665 and the winding of relay 666 to conductors 515 and 516 over the following circuit path: lower outermost operated contacts of relay 659, lower next-to-outermost break contacts of relay 658, upper innermost make contacts of relay 663, over conductor 640, upper middle break contacts of relay 719, over conductor 637 to the center terminal of the primary winding of transformer 667, thence through the left section of said winding, upper outermost break contacts of relay 654, over conductor 604 and through the upper innermost break contacts of relay 718 to conductor 610, thence through the upper innermost break contacts of relay 668 to conductor 515; the path to conductor 516 is traced through the right section of the winding of transformer 667 over conduc-

tor 618, through lower innermost break contacts of relays 718 and 668, over conductor 612 connecting, to conductor 516, aforesaid. Conductors 515 and 516 are extended through the apparatus of Fig. 5, over conductors 162 and 163 through the upper outermost make contacts, and lower innermost make contacts of the operated relay 112 over the line conductors of the calling telephone station 103. Relay 666 operates in the circuit, above traced, provided that a coin 105 has been deposited in the coin box 104, which has thereby connected ground 109 through coin-box contacts 168, and the winding of coin magnet 108 to the tip conductor of line 100, and through the switch contacts of the telephone of station 103 to the ring conductor of said line. Coin collector magnet 108 is now operated and collects coin 105 in the manner well known in the telephone art. Relay 666 operated, operates relay 721 over conductor 633. Relay 721 operated connects (a) ground to the winding of relay 661, over a circuit traced from the winding of relay 661, through lower innermost break contacts of relay 660, over conductor 632, to ground on the upper innermost make contacts of relay 721; (b) locks through its lower innermost make contacts, over conductor 628 to ground on the upper outermost contacts of relay 656; (c) partially prepares a circuit through its lower outermost make contacts for operating relay 668. At the second closure of the contacts of interrupter 711, relay 714 is shunted by ground connected through the upper innermost make contacts of relay 715, to the lower terminal of the winding of relay 714. Relay 714 releases, but relay 715 is held operated through the upper inner normally closed contacts of relay 714, to ground on interrupter 711. When interrupter 711 removes the second application of ground, relay 715 releases. Relay 715 released operates relay 719 in a circuit from battery through the winding of relay 719, over conductor 643, lower middle make contacts of relay 663, lower middle break contacts of relay 668, over conductor 601 to ground on the lower break contacts of relay 715. Relay 719 operated, (a) opens with its upper middle break contacts the circuit for the coin-collect battery 664, before traced, thus releasing relay 666; (b) locks to ground on its upper innermost make contacts over conductor 642; (c) operates relay 805, if relay 721 has failed to operate due to the absence of ground 109, because of failure to deposit a coin, or for any other reason. The operating circuit for relay 805 is traced from battery through the winding of relay 805, over conductor 704, lower innermost break contacts of relay 713, upper middle break contacts of relay 721, lower next-to-innermost break contacts of relay 713, lower innermost make contacts of relay 719, over conductor 648, through upper innermost make contacts of relay 659, over conductor 606, to ground on the lower middle break contacts of relay 802. If relay 721 has operated, in response to the operation of relay 666, as before described, thus indicating the presence of ground at coin box 104, a test is now made to determine whether the coin box 104 has been satisfactorily cleared, as it normally should be cleared, by the operation and release of the coin magnet 108. Under this condition, at the beginning of the third ground closure of interrupter 711, relay 714 operates, but relay 715 is shunted and does not operate, as hereinbefore described in connection with the first ground closure of interrupter 711. At the

end of the third ground closure of interrupter 711, relay 715 also operates and now relay 668 is operated in a circuit traced from battery through the winding of relay 668, over conductor 611, through upper next-to-innermost break contacts of relay 712, lower outermost make contacts of relay 721, over conductor 635, through upper middle make contacts of relay 662, operated as hereinbefore described, over conductor 644, lower outermost make contacts of relay 719, lower innermost make contacts of relay 714, to ground on the lower make contacts of relay 715. Relay 668 operated (a) partially prepares the circuit for operating relay 669, as will be hereinafter described, by closing its lower middle make contacts; (b) locks to ground on its upper next-to-outermost contacts, through upper next-to-innermost contacts of relay 718, and lower outermost make contacts of relay 721; (c) closes a circuit for charging the condensers at station 103, and the line capacity through the winding of relay 669, which circuit may be traced from battery through the winding of relay 669, lower innermost make contacts of relay 668, thence over the ring conductor to station 103; another path for the tip conductor may be traced by way of the lower innermost break contacts of relay 655 and upper innermost make contacts of relay 669 to said tip conductor. Relay 669, even though the coin has been successfully cleared, due to the capacity charging may operate momentarily, but its contacts are ineffective to operate relay 722 until relay 714 releases at the beginning of the fourth closure of interrupter 711. Assuming that relay 669 does not operate effectively due to the successful clearing of the coin, then a circuit is closed for operating release relay 669 which is traced from battery through the winding of relay 669, upper middle break contacts of relay 655, over conductor 620, upper outermost break contacts of relay 722, over conductor 621, lower middle make contacts of relay 658, over conductor 601 to ground on the lower break contacts of relay 715, when it releases after the end of the fourth ground closure from interrupter 711. The coin-control circuit is then released as will be hereinafter described. If, however, relay 669 operates steadily due to a stuck coin, then when relay 714 releases, at the beginning of a fourth ground closure from interrupter 711 then a circuit is closed for operating relay 722, which circuit may be traced from battery through the winding of relay 722, over conductor 623, contacts of relay 659, lower outermost contacts of relay 668, over conductor 619, through upper outer break contacts of relay 720, lower inner break contacts of relay 714 to ground on the lower make contacts of relay 715. The circuit operation of relays 714 and 715 for the beginning of the fourth ground closure is the same as that for the beginning of the second ground closure hereinbefore discussed. Relay 722 operated (a) locks through its lower make contacts, over conductor 627 to ground on the upper outermost contacts of relay 663; (b) closes ground with its upper innermost contacts, over conductor 622, to the winding of relay 669, thereby discharging the capacity of the calling subscriber line to prevent bell tapping when relay 669 is removed from conductors 515 and 516; (c) closes a circuit for operating relay 805, which is traced from battery through the winding of relay 805, over conductor 704, through lower innermost break contacts of relay 721, and lower contacts of relay 722 to the holding ground connected to relay 722.

contacts of relay 721, and lower contacts of relay 722 to the holding ground connected to relay 722.

