Nov. 11, 1941. J. N. WALTERS 2,262,595

TELEPHONE SYSTEM

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FIG. 7

FIG. 4		
FIG. 3		
FIG. 2	FIG. 5	FIG. 6
FIG. 1		

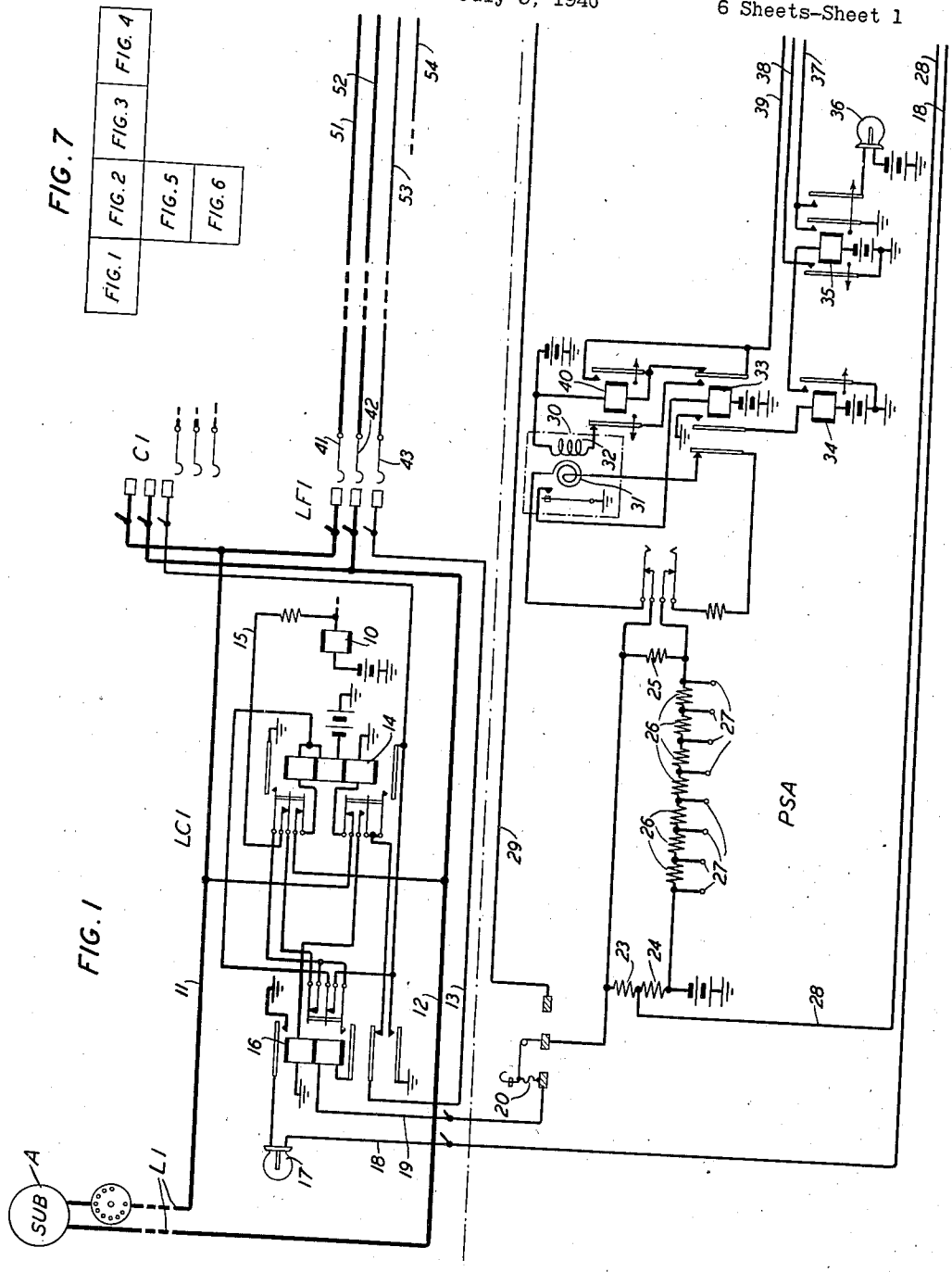

FIG. 1

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TELEPHONE SYSTEM

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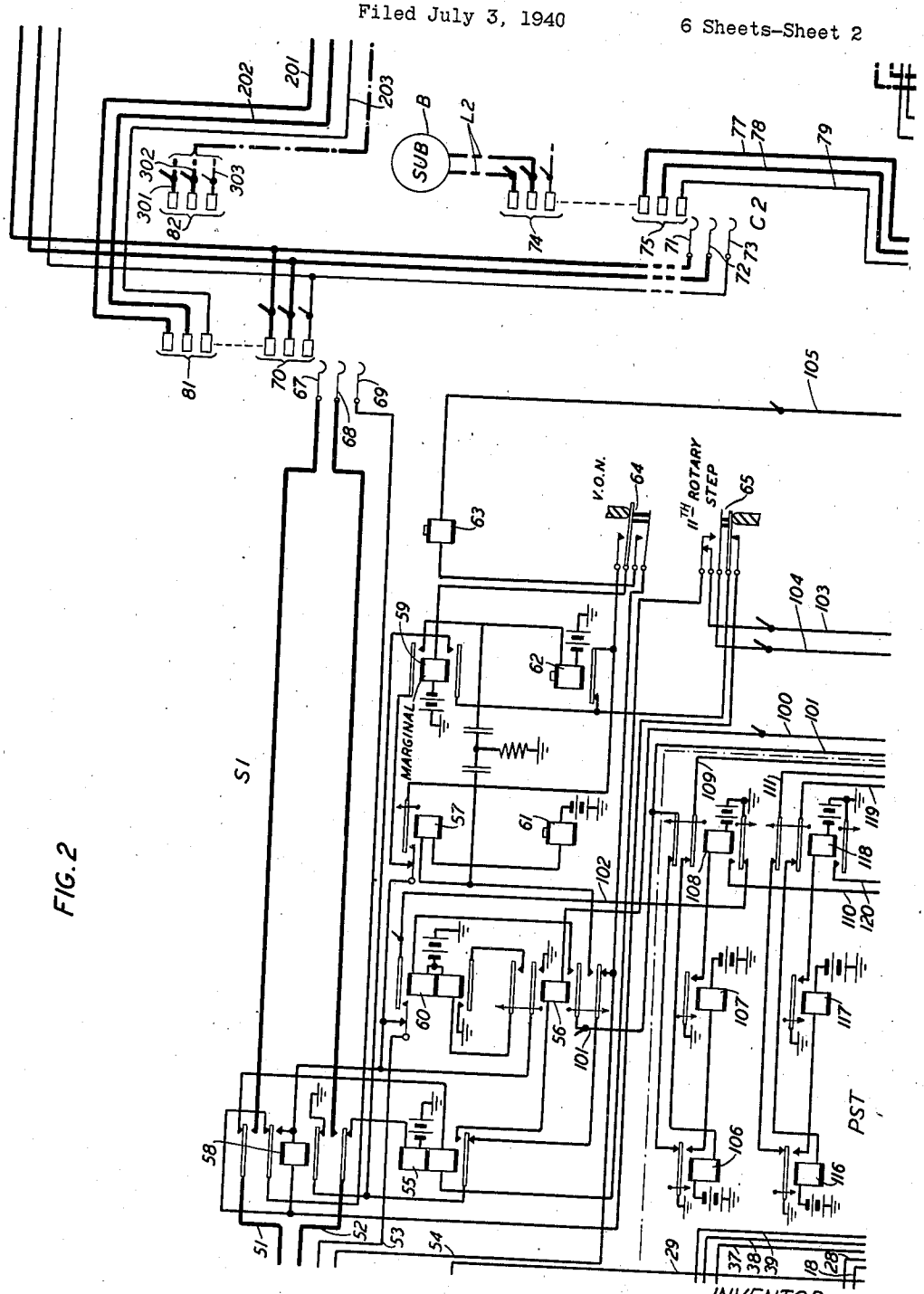

