Oct. 13, 1942. G. KINER ET AL 2,298,488

SPECIAL-SERVICE AUTOMATIC TELEPHONE SYSTEM

Filed May 21, 1941 3 Sheets-Sheet 1

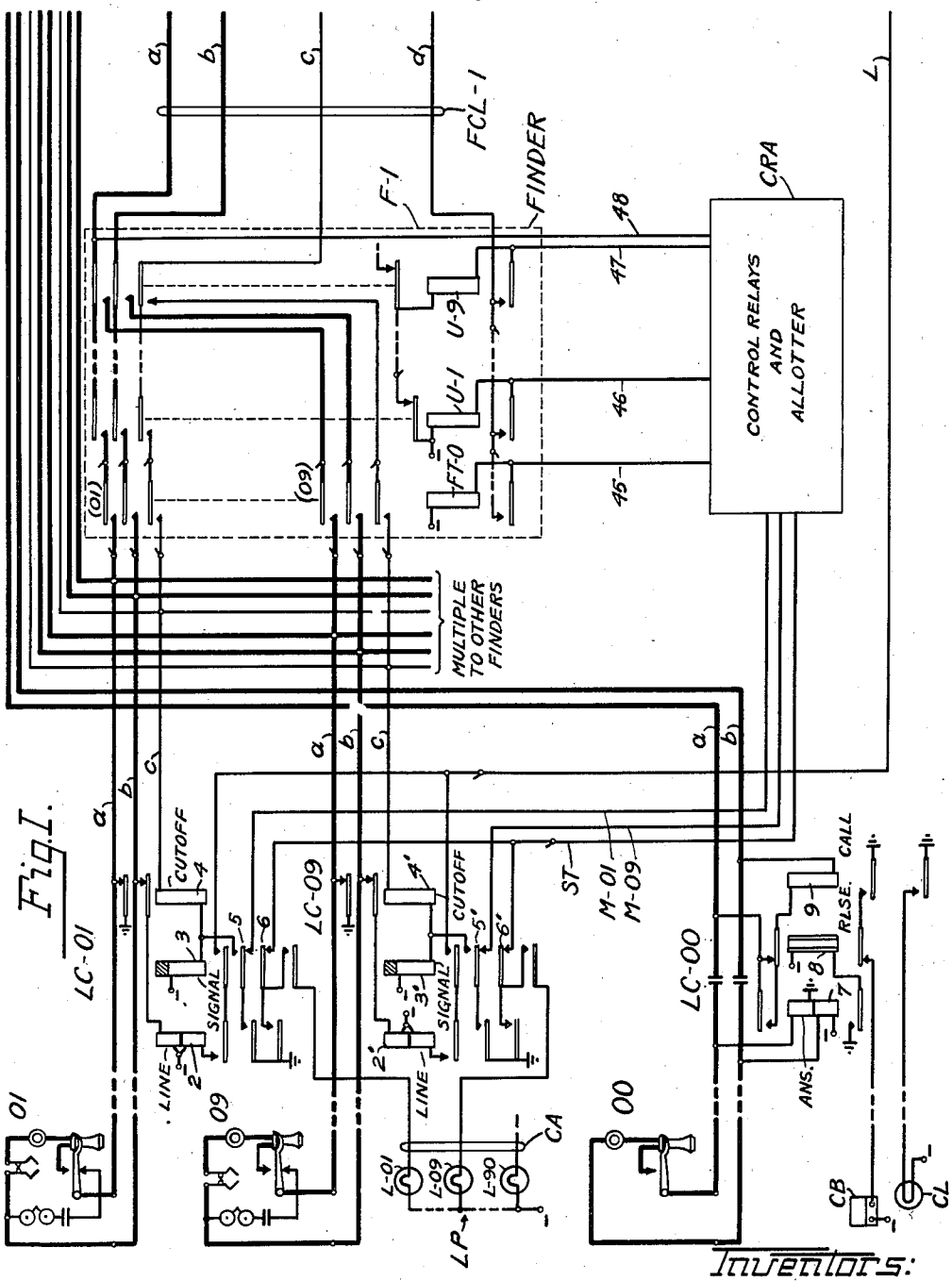


Fig. 1.

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Filed May 21, 1941 3 Sheets-Sheet 2

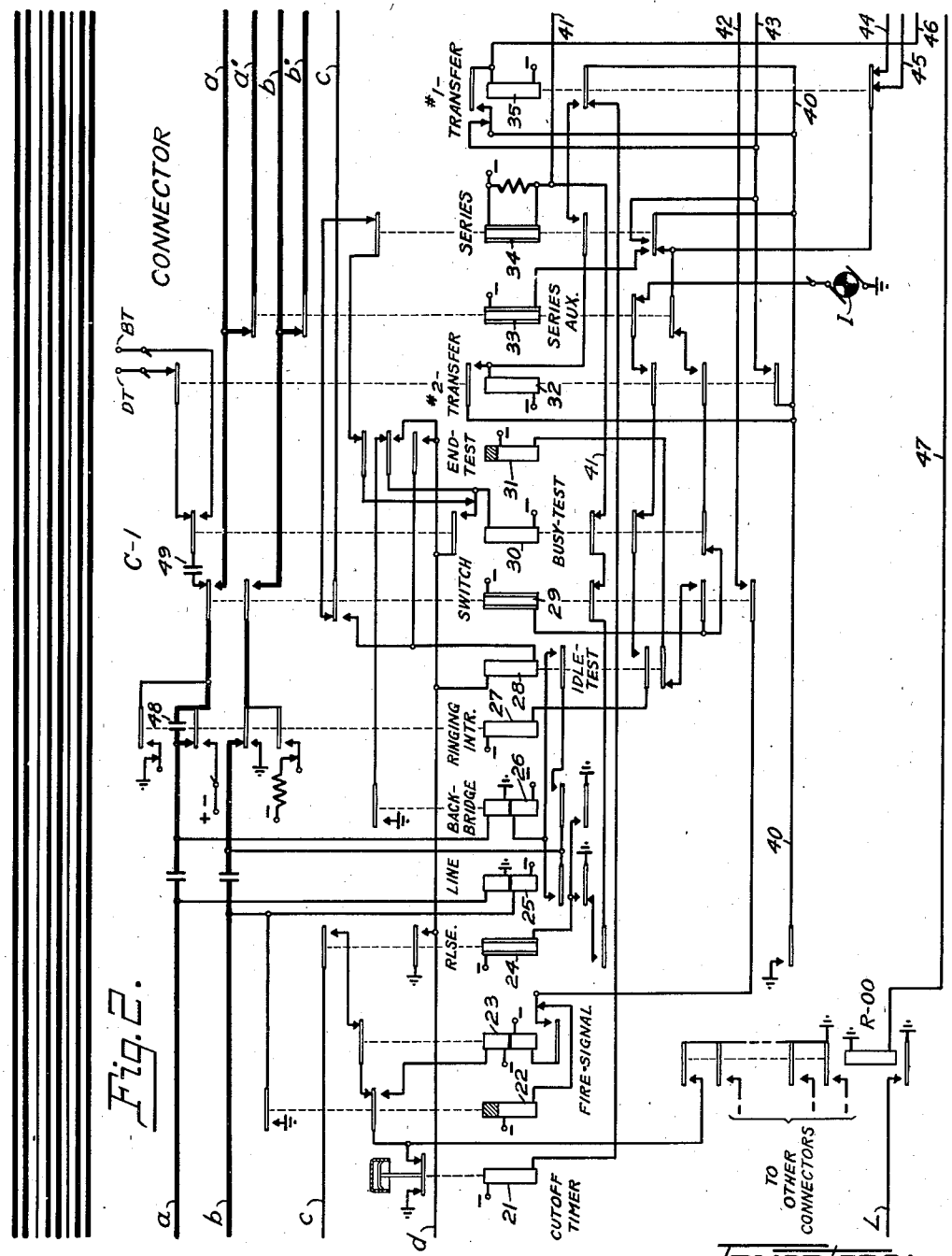


Fig. 2.

