

Jan. 2. 1945.

P. BAKKER

2,366,232

MULTIEXCHANGE AUTOMATIC TELEPHONE SYSTEM

Filed Jan. 2, 1943

4 Sheets-Sheet 1

FIG. 3.

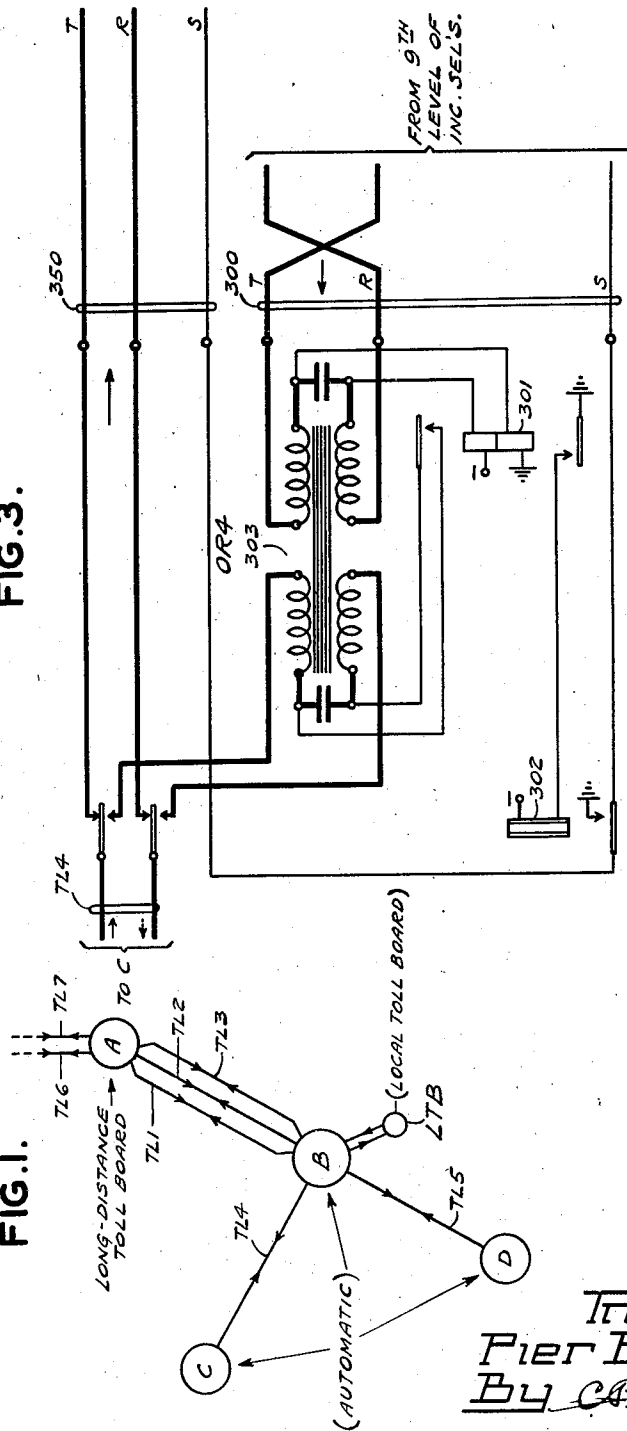
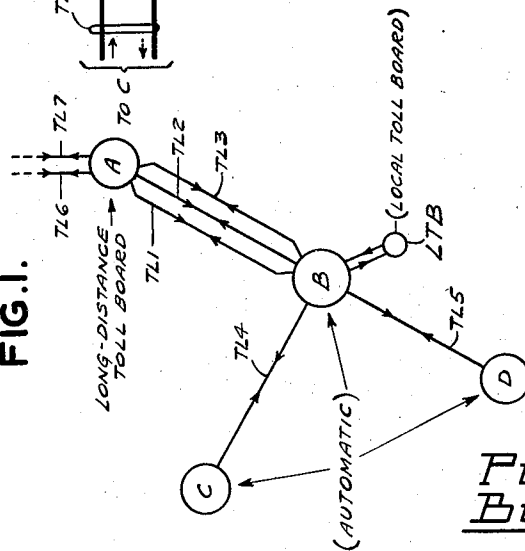


FIG. 1.



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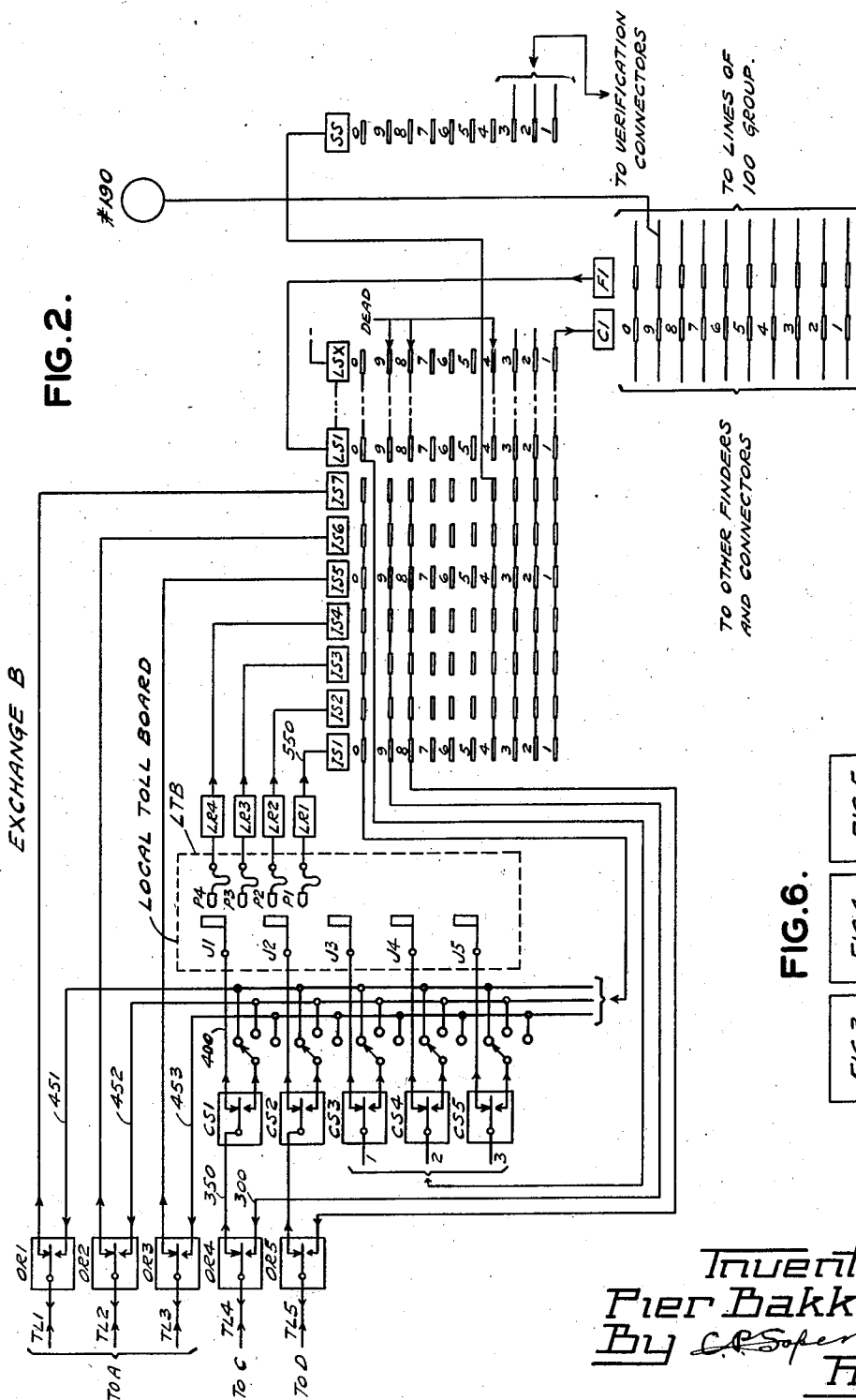
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MULTIEXCHANGE AUTOMATIC TELEPHONE SYSTEM

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Jan. 2, 1945.

