

June 20, 1944.

F. KESSLER

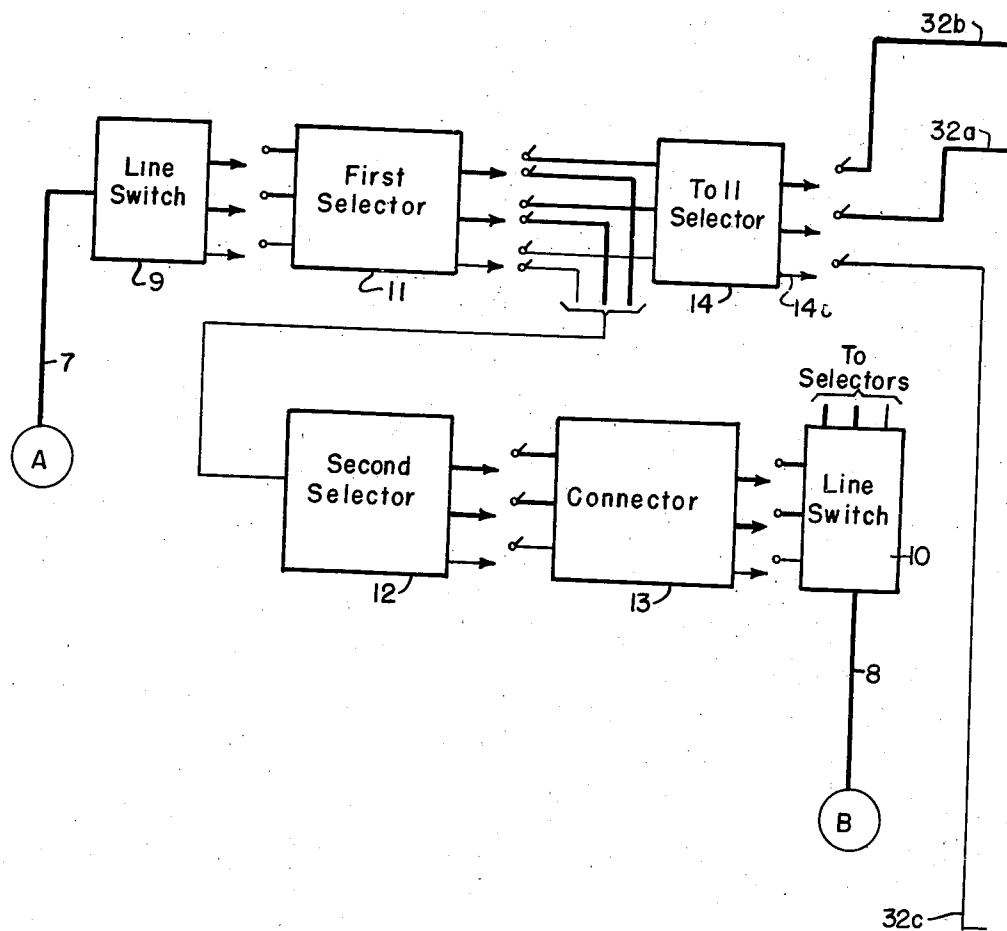
2,352,107

TELEPHONE SYSTEM

Filed Sept. 14, 1942

8 Sheets-Sheet 1

FIG. 1



INVENTOR.

FRANK KESSLER

BY *Davis, Lindsey, Smith & Shonts*

ATTORNEYS

**June 20, 1944.**

**F. KESSLER**

**2,352,107**

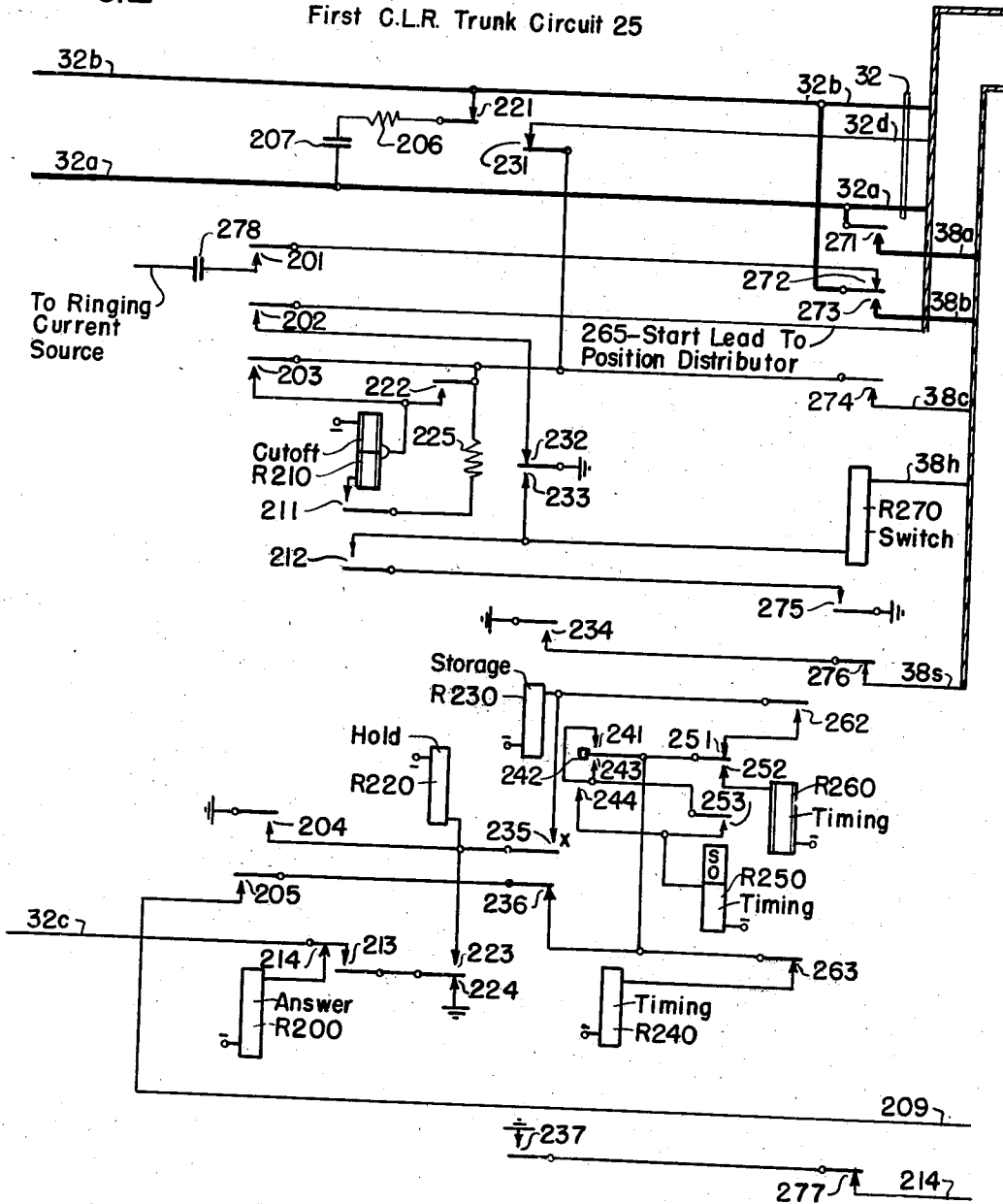
## TELEPHONE SYSTEM

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FIG.2

First C.L.R. Trunk Circuit 25



INVENTOR.  
FRANK KESSLER  
BY *Davis, Lindsey, Smith & Shonts*  
ATTORNEYS

June 20, 1944.

F. KESSLER

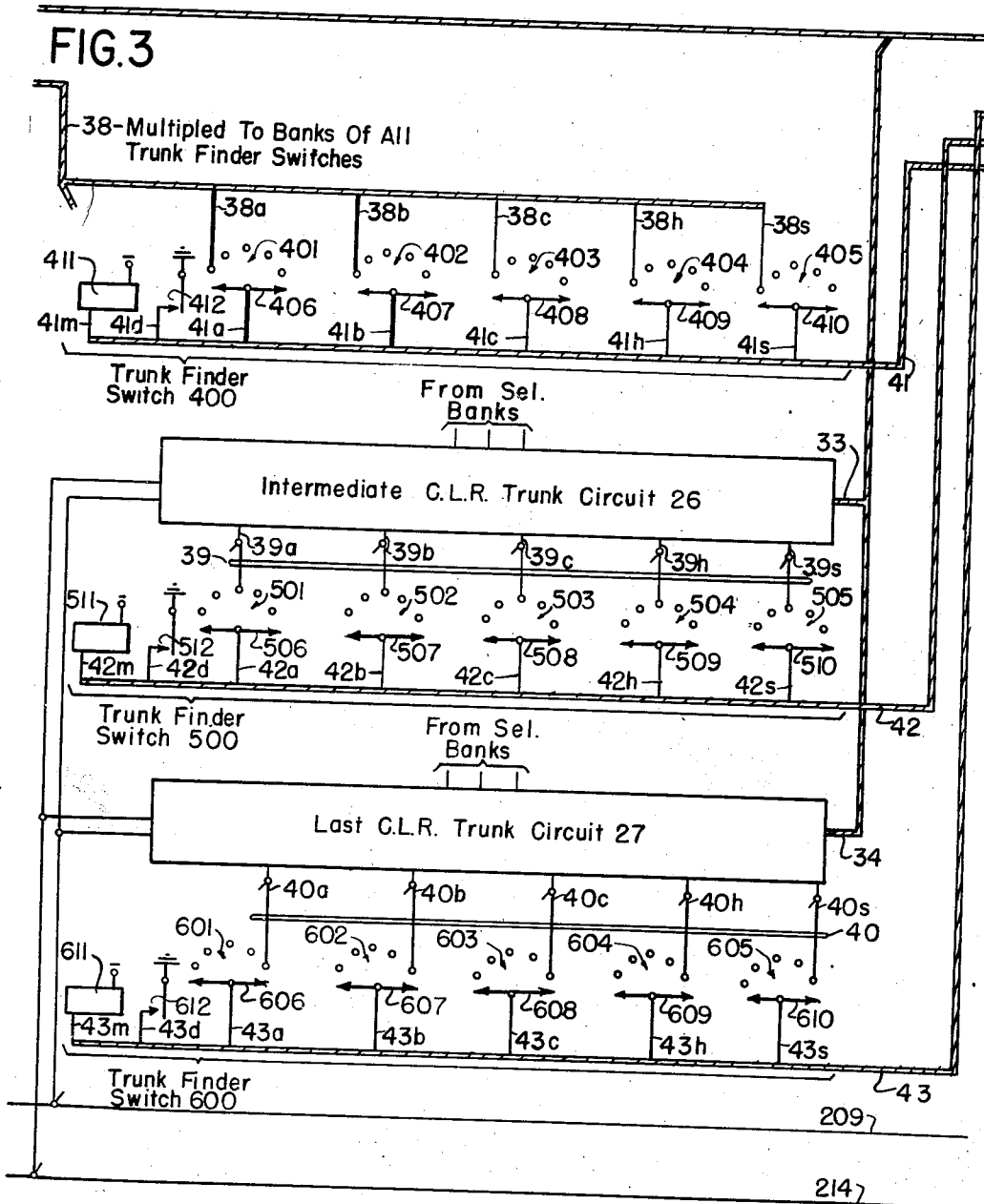
2,352,107

TELEPHONE SYSTEM

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8 Sheets-Sheet 3

FIG. 3



INVENTOR.  
FRANK KESSLER

BY *Davis, Lindsey, Smith & Shonts*

ATTORNEYS

June 20, 1944.

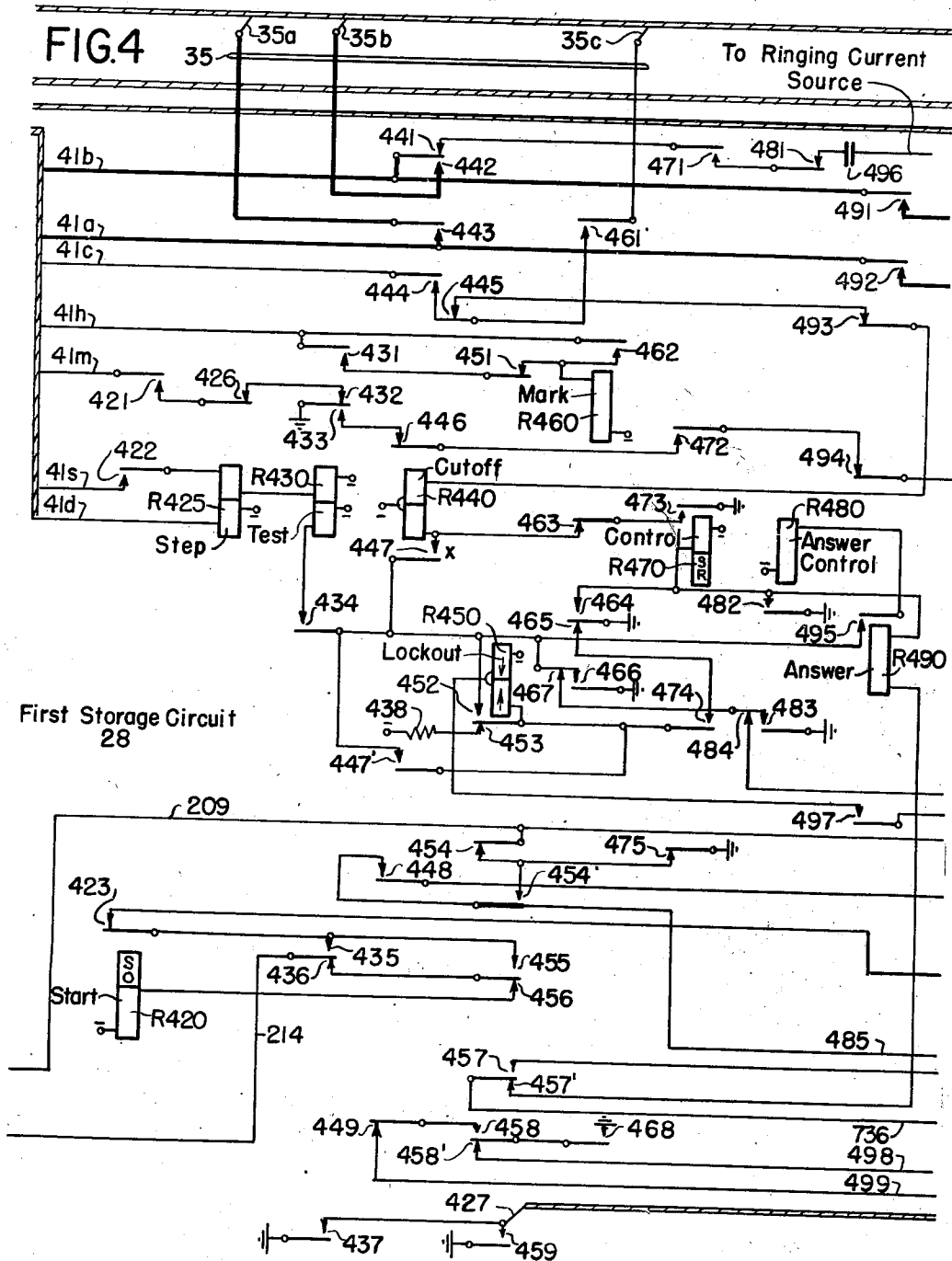
F. KESSLER

2,352,107

TELEPHONE SYSTEM

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8 Sheets-Sheet 4



INVENTOR.  
FRANK KESSLER

BY *Davis, Lindsey, Smith & Shonts*  
ATTORNEYS

June 20, 1944.