The before-given description covers the condition, on a coin-collect call, which exists when a coin is found in the coin box and is either cleared or not cleared. The condition, when a coin is not found, will now be discussed. If no coin is found, relay 666 fails to operate and likewise relay 721. When relay 719 operates, a circuit is also closed for operating relay 805, which is traced from battery through the winding of relay 805, over conductor 704, through lower innermost break contacts of relay 712, upper middle break contacts of relay 721, lower next-to-innermost break contacts of relay 713, lower innermost make contacts of relay 719, over conductor 648, through upper innermost make contacts of relay 659, over conductor 636 to ground on the lower middle break contacts of relay 802. Relay 805 operated releases relay 806, which operated when relay 661 operated. The operating circuit for relay 806 is traced from battery through the winding of relay 806, lower outermost break contacts of relay 805 over conductor 603 to ground on the upper outermost contacts of relay 661. Relay 805 operated, with its lower innermost break contacts removes ground from conductor 513 and opens the operating circuit of relay 112 of the district junctor circuit of Fig. 1. Relay 805 is slow to release to permit relay 112 to release before relay 718 is operated to avoid clicks at the calling station. Relay 718 is operated from battery through its winding, over conductor 708, through right outer break contacts of relay 806, upper innermost make contacts of relay 805, over conductor 600 to ground on the upper outermost break contacts of relay 660. Relay 718 operated (a) connects transmission conductors 513 and 514 by means of its outermost make contacts to conductors 700 and 706 extending to the line-splitting jack 807 but these conductors are not used for stuck coin conditions; (b) connects conductors 610 and 612 to conductors 701 and 703, respectively, extending to the inner make contacts of relay 802; (c) partially prepares the operating circuit for relay 802 by connecting ground, with its upper next-to-outermost make contacts, to conductor 811; (d) releases relay 668 by opening its operating circuit with its upper next-to-innermost break contacts; (e) partially prepares a circuit for lighting lamp 800 by connecting battery through its lower next-to-innermost contacts over conductor 709, through upper outermost break contacts of relay 802, over conductor 614 through outer lower make contacts of relay 714, over conductor 602, through upper middle break contacts of relay 669, upper outermost break contacts of relay 668, through lower innermost make contacts of relay 662, over conductor 645, and through lamp 800 to ground. Due to the interrupted operation of relay 714, lamp 800 will flash. This is a signal to the operator that the coin-control circuit has failed on a coin-collect call which may be due either to no coin in the coin box, or to failure to collect, assuming that the coin is present. Accordingly, the plug of the cord circuit 837 is inserted into jack 809, associated with lamp 800, operating relay 802 over the sleeve circuit and extinguishing lamp 800. The operator will now endeavor to collect the coin by operating coin collect key 812, which will connect coin-collect battery 833 to the tip and ring of the line. If a coin is present pilot relay 815

will operate, lighting the pilot lamp 816; if no coin is present relay 815 will not operate and lamp 816 remains unlighted. If lamp 816 lights, the operator will close the circuit a second time, and if it remains lighted it is an indication that the coin is stuck and cannot be collected. Relay 802 operated also (a) connects condenser 817 across the tip and ring conductors under control of relay 806; (b) holds relays 718 operated to ground through its upper next-to-innermost contacts; (c) operates relay 713 over conductor 728 to ground on its lower next-to-innermost make contacts; (d) opens, with its upper next-to-outermost break contacts the circuit of the alarm relay 804 so that an alarm will not be unnecessarily given if the operator keeps the plug of the cord circuit 837 in jack 809 for a long interval. The purpose of relay 713 for the type of call being described is to guard against premature disconnection should the operator inadvertently plug into the release jack 810 instead of into the monitoring jack 809. Relay 713 operated (a) locks through its upper next-to-innermost make contacts to ground on the upper innermost contacts of relay 712; (b) releases relay 805 by opening the operating circuit hereinbefore traced and thereby operates relay 806 over conductor 603; (c) partially prepares the circuit for operating release relay 660 in a circuit from battery through the winding of relay 660, upper outermost make contacts of relay 662, over conductor 608, upper innermost make contacts of relay 713, over conductor 730 to ground on the left contacts of relay 834, which operates when the operator inserts a plug into release jack 810; (d) closes a holding circuit for relay 718, which may be traced from battery through the winding of relay 718, lower outermost make contacts of relay 713, over conductor 629, through lower outermost make contacts of relay 662, over conductor 607, through next-to-outermost make contacts of relay 718 to ground. When the operator removes the plug from jack 809, relay 802 releases and relights lamp 800 until the operator inserts the plug into release jack 810, which operates relay 834. Relay 834 operated, operates release relay 660 over the circuit hereinbefore traced and connects ground to conductor 605, which connects with conductor 519 extending into the link and control circuit of Fig. 5, thereby keeping relay 506 operated and causing the coin-control circuit to be inaccessible to other district junctors requiring service, until the operator removes the plug of cord circuit 837 from jack 810. The coin-control circuit is released from its connection with the district junctor circuit of Fig. 1 when relay 660 operates. This feature will be described in detail hereinafter.

The operation of the system for coin collection after the calling party has disconnected has been discussed hereinbefore. The operation for coin return, after disconnection, will now be described. Assuming that connection of the coin-control circuit of Figs. 6, 7 and 8 has been established with the district junctor circuit of Fig. 1 as hereinbefore described, ground on the lower outermost break contacts of relay 149 will be connected through upper middle break contacts of relay 150 to conductor 165, thence through switch contacts of Fig. 5 to conductor 525. Coin-return relay 658 is then operated from battery through the winding and the lower outermost make contacts of relay 654 to said ground on conductor 525. Relay 658 operated (a) connects coin-return battery 670, through

resistance lamp 671, lower middle make contacts of relay 658, and thence over the circuit path before described for coin collect to the coin box 104 of the calling station; (b) operates from ground on its upper outermost contacts, over conductor 633, relay 721; (c) locks through its lower innermost contacts to ground on the contacts of relay 656, as did relay 659 in the before-given description; (d) operates relay 712 from ground on its lower outermost contacts, over the path previously traced for operation by relay 659. For an official or free call, the completing trunk, not shown, is arranged so that relay 146 and relay 149 do not operate and consequently the circuits function as for an incompleting call.

The operation of coin-return relay 658, as before described, causes the coin at coin box 104 to be returned, the circuits functioning in a manner similar to that for the coin-collect condition. If however, should there be no coin in box 104, or should the coin be stuck, then the coin-control circuit functions as described for the coin-collect condition except that lamp 800 now lights steadily, since the lower outermost contacts of relay 714, which furnished interrupted battery for the coin-collect condition are now short-circuited by the upper next-to-outermost contacts of relay 658. This short-circuiting is effected over conductors 614 and 602. The operator, observing the steadily lighted lamp 800, now knows that the coin should be returned, and accordingly operates return key 813. If there is a coin present relay 814 operates and lights pilot lamp 816; if the coin clears then lamp 816 is not lighted on the second attempt, but if lamp 816 is relighted, this indicates that the coin is stuck and cannot be returned.

The operation of the system will now be discussed for the condition, whereby after the expiration of a predetermined time interval following the establishment of the conversational connection between calling and called parties, the deposited coin is automatically collected during conversation and a warning tone is connected to the line to indicate that the expiration of the time limit is approaching. It has been found convenient to collect the coin at the end of approximately four and one-half minutes, that is, one-half minute before the end of a five-minute period covered by the initial coin deposit. It is to be understood, however, that any other time interval that may be desired can be used. At the end of this five-minute period, if no additional coin has been deposited, an overtime monitoring operator is called in to supervise the connection.

Let it be assumed now that the called party has answered and that the cams 151, 152 and 153 have begun to time the call. As soon as the timing device moves off-normal, normally closed contacts 169 open. At the end of 265 seconds, pick-up contacts 171 close and thereby provide a circuit for holding operated rotary magnet 158, after the charge relay 149 releases, as will be described hereinafter. About five seconds later, that is, at the expiration of about four and one-half minutes, contacts 170 close, thus operating relay 120 over a circuit traced from ground through the lower winding of relay 120 and contacts 170 to battery through resistance 159. Relay 120 operates and then operates relay 150 in a circuit from battery through the winding of relay 150, upper innermost make contacts of relay 120, lower outermost contacts of relay 136, to ground through the upper outer contacts of

relay 117. Relay 120 operated (a) connects battery 118 through resistance 119, upper outermost make contacts of relay 120, upper innermost make contacts of relay 149 to line register 156, through corresponding contacts of the line link cross-bar switches 101 and 102, and register 156 operates to indicate the completion of a call over its associated line; (b) partially prepares with its upper middle make contacts a ground connection to hold relay 121 operated, when this relay subsequently operates; (c) locks through its lower winding, lower innermost make contacts, and upper innermost break contacts of relay 121 to battery through resistance 159; (d) connects ground, with its lower middle make contacts, through lower middle break contacts of relay 121 to start conductor 160 to summon a coin-control circuit; (e) provides an auxiliary holding ground for relay 136 which is traced from ground on the lower outermost make contacts of relay 120, through lower and upper innermost make contacts and winding of relay 136 to battery. This has no useful function at this time.