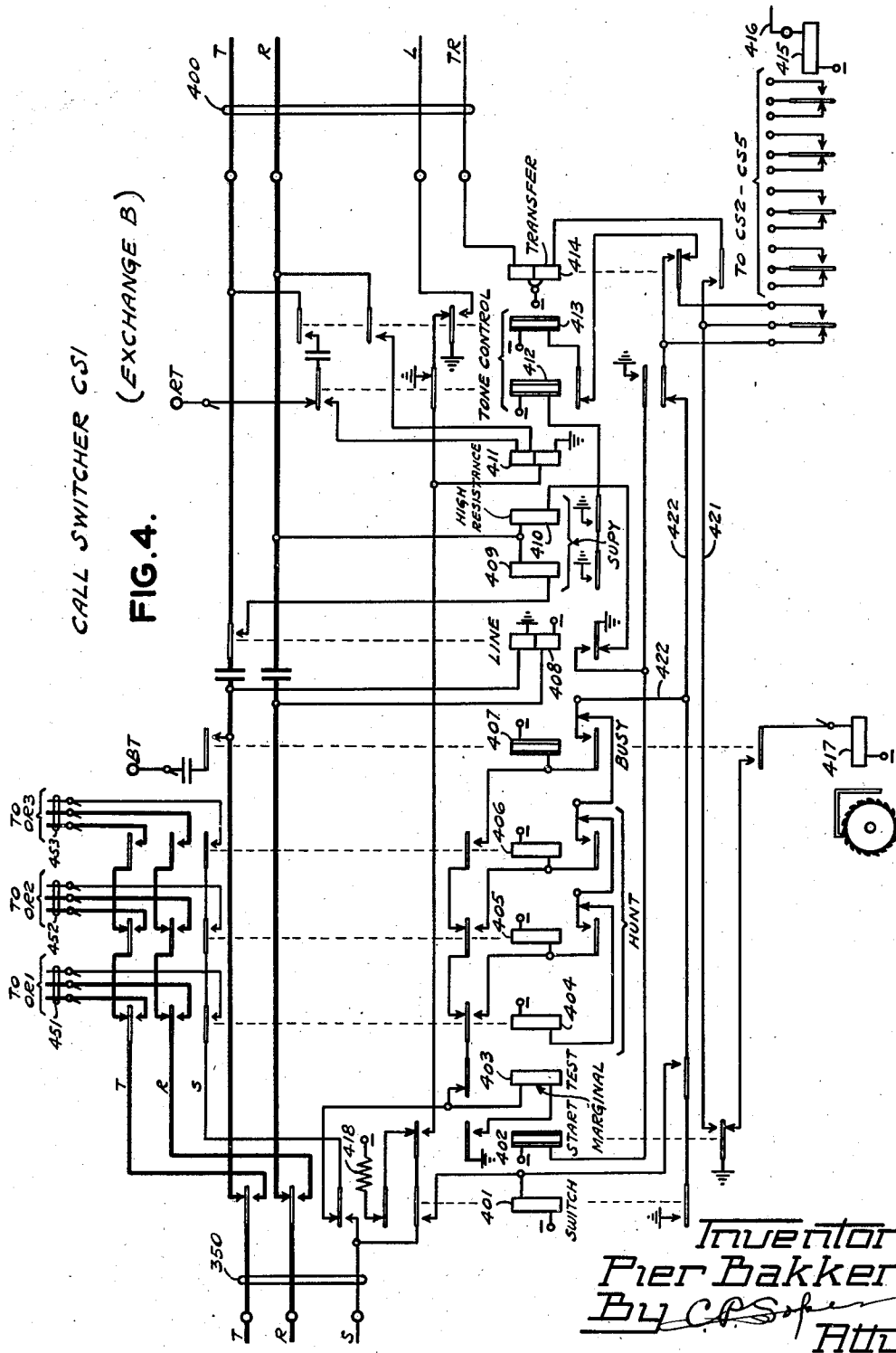
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MULTIEXCHANGE AUTOMATIC TELEPHONE SYSTEM

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4 Sheets-Sheet 3



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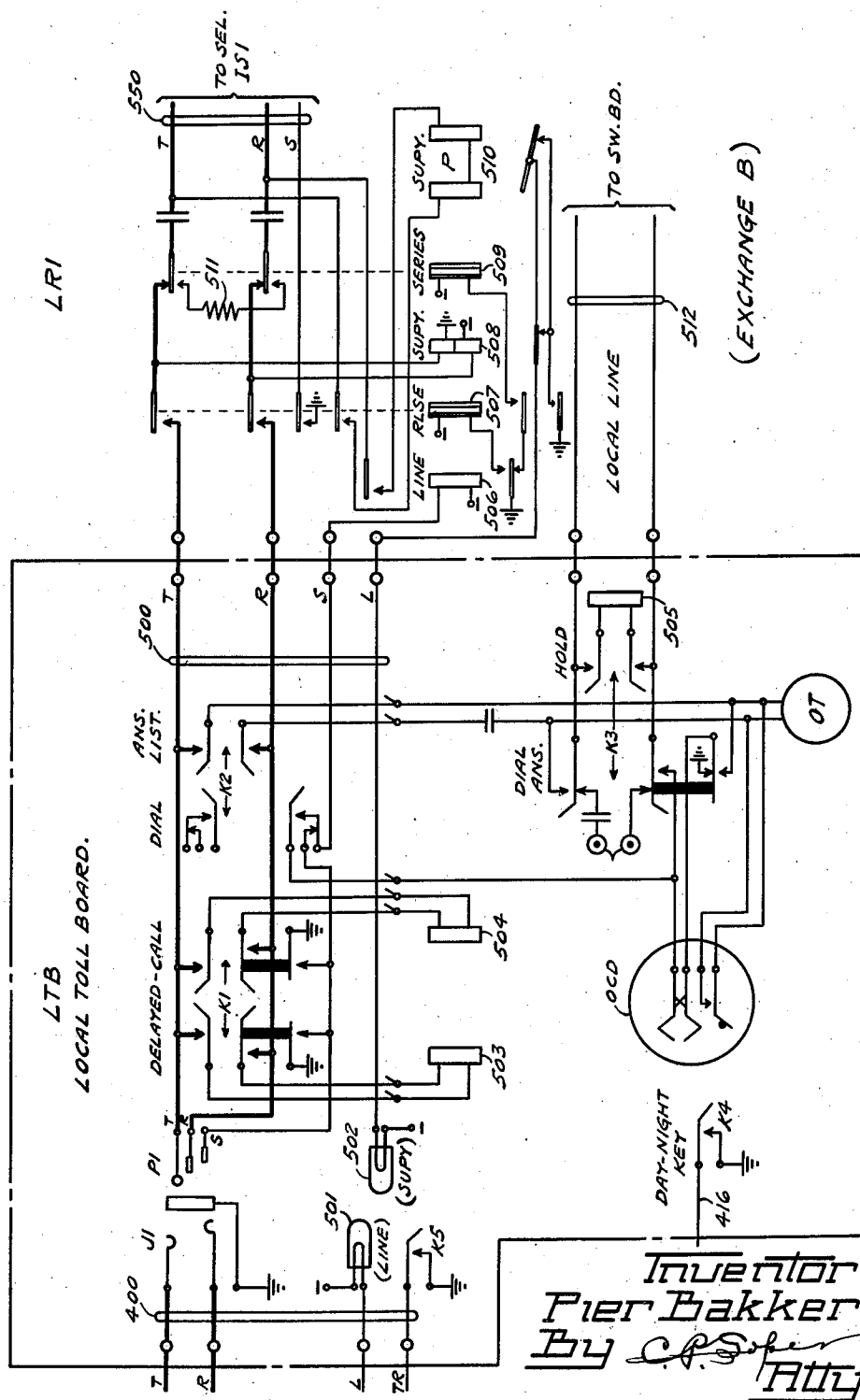
2,366,232

MULTIEXCHANGE AUTOMATIC TELEPHONE SYSTEM

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4 Sheets-Sheet 4

FIG. 5.



