

Dec. 6, 1949

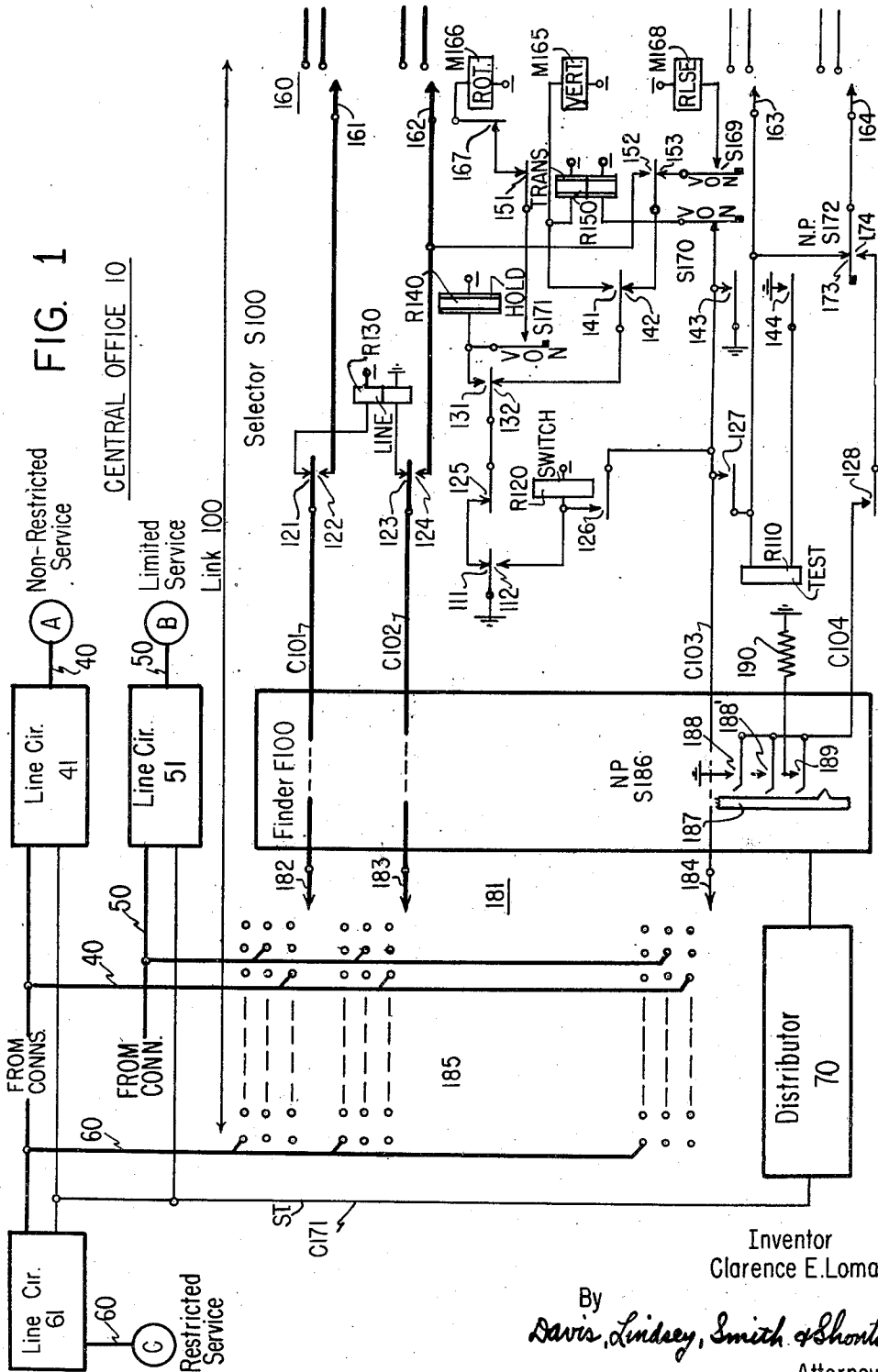
C. E. LOMAX

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AUTOMATIC RESTRICTED SERVICE TELEPHONE SYSTEM

Filed Jan. 3, 1947

4 Sheets-Sheet 1



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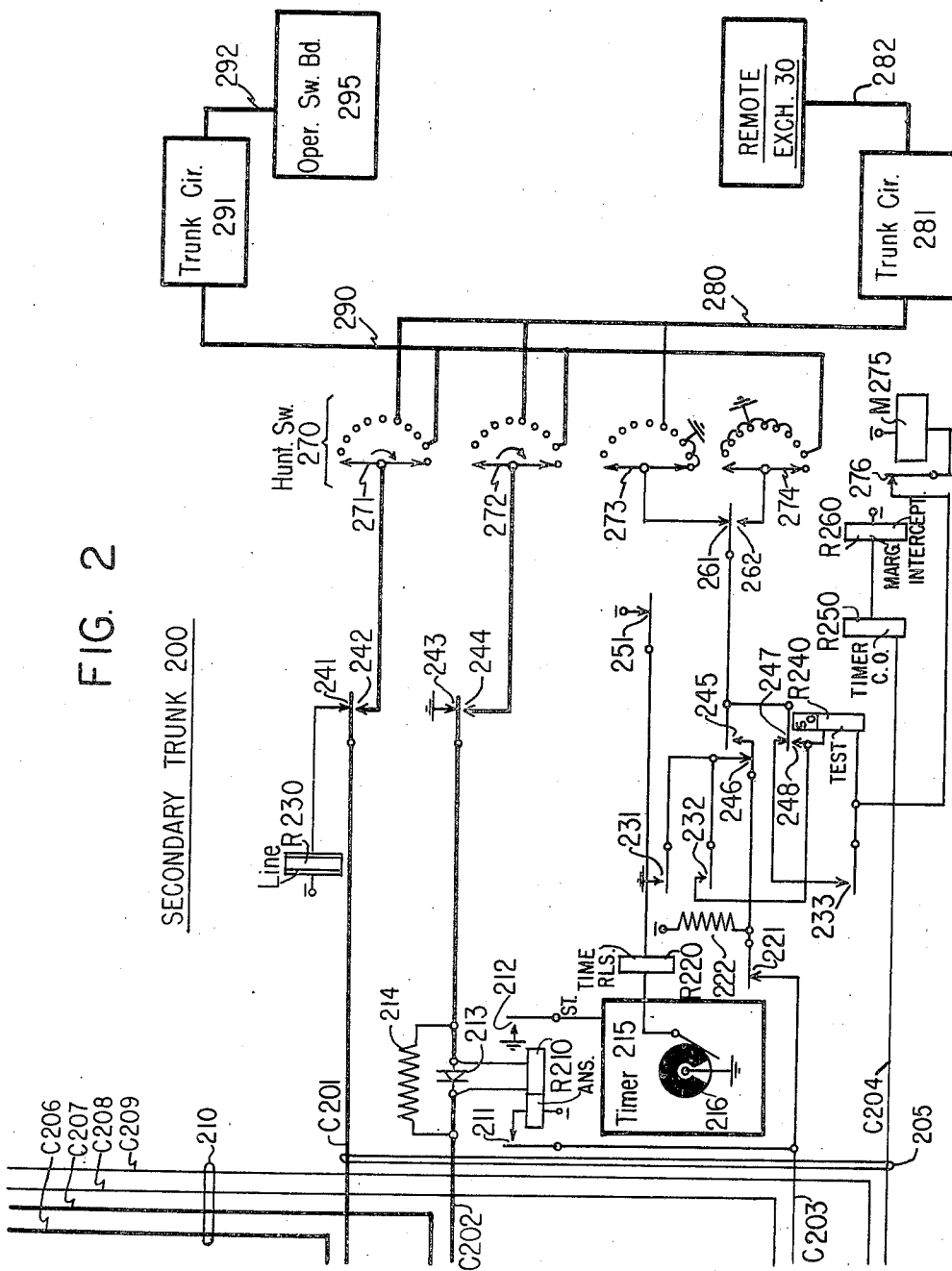