FIG. 2

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TELEPHONE SYSTEM

Filed July 3, 1940

2,262,595

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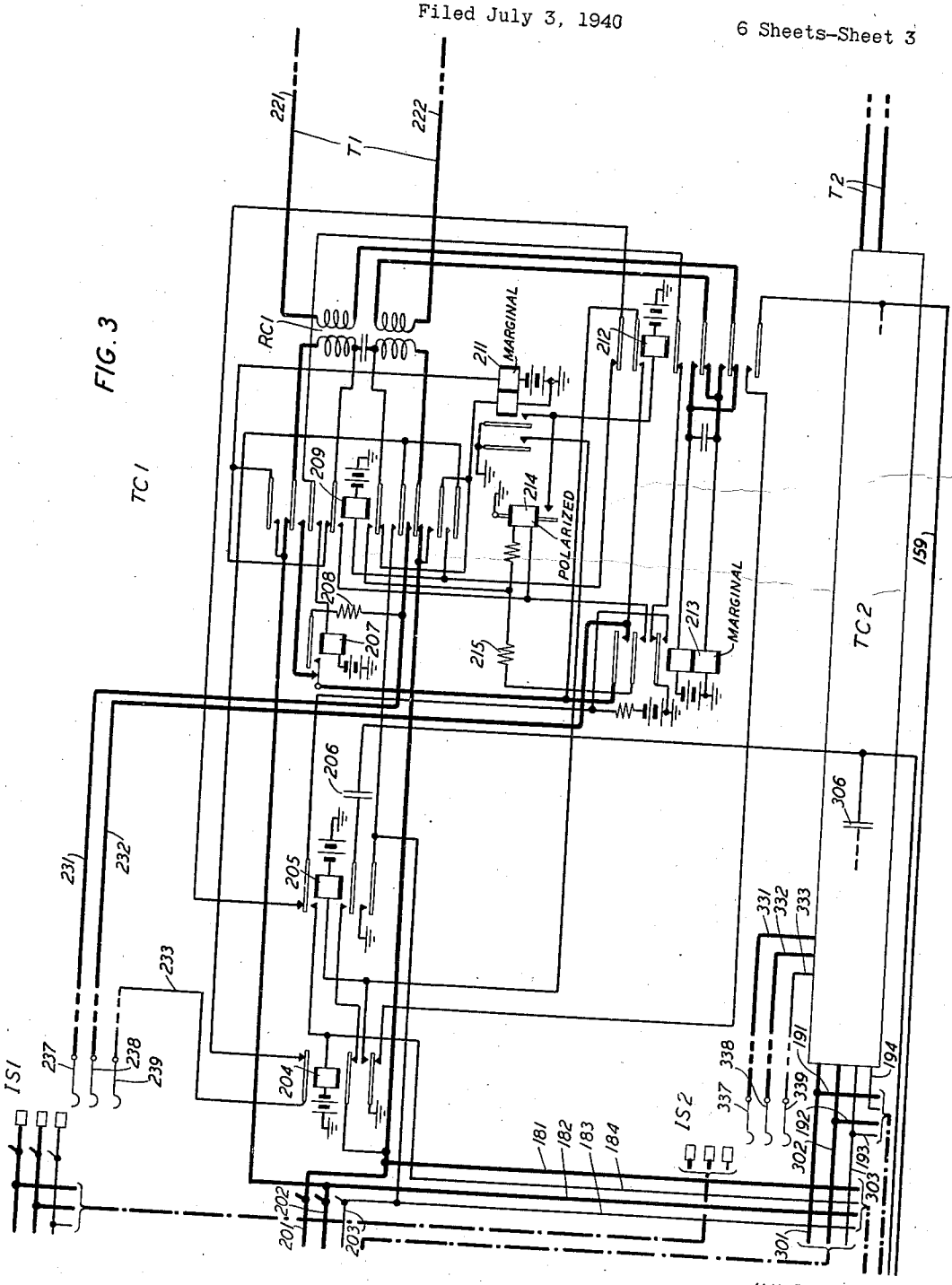
FIG. 3



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TELEPHONE SYSTEM

Filed July 3, 1940

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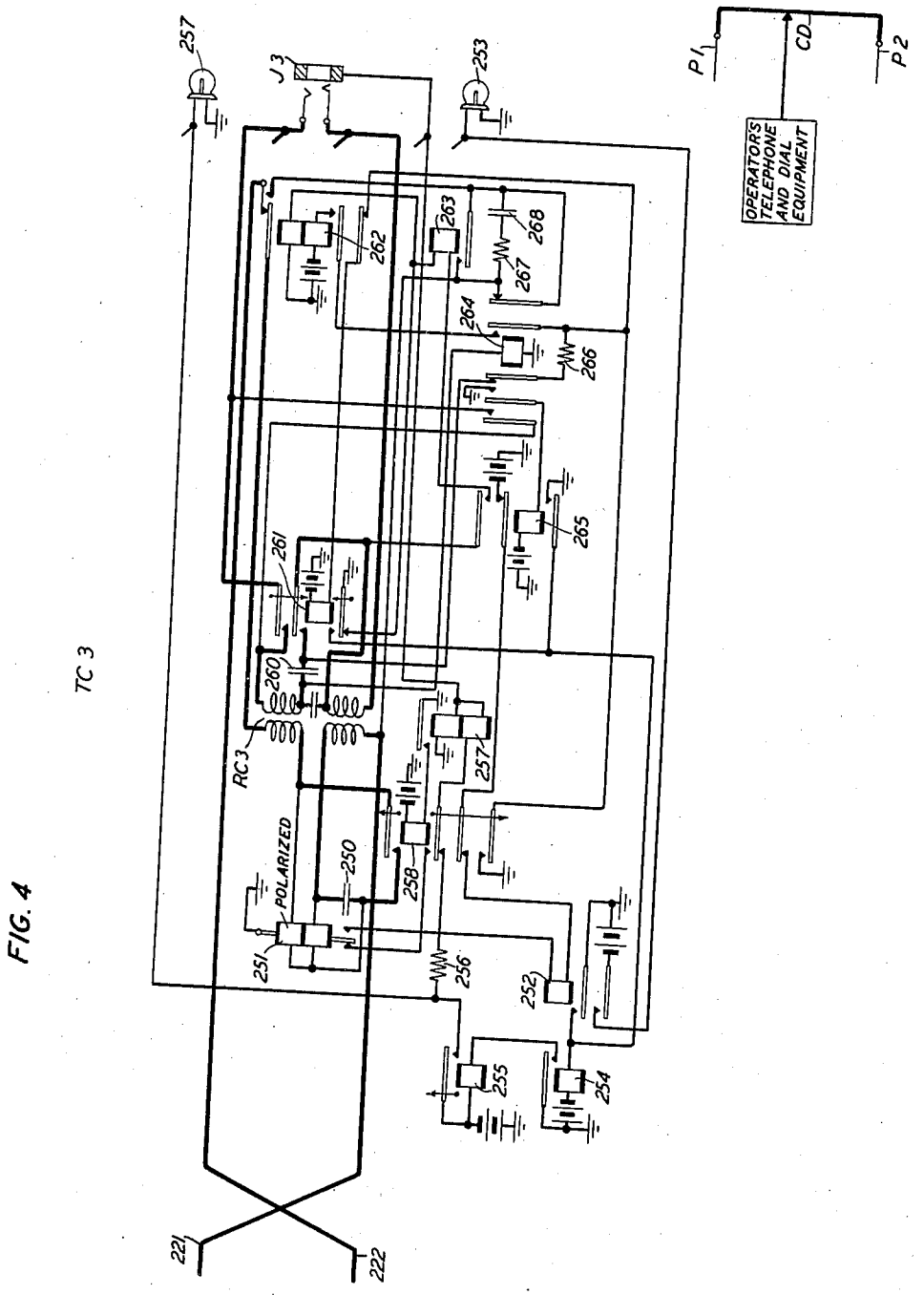

FIG. 4

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TELEPHONE SYSTEM

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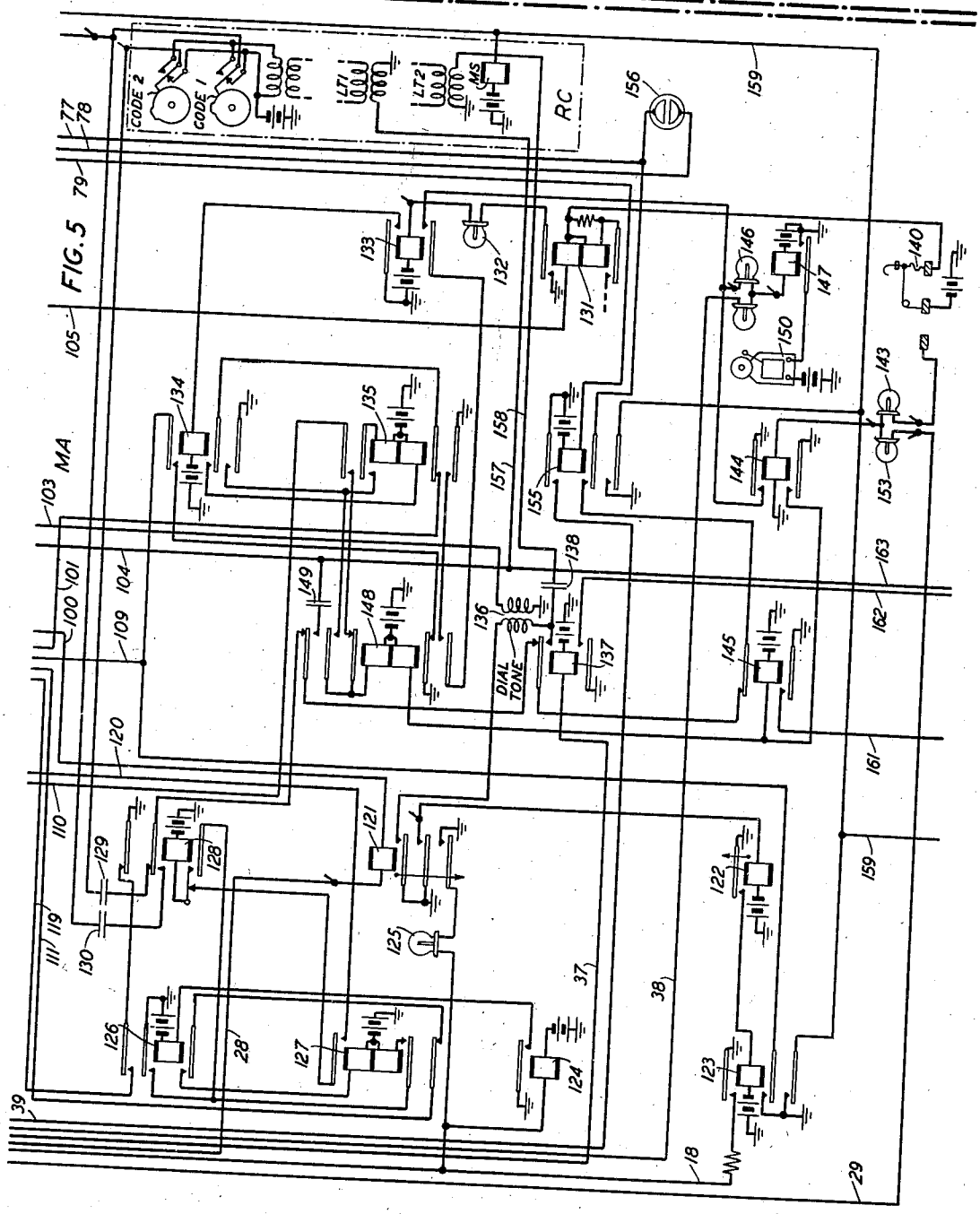