When the connection to the coin-control circuit is established as hereinbefore described in connection with the operation of the system for coin control after the calling party disconnects, relay 121 operates and the coin-control circuit receives a signal over conductor 157 to collect the coin. When this signal is received the coin-control circuit functions, as before described, except that now relay 662 is not operated, since there is no ground on conductor 525 because the calling party has not disconnected. With relay 662 not operated, a warning tone will be superimposed on the line conductors 515 and 516 through the windings of transformer 667. This tone is produced by battery interruptions furnished by the interrupter 674 and transmitted through transformer 672, lower middle break contacts of relay 662, lower middle make contacts of relay 659, condenser 675 and transformer 667 to the coin-control circuit path before traced. When relay 719 operates, as hereinbefore described, it operates release relay 660, provided a coin has been found in the coin box 104, in a circuit from battery through the winding of relay 660, through upper outermost break contacts of relay 662, over conductor 641, through lower middle make contacts of relay 721, lower innermost make contacts of relay 719, over conductor 648, upper innermost contacts of relay 659, over conductor 686 to ground on the lower middle break contacts of relay 802. Relay 660 operating, releases the coin-control circuit, as hereinafter to be described. The stuck coin test, using relay 669, which test was hereinbefore described, is not made at this time, so as to avoid interrupting conversation. This test is made after disconnection. However, if the coin-control circuit finds that no coin has been deposited as evidenced by the non-operation of relay 666 and consequently of relay 721 then a circuit is closed for immediately flashing the overtime monitoring lamp 801. This circuit is traced from ground through lamp 801, over conductor 647, lower innermost break contacts of relay 662, thence over the circuit before traced for coin-control lamp 800. When the operator observes the flashing lamp 801, the plug of the cord circuit 811 is inserted in the overtime monitoring jack 808, relay 802 operates and the circuit functions as before described. Relay 112 of the district junctor circuit is operated as before described in connection with a stuck coin condition and the calling line is

connected to conductors 162 and 163. The called subscriber is bridged across the connection by means of conductors 166 and 167. For this condition, the operator requests the deposit of a coin which she immediately collects by operation of the cord circuit collect key 812.

The operation of the system for overtime monitoring by an operator will now be described. When the test indicates at the end of the five-minute period that a coin has been deposited, the coin-control circuit is released and conversation through the district junctor is uninterrupted. If no coin is found then the monitoring operator is signaled with a steadily lighted lamp, and the operator upon answering the signal requests that the calling subscriber deposit a coin in payment for the succeeding overtime interval or permits the calling party to disconnect if the conversation is to be terminated. If the calling party maintains that a coin has been deposited or disconnects, the operator removes the cord circuit plug from the monitoring jack and the coin-control circuit is then required to verify that a coin has been deposited or that disconnection has occurred. If neither of these conditions is found to exist, the coin-control circuit signals the operator a second time indicating that the subscribers are still talking and that a coin has not yet been deposited for the overtime interval. The operator then repeats the procedure and if the calling party fails to respond the operator may interrupt the conversation by use of a line-splitting jack 807. When the operator disconnects a second time, the coin-control circuit repeats the procedure of verifying disconnection or the presence of a coin at the calling station. When a coin is found present, the coin-control circuit dismisses the district junctor. If disconnection is detected, the coin control circuit is required to proceed with coin-return service to insure that the coin-box station has been properly cleared.

The operation of the system for overtime monitoring will now be discussed in detail. Let it be assumed that the district junctor circuit shown on Fig. 1 has cooperated with the coin-control circuit of Figs. 6, 7, 8 to collect, at the end of the four and one-half minute period, the coin deposited in the coin box 104. The timing mechanism continues to revolve, since a locking circuit for rotary magnet 158 is maintained through contacts 171, lower outermost contacts of relay 136 to ground on the upper outermost contacts of relay 117. Relay 150 also remains operated, being locked through its lower innermost contacts to ground on the winding of magnet 158. A small interval before the timing device completes a cycle of five minutes contacts 169 reclose, and a circuit is closed for operating relay 120, which relay released when ground was removed from conductor 164 following the dismissal of the coin-control circuit after the four and one-half minute period. The circuit for relay 120 is traced from ground through its lower winding, lower outermost make contacts of relay 150, contacts 169, upper outermost make contacts of relay 150, and resistance 159 to battery. The operation of relay 120 summons a coin-control circuit as before described, and closes a circuit for holding relay 150 and magnet 158 energized after contacts 171 open at the end of the five-minute interval. This holding circuit for relay 150 is traced from battery through the winding of relay 150, upper innermost make contacts of relay 120, lower

outermost contacts of relay 136 to ground on the upper outermost contacts of relay 117. Magnet 158 is held to the same ground through the lower innermost contacts of relay 150, and the timing device continues to function. However, the actual timing of the call will not be resumed until the coin-control circuit is released. When this occurs the holding ground on conductor 164 is removed, and relay 120 releases, thereby releasing relay 150. The release of relay 150 opens the operating circuit of magnet 158, which is so constructed that it now immediately restores to normal and the timing of the call is resumed. If, however, assuming an extreme condition, that the coin control circuit should be held until contacts 171 reclose, thereby maintaining the operation of magnet 158, the district junctor must then wait until contacts 171 open, that is, until the timing mechanism has restored to normal, before timing is resumed. As hereinbefore stated, the presence of ground on conductor 162 is a signal to the coin-control circuit that overtime monitoring is required. This ground is connected through lower outermost break contacts of relay 149, upper middle make contacts of relay 150, and upper next-to-outermost break contacts of relay 112 to conductor 162. This ground is transmitted through the link circuit of Fig. 5 to conductor 515 and operates relay 655 in a circuit traced from battery through the winding of relay 655, upper outermost make contacts of relay 654 over conductor 604, through upper innermost break contacts of relay 718, over conductor 610, through upper innermost break contacts of relay 668 to aforementioned conductor 515. Relay 655 locks, when relay 656 operates, in a circuit through its lower middle make contacts, upper innermost break contacts of relay 662 to ground on the lower next-to-outermost make contacts of relay 656. After the link and control circuit of Fig. 5 has operated relay 657 it releases and causes the release of relay 654 as before described. When relay 654 releases relay 712 operates from ground on the upper next-to-outermost contacts of relay 655, over conductor 650, through lower outermost break contacts of relay 802, over conductor 613 through lower outermost make contacts of relay 657, upper innermost break contacts of relay 654, over conductor 673 and through winding of relay 712 to battery. Relay 712 operated (a) connects ground on the upper next-to-outermost contacts of relay 655, over conductor 650, through lower innermost contacts of relay 712 to interrupter 711; (b) connects locking ground with its upper outermost contacts, over conductor 638, to the lower innermost make contacts of relay 663, and with its upper middle contacts to the upper inner make contacts of relay 714; (c) connects ground to ring conductor 514 to guard against clicks to the subscribers when the transmission circuit of the district junctor circuit is interrupted to permit testing the calling coin station for the presence of the overtime deposit. This circuit is traced from conductor 514, through lower outermost break contacts of relay 718, through lower middle make contacts of relay 712, over conductor 710, through upper innermost break contacts of relay 805, over conductor 600 to ground on the upper outermost break contacts of relay 660. Relays 714 and 715 now operate and release in response to ground interruptions furnished by interrupter 711. When relay 714 operates, it operates relay 663 and connects ground to conductor 518, over cir-