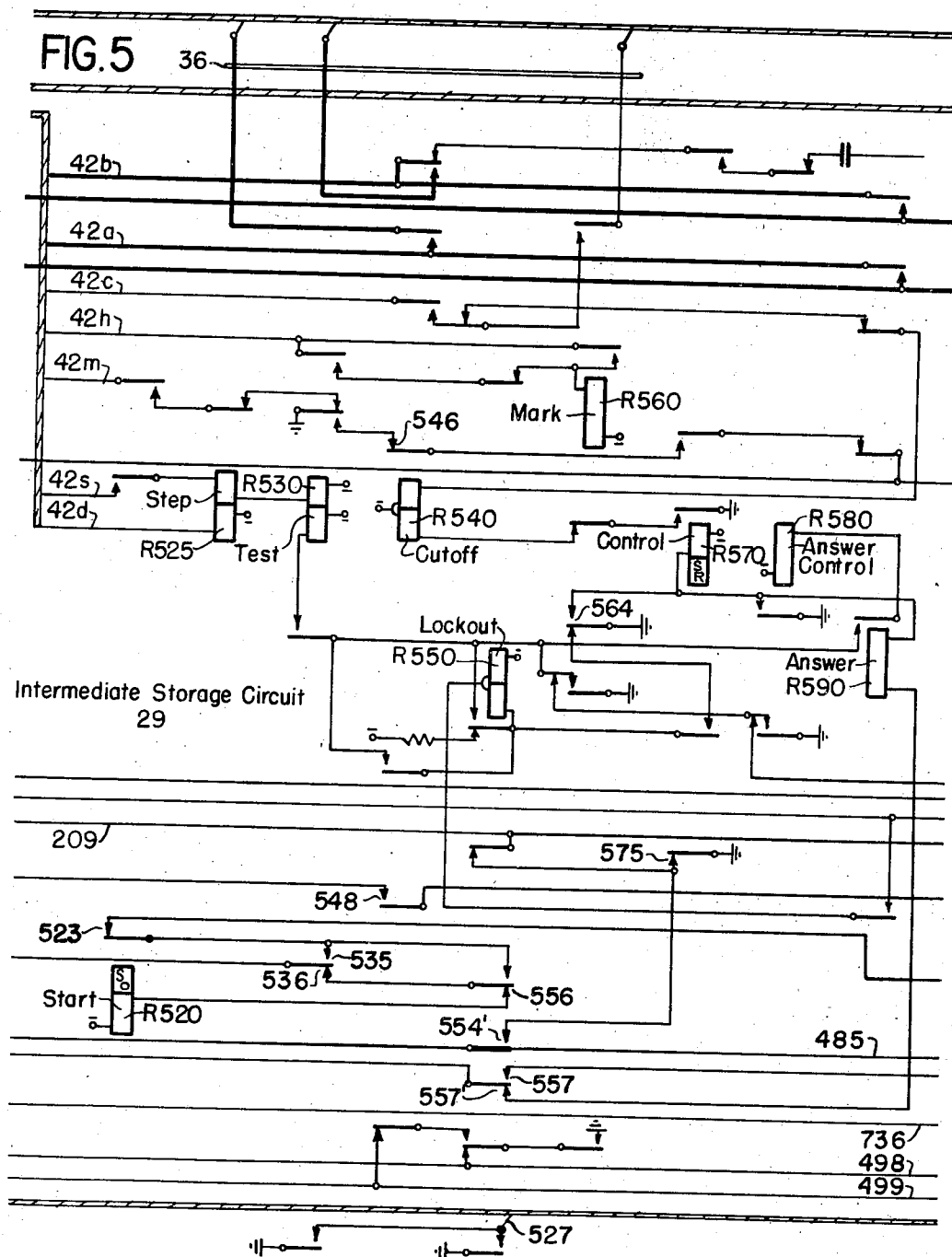
F. KESSLER

2,352,107

TELEPHONE SYSTEM

Filed Sept. 14, 1942

8 Sheets-Sheet 5



INVENTOR,

FRANK KESSLER

BY *Davis, Lindsey, Smith & Shonts*

ATTORNEYS

June 20, 1944.

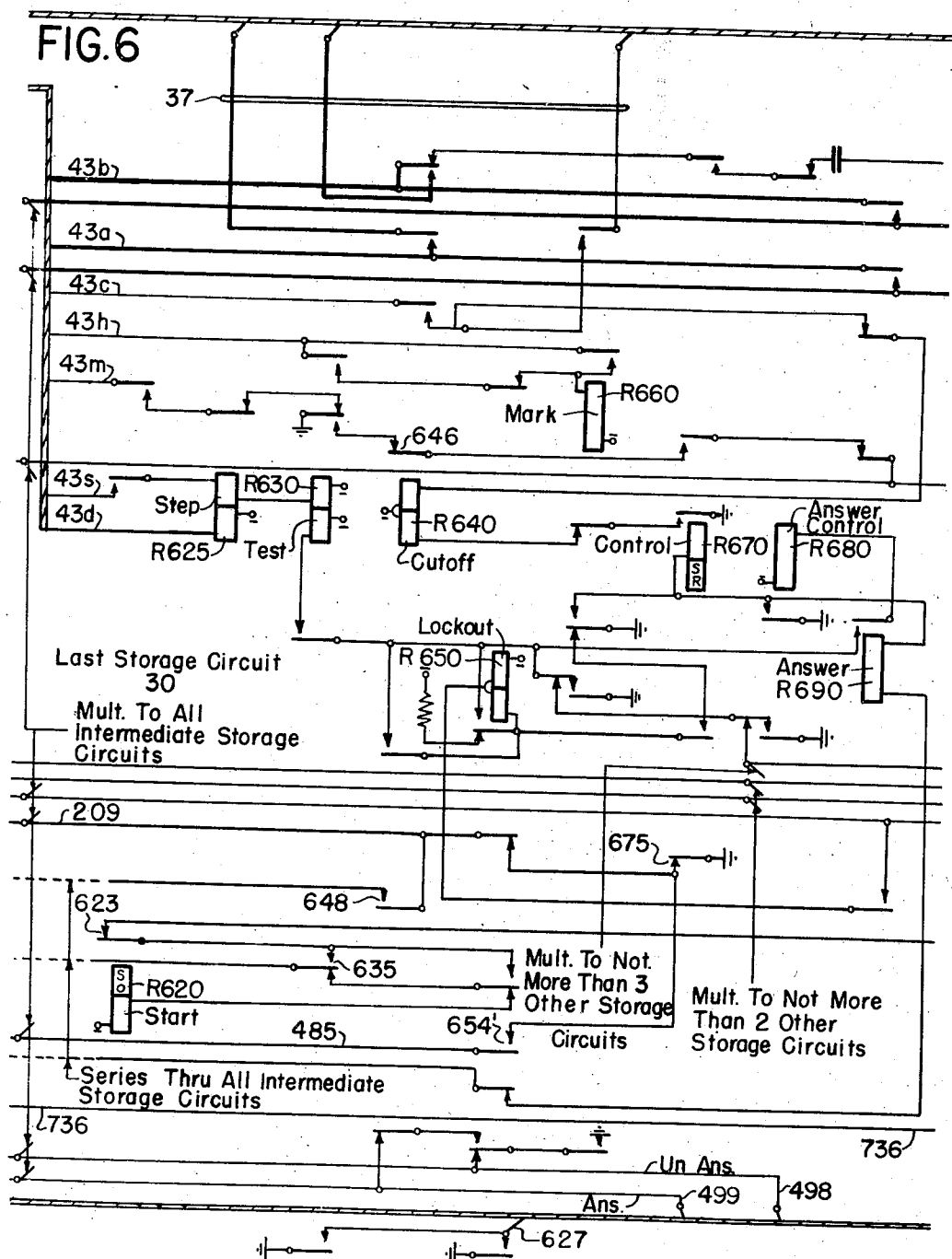
F. KESSLER

2,352,107

TELEPHONE SYSTEM

Filed Sept. 14, 1942

8 Sheets-Sheet 6



INVENTOR.

FRANK KESSLER

BY *Davis, Lindsey, Smith & Shonts*  
ATTORNEYS

June 20, 1944.

F. KESSLER

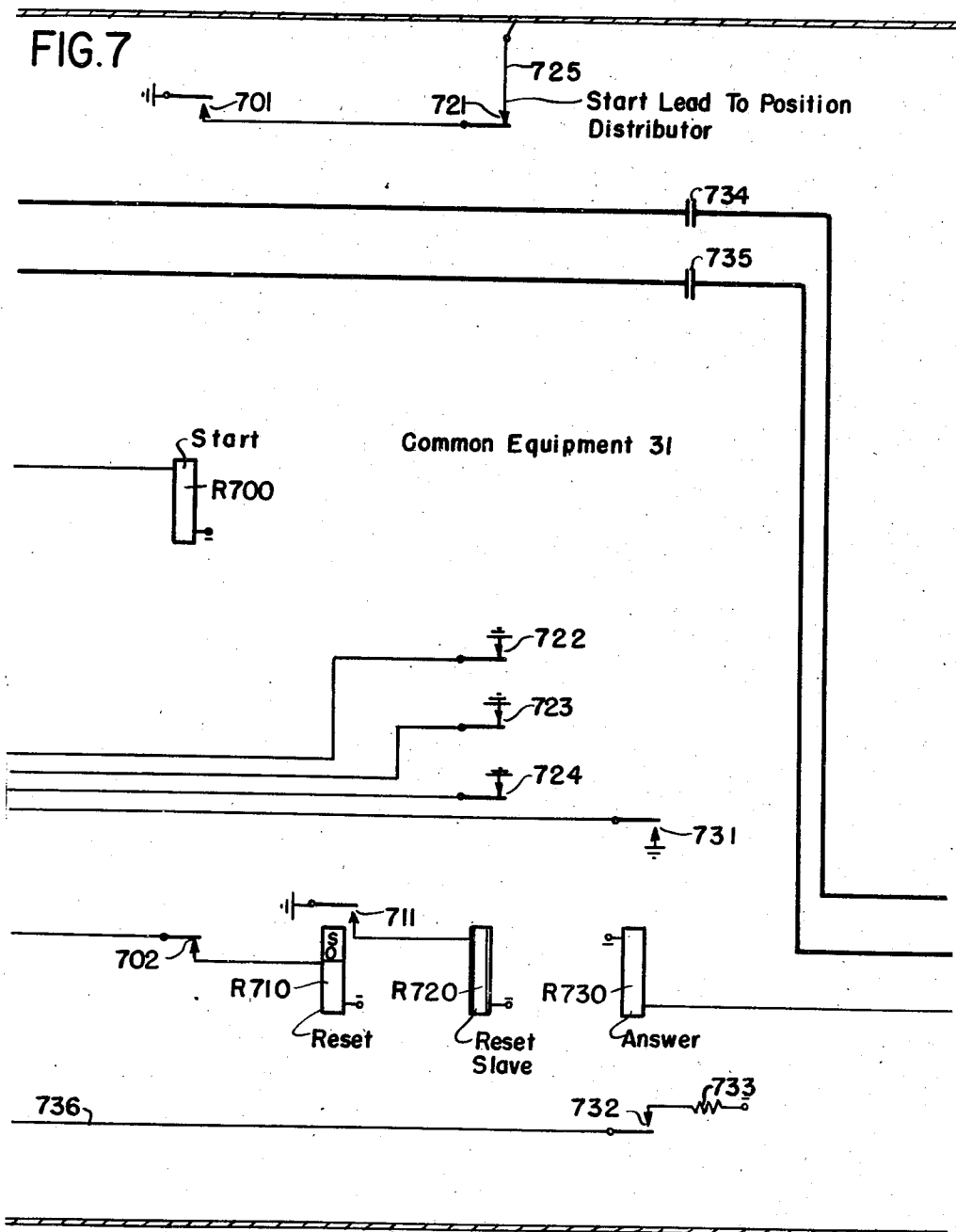
2,352,107

TELEPHONE SYSTEM

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FIG. 7



INVENTOR.

FRANK KESSLER

BY *Davis, Lindsey, Smith & Shorts*  
ATTORNEYS

June 20, 1944.

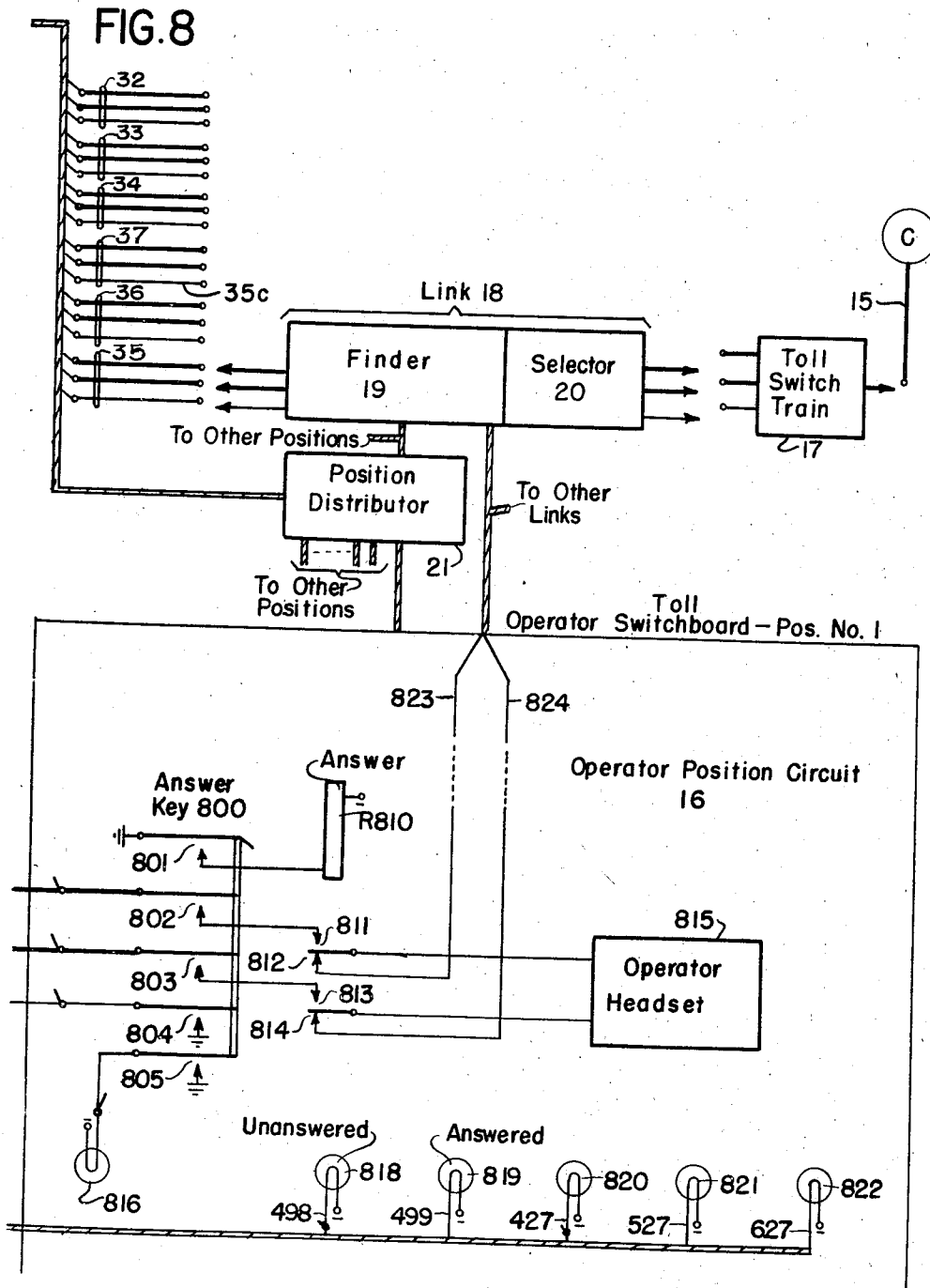
F. KESSLER

2,352,107

TELEPHONE SYSTEM

Filed Sept. 14, 1942

8 Sheets-Sheet 8



INVENTOR.