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UNITED STATES PATENT OFFICE

2,366,232

MULTIEXCHANGE AUTOMATIC TELEPHONE SYSTEM

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Application January 2, 1943, Serial No. 471,207

6 Claims. (Cl. 179-27)

This invention relates to multi-exchange automatic telephone systems, but is concerned more particularly with a telephone system wherein calls between automatic telephone exchanges comprising a local system are handled on a toll basis, through a local toll board, and wherein a long-distance toll board outside the local system is utilized to complete long-distance toll calls to and from the lines of the local multi-exchange system.

The principal object of the invention is the provision of suitable arrangements for the satisfactory completion on a toll basis of all inter-exchange calls to and from lines of the local system.

A specific object is to provide suitable arrangements for transferring locally originated long-distance toll calls from the local toll board to the long-distance toll board.

A further specific object is to provide circuit arrangements effective when the local toll board is not attended to route all locally originated toll calls to the long-distance toll board to be completed therefrom to the respective called lines, whether within or without the local system.

Other objects and features of the invention will become more apparent as the description progresses.

General description

The accompanying drawings, comprising Figs. 1 to 6, show by means of the usual circuit diagrams a sufficient amount of the equipment in a telephone system embodying the features of the invention to enable the invention to be understood.

Fig. 1 is a map-like drawing showing the exchanges of the local system and one of the exchanges outside of the local system;

Fig. 2 shows the trunking arrangements in the exchange with which the local toll board is associated;

Figs. 3 to 5 show the circuit arrangements of certain of the apparatus of Fig. 2; and

Fig. 6 is a diagram indicating how Figs. 3 to 5 are intended to be arranged.

FIGURE 1

Fig. 1 shows the local system comprising automatic exchanges B, C, and D. Toll lines TL4 and TL5 interconnect exchanges C and D with tandem exchange B. Fig. 1 also shows an exchange A located outside the system and interconnected with tandem exchange B by toll lines TL1 to TL3. Exchange A contains a long-distance toll board, and may have toll lines, such as TL6 and TL7,

extending to still other exchanges outside of the local system, in accordance with the usual practice.

The local toll board LTB may be located within exchange B, or it may be located a short distance away, as in the residence of the manager of the local system, and interconnected with the concerned equipment in exchange B by the required number of conductors.

FIGURE 2

As previously stated, Fig. 2 is a diagram of the trunking arrangement in exchange B of Fig. 1. The local toll board LTB is indicated by a broken-line rectangle in Fig. 2.

Exchange B is illustrated as having a present capacity of three hundred lines, comprising three separate hundreds groups reached by way of the first three levels respectively of a single rank of selectors. These selectors include the incoming selectors IS1 to IS7 and a number of local selectors LS1 to LSX.

The connector C1 is one of a number of connectors used to complete calls to lines of the first hundred, of which the line of the illustrated substation #190 is one. The lines of this hundred are also accessible to a number of finders, of which the finder F1 is one. The finder F1 is linked individually to the local selector LS1, each of the other line finders being similarly linked respectively with local selectors.

The first three levels of all of the selectors may be multiplied straight through as indicated, and extended to the connectors serving the respective hundreds groups.

The fourth level of the local selectors LS1 to LSX is unused or "dead," while the fourth level of the incoming selectors IS1 to IS7 gives access to one or more second selectors SS. The second selector SS has access, through the first three levels thereof to verification connectors, one of which may be provided in each hundreds group in accordance with the usual practice, enabling a toll operator to make connection with a busy line to thus verify any indicated busy condition.

The fifth to seventh levels of all of the selectors are at present unused.

The eighth level of the local selectors LS1 to LSX is unused or "dead," while the eighth level of the incoming selectors gives access to the outgoing branch of the toll line TL5 of Fig. 1, extending between exchanges B and D.

The ninth level of the local selectors is unused or "dead," while the ninth level of the incoming selectors gives access to the outgoing branch

of toll line TL4 of Fig. 1, extending between exchanges B and C.

The tenth (0) level of the local selectors gives access to trunk lines leading to jacks J3 to J5 at the local toll board, by way of call switchers CS3 to CS5.

The tenth (0) level of the incoming selectors gives access, by way of outgoing branches 451 to 453 of toll lines TL1 to TL3, respectively, extending between exchanges A and B.

The outgoing repeaters OR1 to OR5 are associated respectively with the toll lines TL1 to TL5. The circuit arrangements of the repeater OR4 are as shown in Fig. 3.

The incoming branches of the toll lines TL1 to TL3 extend respectively to incoming selectors IS1 to IS5, while the incoming branches of the toll lines TL4 and TL5 extend respectively to toll-board jacks J1 and J3, by way of call switchers CS1 and CS2.

The call switchers CS1 to CS5 may all be similar, the circuit arrangements of the call switcher CS1 being shown in Fig. 4.

As above indicated, the normally connected outgoing branches of the call switchers CS1 to CS5 extend respectively to the jacks J1 to J5 at the local toll board LTB. The alternate outgoing branches of the call switchers CS1 to CS5 may be extended by an automatic trunking operation to be hereinafter described to any idle one of the outgoing branches 451 to 453 of the toll lines leading to the long-distance toll board in exchange A.

For the completion of calls through the local toll board LTB, four single-plug cords are provided, ending in the plugs P1 to P4. These four cords are associated respectively, through the local repeaters LR1 to LR4, with the incoming selectors IS1 to IS4. The local repeaters may all be similar, the circuits of the local repeater LR1 being shown in Fig. 5.

The selectors and connectors in exchange B can be of any suitable construction and circuit arrangement, and controllable over the usual loop dialing circuit. Additionally, the construction and circuit arrangements of the finders such as F may be of any suitable type.

FIGURE 3

Referring to Fig. 3, the outgoing repeater OR4 of Fig. 2 includes the repeating coil 303, line relay 301, and release relay 302. As indicated in the drawings, and as previously noted, this repeater is seized for outgoing operation from the ninth level of the incoming selectors, such seizure occurring over the three-conductor trunk 300. Normally, the two conductors comprising toll line TL4 extend through contacts of relay 302 to the corresponding conductors of branch trunk line 350, incoming to the call switcher CS1, but are transferred to the outgoing conductors of the repeater OR4 when the repeater is seized.

FIGURE 4

The call switcher CS1 of Fig. 1 is shown in circuit diagram in Fig. 4. This call switcher is seized over incoming branch 350 of the toll line TL4. It includes relays 401 to 407, associated with the function of selecting an idle one of the outgoing trunk branches 451 to 453 of Figs. 4 and 2, when such operation is desired. Device CS1 also includes line relay 408, and relays 409 to 414, associated principally with the function of signaling the operator at the local toll board LTB of Figs. 1, 2, and 5.