FIG. 5

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TELEPHONE SYSTEM

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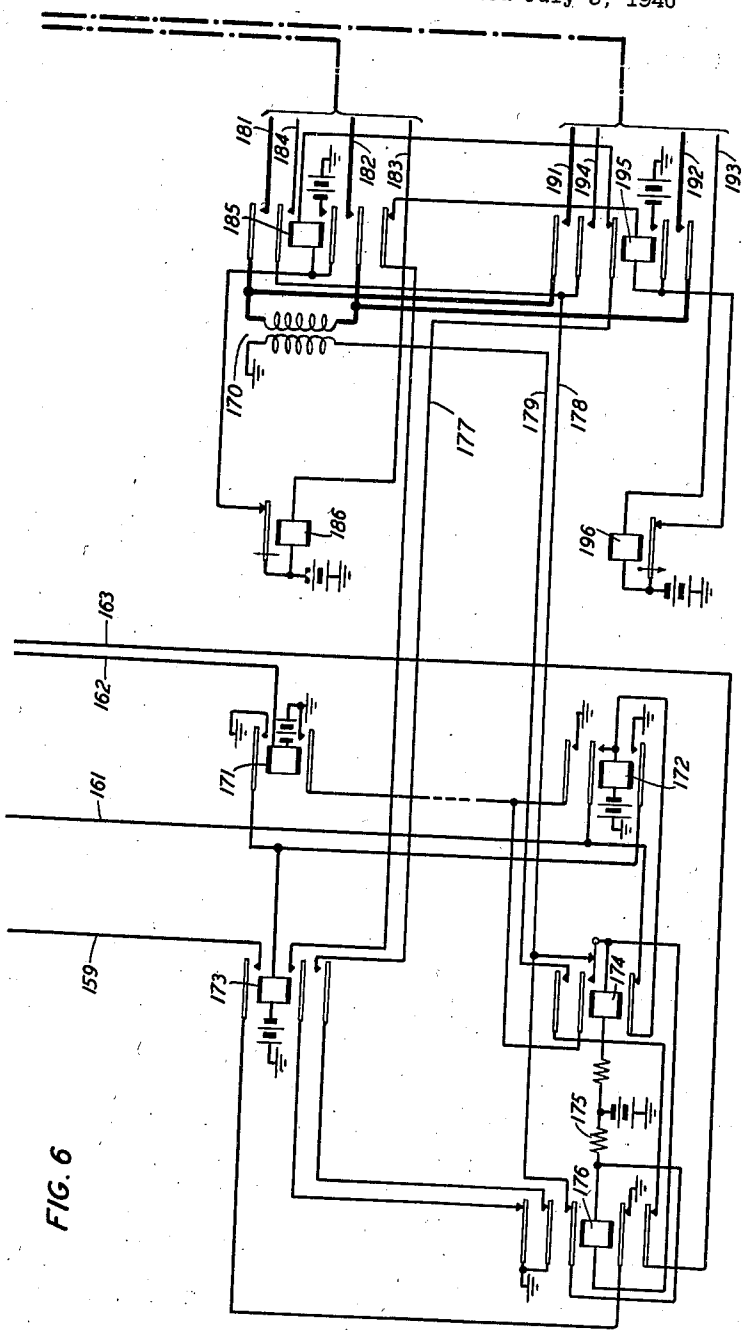

FIG. 6

AS

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Patented Nov. 11, 1941 2,262,595

UNITED STATES PATENT OFFICE

2,262,595

TELEPHONE SYSTEM

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Application July 3, 1940, Serial No. 343,701

10 Claims. (Cl. 179—27)

This invention relates to telephone systems and particularly to systems comprising an unattended automatic office and an attended master office.

It is the object of the invention to improve the maintenance alarm equipment provided in unattended automatic offices and in the transmission of alarms to a master office.

It is usual to provide alarm apparatus in an unattended dial office which is effective when a trouble condition exists to seize a trunk to a master office and upon answer of the call by an operator in the master office to transmit a tone signal to indicate that the call is a trouble alarm call from the unattended office. It is also known to provide a trouble-checking line in the unattended office with which connection may be established on a call from an operator or maintenance test man in the master office to determine whether any trouble exists and the character of the trouble in the unattended office. One of the trouble conditions which, if maintained for an interval of from twenty to thirty minutes, has been effective to initiate a trouble alarm call to the master office is a permanent signal condition on a subscriber's line.

In offices in which some or all of the subscribers are provided with permanent signal lockout relays, whereby a line subjected to a permanent signal is automatically disconnected from the first selector switch and rendered ineffective to initiate another call until after the permanent signal condition is cleared, it is desirable that an alarm call be made only if there are a number of permanent signal conditions existing at the same time. This invention is an improved alarm arrangement in an unattended dial office whereby an alarm call is initiated to a master office when a permanent signal condition exists simultaneously on a predetermined number of subscribers' lines and whereby a distinctive tone signal is transmitted to the calling operator in the master office on a trouble-checking call if a permanent signal condition exists on said predetermined number of subscribers' lines at the time the trouble-checking call is made.

A feature of the invention is a permanent signal alarm circuit comprising a marginal relay of the voltmeter type connected in parallel with a resistance through which battery is connected to subscriber's line circuits and first selectors in an unattended dial office, the relay being operatively effective upon the occurrence of a predetermined number of permanent signal conditions to initiate an alarm call to a master office.

Another feature of the invention is a permanent signal alarm circuit comprising a marginal relay of the voltmeter type for initiating an alarm call to a master office upon the occurrence of a permanent signal condition on a predetermined number of subscribers' lines in an unattended dial office, the voltmeter relay comprising an operating winding for closing its contacts, a small permanent magnet for maintaining the contacts closed, and a reset coil which when energized opens the contacts. In accordance with this and other features, means are provided for operating the reset coil upon establishment of a trouble-checking call from the master office, for transmitting a distinctive tone to the calling operator if a permanent signal condition then exists on as many as, or more than, said predetermined number of subscribers' lines, and for releasing the reset coil and preventing its reoperation on the same trouble-checking call.

A telephone system embodying the features of this invention is represented schematically in the drawings which form a part of this specification. The invention is not limited to the particular system disclosed, or to systems comprising switches of any particular type but is generally applicable to any automatic switching system comprising an unattended central office and a master office.

Referring to the drawings:

Fig. 1 shows a subscriber's station A, line L1 and line circuit LC1, a line-finder switch LF1 and a connector switch C1 in an unattended office; Fig. 1 also shows permanent signal alarm apparatus PSA in the unattended dial office;

Fig. 2 shows a first selector switch S1, a connector switch C2, and a subscriber's line L2 and station B in the unattended office; Fig. 2 also shows permanent signal timing apparatus PST in the unattended dial office;

Fig. 3 shows two-way trunk circuits TC1 and TC2 and incoming selector switches IS1 and IS2 in the unattended dial office associated with interoffice trunks T1 and T2 leading to a master office;

Fig. 4 shows a two-way trunk circuit TC3 terminating the trunk T1 at an operator's position in the master office;

Figs. 5 and 6 show miscellaneous alarm apparatus MA, alarm sender apparatus AS, and a ringing circuit RC in the unattended dial office; and

Fig. 7 shows the positional relation between

Figs. 1 to 6, inclusive, to form an operative arrangement.

The line-finder, selector and connector switches may be of the well-known two-motion step-by-step type. Reference may be had to "Automatic Telephony" by Smith and Campbell, 2nd edition, pages 53 to 65 for a description of the structure of such switches and their operation when used as selectors and connectors.

The subscribers' stations A and B and the other stations in the unattended office are of the type provided on lines terminating in common battery central offices and each includes a dial or other impulse sender for controlling the operation of automatic switches through which desired connections are established. The line circuit LC1 comprises a combined line and cut-off relay 14 and a lock-out relay 16. All of the lines in the office may be provided with a lock-out relay but ordinarily only a part of the lines will be so arranged. If a line is not equipped with a lock-out relay, the lower front contact of its line relay 14 is connected directly to sleeve conductor 13, the upper front contact of its relay 14 is connected directly to and through its outer upper back contact to conductor 15, and the junction between the middle and upper windings of its relay 14 is connected directly to the conductor leading to the sleeve terminals in the banks of connectors such as C1. The line L1 and other lines in the same group are connected to terminals in the banks of a group of line-finder switches including the line finder LF1 and a start relay 10 common to these lines is provided for starting an idle line finder in operation responsive to the origination of a call over any line in the group. The line finder LF1 is represented in the drawings by a set of brushes 41, 42 and 43 and a single set of terminals. Reference may be had to the patent to R. L. Stokely No. 1,799,654, April 7, 1931, and to the patent to T. L. Dimond No. 2,210,068, granted Aug. 6, 1940, for a description of the operation of such line-finder switches.