FRANK KESSLER

BY *Davis, Lindsey, Smith & Shonto*  
ATTORNEYS

## UNITED STATES PATENT OFFICE

2,352,107

## TELEPHONE SYSTEM

Frank Kessler, Lombard, Ill., assignor to Automatic Electric Laboratories, Inc., a corporation of Delaware

Application September 14, 1942, Serial No. 458,254

46 Claims. (Cl. 179—27)

The present invention relates to telephone systems and, more particularly, to improved apparatus for storing calls at a predetermined switching stage of a telephone system when the call handling facilities which follow the predetermined switching stage are all busy.

It is an object of the present invention to provide an arrangement for storing C. L. R. calls to a toll operator switchboard during an interval when the C. L. R. call handling facilities of the switchboard are all busy, and for automatically routing the stored calls to the switchboard as the call handling facilities thereof become idle.

According to another object of the invention, the stored C. L. R. calls are routed to the operator switchboard to be answered in the same order that they are stored.

It is another object of the invention to provide improved call storage facilities of the character described wherein provisions are made for acknowledging the stored calls from an operator switchboard without releasing the calls from storage.

According to a further object of the invention, provisions are made whereby the calls can only be acknowledged from the operator switchboard in the same order as they are stored.

In accordance with another object of the invention, the call storage equipment is provided with a number of storage circuits each capable of storing one call, the circuits are controlled to store calls in a predetermined order, and each circuit is prevented from receiving a second call for storage until the initially established order of circuit use is exhausted.

According to still another object of the invention, improved facilities are provided for holding each storage circuit out of service after a call stored therein has been abandoned or completed, until the order of circuit use as determined by associated circuit distributing equipment is exhausted.

In accordance with another object of the invention, provisions are made for preventing the answer circuit over which the stored calls are acknowledged from the switchboard, from being connected to a storage circuit that is being withheld from service after a call stored therein has been completed or abandoned.

It is another object of the invention to provide in conjunction with an operator switchboard of the type in which incoming calls are received over automatic answer switches, improved call storage facilities for storing incoming calls ahead of the answer switches during an interval when all of

the call answering facilities of the switchboard are busy, and for automatically routing the stored calls through the answer switches to the switchboard as the call answering facilities of the switchboard become idle.

According to another object of the invention, the stored calls are routed from the storage facilities through the answer switches over preferred paths which differ from the paths over which unstored calls are normally routed through the answer switches to the switchboard.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the specification taken in connection with the accompanying drawings in which Figs. 1 to 8, inclusive, when laid side by side in numerical order, illustrate a telephone system having incorporated therein the features of the invention briefly referred to above.

In the illustrated embodiment of the invention, a central office of substantial size is provided in an area wherein the toll traffic to a number of distant points is relatively heavy. This office is utilized to terminate a large number of subscriber lines, of which the lines 7 and 8 are shown in Fig. 1 of the drawings as extending to the substations A and B, respectively. The two lines 7 and 8 terminate in the office in non-numerical line switches 9 and 10, respectively, which have access to the numerically controlled switching equipment through which local connections are set up and through which access may be gained to the toll operator switchboard, as shown in Fig. 8 of the drawings. Each of the other subscriber lines extending to the central office is similarly terminated in a line switch. The numerically controlled switching equipment provided in the central office includes a plurality of first selectors, one of which is indicated at 11; a plurality of groups of second selectors, one of which includes the connector 12; and a plurality of groups of connectors, one of which includes the connector 13. The line switches 9, 10, etc., individual to the various subscriber lines are preferably of the well-known rotary type. In order to permit the subscribers served by the central office to obtain excess to the toll operator switchboard, several toll selectors are provided. One of the toll selectors 14 is shown as being accessible to the first selector 11 and as having access to a number of C. L. R. trunk circuits 25, 26 and 27 through which connections may be extended to the switching equipment associated with the toll operator

switchboard. More specifically, each toll selector includes facilities for automatically effecting the selection of an idle trunk circuit in a selected group, for transmitting on and off hook supervisory signals to the toll operator switchboard, for maintaining itself operated so long as it is held from a calling substation, and for maintaining ground potential upon its test wiper 14c after it has been operated to seize one of the trunk circuits to which it has access and until it is released at the substation from which it is being held. Although they may be of any desired type, such, for example, as the two-motion type which utilize switching mechanisms arranged for rotary movement followed by vertical movement, the first and second selectors, the toll selectors and the connectors are preferably of the well-known Strowger type.

The toll operator switchboard, as schematically shown in Fig. 8 of the drawings, is preferably of the well-known Crocker type and may be of the specific form disclosed and claimed in Patent No. 2,167,710 granted August 1, 1939, to Thomas F. Crocker. In brief, this board comprises a number of operator positions, only the first of which is indicated in the drawings, which positions are universal in that they are each provided with facilities for handling inward and C. L. R. (combined line recording) toll calls as well as interposition calls. The equipment individual to each operator position includes an operator position circuit having embodied therein an operator headset and the usual keys and key controlled relays that are required for the answering of the calls of different types, the routing of the received calls to their proper destinations, and the supervision of the connections over which the calls are extended. Each position also has associated therewith a number of finder-selector links which may be selectively associated with the equipment of the position circuit and are utilized to route incoming calls to the position circuit and in the extension of the calls to their destinations. More specifically considered, the illustrated first position of the switchboard includes an operator position circuit 16 having embodied therein an operator headset 815 and having associated therewith a number of finder-selector links, one of which is indicated at 18 as comprising a finder or answer switch 19 and a selector or call switch 20. For the purpose of automatically distributing calls incoming to the toll operator switchboard to the various positions thereof, a position distributor 21 is provided having the function of assigning the different positions to receive calls in a predetermined order. The toll operator switchboard equipment further comprises a number of register senders together with facilities for automatically associating idle ones of the senders with the different operator position circuits and the different links that are occupied with calls. In the interests of simplifying the disclosure, the details of the operator position circuit 16, the links associated with this position circuit, the position distributor 21, the register senders, and the equipment for automatically associating these senders with the different operator position circuits and links, have not been shown. These various pieces of equipment may be of the exact form disclosed in the above-cited Crocker patent.

In order more easily to explain the improved C. L. R. call storage facilities to which the features of the present invention are particularly directed, it is noted that the operator position

circuit 16 is provided with an answer key 800, an answer relay R810, and an answer busy lamp 816, which are utilized in the acknowledging of C. L. R. calls that have been placed in storage in the manner described below. Each of the other positions of the toll operator switchboard is also equipped with the described facilities for acknowledging stored calls.

The trunk circuits 25, 26, 27, etc. through which connections are extended to the toll operator switchboard from the subscriber lines terminating in the central office are identical in arrangement. Accordingly, only the details of the trunk circuit 25 have been illustrated in the drawings. Briefly considered, this circuit comprises an answer relay R200, a slow-acting cut-off relay R210, a hold relay R220, a storage relay R230, a switching relay R270, and three timing relays R240, R250 and R260. The first of these timing relays is of the well-known pendulum type, while the second and last of the enumerated timing relays are of the slow-to-operate and slow-acting types, respectively.

For the purpose of storing the C. L. R. calls that may be initiated at a time when all positions of the toll operator switchboard are occupied with calls, a number of storage circuits 28, 29, 30, etc. are provided. These storage circuits each have access to storage trunks 38, 39, 40, etc. which individually extend to the different C. L. R. trunk circuits 25, 26, 27, etc., and are identical in circuit arrangement. Accordingly, corresponding circuit elements of the three circuits have been identified by reference numerals differing only in the hundreds digits thereof. Briefly considered, the storage circuit 28 comprises a trunk finder switch 400 of the well-known rotary type, a slow-to-operate start relay R420, a step relay R425, a test relay R430, a cut-off relay R440, a lockout relay R450, a marking relay R460, an answer relay R490, an answer control relay R480, and a slow-to-release control relay R470. The trunk finder switch 400 includes five sets of contacts 401, 402, 403, 404 and 405, each having the required number of points to permit access to be gained to all of the C. L. R. trunk circuits; wipers 406, 407, 408, 409 and 410 individually associated with the five enumerated contact sets; and means comprising an operating magnet 411 and a ratchet and pawl mechanism, not shown, for driving the enumerated wipers over the contacts of their respective associated contact sets.

For the purpose of indicating to the operators attending the toll operator switchboard that C. L. R. calls have been placed in storage, call lamps 820, 821, 822, etc. individual to the various storage circuits and suitably multipled for concurrent energization, are provided at each of the positions of the switchboard. Two additional lamps 818 and 819 are provided at each position of the switchboard which, when energized respectively, indicate that certain stored C. L. R. calls remain unanswered, and that certain stored C. L. R. calls have been answered. The enumerated signal lamps permit the operators attending the different positions of the switchboard to readily ascertain how many calls are in storage and whether or not the stored calls have been acknowledged or remain unacknowledged.

#### OPERATION OF THE SYSTEM

In considering the operation of the system, it may first be assumed that a local call intended for the substation B is initiated at the substation A and that the numerical switches 11, 12 and

13 are utilized in setting up the desired connection. When the receiver provided at the calling substation A is removed from its supporting hook to initiate the call, a loop circuit including the conductors of the line 7 is completed between this substation and the line switch 9. This switch operates in a well-known manner to select and seize the first idle selector, such, for example, as the selector 11, to which it has access. When the selector 11 is seized through the line switch 9, the calling loop circuit is extended to this selector and the usual dial tone signal is returned from the selector over the established loop circuit to inform the calling subscriber that the dialing operation may be started. When the first digit is dialed at the calling substation, the selector 11 elevates its wipers to a position opposite the level of bank contacts terminating the trunks leading to the second selectors through which access is gained to the connectors of the group having access to the desired line 8. Following this operation and during the inter-digit pause between the first and second digits, the wipers of the selector 11 are automatically stepped over the contacts of the selected level until a trunk leading to an idle one of the second selectors in the selected group is found. In the present case, the second selector 12 is selected and seized during the trunk-hunting operation of the first selector 11. Incident to the seizure of this second selector, the calling loop circuit is extended thereto so that the switch is conditioned to receive the impulses of the second digit. When this digit is dialed at the calling substation A, the selector 12 elevates its wipers to a position opposite the level of bank contacts terminating the trunks leading to the connectors of the selected group. Thereafter and during the inter-digit pause between the second and third digits, the wipers of the selector 12 are automatically rotated over the contacts of the selected level until a trunk leading to an idle connector of the group is found. In the case assumed above, the connector 13 is seized during the trunk-hunting operation of the selector 12. Incident to the seizure of this switch, a switch-through operation is effected in the selector 12, whereby the calling loop circuit is extended to the connector 13. When this connector is seized certain of the control relays embodied therein, and more particularly the line and hold relays thereof, operate to condition the connector to receive the impulses of the third and succeeding digits of the directory number designating the desired substation B. The first of these digits as dialed into the connector 13 from the calling substation is utilized to position the wipers of the connector 13 opposite the level of bank contacts at which the group of ten lines, including the called line 8, is terminated. The fourth digit as dialed into the connector 13 from the calling substation, is utilized to position the wipers of the connector on the contacts at which the conductors of the called line 8 are terminated. In accordance with conventional practice, suitable provisions are made in the connector 13 for testing the selected line 8 to determine the idle or busy condition thereof, for returning the usual busy tone signal over the established loop circuit to the calling subscriber in the event the called line is busy, and for projecting ringing current over the selected side of the called line 8 in the event this line is idle. Assuming that the called line is idle, the called substation B is signaled in the usual manner through the transmission of ringing current over the line 8. The desired con-

versational circuit between the calling and called substations is fully completed when the call is answered at the called substation B. More particularly, when the receiver at this substation is removed from its supporting hook or cradle, a direct current conductive bridge is connected across the conductors of the line 8 to complete the usual circuit for energizing the ring cut-off relay in the connector 13. This relay, in operating, functions to arrest the transmission of ringing current over the line 8 and to establish the desired talking circuit between the calling and called lines in an entirely conventional manner.

Preferably, the control relays of the connector 13 are so arranged that the release of the operated switch train is entirely under the control of the calling subscriber at the substation A. With such an arrangement, when the connection is cleared out at the calling substation A, the loop circuit extending from this substation to the connector 13 is interrupted to cause the release of the line and hold relays embodied in this connector in the usual manner. When these relays restore, the selectors 12 and 11, the line switch 9, and the connector 13 are all restored to normal in a manner well understood in the art. Incident to the release of the line switch 9 and the connector 13, the private conductors of the lines 7 and 8 are disconnected from ground to mark these lines as idle in the connectors to which they are respectively accessible.

#### *C. L. R. toll calls*

Referring now more particularly to the manner in which C. L. R. toll calls are handled in the system, it may be assumed that a toll call requiring the assistance of an operator at the toll switchboard is initiated at the substation A, that the call is handled at the No. 1 position of the switchboard in the regular manner, that the first selector 11, the toll selector 14, and the C. L. R. trunk circuit 25 are utilized in routing the call to the toll operator switchboard, and that the link 18 individual to the No. 1 position of the switchboard is utilized in forwarding the call to its destination. After a connection is extended from the line 7 to the first selector 11 and the dial tone signal is returned over the line 7 to inform the calling subscriber that the dialing operation may be started, the first digit of the toll directory number may be dialed at this substation. The impulses of this digit as transmitted to the selector 11 are utilized to position the wipers of this selector opposite the level of bank contacts at which are terminated the trunks extending to the toll selectors. Incident to the vertical movement of the selector wipers the dial tone signal is terminated in the usual manner. During the interdigit pause between the first and second digits, the selector 11 operates automatically to select the trunk extending to the first idle toll selector which, in the case under consideration, is assumed to be the selector 14. When this selector is found by the preceding selector 11, the calling loop circuit is extended thereto and the toll selector is conditioned to respond to the impulses of the second digit of the toll directory number. When this digit is dialed at the calling substation, the wipers of the toll selector 14 are elevated to a position opposite the level of bank contacts at which the trunk conductors of the C. L. R. trunk circuits are terminated. At the end of the digit, the selector functions automatically to select and

seize the first idle trunk circuit of the group. In searching for an idle trunk circuit, the toll selector 14 looks for negative battery potential on the test leads of the trunks extending to the various trunk circuits. Thus when the trunk circuit 25 is idle, negative battery potential is applied to the test conductor 32c over a path which includes the winding of the relay R200 and the contacts 214. In the present example, the C. L. R. trunk circuit 25 is seized during the trunk-hunting operation of the toll selector 14. As previously indicated, this toll selector is of the calling party release type, not requiring the completion of a holding circuit in a succeeding switch in order to maintain itself operated after a trunk circuit has been seized therethrough. Moreover, this selector is provided with the usual relay facilities for impressing ground potential upon its test wiper 14c incident to its operation to seize an idle succeeding switch.

When ground potential is applied to the wiper 14c in the toll selector 14, a circuit including this wiper, the conductor 32c and the contacts 214 is completed for energizing the answer relay R200. In operating, the relay R200 closes a circuit through the condenser 278 and the contacts 201 and 272 for transmitting ringing current back over the calling end of the connection to produce the usual ring-back tone signal at the calling substation A. The calling subscriber is thus informed that the call is being extended to the toll operator switchboard. At its contacts 203, the relay R200 prepares the operating circuit for the cut-off relay R210. At its contact 204, the relay R200 completes an obvious circuit for energizing the hold relay R220. At its contacts 205, the relay R200 completes a circuit for energizing the timing relay R240, this circuit extending from the normally grounded A. T. B. lead 209 by way of the contacts 205, 236 and 263, and the winding of R240 to battery. At its contacts 202, the relay R200 completes a path through the contacts 232 for impressing ground potential upon the start lead 265 extending to the position distributor 21.

The hold relay R220, upon operating, opens its contacts 221 to disconnect the terminating impedance bridge comprising the resistor 206 and the condenser 207 from the talking conductors 32a and 32b of the trunk 32. At its contacts 222, the relay R220 prepares a multiple circuit for energizing the cut-off relay R210. At its contacts 223, the relay R220 prepares a locking circuit for itself. At its contacts 224, the relay R220 opens a point in the path for impressing ground potential upon the test conductor 32c in the trunk circuit 25.