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AUTOMATIC RESTRICTED SERVICE TELEPHONE SYSTEM

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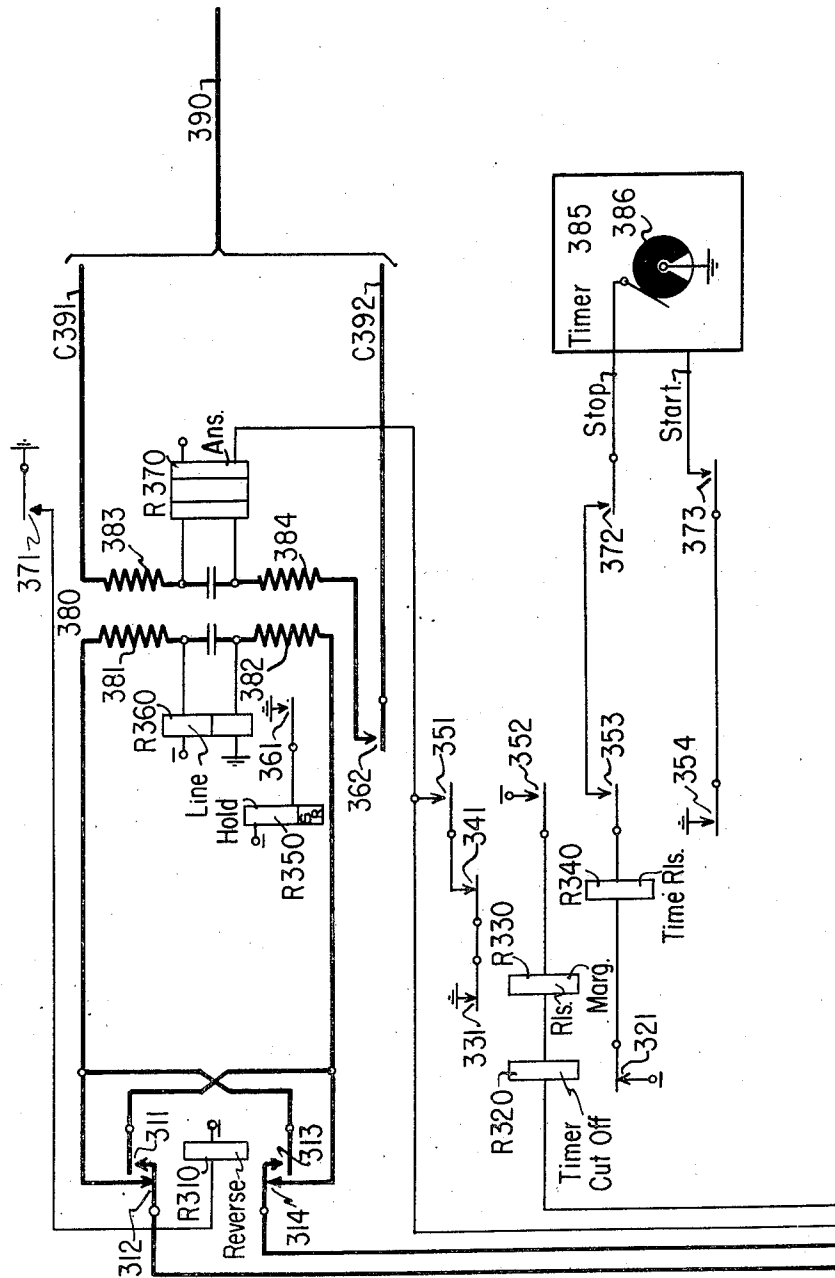
AUTOMATIC RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG. 3