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Filed May 21, 1941 3 Sheets-Sheet 3

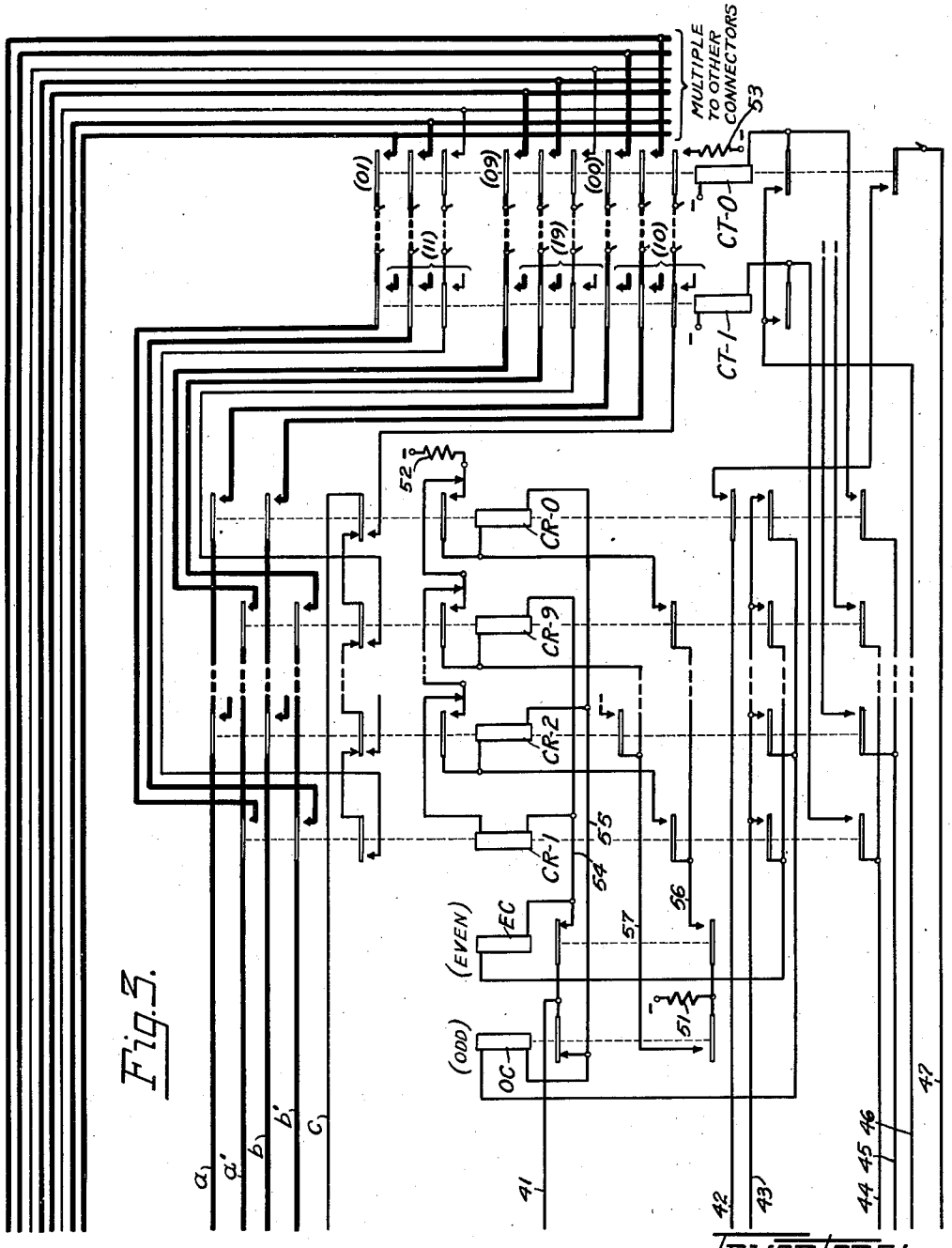


Fig. 3.

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Patented Oct. 13, 1942

2,298,488

UNITED STATES PATENT OFFICE

2,298,488

SPECIAL-SERVICE AUTOMATIC TELEPHONE SYSTEM

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Application May 21, 1941, Serial No. 394,434

6 Claims. (Cl. 179—5)

This invention relates to special-service automatic telephone systems, being concerned more particularly with a special-service automatic telephone system in which special provisions are made for handling calls made over the telephone system to report a fire for example.

One object of the invention is the provision of circuit arrangements effective when any subscriber of an automatic telephone system constructed according to the invention calls a special number, such as to report a fire, for example, to indicate the identity of the calling line to the supervisor answering the call.

A further object of the invention is the provision of circuit arrangements for signaling to the supervisor the identity of any line in calling condition over which dialing has not taken place at the expiration of a reasonable time, whereby the mere upsetting of a telephone by a guard in a prison or similar institution causes the location of such telephone to be signaled to the supervisor to enable an immediate investigation to be made.

A specific object of the invention is to provide circuit arrangements for accomplishing the objects stated above without increasing the number of conductors in the line multiple and, consequently, without increasing the number of contact pairs which must be closed by an automatic switch in setting up a connection.

General Description

The invention, although suited for more general use, is especially desirable in automatic telephone systems used in prisons, reformatories, and similar institutions, in connection with the reporting of fires from any one of the telephones in the buildings located on the grounds of the institution, although it may be used in connection with the reporting and detection of any other similar occurrences and disturbances.

The invention is disclosed as applied to an automatic telephone system having a nominal capacity of one hundred lines, the connections between the telephone lines being set up through finder-connector links, each such link being between a finder and a connector, each having access to the lines through what is termed a finder-connector multiple.

A feature of the invention is that a signal relay is provided in the individual line circuit of each regular-service line, through the action of which an individual signal circuit can be closed leading to the supervisor's station to indicate thereat the identity of the calling line whenever dialing does not follow within a reasonable time after a finder-connector link has been taken for use, as well as whenever a call is made from a line through a finder-connector link to the supervisor's line. A further feature is that the identity of the calling line is signaled to the supervisor each time a call is made to his line even though the caller replaces his receiver as soon as a connection has been made to the supervisor's line.

Other objects and features of the invention will appear as the description progresses.

The drawings

The accompanying drawings, comprising Figures 1 to 3, show sufficient of the equipment in a hundred-line telephone system embodying the invention to enable the invention to be understood.

Figure 1 shows the substations and line circuits of two of the regular-service lines of the system and of the special-service or fire-supervisor line, together with one of the finders having access to the regular-service lines; while

Figures 2 and 3 show a connector having access to all of the lines of the system, and linked with the finder of Figure 1 by the finder-connector link FCL—1.

Referring particularly to Figure 1, the line of substation O1 (telephone No. 01) extends from the illustrated substation O1, by way of the line-circuit LC—O1, to the usual three-conductor finder-connector multiple in the exchange. The line circuit LC—O1 comprises line relay **2**, relay **3**, and cutoff relay **4**. The line of substation O9 is similarly provided with line circuit LC—O9 having corresponding relays **2'** to **4'**.