The timing relay R240, upon operating, attracts its weighted armature 242 to close the contacts 243 and 244 and thus complete a circuit for energizing the slow-to-operate timing relay R250. This circuit extends from the grounded A. T. B. lead 209 by way of the contacts 205, 236, 243 and 244, and the winding of R250 to battery. In operating, the relay R250 locks to the grounded lead 209 over a path which includes the contacts 253, 243, 236 and 205. At its contacts 251, the relay R250 opens a point in the operating circuit for the storage relay R230. At its contacts 252, the relay R250 completes the operating circuit for the slow-acting timing relay R260, this circuit extending from the grounded A. T. B. lead 209 by way of the contacts 205, 236 and 252, and the winding of R260 to battery.

The timing relay R260, upon operating, closes

its contacts 262 to prepare the operating circuit for the storage relay R230. At its contacts 263, the relay R260 opens the operating circuit for the timing relay R240. When the latter relay is de-energized, its weighted armature 242 is released and starts to vibrate so that the contacts 241 and 243 are alternately closed. Each time either of the two sets of contacts 241 and 243 is engaged, a current pulse is transmitted through the winding of the timing relay R250. This relay is slugged so that it remains operated so long as it is periodically energized. After a predetermined time interval elapses, the amplitude of vibration of the armature 242 is decreased by an amount such that the contacts 241 and 243 are no longer closed thereby. At the end of this interval, the relay R250 is deenergized and restores to perform the functions described below.

During the time interval measured by the operation of the three timing relays R240, R250 and R260, in the manner explained above, the call as routed to the C. L. R. trunk circuit 25 is extended to the No. 1 position of the toll operator switchboard. More specifically, if this position has been allotted by the distributor 21 to handle the call, and the talk key of the link 18 has been operated to set this link up for use in handling the call, the application of ground potential to the distributor start lead 265 serves automatically to initiate the operation of the finder 19 to search for the trunk 32 extending to the trunk circuit 25. Thus when this start lead is connected to ground, the start relay of the distributor 21 operates to impress ground potential upon the start lead of the position circuit 16. The position circuit start lead is connected through the contacts of the talk key in the link 18 to the start relay of this link. This relay, when energized over the position start circuit, functions to initiate vertical movement of the wipers of the finder 19. In this regard, it is noted the vertical position of the trunk 32 in the banks of the position link finders is marked by the application of ground potential to start lead 265, this lead being connected to a level marking contact in the contact banks of each finder. When this level, as marked in the banks of the finder 19, is found, vertical movement of the finder wipers is arrested and rotary movement of these wipers is automatically initiated. Such rotary movement of the finder wipers continues until the trunk 32 is found, the rotary position of the trunk 32 in the selected contact level being marked by the application of negative battery potential to the test conductor 32d over a path which includes the upper winding of the cut-off relay R210, the contacts 203 and 222 in parallel, and the contacts 231. When this trunk is found the cut-off relay R210 is energized in series with the switching relay of the finder 19. Incident to the operation of the latter relay, the rotary movement of the finder wipers is arrested and a talking circuit is set up over the talking leads of the trunk 32, the talking wipers of the finder 19, and the conductors 823 and 824 of the operator position circuit to connect the operator headset 815 with the telephone instrument provided at the calling substation A.

When energized in series with the switching relay of the finder 19, the cut-off relay R210 closes its contacts 211 to prepare a holding circuit for itself. At its contacts 212, the relay R210 prepares a locking circuit for the switching relay R270. At its contacts 213, the relay R210 completes a locking circuit for the hold relay R220, this circuit extending from the grounded

test wiper 14c of the toll selector 14 by way of the conductor 32c, the contacts 213 and 223, and the winding of R220 to battery. At its contacts 214, the relay R210 deenergizes the answer relay R200.

In releasing, the answer relay R200 opens its contacts 201 to interrupt the ring-back tone signaling circuit and thus terminate the ring-back signal being produced at the substation A. At its contacts 202, the relay R200 disconnects the distributor start lead 265 from ground, thereby to interrupt the level marking path described above and to deenergize the start relay of the position distributor 21 in the event no other toll calls are awaiting operator assistance for completion. At its contacts 203, the relay R200 opens a multiple point in the operating circuit for the cut-off relay R210. At its contacts 204, the relay R200 opens the operating circuit for the hold relay R220. At its contacts 205, the relay R200 opens a point in the common portion of the operating and locking circuits for the three timing relays R240, R250 and R260, causing any operated ones of these relays to restore. In the present case the release of the timing relays is without effect.

After the connection has been extended to the No. 1 position of the toll operator switchboard, the operator attending this position may converse with the calling subscriber to ascertain the destination of the call and may extend the connection to the desired exchange or substation, in the manner clearly explained in the previously cited Crocker patent. For example, the connection may be extended through the selector 20 and the toll switch train 17 to the line 15 serving the substation C, it being understood in this regard that a portion of the toll switch train 17 is located in an exchange distant from the central exchange in which the toll operator switchboard is provided. After the call is routed to its destination and answered at the called substation, the operator attending the No. 1 position of the switchboard may, by suitable key operations, disconnect the position circuit 16 from the link 18 occupied with the call and rely upon the supervisory signal lamps individual to the link 18 for the production of signals which will enable her to supervise the connection. In this regard it is pointed out in the Crocker patent referred to above that suitable provisions are made in the position circuit 16 and the links individual to the No. 1 position for enabling an operator attending this position to reenter a connection set up through any one of the links, to split a connection set up through any one of the links, or to monitor a connection set up through any one of the links. Provisions are also made in the position equipment for guarding each position against distribution when the position circuit thereof is operatively associated with any one of the links individual thereto. Thus, so long as the illustrated position circuit is occupied with the call under consideration it is marked as busy in the position distributor 21. When, however, the connection is established between the calling substation A and the desired substation, such, for example, as the substation C, and the operator attending the No. 1 position disconnects her position circuit from the link 18, the No. 1 position is marked as idle in the position distributor 21 and is thus rendered available for use in handling other calls. It is further pointed out that immediately the call is extended to the No. 1 position in the manner explained above, the po-

sition distributor 21 operates automatically to select for use another of the available operator positions that is marked as idle in the distributing equipment.

Further to consider the call as extended from the substation A to the No. 1 position of the toll operator switchboard, it is noted that the operator handling the call at this position does not release the link 18 through which the call is forwarded to its destination until call and answer disconnect signals are produced by appropriate control of the call and answer supervisory lamps individual to this link. In this regard it will be understood that when the called subscriber at the substation C, for example, releases the connection, an on-hook supervisory signal is produced by the supervisory lamp individual to the called end of the connection. Similarly, when the calling subscriber at the substation A disconnects, an on-hook supervisory signal is produced by the supervisory lamp of the link 18 which is individual to the calling end of the connection. More specifically, when the calling subscriber at the substation A disconnects, the toll selector 14, the first selector 11, and the line switch 9 are released in the order named and in a manner well understood in the art. Incident to the release of the toll selector 14, the test wiper 14c thereof is disconnected from ground to deenergize the hold relay R220. In restoring, the relay R220 opens its contacts 223 further to interrupt its own locking circuit and, at its contacts 224, connects the test conductor 32c to ground, thereby to maintain the trunk circuit 25 marked as busy in the banks of the toll selectors to which it is accessible. At its contacts 222, the relay R220 opens the circuit for directly energizing the upper winding of the cut-off relay R210 in series with the marginal supervisory relay provided in the link 18. After these contacts are opened, the two windings of the cut-off relay R210 are connected in series with the winding of the supervisory relay in the link 18 over a high resistance path which includes the contacts 211, the resistor 225, the contacts 231, and the test conductor 32d. The resistance of this circuit is such that the supervisory relay of the link 18 is released although the cut-off relay R210 is held in its operated position. When this supervisory relay restores, the usual on-hook supervisory signal is produced by the answer supervisory lamp provided in the link 18.

The operator, upon receiving the disconnect signals in the manner explained above, may reoperate the talk key of the link 18 in order to associate this link with her position circuit 16, and then actuate the answer and call release key of the position circuit in order to initiate the release of the link. The manner in which these operations are effected is clearly explained in the above-cited Crocker patent. Incident to the release of the link 18, the circuit for energizing the supervisory relay of the link in series with the two windings of the cut-off relay R210 is broken. When thus deenergized, the relay R210 restores and opens its contacts 213 to disconnect the test conductor 32c from ground. At its contacts 214, the relay R210 connects the test conductor 32c through the winding of the answer relay R200 to the negative terminal of the exchange battery, whereby the trunk circuit 25 is marked as idle in the bank contacts of the toll selectors. In releasing, the relay R210 also opens its contacts 211 further to interrupt the above-described high resistance holding circuit for it.

self. At its contacts 212, the relay R210 opens a point in the locking circuit for the switching relay R270. Following the release of the cut-off relay R210, the trunk circuit 25 is fully restored to normal and is conditioned for further use.

#### C. L. R. CALL STORAGE

As indicated in the above explanation, the cut-off relay R210 is operated to terminate the timing operation of the three relays R240, R250 and R260 in response to the operation of one of the position link finders to seize the trunk 32. This will obviously not occur if all of the active positions of the toll operator switchboard are occupied with calls at the time the above-described call originating at the substation A is extended to the trunk circuit 25. Accordingly, the timing operation of the three enumerated relays is permitted to continue, with the result that the call under consideration is placed in storage. More specifically, when the timing relay R250 restores, in the manner explained above, it opens its contacts 253 further to interrupt its own locking circuit and, at its contacts 252, to deenergize the timing relay R260. At its contacts 251, the relay R250 completes the prepared operating circuit for the storage relay R230, this circuit extending from the grounded A. T. B. lead 209 by way of the contacts 205, 236, 251 and 262, and the winding of R230 to battery. The release of the timing relay R260 shortly after the storage relay R230 operates is without effect.

In operating, the relay R230 first locks to ground through its preliminary make contacts 235 and the contacts 204. At its contacts 236, the relay R230 then opens its own operating circuit as well as the operating and locking circuits for the timing relays R240, R250 and R260. At its contacts 231, the relay R230 disconnects the test conductor 32d from the negative terminal of the exchange battery, and opens a point in the above-described path for marking the rotary position of the trunk 32 in the banks of the position link finders and a point in the operating circuit for the cut-off relay R210. At its contacts 232, the relay R230 disconnects the start lead 265 from ground. Following the two last-mentioned operations the trunk circuit 25 is no longer marked as a calling trunk circuit in the position distributor 21 and in the banks of the position link finders having access thereto. At its contacts 233, the relay R230 prepares the operating circuit for the switching relay R270. At its contacts 234, the relay R230 completes an obvious path for impressing ground potential upon the test conductor 38s, thereby to mark the trunk circuit 25 in the bank contacts of the trunk finder switches 400, 500, 600, etc. individual to the various storage circuits 28, 29, 30, etc. At its contacts 237, the relay R230 completes a circuit for energizing the start relay of the particular storage circuit which has been preselected for use in storing the call. In this regard it may be assumed that all of the storage circuits are idle, in which case the call as extended to the trunk circuit 25 will be stored in the first storage circuit 28. Thus when the storage relay R230 operates, the slow-to-operate start relay R420 is energized in a circuit which extends from ground by way of the contacts 237 and 277, the start lead 214 common to the several C. L. R. trunk circuits, the contacts 436 and 456, and the winding of R420 to battery.

In operating, the start relay R420 closes its contacts 422 to prepare a circuit for energizing

the upper winding of the step relay R425 in series with the upper winding of the test relay R430. At its contacts 423, the relay R420 opens a point in the common portion of the circuit over which the start relays of the second and succeeding storage circuits may be operated, thereby to prevent a later initialed C. L. R. call from being routed to storage before the call under consideration is fully extended to the storage circuit 28. At its contacts 421, the relay R420 completes the prepared operating circuit for the stepping magnet 411 of the trunk finder switch 400, this circuit extending from ground by way of the contacts 432, 426 and 421, the conductor 41m, and the winding of the magnet 411 to battery. When thus energized, the magnet 411 closes its contacts 412 to complete a circuit over the conductor 41d for energizing the lower winding of the step relay R425. This relay, in operating, opens its contacts 426 to deenergize the magnet 411. In releasing, the magnet 411 advances the wipers 406, 407, 408, 409 and 410 one step and opens the contacts 412 to deenergize the step relay R425. In restoring, the relay R425 closes its contacts 426 to again energize the magnet 411. The inter-related operation of the magnet 411 and the step relay R425 continues until the wipers of the trunk finder switch are positioned on the contacts terminating the conductors of the trunk 38 extending to the trunk circuit 25. At this time, a circuit is completed for energizing the series-connected upper windings of the step relay R425 and the test relay R430. This circuit extends from ground by way of the contacts 234 and 276, the test lead 38s, the wiper 410, the conductor 41s, the contacts 422, the upper winding of R425, and the upper winding of R430 to battery. When its upper winding is thus energized the relay R425 is prevented from releasing to recomplete the operating circuit for the stepping magnet 411. Thus the step by step operation of the trunk finder switch 400 is arrested with the wipers of this switch standing on the contacts terminating the conductors of the trunk 38.

The test relay R430 also operates when its upper winding is energized in the above-traced test circuit. In operating, this relay opens its contacts 432 further to interrupt the operating circuit for the stepping magnet 411, and closes its contacts 433 to prepare a circuit for energizing the start relay R700 of the common equipment 31. At its contacts 434, the relay R430 completes a locking circuit for itself, this circuit extending from ground by way of the contacts 724, 484, 467 and 434, and the lower winding of R430 to battery. At its contacts 431, the relay R430 completes a circuit for energizing the switching relay R270 in series with the marking relay R460, this circuit extending from ground by way of the contacts 233, the winding of R270, the conductor 38h, the wiper 409, the conductor 41h, the contacts 431 and 451, and the winding of R460 to battery. At its contacts 436, the relay R430 interrupts the above-traced operating circuit for the start relay R420. At its contacts 435, the relay R430 prepares the operating circuit for the start relay R520 of the next succeeding storage circuit 29. At its contacts 437, the relay R430 completes a circuit for energizing the signal lamp 820 individual to the storage circuit 28 and provided at the No. 1 position of the toll operator switchboard, and parallel circuits for energizing the corresponding signal lamps as provided at the other positions of the switchboard. This circuit

extends from ground by way of the contacts 437, the conductor 427 and the parallel-connected filaments of the several signal lamps to battery. The energization of these lamps serves to inform the operators in attendance at the toll operator switchboard that a C. L. R. call has been stored in the first storage circuit 28 which should be acknowledged.

The marking relay R460 operates when energized in series with the switching relay R270 in the manner explained above. Upon operating, the relay R460 closes its contacts 462 to complete an obvious holding circuit for itself. At its contacts 463, the relay R460 opens a point in the circuit for energizing the lower winding of the cut-off relay R440. At its contacts 465, the relay R460 opens a point in available circuits for energizing the relays R430, R440 and R450. At its contacts 464, the relay R460 completes an obvious circuit for energizing the control relay R470. At its contacts 466 and 467, the relay R460 first closes an obvious alternative locking circuit for the test relay R430 and then opens the locking circuit for this relay as initially completed through the contacts 724 of the reset slave relay R720. At its contacts 468, the relay R460 prepares a circuit for energizing the answered signal lamps 819 as individually provided at the different positions of the toll operator switchboard, and completes a circuit for energizing the parallel-connected unanswered signal lamps 818 as provided at the different positions of the switchboard. The latter circuit extends from ground by way of the contacts 468 and 458, the signal lead 498 and the parallel-connected filaments of the unanswered signal lamps 818 to the negative terminal of the exchange battery. At its contacts 461, the relay R460 connects the test conductor 35c of the trunk 35 to the negative terminal of the exchange battery over a path which includes the contacts 461, 445 and 493, and the upper winding of the cut-off relay R440. Completion of this path serves to mark the rotary position of the storage trunk 35 in the bank contacts of the position link finders and to prepare a circuit for energizing the cut-off relay R440.