TRUNK CIRCUIT 300



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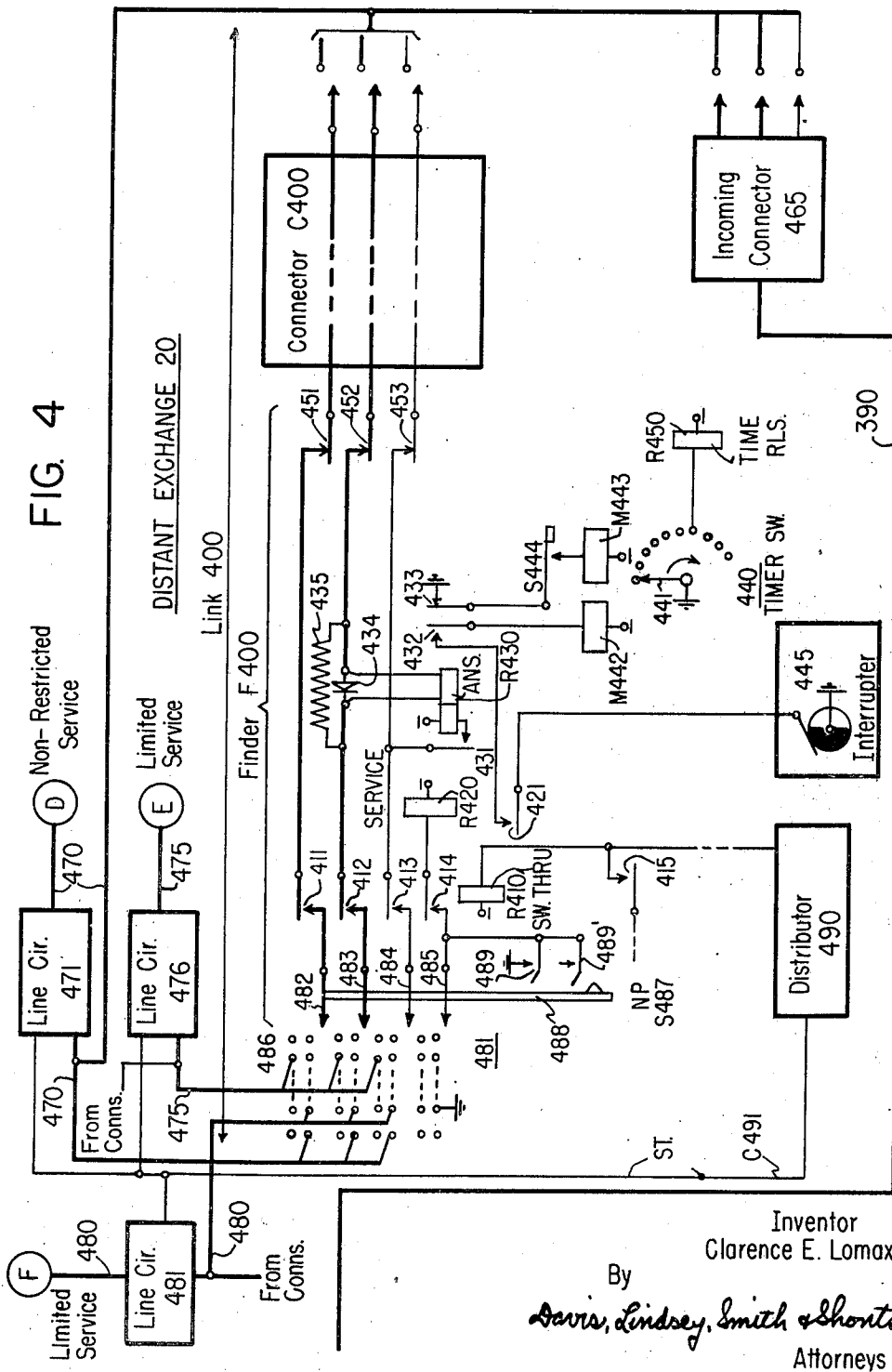
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AUTOMATIC RESTRICTED SERVICE TELEPHONE SYSTEM

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UNITED STATES PATENT OFFICE

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AUTOMATIC RESTRICTED SERVICE
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5 Claims. (Cl. 179—18)

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The present invention relates to automatic telephone systems and more particularly to such systems in which different groups of subscriber substations are rendered corresponding different classes of service.