Substation OO is the substation assigned to the fire supervisor, and it is used for incoming calls only. The line of substation OO extends by way of the special-service line circuit LC—OO to the connector multiple in the exchange, but is not present in the finder multiple, as it is used for receiving calls, but not for originating calls. The line circuit LC—OO is divided by the illustrated talking condensers into a calling branch and an answering branch, and is provided with answering relay **7**, slow restoring release relay **8**, and the bridged call relay **9**. Besides the talking conductors, two signaling conductors individual to the line of substation OO extends from the line LC—OO to the substation, one for the call buzzer CB and another for the call lamp CL.

The lamp panel LP is located adjacent substation OO to enable the supervisor to observe the lighted or unlighted condition of the lamps

therein. A separate lamp in the lamp panel LP is provided for each of the regular-service lines. Lamp L—90 is provided for the line of substation 90 (not shown); the lamp L—09 is provided for the line of substation 09; and the lamp L—01 is provided for the line of substation 01. The lamps in lamp panel LP are connected individually with the line circuits, each lamp to the line circuit of the line to which the lamp is assigned. The individual lamp conductors may be conveniently carried in a cable CA from the line circuits on the switchboard to the lamp panel LP at substation OO.

The finder-connector link FCL—1, together with the finder F—1 of Figure 1 and the connector C—1 of Figures 2 and 3, is one of a number of such links (say ten) arranged to interconnect calling lines in a finder multiple with called lines in the connector multiple. The finder-control relays and allotter CRA are indicated only by a rectangle, as the circuits of these control relays and allotter are well-known and form no part of this invention. It may be pointed out that the start conductor ST, common to line circuits LC—01 and LC—09 and the other line circuits in the "0" group, is shown extending into the equipment CRA, along with marking conductor M—01 of line circuit LC—01, and marking conductor M—09 of line circuit LC—09, in accordance with the usual practice. The other marking and start conductors are not shown.

Only one of the tens relays (FT—O) and two of the units relays (U—1 and U—9) of the finder F—1 are shown. It will be understood, of course, that the finder F—1 may be equipped with nine other tens relays, one for each of the tens groups 1 to 9, and may be equipped altogether with ten units relays, whereby any calling one of one hundred lines can be connected individually to the link FCL—1 by energization of the tens relay corresponding to the tens group of the calling line, and the units relay corresponding to the units designation of the line.

The connector C—1 of Figures 2 and 3 is linked to the finder F—1 of Figure 1 by the link FCL—1, having line conductors *a* and *b*, test conductor *c*, and the hold conductor *d*.

The connector C—1 includes cutoff-timer relay 21; fire-signal relays 22 and 23; release, line, and back-bridge relays 24, 25, and 26; ringing-interrupter, idle-test, and switching relays 27, 28, and 29; busy-test, end-test and #2-transfer relays 30, 31, and 32; series-auxiliary, series, and #1-transfer relays 33, 34, and 35; together with the relays of Figure 3. The relays of connector C—1 shown in Figure 3 include the odd and even control relays OC and EC; ten counting relays CR—1 to CR—O, of which only relays CR—1, CR—2, CR—9, and CR—0 are shown; and ten tens relays CT—1 to CT—0, of which only relays CT—1 and CT—0 are shown.

With reference to the illustrated finder-connector multiple, it should be noted that this multiple contains three conductors (two talking conductors and a test conductor) for each of the regular-service lines, such as the line of substations 01 and 09 of Figure 1, but the connector multiple for the special-service line OO (used only for receiving calls, and has no finder multiple) has only two conductors therein, the two talking conductors. No third conductor is included in the connector multiple of special-service line OO in order to enable as many connections as may be desired to be extended to this line at the same time, for it is desirable for a fire, for example, to be reported thereover irrespective of a previous connection made to that line. The contact in the "00" contact set of the tens relay CT—O which corresponds to the connector-multiple test contact in the other contact sets is connected to battery through the resistor 53, individual to the connector C—1, a similar resistor being provided in each of the other connectors. This resistor enables the connector to function in the absence of a connection to battery through a cutoff relay when the special-service No. 00 is called.

Additionally, relay R—OO (Figure 2) is provided in common for all of the connectors, to operate in conjunction with the fire signal relays 22 and 23 of the connector C—1 and with similar relays in each of the other connectors. The principal purpose of the relay R—OO is to short out the contacts of the cutoff-timer relay 21 of all connectors when the special-service line OO is called. Relay R—OO also controls the application of ground potential to locking conductor L, over which the line circuits involved in calls to substation OO are temporarily held locked until the identity of the calling line has been established, even though the calling person should replace his receiver prematurely.

In order that the utility of the provisions herein disclosed be fully appreciated, it should be kept in mind that the inmates of a prison for example, desiring to cause confusion to enable a planned prison escape to be made more readily, may call from a telephone near which a group of them are congregated for this purpose and report that a fire or a disturbance has broken out at a certain location, giving a location remote from the proposed point at which the escape from the prison is to be attempted. By the arrangement disclosed herein, the identity of each line calling the special report No. 00 is made known on the lamp panel LP to the supervisor at substation OO, whereby the supervisor may cause an investigation to be made in the event that the person reporting a fire or a disturbance gives a location other than the immediate vicinity in which the substation of the calling line is located.

Detailed Description

The invention having been described generally, a detailed description of the operation of the disclosed apparatus will now be given. For this purpose, it will be assumed that someone at substation 01 desires to call someone who can be reached over substation 09.

Substation 01 calling substation 09

When the receiver is removed at substation 01, a direct current bridge is closed across the conductors of the associated line through the transmitter, receiver, and calling device thereof in series (assuming a simple series type of substation circuit to be used), closing an operating circuit through contacts of cutoff relay 4 for line relay 2. Line relay 2 thereupon operates and places ground potential on the "0" tens group start conductor ST and also on the individual marking conductor M—01, whereby the identity of the calling line is established in equipment CRA for the purpose of enabling a finder to make connection therewith.

The control relays and allotter equipment CRA now operate in the usual manner responsive to

the grounding of conductor ST and 01. Assuming that the finder F—1 is the one currently allotted, a battery potential is now placed on conductor 48 leading to the *a* conductor of the link FCL—1, thereby closing a circuit for the ground-connected upper winding of line relay 25, to prepare the connector C—1 for operation. Upon operating, line relay 25 closes a circuit for release relay 24. Release relay 24 thereupon operates and places ground potential on the local conductor 40; places ground potential on the hold conductor *d* of the finder-connector link; and at its uppermost armature it connects the *c* conductor of the link FCL—1 to ground through contacts of relays 23, 22, and 21.

Also, conductor 45 is grounded in the equipment CRA to cause the operation of the "0" tens relay FT—O, and conductor 47 is grounded to cause the operation of the "9" units relay U—9. Relays FT—O and U—9 accordingly operate and each locks itself to the now-grounded hold conductor *d* of the finder-connector link. The *a*, *b*, and *c* leads of the finder-connector multiple of the line of substation 01 are now connected through contacts of the operated relays FT—O and FT—9 to the *a*, *b*, and *c* leads of the link FCL—1.

The ground potential which has been placed on the *c* lead of the finder-connector link FCL—1 by release relay 24 is now effective to guard the line of substation 01 against intrusion by way of the connector multiple, and to operate cutoff relay 4 in series with signal relay 3. Signal relay 3 is preferably slow-operating, as indicated by the shaded upper portion thereof, whereby its operation is delayed until after cutoff relay 4 has operated, and line relay 2 has restored. Upon the operation of cutoff relay 4, ground and the upper winding of line relay 2 are disconnected from the associated talking conductors, whereupon line relay 2 restores and removes ground potential from conductors ST and 01. A moment later, lockout relay 3 operates. Since line relay 2 has already restored at this time, signal relay 3 does not now close a locking circuit for line relay 2 through inner contacts of the two relays in series, even though the locking conductor L should be grounded at this time.