The control relay R470, upon operating, closes its contacts 473 to prepare the above-mentioned circuit for energizing the lower winding of the cut-off relay R440. At its contacts 472, the relay R470 completes the prepared operating circuit for the start relay R700, this circuit extending from ground by way of the contacts 433, 446, 472 and 494, and the winding of R700 to battery. At its contacts 474, the relay R470 prepares circuits for energizing the relays R430, R440 and R450. At its contacts 475, the relay R470 disconnects the A. T. B. lead 209 from ground in the first storage circuit 28, thereby to open one of the multiple paths over which the storage and timing relays of the various C. L. R. trunk circuits 25, 26, 27, etc., may be energized. At its contacts 471, the relay R470 completes a circuit for transmitting ringing current over the calling end of the connection in order to continue the ring-back tone signal being reproduced by the receiver of the telephone instrument provided at the calling substation. The circuit traversed by the ringing current following the operation of the relay R470 and the switching relay R270 of the trunk circuit 25 may be partially traced as extending from the high potential terminal of the exchange ringing current source by way of the condenser 496, the contacts 481, 75

471 and 441, the talking conductor 41b, the wiper 407, the talking conductor 33b, and the contacts 273 to the positive side of the talking circuit as established between the trunk circuit 25 and the toll selector 14. From this conductor the ringing current is further transmitted through the first selector 11 and the line switch 9 to the conductors of the line 7 and over these conductors to energize the receiver provided at the calling substation.

As indicated above, the switching relay R270 is energized in series with the marking relay R460 incident to the operation of the test relay R430. In operating, the switching relay R270 closes its contacts 275 to prepare a locking circuit for itself. At its contacts 276, the relay R270 opens the above-traced circuit for energizing the series-connected upper winding of the step relay R425 and the test relay R430, causing the first of these relays to restore. At its contacts 277, the relay R275 disconnects the start lead 214 from ground, thereby to prevent the start relay, such, for example, as the relay R520, of a succeeding storage circuit from being operated. At its contacts 271 and 273, the relay R270 connects the talking conductors 32b and 32a to the talking conductors 41b and 41a over paths which respectively include the trunk conductors 33b and 33a and the wipers 407 and 406. At its contacts 272, the relay R270 opens the initially completed circuit for transmitting ringing current over the calling end of the connection to produce the usual ring-back tone signal at the calling substation. At its contacts 274, the relay R270 prepares an alternative operating circuit for the cut-off relay R210.

As pointed out above, the start relay R420 is deenergized incident to the operation of the test relay R430 and in response to the operation of the trunk finder switch 400 to select the trunk 38 extending to the trunk circuit 25. The step relay R425 is deenergized in response to the operation of the switching relay R270 immediately the storage circuit 28 is seized. The relay R420, upon restoring, opens its contacts 421 further to interrupt the operating circuit for the stepping magnet 411 and, at its contacts 422, interrupts the circuit for energizing the series-connected upper windings of the step relay R425 and the test relay R430. At its contacts 423, the relay R420 further prepares the operating circuit for the start relay R520, of the next succeeding storage circuit. In this regard it may be noted that normally the switching relay R270 will be operated to open the start circuit at its contacts 277 before the start relay R420 is released to extend the start circuit to the next succeeding storage circuit. In any event, the period during which the start circuit as extended to the next succeeding storage circuit is completed through the contacts 237, 277, 435 and 423, will be insufficient to cause the operation of the start relay in the succeeding storage circuit. The release of the step relay R425 is without effect.

It is also pointed out above that when the control relay R470 operates, a circuit is completed for energizing the start relay R700 of the common equipment 31. The latter relay, upon operating, opens its contacts 702 to interrupt the incomplete but available circuit for energizing the slow-to-operate reset relay R710. At its contacts 701, the relay R700 connects the start lead 725 to ground, thereby to mark the vertical level of bank contacts of the position link finder in which the storage trunks 35, 36, 37, etc., of the

various trunk circuits are terminated, and also to provide a circuit for energizing the start relay in the position distributor 21. It is noted in this regard that the storage trunks are terminated in a level of the position link finder banks which is lower than the levels used to terminate the regular C. L. R. trunks 32, 33, 34, etc., whereby any finder, during its vertical searching operation, will find the storage trunk level before it reaches the regular trunk levels. By virtue of this arrangement, the stored C. L. R. calls are given preference over later initiated C. L. R. calls in the handling of the calls at the operator switchboard.

#### *Release from storage before acknowledgment*

From the above explanation it will be understood that with the marking relay R460 of the storage circuit 28 and the start relay R700 of the common equipment 31 operated, the trunk 35 is marked as a calling trunk both in the bank contacts of the position link finders and in the position distributor 21. Accordingly, if one of the positions of the toll operator switchboard becomes idle before the stored call is acknowledged at this switchboard, the position is selected by the distributor 21 to handle the stored call and the finder portion of the link set up for use by the operator attending this position is operated to search for the trunk 35 in the manner previously explained. Assuming that the illustrated No. 1 position is selected to handle the call, and further that the link 18 is set up for use by the operator in attendance at this position, the cut-off relay R440 is energized in series with the switching relay of the finder 19 when the wipers of this finder are positioned to engage the bank contacts at which the conductors of the trunk 35 are terminated. More specifically, the operating circuit for the cut-off relay R440 extends from ground through the operating winding of the switching relay in the link finder 19 by way of the test wiper of the finder 19, the test conductor 35c of the trunk 35, the contacts 461, 445 and 493, and the upper winding of R440 to battery. When thus energized, the switching relay of the finder 19 operates to prepare a talking circuit including the trunk conductors 35a and 35b which is extended to the operator headset 815 in the operator position circuit 16.

The cut-off relay R440 also operates when energized in the above-described test circuit, and in so doing first closes its preliminary make contacts 447 to complete a locking circuit for itself which includes its lower winding and the contacts 466. At its contacts 446, the relay R440 deenergizes the start relay R700 of the common equipment 31. At its contacts 447', the relay R440 prepares alternative locking circuits for itself and the test relay R430. At its contacts 448, the relay R440 prepares one point in an available chain path for impressing ground potential upon the A. T. B. lead 209. At its contacts 449, the relay R440 opens a point in the circuit for energizing the answered signal lamps as provided at the different positions of the toll operator switchboard. At its contacts 444, the relay R440 completes a circuit for energizing the upper winding of the cut-off relay R210 in series with the operating winding of the supervisory relay provided in the link 18, this circuit extending from ground through the operating winding of the supervisory relay by way of the test wiper of the finder 19, the test conductor 35c of the trunk 35, the contacts 461 and 444, the conductor 41c, the wiper 408, the

conductor 38c, the contacts 274, the parallel-connected contacts 203 and 222, and the upper winding of R210 to battery. After this circuit is completed, the relay R440 opens its contacts 445 to interrupt the previously traced circuits for energizing its upper winding first in series with the operating winding of the switching relay in the link finder 19 and thereafter in series with the operating winding of the supervisory relay provided in this link finder. At its contacts 442 and 443, the relay R440 connects the talking conductors 35b and 35a of the trunk 35 to the talking conductors 41b and 41a of the trunk 41, thereby to complete a talking circuit between the calling substation and the operator headset 815. At its contacts 441, the relay R440 interrupts the previously described circuit for transmitting ringing current over the calling end of the connection, whereby the ring-back signal being reproduced at the calling substation is terminated. At its contacts 447', the relay R440 also completes a circuit for energizing the lockout relay R450, this circuit extending from ground by way of the contacts 466 and 447' and the series-connected windings of the relay R450 to battery.

When thus energized, the relay R450 locks to ground through its preliminary make contacts 452 and the contacts 466. At its contacts 453, the relay R450 opens a point in the circuit for energizing its lower winding in series with the resistor 438. At its contacts 454, the relay R450 opens another point in the path for impressing ground potential upon the A. T. B. lead in the storage circuit 28. At its contacts 454', the relay R450 further prepares the above-mentioned chain path for impressing ground potential upon this lead. At its contacts 455, the relay R450 prepares an alternative path for extending the storage start circuit to the next succeeding storage circuit. At its contacts 456, the relay R450 opens another point in the operating circuit for the start relay R420. At its contacts 457', the relay R450 opens a point in the operating circuit for the answer relay R490. At its contacts 457, the relay R450 prepares the operating circuit for the answer relay R590 of the next succeeding storage circuit 29. At its contacts 458, the relay R450 prepares a circuit for energizing the answered signal lamps 819 as provided at each of the positions of the toll operator switchboard. At its contacts 458', the relay R450 opens another point in the previously traced circuit for energizing the unanswered signal lamp 818 as provided at each of the positions of the toll operator switchboard. At its contacts 459, the relay R450 completes an obvious multiple circuit for energizing the signal lamp 820 as provided at each of the positions of the toll operator switchboard. At its contacts 451, the relay R450 opens a point in the previously traced operating circuit for the marking relay R460.

As indicated above, when the cut-off relay R440 of the storage circuit 28 operates, the upper winding of the cut-off relay R210 in the trunk circuit 25 is energized in series with the operating winding of the supervisory relay provided in the link 18. When thus energized, the relay R210 closes its contacts 212 to complete an obvious locking circuit for the switching relay R270 and, at its contacts 211, prepares the previously described high resistance holding circuit for itself. At its contacts 213 and 214, the relay R210 completes obvious multiple holding circuits for the hold relay R220 and the storage relay R230, and then opens the operating circuit for the answer relay R200. The latter relay, upon restoring, opens

its contacts 205 to interrupt the operating and locking circuits for the three timing relays R240, R250 and R260, as well as the operating circuit for the storage relay R230. At its contacts 204, the relay R200 opens the operating circuit for the hold relay R220. At its contacts 203, the relay R200 opens a multiple branch of the circuit for energizing the upper winding of the cut-off relay R210 in series with the operating winding of the supervisory relay in the link 18. At its contacts 202, the relay R200 opens another point in the path for impressing ground potential upon the start lead 265. At its contacts 201, the relay R200 opens another point in the previously described ring-back tone signaling circuit. Following the relay operations just described, the call is fully extended to the No. 1 position of the toll operator switchboard and the operator handling the call at this position may route it to its destination in a manner which will be clearly apparent from the foregoing description. It will be noted that after the call is extended to the toll operator switchboard, all four relays R210, R220, R230 and R270 are operated in the trunk circuit 25 while the relays R430, R440, R450, R460 and R470 are operated in the storage circuit 28.

*Acknowledging the stored call before it is routed to the switchboard*

The operator attending the No. 1 position of the switchboard, upon observing that the lamps 818 and 820 have been energized, is informed that a C. L. R. call has been extended to the storage circuit 28, which should be acknowledged. Similar indications are provided at each of the other positions of the switchboard. In order to acknowledge the call without releasing it from storage, the operator attending the No. 1 position of the switchboard may actuate the answer key 800 to its off-normal position, thereby to complete a circuit through the contacts 801 for energizing the answer relay R810. At the contacts 805, an obvious circuit is also completed for energizing the answer busy lamp 816 as provided at each of the positions of the switchboard. At its contacts 802 and 803, the relay R800 prepares a circuit for bridging the terminals of the operator headset 815 across the talking conductors 41a and 41b of the trunk 41. This circuit is further prepared at the contacts 811 and 813 of the answer relay R810 when this relay operates. In operating, the relay R810 also opens its contacts 812 and 814 to disconnect the operator headset from the talking conductors 823 and 824 of the operator position circuit 16. At the key contacts 804, an obvious circuit is completed for energizing the answer relay R730 of the common equipment 31. This relay, in operating, closes its contacts 731 to prepare circuits for energizing the lockout relays R450, R550, etc., individual to the storage circuits. At its contacts 732, the relay R730 completes the prepared operating circuit for the answer relay R490 of the storage circuit 28, this circuit extending from ground by way of the contacts 464, the winding of R490, the contacts 457' and 732, and the resistor 733 to battery. When thus energized the relay R490 opens its contacts 494 to deenergize the start relay R700 of the common equipment 31. The latter relay, upon restoring, closes its contacts 702 to reprepare the operating circuit for the reset relay R710. At its contacts 701, the relay R700 disconnects the start lead 725 from ground, whereby the storage circuits are no longer marked as having calls stored therein in the position distributor 21 and

the level marking contacts of the various position link finders.

The relay R490, upon operating, also opens its contacts 493, thereby to disconnect the test conductor 35c of the trunk 35 from the negative terminal of the exchange battery. Thus the path over which the rotary position of the trunk 35 is marked in the banks of the position link finders, is broken. At its contacts 495, the relay R490 completes a circuit through the contacts 466 for energizing the answer control relay R480.

In operating, the relay R480 closes its contacts 482 to complete obvious holding circuits for the answer relay R490 and the control relay R470. At its contacts 481, the relay R480 opens the previously described ring-back tone signaling circuit, thereby to terminate the ring-back tone signal as reproduced by the receiver of the telephone instrument at the calling substation A. At its contacts 483, the relay R480 prepares multiple locking circuits for the relays R430, R440 and R450. At its contacts 484, the relay R480 opens another point in the initially completed locking circuit for the cut-off relay R440.

The relay R490, in operating, also closes its contacts 497 to complete the above-mentioned circuit for energizing the two windings of the lockout relay R450, this circuit extending from ground by way of the contacts 731 to the contacts 497 where it divides, one branch extending through the upper winding of R450 to battery and the other branch extending through the lower winding of R450, the contacts 453 and the resistor 438 to battery. The relay R450 does not operate when its two windings are thus differentially energized. It is noted, however, that due to the presence of the resistor 438 in the circuit for energizing the lower winding of this relay, the upper winding of the relay is somewhat more strongly energized than the lower winding thereof. At its contacts 491 and 492, the relay R490 bridges the operator headset 815 across the talking conductors 41b and 41a of the trunk 41 over a path which includes the condensers 734 and 735 as well as the contacts 802, 803, 811 and 813. When this bridging path is completed a talking circuit is set up between the substation A and the operator headset 815, over which the operator attending the No. 1 position of the switchboard may converse with the calling subscriber and inform this subscriber that the handling of the call at the toll operator switchboard must be delayed for a short interval. After transmitting this information to the calling subscriber the operator may immediately release the talking circuit set up through the storage circuit 28 to the substation A by restoring the answer key 800 to normal. When the key 800 is restored to normal the contacts 801 thereof are opened to deenergize the answer relay R810 and the contacts 802 and 803 thereof are opened to interrupt the talking circuit as established between the operator headset 815 and the calling substation. At the contacts 805, the circuit for energizing the answer busy lamp 816 as provided at each of the several positions of the switchboard, is opened. At the contacts 804, the operating circuit for the answer relay R730 is interrupted.

In releasing, the relay R730 opens its contacts 732 to deenergize the answer relay R490 of the storage circuit 28. At its contacts 731, the relay R730 interrupts the above-traced circuit for energizing the two windings of the lockout relay R450 in opposition. When this circuit is broken,

the inductive kick produced in the upper winding of the relay R450 reverses the direction of current flow through the lower winding thereof and momentarily builds up a magnetic field of sufficient strength to cause the relay to close its preliminary make contacts 452. When this occurs, the two windings of the relay R450 are energized in series aiding relationship over a circuit which extends to ground through the contacts 466. When the latter circuit is completed the relay R450 completes its operation to perform the functions described above.

The relay R490, upon restoring in response to the release of the answer relay R730, opens its contacts 495 to deenergize the answer control relay R480. At its contacts 494, the relay R490 recompletes the operating circuit for the start relay R700 of the common equipment 31. At its contacts 493, the relay R490 recompletes the previously traced path for impressing negative battery potential upon the test conductor 35c for the purpose of marking the rotary position of the trunk 35 in the banks of the position link finders. At its contacts 491 and 492, the relay R490 opens two additional points in the previously traced talking circuit set up between the operator headset 815 and the calling substation A. At its contacts 497, the relay R490 opens another point in the circuit for energizing the two windings of the lockout relay R450 in opposition. The answer control relay R480, upon restoring, closes its contacts 481 to recomplete the ring-back tone signaling circuit, opens its contacts 482 further to interrupt the multiple circuits for energizing the relays R470 and R490, and opens its contacts 483 to interrupt the prepared locking circuits for the three relays R430, R440 and R450. At its contacts 484, the relay R480 re-prepares the initially traced locking circuit for the cut-off relay R440.

