Feb. 28, 1933. N. H. SAUNDERS ET AL 1,899,112

MULTIOFFICE TELEPHONE SYSTEM

Filed June 22, 1931 2 Sheets-Sheet 1

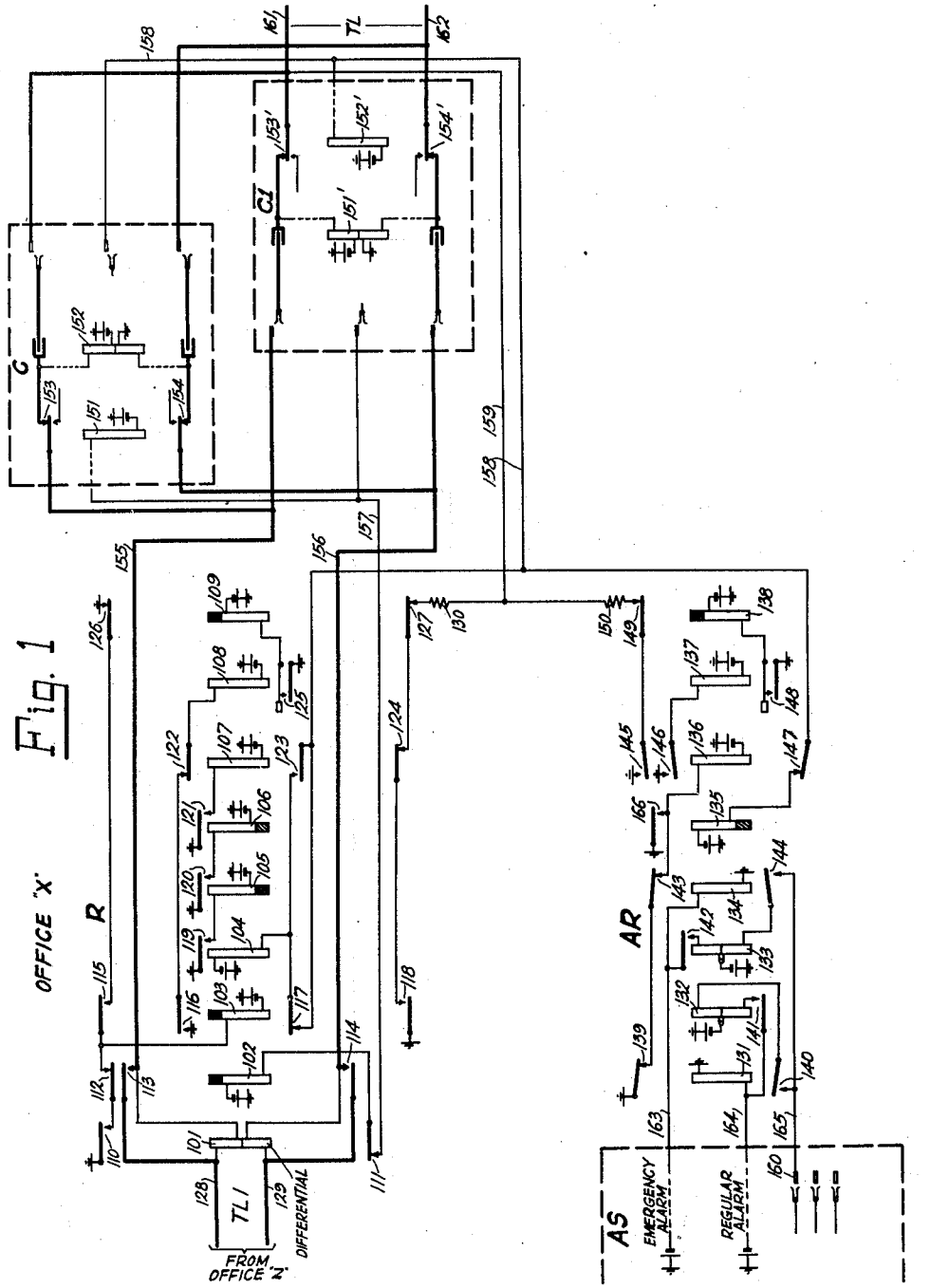


Fig. 1

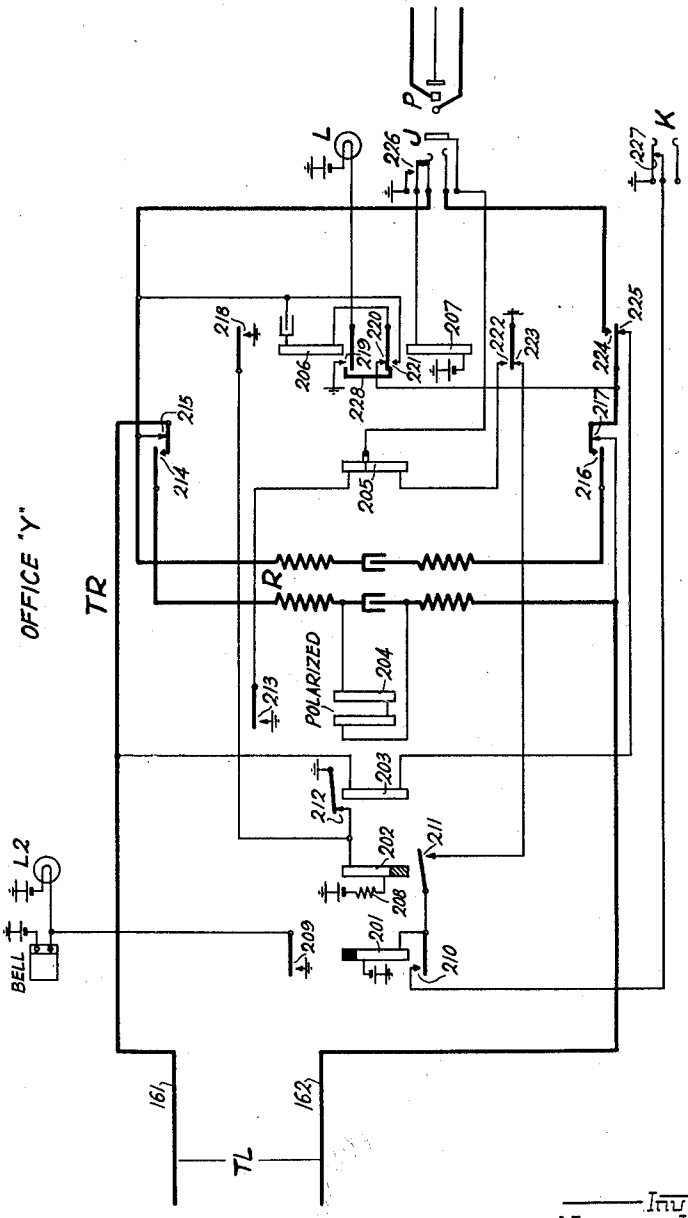
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Fig. 2



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UNITED STATES PATENT OFFICE

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MULTIOFFICE TELEPHONE SYSTEM

Application filed June 22, 1931. Serial No. 545,932.

This invention relates to multi-office telephone systems, particularly to multi-office telephone systems which include one or more unattended automatic offices, and is concerned primarily with improved apparatus and circuits for supervising the unattended offices.

It is the usual procedure in systems of the above type to provide switching apparatus which, in response to an unstandard condition in an unattended office, transmits an alarm signal to an attended office over one of the inter-office trunk lines. In some cases the alarm signal is transmitted in the same manner as a regular trunk call, as shown in the Benson Patent No. 1,616,738 of February 8, 1927, and in other cases it is transmitted by means of special current sent over the trunk line. The systems disclosed in the Saunders Patent No. 1,805,726 of May 19, 1931, and in the co-pending application of J. Wicks, Serial No. 395,882, filed September 8, 1929, are representative of the latter method of transmitting alarm signals. These systems employ, respectively, pulsating current and a high voltage current for signalling, and are superior to the former systems in that they do not busy a trunk line against regular calls when in operation.