The control relays of the equipment CRA may now clear out and the allotter portion therein may move on to the next finder (not shown), disassociating itself from conductors 45 to 48. The initial circuits of relay FT—O and U—9 are thereupon opened, leaving these relays locked over hold conductor *d*, grounded at the inner upper armature of the release relay 24. The allotter control over line relay 25 is likewise terminated, leaving line relay 25 now operated over the calling line and through substation 01.

With local conductor 40 now grounded at contacts of relay 40, a circuit exists through contacts of relay 35 for cutoff-timer relay 21, but this relay has a delayed-operation characteristic and therefore does not operate for some time (fifteen seconds for example).

Dial-tone current from the common dial-tone lead DT may now be impressed on the upper talking conductor through the upper contacts of relays 32, 30, 29, and 27, thereby giving a dial-tone signal in the receiver of the calling substation to inform the caller that he may now begin to dial the digits in the desired number. When the first digit of the called number (the digit 0 of the number 09) is dialed, the circuit of line relay 25 is interrupted ten times momentarily. Relay 25 is thereby restored momentarily ten times. Each time it restores, line relay 25 opens the circuit of release relay 24, but release relay 24, being slow to release, remains operated throughout the series of restorations of relay 25.

As a further result of each restoration of line relay 25, ground potential is placed on impulse conductor 41 at the lower armature and back contact of relay 25, through the inner lower contacts of the operated release relay 24, by way of contacts of relays 29 and 30. Series relay 34 (so called because it remains operated throughout the series of impulses) operates responsive to the transmission of the first impulse to conductor 41, and, being a slow-restoring relay, remains operated until after the last impulse of the series has been received. The slow-restoring action of series relay 34 comes partly from the indicated copper sleeve around the core thereof, and partly from the illustrated resistor in shunt of its winding, which resistor also serves to reduce the tendency of sparking at the back contact of the lower armature of line relay 25 during the delivery of a series of impulses. At its lower armature, relay 34 ungrounds conductors 44 and 45 and operates slow-restoring auxiliary relay 33.

As a result of the delivery of the first ground impulse to conductor 41 by line relay 25, a circuit is closed from ground on conductor 41, through contacts of the even-control relay EC, the winding of the first counting relay CR—1, contacts controlled, respectively, by the inner upper armatures of the counting relays CR—2 to CR—0, and thence to battery by way of resistor 52. Relay CR—1 thereupon operates and closes all its illustrated contacts. The closure of the inner lower contact pair of relay CR—1 prepares a circuit for operating the second counting relay CR—2, but this circuit is incomplete during the delivery of the first impulse because relay EC is not yet operated.

At its middle lower contact pair, relay CR—1 closes a locking circuit for itself in series with the even-control relay EC, from ground potential on conductor 43. Conductor 43 is grounded at this time because it is connected, through contacts controlled by the upper armature of relay 35 to local conductor 40, grounded at the lower armature of the operated release relay 24. The locking circuit for relay CR—1 is from ground on locking conductor 43, through the middle lower contact pair of relay C—1, the winding of relay EC, the winding of relay C—1, and thence to battery by way of the control chain and resistor 52. Relay EC does not operate during the remaining portion of the impulse because it is short-circuited during this time by the ground potential on impulse conductor 41, applied through contacts of relay EC to the junction of the windings of the relays EC and CR—1.

When the first impulse is terminated, the initial operating circuit of relay CR—1 is thereby opened, whereupon relay EC operates in the previously traced locking circuit in series with relay CR—1. Upon operating, relay EC disconnects impulse conductor 41 from conductor 54 to prevent a shunting of the winding of relay EC when the second impulse is delivered. Relay EC also connects the battery-supply resistor 51 through its lower contacts to conductor 56, associated with the even-numbered counting relays CR—2 to CR—0. Conductor 56 has been connected at the lower contacts of relay CR—1 to the second counting relay CR—2.

When the second ground impulse is impressed

on conductor 41, conductor 41 has been disconnected from conductor 54 at the inner contacts of relay EC (whereby relay EC is not shunted at this time), but is still connected to conductor 55 through the inner contacts of relay OC, whereby a circuit is closed from conductor 41 through the said inner contacts of relay OC, conductor 55, the winding of the second counting relay CR—2, the inner lower contacts of relay CR—1, the lower contacts of relay EC, and resistor 51, to battery. Relay CR—2 thereupon operates. At its inner upper armature, it locks the upper terminal of its winding to battery through contacts of the remaining counting relays and resistor 52, at the same time disconnecting and restoring relay CR—1 and relay EC; at its inner lower contacts, relay CR—2 connects up the next odd-numbered counting relay CR—3 (not shown); and at its middle lower armature, it connects the grounded conductor 43 to the upper terminal of the winding of the odd-control relay OC, thereby closing a locking circuit for the windings of relays OC and CR—2, over conductor 55. Nevertheless, relay OC does not operate during the current impulse, because it is short-circuited by the ground potential supplied over conductor 41 through contacts of relay OC to conductor 55.

When the second impulse is terminated by the removal of ground potential from conductor 41, the shunt is thereby removed from around the winding of the odd-control relay OC, whereupon relay OC energizes in series with relay CR—2 over a circuit from ground on locking conductor 43, through the middle lower contacts of relay CR—2, relay OC, conductor 55, relay CR—2, the inner upper armature and front contact of relay CR—2, and thence to battery through the illustrated contact chain and resistor 52. Upon operating, relay OC connects the battery-supply resistor 51 to conductor 57, associated with the odd-numbered relays CR—3 to CR—9 (relays CR—3, CR—5, and CR—7, being among those not shown).

Responsive to the third to eighth impulses impressed on conductor 41, the third to eighth counting relays CR—3 to CR—8, respectively (not shown), operate as described for relays CR—1 and CR—2. The even-control relay EC operates in the locking circuit of each of the odd-numbered ones of such relays, at the end of the impulse delivered thereto, to apply battery potential to conductor 56 in preparation for the operation of the even-numbered one of the relays, while the odd control-relay OC operates in the locking circuit of each of the even-numbered ones of the said relays to apply battery potential to conductor 57 in preparation for the operation of the next odd-numbered relay.

Each of the counting relays, upon operation, restores the previously operated counting relay, and locks itself in the locking chain to battery by way of resistor 52.

At the end of the eighth delivered impulse—the eighth counting relay (not shown) has been operated, and has restored the seventh counting relay (not shown), relay EC restoring at the same time—relay OC operates in the locking circuit of the said eighth counting relay and prepares a circuit over conductor 57 for the ninth counting relay CR—9.

When the ninth impulse is received, a circuit is closed over impulse conductor 41, through contacts of the restored relay EC, conductor 54, winding of relay CR—9, closed contacts (not shown) on the eighth counting relay, conductor 57 and the lower contacts of the operated relay OC, to battery through battery-supply resistor 51. Relay CR—9 thereupon operates and prepares a circuit for relay CR—O at its inner lower contacts; locks itself to resistor 52 and restores the eighth counting relay (not shown) and relay OC at its inner upper armature and contacts; while at its middle lower armature, it locks itself in series with relay EC to conductor 43. Relay EC operates in locking circuit of relay CR—9 when the ninth impulse subsides, applying battery potential from resistor 51 to conductor 56 and thence, through contacts of relay CR—9, to the winding of relay CR—O.