In an automatic telephone system serving a central office area and the adjacent suburban areas, calls from the subscriber substations in the central office area that are to be completed to subscriber substations in the suburban areas are usually first extended to an operator switchboard in the central office area and then routed by the operators thereat to the subscriber substations in the suburban areas. While this system is entirely satisfactory in operation, a large switchboard in the central office, staffed by a great number of operators is required in order to complete the calls from the central office area to the suburban areas.

Accordingly, it is an object of the present invention to provide an automatic telephone system comprising an improved switching arrangement; whereby subscriber substations arranged in a first group in the central office are rendered a first class of service permitting them to set up connections for any desired time interval to subscriber substations in the suburban areas, subscriber substations arranged in a second group in the central office are rendered a second class of service permitting them to set up connections for a limited time interval to subscriber substations in the suburban areas, and subscriber substations arranged in a third group in the central office are rendered a third class of service preventing them from setting up connections to subscriber substations in the suburban areas.

Another object of the invention is to provide an automatic telephone system in which different classes of service are rendered to subscriber lines; wherein the classes of service are selectively established by an improved arrangement incorporated in the finders of the system.

Another object of the invention is to provide an automatic telephone system of the type noted; wherein the class of service rendered to a subscriber line is determined jointly by the operation of the finder to find the subscriber line and by the operation of subsequent switching apparatus to extend the connection from the finder.

A further object of the invention is to provide in a finder, characterized by different primary operations to select corresponding different groups of lines and by different secondary operations to select corresponding different individual lines in the previously selected group of

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lines, an improved arrangement selectively controlled by different primary operations of the finder for establishing corresponding different classes of service to be rendered to the lines in the different groups of lines selected by the finder.

A still further object of the invention is to provide in a finder of the type noted, an improved arrangement selectively controlled by different primary operations thereof for establishing first corresponding controls of classes of service to be rendered to the lines in the different groups of lines and selectively controlled by the particular secondary operations thereof for establishing corresponding second and overriding controls of classes of service to be rendered to the lines in the different groups of lines.

Further features of the invention pertain to the particular arrangement of the circuit elements of the system whereby the above outlined and additional operating features thereof are attained.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings, in which Figures 1 to 4, inclusive, taken together illustrate the details of an automatic telephone system having incorporated therein the features of the present invention. More particularly, Figs. 1 and 2 should be arranged from left to right in end-to-end relation; Figs. 3 and 4 should be arranged from left to right in end-to-end relation; and Fig. 3 should be arranged above Fig. 2 in order to form a unified diagram.

Referring now, more particularly, to Figs. 1 to 4, inclusive, of the drawings, there is illustrated an automatic telephone system comprising a central office 10, a different exchange 20 and a remote exchange 30. The central office 10 is connected to the distant exchange 20 by a group of ten trunk lines, including the trunk line 390; and the central office 10 is connected to the remote exchange 30 by a group of seven trunk lines, including the trunk line 232.

The central office 10 may serve a group of several hundred subscriber substations rendered three individual classes of service, including non-restricted service, limited service and restricted service. A first group of subscriber substations, including the subscriber substation A is rendered non-restricted service, a second group of subscriber substations, including the subscriber substation B, is rendered limited service; and a third

group of subscriber substations, including the subscriber substation C, is rendered restricted service. Each subscriber substation is provided with conventional subscriber substation apparatus and is connected by an associated subscriber line to a line circuit individual thereto and associated with switching apparatus. The subscriber substation A is connected by the associated subscriber line 40 to the line circuit 41 individual thereto; the subscriber substation B is connected by the associated subscriber line 50 to the line circuit 51 individual thereto; and the subscriber substation C is connected by the associated subscriber line 60 to the line circuit 61 individual thereto. Further, the central office 10 comprises a plurality of groups of links each serving a group of 100 of the subscriber lines; the first group of links, including the link 100, serves the first group of 100 subscriber lines, including the subscriber lines 40, 50 and 60 respectively extending to the subscriber substations A, B and C. More particularly, the subscriber line 40 extending to the subscriber substation A is included in a first ten-line group within the first 100-line group; the subscriber line 50 extending to the subscriber substation B is included in a second ten-line group within the first 100-line group; and the subscriber line 60 extending to the subscriber substation C is included in a third ten-line group within the first 100-line group. The first group of links, including a link 100 is provided with a distributor 70 individual thereto; and each link comprises a finder and a selector, the link 100 comprising the finder F100 and the selector S100. Also, the central office 10 comprises a plurality of groups of connectors, not shown, accessible to the selectors in the groups and utilized for the purpose of setting up local telephone connections. The first group of connectors, not shown, has access to the first 100-line group including the subscriber lines 40, 50 and 60 respectively extending to the subscriber substations A, B and C.