The systems above-referred to which are representative of those previously used, are open to criticism in that they are inoperative in the case of a total failure of the branch exchange apparatus such as would result from the blowing of the main battery fuse for example. The systems are also subject to trouble from failure of the signal apparatus itself to respond properly to alarm signals. These more or less objectionable features are overcome by the present invention, which has for its main object the provision of an alarm signalling system which will operate satisfactorily under any unstandard conditions which may arise in a branch exchange and in which a failure of the signalling apparatus itself will result in the notification of the attended office.

Another object of the invention is the provision of circuits and apparatus for relaying or repeating alarm signals through a tandem exchange over regular inter-office trunk lines.

The various features of the invention together with the operation of a system embodying the same will be described in detail hereinafter, reference being had to the accompanying drawings comprising Figs. 1 and 2, which disclose the invention in one of its narrower phases. Fig. 1 shows switching apparatus at an unattended exchange, Fig. 2 shows relay equipment at an attended manual exchange or toll switchboard associated with a trunk line extending to the unattended exchange shown in Fig. 1.

Referring now to Fig. 1, the various circuits shown in this figure are assumed to be in one of the unattended offices which will hereinafter be referred to as office X. This office is connected with another unattended office, which will be referred to as office Z, by the trunk line TL1, and with an attended office, which may be manually operated or which includes a manual switchboard, by the trunk line TL. The attended office will be referred to hereinafter as office Y. In the X office, repeater R is inserted in the trunk line TL1 incoming from Z office and repeats the alarm signals through office X as a tandem center, as will be explained hereinafter. The trunk line extending through the repeater terminates in an incoming connector C through which access is had to the subscribers' lines in office X and to trunk lines extending to office Y. The trunk line TL which connects offices X and Y terminates in connector C1 to which access is had to the subscribers in office X and to trunk line TL1 extending to office Z and also to a group of signal terminals associated with the alarm relay equipment. Connectors C and C1 of which only the line and cut-off relays have been shown, may be similar to the connectors shown in the above-referred to Saunders patent. AR is a group of alarm signal relays which are controlled by the regular exchange alarm signalling equipment AS. This equipment shown only in skeleton form may be of the same general type as that disclosed in the Saunders patent previously referred to, and is arranged so that the hold-

ing potential is removed from the alarm conductors when an unstandard condition develops in the exchange. Associated with this equipment is a group of contacts accessible to connectors, such as C1, to which various tones are applied to identify the character of an unstandard condition to the attendant at the main exchange.

Referring now to Fig. 2, TR is a relay group terminating the trunk line TL at the attended exchange. This trunk apparatus is of the type ordinarily used for terminating two-way automatic to manual trunk lines, modified, however, to operate with the alarm signal apparatus which constitutes the present invention. Connection is made with this trunk line by means of a cord circuit of the type commonly used for toll service, for example, a cord such as that disclosed in the Crocker Patent No. 1,771,842 of July 29, 1930.

The operation of the various circuits will now be described in detail to better illustrate the various features of the invention. Considering first the trunk line TL and its associated apparatus, it will be noted that relays 202 and 203 of relay group TR are normally energized. The circuit for relay 203 may be traced as follows: from battery through the upper winding of relay 151′, contacts 153′, trunk conductor 161, winding of relay 203, contacts 225 and 217, trunk conductor 162, contacts 154′, lower winding of relay 151′ to ground. Relay 151′ is not operated in this circuit due to the high resistance of relay 203. Relay 203 completes the circuit of relay 202 at contacts 212, and relay 202 opens a point in the circuit of relay 201 at contacts 211 to prevent the operation of the latter relay.