When the tenth impulse arrives over conductor 41, it is transmitted through contacts of the restored relay OC, and over conductor 55 to the winding of relay CR—O, to the upper terminal to which the resistor 51 is now connected, as stated above. Relay CR—O thereupon operates and, at its inner upper armature and associated contacts, locks itself to battery through resistor 52 and restores relay CR—9 and relay EC, while at its middle lower armature, it locks itself to conductor 43, through the winding of relay OC. Relay OC, operates when the tenth impulse subsides, but its operation has no particular effect at this time because relay CR—O is the last one in the chain.

Of the counting relays, only relay CR—O is now in operated condition, the preceding ones having been unlocked and restored. A circuit is therefore prepared at the lower armature of counting relay CR—O for the "0" tens relay CT—O.

It will be remembered that there are ten tens relays, of which only the first and tenth are shown and that each relay has ten sets of contacts (thirty contact pairs) of which only three sets are shown for each of the relays CT—1 and CT—O.

Slow-acting series relay 34 restores at the end of the impulse series, opening the circuit of series-auxiliary relay 33 at its lower armature, enabling relay 33 to restore after a slight interval.

At its lower armature and back contact, relay 34 extends ground potential from the grounded local conductor 40 through the lower armature of relay 35 to the tens-relay-energizing conductors 44 and 45, thereby closing a circuit from ground on conductor 45 through the lower contacts of the operated counting relay CR—O for the "0" tens relay CT—O. Relay CT—O thereupon operates. At its inner lower armature, it connects its winding to the tens-relay locking conductor 46, thereby extending its energizing ground potential to the #1-transfer relay 35. Relay 35 thereupon operates and locks itself to the grounded conductor 40, thereby placing locking potential on conductor 46 to maintain relay CT—O energized after its initial circuit is opened.

The transfer relay 35 also, at the contacts controlled by its upper armature, disconnects the counting-relay-locking conductor 43 from the local locking conductor 40, thereby releasing the counting relay CR—O and relay OC, completely clearing out the counting chain. The initial circuit of CT—O is thereby opened at the lower armature of relay CR—O, but relay CT—O remains locked to the now-grounded conductor 46. At its inner lower armature, transfer relay 35 opens the circuit of cutoff-timer relay 21, permitting the timing mechanism of this relay to

restore before the contacts thereof have had time to open.

Relay **35** also prepares a circuit for the #2-transfer relay **32**, to become effective at the commencement of the dialing of the next digit, and at its lower armature, it removes ground from each of the conductors **44** and **45**, isolating these conductors from each other so as to prevent the ground potential reflected back to the lower contacts of the counting chain by the now-actuated and locked tens relay (relay CT—O in the present example) from operating another one of the tens relays when one counting relay is operated, and before the preceding relay has released.

When the next and final digit **9** is dialed, the impulses thereof are transmitted to the slow-restoring series relay **34**, as before, causing relay **34** to operate and remain operated throughout the series impulse. The series-auxiliary relay **33** is operated at the lower armature relay **34** to disconnect conductors *a'* and *b'* from the *a* and *b* outgoing conductors of the connector, to thereby prevent the talking conductors of two lines from becoming connected together by the operation of a counting relay, in the slight interval required for the preceding counting relay to restore. Relay **33** also opens points in the circuits of relays **27** and **29** so as to prevent premature operation of these relays.

At the lower armature of relay **34**, the grounded local conductor **40** is again connected to the counting-relay-locking conductor **43**, having been disconnected therefrom by transfer relay **35**, as pointed out, to permit the counting chain to clear out.

Series relay **34** also maintains the outgoing test lead *c* open at its upper armature during the dialing of the final digit, while at its lower armature it completes a circuit for the #2-transfer relay **32** which includes the inner lower armature and front contact of the #1-transfer relay **35**, and the grounded local conductor **40**. Relay **32** thereupon operates and locks itself at its inner upper armature to conductor **40**; disconnects the dial-tone lead DT at its upper armature to terminate the dial-tone signal; prepares circuits for relays **27** and **29** at its inner lower and middle lower armatures; and at its lowermost armature it connects conductors **40** and **43** together at another point to maintain the locking conductor **43** ground after series relay **34** has restored at the end of the digit.

The counting relays are operated successively as described hereinbefore, under the control of the relays OC and EC, as the impulses of the final digit 9 successively arrive, with the result that relay CR—**9** is operated by the ninth and last impulse of the series, and relay EC operates in series with relay CR—**9** at the end of the last impulse. All of the other counting relays, and relay EC, are in a restored condition at this time.

Slow-acting series, and series-auxiliary, relays **34** and **33** restore successively at the end of the units digit.

The operations now about to take place depend upon whether the called line is busy (in which there is a ground potential on the *c* conductor of the connector multiple of the called line to operate busy-test relay **30**); is a disconnected line (in which case, the test conductor thereof is open in the finder-connector multiple—that is, has neither battery nor ground thereon); or is idle (in which case, there is a battery potential on the *c* lead thereof in the finder-connector multiple to actuate idle-test relay **28**).

The called line is busy

Assuming now that the line of called substation **09** is busy, there is a ground potential on the *c* conductor thereof in the finder-connector multiple, whereby a circuit is closed from the said grounded conductor, through the lowermost contact pair of the set (**09**) of tens relay CT—O, the third armature from the top of the operated counting relay CR—**9**, corresponding armature of the unoperated relay CR—O, the outgoing *c* lead of the connector, inner upper armature and back contact of switching relay **29**, upper contact pair of series relay **34** and of end-test relay **31**, contacts controlled by the inner upper armature of relay **30**, to battery, through the winding of busy-test relay **30**. Busy-test relay **30** operates over the above-traced circuit and locks itself at its inner upper armature, to the hold lead *d* of the finder-connector link (grounded at the inner upper armature of release relay **24**), at the same time opening its initial circuit to avoid making an additional ground connection to the *c* lead of the called busy line. Busy test relay **30** also opens the impulse lead **41** at its inner lower armature to prevent further response of the relays **34** and **33**, and of the counting relays shown in Figure 3, in the event that the calling subscriber should dial another digit; it opens a point in the circuit of ringing-interrupter relay **27** in its middle lower armature; at its lower armature it opens a point in the circuit of switching relay **29** to prevent the latter relay from operating when slow-acting series-auxiliary relay **33** restores a moment later; and at its upper armature it applies busy-tone current from the common lead BT through the small condenser **49** to the talking circuit to inform the caller of the busy condition of the called line. When series-auxiliary relay **33** restores a moment later responsive to the restoration of series relay **34**, it closes points in the circuits of relays **27** and **29**, but neither of these relays can operate because of the previously described operation of the busy-test relay **37**.

Upon hearing the tone signal reaching the calling substation from the busy-tone lead BT, the caller is expected to replace the receiver at substation **01** and permit the connection to clear out in the manner to be described hereinafter.