Also, the central office 10 comprises a group of trunk circuits terminating the trunk lines in the group extending to the distant exchange 20; the trunk circuit 300 terminating the trunk line 390; and another group of trunk circuits terminating the trunk lines in the group extending to the remote exchange 30, the trunk circuit 281 terminating the trunk line 282; and a toll switchboard 295. The toll switchboard 295 terminates a group of three trunks, including the trunk 292, terminated by a further group of trunk circuits, including the trunk circuit 291, the trunk 292 being terminated by the trunk circuit 291. Also, the central office 10 comprises a group of secondary trunks, including the secondary trunk 200. Each of the trunk circuits in the group, including the trunk circuit 300, is provided with an incoming trunk accessible to the selectors of the links in the different groups; the trunk circuit 300 being provided with the incoming trunk 210 accessible to the selector S100 of the link 100 in the first group. Each of the secondary trunks in the group, including the secondary trunk 200, is provided with an incoming trunk accessible to the selectors of the links in the different groups; the secondary trunk 200 being provided with the incoming trunk 205 accessible to the selector S100 of the link 100 in the first group. Each of the trunk circuits in the group, including the trunk circuit 281, is provided with an incoming trunk accessible to the hunt switches incorporated in the secondary trunks 200, etc.; the

trunk circuit 281 being provided with the incoming trunk 280 accessible to the hunt switch 270 incorporated in the secondary trunk 200. Each of the trunk circuits in the group, including the trunk circuit 291, is provided with an incoming trunk accessible to the hunt switches incorporated in the secondary trunks 200, etc.; the trunk circuit 291 being provided with the incoming trunk 290 accessible to the hunt switch 270 incorporated in the secondary trunk 200.

The distant exchange 20 serves a group of 100 subscriber substations rendered two individual classes of service, including non-restricted service and limited service. A first group of subscriber substations, including the subscriber substation D, is rendered non-restricted service; and a second group of subscriber substations, including the subscriber substations E and F, are rendered limited service. Each subscriber substation is provided with conventional subscriber substation apparatus and is connected by an associated subscriber line to a line circuit individual thereto and associated with switching apparatus. The subscriber substation D is connected by the associated subscriber line 470 to the line circuit 471 individual thereto; the subscriber substation E is connected by the associated subscriber line 475 to the line circuit 476 individual thereto; and the subscriber substation F is connected by the associated subscriber line 480 to the line circuit 481 individual thereto. Further, the distant exchange 20 comprises a group of links, including the link 400, serving the subscriber lines mentioned, and provided with a distributor 490. More particularly, the subscriber lines 470 and 480 respectively extending to the subscriber substations D and F are included in a first ten-line group within the 100-line group; and the subscriber line 475 extending to the subscriber substation E is included in a second ten-line group within the 100-line group. At this point it is noted that while the subscriber line 480 extending to the subscriber substation F is included in the first ten-line group that is normally rendered non-restricted service, that this particular subscriber line is rendered limited service by virtue of the application of direct ground potential upon the EC conductor thereof in the contact banks of the finders of the associated links, as explained more fully hereinafter. Each of the links comprises a finder and a connector, the link 400 comprising the finder F400 and the connector C400. The connectors C400, etc., of the links 400, etc., have access to the subscriber lines mentioned. Also, the distant exchange 20 comprises a group of incoming connectors, including the incoming connector 465, terminating the group of trunk lines, including the trunk line 395; the incoming connector 465 terminating the trunk line 390. The incoming connectors 465, etc., have access to the subscriber lines 470, 475 and 480 respectively extending to the subscriber substations D, E and F.

The remote exchange 30 is of the automatic type, comprising conventional apparatus, and renders any desired classes of service to a plurality of subscriber substations therein, not shown.

Preferably, in the central office 10 each of the links is identical to the link 100 which comprises the finder F100 and the selector S100. The finder F100 is of the Strowger type, comprising a relay group, not shown, and a Strowger mechanism 181 including a wiper carriage supporting three wipers 182, 183 and 184 and provided with an

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associated contact bank 185. Also, the Strowger mechanism 181 comprises a set of normal post switch springs S186 which is selectively actuated in response to predetermined operations of the wiper carriage shaft 187 in the vertical direction. More particularly, when the wiper carriage of the Strowger mechanism 181 is operated one step in the vertical direction to select the first ten-line group, including the subscriber line 40 extending to the subscriber substation A, rendered non-restricted service, the set of switch springs S186 is actuated to close the associated contacts 189, thereby to connect ground potential by way of the resistor 190 to the EC conductor C104; when the wiper carriage of the Strowger mechanism 181 is operated two steps in the vertical direction to select the second ten-line group, including the subscriber line 50 extending to the subscriber substation B, rendered limited service, the set of switch springs S186 is actuated to close the associated contacts, thereby to place no potential upon the EC conductor C104; and when the wiper carriage of the Strowger mechanism 181 is operated three steps in the vertical direction to select the third ten-line group, including the subscriber line 60 extending to the subscriber substation C, rendered restricted service, the set of switch springs S186 is actuated to close the associated contacts 188, thereby to connect direct ground potential to the EC conductor C104. Accordingly, when the finder F100 is operated to select a ten-line group rendered non-restricted service, resistance ground potential is applied to the EC conductor C104; when the finder F100 is operated to select a ten-line group rendered limited service, no potential is applied to the EC conductor C104; and when the finder F100 is operated to select a ten-line group rendered restricted service, direct ground potential is applied to the EC conductor C104.