A regular call from office X to Office Y will be extended to the trunk line by an incoming connector, such as C, or by a similar local connector which has access to the trunk line. The connector on seizing the trunk line will apply ground to release trunk conductor 158, thereby operating cut-off relay 152′ of connector C1, relay 135 of the alarm relay group AR and relay 104 of repeater R. Relay 152′ disconnects line relay 151′ of connector C1 from the trunk, and relay 135 completes a holding circuit for relay 136 at contacts 166 to mark the trunk line busy to the alarm apparatus. Relay 104 is connected to conductor 158 by way of contacts 117 and operates to close a circuit for relay 105 at contacts 119. Relay 105 in turn completes a circuit for relay 106 at contacts 120 and relay 106 completes a circuit for relay 107 at contacts 121. Relay 107 opens the circuit of alarm relay 108 at contacts 122, completes a new holding circuit for relay 104 at contacts 123 and opens the signalling circuit at contacts 124. An alarm signal coming in over trunk line TL1 is now unable to interfere with the regular connection being extended over trunk line TL, as will be explained hereinafter. Returning now to the point at which the connector seized the trunk line, relay 203 will now be energized in series with the ring-cut-off relay of the calling connector, although due to the high resistance of relay 203 the cut-off relay will not be operated. Ringing current applied by the connector in the usual manner will operate relay 206 which is bridged across the trunk conductors in parallel with relay 203. Relay 206 on operating, locks mechanically and closes a holding circuit for relay 202 at contacts 218 and a circuit for lamp L at contacts 219. Lamp L glows to notify the operator of the incoming call.

On noting the lighted condition of lamp L the operator will insert the answering plug P of a cord circuit into jack J, thereby closing a circuit for relay 207 at contacts 226. Relay 207 restores the armatures of relay 206 to normal by means of the interlocking arm 228, disconnects relay 203 from across the trunk line at contacts 225, disconnects relay 206 from in bridge of the trunk conductors at contacts 220, and connects ground to the lower high resistance winding of sleeve relay 205 at contacts 222. Relay 205 operates over the sleeve of the jack and plug, extends the trunk conductors through the left-hand windings of repeating coil R to polarized relay 204 by closing contacts 214, connects the ring and tip springs of the jack through to the right-hand windings of the repeating coil R by closing contacts 216, and by opening contacts 215 and 217, divides the trunk into two sections connected through the repeating coil. Relay 203 restores upon the opening of its circuit by relay 207, and relay 202 restores after slight delay following the restoration of relay 206 to normal. Relay 201 is now prevented from operating since a second point in its circuit has been opened at contacts 223 by the operation of relay 207. The ring-cut-off relay of the calling connector operates in series with relay 204 and stops the application of ringing current to the trunk line. The operator may now converse with the calling subscriber and further extend the connection by means of her cord circuit in the usual manner.

To terminate the connection the calling subscriber will hang up and the operator will withdraw plug P from the jack. Connector C or the connector in use will restore, thereby removing ground from release trunk conductor 158 and relays 152′, 135 and 104 to 107, inclusive, will restore to normal. At the trunk relay group relays 205 and 207 will restore, again bridging relay 203 across the trunk line. Relay 203 will operate before relay 201 has time to energize since this latter relay is slow to operate. Relay 202 will operate following the operation of relay

203 and will open the circuit of relay 201 at contacts 211. The trunk will now be in the normal condition described in previous paragraphs.

In making an outgoing call over the trunk line TL the operator will insert the calling plug of a cord circuit into jack J, thereby closing the circuit to relay 207 which operates with the same results as previously described, except that relay 206, not having operated, is not restored to normal. The line relay of connector C1 is now operated over a loop which may be traced from conductor 161, contacts 214, upper left-hand winding of repeating coil R, polarized relay 204 and lower left-hand winding of repeating coil R, to conductor 162. Relay 204 does not operate at this time due to the direction of current flow over the trunk line. The operator now proceeds to dial the number of the wanted subscriber's line in the usual way. Each time the calling device is turned off-normal the circuit to sleeve relay 205 is opened and that relay restores and extends the trunk conductors straight through to the ring and tip conductors of the jack and plug by way of contacts 215 and 217. Upon the call being answered, the connection of line relay 151′ to the trunk conductors is reversed by means of the usual reversing contacts on the battery-feed relay of connector C1, and polarized relay 204 of the relay group TR operates. Ground is connected through the low-resistance upper winding of relay 205 by way of contacts 213 to operate the supervisory signal in the cord circuit in the well known manner. Upon the termination of a call the called subscriber will hang-up and the operator will withdraw the plug from the jack J, thereby releasing the apparatus in the manner previously described.

