Sept. 18, 1934. C. P. STOCKER 1,974,087

TELEPHONE SYSTEM

Filed April 21, 1933 3 Sheets-Sheet 1

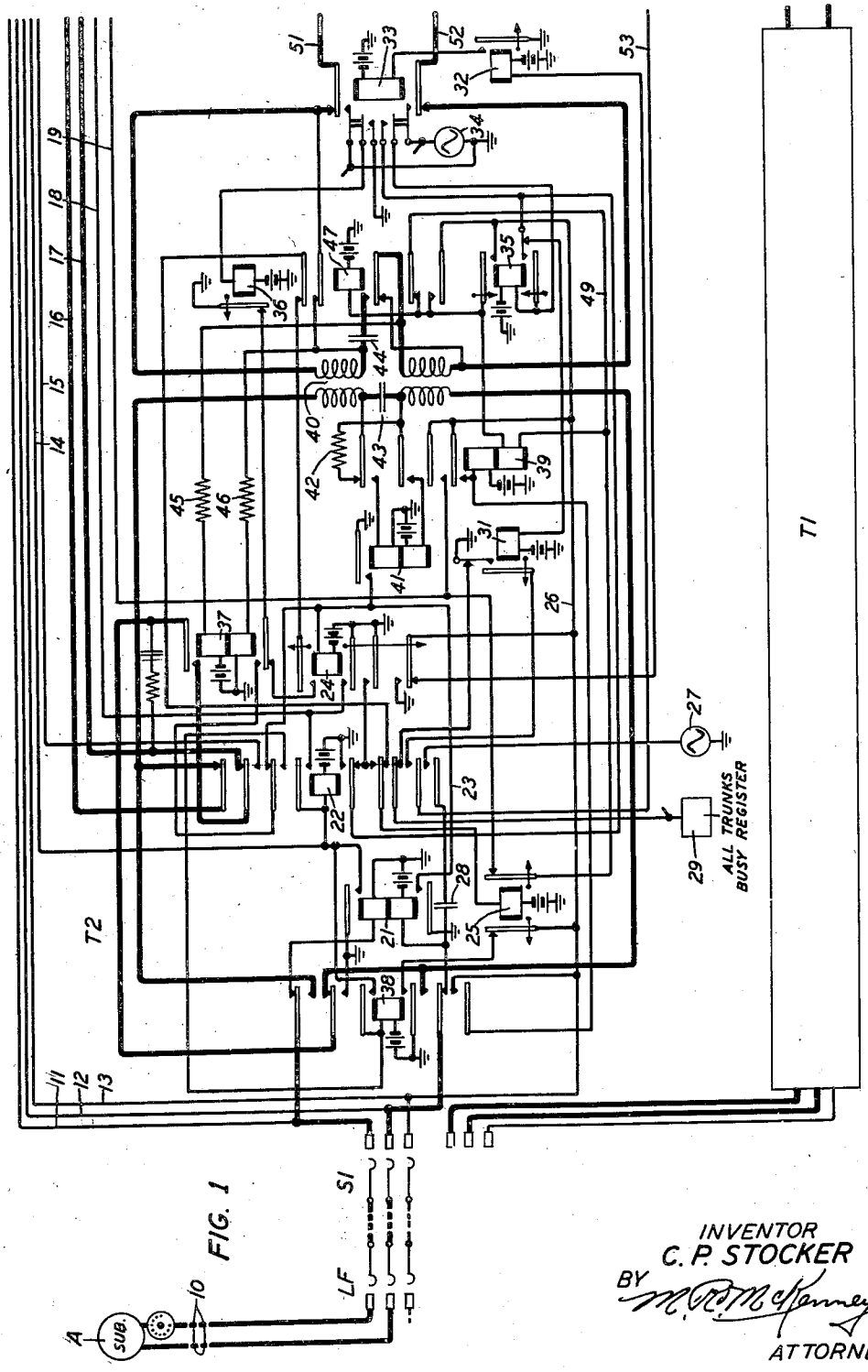

FIG. 1

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TELEPHONE SYSTEM

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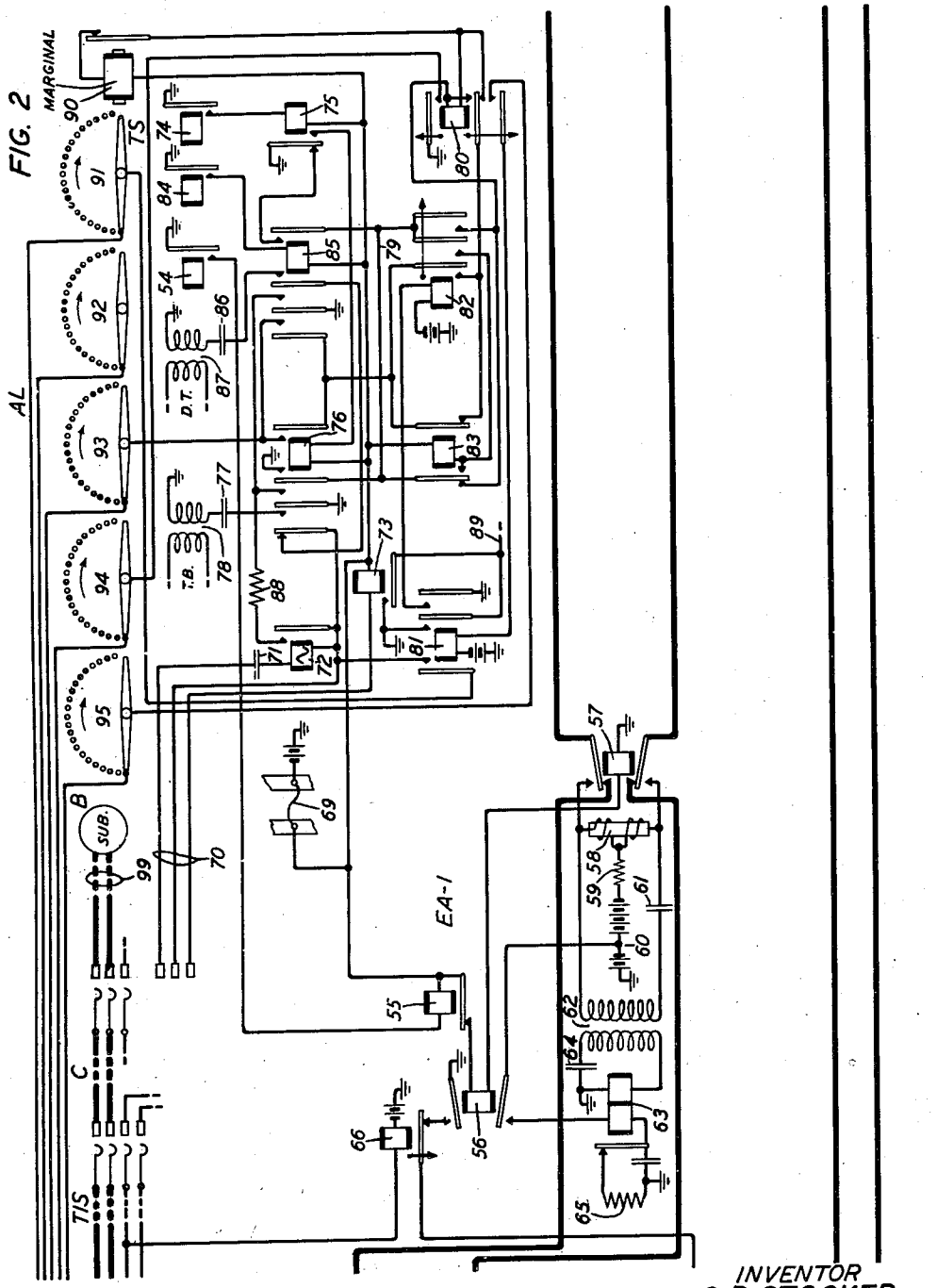
FIG. 2



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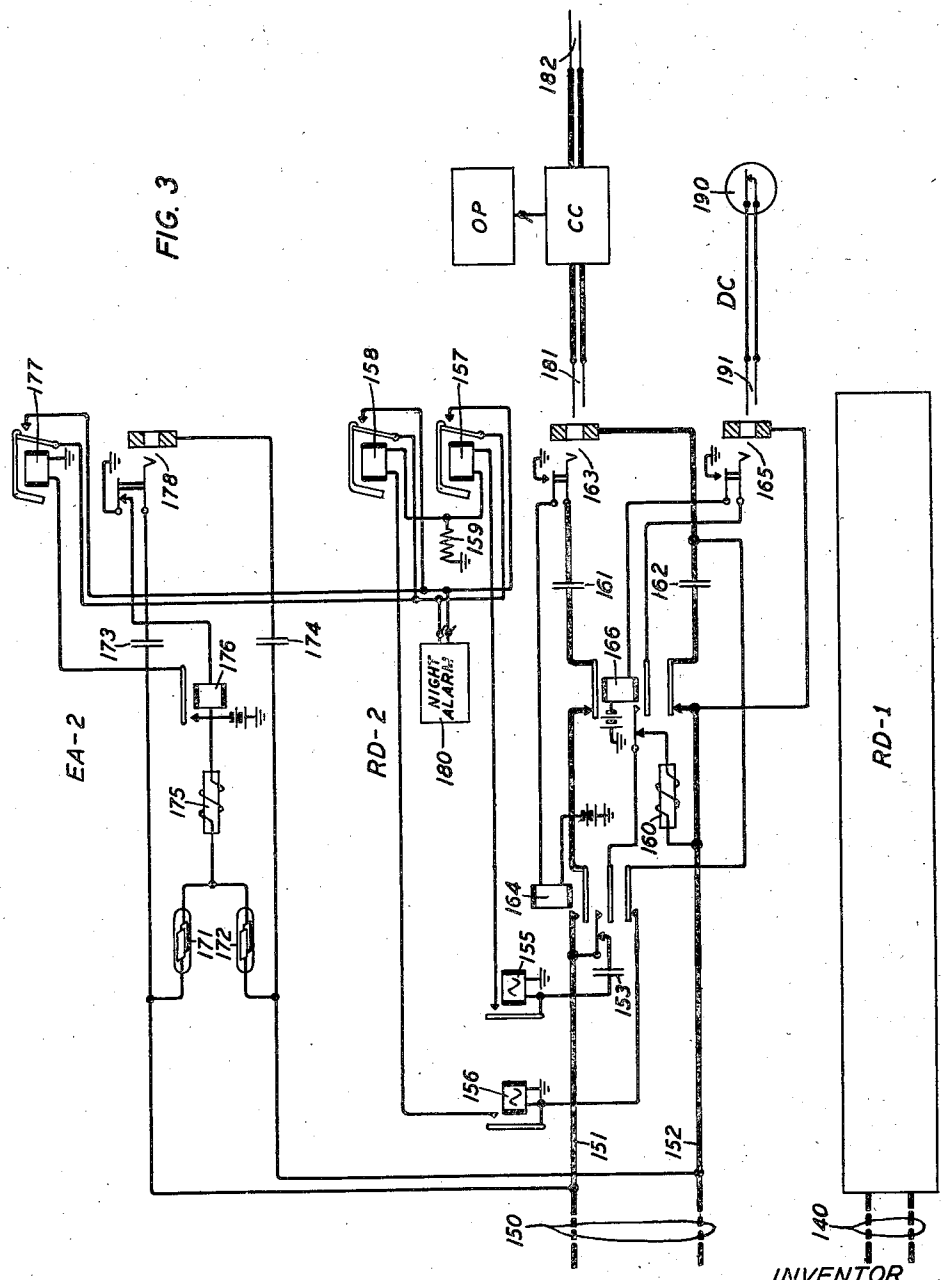
TELEPHONE SYSTEM

Filed April 21, 1933 3 Sheets-Sheet 3

FIG. 3



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Patented Sept. 18, 1934 1,974,087

UNITED STATES PATENT OFFICE

1,974,087

TELEPHONE SYSTEM

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Application April 21, 1933, Serial No. 667,211

17 Claims. (Cl. 179—27)

This invention relates to telephone systems and more particularly to systems which include one or more unattended automatic offices.