Common switching relay 415 is associated with the call switchers CS1 to CS5. When this relay is in normal condition, the automatic selecting portions of the call switchers are conditioned to extend the incoming calls automatically to the long-distance toll board in exchange A, over one or another of the toll lines between exchanges B and A, but relay 415 may be operated over the associated conductor 416 from the local toll board at any time such local toll board is attended to thereby cause the calls arriving at the call switchers CS1 to CS5 to be brought in at the local toll board through the concerned one of the jacks J1 to J5 of Fig. 2.

FIGURE 5

Fig. 5 shows the first of the jacks J1 to J5 of Fig. 2, together with its associated line lamp 501 and transfer key K5. Transfer key K5 is to be actuated momentarily by the operator at the local toll board whenever a call received over the associated jack is one intended for a subscriber reached by way of manual exchange B, to thereby cause the associated call switcher to transfer the call in a manner to be subsequently pointed out. The plug P1, together with the associated cord circuit, link 530, local repeater LR1, trunk 550, and incoming selector IS1 of Fig. 2, comprises one of the four call-completing links shown in Fig. 2, through which the operator at the local toll board LTB can complete calls through such local toll board.

The cord circuit associated with the plug P1 includes a delayed-call key K1, and a key K2 having a dial position and an answering and listening position. The delayed-call keys of the various cord circuits are used to enable the operator at the local toll board to set up one or two tail-to-tail, delayed-call connections, as will be subsequently described.

The common equipment at the local toll board includes the operator's telephone indicated generally at OT and an operator's calling device OCD of the usual dial type.

A local telephone line 512 extends to the local toll board and terminates in the contacts of the key K3. A ringer is normally bridged across this line to permit the operator to be signaled as in the case of a regular telephone subscriber. The key K3 enables the operator to answer calls over the line 512, to make calls thereover, and to hold an originated connection while she attends to other duties.

DETAILED DESCRIPTION

The disclosure having been described generally, a detailed description of the operation of the disclosed apparatus will now be given.

I. DAY OPERATION

For this purpose, it will be assumed that the operator is in attendance at the local toll board LTB of Figs. 2 and 4, and that the day-night key K4 is accordingly in actuated position, maintaining switching relay 415 in operated position over conductor 416.

IA. Exchange C to exchange B

The handling of calls from exchange C to exchange B, over toll line TL4 of Figs. 1 to 3, will now be described.

IA1. Calling the local toll operator

The calling subscribed in exchange C may dial a preassigned number, such as the digit 0, to cause the automatic switching equipment (not

shown) in exchange C to extend connection to the exchange-C end of the toll line TL4. When this occurs, a direct current bridge is closed across the conductors of the toll line TL4 in exchange C, thereby operating line relay 408 of the call switcher CS1 (Fig. 4) over the toll line TL4, through contacts of relay 302 of the repeater OR4, tip and ring conductors of incoming branch 350, and contacts of switching relay 401.

At the front contact of its lower armature, line relay 408 operates start relay 402. At the front contact of its uppermost armature, start relay 402 applies ground potential (obtained originally through contacts of relays 412 and 413) to sleeve conductor S of the associated incoming branch 350 of the toll line TL4, and consequently to the sleeve conductor S of the outgoing branch 300 of the toll line. The toll line TL4 and outgoing repeater OR4 are thus marked busy to the selectors (IS1 to IS7, Fig. 2) having access thereto.

At its lower armature, relay 402 applies ground potential to conductor 421, thereby grounding conductor 423 through the outer armature and front contact of the operated switching relay 415. Ground potential on conductor 423 operates relay 413 of the tone-control pair, through contacts of relays 414 and 412.

At its uppermost contacts, relay 413 connects the common ringing-tone lead RT to the tip talking conductor to transmit the usual ringing-tone signal back to the calling line.

At the front contact of its first upper armature, relay 413 applies ground potential to lamp conductor L of link 400, thereby lighting the line lamp 501 associated with the jack J1 at the local toll board LTB.

IA2. Answering the call

Upon noting the lighted condition of the lamp 501, the operator at LTB may insert the plug of an idle cord circuit (the plug P1, for example) into the jack J1. When this occurs, line relay 506 in the local repeater LR1 operates, over the sleeve conductor S of link 500 through dial-position contacts of the key K2, the sleeve of the plug P1, and the sleeve of the jack J1.

The operation of line relay 506 is followed by the operation of the slow-restoring release relay 507, whereupon supervisory relays 508 and 409 operate in series over the tip and ring conductors of the links 400 and 500, through the tip and ring contacts of the jack J1 and plug P1.

Upon operating, relay 409 operates slow-restoring tone-control relay 412. At its uppermost contacts, relay 412 disconnects the ringing-tone lead RT to thereby terminate the simulated ringing signal, while at its lowermost armature, it closes a circuit for start relay 402 thereby holding start relay 402 operated independent of line relay 408 for so long a time as the plug P1 remains in the jack J1.

Relay 413, being disconnected at the inner lower contacts of relay 412, now restores to extinguish line lamp 501.

IA3. Class tone

During the time required for slow-restoring relay 413 to restore following the operation of relay 412, the primary (lower) winding of relay-type transformer 411 is the sole source of ground supply for the sleeve lead incoming to the call switcher CS1. Any tone signal impressed on such lead is accordingly induced in the secondary winding, then bridged across the talking

conductors by relays 412 and 413, to enable the operator to hear such tone. For this purpose the operator is expected to actuate her listening key before plugging in.

The above induced-tone arrangement is of particular utility in connection with call switchers CS3 to CS5, accessible to local lines, for class-identifying tones may be impressed on the sleeve leads of desired ones of such lines, according to the usual practice.

The operator at the local toll board LTB may now converse with the calling subscriber and make any desired record of the identity of the calling substation and of the destination of the call.

In the local repeater LR1 of Fig. 5, as a further result of the described operation of release relay 507, ground potential is placed on conductor L of the link 500, by way of the contacts of the polarized supervisory relay 510, thereby lighting supervisory lamp 502.

IA4. Preparing the incoming selector

At its third upper armature, release relay 507 applies ground potential to the sleeve conductor S of link 550, while at its first upper armature, it bridges the windings of polarized supervisory relay 510 across the tip and ring conductors of the link 550, through the upper contacts of line relay 506. When this occurs, the selector IS1 of Fig. 2, to which the link 550 extends, is prepared for operation in the usual manner.

IA5. Extending the connection

In order to extend the connection to the desired line of exchange B, the operator actuates the key K2 from answering position to dial position, thereby restoring the right-hand contacts of the key and actuating the left-hand contacts thereof. With the lower left-hand contacts of the key K2 actuated, the sleeve conductor S of the link 500, over which line relay 506 of the local repeater LR1 is controlled, is transferred from the plug and jack ground to a new circuit to ground including the impulse contacts of the operator's calling device OCD and contacts of the key K3. Following this, the operator actuates the dial of the calling device OCD in accordance with the digits in the local number of the desired called line. As a result of each operation of the calling device OCD, a series of momentary restorations of line relay 506 is produced. Slow-restoring release relay 507 remains unaffected.

At its upper contacts, line relay 506 repeats the momentary calling-device interruptions over the tip and ring conductors of the link 550 to bring about the operation of the associated incoming selector IS1 of Fig. 2, followed by the operation of a connector, such as C1, to complete the connection to the desired line.