A call from office Z to office X or Y will be extended over the trunk line TL1 by a connector similar to connector C in the Z office. These connectors, it will be appreciated, are arranged to switch through and operate as selectors on certain levels, in which case no ringing current is transmitted over the called trunk line and dialled impulses are repeated to operate succeeding switches. Upon the seizure of the trunk line TL1 a loop circuit will be closed for line relay 152 of connector C. This loop includes the upper and lower winding of differential relay 101 which does not operate under these conditions since its two windings oppose each other. Relay 152 on operating, prepares connector C for operating and the connector in the usual way returns a holding ground on release trunk conductor 157. This ground by way of contacts 111 operates relay 102 which short-circuits the two windings of relay 101 and at contacts 113 and 114, and opens a point in the circuit of relay 103 at contacts 112. The calling subscriber now dials the number of the wanted subscriber and connector C operates in the usual way to extend a connection. It is further noted that connector C also has access to the trunk line TL and by dialing the proper number the calling subscriber is able to call the operator at the office Y in lieu of a subscriber in the X office.

A call from office X or office Y to office Z will be extended over the trunk line TL1 by an incoming connector such as C1 or a similar local connector. The connectors of this type on seizing the trunk line in question switch through and operate as selectors and repeat the dialled impulses over the trunk line. Upon seizing the trunk line, ground is extended ahead upon release conductor 157, operating relay 102 of the repeater R which short-circuits the windings of differential relay 101 and opens the circuit to relay 103 as previously described. The setting up of the connection and release thereof follow the usual well-known routine operations and will not be described in detail.

The normal operation of the trunking apparatus has now been considered and the operations involved in the transmission of alarm signals will now be described. Referring to the alarm relay group AR, Fig. 1, it will be noted that relays 131 and 134 are normally energized by battery connected to the alarm conductors 163 and 164, respectively. Relay 136 is held operated over a circuit including contacts 139 and 143. Relay 131 disconnects the upper winding of relay 132 from test conductor 165 at contacts 140 and relay 134 disconnects the lower winding of relay 133 from this same conductor at contacts 144. Relay 136 maintains the alarm circuit open at contacts 145, opens the circuit of relay 137 at contacts 146 and connects relay 135 to release trunk conductor 158 at contacts 147. In the case of an emergency alarm, the alarm signal apparatus AS operates in the usual manner and battery is disconnected from conductor 163, thereby permitting relay 134 to restore. In the case of a regular alarm the battery is disconnected from conductor 164, thereby permitting relay 131 to restore. The release of either of these relays opens a point in the circuit of relay 136 at either contact 139 or contact 143 and the associated cut-off relay 132 or 134 is connected to conductor 165. In the event that the trunk line TL is in use at the time the alarm signal comes in, relay 135 will be operated as previously described and relay 136 will be prevented from restoring since a holding circuit is closed by way of contacts 166. In case the trunk line TL is idle or, when it becomes idle after having been in use, relay 135 will restore upon the removal of ground from release trunk conductor 158 and the circuit of relay 136 will be opened, thereby permitting that relay to restore. Relay 136 on restoring disconnects

relay 135 from the release trunk conductor at contact 147, closes a circuit for relay 137 at contacts 146, and at contacts 145 connects ground to the upper conductor of the trunk line TL over a circuit extending by way of contacts 149, resistance 150, and conductor 159 to conductor 161. This ground operates relay 151', although no useful purpose is served thereby. Relay 203 of the trunk group TR is normally operated in series with relay 151', as previously explained, and upon the connection of ground to conductor 161, the relay is shunted and restores. The circuit of relay 202 is opened at contacts 212 and after a short delay relay 202 restores and closes the circuit of relay 201 at contacts 211. Relay 201, after a short delay, operates and completes a locking circuit for itself by way of contacts 210 and contacts 227 of key K. The alarm circuit is closed at contacts 209 and the bell and lamp L2 are operated to notify the attendant at the main exchange that an unstandard condition has developed at the unattended exchange. Returning now to the alarm relay group AR it will be recalled that the circuit of relay 137 was closed upon the release of relay 136. Relay 137 is provided with a weighted spring armature which is set in vibration upon the operation of the relay. The vibrations of the armature spring gradually decrease and contacts 148 remain closed for a longer interval as the relay is maintained energized. After a delay which is governed by the adjustment of the weight on the armature springs, contacts 148 remain closed long enough for the high-impedance relay 138 to operate. This relay opens the signal circuit at contacts 149, thereby removing the shunt from relay 203 and restoring the trunk line to normal condition. Relay 136, however, will remain in normal condition as long as the unstandard condition persists or until the operator at the attended exchange calls back to verify the alarm as will be explained later, and relays 137 and 138 will also remain operated. Relay 201 at the main exchange will remain locked up and the alarm signal will be operated until released by the operation of key K which opens the holding circuit of relay 201 at contacts 227. The trunk line TL will be available for regular calls immediately after relay 138 is operated.