The object of the invention is to provide improved arrangements for the supervision of unattended automatic telephone offices.

In telephone systems which include an unattended automatic office it is usual to provide means for transmitting trouble alarms from the unattended office to an attended automatic or manual office. Systems providing for the transmission of trouble alarms from a branch office to a main office are disclosed in Patent No. 1,196,876, granted to F. Lubberger, September 5, 1916, in Patent No. 1,616,738, granted to W. A. Benson, February 8, 1927 and in Patent No. 1,805,726, granted to N. H. Saunders, May 19, 1931. The supervisory office may be a manual office with ring-down trunks incoming from the unattended automatic office, in which case the usual direct current or ringing current alarm transmitting circuits are ineffective.

According to this invention means is provided at an unattended automatic office for connecting a high potential source of current to both conductors of one of the ring-down trunks leading to a main office comprising a magneto switchboard. At the magneto end of the trunk, there is provided alarm-initiating apparatus which responds to the connection of the alarm voltage without responding to normal ringing voltage.

A feature of the invention is the connection of each conductor of an incoming trunk through a space discharge device to the winding of an alarm relay, whereby the connection of a source of high potential to both of said conductors at their distant end is effective to operate the relays and initiate an alarm.

Another feature of the invention is the connection of two space discharge lamps in series across the conductors of an incoming trunk, the mid-point of said bridge being connected through a retard coil and the winding of an alarm relay to ground, whereby the relay is operatively responsive to the breakdown of the lamps when a high potential is connected to the distant end of both of said trunk conductors and operatively unaffected by the breakdown of the lamps when a high potential is induced or bridged across the distant ends of said conductors.

The drawings, which form a part of this specification, illustrate schematically a portion of a telephone system arranged in accordance with the features of this invention. It is, of course, understood that the invention is not limited in its application to the particular system illustrated. Referring to the drawings,

Fig. 1 shows, in diagrammatic form, a subscriber's station A and line 10, a line-finder LF having access to the line 10, a selector switch S1, and two two-way trunk circuits T1 and T2 all located in an unattended automatic branch office;

Fig. 2 shows, in diagrammatic form, a toll intermediate selector TIS associated with trunk circuit T2, a connector C accessible to the selector TIS, a subscriber's line 99 and station B, a miscellaneous alarm circuit AL, and emergency alarm apparatus EA—1 associated with the trunk circuit T2 for use in transmitting a trouble-alarm signal to a distant main office, all of which equipment is located in the branch office; and

Fig. 3 shows, in a diagrammatic form, two two-way trunk circuits RD1 and RD2 in a manual main office associated with trunks 140 and 150 extending between the main office and the unattended branch office of Figs. 1 and 2; Fig. 3 also shows emergency alarm apparatus EA—2 associated with the trunk 150, a cord circuit CC, operator's position equipment OP, and a dialing cord DC.

The trunk circuit RD2 terminating the trunk 150 at the main office and the trunk circuit T2 terminating this trunk at the branch office are shown in detail while the trunk circuits RD1 and T1 terminating the trunk 140 are represented by the enclosures within which these designations are located. The trunk circuits T1 and RD1 are the same as the trunk circuits T2 and RD2, respectively, except that there is no emergency alarm apparatus provided for trunk 140. The selector and connector switches are each represented schematically by its set of brushes and one set of terminals, the associated apparatus and circuit connections being omitted. These switches may be of the well known, two-motion step-by-step type, for a description of the structure and operation of which reference may be had to pages 53 to 65, inclusive, of the 2nd edition of "Automatic Telephony" by Smith and Campbell, published in 1921. The toll intermediate selector switch TIS is provided with a fourth conductor over which supervisory signals are transmitted from the connector C to the trunk T2 for controlling the cutting-in of the repeating coil of trunk T2. Reference may be had to the patent to B. G. Dunham No.

1,849,662, granted March 15, 1932, for a disclosure of a toll transmission selector and a toll connector having the same supervisory-control features as the trunk T2 and connector C.

By placing Figs. 1, 2 and 3 adjacent each other in the order named, the drawings represent a system which includes an unattended automatic branch office and a main office equipped with a magneto switchboard. The trunks 140 and 150 represent a group of two-wire two-way trunks connecting the main and the branch office. At the branch office these trunks are connected to terminals in the banks of selector switches for seizure on calls outgoing to the main office and are also connected to incoming selectors for use on calls incoming from the main office. The associated trunk circuits in the branch office are arranged to transmit an impulse of ringing current to the main office upon seizure by any of the selectors to whose terminal banks the trunks are connected. At the main office the trunks terminate at an operator's position, ring-down signals being provided for responding to ringing current received from the branch office. Each trunk has two jacks associated therewith, one for use in establishing a talking connection and the other for use in dialing on outgoing calls.

The automatic branch office being unattended, it is necessary to provide automatic signaling means for transmitting trouble indicating signals to the main office whenever conditions arise which require the attention of a maintenance attendant. To this end, the miscellaneous alarm equipment AL in the branch office is provided with a single motion step-by-step trunk-selecting switch TS for selecting when a trouble condition arises, any one of the idle outgoing trunks. When a trunk is thus seized, a trouble indicating tone of the desired character is transmitted to the main office. One of the outgoing trunks is also provided with emergency alarm apparatus for use in indicating power failure or other emergency arising at the branch office. In the drawings such alarm apparatus is shown in Fig. 2 associated with the trunk 150 and the trunk circuit T2 of Fig. 1. The trunk 140 represents the remaining trunks of the group, none of which are arranged for use in giving emergency alarm signals. When an emergency arises, the trunk 150 is appropriated for transmission of the alarm signal irrespective of its idle or busy condition, means being provided for cutting off any line to which the trunk may be connected when seized.