cuits hereinbefore traced. Ground on conductor 518 causes relay 112 of the district junctor to operate, which connects the calling station to conductors 162 and 163 extending to the coin-control circuit. Relay 663 operated operates relay 668 in a circuit from battery through the winding of relay 668, over conductor 611, through upper next-to-innermost break contacts of relay 718, through lower outermost break contacts of relay 721, over conductor 636, through upper next-to-outermost make contacts of relay 653 to the same ground that is holding relay 655. Relay 663 operated also partially prepares a circuit for operating relay 719. This is traced from battery through the winding of relay 719, over conductor 643, through upper and lower next-to-innermost contacts of relay 663, over conductor 624, to the open upper middle make contacts of relay 805, thence over conductor 631, through upper middle make contacts of relay 655, over conductor 620, through upper outermost break contacts of relay 722, over conductor 621, through lower middle make contacts of relay 668, over conductor 601, to ground on the lower break contacts of relay 715. Relay 668 operated (a) partially prepares a circuit for operating release relay 660 by closing its lower middle make contacts; (b) closes the circuit for charging the station condensers and the capacity of the calling line through the winding of relay 669 which has its contacts made ineffective for a short interval in order to guard against false operation of relay 722 on line surges; (c) prepares a circuit for operating relay 722 if a coin is present in coin box 194, all of which has been described in detail in connection with operation for stuck coin conditions. If relay 669 should operate on any line surges at this time, it should release before its contacts are made effective when relay 714 releases at the beginning of the second ground closure from interrupter 711. If a coin has been deposited, relay 669 will operate as soon as relay 668 operates, so that when relay 714 releases, relay 722 will operate immediately. Relay 722 operated (a) connects ground to ring conductor 516, the circuit being traced from ground on the upper innermost contacts of relay 722, over conductor 622 and through lower innermost make contacts of relay 668 to conductor 516; this prevents bell tapping on party coin lines when relay 669 is disconnected from the calling line; (b) operates release relay 660 over conductor 630, through upper outermost break contacts of relay 721 and lower contacts of relay 722 to the operating ground on the winding of relay 722. Relay 660 in operating releases the coin-control circuit of Figs. 6, 7 and 8 as will be hereinafter described. If a coin has not been deposited relay 669, and consequently relay 722, will not be operated when the contacts of relay 669 are made effective when relay 714 releases at the beginning of the second ground closure from interrupter 711. When relay 715 releases at the end of the second ground closure from interrupter 711, a circuit is closed for operating relay 805 which is traced from ground on the lower break contacts of relay 715, over conductor 601, through lower middle make contacts of relay 668, over conductor 621, through upper outermost break contacts of relay 722 over conductor 620, through upper middle make contacts of relay 655, over conductor 631, through lower innermost break contacts of relay 713, over conductor 704 and through winding of relay 805 to battery. Relay 805 locks to ground in

a circuit from battery through the winding of relay 805, over conductor 704, through lower innermost break contacts of relay 713, over conductor 631, through upper middle make contacts of relay 805, over conductor 624, through upper next-to-innermost make contacts of relay 663, over conductor 642 to ground on the upper innermost make contacts of relay 719. The operation of relay 805 opens with its lower outermost break contacts the circuit of relay 806, which releases and closes a circuit for operating relay 718, which is traced from battery through the winding of relay 718, over conductor 703, through right outer break contacts of relay 806, upper innermost make contacts of relay 805, over conductor 600 to ground on the upper outermost break contacts of release relay 660, which did not operate to release the coin-control circuit, since by assumption no coin was found in the coin box 104.

The signaling of the operator due to the non-detection of the overtime coin deposit will now be discussed. With relay 718 operated as before described, the shunt consisting of the serially connected resistances 723 and 724 is disconnected by the outermost break contacts of relay 718 from the talking conductors 513 and 514. This shunt is used to reduce clicks at the station of the calling party. Relay 805 operated also prevents ground from being connected to conductor 518, thereby avoiding the operation of relay 112 in the district junctor of Fig. 1, which would interrupt the conversation between the subscribers, while awaiting the response of the monitoring operator. This circuit path which is kept open is traced from conductor 518, through upper innermost break contacts of relays 660 and 658, over conductor 649, through lower outer break contacts of relay 720, through upper next-to-outermost break contacts of relay 713, lower next-to-outermost break contacts of relay 718 (which relay operates after relay 805), over conductor 705, through lower innermost break contacts of relay 805, over conductor 653 to ground on the winding of operated relay 663. Relay 718 also connects, with its outermost make contacts, talking conductors 513 and 514 over conductors 700 and 706 to the line-splitting jack 807; also releases relay 662, by opening the operating circuit, hereinbefore traced, by the operation of its upper next-to-innermost break contacts; also connects conductors 610 and 612, with its innermost make contacts to conductors 701 and 703, respectively, which latter conductors extend to the innermost contacts of relay 802; also lights lamp 801 steadily when relay 663 releases. This circuit is traced from ground through lamp 801, over conductor 647, through lower innermost break contacts of relay 662, through upper outermost break contacts of relay 662, upper middle break contacts of relay 660, upper innermost make contacts of relay 655, over conductor 626, through lower next-to-outermost contacts of relay 713, over conductor 614, through upper outermost break contacts of relay 802, over conductor 709 to battery on the lower next-to-innermost contacts of relay 718. The operator answers the call by inserting the plug of cord circuit 837 into the overtime monitoring jack 808, and relay 802 operates over the sleeve circuit. Relay 802 operated, (a) opens the circuit, before traced, of lamp 801, extinguishing it; (b) connects condenser 817 through break contacts of relay 819 under control of relay 806 across talking conductors 700 and 706 to guard against clicks to the operator

as well as to the subscribers while the connection is being established from the calling line to the operator and also while the transmission battery is being removed by relay 112 of the district junctor which operates later; (c) furnishes a holding circuit for relay 718 over conductor 708 to ground on the upper next-to-innermost contacts of relay 802 so that relay 718 will remain operated as long as cord circuit 811 is plugged into jack 808; (d) operates relay 713 over conductor 728 to ground on the lower middle make contacts of relay 802; (e) opens, with its upper next-to-outermost break contacts the circuit of time alarm relay 804, to prevent the sounding of an alarm, if the plug should be kept in jack 808 for an abnormal length of time; (f) releases relay 712 by opening, with its lower outermost contacts, the operating circuit for relay 712, before traced. Relays 714 and 715 continue to function while the operator is being awaited, but perform no useful function at this time. However, these relays release when relay 712 releases due to the disconnection of operating and locking ground. Relays 663 and 719 also release, due to the disconnection of ground on the upper outermost contacts of relay 712. The operation of relay 713 connects ground on its upper next-to-outermost contacts, through lower outer break contacts of relay 720 to conductor 649, thence through upper innermost break contacts of relays 658 and 660 to conductor 518, thereby causing the operation of relay 112 of the district junctor circuit. Relay 112 operated disconnects, with its upper and lower next-to-innermost break contacts, transmission battery supplied through the windings of relay 141, from the calling line; also, relay 112 connects with its upper outermost and lower innermost make contacts, conductors 110 and 111 to conductors 162 and 163, respectively, so that the operator may talk to the calling party while the called party is listening to the conversation over conductors 166 and 167, the extensions of conductors 162 and 163 and of conductors 166 and 167 in Fig. 8 being connected together through break contacts of relay 819. This arrangement also permits the operator to have cord supervision by the functioning of supervisory relay 820 and lamp 821. The operation of relay 713 also (a) opens the operating circuit of relay 805, which releases and reoperates relay 806, the latter relay disconnecting condenser 817; (b) connects ground, with its upper outermost make contacts to conductor 605, which is an extension of conductor 519, thereby maintaining a busy condition for the coin-control circuit as long as the cord circuit is plugged into jack 808; (c) opens with its lower next-to-outermost break contacts, the short circuit around the lower outermost make contacts of relay 714 (which was established by the upper innermost contacts of relay 655, when this relay operated), thereby partially preparing a circuit for flashing lamp 801, should the subsequent repeat test for the overtime coin deposit, as hereinbefore described, show that the coin has not been deposited.