In order to determine the character of the unstandard condition of the branch exchange, the operator will call back over trunk line TL or a similar trunk line, operating the associated connector, such as C1, into engagement with the set of contacts including test contact 160. Upon the connector engaging this set of contacts, ground over the test wiper of the connector by way of conductor 165 and either of the closed contacts 140 or 144, will operate the particular cut-off relay which has been connected to conductor 165. Assuming that relay 132 is the relay involved, this relay will lock in series with relay 131 by way of contacts 141 and thereby operating that relay and again closing the circuit for relay 136 at contacts 139. Relays 131 and 132 will remain locked up and prevent the alarm from being retransmitted to the main exchange. When the unstandard condition is remedied the connection of battery to conductor 164 will shunt relay 132 and will maintain relay 131 operated in the usual way. The restoration of relay 132 will place the apparatus in condition for its usual operation. The operation of relay 133 is substantially the same as that of relay 132, except that its upper winding is locked in series with relay 134 by way of contacts 142. The alarm signal apparatus AS applies various tones to the contacts engaged by the wipers of the calling connector to inform the operator of the character of the unstandard condition. This arrangement is shown in detail in the Saunders patent referred to in the early part of the specification and need not be described in detail at this point.

In the case of an unstandard condition in the unattended office Z, an alarm signal relay apparatus similar to AR will be operated, thereby applying ground to conductor 128 of the trunk line TL1. Application of ground energizes the upper winding of relay 101 in series with the upper winding of relay 152 of connector C. Relay 101 upon operating, completes a circuit by way of contacts 110 and 112 to slow-to-operate relay 103. Relay 103 upon operating, completes a locking circuit for itself at contacts 115, closes a circuit for relay 108 at contacts 116, opens the circuit of cut-off relay 104 at contacts 117, and at contacts 118 applies ground by way of contacts 124 and 127, resistance 130 and conductor 159 to trunk conductor 161 of the trunk line TL. Relays 203 and 202 of the trunk relay group TR, Fig. 2, restore as in the previous case, relay 201 operates and locks and completes a circuit for the alarm bell and lamp. Relay 108 of repeater R is provided with a weighted armature spring, similar to that of relay 137, and after a delay determined by the adjustment of the weight on this armature spring, a circuit is completed for relay 109 at contacts 125. Relay 109 which has a high impedance operates after a slight delay, opens the alarm signalling circuit at contacts 127, and opens the locking circuit of relay 103 at contacts 126. The ground is removed from the trunk conductor 128 of trunk line TL1 after a short interval by a relay corresponding to relay 138 of the relay group AR at the office Z. Relay 101 consequently restores to normal and upon the operation of relay 109 relay 103 restores to normal and opens the circuit of relay 108. Relay 108 in turn restores and opens the circuit of relay 109 and the re-

peater is returned to normal condition and is available for regular calls.

In the case of a failure of the alarm signal apparatus itself, such as the blowing of a fuse in the battery-feed circuit, relay 136 will restore and apply ground to trunk conductor 161 to operate the alarm signal in the attended exchange. In this case, however, relays 137 and 138 will not operate to free the trunk line for regular calls. The attendant will be apprised of this condition by continued operation of the alarm signal after the operation of the alarm release key K.