The operation of the trunk circuits T2 and RD2 on regular calls will be first described. On a call from the main office to the branch office, the operator inserts the calling plug 181 of the cord circuit CC into the talking jack 163 thereby closing a circuit for operating relay 164. Relay 164 disconnects signal relays 155 and 156 from the conductors of trunk 150, bridges the impedance coil 160 across these conductors, and establishes a talking connection from the trunk through condensers 161 and 162 to the conductors of jack 163. The bridging of impedance coil 160 across conductors 151 and 152 causes the operation of the incoming line relay 37 of trunk circuit T2 in the branch office. The circuit for operating relay 37 may be traced from battery through the upper winding of relay 37, resistance 45, inner lower back contact of relay 47, lower back contact of relay 33, conductor 52, lower normally closed front contact of relay 57, over conductor 152 of trunk 150, through impedance coil 160 of trunk circuit RD2 in the main office, through the inner lower back contact of relay 166, outer front contact of relay 164, conductor 151 of trunk 150, upper normally closed front contact of relay 57, conductor 51, upper back contact of relay 33, inner upper back contact of relay 47, resistance 46, and through the lower winding of relay 37 to ground. Relay 37 closes a circuit for operating relay 24, this circuit being traced from battery, through the winding of relay 24, inner upper back contact of relay 22, lower front contact of relay 37 to ground at the back contact of relay 36, Relay 37 also closes a bridge across conductors 16 and 17 leading to the incoming selector TIS to operate the line relay (not shown) of the selector; this bridge is traced from conductor 16 through the uppermost back contact of relay 22, left upper winding of repeating coil 40, uppermost back contact of relay 39, resistance 42, left lower winding of repeating coil 40, inner upper back contact of relay 38, upper front contact of relay 37, middle upper back contact of relay 22, to conductor 17. Relay 24 closes a circuit for operating relay 31, connects ground to the sleeve conductor 18 leading to the toll intermediate selector TIS, and connects ground over conductor 26 to the sleeve terminal of trunk T2 in the banks of all selectors having access thereto as a busy indicating condition. The operation of relay 31 disconnects ground from the conductor leading to the all-trunks-busy register 29. The ground connected to conductor 18 serves as a holding ground for the switches of the toll train and also serves to operate relay 66 of the emergency alarm apparatus EA—1. The function of relay 66 will be hereinafter described in connection with the operation of the apparatus EA—1.

When the operator in the main office inserts the plug 191 of a dialing cord DC into jack 165, a circuit is closed for operating relay 166. Relay 166 bridges the interrupter contacts of dial 190 across conductors 151 and 152 in place of the impedance coil 160. When the operator dials the number of the called station, the incoming line relay 37 of trunk circuit T2 in the branch office is alternately released and reoperated in response to each dial impulse. The impulses are repeated by the upper contacts of relay 37 over conductors 16 and 17 to selectively operate the switch TIS and the succeeding switches employed in establishing connection with the called line in the well known manner. Upon the release of relay 37 in response to the first impulse of each digit, relay 25 operates and, being slow in releasing, remains operated until all of the impulses in a train have been received. The operation of relay 25 prevents premature operation of relay 47. In response to the impulses repeated over conductors 16 and 17, the selector TIS and connector C are selectively operated to extend the connection to the called line, which is represented by line 99 and station B. When dialing is completed the plug 191 of cord DC is removed from jack 165, releasing relay 166. If the called line is idle, ground (not shown) at the connector C is connected over the control conductor and through the lowermost brush of selector TIS to the control conductor 19, thereby causing the operation of relay 47, the circuit connection from conductor 19 being traced through the right back contact of relay 25, conductor 49, and through the outer lower back contact and wind-

ing of relay 47, to battery. Relay 47 locks through its lowermost front contact over conductor 26 to ground at the front contact of relay 24. A short circuit, normally existing around the lower winding of relay 39, and the operating path for relay 47 are opened after the locking path is closed. With relay 47 operated, the right-hand windings of repeating coil 40 are inserted in series with the windings of relay 37, and the condenser 44 is bridged across the inner ends of these windings. Signaling current is transmitted from connector C over line 99 in the well known manner, and when the called subscriber answers, the ground connected to the control lead of connector C is replaced by a battery potential (not shown) thereby causing the operation of relay 39, the circuit connection from conductor 19 being traced through the right back contact of relay 25, the lower winding of relay 39, the lowermost front contact of relay 47, over conductor 26 to ground at the front contact of relay 24. Relay 39 locks through its upper winding and inner front contact over conductor 26 to the ground at relay 24. With relay 39 operated, the impulse bridge across conductors 16 and 17 is opened; and the windings of relay 41 are connected through the left windings of repeating coil 40 to these conductors to supply the called station with talking current. Relay 41 connects ground to conductor 23 but the connection is under the control of the operator in the main office since the release of relay 37 opens the circuit for relay 41. Relay 24 supplies the ground over sleeve conductor 18 for holding the selector TIS and connector C. The talking currents are inductively transmitted through the windings of the repeating coil 40 in the trunk circuit T2 and through condensers 161 and 162 of trunk circuit RD2. The potential normally applied to conductors 151 and 152 being insufficient to break down the resistance of lamps 171 and 172, the alarm circuit EA—2 does not interfere with the talking circuit. When the calling plug 181 is removed from jack 163, upon the termination of the call, relay 164 releases opening the bridge across the trunk 150, thus causing the release of relay 37 of trunk circuit T2. Relay 37 in turn causes the release of relays 41, 24 and 31. The release of relay 24 also removes ground from conductor 18, thereby causing the release of relay 66 and the release of the intermediate toll selector TIS and connector C, these switches being restored to normal in the usual manner.