The selector S100 is of the Strowger type and comprises a relay group including a test relay R110, a switch relay R120, a line relay R130, a hold relay R140 and a transfer relay R150; as well as a Strowger mechanism 160. The Strowger mechanism 160 comprises a wiper carriage supporting four wipers 161, 162, 163 and 164 provided with an associated contact bank; as well as a vertical magnet M165, a rotary magnet M166 and a release magnet M168. Associated with the wiper carriage of the Strowger mechanism 160 are three sets of switch springs S169, S170 and S171 which are actuated when the wiper carriage is driven in the vertical direction away from its home position; as well as a set of normal post switch springs S172, which is actuated when the wiper carriage of the Strowger mechanism 160 is driven either one step or two steps in the vertical direction away from its home position and respectively corresponding to the group of trunks, including the trunk 205 and to the group of trunks, including the trunk 210. In other words, when the Strowger mechanism 160 is operated to select either the group of trunks, including the trunk 205, or the group of trunks, including the trunk 210, the set of switch springs S172 is actuated.

Preferably, each of the secondary trunks is identical to the secondary trunk 200, which comprises a relay group including an answer relay R210, a time release relay R220, a line relay R230, a test relay R240, a timer cutoff relay R250 and an intercept relay R260; as well as a timer 215 and a hunt switch 270. The hunt switch 270 is of the rotary type including four wipers 271 to

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274, inclusive, provided with individually associated contact banks, and a magnet M275 for driving the wipers noted step by step in the clockwise direction.

Preferably, each of the trunk circuits is identical to the trunk circuit 300, which comprises a relay group including a reverse battery relay R310, a timer cutoff relay R320, a release relay R330, a time release relay R340, a hold relay R350, a line relay R360 and an answer relay R370; as well as a repeater 380 and a timer 385.

Preferably, in the distant exchange 20 each of the links is identical to the link 400 which comprises the finder F400 and the connector C400. The finder F400 is of the Strowger type comprising a relay group including a switch-through relay R410, a service relay R420, an answer relay R430 and a time relay R450; as well as a Strowger mechanism 481 and a timer switch 440. The Strowger mechanism 481, comprising a wiper carriage supporting four wipers 482, 483, 484 and 485 provided with an associated contact bank 486; as well as vertical, rotary and release magnets, not shown. Associated with the Strowger mechanism 481 is a set of switch springs, not shown, which is actuated when the wiper carriage is driven in the vertical direction away from its home position; as well as a set of normal post switch springs S487, which is selectively operated in response to predetermined operations of the wiper carriage shaft 488 in the vertical direction. More particularly, when the wiper carriage of the Strowger mechanism 481 is operated one step in the vertical direction to select the first ten-line group, including the subscriber lines 470 and 480 respectively extending to the subscriber substations D and F, respectively rendered non-restricted service and limited service, the set of switch springs S487 is actuated to close the associated contacts, thereby to connect no potential to the EC conductor; and when the wiper carriage of the Strowger mechanism 481 is operated two steps in the vertical direction to select the second ten-line group, including the subscriber line 475 extending to the subscriber substation E, rendered limited service, the set of switch springs S487 is actuated to close the associated contacts 489, thereby to connect direct ground potential to the associated EC conductor. Accordingly, when the finder F400 is operated to select a ten-line group rendered non-restricted service, no ground potential is applied by the set of switch springs S487 to the associated EC conductor; and when the finder F400 is operated to select a ten-line group rendered limited service, direct ground potential is applied by the set of switch springs S487 to the associated EC conductor. Notwithstanding operation of the finder F400 to select a ten-line group rendered non-restricted service, direct ground potential may be applied to the associated EC conductor via the wiper 485 incident to complete operation of the finder F400 to select a particular line in the ten-line group mentioned; which particular line in the selected ten-line group is rendered limited service. This is brought about by the application of direct ground potential to the EC contact in the contact bank 486 engaged by the wiper 485 of the Strowger mechanism 481 in response to operation thereof to select the particular line in the previously selected ten-line group.

The timer switch 440 incorporated in the finder F400 is of the minor type comprising a wiper 441 provided with an associated contact bank, a magnet M442 for driving the wiper noted step by step

in the clockwise direction and a release magnet M443 for releasing the wiper noted and for causing it to be returned to its normal home position. Also, associated with the wiper 441 is a set of switch springs S444 which is actuated when the wiper noted is driven away from its home position.

The connector C400 is of the Strowger type and comprises a conventional relay group, not shown; as well as a Strowger mechanism, the wiper set of which is diagrammatically illustrated.

Operation of the finders in the central office 10

First, assuming that a call is initiated at a subscriber substation, such, for example, as the subscriber substation A in the ten-line group rendered non-restricted service in the central office 10; the line circuit 41 is controlled over the associated subscriber line 40 and operates in order to place ground potential upon the start conductor C71 extending to the distributor 70 and to mark the particular rotary position of the contact sets terminating the subscriber line 40 in the contact banks of the Strowger mechanisms incorporated in the finders of the links in the first group. The distributor 70 then operates in order to assign an idle one of the links in the first group to find the calling line, such, for example, as the link 100. Also, the distributor 70 marks to the finder F100 of the link 100 the level of the contact set in the contact bank 185 of the Strowger mechanism 181 terminating the calling subscriber line 40; the first level in the present example. The finder F100 is then controlled by the distributor 70; whereby the wiper carriage of the Strowger mechanism 181 is driven one step in the vertical direction and then operated automatically in the rotary direction in search of the calling subscriber line 40.