Series relay 509 is operated, through contacts of release relay 507, at the beginning of each series of restorations of line relay 506, and remains operated throughout the series. Relay 509 interrupts the tip and ring talking conductors between the links 500 and 550 to avoid the transmission back to the calling line of a series of objectionable clicks. At the same time, it shunts the resistor 511, in series with the associated talking condensers, across the tip and ring conductors of link 550 to improve the dialing circuit to the switches being operated.

Having dialed the digits in the desired number, the operator may reactuate the key K2 from

dial position to answering and listening position to enable her to hear when the called subscriber answers. When the dial-position contacts of the key K2 are restored, the holding circuit of line relay 506 is transferred back from the calling device OCD to the sleeve of the plug P1 and jack J1.

It may be assumed that the desired subscribed is the one at substation #190 (Fig. 2). In this event, the first digit dialed is the digit 1, causing the selector IS1 to associate itself with the first level thereof and to search for an idle connector in the first hundreds group of lines. It may be assumed that the connector C1 is the first one found to be idle and is consequently selected. The connector C1 is accordingly prepared for operation in the usual manner, and it responds to the final digits 9 and 0 in the desired number to complete connection to the called line. If the called line is idle, ringing current is applied thereto in the usual manner.

IA6. Answered supervision

When the called subscriber responds, the connector C1 may cause the current flow over the conductors incoming thereto to be reversed in the usual manner, causing a consequent reversal in the current flow through the polarized supervisory relay 510 (Fig. 5). Supervisory relay 510 thereupon operates. With supervisory relay 508 being held in operated position (in series with relay 509), supervisory lamp 502 is extinguished to indicate visually that the calling subscriber has answered.

The two subscribers may now converse with each other as desired over the tip and ring conductors of the established connection. After noting the time at which conversation began, the operator may restore her key K2.

IA7. Disconnect supervision

When the two subscribers have finished their conversation, they are expected to replace their receivers to permit the established connection to be cleared out.

The first subscriber to replace his receiver causes the supervisory lamp 502 associated with the plug P1 to become relighted as a disconnect signal. The circuit of such lamp is reestablished responsive to the restoration of polarized supervisory relay 510 when the receiver is replaced on the called line.

When the calling subscriber replaces his receiver, supervisory relays 409 and 508 restore as a result of the disconnection of supervisory relay 509 from in bridge of the tip and ring conductors, at the upper contacts of line relay 408. Relay 508 closes a multiple point in the circuit of supervisory lamp 502.

At the back contact of its lower armature, line relay 408 closes an operating circuit for the high resistance supervisory relay 410 over the ring conductor of the established connection through the lower winding of supervisory relay 508. Relay 508 is unable to operate or remain operated over this circuit because of the high resistance of relay 410. The operation of relay 410 occurs concurrently with the restoration of relay 409 and serves to prevent the restoration of tone-control relay 412. Relay 412 accordingly maintains start relay 402 operated after line relay 408 has restored.

Upon noting the lighted condition of supervisory lamp 502, the operator at the local toll board LTB may verify that both subscribers have

replaced their receivers by actuating the key K2 to listening position and uttering the usual challenge.

IA8. Clearing out

Upon assuring herself that both subscribers have replaced their receivers, the operator may take down the connection, by removing the plug P1 from the jack J1.

In the local repeater LR1, line and release relays 506 and 507 restore in sequence, causing the extended portion of the connection to clear out in the usual manner, and extinguishing the supervisory lamp 502.

In the call switcher CS1, supervisory relay 410 restores responsive to the removal of the plug P1 from the jack J1. Upon so doing, it open-circuits slow-restoring start relay 402 to permit the latter relay to restore after a slight interval. When it restores, relay 402 completes the clearing out of the exchange-B end of the toll line TL4, the originating portion of the connection having cleared out in the usual manner responsive to the receiver being replaced at the calling station in exchange C (Fig. 1).

IB. Long distance toll calls from exchange C

The operations involved in setting up a long-distance toll call originated in exchange C will now be described.

IB1. Calling the local toll operator

The calling subscriber in exchange C causes connection to be extended over the toll line TL4 of Figs. 1 to 3 to the call switcher CS1 of Figs. 2 and 4, as previously pointed out. Operations occur as previously described, including the lighting of the line lamp 501, and the answering of the call at the toll board LTB, as by the insertion of the plug P1 into the jack J1.

IB2. Transferring the call to the long-distance toll operator

When the local toll operator at LTB (Fig. 4) learns that the instant call is a long-distance toll call, which must be completed through the long-distance toll board in exchange A of Fig. 1, she momentarily actuates the transfer key K5 individual to the jack J1, thereby closing a circuit over transfer conductor TR of the link 400 for the upper winding of transfer relay 414. Relay 414 thereupon operates, locking its lower winding to grounded conductor 421, whereby relay 411 is maintained operated after key K5 is restored.

The operator at the local toll board LTB may now remove the plug P1 from the jack J1, freeing and clearing out the local repeater LR1 and associated incoming selector.

In the call switcher CS1, relays 409 and 412 restore successively when the plug P1 is withdrawn. With transfer relay 414 operated, the restoration of relay 412 extends ground potential to conductor 422: from ground through the front contact of the lower armature of relay 402, conductor 421, contacts of the operated relay 416, conductor 423, front contact of the first lower armature of relay 414, and through contacts of relay 412, to conductor 422.

The placing of ground potential on conductor 422 initiates the previously mentioned hunting action of the call switcher CS1. With ground on conductor 422, the first hunting relay 404 operates through normally closed contacts of relays 407 to 405. Upon operating, relay 404 makes a

test connection with the outgoing branch 451 of the toll line TL1 (Fig. 2) leading to the repeater OR1, similar to the repeater OR4 of Fig. 3.

IB3. Trunk hunting in CS1

The further operation now depends upon whether the toll line TL1 is busy or is idle. If such toll line is idle, there is a battery potential on the sleeve conductor thereof effective to operate test relay 403, to thereby prevent the next succeeding hunting relay 405 from operating.

If toll line TL1 is busy, there is no idle-indicating battery potential on the sleeve conductor of its outgoing branch 451. Test relay 403 therefore fails to operate. The operation of hunting relay 404 is now followed by the operation of hunting relay 405 over the following circuit: from ground, through the front contact of the first upper armature of start relay 402, the winding of test relay 403, upper contacts of relay 403, front contact of the first upper armature of relay 404, and through the winding of relay 405, to battery. Being marginally adjusted, as indicated, test relay 403 does not operate in series with a relay such as 405. Upon operating, relay 405, at its lower armature, locks itself to the grounded conductor 422, open-circuiting and restoring the first hunting relay 404. A test connection is now made with outgoing branch 452 of the second toll line TL2 of Fig. 2.

If the second toll line is also busy, relay 403 still fails to operate, as a result of which the third hunting relay 406 is operated through contacts of the restored relay 404 and contacts of the operated relay 405. Relay 406 locks itself to conductor 422 and restores relay 405. A test connection is now made with the outgoing branch 453 of the third toll line TL3.

If the third toll line is also busy, the operation of the third hunting relay 406 is followed by the operation of busy relay 407. Busy relay 407 locks itself directly to the grounded conductor 422, open-circuiting and restoring hunting relay 406. At its upper armature, relay 407 applies busy tone (from the common lead BT) to the associated talking conductor to thereby inform the calling subscriber of the busy condition.

At its lowermost contacts, relay 407 prepares a circuit for momentarily energizing the magnet of meter 417 (when start relay 402 clears out) to record the all-trunks-busy condition.