Each of the line finders is permanently associated with a first selector switch, the line finder LF1 being connected to the selector S1. The selectors may have direct access to groups of outgoing trunks and to connector switches as shown in the drawings. If, however, the number of subscribers in the office makes necessary the provision of one or more additional stages of selection, intermediate selectors will be provided.

The selector S1 comprises a set of brushes 67, 68 and 69 and a bank of terminals which is represented in the drawings by one set of terminals 70 in a level giving access to connector switches and two sets of terminals 81 and 82 in a level giving access to a group of trunks to the master office. The selector S1 further comprises a line relay 55, a release relay 56, a change-over relay 57, a switching relay 58, a rotary-stepping relay 59, a vertical-stepping magnet 61, a rotary-stepping magnet 62, a release magnet 63, a set of vertical off-normal springs 64 and eleventh rotary-step springs 65, all of which have usual and well-known functions. The selector S1 also comprises a release-control relay 60 which controls the connection of holding ground potential to and through conductor 53, to the associated line finder LF1. After connection of a calling line to selector S1, the line relay 55 and release relay 56 are actuated to connect holding ground potential to conductors 53 and 13. When the calling subscriber dials the first digit of a called subscriber's number, the selector S1 is operated to extend the connection to the next switch or to a trunk; and in this case relay 60 performs no useful function. But, if the calling subscriber fails to dial, or if the extension of a link to selector S1 is due to a trouble condition, relay 60 is operated to place the holding ground potential under control of the permanent signal timing apparatus PST; and, if the selector S1 has not been selectively operated by dial impulses within an interval of two minutes after relay 60 is operated, the holding ground potential is disconnected from conductors 53 and 13 to effect the release of the line finder LF1 and operation of the lock-out relay 16. The selectors such as S1 may be common to lines equipped with lock-out relays and to lines which are not so equipped. For this reason the release relay 56 and release relays of the other first selectors are connected through the windings of relays such as relay 121 of the miscellaneous alarm apparatus MA to battery in the permanent signal alarm apparatus PSA in order that the permanent signal alarm relay 137 of the miscellaneous alarm apparatus will be responsive to permanent signal conditions on all lines, as hereinafter explained in detail.

Groups of connector switches have access to subscribers' lines for completing calls thereto, the connector C1 being one of a group having access to the line L1 and the connector C2 being one of a group having access to the line L2. The connectors are multipled to terminals in the banks of local selectors (first selectors such as S1 or intermediate selectors if provided) and to terminals in the banks of incoming selectors such as IS1 and IS2. The connector C1 is represented by a set of brushes and a single set of terminals, and the connector C2 by a set of brushes 71, 72 and 73, and two sets of terminals 74 and 75, the magnets, relays and other associated apparatus being omitted.

The trunks T1 and T2 represent a group of two-way trunks between the unattended office and an operator's position in the master office. The trunks T1 and T2 terminate in two-way trunk circuits TC1 and TC2 in the unattended office and in two-way trunk circuits such as TC3 in the master office, of which only the trunk circuits TC1 and TC3 are shown in detail. The trunk circuits TC1 and TC2 are connected to terminals 81 and 82 in the bank of selector S1 and in like manner to other selectors in the unattended office, thereby enabling seizure of the trunks on calls outgoing to the master office. The trunk circuits TC1 and TC2 are also connected to incoming selectors IS1 and IS2 which have access to the groups of connectors in the unattended office, the incoming selectors being operated on incoming calls under control of the calling operator in the master office to select idle connectors in groups having access to the called lines. Each of the trunk circuits TC1 and TC2 is also connected to the alarm sender apparatus shown in Fig. 6 so that the one or the other of these trunks may be seized when a trouble condition occurs in the unattended office and thereby transmit to the operator in the master office an indication of trouble as hereinafter explained in detail. Each of the incoming selectors IS1 and IS2 is represented in the drawing by a set of brushes and a single set of terminals, all of the magnets, relays and other associated apparatus being omitted.

The trunk circuit TC1 comprises a repeating coil RC1, a line relay 211 and release relay 205

responsive to seizure on outgoing calls, a line relay 213 and switching relay 209 responsive to seizure on incoming calls, a polarized supervisory relay 214 responsive to answer of the called subscriber on incoming calls, a reversing relay 212 controlled by relays 211 and 214 responsive to seizure on outgoing calls and to answer of the called subscriber on incoming calls, and a relay 207 for establishing a non-inductive impulse repeating bridge during the repeating of impulses to the incoming selector IS1 and a connector switch on incoming calls. The trunk circuit TC2 is similar to the trunk circuit TC1.

The trunk circuit TC3 comprises a jack J3, a repeating coil RC3, a polarized relay 251 responsive to seizure of trunk T1 in the unattended office, relays 252, 254 and 255 for controlling the answering lamp 253, the busy lamp 257 and the connection of a busy potential to the sleeve of jack J3, a sleeve relay 257 and an auxiliary sleeve relay 258, a cut-through relay 261, and a group of relays 262, 263, 264 and 265 which operate to establish the dialing condition on a call from the master office to the unattended office.

The cord CD and operator's position equipment at which the jack J3 is located may be similar to cord and position equipment disclosed in detail in the patent to R. E. King, et al., No. 2,208,765, granted July 23, 1940.

The permanent signal alarm apparatus PSA shown in Fig. 1 comprises a voltmeter relay 30 the operating winding 31 of which is connected in parallel with resistors 23, 24 and 25 to supply battery to the locking windings of the lock-out relays 16 of subscribers' line circuits which are arranged for lock-out and in parallel with resistor 24 to supply battery through the windings of relays such as relay 121 in the alarm apparatus MA to the windings of the release relays of the first selectors, for instance release relay 56 of selector S1. The terminals 27 enable the connection of a desired number of resistors 26 in circuit so that the voltage required for operating the voltmeter relay 30 may be adjusted to secure its operation when a permanent signal condition exists on a desired and predetermined number of lines of either type, that is lines equipped and lines not equipped with lock-out relays. The resistances 23 and 24 are so chosen that the increase of current through the winding 31 of voltmeter relay 30 due to the operation of a permanent signal lock-out relay 16 is equal to the increase therethrough due to seizure of a selector S1 and closure of the circuit through the winding of its release relay. The operation of relay 30 causes the successive operation of relays 33, 34 and 35. The operation of relay 35 lights lamp 36 and effects the operation of relay 137 of the miscellaneous alarm apparatus MA to initiate an alarm call to the master office as hereinafter described. The stationary contact of the voltmeter relay comprises a small permanent magnet and the movable contact spring has a small iron tip so that the contacts are held closed, after relay 33 opens the circuit through coil 31, until restored to normal by the energization of a reset coil 32. Reference may be had to the patent to A. H. Lamb, No. 2,014,385 granted September 17, 1935 for disclosure of a relay of this type. The reset coil 32 is operatively controlled by relay 155 of the miscellaneous alarm apparatus to effect the release of relays 33, 34 and 35 when relay 155 operates due to seizure of the terminals 75 by a connector C2 on a trouble-checking call from the master office as hereinafter described. The permanent signal alarm apparatus further comprises a relay 40 for disconnecting the reset coil 32 and holding it disconnected as long as the trouble-checking call is maintained by the operator.

The permanent signal timing apparatus PST comprises two sets of relays, one set comprising relays 106, 107 and 108 for completing a timing cycle of operations in two minutes and the other comprising relays 116, 117 and 118 for completing a timing cycle in twenty minutes. Upon connection of ground to start conductor 109, relays 106, 107 and 108 are successively operated and then successively released in a two-minute cycle, ground being disconnected from conductor 101 when relay 106 operates and reconnected to conductor 101 when relay 108 releases, ground being disconnected from conductor 102 and connected to conductor 110 when relay 108 operates and reconnected to conductor 102 and disconnected from conductor 110 when relay 108 releases. Upon release of relay 108 at the end of a two-minute cycle, ground is connected to conductor 101 to operate the release-control relay 60 of all first selectors which have been seized during the preceding two-minute interval and which have not been selectively operated by dial impulses to select a desired group and seize an idle trunk in the selected group; and ground is connected to conductor 102 to hold the line finders associated with these first selectors. When relay 108 next operates at the end of another two-minute interval, it disconnects the holding ground potential from conductor 102 to cause the release of the line finders and operation of the lock-out relays of lines associated with first selectors whose release-control relays 60 were operated at the beginning of the interval and which have not been released because group selection and seizure of a trunk has not been completed. Upon connection of ground to start conductor 119, relays 116, 117 and 118 are successively operated and then successively released in a twenty-minute cycle, ground being disconnected from conductor 111 when relay 116 operates and reconnected to conductor 111 when relay 118 releases, and ground being connected to and disconnected from conductor 120 by the operation and release of relay 118.