When the wiper set of the Strowger mechanism 181 engages the third contact set in the first level in the contact bank 185 terminating the calling subscriber line 40, further operation thereof is arrested; the distributor 70 is released; and the line circuit 41 associated with the calling subscriber line 40 is controlled in order to mark the subscriber line 40 as busy to the connectors in the associated group having access thereto. Also, at this time, a loop circuit is completed including the wipers 182 and 183, the line conductors C101 and C102, and the contacts 121 and 123 for energizing in series the upper and lower windings of the line relay R130 in the selector S100; whereby the latter relay operates. Upon operating the line relay R130 completes, at the contacts 131, a circuit, including the contacts 111 and 125, for operating the hold relay R140. Upon operating the hold relay R140 completes, at the contacts 143, an obvious path for applying ground potential to the control conductor C103, and consequently to the wiper 184, thereby to maintain the line circuit 41 associated with the subscriber line 40 in its operated position as previously noted. Also, the hold relay R140 completes, at the contacts 143, a circuit, including the set of switch springs S170, for energizing the lower winding of the transfer relay R150, thereby to cause the latter relay to operate. At this time, the selector S100 is conditioned to be responsive to the first digit dialed at the calling subscriber substation A, since the previously traced loop circuit is completed between the calling subscriber substation A and the line relay R130 in the selector S100.

Also, incident to operation of the finder F100

to find the calling line 40, the wiper carriage shaft 187 actuates the set of switch springs S186 to close the contacts 189; whereby ground potential is applied by way of the resistor 190 to the EC conductor C104 extending into the selector S100; by virtue of the fact that the calling subscriber line 40 is terminated in the first level of the contact bank 185 of the Strowger mechanism 181. This application of resistance ground potential to the EC conductor C104 extending into the selector S100 establishes a control which may be utilized ultimately in the switch train beyond the selector S100, in the event the subscriber at the calling substation A operates the selector S100 in order to make a trunk call to the distant exchange 20 or to the remote exchange 30, as explained more fully hereinafter.

Now assuming that a call is initiated at a subscriber substation, such, for example, as the subscriber substation B in the ten-line group rendered limited service in the central office 10; the line circuit 51 is controlled over the associated subscriber line 50 and operates in order to place ground potential upon the start conductor C71 extending to the distributor 70 and to mark the particular rotary position of the contact sets terminating the subscriber line 50 in the contact banks of the Strowger mechanisms incorporated in the finders of the links in the first group. The distributor 70 then operates in order to assign an idle one of the links in the first group to find the calling line, such, for example, as the link 100. Also, the distributor 70 marks to the finder F100 of the link 100 the level of the contact set in the contact bank 185 of the Strowger mechanism 181 terminating the calling subscriber line 50; the second level in the present example. The finder F100 is then controlled by the distributor 70; whereby the wiper carriage of the Strowger mechanism is driven two steps in the vertical direction and then operated automatically in the rotary direction in search of the calling subscriber line 50.

When the wiper set of the Strowger mechanism 181 engages the second contact set in the second level in the contact bank 185 terminating the calling subscriber line 50, further operation thereof is arrested; the distributor 70 is released; and the line circuit 51 associated with the calling subscriber line 50 is controlled in order to mark the subscriber line 50 as busy to the connectors in the associated group having access thereto. Also, at this time, a loop circuit is completed in order to effect operation of the line relay R130, the hold relay R140 and the transfer relay R150 in the selector S100 in the manner previously explained; whereby the selector S100 is conditioned to be responsive to the first digit dialed at the calling subscriber substation B, since the loop circuit mentioned is completed between the calling subscriber substation B and the line relay R130 in the selector S100.

Also, incident to operation of the finder F100 to find the calling subscriber line 50, the wiper carriage shaft 187 actuates the set of switch springs S186 to close the associated contacts 188; whereby no potential is applied to the EC conductor C104 extending into the selector S100; by virtue of the fact that the calling subscriber line 50 is terminated in the second level of the contact bank 185 of the Strowger mechanism 181. This application of no potential to the EC conductor C104 extending into the selector S100 establishes a control which may be utilized ultimately in the switch train beyond the selector

S100, in the event the subscriber at the calling subscriber substation B operates the selector S100 in order to make a trunk call to the distant exchange 20 or to the remote exchange 30, as explained more fully hereinafter.

Finally, assuming that a call is initiated at a subscriber substation, such, for example, as the subscriber substation C in the ten-line group rendered restricted service in the central office 10; the line circuit 61 is controlled over the associated subscriber line 60 and operates in order to place ground potential upon the start conductor C71 extending to the distributor 70 and to mark the particular rotary position of the contact sets terminating the subscriber line 60 in the contact banks of the Strowger mechanisms incorporated in the finders of the links of the first group. The distributor 70 then operates in order to assign an idle one of the links in the first group to find the calling line, such, for example, as the link 100. Also, the distributor marks to the finder F100 of the link 100 the level of the contact set in the contact bank 185 of the Strowger mechanism 181 terminating the calling subscriber line 60; the third level in the present example. The finder F100 is then controlled by the distributor 70; whereby the wiper carriage of the Strowger mechanism 181 is driven three steps in the vertical direction and then operated automatically in the rotary direction in search of the calling subscriber line 60.