The start relay R700 of the common equipment 31, upon reoperating, closes its contacts 701 to again mark the vertical position of the storage trunks 35, 36, 37, etc. in the banks of the position link finders and to again mark the various storage circuits as being occupied with calls in the position distributor 21. At its contacts 702, the relay R700 opens the operating circuit for the reset relay R710.

*Routing the stored call to the switchboard after it has been acknowledged*

After the call has been acknowledged by the operator attending the No. 1 position of the switchboard in the manner just explained, and when one of the positions of this switchboard becomes idle for call assignment by the position distributor 21, the call as stored in the storage circuit 28 may be released from storage and extended through one of the position links to the operator position circuit of the assigned position in the exact manner explained above with reference to the release of a call from storage before it is acknowledged. In the present case, however, the lockout relay R450 occupies its operated position before the call is released from storage. The fact that this relay is operated does not, however, alter in any way the manner in which a connection is extended over the trunk 35 to the toll operator switchboard when a position of this switchboard is selected to handle the call by the distributor 21.

*The call is abandoned*

If the calling party abandons the call while it is being held in the storage circuit 28, the trunk circuit 25 occupied with the call is released but

the storage circuit 28 is held out of service until reallocated for use under the control of the common equipment 31. More specifically, when the calling party disconnects, the toll selector 14, the first selector 11, and the line switch 9 are released in the exact manner explained above. Incident to the release of the toll selector 14, the private wiper 14c thereof is disconnected from ground to deenergize the answer relay R200. Upon restoring, the relay R200 opens its contacts 201 further to interrupt the initially completed ring-back tone signaling circuit. At its contacts 202, the relay R200 opens another point in the path for impressing ground potential upon the start lead 265. At its contacts 203, the relay R200 opens one of the multiple operating circuits for the cut-off relay R210. At its contacts 205, the relay R200 opens another point in the common portion of the operating and locking circuits for the three timing relays R240, R250 and R260. At its contacts 204, the relay R200 deenergizes the hold relay R220 and the storage relay R230. In releasing, the relay R220 closes its contacts 221 to again bridge the terminating impedance comprising the resistor 206 and the condenser 207 across the talking conductors 32a and 32b of the trunk 32. At its contacts 222, the relay R220 opens the multiple branch of the operating circuit for the cut-off relay R210. At its contacts 223, the relay R220 opens a point in its own locking circuit. At its contacts 224, the relay R220 prepares the previously described path for impressing ground potential upon the test conductor 32c.

The storage relay R230, upon restoring, opens its contacts 233 to deenergize the series-connected relays R270 and R460, causing both of these relays to restore. At its contacts 232, the relay R230 reprepares the path for impressing ground potential upon the start lead 265. At its contacts 231, the relay R230 reprepares the path for impressing negative battery potential upon the test conductor 32d. At its contacts 234, the relay R230 opens another point in the path for impressing ground potential on the test conductor 38s. At its contacts 235, the relay R230 opens another point in its own locking circuit. At its contacts 236, the relay R230 reprepares the operating and locking circuits for the three timing relays R240, R250 and R260. At its contacts 237, the relay R230 opens another point in the path for impressing ground potential upon the start lead 214 in the trunk circuit 25.

The relay R270, in releasing, closes its contacts 271 to reprepare the path for impressing ground potential upon the start lead 214 in the trunk circuit 25, and closes its contacts 276 to reprepare the path for connecting the test conductor 38s to ground. At its contacts 275, the relay R270 opens a point in its own locking circuit. At its contacts 274, the relay R270 opens a point in one of the previously traced operating circuits for the cut-off relay R210. At its contacts 271 and 273, the relay R270 disconnects the talking conductors 38a and 38b of the trunk 38 from the corresponding talking conductors of the trunk 32. At its contacts 272, the relay R270 reprepares the ring-back tone signaling circuit as provided in the trunk circuit 25.

When the marking relay R460 is deenergized in response to the release of the storage relay R230, it opens its contacts 462 further to interrupt its own locking circuit. At its contacts 461, the relay R460 disconnects the test conductor 35c from the negative terminal of the exchange battery.

At its contacts 463, the relay R460 completes an obvious circuit for energizing the cut-off relay R440, which circuit extends to ground through the contacts 473. At its contacts 464, the relay R460 deenergizes the control relay R470. At its contacts 465, the relay R460 completes another locking circuit for the relay R450. At its contacts 467, the relay R460 completes an additional set of locking circuits for the relays R430 and R450, which circuits commonly extend to ground over a path including the contacts 484 and 723. After completing the latter circuits, the relay R460 opens its contacts 466 to interrupt the local locking circuits for the relays R430 and R450. At its contacts 468, the relay R460 opens a point in the common portion of the circuits for energizing the answered and unanswered signal lamps as provided at the toll operator switchboard.

The cut-off relay R440, upon operating, locks to ground through its preliminary make contacts 447 and the contacts 467, 484 and 723. It also locks to ground over a path including the contacts 447, 447', 474 and 465. At its contacts 447', it completes an obvious multiple holding circuit for the relay R430. At its contacts 448, the relay R440 closes a point in the chain path for impressing ground potential upon the A. T. B. lead 209. At its contacts 446, the relay R440 opens the operating circuit for the start relay R700. The remaining circuit switching operations performed by the relay R440 are without effect.

The control relay R470, upon restoring, opens its contacts 473 and 474 to interrupt two sets of the circuits over which the three relays R430, R440 and R450 are energized, leaving these three relays locked up in circuits which commonly extend to ground through the contacts 723 of the reset slave relay R720. The three enumerated relays remain in their operated positions to prevent the storage circuit 28 from storing other C. L. R. calls until such time as the reset relays R710 and R720 are operated to reallocate the several storage circuits for further use.

In the event the storage circuit 28 is the only storage circuit occupied with a call, the start relay R700 is deenergized and restores in response to the operation of the relay R440. In releasing, the relay R700 closes its contacts 702 to reprepare the operating circuit for the reset relay R710. At its contacts 701, the relay R700 disconnects the start lead 725 from ground.

In the event the above-described call as stored in the storage circuit 28 is not extended to the toll operator switchboard or acknowledged by an operator attending one of the positions of this switchboard prior to the abandonment of the call at the substation A, the cut-off relay R440 and the lockout relay R450 are not operated in the storage circuit 28 at the time the calling subscriber disconnects. Under these circumstances, the relay R440 is energized through the contacts 463 and 473 and the relay R450 is energized in a circuit including the contacts 465 and 474, in response to the release of the marking relay R460. In operating, the relay R450 locks to ground through its preliminary make contacts 452 and the contacts 467, 484 and 723. The relay R440 locks to ground over the same path. Thus, regardless of whether or not the call as stored in the storage circuit 28 is abandoned before or after it is acknowledged at the toll operator switchboard, the three relays R430, R440 and R450 are locked in their respective operated positions after the trunk circuit 25 is released.

### *Releasing the equipment after the call is released from storage*

If the call as stored in the storage circuit 28 is released from storage and extended to the No. 1 position of the toll operator switchboard through the link 18, for example, and is then released at the calling substation, the trunk circuit 25 occupied with the call is released and the storage circuit 28 assumes its lockout setting. More specifically, when the calling party disconnects to cause the release of the switch train comprising the selectors 14 and 11 and the line switch 9, the test lead 32c is disconnected from ground in the selector 14 to cause the deenergization and release of the two relays R220 and R230. The relay R220, in restoring, opens its contacts 222 to give the operator handling the call disconnect supervision and, at its contacts 224, applies guarding ground potential to the test conductor 32c to guard the trunk circuit 25 against seizure. Following the release of the toll selector 14 the cut-off relay R210 and the switching relay R270 remain operated in the trunk circuit 25 until such time as the connection is released by the operator attending the No. 1 position of the switchboard. When this operator releases the link 18 occupied with the call in the manner previously described, the test conductor 35c is disconnected from ground in this link to cause the release of the cut-off relay R210 in the trunk circuit 25. Upon restoring, the relay R210 opens its contacts 212 to deenergize the switching relay R270 and the marking relay R460. At its contacts 213 and 214, the relay R210 disconnects the test conductor 32c from ground and connects this conductor to the negative terminal of the exchange battery, thereby to mark the trunk circuit 25 as idle in the banks of the toll selectors having access thereto. Following the release of the two relays R210 and R270, the trunk circuit 25 is fully restored to normal and is rendered available for handling other C. L. R. calls.

The marking relay R460, upon restoring, performs the functions described above in connection with the abandonment of a call before it is acknowledged at the toll operator switchboard. Following the release of this relay, the three relays R430, R440 and R450 are locked operated in the storage circuit 28 under the control of the reset slave relay R720 of the common equipment 31. Thus, the storage circuit 28 is prevented from receiving another call until such time as the two reset relays R710 and R720 have been operated to reallocate the idle storage circuits for further use.

### *Storing and acknowledging other C. L. R. calls*

From the preceding explanation it will be understood that immediately after the first storage circuit 28 operates to store the call originating at the substation A, the next succeeding storage circuit 29 is conditioned to store another C. L. R. call extended to one of the C. L. R. trunk circuits 26, 27, etc. Thus, when the test relay R430 operates incident to the operation of the trunk finder switch 400 to seize the calling trunk circuit 25, it opens its contacts 436 to deenergize the start relay R420, and closes its contacts 435 to prepare the operating circuit for the start relay R520 of the next succeeding storage circuit 29. This circuit is further prepared at the contacts 423 incident to the release of the start relay R420 in the first storage circuit. It will be

understood, therefore, that if a second call is extended to the trunk circuit 26, for example, at a time when all of the positions of the toll operator switchboard are busy, it will be stored in the storage circuit 29. Thus, when the timing relays of the second trunk circuit 26 operate to connect the start lead 214 to ground, the start relay R520 of the second storage circuit 29 is energized in a circuit which includes the contacts 435, 423, 536 and 556. This relay, in operating, causes the trunk finder switch 500 included in the storage circuit 29 to operate and seize the storage trunk 39 extending to the trunk circuit 26 occupied with the call. The manner in which the second storage circuit 29 operates to handle the call is in all respects identical with that of the storage circuit 28 as described above. In this regard it will be noted that after the test relay R530 is operated and the start relay R520 has restored, the start circuit including the conductor 214 is extended to the start relay of the third storage circuit, whereby the C. L. R. call next initiated at a time when all of the positions of the toll operator switchboard are busy is stored in the third storage circuit. More generally considered, the calls are stored in successive ones of the available storage circuits in the order of their initiation.

From the above explanation it will be understood that the storage circuits are used in succession to receive the calls requiring storage, regardless of whether such calls overlap. Thus, even if the above-described call as extended to the first storage circuit 28 is abandoned, either before or after acknowledgment, or is routed to the toll operator switchboard, forwarded to its destination and then released, the test relay R430 is held in its operated position under the control of the reset relays R710 and R720 as provided in the common equipment 31. Similarly, after a call is once stored in the second storage circuit 29, the test relay R530 remains in its operated position until such time as the two reset relays R710 and R720 are operated. This arrangement insures that the storage circuits will be used in rotation and, further, that overlapping C. L. R. calls will be stored therein in a predetermined order.

It is noted further that the storage trunks 35, 36, 37, etc., individual to the storage circuits are terminated in the bank contacts of the position link finders in such order that the stored calls will be released from storage in the same order that they are stored. Thus, the conductors of the first storage trunk 35 are terminated in the first set of contacts of the storage level in each of the position link finder banks, whereby the wipers of any one of the finders in searching for a storage trunk will encounter the contacts terminating the conductors of the trunk 35 before reaching the contacts terminating the conductors of the storage trunks extending to the intermediate and last storage circuits.

The arrangement of the equipment is also such that calls stored in the various storage circuits can only be acknowledged by the operators attending the toll operator switchboard in a predetermined order. In this regard it will be recalled that when the above-described call originating at the substation A is stored in the storage circuit 28, the lockout relay R450 is operated incident to the acknowledgment of the call at the toll operator switchboard. With this relay operated, the operating circuit for the answer relay R490 is held open at the contacts 457' and

the operating circuit for the answer relay R590 of the second storage circuit 29 is prepared at the contacts 457. Accordingly, if the answer relay R730 in the common equipment 31 is reoperated, the answer relay R590 is energized in a circuit which includes the answer lead 736, the contacts 457, 557' and 554. When the lockout relay R550 of the second storage circuit is subsequently operated in response to the release of the answer relay R730, it opens its contacts 557' to prevent subsequent energization of the answer relay R590, and closes its contacts 557 to extend the answer lead to the winding of the answer relay in the next succeeding storage circuit. Thus, it will be understood that the stored calls can only be acknowledged by the operators attending the toll operator switchboard in a predetermined order.

#### *Release of the storage circuits*

After each of the call storage circuits has received a call for storage and all such calls have either been abandoned or extended to the toll operator switchboard in the manner previously explained, all of the idle storage circuits are automatically released when the next C. L. R. call requiring storage is routed to one of the various trunk circuits. Thus, it will be noted that when the test relay R630 of the last storage circuit operates to release its associated start relay R620, the start circuit is extended through the contacts 635 and 623 to the contacts 702 of the start relay R700 in the common equipment 31, thereby to prepare the operating circuit for the slow-to-operate reset relay R710. It will also be noted that the operating circuit for the start relay R700 includes parallel branches individual to the various storage circuits, which branches respectively include the contacts 446, 546, 646, etc., of the cut-off relays individual to the storage circuits. Accordingly, so long as any stored call has not been abandoned and has not been extended to the toll operator switchboard through one of the position links associated with this switchboard, the start relay R700 is held operated over the branch of its operating circuit which is completed in the storage circuit occupied with the call that has not been released from storage. When, however, the last stored call is released from storage, the cut-off relay, such, for example, as the relay R640 of the storage circuit occupied with the call, is operated to deenergize the start relay R700. This relay, in releasing, closes its contacts 702 to prepare or complete the operating circuit for the reset relay R710. Thus, if one of the trunk circuits, such, for example, as the trunk circuit 25 is occupied with a call awaiting storage, the timing relays R240, R250 and R260 operate to measure a predetermined time interval, after which the storage relay R230 is energized, all in the manner previously explained. In the present case, the previously mentioned chain path for connecting the A. T. B. lead 209 to ground is utilized to provide circuits for energizing the four enumerated relays. More specifically, this path extends from the lead 209 by way of the chain-connected contacts 648, 548, 448, etc., controlled by the respective cut-off relays of the various storage circuits, to the conductor 485. From this point branch paths extend to ground in each of the storage circuits not occupied with a call. Thus, if the first storage circuit 28 occupies its lockout setting, the conductor 485 is connected to ground through the contacts 454' and 475. Similarly, if the second storage circuit 29 occupies its lockout setting,

the conductor 485 is connected to ground through the contacts 554' and 575. From a consideration of the described paths for impressing ground potential upon the A. T. B. lead 209, it will be understood that if all of the storage circuits are occupied with calls so that no further call storage facilities are available, the A. T. B. lead 209 is disconnected from ground at the contacts 475, 575, 675, etc., of the control relays respectively provided in the various storage circuits. If a call is extended to the trunk circuit 25, for example, during an interval when this condition prevails, no circuits are available for energizing the timing relays R240, R250 and R260 and, accordingly, the timing operations of these three relays are not initiated. When, however, one of the available storage circuits, such, for example, as the first storage circuit 28 is operated to its lockout setting at the conclusion of the call, the above-described path through the contacts 475 and 454' is completed for impressing ground potential upon the A. T. B. lead 209, thereby to provide the necessary circuits for initiating the operation of the timing relays R240, R250 and R260. At the conclusion of this timing operation the storage relay R230 is operated in the trunk circuit 25.