The miscellaneous alarm apparatus MA comprises relays such as relay 121 through the windings of which battery is connected to the release relays of first selectors, relays such as relay 131 through the windings of which battery is connected to the release magnets of selectors and connectors, fuse alarm relays such as relay 144, permanent signal alarm relays 124 and 137 and a trouble-checking-call relay 155. The miscellaneous alarm apparatus also includes other relays and apparatus necessary for the operation of visual and audible alarms and for initiating the operation of the alarm sender AS as hereinafter described.

The alarm sender AS comprises relays 185 and 186 individual to trunk T1 and relays 195 and 196 individual to trunk T2, relays 171, 172 and 173 responsive to alarm conditions for effecting seizure of the one or the other of trunks T1 or T2 if idle, a transformer 170 for impressing a trouble tone across the seized trunk, a relay 174 operatively responsive to the answer of a trouble call over either of trunks T1 or T2, and a relay 176 for preventing a second seizure of one of these trunks if the alarm condition continues after a trouble call is answered.

The ringing circuit RC, represented by a rectangular enclosure in Fig. 5, is similar to that disclosed in the patent to J. M. Duguid et al. No. 2,225,907 granted Dec. 24, 1940. It comprises a motor start relay MS, tone transformers LT1 and LT2, and code 1 and code 2 ringing sources which together with the aforementioned transformers supply the tones for indicating various alarm conditions on trouble-checking calls from the master office.

Assume now that a call is originated at station A, thereby closing a circuit from battery through the middle and upper windings and a back contact of line relay 14, conductor 12, over one of the conductors of line L1 and through the telephone at station A, back over the other conductor of line L1, conductor 11, through a lower back contact and the lower winding of relay 14 to ground. Relay 14 is thereby partially energized to close its upper and inner lower front contacts without affecting any of the other contacts. At the upper front contact of relay 14 a circuit is closed for operating the start relay 10. The operation of relay 10 causes the starting of an idle line finder LF1 in the manner described in the aforementioned patent to T. L. Dimond. When the brushes 41, 42 and 43 of the line finder LF1 find the terminals of the line L1, ground momentarily supplied in the line-finder circuit is connected through brush 43, conductor 13, a back contact of relay 16, lowermost front contact of relay 14, another back contact of relay 16, and through the middle winding of relay 14 to battery. Relay 14 is thereby energized to operate all of its contacts, disconnecting the conductors of line L1 from the windings of relay 14 and opening the operating circuit of start relay 10. The line L1 is connected through conductors 11 and 12, brushes 41 and 42 of line finder LF1, conductors 51 and 52, and through back contacts of relay 58 to the windings of line relay 55 of selector S1, the upper winding of relay 55 being connected directly to battery and the lower winding of relay 55 being connected through normally closed contacts of eleventh rotary-step springs 65 and conductor 103 to ground through the right winding of dial tone transformer 136 in the miscellaneous alarm apparatus MA. Relay 55 is thereby operated, closing a circuit for operating release relay 56 in series with relay 121 of the miscellaneous alarm apparatus MA. Relay 56 connects ground to conductor 53 to hold relay 14 operated and connects the upper winding of relay 60 to conductor 101 leading to the permanent signal timing apparatus. If relays 106 and 108 are then normal, or if these relays both become normal before selection of a level and an unguarded set of terminals therein is completed, relay 60 operates, closes a locking circuit through its lower winding, and transfers the test conductor 53 from ground at the front contact of relay 56, through conductor 102, to ground at a back contact of timing relay 108.

The operation of relay 121 of the miscellaneous alarm apparatus causes the successive operation of relays 122 and 123. Relay 123 connects ground to the start conductor 159 leading to the ringing circuit RC and connects ground to start conductor 109 leading to the permanent signal timing apparatus PST to start the operation of timing relays 106, 107 and 108 if not already in operation. Relay 121 also closes a circuit for energizing the left, primary winding of dial tone transformer 136 in series with the low tone source LT2 of the ringing circuit, the right winding of transformer 136 being thereby rendered effective to transmit dial tone through conductor 103 to selector S1 and other first selectors and the associated calling subscribers awaiting dial tone. The operation of relay 121 further causes the successive operation of relays 124 and 126, thereby connecting ground to start conductor 119 to start the operation of timing relays 116, 117 and 118. If relays 121, 124 and 126 are held operated, due to a trouble condition for an interval during which timing relays 116, 117 and 118 complete a timing cycle, the connection of ground to conductor 111 causes the operation of relay 127. Relay 127 locks under control of relay 126, and at the end of the cycle the connection of ground to conductor 120 causes the operation of relay 128. Relay 128 locks under control of relay 126, disconnects ground from start conductor 119, and connects the code 1 ringing conductor through condenser 130, a front contact of relay 128 and back contacts of relays 148, 137 and 145 to a front contact of the trouble-checking-call relay 155, so that if relay 155 operates as hereinafter described on a call from an operator in the master office, a distinctive trouble tone will be transmitted to the operator.

Assume now that the calling subscriber dials the first digit of the called subscriber's number before relay 60 operates or, if relay 60 has operated, before the next operation of timing relay 108. Relay 55 releases and reoperates in response to each impulse of the series created by the dialing of this digit. Being slow in releasing, relay 56 remains operated while these impulses are being received. The release of relay 55 in response to the first impulse closes a circuit for operating the vertical-stepping magnet 61 and the change-over relay 57 in series. The operation of magnet 61 steps the brushes 67, 68 and 69 up to the first level of the terminal bank. As soon as the shaft moves out of its normal position the vertical off-normal springs 64 are actuated thereby closing a circuit including the front contact of relay 57 for operating relay 59. Relay 59 locks under the control of the rotary-stepping magnet 62 to ground at a back contact of relay 58. When relay 55 reoperates at the end of the first impulse, magnet 61 releases; but relay 57 is slow in releasing and remains operated until all of the impulses in the series have been received by relay 55. Each succeeding release and reoperation of relay 55 causes the reoperation and release of magnet 61, thereby advancing the brushes of the switch to the level corresponding to the digit dialed. When relay 57 releases after the last impulse of the series has been received, the rotary-stepping magnet 62 is operated to advance the brushes into engagement with the first set of terminals in the selected level. The operation of magnet 62 also causes the release of relay 59; and the release of relay 59 causes the release of magnet 62. The release of magnet 62 closes a busy test circuit from battery, through the winding of relay 59, upper contact of springs 64, back contact of magnet 62, lower contact of the eleventh rotary-step springs 65, a back contact of relay 58 and the test wiper 69 to determine whether the trunk or the switch connected to the first set of terminals in the selected level is busy or idle. If this trunk or switch is busy, ground potential connected to the terminal engaged by test wiper 69 causes the reoperation of relay 59; and in this case relay 59 again closes the circuit for operating magnet 62 to cause the advance of the brushes to the next set of ter-

minals in the level. Relay 59 and magnet 62 repeat their cycle of operations to cause advance of the brushes from one set of terminals to the next until an unguarded set of terminals is encountered. If the brushes reach the eleventh rotary position without finding an idle set of terminals, the springs 65 are actuated to prevent further operation of relay 59 and magnet 62 and to connect the lower winding of relay 55 through conductors 104 and 157 to the tone transformer LT1 in the ringing circuit RC. An all-trunks-busy tone is thereby transmitted to the calling subscriber. If and when the test brush 69 engages the test terminal of an idle trunk or switch, there being no guarding ground connected thereto to cause the reoperation of relay 59, relay 58 is operated by the current in a circuit from battery through the winding of relay 59, upper contact of springs 64, back contact of magnet 62, lower contact of springs 65, winding of relay 58, to ground at a front contact of relay 56. Relay 59 is marginal and does not reoperate in series with relay 58. Relay 58 disconnects the calling line from the windings of relay 55 and extends the connection from the calling line to the selected trunk or switch by connecting conductors 51 and 52 to the brushes 67 and 68. Relay 58 also connects ground to the test brush 69 to guard the selected trunk or switch against seizure by another selector prior to the connection of busy ground to the test terminal by the seized trunk or switch in the usual manner. When relay 55 releases, it opens the circuit energizing relay 56, but relay 56 is slow in releasing and does not release until a busy and holding ground potential has been connected to the terminal engaged by brush 69 to hold relay 58 operated. When relay 56 releases, it causes the release of relay 60, if operated. With relay 60 normal, conductor 53 is connected, through a front contact of relay 58, to the test brush 69 so that the busy, ground potential connected to the terminal engaged by this brush is also effective to hold the line finder LF1 and to hold the combined line and cut-off relay 14.