The called line is disconnected

In the event that the called line is a disconnected one, and no potential is therefore encountered on the *c*, or test, lead thereof, busy-test relay **30** cannot operate over the outgoing *c* lead of the connector when connected thereto at the upper contacts of series relay **34** upon the restoration of the latter relay. In this event, the restoration of series-auxiliary relay **33**, a moment after series relay **34** restores, results in the closure of a circuit for switching relay **29** from the grounded local conductor **40** through the lower armature and back contact of relay **34**, lower contact pair of relay **33**, middle lower contact pair of relay **32**, lower contact of busy-test relay **30**, and thence to battery, through the winding of switching relay **29**. Relay **29** thereupon operates and completes a talking circuit from the calling line to the called-line multiple at its upper and middle upper armatures; at its inner upper armature, it transfers the outgoing *c* lead from the winding of busy-test relay **30** to the winding of idle-test relay **28**; opens the im-

pulse lead 41 at its inner lower armature to prevent further action thereover in case of further dialing; closes a point in the circuit of fire-signal relay 22 at its lowermost armature, but the latter relay does not operate at this time because its circuit is open at the contacts of relay CR—O; and at its middle lower armature it extends ground potential from the lower terminal of its winding, by way of the lower contacts of idle-test relay 28 to the winding of end-test relay 31. End-test relay 31 is slow-operating, as intended to be indicated by the cross-hatched upper portion thereof. The operation of relay 31 is thereby delayed sufficiently to enable idle-test relay 28 to operate first and disconnect relay 31 in the event that the called line is a connected one, and is idle. Under the present assumed example, the called line is disconnected and no circuit is closed for the idle-test relay 28. End-test relay 31 therefore operates after a slight interval. Upon doing so, at its upper armature, it disconnects the winding of busy-test relay 30 at another point from the outgoing *c* lead; at its middle armature, it connects the winding of busy-test relay 30 to the grounded hold lead *d*; and at its lowermost armature it short-circuits the idle-test relay 28 to avoid the possibility of a subsequent operation thereof before the connection is released. By the operation of busy test relay 30, busy-tone lead BT is connected through condenser 49 to the talking circuit to inform the caller that the called line is unavailable.

The called line is idle

Assuming now that the line of substation 09 is idle when called, busy-test relay 30 is unable to operate over the outgoing *c* lead of the connector because of the absence of ground potential on the *c* lead of the called line, and switching relay 29 operates as previously explained responsive to the restoration of series-auxiliary relay 33. Idle-test relay 28 now operates in the following circuit: from ground potential applied to the hold lead *d* at the inner upper armature of release relay 24, the winding of idle-test relay 28, front contact and inner upper armature of switching relay 29, the outgoing *c* lead of the connector, an armature and back contact of relay CR—O, an armature and front contact of the operated counting relay CR—9, lowermost contact pair in set (09) of the actuated tens relay CT—O, the corresponding *c* lead in the finder-connector multiple, the *c* lead associated with the line circuit LC—09, Figure 1, the winding of cutoff relay 4', and the winding of signal relay 3', to battery. Cutoff relay 4' operates at this time to clear the conductors of the called line for ringing and talking purposes. The slow-operating signal relay 3' operates after a slight interval, but with no effect, because line relay 2' is in a restored condition at this time.

In the connector C—I, idle-test relay 28 disconnects end-test relay 31 at its lowermost armature before the latter relay has had time to operate, while at its middle lower armature it completes a circuit for ringing-interrupter relay 27 including contacts of relays 30, 32, and 33, and the common interrupter I. Relay 27 is operated intermittently over this circuit to intermittently apply ringing current to the called line. Each time it operates, relay 27 disconnects the outgoing talking conductors from the incoming talking conductors and applies ringing current from the indicated common generator lead to the upper outgoing talking conductor, and makes a ground-return connection to the lower outgoing talking conductor. A small condenser 48 permits a sufficient, but small, flow of ringing current to pass back to the calling substation to give a ringing-tone signal in the receiver thereat to inform the caller that the called line is being signaled.

Connections are also shown in association with the outgoing talking conductors for applying ground potential momentarily (by a passing contact) to the upper talking conductor and for applying ground potential momentarily (by a passing contact) to the lower outgoing talking conductor as ringing-interrupter relay 27 restores after each application of ringing current, whereby the called line is "drained" and the condenser charge in the circuit of the ringer at the called substation is equalized with the potential applied to the talking conductors through the windings of back-bridge relay 26. This is the usual arrangement for avoiding undesired, disagreeable noises in the calling telephone upon the restoration of the ringing-interrupter relay following an application of ringing current.

When the call is answered by the removal of the receiver at the called substation O9, the resulting closure of a direct-current bridge across the talking conductors of the called line permits the operation of back-bridge relay 26 over the called line as soon as ringing-interrupter relay 27 restores, or immediately, if the call is answered between applications of ringing current.

Upon operating, back-bridge relay 26 makes a multiple application of ground potential to the winding of release relay 24 so as to hold the latter relay operated until the receiver is replaced at the called substation. It is to be noted that the initial circuit path for the lower winding 26 includes the inner lower contacts of the actuated line relay 25. Relay 26 locks itself independent of the contacts of the line relay by a circuit path including the inner lower contacts of relays 26 and 28 in series.

Back-bridge relay 26 also closes an operating circuit for busy-test relay 30 at its upper armature, whereupon busy-test relay 30 operates and locks itself to the ground on the hold lead *d*, while at its middle lower armature it disconnects the ringing-interrupter relay 27, thereby acting as a ring-cutoff relay to preclude further application of ringing current to the called line.

Conversation may now take place over the interconnected lines of substation O1 and O9, the talking conductors being heavily inked to show the circuit path over which conversation occurs. It may be pointed out that the talking conductors in use in the connector C—I of Figures 2 and 3 are the conductors *a'* and *b'*, connected with the outgoing *a* and *b* talking conductors through contacts of the restored series-auxiliary relay 33, and thence connected with the called line through contacts of the operated counting relay CR—9 and the (09) contact set of the operated tens relay CT—0.

Clearing out the established connection

Assuming that the receiver is replaced first at the called substation O9, back-bridge relay 26 in the connector C—I, Figure 2, thereupon restores to place the holding of the connection solely under the control of line relay 25. Under this condition, when the receiver is replaced at the calling substation O1, the restoration of line relay 25 results in the restoration of the slow-acting release relay 24 a short interval thereafter.

When relay 24 restores, it removes ground potential from local conductor 40, thereby restoring relays 29, 31, 32, 35, OC, CR—9, and CT—0. The connection between the calling and called lines is thereby broken, whereupon idle-test relay 28 restores, and relays 4' and 3', Figure 1, restore. Additionally, release relay 24 removes ground potential from the c lead of the finder-connector link FCL—1 at its upper armature to restore cutoff and signal relays 4 and 3, while at its inner upper armature it removes ground potential from the hold lead d, thereby restoring busy-test relay 30 in the connector C—1 and relays FT—0 and U—1 in the finder F—1.

The apparatus used in setting up the previously described connection is now in normal condition in readiness to be used in setting up of subsequent connections.

Trouble signaling

Let it be assumed that the line of substation O9 is placed in calling condition by an upsetting of the telephone apparatus, such as by a struggle between an inmate and a guard. In this case, the resulting closure of the hook-switch contacts causes line relay 2 to operate as before described to cause connection to be extended through an idle finder to the connector linked therewith. It may be assumed that the finder F—1 is the one currently allotted when this occurs. In this case, the connection is extended from the line of substation O1 through the finder F—1 to the connector C—1 as previously described. Also, as previously described, the extension of the connection to the connector C—1 results in the operation of line relay 25 and release relay 24 to prepare the connector for operation. Among other things, release relay 24 places ground potential on conductor 40 at this time, thereby closing a circuit through the lower armature and back contact of #1-transfer relay 35 for cutoff-timer relay 21. As before explained, relay 21 preferably requires some time (say fifteen seconds) for its operation. As a result, it is ordinarily disconnected by #1-transfer relay 35 at the end of the dialing of the first digit, as pointed out, before it has had time to operate. In the present assumed example, the seizure of the connector C—1 is not followed by a dialing operation, and relay 35 therefore does not operate. In this event, the circuit of cutoff-timer relay 21 remains closed long enough for the relay to open its contacts. When this occurs, ground potential is removed from the link conductor c by the contacts of relay 21, leaving conductor d grounded at the inner upper contacts of release relay 24 for the time being to maintain the relays of the finder F—1 locked. When the conductor c of the link FCL—1 is ungrounded as above pointed out, the circuit of cutoff relay 4 and of signal relay 3 is opened. Signal relay 3 is both slow-operating and slow-restoring. Upon restoring, cutoff relay 4 makes a ground connection to the upper conductor of the line of substation O9, and it connects the upper winding of line relay 2 to the lower conductor of the line. The upper winding of line relay 25 in the connector C—1 is short-circuited at this time, but the lower winding of the relay 25 remains energized in parallel with the upper winding of line relay 2, thus holding release relay 24 actuated to hold the finder F—1.