Should a fault develop on the trunk line TL, for example, the breaking of either trunk conductor or the grounding of conductor 161, the alarm signal at the attended exchange will be operated. In either case, relay 203 will be released to initiate the signal operation. The attendant will be apprised of this condition in the manner described above, that is, the signal will persist even though the alarm release key K is operated.

It will be noted that the alarm signals from both office X and office Z are transmitted over trunk line TL1 to the main exchange office Y. This arrangement has been shown for convenience only, and it is obvious that the repeater R may be arranged to transmit alarm signals over a different trunk line from that used by the apparatus AR when such is desired. It is also evident that in the transmission of alarm signals the inter-office trunks are withheld from regular service for the very short interval required to operate the relays 137 and 138 or the relays 108 and 109 and that after the alarm signal has been transmitted to the main exchange, the trunk line is again restored to normal use.

What is claimed is:

1. In a telephone system, two exchanges, a trunk line connecting said exchanges, a signal device at one exchange, means at the other exchange automatically operated responsive to an unstandard condition therein for momentarily connecting ground to a conductor of said trunk line to initiate the continuous operation of said signal device.

2. In a telephone system, two exchanges, a trunk line connecting said exchanges, a signal device at one exchange, means at the other exchange operated responsive to an unstandard condition therein for momentarily connecting ground to a conductor of said trunk line to operate said signal device, means at said one exchange for maintaining the operated state of said signal device after the ground connection to the trunk conductor is removed, and manually controlled means at said one exchange for disabling said last means.

3. In a telephone system, two exchanges, a trunk line connecting said exchanges, means for establishing talking connections between subscribers in said exchanges over said trunk line, a signal device in one exchange, means in the other exchange operated responsive to an unstandard condition therein for momentarily connecting ground to a conductor of the trunk line, and means at the other exchange operated responsive to said ground connection for initiating the continuous operation of said signal device.

4. In a telephone system, two exchanges, a trunk line connecting said exchanges, a signal at one exchange, and means associated with said trunk line at said one exchange for operating said signal responsive to an unstandard condition either in said other exchange or on said trunk line.

5. In a telephone system, two exchanges, a trunk line connecting said exchanges, a signal at one exchange, means associated with the trunk line at said one exchange for actuating said signal responsive to an unstandard condition either in the other exchange or on the trunk line, and manually controlled means at said one exchange for deactuating said signal when the same has been actuated responsive to an unstandard condition in said other exchange.

6. In a telephone system, two exchanges, a trunk line connecting said exchanges, means for establishing talking connections between subscribers in said exchanges over said trunk line, a signal in one exchange, means in said one exchange controlled over said trunk line and operated responsive to an unstandard condition either in the other exchange or on the trunk line for initiating the continuous operation of said signal, and manually controlled means at said one exchange effective for disabling said signal only in case the signal has been operated responsive to an unstandard condition in the other exchange.

7. In a telephone system, two exchanges, a two conductor trunk line connecting said exchanges, switching apparatus in said exchanges, means for establishing talking connections between subscribers' lines terminating in said exchanges via said trunk line and said switching apparatus, a signal device at one exchange, a signal at the other exchange, means including said device operated responsive to the development of a fault in the switching apparatus at said one exchange for momentarily connecting ground to one conductor of the trunk line, and means at the other exchange controlled by said momentary ground connection for initiating the continuous operation of said signal.

8. In a telephone system, two exchanges, switching apparatus and signalling apparatus in one exchange, an alarm signal in the other exchange, a trunk line connecting said exchanges, means for establishing talking connections between subscribers in said exchanges over said trunk line and through said switching apparatus, means including said signalling apparatus for momentarily

connecting ground to a conductor of said trunk line to operate said alarm signal responsive to an unstandard condition in said switching apparatus, and means for continuously connecting ground to said trunk conductor to operate said signal responsive to an unstandard condition in said signalling apparatus.

9. A telephone system as claimed in claim 8 in which the alarm signal is maintained in continuous operation after being initially operated by the momentary connection of ground to a conductor of the trunk line.