Assuming the subscriber at station A to have originated a call, that the line-finder LF has extended line 10 to the selector S1, and that the brushes of this selector have been selectively advanced in response to the dialing of a digit by the calling subscriber, and that the trunk circuit T2 and trunk 150 have been seized, the line relay 21 of trunk circuit T2 is operated in a loop circuit over the line 10. Relay 21 closes obvious circuits for operating relays 22 and 24. Relay 24 connects a guarding ground over conductor 26 to the sleeve terminals of this trunk to prevent its seizure by another selector and over conductor 13 to the sleeve terminal of the trunk hunting switch TS of the alarm circuit AL. Relay 22 locks to ground at the inner lower front contact of relay 24, disconnects ground from the conductor leading to the all-trunks-busy register 29, closes a circuit for operating relay 31, and connects the source of ringing current 27 through the lowermost front contact of relay 22, condenser 28, the lower back contact of relay 38, and over the ring conductor of selector S1 to transmit an audible ringing signal to the calling station. The ground connected through the inner lower front contact of relay 24, over conductor 18, is effective to operate relay 66 of the emergency alarm apparatus EA—1. With relays 22 and 24 operated, a circuit is closed for operating relay 25; and with relays 22 and 31 operated, a circuit is closed for operating relay 32. Relay 32 closes a circuit for operating relay 33. Relay 33 closes circuits for operating relays 35 and 36, connects the grounded side of the ringing current source 34 to conductor 51 and closes a signaling circuit from the source of ringing current 34, through the outer lower front contact of relay 33, over conductor 52, lower normally closed front contact of relay 57, over conductor 152 of trunk 150, outer lower back contact of relay 166, condenser 162, outer lower back contact of relay 164, through the winding of relay 156 to ground. Relay 156 responds to alternating current, thereby extending the ringing circuit through its front contact, the winding of drop signal 158, and resistance 159 to ground. The winding of signal 158 is then energized in parallel with the winding of relay 156 and the operation of drop signal 158 closes a circuit to the supervisory (night alarm) signal 180. The operation of relay 35 causes the release of relay 31, and closes a circuit for operating relay 47. The release of relay 31 causes the release of relays 32 and 33 in turn. The release of relay 33 causes the release of relay 36 and opens the signaling circuit from source 34. Relay 35 remains operated, being locked through its lower front contact to ground at relay 22. Relay 36 is slow in releasing to prevent the premature operation of relay 38 in case relay 37 responds to potential surges over the trunk conductor when relay 33 releases. Relay 47 inserts the right-hand windings of repeating coil 40 in series with the windings of relay 37 and the conductors of trunk 150, and connects condenser 44 across the inner ends of these repeating coil windings.

When the operator at the magneto office answers the call by inserting the answering plug of an idle cord such as CC in the jack 163, relay 164 operates closing the talking circuit through condensers 161 and 162 and bridging impedance 160 across the conductors of trunk 150 to cause the operation of relay 37 of trunk circuit T2 as hereinbefore described. With relays 22 and 37 both operated and relay 36 released relay 38 operates. Relay 38 locks under control of relays 22 and 24 and closes a circuit for energizing the upper winding of relay 39. Relay 39 operates and locks through its inner upper front contact, over conductor 26, to ground at relay 24. Relay 38 also opens the audible ringing tone circuit, and transfers the calling line loop from the windings of relay 21, through the left-hand windings of repeating coil 40, to the windings of relay 41. Relay 21 releases and relay 41 operates; relay 41 connects ground to conductor 23 thus holding relay 24 operated.

When the calling subscriber replaces the receiver on the receiver hook, relays 41 and 24 release in turn. The release of relay 24 causes the release of relays 39, 47 and 25. Relay 25 is slow in releasing to provide a momentary disconnection of the holding ground from sleeve conductor 26, thus enabling the return of switches S1 and LF to normal in the usual manner. If the operator at the main office has not

yet removed the answering plug from jack 163, relays 37, 38, 22 and 35 are held operated, the release of relay 25 connecting a guarding ground potential from the inner lower front contact of relay 38, through the left back contact of relay 25 over conductor 26 to the sleeve terminal of trunk circuit T2 in the banks of the first selectors and also over conductor 13 to the sleeve terminal of this trunk circuit in the bank of switch TS of the miscellaneous alarm circuit AL. No disconnect signal is given to the main office operator.

When the operator disconnects, relays 37, 38, 22 and 35 of trunk circuit T2, relay 66 of emergency alarm apparatus EA—1, and relay 164 of trunk circuit RD2 all release. Should the operator disconnect before the calling subscriber releases the connection, relay 37 releases but relay 41 holds relay 24 and relay 24 holds relay 22. When the calling subscriber releases the connection, relays 41, 24 and 22 release and the switches S1 and LF are restored to normal.

When a trouble condition arises in the branch office, an alarm initiating relay such as either of relays 74 or 84 of the alarm circuit AL is operated, the operation of relay 74 being effective to operate relays 75 and 76 to initiate a class A alarm and the operation of relay 84 being effective to operate relay 85 to initiate a class B alarm. The operation of either of relays 76 or 85, closes a circuit from ground through a front contact of the operated relay, over conductor 79, through the left back contact of relay 83, winding of relay 80, back contact and winding of magnet 90 of switch TS, to battery through the main power fuse 69. The operation of either of relays 76 or 85 also connects the winding of magnet 90, through the back contact of relay 80, right back contact of relay 83, front contact of relay 76 or 85, through brush 93, to the sleeve terminal of the trunk with which the brushes of switch TS are in contact. If this trunk is busy, the ground potential connected over conductor 13 to its sleeve terminal in the bank of switch TS, as hereinbefore described, is effective to short-circuit the winding of relay 80 and cause the operation of stepping magnet 90. With magnet 90 operated, the energizing circuit through its winding is opened to cause its release, each operation and release of magnet 90 being effective to advance the brushes of switch TS one step. The switch TS is advanced step by step by the operation of magnet 90 until brush 93 encounters the sleeve terminal of an idle trunk, at which time relay 80 operates in series with magnet 90. The magnet 90 is marginal and does not operate in series with relay 80. The operation of relay 80 extends the ground from conductor 79 through its inner lower front contact to the sleeve brush 93 as a guarding potential to prevent seizure of this trunk by any of the selectors such as S1.