In the line circuit LC—O1, the energization of the upper winding of line relay 2 results in a reoperation of the line relay. The slow-acting signal relay 3 is still in operated condition, whereby the operation of line relay 2 results in the closure of a locking circuit for the winding of signal relay 3 through the middle contacts of relay 2 and armature 5 and its front contact. Signal relay 3 is thereby maintained operated as long as the trouble condition endures on the line of substation 09. The closure of the locking circuit for relay 3 results in the application of ground potential through the winding of cutoff relay 4 to the associated c lead of the finder-connector multiple to mark the line of substation O1 busy in the connector multiple.

With armatures 5 and 6 of signal relay 3 in operated condition, the operation of line relay 2 does not result in the grounding of the start and mark conductors ST and M—O1. Additionally, a circuit is closed through the lowermost contacts of relays 2 and 3 and over a conductor of cable CA for lamp L—O1 in lamp panel LP individual to the line of substation O1, indicating to the supervisor at substation OO that substation O1 is in calling condition but no call has been made.

The supervisor at substation OO may cause an investigation to be made, and the upset telephone to be righted, and the receiver to be replaced. When this has been done, line relay 2 restores and opens the circuit of lamp L—O1, at the same time opening the locking circuit of signal relay 3, marking the line as idle in the connector multiple and permitting the signal relay to restore. The restoration of signal relay 3 returns the line circuit LC—O1 to its normal condition.

The line relay 25 of the connector C—1 restores responsive to the replacing of the receiver at substation O1, resulting in the restoration of release relay 24 and initiation of clearing out of the connector C—1, and the finder F—1, and the restoration to normal of cutoff-timer relay 21.

Reporting a fire from substation O1

Let it be assumed now that someone in the vicinity of substation O1 observes that a fire has broken out and wishes to report the fact to the supervisor. To do this, he removes the receiver at substation O1 (assuming this to be the nearest substation) and dials the number 00, assigned for the reporting of observed fires and disturbances.

It may be assumed that the removal of the receiver at substation O1 results in the extension of a connection through the finder F—1 to the connector C—1, and in relay operation in the connector C—1 as described to prepare the connector for operation.

Responsive to the dialing of the first digit 0 in the desired number, relay operation as described hereinbefore takes place, including the successive operation of counting relays CR—1 to CR—0, and the operation of the tenth tens relay CT—0.

Conductor 47, controlling relay R—00, Figure 2, is common to all of the connectors. A circuit is now partially prepared for this relay at the lower contacts of relay CT—0. This circuit, however, is maintained open at the lower contacts of switching relay 29 until that relay operates, and is not then closed except when the second digit dialed is also an "0", to again operate relay CR—0.

When the second digit 0 is dialed, the relays of the counting chain are again operated as de-

scribed responsive to the ten impulses thereof. Relay CR—0 is again operated.

Connection with the called line is now made through the uppermost contacts of relay CR—0, and thence through the contact set (00) of relay CT—0. Keeping in mind that the called multiple of special-service line 00 does not include a test lead, being a two-conductor multiple as shown, the number 00 cannot test busy.

When relays 34 and 33 restore at the end of the impulse series, and switching relay 29 operates, idle-test relay 28 operates in series with resistor 53. At the same time, since the number called is 00, and relays CR—0 and CT—0 are in operated condition, relay R—00, operates in series with fire-signal relay 22, over the following circuit: from ground, by way of the winding of relay R—00, conductor 47, contacts of relays CT—0, and CR—0, conductor 42, contacts of switching relay 29 and of relay 23, and the winding of relay 22, to battery. Upon operating, relay R—00, at its lower armature, places ground on the locking conductor L to thereby prepare a locking circuit for the line relay in the line circuit of the line over which the call to the supervisor's line has been made, which line circuit is to be immediately placed in signal condition for identification purposes, by operations to be described shortly. Relay R—00 also applies ground potential to the junction of the armature of fire-signal relay 22 and the contacts of cut-off timer relay 21, thereby by-passing the contacts of the cutoff-timer relay to thus incapacitate such relay for the time being to bring the line circuit of the calling line into signal condition in the manner previously pointed out, responsive to the mere absence of dialing for an interval. This operation has no present purpose in the particular connector (the connector C—1) which has been used in making the call to the supervisor's line, but ground potential is likewise extended by other contacts of relay R—00, as indicated, to each of the other connectors, to thereby prevent the relay corresponding to 21 in each of the other connectors from placing calling line circuits in signal condition. This is done so as to prevent the possibility of confusing signals on the lamp panel LP during the period of identification of the calling line over which the supervisor's line has been called.

Fire-signal relay 22 operates over the above-traced circuit in series with relay R—00; it disconnects ground potential from the associated *c* lead of the link FCL—1 to place the calling line circuit LC—01 in signal condition; closes a circuit for the upper winding of fire-signal relay 23; and it places ground potential directly on the associated *b* lead of the link FCL—1 to hold the line relay 25 of the connector *c* operated temporarily, independent of whether or not the caller immediately replaces his receiver without waiting to converse with the supervisor. This ground potential serves also to afford a reoperating circuit for the line relay in the calling line circuit when it is being brought into lockout condition in the event that the calling subscriber decides to replace his receiver as mentioned.

Relay 23 now operates to substitute its own lower winding for the winding of relay 22 and to open another point in the ground-supply path to the associated *c* lead. Slow-acting relay 22 is restored after a slight interval, sufficiently long to enable the line LC—01, associated with the line over which the fire call was made, to be brought into signal condition.

Following the restoration of relay 22, line relay 25 is again under the control of the calling line.

In the line circuit LC—01, the previously mentioned removal of ground potential from the *c* lead of the link FCL—1 in the connector C—1, results in the restoration of cutoff relay 4 to again connect up line relay 2, relay 3 remaining operated for an interval. Line relay 2 operates at this time over a branch circuit through the *b* lead of the connection established through the finder F—1, to ground at the upper contacts of the relay 22, irrespective of whether or not a circuit exists therefor over the calling line and through the upper contacts of the cutoff relay 4 to ground. Bringing the line circuit into signal condition is thus not defeated by replacing the receiver immediately after calling the number 00. Upon operating, line relay 2 closes the previously described locking circuit at its middle lower armature, and through armature 5 and its front contact, for locking the slow-restoring lockout relay 3 to hold the latter relay operated. The common locking conductor L has been grounded at the lower contacts of relay R—00, Figure 2, operated only when the supervisor's number is called. Line relay 2, therefore, now closes a locking circuit for its lower winding, through contacts of the locked cutoff relay 3, and thence to ground over the common locking conductor L and the lower contacts of relay R—00. The line relay 2 is thus held operated for the time being to keep the line circuit LC—01 locked in signal condition irrespective of whether or not the caller replaces the receiver at substation 01 without waiting to converse with the fire supervisor.

A lighting circuit for identifying lamp L—01 in the lamp panel LP is now closed through the lower contacts of the relays 2 and 3.