The operation whereby the aforesaid repeat test for the overtime coin deposit is made will now be discussed. When the monitoring operator removes the plug of cord circuit 811 from jack 808, relay 802 releases and the coin-control circuit proceeds to verify the presence of the overtime coin deposit or to determine whether the calling party has disconnected. Relay 802 released (a) partially prepares the circuit for

lighting lamp 801 by closing its upper outermost break contacts, (b) releases relay 718 by removing the holding ground connected to conductor 708; (c) recloses ground, with its upper next-to-outermost break contacts, to the time alarm relay 804; (d) closes a circuit for reoperating relay 712, which circuit is traced from battery through the winding of relay 712, over conductor 673, upper innermost break contacts of relay 654, through lower outermost make contacts of relay 657, over conductor 613, through lower outermost break contacts of relay 802, over conductor 650, to ground on the upper next-to-outermost make contacts of relay 655. The operation of relay 712 causes the test for the overtime coin deposit, as before described, to be repeated. However, at the conclusion of the repeat test, relay 713 is already operated so that the circuit will delay lighting lamp 801, if no coin has been detected until a time interval has been measured, as hereinafter described, to permit disconnection by the calling subscriber to be recognized. Assuming that the repeat test did not disclose the presence of the overtime coin deposit, then the release of relay 715 at the completion of the test connects ground over conductor 601 through the lower middle operated make contacts of relay 668, over conductor 621, through upper outermost break contacts of relay 722 over conductor 620, through upper middle make contacts of relay 655, over conductor 631, through lower innermost make contacts of relay 713, lower outermost make contacts of relay 712, over conductor 651, through lower outermost make contacts of relay 655, over conductor 652, and through winding of relay 720 to battery. Relay 720 operates and locks through a circuit from battery through the winding of relay 720, over conductor 652, through lower outermost make contacts of relay 655, over conductor 651, through lower outermost contacts of relay 712, to ground through the lower inner make contacts of relay 720. Relay 720 operated partially prepares the operating circuit for relay 725, by connecting ground with its upper inner make contacts to the armature of interrupter 727, and to the lower and upper make contacts of relays 726 and 725, respectively, to establish holding circuits for these relays as hereinafter described. Relay 720 operated also opens with its lower break contacts, the circuit of relay 712, which relay releases and permits the district junctor to record a possible disconnection of the calling party. While relay 712 is operated supervisory relay 141 is released, having been disconnected from the calling subscriber's line. Relay 117, however, being slow acting, it is held in the following circuit during the time relay 712 is operated: battery through the winding of relay 117, upper next-to-innermost break contacts of relay 712, upper inner make contacts of relay 712 to ground at the upper contacts of relay 117. When, therefore, relay 712 releases as above noted the holding circuit of relay 117 is opened, and this relay must now depend upon the immediate reoperation of the supervisory lamp 141. If the calling party has disconnected, relay 141 fails to operate when relay 712 releases, and relay 117 releases. A circuit is now completed from ground on the lower outermost break contacts of relay 149, through upper middle break contacts of relay 150 to conductor 165, thereby operating relay 662 which will cause the connection to be released, as hereinafter described. This action will occur before relay 726 operates. While the district junctor is recog-

nizing disconnection, relay 725 operates from ground on the left contacts of interrupter 727 and locks to ground on the upper inner contacts of relay 720. Ground is then connected to the right contacts of interrupter 727, after some predetermined interval, say two seconds, which is sufficient to assure the release of the connection and the unnecessary signaling of the operator, if disconnection has been recognized. The aforesaid ground on the right contacts of interrupter 727, if the connection has not been released due to the disconnection of the calling party, causes the operation of relay 726 in a circuit from battery through the winding of relay 726 and the lower make contacts of relay 725. Relay 726 locks to ground on the upper inner contacts of relay 720, and operates with its upper contacts relay 805 over conductor 704. Relay 805 operated releases relay 806, which operates relay 718 over a circuit hereinbefore traced. Relay 718 operated releases relay 668 over conductor 611, and connects battery with its lower next-to-innermost make contacts, over conductor 709, through upper outermost break contacts of relay 802, over conductor 614 to the lower outer make contacts of relay 714 for flashing lamp 801. Relays 714 and 715 continue to operate and release, while the operator is awaited, thereby flashing lamp 801, which is a signal to the operator that the calling party is still holding the connection and has not yet deposited a coin for the overtime interval. When the operator plugs into the monitoring jack 808, relay 802 operates extinguishing lamp 801, and releasing relay 712, which in turn effects the release of relays 714, 715, 663 and 719, all as before described. Relays 720, 725 and 726 also release, due to the opening of the lower outermost make contacts of relay 712. The release of relay 726, releases relay 805 and the release of relay 720, closes with its lower outer break contacts the circuit for operating relay 112 of the district junctor circuit which in turn connects the calling line to conductors 162 and 163 so that the operator can again converse with the calling party with the called subscriber listening as before over conductors 166 and 167. If the calling party still fails to make the overtime coin deposit, the operator may insert a plug into the splitting jack 807, thereby operating relay 819 which opens with its inner break contacts the conversational connection between the calling and called parties. Relay 819 also connects ground, with its upper inner contacts, to conductor 605, thereby causing the coin-control circuit to test busy to link and control circuits, as long as the plug is in jack 807. When the plug is removed from the monitoring jack 808, relay 802 releases in turn releasing relay 718 and then a second repeat test is made by the coin-control circuit. Assuming that at the end of the second repeat test, the overtime coin deposit is detected, then relay 660 will operate and lock when relay 722 operates indicating the presence of a coin. The locking circuit for relay 660 is through its lower innermost make contacts to ground on the upper innermost contacts of relay 656. Release will then take place as to be hereinafter described. Assuming that no coin deposit has been detected but that the calling party has disconnected, then relay 662 operates when the district junctor connects ground to conductor 165 as before described.

The functioning of the coin-control circuit will now be described, when disconnection is recognized and the operator is being awaited for over-

time monitoring calls. If the calling party should disconnect while awaiting the operator with lamp 801 lighted, the coin-control circuit functions to extinguish lamp 801, and set up the cycle of operations for a coin-return call to insure that the coin box is cleared. This is done since it is possible that the calling subscriber may have deposited a coin after the overtime coin deposit test was made but before the operator has answered in which case the coin should be refunded. When the district junctor circuit recognizes that the calling party has disconnected, it connects ground to conductor 165, thus operating relay 662, as before described. Relay 662 operated (a) releases relay 655, which was previously operated by ground connected to conductor 162 of the district junctor and which was held through its lower middle make contacts, and upper innermost break contacts of relay 662 to ground on the lower next-to-outermost make contacts of relay 656; (b) extinguishes monitoring lamp 801, by opening its circuit over conductor 647 and partially prepares the circuit for lighting lamp 800 used for the stuck coin test; (c) partially prepares the circuit for operating the coin-return relay 658. When relay 655 releases it releases relay 712 which in turn causes relays 663, 719, 714, 715, 805 and 718 to release. When all of these relays have released a circuit is closed for operating relay 658 which is traced from ground on the upper outermost break contacts of relay 659, lower middle break contacts of relay 655, upper innermost make contacts of relay 662, lower outermost break contacts of relay 663, over conductor 648, through upper outermost break contacts of relay 719, over conductor 639, through upper next-to-innermost break contacts of relay 668, over conductor 609, through upper outermost break contacts of relay 805, over conductor 707, through upper middle break contacts of relay 722, upper outermost break contacts of relays 714 and 715, over conductor 634 and through winding of relay 658 to battery. Relay 658 operates and causes the circuit to function for coin return as hereinbefore described.