When the relay R230 operates under either of the two conditions described above, it closes the operating circuit for the reset relay R710, this circuit extending from ground by way of the contacts 237 and 277, the start lead 214, the contacts 435, 423, 535 and 523, the chain-connected contacts controlled by the start and test relays of the intermediate trunk circuits, the contacts 635, 623 and 702, and the winding of R710 to battery.

When thus energized the relay R710 operates after an interval to close its contacts 711 and thus complete an obvious circuit for energizing the reset slave relay R720. The latter relay, upon operating, opens its contacts 722, 723 and 724 to deenergize the operated relays in all of the storage circuits which are idle. Thus, if the first storage circuit 28 is idle but has had a call stored therein, the three relays R430, R440 and R450 are operated therein. When, however, the contacts 724 are opened, all three of these relays are deenergized and restore.

The test relay R430, upon restoring, closes its contact 432 to reprepare the operating circuit for the stepping magnet 411 of the trunk finder switch 400. At its contacts 431, the relay R430 opens a point in the operating circuit for the marking relay R460. At its contacts 433, the relay R430 opens another point in one of the branches of the operating circuit for the start relay R700 in the common equipment 31. As its contacts 434, the relay R430 opens a point in its own locking circuit. At its contacts 435, the relay R430 opens a point in the above-traced operating circuits for the start relays of the succeeding storage circuits and also a point in the operating circuit for the reset relay R710. At its contacts 436, the relay R430 reprepares the operating circuit for the start relay R420. At its contacts 437, the relay R430 opens one of the multiple circuits for energizing the signal lamp R820 of the No. 1 operator position and the corresponding lamps of the other positions in multiple.

The cut-off relay R440, upon restoring, closes its contacts 446 to reprepare one branch of the operating circuit for the start relay R700. At its contacts 444 and 445, the relay R440 opens an-

other point in the path for connecting the two test conductors 35c and 41c together and reprepares one of its own operating circuits. At its contacts 442 and 443, the relay R440 disconnects the talking conductors 35a and 35b of the trunk 35 from the talking conductors 41a and 41b of the trunk 41. At its contacts 441, the relay R440 reprepares the previously described ring-back tone signaling circuit. At its contacts 447, the relay R440 opens another point in its own locking circuit. At its contacts 447', the relay R440 opens a point in the previously described circuits for energizing itself, the lockout relay R450 and the test relay R430. At its contacts 448, the relay R440 opens a point in the above-described chain path for impressing ground potential upon the A. T. B. lead 209. At its contacts 449, the relay R440 reprepares the circuit for energizing the answered signal lamp 819 provided at the No. 1 operator position in parallel with the corresponding lamps respectively provided at the other positions of the switchboard.

The relay R450, upon restoring, closes its contacts 451 to reprepare the operating circuit for the marking relay R460. At its contacts 452, the relay R450 opens a point in its own locking circuit. At its contacts 453, the relay R450 prepares the previously traced circuit for energizing its lower winding in series with the resistor 438. At its contacts 454, the relay R450 connects the A. T. B. lead 209 to ground through the contacts 475. At its contacts 454', the relay R450 opens another point in the above-described chain path for impressing ground potential upon the A. T. B. lead 209. At its contacts 456, the relay R450 reprepares the operating circuit for the start relay R420. At its contacts 457', the relay R450 reprepares the operating circuit for the answer relay R490. At its contacts 458, the relay R450 opens a point in the circuit for energizing the answered signal lamps provided at the toll operator switchboard. At its contacts 458', the relay R450 reprepares the circuit for energizing the unanswered signal lamps provided at the toll operator switchboard. At its contacts 459, the relay R450 deenergizes the signal lamps 820 as provided at the different positions of the toll operator switchboard. Following the release of the three relays R430, R440 and R450 in the manner just explained, the storage circuit 28 is fully restored to normal and is thus rendered available for use in storing another call.

In a similar manner, all of the other storage circuits that are idle but have had calls stored therein which have either been abandoned or completed, are released. Thus, if the three relays R530, R540 and R550 of the second storage circuit 29 are operated, these relays are deenergized and restore in response to the opening of the contacts 723. On the other hand, if the second storage circuit 29, for example, is still occupied with a call at the time the reset relay R710 is operated, which call has been extended to the toll operator switchboard but has not been completed, the marking relay R560 is operated in this circuit. With this relay operated the four associated relays R530, R540, R550 and R570 are obviously energized independently of the break contacts controlled by the reset slave relay R720. Accordingly, the storage circuit is prevented from being prematurely released to interrupt the call in progress and is omitted from the redistribution of the storage circuits for further use.

The reset slave relay R720, upon operating, also opens its contacts 721 to insure that the start

lead 725 will not be connected to ground during the period when the idle storage circuits are being released. In this regard it will be noted that as the respective test relays R430, R530, etc., of the idle storage circuits restore, the operating circuit for the reset relay R710 is broken at a number of points. Moreover, as the cut-off relays R440, R540, etc., of the various storage circuits release, the various branches of the operating circuit for the start relay R700 are reprepared.

When the operating circuit for the reset relay R710 is broken at one or more points in response to the release of the test relay of the respective storage circuits, it restores and opens its contacts 711 to deenergize the reset slave relay R720. The latter relay, in releasing, closes its contacts 721 to reprepare the path for impressing ground potential upon the distributor start lead 725. At its contacts 722, 723 and 724, the relay R720 reprepares the previously described locking circuits for the test, cut-off and lockout relays respectively provided in the different storage circuits. Following the release of the reset slave relay R720, all of the idle storage circuits have been reallocated for further use. In this regard it will be understood that due to the chain circuit arrangement of the operating circuits for the respective start relays of the different storage circuits, these circuits can only be seized by the C. L. R. trunk circuits in a predetermined order. Moreover, by virtue of the chain circuit arrangement of the operating circuits for the respective answer relays of the reallocated storage circuits, calls stored in these circuits can only be acknowledged from the toll operator switchboard in a predetermined manner. It will also be noted that the two described chain circuit arrangements permit any of the storage circuits which were not released through operation of the two reset relays to be passed over in the storing and acknowledgment of calls. Thus, if the test and lockout relays of the second storage circuit 29, for example, are not released when the reset slave relay R720 operates, these relays cannot thereafter be released until the indicated reset slave relay is again operated. With the test relay R530 operated in this storage circuit, the contacts 535 and 523 are closed so that the chain start circuit is extended through this storage circuit to the next succeeding circuit. Moreover, with the lockout relay R550 operated therein, the circuit for energizing the answer relay R590 is held open at the contacts 557', and that for energizing the answer relay of the next succeeding storage circuit is prepared at the contacts 557. Thus, it will be understood that if the storage circuit 29, for example, is not released during the reallocation of the idle storage circuits in the manner just explained, it is held out of service until the two reset relays R710 and R720 are next operated.

While one embodiment of the invention has been disclosed, it will be understood that various modifications may be made therein which are within the true spirit and scope of the invention.

What is claimed is:

1. In a telephone system, an operator switchboard including facilities for answering incoming calls, a plurality of lines, answer switches associated with said switchboard and having access to said lines, means including said switches for routing calls from said lines to said switchboard to be answered, call storage means accessible to said switches and operative to store calls

originating on said lines during an interval when all of the call answering facilities of said switchboard are unavailable, and means including said switches for extending the stored calls from said call storage means to said switchboard to be answered as the call answering facilities of said switchboard become available.

2. In a telephone system, an operator switchboard including facilities for answering incoming calls, a plurality of lines, answer switches associated with said switchboard and having access to said lines, means including said answer switches for routing calls from said lines to said switchboard to be answered, call storage means accessible to said answer switches and operative to store in a predetermined order calls originating on said lines during an interval when all of the call answering facilities of said switchboard are unavailable, and means including said answer switches for extending the stored calls from said call storage means to said switchboard to be answered as the call answering facilities of said switchboard become available.

3. In a telephone system, an operator switchboard including facilities for answering incoming calls, a plurality of lines, answer switches associated with said switchboard and having access to said lines, means including said answer switches for routing calls from said lines to said switchboard to be answered, call storage means accessible to said answer switches and operative to store calls originating on said lines during an interval when all of the call answering facilities of said switchboard are unavailable, storage trunks connecting said storage means and the outlet contacts of said answer switches, and means for causing said answer switches to seize said storage trunks as the call answering facilities of said switchboard become available, thereby to extend the stored calls from said call storage means to said switchboard to be answered.

4. In a telephone system, an operator switchboard including facilities for answering incoming calls, a plurality of lines, answer switches associated with said switchboard and having access to said lines, means including said answer switches for routing calls from said lines to said switchboard to be answered, call storage means accessible to said answer switches and operative to store in a predetermined order calls originating on said lines during an interval when all of the call answering facilities of said switchboard are unavailable, storage trunks connecting said storage means and the outlet contacts of said answer switches, means for causing said answer switches to seize said storage trunks as the call answering facilities of said switchboard become available, thereby to extend the stored calls from said call storage means to said switchboard to be answered, and means for controlling said answer switches in their operation to seize said storage trunks so that said stored calls are extended to said switchboard to be answered in the same order as they are stored.

5. In a telephone system, an operator switchboard including facilities for answering incoming calls, a plurality of lines, answer switches associated with said switchboard and having access to said lines, means including said answer switches for routing calls from said lines to said switchboard to be answered, call storage means accessible to said answer switches, storage finders having access to said lines, means for controlling said storage finders to route calls from

said lines to said storage means during an interval when all of the call answering facilities of said switchboard are unavailable, and means including said answer switches for extending the stored calls from said call storage means to said switchboard to be answered as the call answering facilities of said switchboard become available.

6. In a telephone system, an operator switchboard including facilities for answering incoming calls, a plurality of lines, answer switches associated with said switchboard and having access to said lines, means including said answer switches for routing calls from said lines to said switchboard to be answered, call storage means accessible to said answer switches, storage trunks connecting said storage means and the outlet contacts of said answer switches, storage finders having access to said lines, means for controlling said storage finders to route calls from said lines to said storage means during an interval when all of the call answering facilities of said switchboard are unavailable, and means for causing said answer switches to seize said storage trunks as the call answering facilities of said switchboard become available, thereby to extend the stored calls from said call storage means to said switchboard to be answered.

7. In a telephone system, an operator switchboard including facilities for answering incoming calls, a plurality of trunk circuits, answer switches associated with said switchboard and having access to said trunk circuits, means including said answer switches for routing calls from said trunk circuits to said switchboard to be answered, call storage means accessible to said answer switches, means comprising timing devices individual to said trunk circuits for causing said storage means to store calls routed to said trunk circuits during an interval when all of the call answering facilities of said switchboard are busy, and means including said answer switches for extending the stored calls to said switchboard to be answered as the call answering facilities of said switchboard become idle.

8. In a telephone system, an operator switchboard including facilities for answering incoming calls, a plurality of trunk circuits, answer switches associated with said switchboard and having access to said trunk circuits, means including said answer switches for routing calls from said trunk circuits to said switchboard to be answered, call storage means accessible to said answer switches, storage finders having access to said trunk circuits, means comprising timing devices individual to said trunk circuits for controlling said storage finders to route calls from said trunk circuits to said storage means during an interval when all of the call answering facilities of said switchboard are busy, and means including said answer switches for extending the stored calls to said switchboard to be answered as the call answering facilities of said switchboard become idle.

9. In a telephone system, an operator switchboard including facilities for answering incoming calls, answer switches associated with said switchboard, a plurality of trunk circuits each including a trunk terminating in the outlet contacts of said answer switches, means in said trunk circuits for causing said answer switches to seize said trunks in the routing of calls from said trunk circuits to said switchboard to be answered, call storage means including storage trunks terminating in the outlet contacts of said

answer switches, storage switches having access to said trunk circuits, means comprising timing devices individual to said trunk circuits for controlling said storage switches to route calls from said trunk circuits to said storage means during an interval when all of the call answering facilities of said switchboard are busy, and means for causing said answer switches to seize said storage trunks as the call answering facilities of said switchboard become idle, thereby to extend the stored calls to said switchboard to be answered.

10. In a telephone system, an operator switchboard including facilities for answering incoming calls, a plurality of lines, answer switches associated with said operator switchboard and having access to said lines, means including said answer switches for routing calls from said lines to said switchboard to be answered, a plurality of call storage circuits each accessible to said answer switches and each operative to store a call originating on one of said lines during an interval when all of the call answering facilities of said switchboard are unavailable, means for controlling said storage circuits so that successive calls are stored in successive circuits, and means including said answer switches for routing the stored calls from said storage circuits to said switchboard as the call answering facilities of said switchboard become available.

11. In a telephone system, an operator switchboard including facilities for answering incoming calls, a plurality of lines, answer switches associated with said operator switchboard and having access to said lines, means including said answer switches for routing calls from said lines to said switchboard to be answered, a plurality of call storage circuits each accessible to said answer switches and each operative to store a call originating on one of said lines during an interval when all of the call answering facilities of said switchboard are unavailable, means for controlling said storage circuits so that successive calls are stored in successive circuits, and means for routing the stored calls from said storage circuits through said answer switches to said switchboard as the call answering facilities of said switchboard become available.

12. In a telephone system, an operator switchboard including facilities for answering incoming calls, a plurality of answer switches associated with said operator switchboard and having access to said lines, means including said answer switches for routing calls from said lines to said switchboard to be answered, call storage means accessible to said answer switches and operative to store calls originating on said lines during an interval when all of the call answering facilities of said switchboard are unavailable, and means including said answer switches for routing the stored calls from said lines through said storage means to said switchboard as the call answering facilities of said switchboard become available.

13. In a telephone system, an operator switchboard including facilities for answering incoming calls, a trunk circuit including a timing device operative in response to the initiation of a call on said line, means for routing a call to said trunk circuit, an answer switch associated with said switchboard and normally operative to seize said trunk circuit, thereby to extend the call to said switchboard, in response to the routing of said call to said trunk circuit, means responsive to the seizure of said trunk circuit by said answer switch for arresting the operation of said timing device, and means controlled by said tim-

ing device for storing the call in the event all of the call answering facilities of said switchboard are busy at the time the call is extended to said trunk circuit.

14. In a telephone system, an operator switchboard including facilities for answering incoming calls, a trunk circuit including a timing device operative in response to the initiation of a call on said line, means for routing a call to said trunk circuit, an answer switch associated with said switchboard and normally operative to seize said trunk circuit, thereby to extend the call to said switchboard, in response to the routing of said call to said trunk circuit, means responsive to the seizure of said trunk circuit by said answer switch for arresting the operation of said timing device, means for preventing said answer switch from operating in the event all of the call answering facilities of said switchboard are busy at the time the call is extended to said trunk circuit, and means responsive to the continued operation of said timing device for storing the call.

15. In a telephone system, an operator switchboard including facilities for answering incoming calls, a trunk circuit including a timing device operative in response to the initiation of a call on said line, means for routing a call to said trunk circuit, an answer switch associated with said switchboard and normally operative to seize said trunk circuit, thereby to extend the call to said switchboard, in response to the routing of said call to said trunk circuit, means responsive to the seizure of said trunk circuit by said answer switch for arresting the operation of said timing device, means for preventing said answer switch from operating in the event all of the call answering facilities of said switchboard are busy at the time the call is extended to said trunk circuit, a call storage circuit, means responsive to the continued operation of said timing device for routing the call to said storage circuit, and means for routing the call from said storage circuit to said switchboard when call answering facilities become idle at said switchboard.