Returning now to the point at which switching relay 29, Figure 2, operated to complete a circuit for the described operation of fire-signal relays 22 and 23, the talking circuit is completed at the two uppermost armatures of relay 29, whereupon back-bridge relay 26, connected up at the inner lower armature of line relay 25, operates over the called supervisor's line, the talking conductors of which are normally bridged in the line circuit LC—00, Figure 1, by the upper contacts of release relay 8, and the winding of call relay 9. Back-bridge relay 26 locks itself through contacts of idle-test relay 28 and brings about the previously described operation of relay 30 to open the circuit of ringing interrupter 27. Ringing current is thereby prevented from being applied to the called line.

With back-bridge relay 26 now operated, a multiple holding circuit is closed for release relay 24, whereby the connection is held from the called fire supervisor's line independent of the calling line.

Call relay 9 in line circuit LC—00, Figure 1, now closes a circuit for the call lamp CL at the supervisor's station, and it also closes a circuit through contacts of release relay 8 for the call buzzer CB to thus audibly call the attention of the supervisor to the call.

When the fire supervisor removes the receiver at his substation 00, he is placed in immediate telephonic communication with the calling line. Answering relay 7 shunts the upper contacts of relay 8, and it operates slow-restoring release relay 8 to disconnect the call buzzer CB, and to prepare for subsequently opening the associated

call bridge across the line to let the connection clear out.

Assuming now that the caller at substation 01 is making a report, of an observed fire for example, in good faith, and has not therefore made a call mischievously and replaced his receiver, the supervisor may converse with the caller at substation 01 over the established connection and learn of the purpose of the call. By observing the lighted condition of the lamp L—01, the supervisor is able to confirm that the call was in fact made from substation 01, and can thus cause steps to be taken to cope with the reported situation.

Since the line of the supervisor has not been made busy in the connector multiple, a second call may be received by the supervisor over another finder-connector link while the current connection is still established. In this event, the fire-signal relays corresponding to relays 22 and 23 of Figure 2 are operated in the other connector to cause the second connection to be held, and the line circuit concerned to be brought into signal condition and locked to the common conductor L, causing the lamp individual to the associated calling line to become lighted in the lamp panel LP to indicate to the supervisor the identity of the second substation from which another or the same fire or other happening is being reported. By being now connected to the *a* and *b* talking conductors in the connector multiple of the line of the supervisor, the back-bridge relay of the other connector over which the supervisor has been called is operated in multiple with the back-bridge relay 26 of the connector C—1, and both back-bridge relays are held through the calling bridge in line circuit LC—00, through the winding of call relay 9.

When the conversation with the supervisor has been completed, the caller at substation 01, (as well as the caller at any other substation over which a call has been made to the fire supervisor) is expected to replace his receiver.

When the receiver is replaced at substation 01, line relay 25 restores, leaving back-bridge relay 26 locked through the inner lower contacts thereof and the corresponding contacts of idle-test relay 28, and leaving release relay 24 held only by back-bridge relay 26. A similar operation occurs in any other connector through which a connection may have been extended to the supervisor's line.

When the supervisor replaces his receiver at substation 00, line relay 7 restores and opens the circuit of slow-acting release relay 8. Line relay 7 also opens the bridge including call relay 9, release relay 8 momentarily remaining in operated position. Call relay 9 now restores and extinguishes call lamp CL. Release relay 8 restores a moment later and again bridges call relay 9 across the associated talking conductors.

In connector C—1, back-bridge relay 26 restores when its circuit is momentarily opened as above described. When it does so, line relay 25 having restored, relay 26 unlocks itself, and cannot therefore reoperate over the called line when the bridged condition thereof is reestablished when release relay 8, Figure 1, restores as described. Release relay 24 restores a short interval thereafter, causing the connection to be cleared out in the connector C—1 and the finder F—1 as previously described.

When connection is cleared out, relay 23 in the connector C—1 restores along with the other relays, its circuit being opened by relays 29, CR—0, and CT—O. The common relay R—00 is likewise restored, and it again places the connectors in condition to control the calling line circuits by the action of the cutoff-timer relays, such as 21. Additionally, locking conductor L is ungrounded by relay R—00, thus unlocking line relay 2 (and the corresponding relay in any other line circuit in signal condition). Since the receiver has been replaced at substation 01 at this time, line relay 2 now restores and opens a further point in its locking circuit, as well as opening the locking circuit of signal relay 3. Relay 3 restores shortly thereafter returning the line circuit LC—1 to normal condition, and extinguishing lamp L—01 in the lamp panel LP.

What is claimed is:

1. In a telephone system, lines terminating at a switchboard, link equipment at said switchboard effective to interconnect any calling one of said lines with any called one thereof, a supervisor's station, said link equipment being effective and also to connect any calling one of the said lines to said supervisor's station, display signal means at the supervisor's station, means effective when any one of said lines has been in an inactive calling condition for a predetermined length of time for causing said signal means to display the identity of such line, and means automatically effective whenever a connection is extended from any one of said lines to said supervisor's station for causing said signal means to display the identity of such line.

2. In a telephone system, lines terminating at a switchboard, each line having a line circuit individual thereto, link equipment at said switchboard effective to interconnect any calling one of said lines with any called one thereof, a supervisor's station including display signal means, and means effective incident to any one of said lines having been in an inactive calling condition for a predetermined length of time for causing said signal means to display the identity of such line.

3. In an automatic telephone system, a group of links, each link including dial-controlled switching equipment effective to extend a connection toward a called line, means responsive to the removal of the receiver on any one of said lines to initiate a call for interconnecting the calling line with an idle one of said links, whereby the dial-controlled switching equipment of said link is placed under the control of the dial of the calling line, a group of signal lamps, each signal lamp being individual to a separate one of said individual line circuits, time-controlled means in each link rendered effective upon interconnection thereof with a calling line for impressing a signal condition on the individual line circuit of the calling line responsive to the lapse of a predetermined time interval, means also in each link circuit responsive to said dial-controlled switching equipment of the link in the event that the dialing of the desired number is begun before the said predetermined interval of time elapses for disabling said time-controlled means, and means effective in any line circuit placed in said signal condition for closing a lighting circuit for the one of said lamps which is individual thereto, whereby the identity of the non-dialing calling line is displayed.

4. In an automatic telephone system, means including a group of automatic switches for interconnecting calling and called telephone lines, each calling line having a line circuit individual thereto including a signal relay, and means con-

trolled from any one of said automatic switches when interconnected with any calling one of said lines for operating said signal relay in the line circuit of the calling line responsive to the dialing of a predetermined number.

5. In an automatic telephone system, telephone lines, each of said lines having a line circuit individual thereto including a line relay, a cutoff relay, and a signal relay; automatic switches accessible in common to said lines, a locking relay common to said automatic switches, means for interconnecting any calling one of said lines with any one of said automatic switches, means responsive to the dialing of a predetermined number over the calling line for causing the one of said automatic switches in use to operate said common locking relay and to operate the said signal relay in the line circuit of the calling line, means also effective at such time for reoperating the line relay, a locking circuit for said line relay controlled by the line relay jointly with said signal relay and said common locking relay, and a signal circuit individual to the said calling line including contacts of the line and signal relays thereof.

6. In an automatic telephone system, a group of automatic switches, means for connecting calling lines separately to idle ones of said switches, separately designated lines accessible to said switches, each of said switches being responsive to the transmission of deignating dial pulses thereto from the connected calling line for extending connection to the line designated thereby, one of said lines accessible to said switches being a supervisory line extending to a supervisor's station, signal display means at said supervisor's station, means controlled from any one of said automatic switches responsive to a connection being extended therethrough to said supervisory line for locking up the connection between the calling line and the supervisory line to render it incapable of being released by control exercised over the calling line, and for causing said signal display means to display the identity of the calling line, and means controlled over said supervisor's line from the supervisor's station for unlocking the locked up connection and clearing it out.

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