The release of the coin-control circuit of Figs. 6, 7 and 8 will now be discussed. For the various operating functions hereinbefore described release relay 660 was operated, whenever a releasing condition was established. Relay 660 operated (a) removes ground with its upper innermost break contacts from conductor 518, thereby releasing relay 112 of the district junctor circuit; (b) connects ground with its upper outermost make contacts to conductor 519 thereby causing the coin-control circuit to test busy until relay 660 has restored to normal; (c) connects conductor 517, through its lower outermost make contacts to the winding of relay 657 as a check for trouble ground conditions on conductor 517, which is the conductor that is used to signal a coin-collect condition; (d) releases by opening its lower innermost break contacts, relay 661; (e) holds, through its lower innermost make contacts to ground supplied by the upper innermost make contacts of relay 656, upper next-to-innermost contacts of relay 659, upper outermost make contacts of relay 655, or over conductor 632 by the upper innermost make contacts of relay 721, as a check that these relays are normal before the circuit is restored to normal; (f) connects ground, during the releasing time of relay 661, to conductor 517; this ground is supplied by the upper innermost make contacts of relay 661, through the lower innermost make

contacts of relay 657 and the lower outermost make contacts of relay 660 to conductor 517 to operate relay 123 of the district junctor through its upper winding which in turn releases the connection from the line of station 103 to the district junctor circuit for early release calls, that is, for calls abandoned by the calling party, before sender 900 has completed its functions; (g) opens with its upper middle break contacts the circuit of lamp 800. Relay 661 is slow in releasing to allow relay 123 aforesaid to operate and with its upper outer break contacts to release hold magnets 107 and 126, thereby releasing the line link connection. When relay 661 releases it (a) releases relay 657 provided that no trouble ground exists on conductor 517 and (b) opens conductor 525 with its lower make contacts to avoid breaking any current on this conductor at the cross-points of the switches 500 and 501. When relay 657 releases it (a) removes ground with its upper outermost make contacts from busy conductor 519; (b) removes ground, with its upper middle contacts, from sleeve conductor 521, thus releasing hold magnets 509, 510, 511 and 512 of the link and control circuit which breaks the connection between the district junctor and coin-control circuit; (c) releases relay 656 by opening the circuit of its upper winding. Relay 656 released (a) removes ground with its upper middle contacts from conductor 523 and also from the winding of the time alarm relay 804; (b) releases, with its upper outermost contacts, over conductor 628, relay 721, provided that relay 650 is not operated; (c) opens, with its lower next-to-innermost make contacts the locking circuits of relay 658 and 659, and whichever one of these relays that previously operated, now releases. When relay 655 has released due to the operation of relay 662, or also when relay 659 or 721 and 722 have released relay 660 releases. The release of relay 663 as before described releases relay 722 if it has been previously operated. Relay 663 releases relay 719 if this relay is operated at this time. Relay 718 releases provided that the operator has removed the plug from jack 808 or 809, thereby releasing relay 802. Relay 834 releases when the operator removes the plug from the release jack 810. Relay 806 releases when relay 661 releases, removing ground from conductor 603. When ground is removed from conductor 519 relay 506 releases removing ground from conductor 523. This causes ground to be removed from the winding of time alarm relay 804.

The release of the district junctor circuit shown by Fig. 1, including that of the connection through the cross-bar switches 101 and 102 of the line link circuit will now be discussed. When the calling party of station 103 disconnects, relay 141 releases, which in turn releases relay 117. Relay 146 releases when the called party disconnects or when relay 117 releases, opening the circuit of relay 146. When relay 117 releases it releases rotary timing magnet 153 and relay 150 if these are operated, by opening its upper outer contacts and operates relay 120. Relay 120 operated (a) locks under control of relay 121; (b) connects ground to conductor 160 to summon a coin-control circuit, (c) furnishes a holding ground for relay 126. When a coin-control circuit, as illustrated by Figs. 6, 7 and 8, is connected to the district junctor of Fig. 1, ground is supplied to conductor 164, which operates relay 121. These circuit operations have been described in detail hereinbefore, in con-

nection with the functioning of the coin-control circuit, in response to the disconnection of the calling party of station 103. Relay 121 operated operates relay 172 from battery through its winding, lower outermost make contacts of relay 121, lower outer break contacts of relay 117 to ground on the upper outermost make contacts of relay 121. Relay 172 locks through its upper innermost make contacts to ground on the upper next-to-innermost make contacts of relay 136. The coin-control circuit then connects ground to conductor 161, to operate relay 112 as before discussed. Relay 112 operated, (a) opens with its lower outermost break contacts the locking circuit for relay 149, if this relay was operated in response to a completed call for which a coin is to be collected; (b) removes ground on the lower outermost make contacts of relay 120, with its lower next-to-outermost contacts, from the upper outermost break contacts of relay 127 and sleeve conductor 174 thereby releasing the connections through the district and office switches of Fig. 2 to the outgoing trunk 206. When the coin-control circuit has completed its functions, it releases, as hereinbefore described, and thereby removes ground from conductors 161 and 164, releasing relays 112 and 120. When relay 120 releases, (a) it opens with its upper middle make contacts the locking circuit for relay 121, which releases; (b) opens with its lower outermost make contacts the locking circuit for relay 136, which releases and removes ground from sleeve conductor 125, releasing the connection through the line link and group control circuit to the calling line 100. When relay 136 releases, it releases relay 172 and the district junctor circuit is then restored to normal. The operation of the system for connections established without the aid of an operator, has been hereinbefore discussed; the operation for calls directed to an operator will now be described.

When the establishment of a call to an operator's trunk, not shown, is required the connection to the terminals 220 is made in the manner hereinbefore described for a non-operator class call, except that in this case marker 200 now grounds conductor 130 through upper next-to-innermost contacts of marker connector relay 207, thereby operating relay 133 through upper innermost contacts of relay 127. Relay 133 locks temporarily through its lower innermost make contacts to ground supplied by subscriber sender 900 over conductor 134, and ultimately through its upper next-to-innermost make contacts and lower outermost make contacts of relay 136 to ground on the outer upper contacts of relay 117. Relay 136 is operated when sender 900 connects ground to conductor 135 through lower outermost break contacts of relay 127. If the calling party should disconnect before the operator answers, the release of relay 117, releases relay 133 and then the circuit summons the coin-control circuit of Figs. 6, 7 and 8, which functions to cause the return of the deposited coin and then restores to normal all as hereinbefore described in connection with the description for coin return. When the operator answers polarized relay 146 operates due to the reversal of current through its winding, and operates relay 172 from battery through its winding, upper innermost make contacts of relay 133 to ground on the make contacts of relay 146. Relay 136 does not release now, although its locking circuit through the upper innermost break contacts of relay 172

is opened by the operation of relay 172; it is held by ground supplied over sleeve conductor 174, which ground is supplied by the operator's trunk which is arranged to function in this manner. The holding circuit for relay 136 is traced from said ground on conductor 174, through upper outermost contacts of relay 127, through lower next-to-outermost break contacts of relay 112, lower and upper innermost contacts and winding of relay 136 to battery. When relay 172 operates, and relay 133 has released as hereinafter described the circuit of the windings of relay 141 is opened. Relay 141 releases and transmission battery supply for the station of the calling party is now furnished from the operator's trunk, under the control of which the connection is now maintained. The transmission circuit over the tip may be traced from conductor 140, through upper next-to-outermost break contacts of relay 121, lower innermost break contacts of relay 149, upper next-to-outermost make contacts of relays 172 and 136 and thence over the circuit path hereinbefore traced; over the ring conductor the transmission path is from conductor 138, through lower next-to-innermost make contact of relays 172 and 136 and thence over the circuit before traced. Relay 172 in operating, opens with its upper next-to-innermost contacts the circuit of relay 117, which releases and in turn releases relay 133. The circuit is arranged so that the upper and lower outermost and next-to-outermost break contacts of relay 172 are short-circuited by similarly located contacts of relay 133, until relay 172 has operated, thereby maintaining the continuity of the battery supply to station 103 and the continuity of the transmission circuit. With the connection established the operator can now, by means of a coin-control cord circuit, similar to cord circuit 811, collect or refund the coin at the calling station, as required. When disconnection occurs the operator's trunk removes ground from conductor 174, thus releasing relay 136, which releases relay 172, the connection through the switches of the line link and group-control circuit and the district and office switches, thus restoring the circuit to normal.