16. In a telephone system, an operator switchboard including facilities for answering incoming calls, a trunk circuit including a timing device operative in response to the initiation of a call on said line, means for routing a call to said trunk circuit, an answer switch associated with said switchboard and normally operative to seize said trunk circuit, thereby to extend the call to said switchboard, in response to the routing of said call to said trunk circuit, means responsive to the seizure of said trunk circuit by said answer switch for arresting the operation of said timing device, means for preventing said answer switch from operating in the event all of the call answering facilities of said switchboard are busy at the time the call is extended to said trunk circuit, a call storage circuit accessible to said answer switch, means responsive to the continued operation of said timing device for routing the call to said storage circuit, and means for causing said answer switch to seize said storage circuit, thereby to route the call to said switchboard, when call answering facilities become idle at said switchboard.

17. In a telephone system, a trunk circuit including a timing device, a finder having access to said trunk circuit, means responsive to the routing of a call to said trunk circuit for initiating the operation of said timing device and for normally causing said finder to seize said

trunk circuit, and means controlled by said timing device for storing the call in the event said finder fails to seize said trunk circuit within a predetermined time interval after operation of said timing device is initiated.

18. In a telephone system, a trunk circuit including a timing device, a finder having access to said trunk circuit, means responsive to the routing of a call to said trunk circuit for initiating the operation of said timing device and for normally causing said finder to seize said trunk circuit, thereby to extend the call to the switching facilities which follow said finder, means responsive to the seizure of said trunk circuit by said finder for arresting the operation of said timing device, means for preventing said finder from seizing said trunk circuit in the event the switching facilities following said finder are all busy, and means responsive to the continued operation of said timing device for storing the call.

19. Call storage apparatus comprising a plurality of call storage circuits each operative to store a call, means for releasing said circuits as calls stored therein are completed or abandoned, and means for preventing any of the released storage circuits from storing additional calls until calls have been stored in a predetermined plurality of said circuits.

20. Call storage apparatus comprising a plurality of call storage circuits each operative to store a call, means for releasing said circuits as calls stored therein are completed or abandoned, and means for preventing any of the released storage circuits from storing additional calls until calls have been stored in all of said circuits.

21. Call storage apparatus comprising a plurality of call storage circuits each operative to store a call, each of said circuits having three different settings depending upon whether the circuit is occupied with a stored call, is idle, or has been released through the abandonment or completion of a call stored therein, means controlled in accordance with the settings of said circuits for causing those circuits having released settings to assume idle settings, and means for preventing the operation of said last-named means until calls have been stored in a predetermined plurality of said circuits.

22. Call storage apparatus comprising a plurality of call storage circuits each operative to store a call, each of said circuits having three different settings depending upon whether the circuit is occupied with a stored call, is idle, or has been released through the abandonment or completion of a call stored therein, means controlled in accordance with the settings of said circuits for causing those circuits having released settings to assume idle settings, and means for preventing the operation of said last-named means until calls have been stored in all of said circuits.

23. Call storage apparatus comprising a plurality of call storage circuits each operative to store a call, means for causing said circuits to store calls in a predetermined order, and means for preventing any circuit that has received one call for storage from becoming idle to store a second call until the other circuits have received calls for storage in the order determined by the operation of said last-named means.

24. Call storage apparatus comprising a plurality of call storage circuits each operative to

store a call, means for causing said circuits to store calls in a predetermined order, means for preventing any circuit that has received one call for storage from becoming idle to store a second call until the other circuits have received calls for storage in the order determined by the operation of said last-named means, and means for rendering idle all circuits not occupied with stored calls each time all of the circuits previously rendered idle have received calls for storage in the order determined by the operation of said first-named means.

25. Call storage apparatus comprising a plurality of call storage circuits each operative to store a call, distributing means for causing said circuits to store calls in a predetermined order, said circuits respectively including lock-up relays which are operated to prevent the associated circuits from storing calls after calls previously stored therein have been abandoned or completed, and means for releasing the lock-up relays of all circuits not occupied with calls after the circuits have all received calls for storage in the order determined by said distributing means.

26. In combination with a plurality of trunk circuits and means for routing calls to said trunk circuits, call storage apparatus including a plurality of storage circuits each operative to store a call routed to one of said trunk circuits at a time when the switching facilities following said trunk circuits are all busy, distributing means for causing said storage circuits to store calls in a predetermined order, said storage circuits respectively including lock-up relays which are operated to prevent the associated storage circuits from storing calls after calls previously stored therein have been completed or abandoned, and means responsive to the routing of a call requiring storage to one of said trunk circuits after all storage circuits have had calls stored therein for releasing all storage circuits not occupied with calls.

27. In a telephone system, an operator switchboard including facilities for answering incoming calls and for extending the calls from said switchboard, a plurality of trunk circuits, a plurality of channels over which calls extended to said trunk circuits may be routed to said switchboard to be answered, call storage means operative to store calls extended to said trunk circuits during an interval when all of the call answering facilities of said switchboard are busy, and an additional channel over which the stored calls may be answered at said switchboard independently of said first-named channels.

28. In a telephone system, an operator switchboard including facilities for answering incoming calls and for extending the calls from said switchboard, a plurality of trunk circuits, a plurality of channels over which calls extended to said trunk circuits may be routed to said switchboard to be answered, call storage means operative to store calls extended to said trunk circuits during an interval when all of the call answering facilities of said switchboard are busy, and means including an additional channel connecting said call storage means and said switchboard for enabling the stored calls to be acknowledged from said switchboard during an interval when said facilities are all busy.

29. In a telephone system, an operator switchboard including facilities for answering incoming calls and for extending the calls from said switchboard, a plurality of trunk circuits, a plu-

5 rality of channels over which the calls extended to said trunk circuits may be routed to said switchboard to be answered, call storage means operative to store calls extended to said trunk circuits during an interval when all of the call answering facilities of said switchboard are busy, means including at least portions of said channels for routing the stored calls to said switchboard as the call answering facilities of said switchboard become idle, and means including an additional channel connecting said call storage means and said switchboard for enabling the stored calls to be acknowledged from said switchboard during an interval when said facilities are all busy.

10 30. In a telephone system, an operator switchboard including facilities for answering incoming calls and for extending the calls from said switchboard, a plurality of lines, means for routing calls from said lines to said switchboard to be answered, a plurality of call storage circuits each operative to store a call initiated on one of said lines during an interval when all of said facilities are busy, an answer circuit common to said storage circuits and extending to said switchboard, means for connecting the storage circuits in which calls are stored to said answer circuit in a predetermined order, and means including said answer circuit for permitting any stored call to be acknowledged from said switchboard when said answer circuit is connected to the storage circuit in which the call is stored.

15 31. In a telephone system, an operator switchboard including facilities for answering incoming calls and for extending the calls from said switchboard, a plurality of lines, means for routing calls from said lines to said switchboard to be answered, a plurality of call storage circuits each operative to store a call initiated on one of said lines during an interval when all of said facilities are busy, an answer circuit common to said storage circuits and extending to said switchboard, means controllable from said operator switchboard for selectively connecting said answer circuit to said storage circuits, and means including said answer circuit for permitting any stored call to be acknowledged from said switchboard when said answer circuit is connected to the storage circuit in which the call is stored.

20 32. In a telephone system, an operator switchboard including facilities for answering incoming calls and for extending the calls from said switchboard, a plurality of lines, means for routing calls from said lines to said switchboard to be answered, a plurality of call storage circuits each operative to store a call initiated on one of said lines during an interval when all of said facilities are busy, an answer circuit common to said storage circuits and extending to said switchboard, each of said storage circuits including a relay operated in response to the answering or acknowledgment of a call stored therein at said switchboard, an answer key at said switchboard, means jointly controlled by said relays and said key for connecting said storage circuits to said answer circuit in a predetermined order, and means including said answer circuit for permitting any stored call to be acknowledged from said switchboard when said answer circuit is connected to the storage circuit in which the call is stored.

25 33. In a telephone system, an operator switchboard including facilities for answering incoming calls and for extending the calls from said switchboard, a plurality of lines, means for routing calls from said lines to said switchboard to be

answered and extended, a plurality of call storage circuits each operative to store a call initiated on one of said lines during an interval when all of said facilities are busy, means for causing said circuits to store calls in a predetermined order, an answer circuit common to said storage circuits and extending to said switchboard, means for connecting the storage circuits in which calls are stored to said answer circuit only in the same order that calls are stored in said storage circuits, and means including said answer circuit for permitting any stored call to be acknowledged at said switchboard when said answer circuit is connected to the storage circuit in which the call is stored.

34. In a telephone system, an operator switchboard including facilities for answering incoming calls and for extending the calls from said switchboard, a plurality of lines, means for routing calls from said lines to said switchboard to be answered and extended, a plurality of call storage circuits each operative to store a call initiated on one of said lines during an interval when all of said facilities are busy, means for causing said circuits to store calls in a predetermined order, an answer circuit common to said storage circuits and extending to said switchboard, each of said storage circuits including a relay operated in response to the answering or acknowledgment of a call stored therein at said switchboard, an answer key at said switchboard, means jointly controlled by said relays and said key for connecting said storage circuits to said answer circuit only in the same order that calls are stored in said storage circuits, and means including said answer circuit for permitting any stored call to be acknowledged at said switchboard when said answer circuit is connected to the storage circuit in which the call is stored.

35. In a telephone system, an operator switchboard including facilities for answering incoming calls and for extending the calls from said switchboard, a plurality of trunk circuits, a plurality of channels over which calls extended to said trunk circuits may be routed to said switchboard to be answered, a plurality of storage circuits each operative to store a call extended to one of said trunk circuits during an interval when all of said call answering facilities are busy, means for causing said circuits to store calls in a predetermined order, an additional channel over which the stored calls may be answered at said switchboard independently of said first-named channels, and means for preventing any storage circuit that has received a call for storage from becoming idle to store another call until the other storage circuits have received calls for storage in the order determined by the operation of said first-named means.

36. In a telephone system, an operator switchboard including facilities for answering incoming calls and for extending the calls from said switchboard, a plurality of trunk circuits, a plurality of channels over which calls extended to said trunk circuits may be routed to said switchboard to be answered, a plurality of storage circuits each operative to store a call extended to one of said trunk circuits during an interval when all of said call answering facilities are busy, means for causing said circuits to store calls in a predetermined order, an answer circuit common to said storage circuits and extending to said switchboard, means for connecting the storage circuits to said answer circuit in the same order that calls are stored therein, means including

said answer circuit for permitting any stored call to be acknowledged from said switchboard when said answer circuit is connected to the storage circuit in which the call is stored, means for preventing any storage circuit that has received a call for storage from becoming idle to store another call until the other storage circuits have received calls for storage in the order determined by the operation of said first-named means, and means for preventing said answer circuit from being connected to any storage circuit not occupied with a stored call.

37. In a telephone system, an operator switchboard including facilities for answering incoming calls and for extending the calls from said switchboard, a plurality of trunk circuits, a plurality of channels over which calls extended to said trunk circuits may be routed to said switchboard to be answered, a plurality of storage circuits each operative to store a call extended to one of said trunk circuits during an interval when all of said call answering facilities are busy, means for causing said circuits to store calls in a predetermined order, an answer circuit common to said storage circuits and extending to said switchboard, means for connecting the storage circuits to said answer circuit in the same order that calls are stored therein, means including said answer circuit for permitting any stored call to be acknowledged from said switchboard when said answer circuit is connected to the storage circuit in which the call is stored, said storage circuits respectively including lock-up relays which are operated to prevent the associated storage circuits from storing calls after calls previously stored therein have been abandoned or released, and means controlled by said relays for preventing said answer circuit from being connected to any storage circuit in which a call has been stored and then abandoned or completed.

38. In a telephone system, an operator switchboard including facilities for answering incoming calls and for extending the calls from said switchboard, a plurality of trunk circuits, a plurality of channels over which calls extended to said trunk circuits may be routed to said switchboard to be answered, a plurality of storage circuits each operative to store a call extended to one of said trunk circuits during an interval when all of said call answering facilities are busy, means for causing said circuits to store calls in a predetermined order, an answer circuit common to said storage circuits and extending to said switchboard, means for connecting the storage circuits to said answer circuit in the same order that calls are stored therein, means including said answer circuit for permitting any stored call to be acknowledged from said switchboard when said answer circuit is connected to the storage circuit in which the call is stored, said storage circuits respectively including lock-up relays which are operated to prevent the associated storage circuits from storing calls after calls previously stored therein have been abandoned or released, means controlled by said relays for preventing said answer circuit from being connected to any storage circuit in which a call has been stored and then abandoned or completed, and means for releasing the lock-up relays of all storage circuits not occupied with calls after the circuits have all received calls for storage in the order determined by the operation of said first-named means.

39. In combination with a plurality of trunk circuits, a plurality of storage circuits each oper-

ative to store a call routed to one of said trunk circuits during an interval when the switching facilities following said trunk circuits are all busy and each including a channel over which a call stored therein may be routed to the switching facilities as they become idle, an answer circuit common to said storage circuits for acknowledging stored calls, and means for connecting said storage circuits to said answer circuit in a predetermined order at a time when all said switch facilities are busy.

40. In combination with a plurality of trunk circuits, a plurality of storage circuits each operative to store a call routed to one of said trunk circuits during an interval when the switching facilities following said trunk circuits are all busy and each including a channel over which a call stored therein may be routed to the switching facilities as they become idle, distributing means for causing said circuits to store calls in a predetermined order, an answer circuit common to said storage circuits for acknowledging stored calls, and means independent of said channels and said switching facilities for connecting said storage circuits to said answer circuit in the order that calls are stored therein.

41. In a call storage circuit which is adapted to receive a call for storage over one channel and to release the call from storage over a second channel, a lockout relay operative in response to the release of one call from storage for preventing said circuit from receiving a second call for storage, and means responsive to the abandonment of a call stored in said circuit for operating said relay.

42. In a call storage circuit which is adapted to receive a call for storage over one channel and to release the call from storage over a second channel, a lockout relay operative in response to the release of one call from storage for preventing said circuit from receiving a second call for storage, means responsive to the abandonment of a call stored in said circuit for operating said relay, an answer circuit adapted to be connected to said storage circuit for the purpose of permitting an operator to acknowledge a call stored therein, means for connecting said answer circuit to said storage circuit, and means controlled by said last-named means for also operating said relay.

43. In a call storage circuit which is adapted to receive a call for storage over one channel and to release the call from storage over a second channel, an answer circuit adapted to be connected to said storage circuit for the purpose of permitting an operator to acknowledge a call

stored therein, answer means for connecting said answer circuit to said storage circuit, lockout means operative in response to the release of one call from storage to prevent said storage circuit from receiving a second call for storage and to prevent said answer circuit from being connected to said storage circuit, means responsive to the abandonment of a call stored in said storage circuit for operating said lockout means, and means controlled by said answer means for operating said lockout means.

44. In a telephone system, a toll operator switchboard provided with facilities for handling C. L. R. calls, a plurality of lines, means for routing C. L. R. calls originating on said lines directly to said switchboard so long as any of the call handling facilities of said switchboard are idle, and storage means automatically operative to store C. L. R. calls originating on said lines during an interval when all of the call handling facilities are busy and to route the stored calls to said switchboard as said facilities become idle.

45. In a telephone system, a toll operator switchboard provided with facilities for handling C. L. R. calls, a plurality of lines, means for routing C. L. R. calls originating on said lines directly to said switchboard so long as any of the call handling facilities of said switchboard are idle, storage means automatically operative to store C. L. R. calls originating on said lines during an interval when all of the call handling facilities are busy and to route the stored calls to said switchboard as said facilities become idle, and means whereby the stored calls may be acknowledged from said switchboard without utilizing the call handling facilities of said switchboard.

46. In a telephone system, a toll operator switchboard provided with facilities for handling C. L. R. calls, a plurality of lines, means for routing C. L. R. calls originating on said lines directly to said switchboard so long as any of the call handling facilities of said switchboard are idle, storage means automatically operative to store C. L. R. calls originating on said lines during an interval when all of the call handling facilities of said switchboard are busy, means for automatically routing the stored calls to said switchboard in the same order as they are stored as the call handling facilities of said switchboard become idle, and means whereby the stored calls may be acknowledged from said switchboard without utilizing the call handling facilities of said switchboard.

FRANK KESSLER.