Assuming the selected set of terminals to be connected to trunk circuit T2, relay 80 connects ground through its upper front contact and through brush 94 over conductor 14 to cause the operation of relay 22 of trunk circuit T2. The operation of relay 22 causes the operator at the main office to be signaled as hereinbefore described for a call initiated at station A. When the operator answers the call, the operation of relay 37 over the trunk 150 and the resulting operation of relay 38, both as hereinbefore described, complete a circuit for operating relay 81 of the alarm circuit AL. This circuit is traced from battery through the winding of relay 81, lowermost front contact of relay 80, brush 95 of switch TS, over conductor 15, through the uppermost front contact of relay 22 of trunk circuit T2, and through the upper front contact of relay 37 to ground at the middle upper front contact of relay 38. Relay 81 closes a circuit for operating relay 82, and connects ground to conductor 89, to start the ringing machine (not shown). Relays 24 and 25 of trunk circuit T2 are not operated and relay 38 closes a circuit for operating relay 39, from battery through the upper winding of relay 39, lowermost front contact of relay 38, left back contact of relay 25, to ground at the inner lower front contact of relay 38. Relay 39 locks through its inner upper front contact to the same ground and also to the guarding ground connected to sleeve conductor 13 by brush 93 of switch TS. In the case of a class B alarm, relay 81 also connects the right-hand winding of the dial tone transformer 87 in series with condenser 86, through the inner left front contact of relay 85, back contact of relay 76, and left front contact of relay 81 to brush 91 of switch TS, thence over conductor 11 to trunk circuit T2, through the uppermost front contact of relay 38, left upper winding of repeating coil 40, uppermost front contact of relay 39, through the upper winding of relay 41 to ground. The tone circuit is ineffective to operate relay 41 but is effective to inductively transmit through repeating coil 40 a class B trouble tone to the operator in the main office. In case of a class A trouble, the secondary winding of trouble tone transformer 78 in series with condenser 77 is connected through the outer left front contact of relay 76 and left front contact of relay 81, thence as traced to ground through the upper winding of relay 41, thereby transmitting a class A alarm tone to the operator in the main office. The aforementioned operation of relay 82 of the alarm circuit closes a circuit for holding relay 80 operated, and closes a circuit for operating relay 83. Relay 83 locks through its front contact over conductor 79 to ground at the front contact of relay 76 or back contact of relay 75. The ground potential connection for guarding the trunk T2 is now traced from conductor 79, through the outer front contact of relay 82 instead of the left back contact of relay 83, and through the inner front contact of relay 82 instead of the right back contact of relay 83. When the main office operator disconnects, relay 37 releases, but relay 38 holds temporarily through its inner upper front contact in parallel with relay 22 over conductor 14 to ground at relay 80 of alarm circuit AL. The release of relay 37 causes the release of relays 81, 82 and 80 of the alarm circuit in the order named, relay 83 remaining operated as long as either of the alarm initiating relays 76 or 86 remain operated, that is until the trouble no longer exists. The release of relay 82 disconnects the busy potential from brush 93, thereby releasing relays 22 and 38 of trunk circuit T2. Relay 38 releases relays 39 and 47, and relay 22 releases relay 35, the trunk circuit T2 being restored to normal for use in regular traffic.

Should the operator at the main office wish to check the existence of a class A or class B trouble condition at the branch office, the trunk is seized as hereinbefore described, the number dialed by the operator being a number assigned to the miscellaneous alarm circuit AL. When a selector such as TIS and a connector such as

C have been selectively operated to seize the terminals connected to the line 70 of alarm circuit AL, a ringing circuit is closed from the source of ringing current (not shown) in connector C, through condenser 71 and the winding of relay 72. Relay 72 responds to alternating ringing current and if either of relays 76 or 85 is at that time in an operated condition as a result of an existing trouble condition, ground is connected through resistance 88 and the front contact of relay 72, to the ring conductor of line 70, thus operating the tripping relay (not shown) of connector C. With relay 85 operated the class B tone source is connected to the ring conductor of line 70 and with relay 76 operated the class A tone source is connected to the ring conductor of line 70, the tone in either case being transmitted over the talking circuit through connector C, switch TIS, trunk circuit T2 and trunk 150 to the calling operator. If no trouble condition exists and neither of relays 85 or 76 is operated, ground is not connected to the ring conductor of line 70, and ringing is continued without being tripped, thus serving to indicate to the calling operator that no trouble condition exists. When the operator disconnects from the trunk, the trunk is released for use in regular traffic.

When an emergency arises in the branch office, such as power failure, the normal signaling circuits are or may be ineffective to transmit signaling current to the main office. It being necessary that a maintenance attendant be summoned immediately, one of the trunks to the main office is provided with emergency alarm apparatus EA—1 at the branch office and with emergency alarm apparatus EA—2 in the main office. The trunk 150 is so equipped. The apparatus EA—1 comprises an independent and reliable source of signaling current 60 arranged for connection to the trunk conductors leading to the main office when the emergency trouble condition arises. The closing of such a connection is effective to operate the signal apparatus EA—2 at the main office to signal the operator. A special tone source is included in the apparatus EA—1 for connection to the trunk to give the answering operator an emergency alarm tone. The source of signaling current 60 may be a 135-volt dry battery such batteries being of known reliability and long life for noncontinuous and infrequent use. The apparatus EA—2 comprises the neon lamps 171 and 172 connected to the conductors 151 and 152 of trunk 150, an alarm relay 176, the alarm drop signal 177 and the alarm answering jack 178. The relay 54 in the alarm circuit AL represents alarm relays which are operated in case of the operation of a relay rack fuse, the operation of a switch frame fuse, in case of the failure of the ringing supply, or in case the automatic battery charging apparatus fails to operate when required. With all of the alarm relays represented by relay 54 normal, relay 55 of the emergency alarm apparatus EA—1 remains normal. Relays 56 and 57 are normally operated being connected directly to the main power fuse 69. Relay 57 normally connects trunk conductors 51 and 52 to trunk 150 for use in regular traffic as hereinbefore described.