Assuming that the called subscriber is in the unattended office, the impulses created by the dialing of the remaining digits of the called subscriber's number effect the operation of additional selectors, if any, and a connector C2 to establish a connection with the called line in usual and well-known manner. If the called line is idle a ringing circuit is closed; and when the call is answered the ringing circuit is opened, the talking circuit is established and the connection is maintained under the control of the calling subscriber in usual manner. When the calling subscriber restores the receiver to normal, holding ground potential is disconnected in usual manner from the terminal engaged by brush 69, causing the release of relay 58 of selector S1, the release of the line finder LF1 and the release of the combined line and cut-off relay 14. When relay 58 releases, it closes a circuit from ground at its inner lower back contact through back contacts of relays 55 and 56, the lower contact of springs 64, winding of release magnet 63, conductor 105, upper winding of relay 131 in the miscellaneous alarm apparatus, through fuse 140 to battery. The operation of magnet 63 causes the shaft and brushes of selector S1 to be restored to normal. When the shaft reaches normal, the springs 64 are restored to normal, thereby opening the circuit through release magnet 63 and relay 131. If, however, the selector shaft fails to return to normal after relay 58 releases, the continued operation of relay 131 causes the successive operation of relays 133 and 134 and the lighting of lamp 132 of the miscellaneous alarm apparatus. At its upper front contact, relay 134 connects ground to start conductor 109 to start the operation of timing relays 106, 107 and 108, if not already operating. If ground is connected to conductor 101 at the time relay 134 operates, or as soon thereafter as ground is connected to conductor 101, the lower winding of relay 135 is operatively energized. Relay 135 locks through its upper winding under control of relay 134. As soon after the operation of relay 135 as ground is next connected to conductor 110, the upper winding of relay 148 is operatively energized and locked under control of relay 134. At its lower back contact, relay 148 disconnects ground from conductor 109 and at its lower front contact closes a circuit for lighting lamp 146 and operating the alarm control relay 147. Relay 147 closes the circuit for operating the audible alarm 150. With relay 148 operated, tone conductor 157 is connected through condenser 149, a front contact of relay 148 and back contacts of relays 137 and 145 to a front contact of the trouble-checking-call relay 155, so that if relay 155 operates as hereinafter described on a call from an operator in the master office, a distinctive trouble tone will be transmitted to the operator.

Assume next that the selector S1 is selectively operated by the first digit dialed at station A to select the group of trunks leading to the master office, that the trunk T1 is idle and that the switching relay 58 is operated when the brushes 67, 68 and 69 engage the first set of terminals 81 in the group. When relay 58 operates, it extends the connection from the calling line L1 to and through brushes 67, 68 and 69 to the trunk circuit TC1, thus completing a circuit for operating the line relay 211. This circuit is traced from battery through the right winding of relay 211, a back contact of relay 209, upper left winding of repeating coil RC1, another back contact of relay 209, conductor 202, brush 68 of selector S1, front contact of relay 58, conductor 52, brush 42 of line finder LF1, conductor 12, over one of the conductors of line L1, through the telephone of station A, back over the other conductor of line L1, conductor 11, brush 41, conductor 51, front contact of relay 58 of selector S1, brush 67, conductor 201, a back contact of relay 209, lower left winding of repeating coil RC1, another back contact of relay 209, through the left winding of relay 211 to ground. Relay 211 closes circuits for operating relays 205 and 212. Relay 205 connects ground to test conductor 203 to hold the switching relay 58 of selector S1 after relay 56 releases, and to guard the trunk circuit TC1 against seizure by any other seletcor having access thereto. This ground is further extended from conductor 203 through conductor 183 in the alarm sender apparatus to operate relay 186 and thus prevent seizure of trunk T1 by the alarm sender apparatus AS. Relay 212 connects ground to conductor 159 to operate the motor start relay MS of the ringing circuit RC; and relay 205 closes a path from the code 1 ringing conductor, through condenser 206 to conductor 201 to transmit ringing tone to the calling subscriber as an indication that an operator in the master office is being signaled. Relay 212 interchanges the connections between the windings of relay 213 and conductors 221 and 222 over trunk T1 leading to the master

office, thereby effecting the operative energization of both windings of the polarized relay 251 of trunk circuit TC4. Although the windings of relays 213 and 251 are normally connected in a closed circuit over trunk T1, the current in this circuit is not strong enough to operate the marginal relay 213 and is in the non-operating direction with respect to relay 251. The operation of relay 251 closes a circuit for operating relay 252. Relay 252 closes a circuit for lighting the answering lamp 253 and a circuit for operating relay 254. Relay 254 closes a circuit for operating relay 255. Relay 255 closes a circuit for lighting busy lamp 257 and connects a busy potential through resistor 256 and the lower winding of relay 257 to the sleeve of jack J3.

When an operator answers the call by inserting the plug P1 of a cord CD in jack J3, a circuit is closed from battery in the operator's position circuit through the sleeve conductors of plug P1 and jack J3 and the upper high resistance winding of relay 257 to ground. Relay 257 operates, closing a circuit for operating relay 258. Relay 258 closes a circuit for operating relay 261, closes a short circuit around the upper, high resistance winding of relay 251, thereby causing the operation of relay 213 of trunk circuit TC1, and opens the circuit through the winding of relay 252 to release this relay and thus extinguish lamp 253. Relay 261 closes a holding circuit for relay 254 and completes a talking connection between the right windings of repeating coil RC3 and the line conductors of jack J3.

The aforementioned operation of marginal relay 213 when the call is answered, closes a circuit for operating relay 204. Relay 204 disconnects condenser 206 from conductor 201 to end the transmission of ringing tone to the calling subscriber, disconnects ground from the start conductor 159 of the ringing circuit RC, and closes a circuit for holding relay 205. The talking connection between the calling line and the operator in the master office includes the repeating coils RC1 and RC2 and the conection is under the joint control of the calling subscriber and the answering operator. When the calling subscriber releases the connection, relay 211 releases. The release of relay 211 causes the release of relay 212, thereby restoring the current over trunk T2 to its normal direction to effect the release of relay 251 over trunk circuit TC3 in the master office. After relay 211 releases, relay 205 is held under the control of relays 213 and 204. When relay 251 releases, it connects ground to the low resistance winding of relay 257 thereby causing the lighting of a supervisory lamp in the operator's cord circuit as a disconnect signal. When the plug P1 of cord CD is disconnected from jack J3, relay 257 releases, causing the successive release of relays 258 and 261. Relay 252 reoperates if relay 251 has not yet released. The release of relay 258 opens the short circuit around the upper high resistance winding of relay 251, thereby causing the release of relay 213 of trunk circuit TC1. The release of both relays 211 and 213 in trunk circuit TC1 causes the release of relays 204 and 205. Relay 205 disconnects ground potential from conductor 203 to effect the release of relay 186 in the alarm sender AS, the release of relay 58 of selector S1, the release of relay 14 of line circuit LC1, and the return of the line-finder switch LF1 to normal in the usual manner. The release of relay 58 causes the return of the shaft and brushes of selector S1 to normal as hereinbefore described.

Assume next that an operator in the master office inserts the plug of a cord in jack J3 to initiate a call to a subscriber at an unattended office. Relay 257 operates in the circuit including the sleeve conductors of jack J3 and plus P1 to battery in the operator's position circuit. Relay 257 closes a circuit for operating relay 258. Relay 258 closes a short circuit around the upper winding of relay 251 to effect the operation of relay 213 of trunk circuit TC1, closes a circuit for operating relay 261, and connects ground to the lower winding of relay 257 to effect the lighting of a supervisory lamp in the cord circuit CD. Relay 261 closes a circuit for operating relay 254, connects the winding of relay 264, through the upper right winding of repeating coil RC3 to the tip of jack J3 and connects ground at the outer lower front contact of relay 258 through resistor 266, inner back contact of relay 264, inner upper front contact of relay 261, lower right winding of repeating coil RC3 to the ring conductor of jack J3. Relay 254 closes a circuit for operating relay 255. Relay 255 lights the busy lamp 257. The operation of relay 213 of trunk circuit TC1 closes a circuit including back contacts of relays 205 and 212, through the winding of relay 209. Relay 209 operates, thereby connecting its winding to sleeve conductor 233 of the associated incoming selector IS1 and extending ground potential to conductor 203 to mark the trunk circuit TC1 as busy in the banks of selectors having access thereto. Relay 209 closes a bridge comprising the winding of relay 214 and resistor 215, in parallel, across conductors 231 and 232 of selector IS1 to prepare this selector for operation by dial impulses. The selector IS1 connects a holding ground potential to sleeve conductor 233 in the usual manner to hold relay 209.

When the calling operator operates the position dial key, battery is connected through the tip conductors of plug P1 and jack J3, a front contact of relay 261, upper right winding of repeating coil RC3 through the winding of relay 264 to ground. Relay 264 operates, closing a circuit for operating relay 265 and connecting the tip of jack J3 to repeating coil RC3 independent of the contact of relay 261. Relay 265 closes a circuit for holding relay 254 operated and connects the upper winding of relay 262 in series with the winding of relay 263 through the lower right winding of repeating coil RC3 to the ring conductor of jack J3. When the operator's dial circuit functions to connect battery through the ring conductor of plug P1 to the ring conductor of jack J3, relays 263 and 262 operate. Relay 262 locks under control of relays 264 and 258, and opens the circuit through the winding of relay 261. Relay 261 releases, disconnecting the ring conductor of jack J3 from condenser 260. Relay 261 connects ground to the winding of relay 263, thereby short-circuiting the upper winding of relay 262 to prepare relay 263 for response to dial impulses. With relays 263 and 262 operated, the bridge comprising the lower winding of relay 251 is disconnected from trunk T1 and the impulse repeating contacts of relay 263 are connected across the conductors 221 and 222. When the operator dials the number of a called subscriber, relay 263 is alternately released and reoperated responsive to dial impulses. Corresponding impulses are transmitted by the contacts of relay 263 over trunk T2 to relay 213 of trunk circuit TC1. When dialing is completed, the restoring of the operator's dial key disconnects battery from the tip of the cord, releasing relay 264. Relay 264 opens the connection

between repeating coil RC3 and the tip of jack J3, short-circuits the contacts of relay 263 and releases relays 265 and 262. The release of relay 265 disconnects the winding of relay 263 from the ring of conductor of jack J3 and opens the holding circuit of relay 254. The release of relay 262 disconnects the contacts of relay 263 from trunk T1 and reestablishes the bridge comprising the lower winding of relay 251 across conductors 221 and 222. The release of relay 262 also causes the reoperation of relay 261 and completion of the talking connection between jack J3 and repeating coil RC3. Relay 261 recloses the operating circuit of relay 254 and relay 254 reoperates. Since relay 255 is slow in releasing, it remains operated during the transfer from dialing to talking conditions.