The operation of the district junctor circuit of Fig. 1 for abandoned calls, that is, for calls where the calling party releases the connection before the sender has completed its functions and has released, will now be discussed. Under this condition it is desirable to release the calling subscriber line as quickly as possible. This is done under the control of the subscriber sender 900, which connects battery to conductor 134 for an interval sufficient to operate relay 120 through its lower winding and the lower innermost break contacts of relay 133. Relay 120 locks through resistance 159 to battery as before described. Battery is connected to conductor 134 immediately if disconnection occurs before marker 200 is connected to sender 900. If disconnection occurs after the marker connection, then the sender will delay the connection of battery to conductor 134 until marker 200 releases as before described. When battery is connected to conductor 134, relay 133 releases if previously operated, due to the deenergizing of its locking circuit and relay 120 then operates as just described. Relay 120 operated connects ground to conductor 160 to summon a coin-control circuit and also furnishes ground to hold the connection through the line link and group-control circuit. This holding circuit is traced from 75

ground on the lower outermost make contacts of relay 120, through upper outer break contacts of relay 123, through resistance 124 to sleeve conductor 125. When the coin-control circuit is connected to the district junctor circuit ground on conductor 164 operates relay 121 through its continuity contacts. Relay 121 locks through these contacts to ground on the upper middle make contacts of relay 120 and removes ground from the start lead 160 by opening its lower middle break contacts. Relay 117 releases when the sender link is released by sender 900, when ground is removed from conductor 116 by the release of hold magnet 904. This will operate relay 172 if relay 117 releases while relay 121 is operated. The operating circuit for relay 172 is traced from battery through the winding of relay 172, lower outermost make contacts of relay 121, lower outer break contacts of relay 117 to ground on the upper outermost make contacts of relay 121. The coin-control circuit now receives a ground signal over conductor 165, from ground on the lower outermost break contacts of relay 149, that the deposited coin should be returned. After the coin-control circuit has completed its functions it connects ground momentarily from the upper innermost contacts of slow-releasing relay 561, to conductor 157, thereby operating relay 123 through its upper winding. Relay 123 operating opens with its upper outer break contacts the sleeve circuit for the line link and group control hold magnets 107 and 126, thereby releasing the cross-bar switch connection to the line 100. When the coin-control circuit finally releases and ground is removed from conductors 157 and 164, relays 123 and 120 release. When relay 120 releases, it releases relay 121 by opening its locking circuit. Relay 121 releasing, releases relay 172, if it has been previously operated by relay 121. The circuit is thus restored to normal.

The automatic release of the line of the calling party, in case the called party answers and then disconnects but the calling party fails to disconnect, will now be described. This is accomplished when relay 146 releases after the called party disconnects due to the opening of the locking circuit of the operated relay 123. This locking circuit is traced from battery through the lower winding and lower inner make contacts of relay 123, upper innermost break contacts of relay 133 to ground on the make contacts of relay 146. The release of relay 146 connects ground through its break contacts, upper outermost make contacts of operated relay 149 to the right contacts of interrupter 154. In order to assure that the automatic release circuit will function after relay 149 has released, following the automatic collection of a coin at the end of the predetermined interval, assumed hereinbefore as four and one-half minutes, an alternate circuit path through lower next-to-innermost make contacts of relay 150 is provided. This interrupter with its associated relay 155, is provided for a group of district junctors, usually twenty in number, and is used to guard against immediate disconnection if the called party should flash on his connection.

When the right contacts of interrupter 154 close, relay 155 operates and locks through its lower contacts to the operating ground. Left contacts of interrupter 154 close, after a suitable predetermined interval, say two minutes later, and if the calling party has not disconnected at this time ground is connected, through the up-

per make contacts of relay 155, lower outer break contacts of relay 123, upper next-to-innermost make contacts of relay 149 to battery through the winding of relay 172, which operates. When relay 172 operates under this condition it releases relay 141, which in turn releases relay 117. When relay 117 releases, it causes relay 120 to operate through its lower winding, over the circuit hereinbefore traced. The coin-control circuit is then summoned, and after it functions, release of all apparatus is effected as hereinbefore described for a regular release.

The functioning of the district junctor circuit, when the marker 200, selected to handle a call, fails to establish a satisfactory connection between the district junctor and the out-going trunk 206, will now be discussed. When this occurs, marker 200 connects ground, through the upper innermost make contacts of relay 207, over conductor 132, through lower outermost make contacts of relay 127 to conductor 135 as a trouble release signal to sender 900, which then removes ground from conductor 134 thereby releasing relay 133, which may have been operated by marker 200 for an operator class call on the first trial. Marker 200 then releases and sender 900 then selects another marker, similar to marker 200, to serve the call as though it were a new connection. The subscriber sender 900, during this operation, continues to hold the sender link connection thus maintaining ground on conductor 122 due to the operation of hold magnet 903. The circuit details whereby the marker and sender cooperate to effect this second attempt to establish a connection are not a part of this invention and consequently are not shown. Detailed information covering this feature may be obtained from the aforementioned application of W. W. Carpenter, Serial No. 214,356, filed June 17, 1938.

An auxiliary feature of the coin-control circuit of Figs. 6, 7 and 8—the time alarm feature shown on Fig. 8—will now be discussed. The purpose of this arrangement is to call maintenance attention to any coin-control circuit which is held off-normal for an abnormal length of time without receiving the attention of an operator. Ground is connected over conductor 616, as soon as the coin-control circuit is seized, and is extended through upper next-to-outermost break contacts of relay 802, break contacts of make busy jack 803 to the winding of relay 804, which operates. Relay 804 remains operated the entire time that the coin-control circuit is off-normal, except for the time that its circuit is opened by the operation of relay 802 by an operator's insertion of a plug in jack 808 or 809. Relay 804 operated furnishes a holding ground through its upper contacts for relays 822, 823 and 824 and also connects with its lower contacts the winding of relay 822 to interrupter 829. When interrupter 829 connects ground for the first time and operates relay 822, relay 824 also operates from ground through the upper contacts of relay 804, upper outer make contacts of relay 822 and upper outer break contacts of relay 823. Relay 824 locks through its upper contacts and upper contacts of relay 804. When interrupter 829 releases at the end of the first ground closure, relay 822 releases and in turn operates relay 823. The circuit for relay 823 is traced from ground on the upper contacts of relay 804, upper outer break contacts of relay 822, lower operated make contacts of relay 824 and winding of relay 823 to battery. Relay 823 locks

through its lower inner make contacts to ground on upper contacts of relay 804. When interrupter 829 connects ground for a second time relay 822 operates as before and now locks in a circuit from battery through its winding and its lower inner make contacts, upper outer make contacts of relays 823 and 822 to the locking ground on the upper contacts of relay 804. This connects ground to the alarm circuit 831, through the upper inner contacts of relays 822 and 823 through winding of relay 825 to battery. Relay 825 operates, lights lamp 826 and causes ringer 827 to function. The group of coin-control circuits in trouble is identified by the lighting of lamp 828 through the lower outer contacts of relays 822 and 823. It has been found in practice that a coin-control circuit arranged according to Figs. 6, 7 and 8 has a normal holding time of approximately two seconds. The timing of interrupter 829 may be suitably predetermined so that an alarm is not indicated until after about 45 seconds. This arrangement insures that there will be no alarm unless there is a case of actual trouble. When ground is removed from the winding of relay 804, relays 804, 822, 823 and 824 release restoring the time alarm circuit to normal. Relay 825, if not operated from another circuit, also releases.