When the main power fuse 69 blows or when relay 55 operates, due to the operation of one of the emergency alarm relays 54, relays 56 and 57 release. The release of relay 57 disconnects the conductors of trunk 150 from trunk circuit T2 and connects the source of signaling current 60 through resistance 59, windings of retard coil 58, back contacts of relay 57, over both conductors of trunk 150, through the lamps 171 and 172, retard coil 175, winding of relay 176, to ground at jack 178. The release of relay 56 closes a circuit from a middle tap of current source 60, through the lower back contact of relay 56, left winding and interrupter contact of buzzer relay 63, and through resistance 65 to ground. The interruption of this circuit by the contacts of relay 63 induces a potential difference across the right winding of this relay, thus constituting, in combination with condenser 64 and the windings of transformer 62, a tone source from which a tone is transmitted through condenser 61 and the back contacts of relay 57 over trunk 150 to the main office. Relay 56 also connects ground through its upper back contact and the back contact of relay 66 over conductor 53 and through the back contact of relay 24, over conductor 26 of trunk circuit T2 to sleeve conductor 13 to guard this trunk circuit against seizure while the trunk 150 is being used for the emergency alarm. Should the trunk 150 be busy on an incoming or an outgoing call at the time the emergency alarm condition arises, relay 66 will have been operated over conductor 18 to ground in trunk circuit T2, in which case the connection of ground to conductor 53, by the release of relay 56, is delayed; when the trunk circuit T2 restores to normal due to release by the calling subscriber on an outgoing call, or to the disconnection of trunk circuit T2 from trunk 150 at relay 57 on an incoming call, relay 66 is released and the guarding ground potential at relay 56 is then connected to sleeve conductor 53.

The potential difference across the neon tubes 171 and 172 of alarm apparatus EA—2, when the source of signaling current 60 of emergency alarm apparatus EA—1 becomes connected to the conductors of trunk 150, is sufficient to cause the breakdown of the normal resistance of these lamps, the current flowing as a result thereof causing the operation of relay 176. Relay 176 closes the circuit for operating the drop signal 177. The operation of signal 177 closes the circuit leading to the night-alarm signal apparatus 180 giving the usual audible signal in addition to the drop signal. When an operator inserts the plug of an answering cord in jack 178, relay 176 is released, signal 177 is restored, and the tone generated by the buzzer relay 63 in the branch office is received through condenser 173 and 174. When the emergency signal apparatus EA—1 is restored to normal, the source of signaling current 60 and tone transformer 62 are disconnected from trunk 150, the trunk 150 being reconnected to trunk circuit T2 by the operation of relay 57. The busy potential is disconnected from sleeve conductor 13 of trunk circuit T2 by the reoperation of relay 56.

The arrangement of apparatus EA—2 is such that the alarm relay 176 will not respond to the connection of low potential or a ringing current source to the conductors of trunk 150. The connection of a non-grounded high potential across the conductors of trunk 150 is also ineffective to operate the alarm since relay 176 would be operatively unaffected even though the resistance of lamps 171 and 172 were broken down in the metallic loop circuit; relay 176 is therefore not responsive to high potential surges

which may arise during normal or abnormal operating conditions.

What is claimed is:

1. In combination, a two-conductor line, means at one end of said line for impressing a potential on both of said conductors in parallel, and signaling means at the other end of said line comprising two like devices bridged across said conductors, said devices having approximately infinite electrical resistance when subjected to differences of potential below a certain critical value and having a comparatively low resistance when subjected to differences of potential equal to or greater than said critical value.

2. In combination, a two-conductor line, two devices bridged across one end of said line, each of said devices having approximately infinite electrical resistance to differences of potential below a certain critical value and having a comparatively low resistance to differences of potential equal to or greater than said critical value, a relay connected to the mid-point of said devices, and means for connecting a source of current to both of said conductors in parallel, said source being of high enough potential to cause an electrical current through said devices and relay, and signaling means controlled by said relay.

3. In combination, a two-conductor line, two space discharge devices connected in series across one end of said line, signaling means connected to the mid-point of the connection between said devices, and means at the other end of said line for connecting a source of current to both of said conductors in parallel, said source being of high enough potential to cause the operation of said devices and said signaling means.

4. In combination, a two-conductor line, means at one end of said line for impressing a low electrical potential difference across said conductors, means at the same end of said line for impressing a high electrical potential on both of said conductors in parallel, two space discharge devices connected in series across the other end of said conductors, and signaling means connected to the mid-point of the connection between said devices, said devices and signaling means being operatively responsive to the impression of said high potential and operatively non-responsive to the impression of said low potential.

5. In combination, a two-conductor line, means at one end of said line for impressing a difference in electrical potential across said conductors, means for impressing an electrical potential on both of said conductors in parallel, two space discharge devices connected in series across the other end of said conductors, and signaling means connected to the mid-point of the connection between said devices, said devices and signaling means being operatively responsive to the impression of an electrical potential to both of said conductors in parallel and operatively non-responsive to the impression of a difference in potential across said conductors.

6. In combination, a two-conductor line, a source of ringing current and means for connecting said ringing current source across said conductors, means for impressing an electrical potential on both of said conductors in parallel, and signaling means at the other end of said line comprising two space discharge devices connected in series across said conductors and a relay, said means being operatively responsive to the impression of an electrical potential on both of said conductors in parallel and operatively non-responsive to the connection of a source of ringing current across said conductors.

7. In a telephone system, a first office, a second office, subscribers' lines in each office, a group of trunks for use in completing calls between said offices, alarm apparatus located in one of said offices for indicating a trouble indication in said other office, said apparatus being associated with one of said trunks and comprising two space discharge devices connected in series across the conductors of said trunk and a relay, and means in said other office responsive to the occurrence of a trouble condition for connecting an electrical potential to both conductors of said trunk, said potential being high enough to break down the resistance of said devices and operate said relay.