Relay 213 of trunk circuit TC1 is alternately released and reoperated by the dialing impulses transmitted over conductors 221 and 222 by the contacts of relay 263. When relay 213 releases in response to the first impulse of the train, it opens the bridge across conductors 231 and 232 and closes a circuit including a back contact of relay 212 and a front contact of relay 209 for operating the slow-to-release relay 207. With relay 207 operated, the reoperation of relay 213 closes a bridge comprising resistor 208 across conductors 231 and 232 in place of the bridge comprising the winding of relay 214. Relay 207 remains operated while each train of impulses is being repeated by relay 213. The release of relay 207 after each train of impulses, reconnects the winding of relay 214 across conductors 231 and 232 for receiving supervisory signals.

The first train of impulses repeated by relays 263 and 213 controls the operation of the incoming selector IS1 to select a corresponding group of trunks. This selector thereupon operates automatically to select an idle trunk in the selected group, which trunk leads to a connector C2 or to an intermediate selector if such selectors are provided. The impulses created by the dialing of the last two digits of the called subscriber's number are repeated by relays 263 and 213 to control the operation of a connector C2 to complete connection with the called line in the usual manner. If the line is idle, the called station is signaled. If the call is answered, the connector functions in a well-known manner to reverse the direction of current through conductors 231 and 232 to operate relay 214. Relay 214 closes a circuit for operating relay 212; and relay 212 effects the reversal of current through conductors 221 and 222 to operate relay 251 of trunk circuit TC3. The operation of relay 251 disconnects ground from the lower winding of relay 257 to extinguish the supervisory lamp in the operator's cord circuit. The talking connection between the operator and the called subscriber includes the repeating coils RC1 and RC3 and is under the sole control of the operator.

If the called subscriber restores the telephone to normal before the operator disconnects, the connector C2 restores the direction of the current through conductors 231 and 232 to successively release relays 214, 212 and 251 and thus cause the lighting of the supervisory lamp in the operator's cord circuit. When the operator disconnects, relays 257, 253, 261, 254 and 255 are released. The release of relay 253 opens the short circuits around the upper winding of relay 251, thereby causing the release of marginal relay 213 in trunk circuit TC1. The release of relay 213 opens the operating circuit of relay 209 and opens the bridge across conductors 231 and 232, thereby causing the release of the incoming selector IS1 and the connector C2. If at that time the called subscriber has failed to hang up, the connector switch is held operated but the incoming selector IS1 is restored to normal in usual manner. When the called subscriber hangs up, the connector switch is also restored to normal in usual and well-known manner.

Assume next that the selector S1 has not been selectively operated by dial impulses to select a group and a set of terminals therein by the time that ground is next disconnected from conductor 102 following the operation of relay 60. In this case the disconnection of ground from conductors 102 and 53 effects the return of line finder LF1 to normal, thereby causing the release of relays 55, 56 and 60. The disconnection of ground from conductors 102 and 53 also effects the operative energization of the upper winding of the permanent signal lock-out relay 16 in series with the middle winding of relay 14. Relay 16 is thereby energized sufficiently to close its inner lower front contact and energize its lower winding to complete the actuation of its contacts. Relay 14 is not held operated by its middle winding in series with the upper winding of relay 16 but is slow in releasing so as to insure the operative energization of the lower winding of relay 16. When relay 14 releases, it opens the holding circuit of relay 16 and again closes the circuit through its three windings in series with the conductors of line L1. If the permanent signal condition has not been cleared, relay 14 immediately reoperates partially so as to again close the holding circuit of slow-to-release relay 16 before this relay releases. With relay 16 operated, the partial energization of relay 14 is ineffective to cause the operation of start relay 10 and no line finder is started in search for the line. While relay 16 is operated, ground potential is connected through lamp 17 and conductor 18 to operate relay 124 of the miscellaneous alarm circuit. If not previously operated, relay 124 causes the operation of relays 126, 127 and 128 under the control of timing relays 116, 117 and 118 as hereinbefore described to establish the desired trouble tone condition for a trouble-checking call in case such a call is originated by the operator in the master office, while the trouble condition exists.

Whenever there is a large enough number of permanent signal conditions existing at one time to cause the operation of the voltmeter relay 30 and the condition continues long enough to cause the successive operation of relays 33, 34 and 35 of the permanent signal alarm circuit PSA, relay 137 of the miscellaneous alarm circuit MA is operated. Relay 137 connects the tone source LT2, through condenser 138 and the back contact of relay 145, to the front contact of trouble-checking call relay 155; so that, if this relay operates due to seizure of the trouble-checking terminals 75 on a call from the operator in the master office, a distinctive tone will be transmitted to the operator. Relay 137 also closes a circuit for operating relay 171 of the alarm sender apparatus AS to initiate a trouble call to the master office as hereinafter described.

If a fuse alarm relay 144 of the miscellaneous alarm circuit is operated, due to the operation of a fuse, such as fuse 20 or fuse 140, an aisle pilot lamp such as 143 or 153 is energized. Relay 144 closes a circuit for lighting lamp 146 and operating relay 147; and relay 147 controls

the audible alarm 150. The operation of relay 144 also causes the operation of relays 145 and 148. Relay 145 connects ground to conductor 161 to operate relay 172 of the alarm sender AS to initiate a trouble call to the master office. Relay 148 connects tone conductor 157 through condenser 149 to the front contact of relay 155 so that the desired trouble tone will be transmitted to the master office operator if relay 155 operates due to seizure of terminals 75 on a trouble-checking call.

If relay 171 operates, due to the occurrence of a permanent signal condition on enough lines to effect the operation of relay 137 of the miscellaneous alarm circuit MA, or if relay 172 operates due to the operation of fuse alarm relays 144 and 145, a circuit is closed for operating relay 173. Relay 173 connects ground to conductor 159 to operate the motor start relay MS of the ringing circuit, and connects ground at the back contacts of relay 176, through the back contacts of relays 185 and 195, to battery at the back contacts of relays 186 and 196, relay 186 being normal if trunk T1 is idle and relay 196 being normal if trunk T2 is idle. Whichever of relays 185 and 195 operates first, it locks and opens the circuit for operating the other. If relay 185 operates, it connects the secondary winding of transformer 170 across conductors 181 and 182 and connects supervisory relay 174, through conductors 178 and 184, in parallel with relay 204 of trunk circuit TC1. If relay 195 operates, it connects the transformer 170 across conductors 191 and 192 and connects supervisory relay 174, through conductors 178 and 194, in parallel with the relay of trunk circuit TC2 which corresponds to relay 204 of trunk circuit TC1.

Assuming that the operation of relay 173 causes the operation of relay 185, the connection of the right winding of transformer 170 across conductors 181 and 182 causes the successive operation of relays 211 and 212 of trunk circuit TC1. Relay 212 reverses the current over trunk T1 to operate relay 251 of trunk circuit TC3. Relay 251 causes the successive operation of relays 252, 254 and 255, and the lighting of lamps 253 and 257. When the call is answered, relays 257, 258 and 261 operate, relay 252 releases and lamp 253 is extinguished. Relays 254 and 255 are held under the control of relay 261. The operation of relay 258 short-circuits the upper winding of relay 251, causing the operation of relay 213 of trunk circuit TC1. Relay 213 closes a circuit for operating relay 204 and closes a circuit through conductor 184 for operating relay 174 of the alarm sender apparatus. Relay 204 closes a circuit for holding relay 205. Relay 174 locks under control of relay 171 or relay 172, depending upon which of these relays operated to initiate the alarm call. The operation of relay 174 also closes a circuit from ground through the left winding of transformer 170, conductor 179, a front contact of relay 174, a back contact of relay 176, conductor 163, to tone conductor 157 thereby transmitting a tone to the answering operator to indicate that the call is a trouble alarm call. When the operator releases the connection, relays 257, 258 and 261 release. Relay 258 opens the short circuit around the upper winding of relay 251 to release relay 213 of trunk circuit TC1. The release of relay 213 causes the release of relay 204 and disconnects ground from conductor 184, thereby opening a short circuit around the winding of relay 176 of the alarm sender apparatus to cause its operation in parallel with relay 174. Relay 176 disconnects its winding from conductor 178, releases relay 185, and disconnects ground from conductor 159. The release of relay 185 disconnects the right winding of transformer 170 from conductors 181 and 182, causing the successive release of relays 211, 212 and 205 of trunk circuit TC1 so that this trunk may now be seized on another call. Relays 174 and 176 remain operated as long as either of relays 171 or 172 is operated. When the trouble conditions clears, and all of relays such as 137 and 145 in the miscellaneous alarm circuit are normal, relays 171, 172 and 173 are released and relays 174 and 176 release, thereby restoring the alarm sender apparatus to normal.