10. In a telephone system, two exchanges, a trunk line comprising two conductors connecting said exchanges, a relay at one exchange bridged across the trunk conductors, a signal controlled by said relay, a source of current bridged across the trunk conductors at the other exchange for maintaining said relay in operated condition, and means at said other exchange for shunting said current source to release said relay and operate said signal.

11. In a telephone system, two exchanges, a two conductor trunk line connecting said exchanges, means for establishing talking connections between subscribers in said exchanges over said trunk line, a signal at one exchange, a relay for controlling said signal, a second relay normally energized over the trunk line from a source of current in the other exchange for preventing the operation of said first relay, and means for releasing said second relay while still preventing the operation of said first relay responsive to the establishment of a talking connection over the trunk line.

12. In a telephone system, an attended exchange, a plurality of unattended exchanges, trunk lines serially connecting said exchanges, a signal in the attended exchange, and means operated responsive to an unstandard condition in one of said unattended exchanges for momentarily connecting ground to a conductor of each of the intervening trunk lines to initiate the continuous operation of said signal.

13. In a telephone system, an attended exchange, a plurality of unattended exchanges, trunk lines serially connecting said exchanges, a signal in the attended exchange, means for establishing talking connections between subscribers in different ones of said exchanges over one or more of said trunk lines, means operated responsive to an unstandard condition in one of said unattended exchanges for initiating the continuous operation of said signal by the momentary connection of ground to the intervening trunk lines, and means whereby the establishment of talking connections over said trunk lines is prevented only during the interval through which said ground connections are maintained.

14. In a telephone system, three exchanges, trunk lines serially connecting said exchanges, a signal at the third exchange, means for establishing talking connections between subscribers in different exchanges over said trunk lines, means in the first exchange operated responsive to an unstandard condition therein for momentarily connecting ground to the trunk line extending to the second exchange provided the trunk line is not in use in a talking connection, means in the second exchange controlled by said signal current for momentarily connecting ground to the trunk line extending to the third exchange to operate said signal provided the trunk line is not in use in a talking connection, and means in the second exchange operated when the trunk line extending to the third exchange is in use in a talking connection for causing said last means to withhold the ground connection from the trunk line until the same is released from the talking connection.

15. In a telephone system, three exchanges, a two conductor trunk line connecting the first and second exchanges, a two conductor trunk connecting the second and third exchanges, means for establishing talking connections between subscribers in different exchanges over said trunk lines, means responsive to an unstandard condition in the first exchange for momentarily connecting ground to a conductor of said first trunk line, means in the second exchange controlled by said ground connection for momentarily connecting ground to a conductor of said second trunk line, and a signal in the third exchange set in a continuously operated condition responsive to said last ground connection.

16. The method of supervising an unattended telephone exchange over a two conductor trunk line ordinarily used for establishing talking connections to and from subscribers' lines, which consists in disabling an alarm signal by energizing a relay over the two trunk conductors in series as long as the exchange apparatus and the trunk line remain in operating condition and the trunk line remains idle.

17. The method of supervising an unattended telephone exchange over a two conductor trunk line ordinarily used for establishing talking connections to and from subscribers' lines, consisting of disabling an alarm signal by energizing a relay over the two trunk conductor in series as long as the exchange apparatus and the trunk line remain in operating condition and the trunk line remains idle, and of energizing said relay in a local circuit when the trunk line is in use in a talking connection.

18. The method of supervising an unattended automatic telephone exchange over a trunk line ordinarily employed for establishing talking connections to and from sub-

scribers' lines, consisting of normally energizing a relay over the trunk line and of automatically connecting ground to the trunk line to deenergize the relay when an unstandard condition develops in the exchange.

19. The method of automatically transmitting alarm signals from one exchange to another over trunk lines ordinarily used for establishing talking connections between subscribers in the different exchanges consisting of applying ground to a trunk conductor at one exchange to shunt a signal control relay at the other exchange which is normally held energized by current flow over the trunk line from a current source in the one exchange.

In witness whereof, we hereunto subscribe our names this 17th day of June, A. D. 1931.

NORMAN H. SAUNDERS.
CLARENCE E. LOMAX.
THOMAS F. CROCKER.