In the present example, it may be assumed that the first toll line TL1 is idle, instead of being busy as previously assumed. In this event, the described operation of hunting relay 404 results in the immediate operation of test relay 403 over the following circuit: from ground, through the front contact of the first upper armature of start relay 402, the winding of test relay 403, back contact of the third upper armature of switching relay 401, the associated sleeve conductor, the front contact of the second upper armature of the operated hunting relay 404, the sleeve conductor of branch trunk 451, and thence to battery over the sleeve conductor (not shown) extending from the outgoing repeater OR1 to the associated incoming selector IS7 (Fig. 2). This sleeve conductor is similar to the one in trunk branches 300 and 350 of Fig. 3, and extends to battery in the selector IS7 through a resistor similar to the resistor 418 of the call switcher CS1.

Upon operating over its above-traced circuit, test relay 403 opens the hunting circuit at its upper contacts, whereby the operation of the

succeeding ones of the relays 405 to 407 is prevented. At its lower contacts, relay 403 extends the grounded conductor 422 to the winding of switching relay 401, whereupon the latter relay operates.

IB4. Seizing toll line TL1

At its lower contacts, switching relay 401 makes an application of holding ground potential to conductor 422 so as to hold the operated hunting relay (404) after start relay 402 has restored. At the inner upper contacts, relay 401 locks itself to the sleeve conductor S of link 350 (now grounded by start relay 402); at its third upper armature, relay 401 disconnects the extended sleeve conductor from the winding of test relay 403 and transfers it to the incoming sleeve conductor S in branch 350, whereby the seized toll line is marked busy, and test relay 403 is restored. At its fourth and fifth upper armatures, relay 401 disconnects the tip and ring conductors in incoming group 350 from those extending to the jack J1 and extends them, through contacts of the operated hunting relay 404, to the corresponding conductors in group 451, leading to the outgoing repeater OR1, Fig. 2. When this occurs, line relay 408 restores and open-circuits the slow-restoring start relay 402. Start relay 402, however, being slow restoring, remains operated until a holding ground potential has been returned over to the extended sleeve lead (the sleeve conductor in group 451) to maintain switching relay 401 locked operated.

In the repeater OR1 of Fig. 2, the relay corresponding to relay 301 of the repeater OR4 (Fig. 3), is operated over the tip and ring conductors of the extended connection to thereby operate the associated release relay corresponding to relay 302. The latter relay transfers the tip and ring conductors of the toll line TL1 from the incoming branch (leading to the selector IS7) into connection with the outgoing tip and ring conductors of the repeater OR1 to cause the long-distance operator in exchange A to be signaled in the usual manner. The release relay in the repeater OR1, corresponding to relay 302 of the repeater OR4, grounds the associated sleeve conductor, being the sleeve conductor of group 451 (Fig. 4), to thereby establish a holding circuit for switching relay 401. By this holding circuit, the call switcher CS1 is maintained in switched-through condition, and the toll line TL1 is maintained guarded because the sleeve conductor of the outgoing branch 300 thereof is supplied with ground potential through contacts of the operated relay 401. Resistor 418 is maintained disconnected at the back contact of the second upper armature of switching relay 401.

When the long-distance operator in exchange A answers the call, she may extend it in the usual manner to the desired called line, making any desired record of the identity of the calling line.

IB5. Clearing out

When the conversation is terminated and the receiver is replaced at the calling substation, the line and release relays in the repeater OR1 (corresponding to relays 301 and 302 of Fig. 3) restore. The latter relay removes ground potential from the associated sleeve conductor, being the sleeve conductor in group 451 (Fig. 4). When this occurs, switching relay 401 restores and removes ground potential from conductor 422 at its lower contacts, whereupon hunting relay 404 restores. The call switcher CS1 is thus returned

to its normal condition, and idle-indicating battery potential is reapplied from resistor 418, through contacts of relays 401 and 402, to sleeve conductor S in groups 350 and 300, marking the toll line TL4 idle in exchange B.

IC. Exchange B to exchange C

The handling of local toll calls from subscribers of exchange B to subscribers of exchange C will now be considered. It may be assumed that the subscriber at substation #190 (Fig. 2) desires to converse with a subscriber of exchange C (Fig. 1). For this purpose, the subscriber at substation #190 removes his receiver and dials the digit 0 assigned as the call number of the local toll board LTB (Figs. 1, 2, and 5).

When the receiver is removed at the calling substation #190 (Fig. 2), the usual operations occur to cause an idle finder such as F1 to make connection with the calling line. If the finder F1 is the one used to make this connection, the associated local selector LS1 is thereby seized and prepared for operation.

IC1. Calling the local toll operator

When the digit 0 is dialed, the selector LS1 associates itself with the tenth (0) level thereof, and searches for an idle trunk line of this level. The active trunk lines reached from the 0 level of the local selectors include the three trunk lines incoming to the call switchers CS3 to CS5 respectively, Fig. 2. It may be assumed that the call switcher CS3 is idle and is therefore the one seized. This call switcher thereupon operates as described hereinbefore for the call switcher CS1 (Fig. 4) to light the line lamp (not shown but similar to 501) associated with the jack J3 (Fig. 2).

The operator at the local toll board LTB may thereupon answer the call by inserting the plug of an idle cord circuit into the jack J3. This plug may be plug P1 (Figs. 2 and 5), if idle. When this occurs, the relays of the local repeater LR1 operate as previously described to cause supervisory lamp 502 to become lighted and to cause the tip and ring conductors of the trunk 550 to be bridged, thereby preparing the incoming selector IS1 (Fig. 2) for operation in the usual manner.

IC2. Calling exchange C

The operator may now associate her calling device OCD with the cord circuit in use, and dial the digit 9 assigned to exchange C. If the toll line TL4 is idle at the moment, this toll line is seized by the operator selector IS1 over its outgoing branch 300 by way of the repeater OR4, Figs. 2 and 3. When this occurs, line relay 301 of the repeater OR4 operates over the tip and ring conductors of group 300, followed by the operation of release relay 302. At its lower contacts, relay 302 grounds the associated sleeve conductor to provide a holding circuit for the selector IS1, Fig. 2. Because of the indicated reversal in the tip and ring conductors in group 300, polarized supervisory relay 510 now operates to extinguish supervisory lamp 502 to simulate answered supervision. This arrangement is in lieu of reverse-battery supervision through the repeater OR4.

At its upper armatures, relay 302 disconnects the conductors of the toll line TL4 from the incoming branch 350 and transfers them into connection with the left-hand windings of repeating coil 303. A signal bridge is thus established across the toll line, through contacts of line relay 301

to prepare an incoming switch for operation in the distant exchange C.

IC3. Completing the connection

Following the extension of the connection to the toll line TL4, by way of the repeater OR4, the operator at the local toll board LTB (Fig. 5) actuates her calling device OCD in accordance with the digits in the number of the desired line in exchange C. The resulting impulse series are repeated, at the upper contacts of line relay 301, over the toll line TL4 to the switching equipment in the called exchange C, which switching equipment thereupon responds to complete connection to the called line in the usual manner. If this line is idle, the usual ringing current is automatically applied, and the talking connection is completed when the called subscriber responds.

IC4. Clearing out

When the conversation is ended, and the calling subscriber at substation #190 (Fig. 2) replaces his receiver, the concerned call switcher CS3 of Fig. 2 operates as described hereinbefore for the call switcher CS1 of Fig. 4 to give disconnect supervision to the operator, by restoring supervisory relay 508 of the local repeater LR1. Supervisory lamp 502 is thereby lighted as a disconnect signal.