Assume now that an operator in the master office initiates a trouble-checking call to the unattended office. Upon connection of a cord CD with jack J3, trunk circuits TC3 and TC1 operate as hereinbefore described to prepare the incoming selector IS1 for response to the impulses created by the dialing of the first digit of the trouble-checking number. The selector IS1 is selectively controlled by these impulses to select a connector C2, and the connector C2 is selectively operated responsive to the impulses created by the dialing of the last two digits of the number to select the trouble-checking line terminals 75. Upon seizure of these terminals, relay 155 of the miscellaneous alarm apparatus MA is operatively energized in a circuit from battery through its winding, conductor 79, through the test terminal and test brush 73 of the connector C2 to ground. The two-element gas-filled tube 156, bridged across conductors 77 and 78, responds to ringing current impressed thereon by the operation of the connector. The energization of tube 156 effects the operation of the ringing trip relay (not shown) in the connector to cause the disconnection of the ringing current source and the closing of the talking connection in usual manner. The tube 156 is thereupon deenergized so that the connector does not reverse the current to operate relay 214 of trunk circuit TC1. Relay 155 connects ground to conductor 159 to operate the motor start relay MS of the ringing circuit, and connects ground to conductor 39 to operate the reset coil 32 of voltmeter relay 30 if at this time relay 33 of the permanent signal alarm circuit is operated. At its inner lower front contact, relay 155 closes a trouble tone transmitting circuit, the particular tone being dependent on the character of the trouble. If relay 137 is operated, due to the existence of a large enough number of permanent signal conditions, the tone transmitting circuit is traced from the lower winding of tone transformer LT2, through conductor 158, condenser 138, front contact of relay 137, back contact of relay 145, front contact of relay 155, conductor 77 and brush 71 of connector C2, thence to the calling operator. If relay 145 is operated or if the ringing machine has ceased to operate, no tone is transmitted, thereby indicating a major alarm. If relays 145 and 137 are normal and relay 148 has operated due to a release alarm condition, the tone is supplied through condenser 149 and conductor 157 from the tone transformer LT1. If relays 145, 137 and 148 are normal and relay 128 is operated due to the continued existence of one or more permanent signal conditions for an interval of twenty minutes or more in a first selector or subscriber's line circuit, the tone is supplied through condenser 130 from the code 1 ringing conductor of the ringing circuit RC. If there is no trouble

condition then existing, all of relays **145**, **137**, **148** and **128** are normal and tone is supplied through condenser **129** from the code **2** ringing conductor of the ringing circuit RC. When the calling operator releases the connection, the switches C2 and IS1 are restored to normal, relay **155** releases, and the trunk circuits are restored to normal as hereinbefore described.

What is claimed is:

1. In a telephone system, lines, subscribers' stations connected to said lines, selector switches for use in connecting calling and called lines, means for connecting each calling line with an idle switch, control means at each calling station for controlling the selective operation of the connected switch, alarm apparatus including an alarm relay, and means for operating said relay when a predetermined number of said switches have been connected to calling lines for a predetermined interval of time without being selectively operated.

2. In a telephone system, subscribers' lines, permanent signal lock-out relays one for each of said lines, means comprising subscriber controlled selectors for completing connections between calling and called lines, line finders adapted to connect calling lines with selectors, means effective upon connection of a calling line with a selector for measuring a predetermined interval of time, means comprising an impulse sender at each calling station and relay means in each of the associated selectors for selecting a desired group and for selecting an unguarded set of terminals in the selected group, means effective at the end of the measured interval for releasing the line finders associated with selectors which were associated with calling lines at the beginning of said interval and which have failed to complete terminal selection during said measured interval and for causing the operation of the lock-out relays of the lines connected to said selectors, alarm apparatus comprising an alarm relay, and means responsive to the simultaneous operation of a predetermined number of said lock-out relays for operating said alarm relay.

3. In a telephone system, subscribers' lines, permanent signal lock-out relays, one for each of a number but not all of said lines, means including subscriber controlled selectors for completing connections between calling and called lines, means comprising line finders adapted to connect calling lines with selectors, means effective upon connection of a calling line with a selector for measuring a predetermined interval of time, means comprising an impulse sender at each calling station and relay means in each of the associated selectors for selecting a desired group and for selecting an unguarded set of terminals in the selected group, means effective at the end of a measured interval of time for releasing the line finders associated with selectors which were associated with calling lines at the beginning of said interval and which have failed to complete terminal selection during said measured interval and for causing the operation of the lock-out relays of the lines connected to said selectors and equipped with lock-out relays, alarm apparatus comprising an alarm relay, and means for operating said alarm relay, said last-mentioned means being operatively responsive to the simultaneous operation of a predetermined number of said lock-out relays, or to the simultaneous connection of said predetermined number of lines to selectors which have not completed terminal selection, or to the simultaneous operation of a number of said lock-out relays and connection of a number of lines to selectors which have not completed terminal selection, the total of both of said last-mentioned numbers being equal to or greater than said predetermined number.

4. In a telephone system, an unattended office, a master office, lines including a trouble-checking line in said unattended office, trunks between said offices, means in said unattended office for connecting calling lines with called lines and with said trunks and for connecting calling trunks with called lines, means in said unattended office responsive to a permanent signal condition existing on a predetermined number of lines for originating a call over one of said trunks and for connecting a distinctive tone to said trunk to indicate the character of the call thereover, the last-mentioned means comprising a marginal relay, means effective upon operation of said relay for locking said relay, means in said attended office for answering said call and for calling said trouble-checking line, means responsive to completion of a connection with said line for releasing said relay, and means for connecting a distinctive tone indicative of the character of the trouble to said trouble-checking line in case said predetermined number of permanent signal conditions exist when said trouble-checking line is seized.

5. In a telephone system, an unattended dial office, a master office comprising an operator's position, and trunks between said dial office and said position, said unattended office comprising subscribers' lines, means including subscriber controlled switches for establishing connections between calling lines and called lines or trunks, and means responsive to a permanent signal condition existing at one time on more than a predetermined number of lines for seizing one of said trunks on a trouble indicating call to said position.

6. In a telephone system, an unattended dial office, a master office comprising an operator's position and trunks between said dial office and said position, said unattended office comprising subscribers' lines, means including subscriber controlled switches for establishing connections between calling lines and called lines or trunks, means responsive to a permanent signal condition existing at one time on more than a predetermined number of said lines for seizing one of said trunks on a trouble indicating call to the master office, a trouble indicating tone source, and means responsive to the answer of the trouble call at the master office for connecting said tone source to said trunk to indicate to the answering operator the character of the call.

7. In a telephone system, an unattended dial office, a master office comprising an operator's position, trunks between said dial office and said position, subscribers' lines in said dial office, means including subscriber controlled switches for establishing connections between calling lines and called lines or trunks, an alarm relay in said dial office, and means comprising a voltmeter type relay responsive to the existence at one time of a permanent signal condition on more than a predetermined number of said lines for operating said alarm relay.

8. In a telephone system, an unattended dial office, a master office comprising an operator's position, trunks between said dial office and said position, subscribers' lines in said dial office, means including subscriber controlled switches

for establishing connections between calling lines and called lines or trunks, an alarm relay in said dial office, means comprising a voltmeter type relay responsive to the existence at one time of a permanent signal condition on more than a predetermined number of said lines for operating said alarm relay, and means controlled by said alarm relay for seizing an idle one of said trunks on a trouble indicating call to said position, a trouble tone source, and means responsive to answer of said call at said position for connecting the trouble indicating tone source to said trunk.

9. In a telephone system, an unattended dial office, subscribers' lines in said office, a master office comprising an operator's position, trunks between said dial office and said position, means including subscriber controlled switches for establishing connections between calling lines and called lines or trunks, an alarm relay in said dial office, means comprising a voltmeter type relay responsive only to the existence at one time of a permanent signal condition on more than a predetermined number of said lines for operating said alarm relay, said voltmeter relay comprising means for holding said relay operated and a reset coil for restoring the contacts of said relay to normal, means controlled by said alarm relay for seizing an idle one of said trunks on a trouble indicating call to said position, a trouble tone source, means responsive to the answer of said trouble call at said position for connecting said trouble tone source to said trunk, a trouble-checking line in said dial office, means at said position for initiating a trouble-checking call over one of said trunks and for controlling the operation of switches in said dial office to establish connection with said trouble-checking line, a line relay for said trouble-checking line responsive to connection of a trunk therewith, means including contacts of said relay for operating said reset coil to release the voltmeter relay, means for preventing the re-operation of said reset coil while said line relay remains operated, a tone source for producing a tone indicative of a permanent signal alarm condition, and means effective if said voltmeter relay immediately reoperates after its release due to the operation of its reset coil for connecting said permanent signal tone source to said trunk.

10. In a telephone system, an unattended office comprising subscribers' lines and a trouble-checking line, an attended office, trunks between said offices, switching means including first selector switches in said unattended office for connecting calling lines with called lines or with an idle one of said trunks and for connecting a calling one of said trunks with a called line, means for connecting each calling line with an idle one of said first selector switches, control means at each calling station for controlling the selective operation of the connected switch, means in said attended office for connecting with an idle one of said trunks and for controlling the operation of switches in the unattended office to connect with any desired one of said lines, and means responsive to seizure of said trouble-checking line for transmitting a trouble tone over the connected trunk in case a predetermined number of first selector switches are then connected to calling lines and said first selector switches have been so connected for a predetermined interval of time without being selectively operated.

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