8. In a telephone system, an unattended office, an attended office, subscribers' lines in each of said offices, a trunk extending between said offices for completing calls, a source of ringing current at the unattended office for connection across the conductors of said trunk to signal an operator at the attended office, a high potential source of current at said unattended office having one of its terminals connected to ground, means operative in case of an emergency for connecting the other terminal of said high potential source to both of the conductors of said trunk, and alarm equipment at said attended office operatively responsive to the connection of said high potential but unresponsive to ringing current from said unattended office.

9. In a telephone system, a first office, a second office, a group of trunks for use in completing calls between said offices, means in the first office operative in response to a trouble condition for selecting an idle one of said trunks, means for transmitting a trouble indicating signal over the selected trunk to the second office, a central office source of potential for use on calls initiated or terminating in said first office, another source of potential for use in transmitting an emergency alarm signal, means permanently associated with one of said trunks and operatively responsive to an emergency trouble condition in the first office for connecting said other source of potential to said trunk, and means at said second office responsive to the connection of said other source of potential to said trunk for signaling an operator in said second office.

10. In a telephone system, a first office, a second office, a group of trunks for use in completing calls between said offices, means in the first office operative in response to a trouble condition for selecting an idle one of said trunks, means for transmitting a trouble indicating signal over the selected trunk to the second office, a central office source of potential for use on calls initiated or terminating in said first office, another source of potential for use in transmitting an emergency alarm signal, means permanently associated with one of said trunks and operatively responsive to an emergency trouble condition in the first office for connecting said other source of potential to said trunk, means at said second office responsive to the connection of said other source of potential to said trunk for signaling an operator in said second office, and means for transmitting an emergency trouble tone over said trunk during the connection

of said other source of potential to the conductors of said trunk.

11. In a telephone system, a first office, a second office, a trunk extending between said offices for use in completing calls, apparatus in said first office associated with said trunk for use on calls incoming and on calls outgoing over said trunk, a central office source of potential for use on calls originating or terminating in said first office, another source of potential for use in transmitting an emergency alarm signal over said trunk, and means operatively responsive to an emergency trouble condition in said first office for disconnecting said trunk from said apparatus.

12. In a telephone system a first office, a second office, a trunk extending between said offices for use in completing calls, apparatus in said first office associated with said trunk for use on calls incoming and on calls outgoing over said trunk, a central office source of potential for use on calls originating or terminating in said first office, another source of potential for use in transmitting an emergency alarm signal over said trunk, and means operatively responsive to an emergency trouble condition in said first office for disconnecting said trunk from said apparatus and for connecting said other source of potential to said trunk.

13. In a telephone system, a first office, a second office, a trunk extending between said offices for use in completing calls, apparatus in said first office associated with said trunk for use on calls incoming and on calls outgoing over said trunk, a central office source of potential for use on calls originating or terminating in said first office, another source of potential for use in transmitting an emergency alarm signal over said trunk, and means operatively responsive to an emergency trouble condition in said first office for disconnecting said trunk from said apparatus and for connecting said other source of potential to both conductors of said trunk in parallel.

14. In a telephone system, a first office, a second office, a trunk extending between said offices for use in completing calls, apparatus in said first office associated with said trunk for use on calls incoming and on calls outgoing over said trunk, a central office source of potential for use on calls originating or terminating in said first office, another source of potential for use in transmitting an emergency alarm signal over said trunk, means operatively responsive to an emergency trouble condition in said first office for disconnecting said trunk from said apparatus and for connecting said other source of potential to said trunk, and signal means at said second office operatively responsive to the connection of said other source of potential to said trunk.

15. In a telephone system, a first office, a second office, a trunk extending between said offices for use in completing calls, apparatus in said first office associated with said trunk for use on calls incoming and on calls outgoing over said trunk, means operatively responsive to a trouble condition other than an emergency trouble condition for seizing said trunk, apparatus in said second office associated with said trunk for use on calls incoming to and outgoing from said second office and for use in responding to an alarm signal other than an emergency alarm signal received over said trunk, other apparatus associated with said trunk in said second office for use in receiving an emergency alarm signal from said first office, a central office source of potential for use on calls originating or terminating in said first office, another source of potential in said first office, and means operatively responsive to an emergency trouble condition in said first office for connecting said other source of potential to said trunk.

16. In a telephone system, a first office, a second office, subscribers' stations and lines, a trunk connecting said offices, a central office source of potential for use on calls originating or terminating at a subscriber's station in said first office, another source of potential in said first office, apparatus in said second office associated with said trunk for use on calls incoming to and outgoing from said second office and for use in responding to an alarm signal other than an emergency alarm signal, emergency alarm apparatus normally connected to said trunk in said second office, an operator's link in said second office for connection with a trunk, means responsive to the connection of said link with said trunk for disconnecting from said trunk the emergency alarm apparatus in said second office, and means in said first office operatively responsive to an emergency trouble condition for connecting said other source of potential to said trunk for operating the emergency alarm apparatus in said second office.

17. In a telephone system, a first office, a second office, subscribers' stations and lines, a trunk connecting said offices, a central office source of potential for use on calls originating or terminating at a subscriber's station in said first office, another source of potential in said first office, apparatus in said second office associated with said trunk for use on calls incoming to and outgoing from said second office, emergency alarm apparatus normally connected to said trunk in said second office, an operator's link in said second office for connecting with said trunk, means responsive to the connection of said link with said trunk for disconnecting from said trunk the emergency alarm apparatus in said second office, means in said first office operatively responsive to an emergency trouble condition for connecting said other source of potential to said trunk for operating the emergency alarm apparatus in said second office, and means for transmitting an emergency trouble tone over said trunk during the connection of said other source of potential to said trunk.

CLOSMAN P. STOCKER.