When the operator withdraws the plug P1 of Figs. 5 and 2 from the jack J3, the call switcher CS3, acting as described for the call switcher CS1, restores its start relay, such as 402, to thereby remove ground potential from the associated sleeve lead, and permit the operated local selector LS1 and interlinked finder F1 to restore, clearing out the connection between the calling line and the local toll board.

A further result of the removal of the plug P1 (Figs. 2 and 5) from the jack is the restoration of line relay 506. Line relay 301 of the repeater OR4 restores in response thereto, followed a moment later by the restoration of relay 302. The clearing-out operation in the distant exchange C is initiated at the upper contacts of line relay 301. The incoming selector IS1 clears out responsive to the removal of ground potential from the sleeve conductor of trunk branch 300 at the lower contacts of relay 302.

ID. Other local toll calls

From the foregoing description, it is apparent that other local toll calls may be handled in substantially the manner described. For example, calls from exchange C to exchange D are handled as follows:

Calls from exchange C to exchange D arrive over the toll line TL4, and pass through the call switcher CS1 to the jack J1, as previously described. The operator may answer with one or another of her plugs P1 to P4, and then extend the call over the eighth level of one or another of the incoming selectors IS1 to IS4, and through the repeater OR5, to the toll line TL5, leading to exchange D.

Local toll calls originated in exchange D arrive at exchange B over the toll line TL5, and pass through the call switcher CS2 to the jack J2 at the local toll board. From this point, they may be extended, through one of the selectors IS1 to IS4, to desired lines of either exchange B or exchange D.

As previously noted, toll calls originated in exchange B reach the toll board through one or another of the call switches CS3 to CS5, and they

may be extended to either of the local exchanges C and D.

IE. Other locally originated long-distance calls

During day-time operation, now being considered, all toll calls originated in any of the local exchanges B, C, and D arrive at the local toll board LT3 over one or another of the jacks J1 to J5. When the local toll operator learns that any such toll call is a long-distance call, she may transfer such call to the long-distance toll board in exchange A (Fig. 1) by operations as hereinbefore described in connection with the call switcher CS1 and the jack J1 (Figs. 4 and 5). When the operator actuates the transfer key individual to the associated jack and removes her plug from such jack, the concerned one of the call switchers CS1 to CS5 operates as hereinbefore described to extend the connection, over one or another of the outgoing branches 451 to 453, to the associated one of the toll lines TL1 to TL3 extending to the long-distance switchboard in exchange A.

IF. Incoming long-distance calls

Long-distance calls incoming to the local system, by way of the long-distance toll board in exchange A, arrive over one or another of the toll lines TL1 to TL3 (Figs. 1 and 2). The incoming branches of such toll lines extend respectively to the incoming selectors IS7 to IS5 in exchange B. These selectors may be controlled in the usual manner from the long-distance toll board. If the desired subscriber is a subscriber of exchange B, the incoming selector is operated into association with the concerned one of the first three levels thereof to make connection with a local connector, such as C1, which is then operated to complete the connection to the desired line of exchange B.

On the other hand, if the call is for local exchange C or local exchange D, the concerned one of the incoming selectors IS5 to IS7 is caused to associate itself with level 8 or level 9 thereof to make connection either with the toll line TL4 extending to exchange C or with the toll line TL5 extending to the exchange D, as the case may be. Following this, the concerned one of the repeaters OR4 and OR5 is controlled from the long-distance toll board to repeat the series of impulses constituting the remaining digits in the number to cause the connection to be completed to the desired line in the called exchange.

IG. Delayed calls at the local toll board

The delayed-call key K1 (together with the corresponding keys in the other cords) and the associated equipment enable the operator at the local toll board LTB to set up delayed-call (tail-to-tail) connections. She may set up such a connection under either of two conditions. First, if the operator has reason to doubt that the calling subscriber has given the designation of his own line, she may request him to replace his receiver and wait until he is called back. Second, if the called line is busy (a true delayed call), the operator may request the calling subscriber to replace his receiver and wait until he is called back when the called line becomes available.

To originate one leg of a delayed-call connection over the cord circuit illustrated in Fig. 5, the operator may actuate the key K1 to the left, when the cord is idle, and the plug P1 is consequently not in a jack. When this occurs, the sleeve conductor associated with the plug P1 is

grounded by contacts of the key K1, to thereby cause the local repeater LR1 to respond in the same manner as when the plug P1 is inserted into a jack. Accordingly, line and release relays 506 and 507 operate sequentially and the associated selector IS1 (Fig. 2) is prepared for operation in the usual manner over conductor 550.

The left-hand contacts of K1 also bridge the associated common talking conductors across the tip and ring conductors of the cord. The common retard coil 503 thereupon provides a circuit for operating supervisory relay 508, through contacts of the operated release relay 507. Supervisory lamp 502 becomes lighted through contacts of release relay 507 and contacts of the polarized supervisory relay 510.

Leaving the delayed-call key K1 operated, the operator may now actuate the key K2 to dial position, and then operate the calling device OCD to cause the connection to be set up to the desired line as previously described.

When she completes the dialing of the number, the operator may transfer the key K2 from dial position to talking position and converse with the subscriber when he answers. She may request such subscriber to wait on the line while she completes the other portion of the connection.

To complete the second leg of the delayed-call connection, the operator actuates to the left the delayed-call key of another idle one of her cord circuits, thereby connecting the tip and ring conductors of the latter cord in parallel with the tip and ring conductors of the cord illustrated in Fig. 5, over the common conductors extending between the keys such as K1 and the retard coil 503. The second leg of the delayed-call connection may then be extended in the same manner as described for the first leg of such connection.

When the call over the second leg of the connection has been answered, the two subscribers may converse with each other, as the talking conductors of the two cords are then interconnected through the delayed-call keys thereof, both actuated to the left-hand position in association with the conductors leading to retard coil 503.

If the occasion arises, the operator may set up a second delayed-call connection while the first one exists, this time actuating the delayed-call keys of the concerned idle cord circuits to the right to bring the talking conductors of such cords into association with the common talking conductors associated with retard coil 504.

IH. The operator's local line

As previously noted, the operator at the local toll board LTB is provided with a local line 512. This line may be one of the local lines equipped for the usual two-way subscriber service, being a line of one of the three hundreds groups of exchange B. The usual substation ringer is bridged across the conductors of local line 512, through contacts of the dial and answer position of the key K3, whereby the operator is signaled in the usual manner when called over the local line 512.

When the operator answers the local call, by actuating the left-hand contacts of the key K3, the usual direct-current answering bridge is placed across the conductors of line 512. This bridge includes the operator's telephone OT, contacts of the key K3 and the impulse contacts of the calling device OCD. When the conversation is terminated, the operator may restore the key K3, freeing the local line.

When the operator desires to originate a call

over local line 512, she may do so by actuating the left-hand contacts of the key K3, thereby bridging her headset conductors across the local line in series with the impulse contacts of the calling device OCD. By operating this calling device, the operator may extend the local line in the usual manner. The lower contacts of the calling device OCD shunts the operator's telephone during such time as the calling device is in an off-normal position, thereby improving the dialing circuit and avoiding disagreeable clicks in the receiver of the operator's telephone.

If, while conversing over the local line 512, the operator must temporarily attend to other duties, she may acquaint the called subscriber of this fact and then transfer the key K3 from dial position to hold position, thereby restoring the left-hand contacts thereof and actuating the right-hand contacts of such key. Retard coil 505 is thereby bridged across the local line 512 to hold the connection until the operator returns to it and reactuates the key K3 from its right-hand position to its left-hand position.

The connection extended over local line 512 is cleared out in the usual manner when the operator restores the key K3 to normal position.