The make busy jack 803 is provided to permit removal of a coin-control circuit from service. When it is desired to make a circuit busy, a plug 830 having the tip, ring and sleeve conductors connected together is inserted into jack 803. This causes the break contacts of jack 803 to open, disconnecting alarm relay 804 to avoid sounding an alarm for this type of busy condition and connects the ground on the sleeve of jack 800 to conductor 605, thereby preventing the link and control circuit of Fig. 5 from seizing the coin-control circuit.

What is claimed is:

1. In a telephone system, a pay-station line, means at the pay station for receiving deposited coins, a group of trunks, means for extending a conversational connection from said line over one of said trunks, a controlling mechanism common to said group of trunks, timing means for measuring periods of conversation, means rendered effective during each measured period of conversation for connecting said controlling mechanism to the trunk involved in the conversational connection, means in said mechanism for causing the collection of a deposited coin, means for then causing the release of said mechanism from said trunk, means effective at the end of each conversational period for causing said controlling mechanism to be connected again to said trunk to test said line to determine if another coin has been deposited, and means effective if the test shows that another coin has been deposited for disconnecting said mechanism from said trunk.

2. In a telephone system, a pay-station line, means at the pay station for receiving deposited coins, a group of trunks, means for extending a conversational connection from said line over one of said trunks, a controlling mechanism common to said group of trunks, timing means for measuring periods of conversation, means rendered effective during each measured period of conversation for connecting said controlling mechanism to the trunk involved in the conversational connection, means in said mechanism for causing the collection of a deposited coin, means for then causing the release of said mech-

anism from said trunk, an operator's position, means controlled by said mechanism if it fails to find a deposited coin for signaling the operator at said position, and means effective at the end of each conversational period for causing said controlling mechanism to be connected again to said trunk to test said line to determine if a coin has been deposited in payment for the next succeeding period.

3. The combination in a telephone system of a line having a pay station thereon arranged to receive deposited coins, a group of trunks and means for extending a conversational connection from said line over any one of said trunks, a coin-control mechanism common to said trunk group, means for measuring successive periods of conversation on said line, means effective during each measured period of conversation for connecting said mechanism to the conversational connection, means in said mechanism for causing the collection of a coin if one has been deposited at the pay station, means responsive to the successful collection of a coin for causing the release of said mechanism from the conversational connection, an operator's position, means controlled by said mechanism if it fails to collect the coin for signaling the operator at said position, means at said position to enable the operator to establish a conversational connection with the calling line to request the deposit of a coin, means controlled by the operator for collecting the coin when deposited, and means effective at the end of each conversational period for causing said mechanism to be connected again to the conversational connection to test said line to determine if another coin has been deposited in payment for the next period of conversation.

4. In a telephone system, a pay-station line, means at the pay station for receiving deposited coins, a group of trunks, means for extending a conversational connection from said line over one of said trunks, a controlling mechanism common to said group of trunks, timing means for measuring conversational periods, means rendered effective during each one of the measured periods for connecting said controlling mechanism to the established conversational connection to effect the collection of a coin deposited at the pay station, means for causing the release of said mechanism following the collection of the coin, means effective at the end of each conversational period for causing said mechanism to be connected again to the conversational connection for making a test of said line to determine whether another coin has been deposited, an operator's position having a signal lamp thereat, and means effective if the test of said line indicates that another coin has not been deposited for lighting the signal lamp at said operator's position.

5. The combination in a telephone system of a line having a pay station thereon arranged to receive deposited coins, a group of trunks and means for extending a conversational connection from said line over one of said trunks, a controlling mechanism common to said trunks, means for measuring successive periods of conversation on said line, means rendered effective during each one of the measured periods for connecting said controlling mechanism to the established conversational connection to effect the collection of a coin deposited at the pay station, means for causing the release of said mechanism following the collection of a coin, means effective at the end of each conversational period

for causing said mechanism to be connected again to the conversational connection for making a test of said line to determine whether another coin has been deposited, an operator's position, means effective if the test of said line indicates that another coin has not been deposited for signaling the operator, and means controlled by the operator for establishing a conversational connection with the calling line enabling her to request the deposit of another coin.

6. A telephone system of the kind characterized by claim 5 and further characterized by means effective in response to the withdrawal of the operator from said connection for causing said controlling mechanism to retest the line to determine whether the coin was deposited in response to the operator's request, and by means effective to cause the release of said controlling mechanism from the connection if it finds on retest that the coin has been deposited.

7. A telephone system as set forth in claim 5 characterized by means effective in response to the withdrawal of the operator from said connection for causing said controlling mechanism to retest the line to determine whether the coin was deposited in response to the operator's request, and further characterized by means effective to cause the release of said controlling mechanism from the connection if it finds on retest that the coin has been deposited and effective to resignal the operator at said position if the controlling mechanism finds on retesting the line that the coin requested by the operator has not been deposited.

8. A telephone system as set forth in claim 5 characterized by means effective upon each successive withdrawal of the operator from connection with the calling line to cause said mechanism to make a retest of the line to determine if a coin has been deposited and to resignal the operator following each unsuccessful retest, and further characterized by means for releasing the control mechanism from the established connection following the particular one of its successive tests that discloses the presence of a deposited coin.

9. In a telephone system, a pay-station line, means at the pay station for receiving deposited

coins, a group of trunks and means for establishing a conversational connection from the line over any one of said trunks, a coin-controlling mechanism common to said group of trunks, timing means for measuring periods of conversation, means effective during each measured period of conversation for connecting said controlling mechanism to the trunk involved in such conversational connection, means in said mechanism for causing the disposal of coins deposited at the pay station, means effective once per measured period of conversation for connecting the controlling mechanism to said trunk to test the line to determine if another coin has been deposited in payment for the next conversational period, an operator's position, a connecting circuit individual to said controlling mechanism appearing at said position, and means at the position for enabling the operator to make a connection with the calling line by way of said connecting circuit and said controlling mechanism to supervise the deposit and disposition of coins at the pay station.

10. In a telephone system, a pay-station line, means at the pay station for receiving deposited coins, a group of trunks, means for extending a conversational connection from said line over one of said trunks, a controlling mechanism common to said group of trunks, timing means for measuring periods of conversation, means rendered effective during each measured period of conversation for connecting said controlling mechanism to the trunk involved in the conversational connection, means in said mechanism for causing the collection of a deposited coin and the transmission of a tone signal to the pay station apprising the calling party that another coin should be deposited, means for then causing the release of said mechanism from said trunk, means effective at the end of each conversational period for causing said controlling mechanism to be connected again to said trunk to test said line to determine if another coin has been deposited, and means effective if the test shows that another coin has been deposited for disconnecting said mechanism from said trunk.

ALOYSIUS J. BUSCH.