II. NIGHT OPERATION

The special arrangements for handling all locally originated toll calls through the long-distance toll board at night, or at other times, when the local toll board is unattended will now be described.

I. Initiating night operation

To initiate night operation, the operator at the local toll board LTB restores the day-night key K4 to normal position, open-circuiting and restoring transfer relay 415. At its outermost armature, relay 415 disconnects conductor 421 of the call switcher CS1 from conductor 423, and transfers it into connection with conductor 422, provided tone-control relay 412 is restored. At the same time, the remaining armatures of relay 415 make a similar transfer of the corresponding conductors of the call switchers CS2 to CS5.

If, at the time key K4 and relay 415 are restored to place the call switchers into condition for night operation, there exists a connection through one of these call switchers by way of the local toll board, such connection is not thereby disturbed. Considering the call switcher CS1, for example, conductors 422 and 423 are both open, at the contacts of tone-control relay 412, after a call has been answered at the local toll board and supervisory relay 409 has brought about the operation of relay 412. But, when the concerned calling subscriber has replaced his receiver and caused disconnect supervision to be given to the operator at the local toll board as hereinbefore described, and the operator has taken down the connection, tone-control relay 412 restores to join conductor 422 to conductor 421, through the back contact of the outer armature of transfer relay 415.

IIB. Extending locally originated toll calls

With common transfer relay 415 restored, when the call switcher CS1 of Figs. 2 and 4 is seized, over the toll line TL4, and relays 408 and 402 operate as previously described, ground potential is placed on conductor 422 over the following circuit path: from ground, through the front contact of the lower armature of start relay 402, over conductor 421, back contact of the

outer armature of the restored relay 415, and the lowermost contact pair of relay 412, to conductor 422, with start relay 402 in operated condition, causes the hunting portion of the call switcher (comprising test relay 403, hunting relays 404 to 406, and busy relay 407) to operate as hereinbefore described to cause the call incoming to the call switcher CS1 to be transferred over an idle one of the outgoing branches 451 to 453, and the corresponding one of the toll lines TL1 to TL3 of Fig. 2, to the long distance toll board in exchange A (Fig. 1).

If the locally originated toll call is for a line outside of the local system, such toll call may be completed by the operator at the long-distance toll board in the usual manner.

IIC. Completing local toll calls

When the operator at the long-distance toll board receives a call from the local system, over one of the toll lines TL1 to TL3, and learns that the desired line terminates in one or another of the local exchanges B to D, she may extend such connection to the called line in the desired local exchange by interconnecting the toll line over which the call was received to any other one of the toll lines TL1 to TL3 which happens to be idle at the time.

Upon the taking of the last-named one of the toll lines TL1 to TL3 for use at the long-distance toll board, the concerned one of the incoming selectors IS5 to IS7 is prepared for operation in the usual manner. Such selector responds in the usual manner to extend the connection toward the desired line. If the desired line is one of exchange B, the incoming selector is caused to associate itself with one or another of the first three levels thereof. If the desired line is one terminating in either of the exchanges C and D, the incoming selector is caused to associate itself with the level assigned thereto. From this point, the connection is completed to the desired called line as previously discussed.

IID. Delayed calls

Delayed calls between lines of the local system may be completed through the long-distance toll board by the setting up of a connection from such toll board over one of the toll lines TL1 to TL3 to the called line, and by joining such toll line with another one of the three toll lines and setting up a connection over the latter toll line to the calling line. This procedure may be used also when the operator at the long-distance toll board has reason to believe that the calling subscriber has not given the designation of his own line, and requests him to replace his receiver and wait until called.

III. Terminating night operation

When the operator returns to the local toll board LTB of Figs. 2 and 4 to resume operations thereat, she actuates the day-night key K4, thereby operating the common transfer relay 415 over conductor 416. Each of the call switchers is thereupon converted from night operation to day operation.

In the call switcher CS1 of Fig. 4, conductor 421 is disconnected from conductor 422 and is transferred into connection with conductor 423. If this occurs during a time when a connection exists through this call switcher over one or another of the outgoing trunk branches 451 to 453, the change-over has no immediate effect, for

conductor 422 is held energized at the lower contact pair of the then operated switching relay 401, and there is no energizing potential on conductor 421, for start relay 402 is then in a restored condition.

Upon the clearing out of the above-noted connection existing through call switcher CSI, relay 401 restores to return the call switcher to its normal condition. Thereafter, calls arriving at this call switcher do not pass automatically to the long distance toll board, but result in the lighting of the line lamp 501 at the jack J1, as previously described.

I claim:

1. In a telephone system, a group of local telephone exchanges each including automatic switching equipment controllable over calling lines thereof to set up connections therefrom to called lines thereof, other telephone exchanges, a local toll board, means effective when a subscriber of any local exchange desires a connection with a line other than a line of such exchange for extending connection from the calling line to said local toll board, means at said local toll board for extending such connections therethrough and by way of automatic switching equipment to desired called lines of said local exchanges, means including a long-distance toll board for completing toll connections to lines of said other exchanges; and means controlled from said local toll board, when a call received thereat is intended for one of said other exchanges, for completing a connection from the calling line to said long-distance toll board in by-pass of said local toll board.

2. In a telephone system, a group of local telephone exchanges each including automatic switching equipment controllable over calling lines thereof to set up connections therefrom to called lines thereof, other telephone exchanges, a local toll board, means effective when a subscriber of any local exchange desires a connection with a line other than a line of such exchange for extending connection from the calling line to said local toll board, means controlled from said local toll board for extending such connections by way of automatic switching equipment to desired called lines of said local exchanges, means including a long-distance toll board for completing toll connections to lines of said other exchanges; and means controlled from said local toll board, when a connection is extended thereto pursuant to a call to a line of one of said other exchanges, for extending a branch connection therefrom to said long-distance toll board.

3. In a telephone system, two exchanges, an operator's switchboard associated with the first

exchange, links incoming to said switchboard, means for extending connections from calling lines of the first exchange over said links respectively to said switchboard, separate switching means associated individually with said links and controllable by the operator at said switchboard, and means responsive to the actuation of the said switching means associated with any link over which a connection has been extended to said switchboard for diverting such connection from the operator's switchboard to the second exchange.

4. In a telephone system, two exchanges, an operator's switchboard associated with the first exchange, links incoming to said switchboard, means for extending connections from calling lines of the first exchange over said links respectively to said switchboard, switching means common to said links and controllable by the operator at said switchboard; and means responsive to the actuation of the said switching means for diverting, from the operator's switchboard to the second exchange, connections incoming over any of said links.

5. In a switching system, an operator's switchboard, a call switcher, a trunk line incoming to said call switcher, a first outgoing trunk line extending from said call switcher to said switchboard, other outgoing trunk lines extending from said call switcher to another destination, control means associated with said switcher and capable of assuming two positions, means responsive to the control means being in one position for extending a call received over said incoming trunk line over said first outgoing trunk line to the operator's switchboard, and means responsive to said control means being in the other position when there is a call incoming to the call switcher for selecting an idle one of said other outgoing trunk lines and for extending the call thereover.

6. In a switching system, an operator's switchboard, a call switcher, a trunk line incoming to said call switcher, a first outgoing trunk line extending from said call switcher to said switchboard, other outgoing trunk lines extending from said call switcher to another destination, control means associated with said switcher and capable of assuming two positions, means responsive to the control means being in one position when a call is received over said incoming trunk line for extending such call over said first outgoing trunk line to the operator's switchboard, and means responsive to said control means subsequently assuming the other position for selecting an idle one of said other outgoing trunk lines and for extending said received call thereover.

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