When the wiper set of the Strowger mechanism 181 engages the tenth contact set in the third level in the contact bank 185 terminating the calling subscriber line 60, further operation thereof is arrested; the distributor 70 is released; and the line circuit 61 associated with the calling subscriber line 60 is controlled in order to mark the subscriber line 60 as busy to the connectors in the associated group having access thereto. Also, at this time, a loop circuit is completed in order to effect operation of the line relay R130, the hold relay R140 and the transfer relay R150 in the selector S100 in the manner previously explained; whereby the selector S100 is conditioned to be responsive to the first digit dialed at the calling subscriber substation C, since the loop circuit mentioned is completed between the calling subscriber substation C and the line relay R130 in the selector S100.

Also, incident to operation of the finder F100 to find the calling subscriber line 60, the wiper carriage shaft 187 actuates the set of switch springs S188 to close the associated contacts 188; whereby direct ground potential is applied to the EC conductor C104 extending into the selector S100; by virtue of the fact that the calling subscriber line 60 is terminated in the third level of the contact bank 185 of the Strowger mechanism 181. This application of direct ground potential to the EC conductor C104 extending into the selector S100 establishes a control which may be utilized ultimately in the switch train beyond the selector S100, in the event the subscriber at the calling subscriber substation C operates the selector S100 in order to attempt to make a trunk call to the distant exchange 20 or to the remote exchange 30, as explained more fully hereinafter.

Local calls in the central office 10

Now assume that a call has been initiated at any subscriber substation in the central office 10, such, for example, as the subscriber substation A; that the finder F100 of the link 100 has operated to seize the calling subscriber line 40; and that

the selector S100 of the link 100 is conditioned to be responsive to the first digit dialed at the calling subscriber substation A. When the subscriber at the calling subscriber substation A dials the first digit the line relay R130 in the selector S100 follows the impulses thereof. Each time the line relay R130 restores and then reoperates, it interrupts and then recompletes, at the contacts 131, the previously traced circuit for maintaining operated the hold relay R140, the latter relay remaining operated during the digit since it is of the slow-to-release type; and completes and then interrupts, at the contacts 132, a multiple circuit, including the contacts 111, 125 and 141, for energizing the upper winding of the transfer relay R150 and the vertical magnet M165. The transfer relay R150 being of the slow-to-release type remains operated during the digit; and the vertical magnet M165 is operated a number of times corresponding to the number of impulses of the first digit dialed at the calling subscriber substation A. When the wiper carriage of the Strowger mechanism 160 is driven away from its home position the sets of switch springs S169, S170 and S171 are actuated. More particularly, the set of switch springs S170 is actuated into disengagement thereby to interrupt the previously traced circuit for energizing the lower winding of the transfer relay R150; however, the latter relay is maintained in its operated position, at this time, by virtue of the intermittent completion of the previously traced circuit for energizing the upper winding thereof, since the transfer relay R150 is of the slow-to-release type.

At the conclusion of the first digit the line relay R130 is maintained in its operated position in order to maintain operated the hold relay R140; whereby the transfer relay R150 restores shortly thereafter. At this time, the wiper carriage of the Strowger mechanism 160 is operated in the vertical direction to select a group of trunks extending to the corresponding group of connectors, not shown; whereby the set of switch springs S172 is not actuated. As previously noted, the set of switch springs S172 is actuated only when the wiper carriage of the Strowger mechanism 160 is driven either one step or two steps away from its home position in order to select respectively the two groups of trunks including the trunks 205 and 210; which positions the wiper carriage of the Strowger mechanism 160 does not occupy at this time, since the first digit dialed at the calling subscriber substation A was the first digit of a directory number corresponding to a local call. Thus, the application of resistance ground potential in the finder F100 upon the EC conductor C104 extending into the selector S100 is without effect and will not be utilized ultimately, since the set of switch springs S172 was not actuated in the present example in response to movement of the wiper carriage of the Strowger mechanism 160 in the vertical direction. Upon restoring the transfer relay R150 completes, at the contacts 151, a circuit, including the contacts 111, 125 and 131, the set of switch springs S171 and the contacts 151 and 167, for operating the rotary magnet M166. Upon operating the rotary magnet M166 interrupts, at the contacts 167, the previously traced operating circuit therefor; whereby the rotary magnet M166 operates buzzer-fashion in order to drive the wiper carriage of the Strowger mechanism 160 step by step in the rotary direction.

When the wiper carriage of the Strowger mechanism 160 is driven one step in the rotary direc-

tion, the first trunk in the previously selected group, not shown, extending to the corresponding connector in the associated group, not shown, is tested; battery potential appearing upon the control conductor thereof in the event the connector mentioned is idle and ground potential appearing upon the control conductor thereof in the event the connector mentioned is busy. The application of ground potential to the control conductor of the selected trunk completes a path, including the control wiper 163 and the contacts 144, for short-circuiting the winding of the test relay R110; whereas the application of battery potential to the control conductor of the trunk mentioned completes an identical circuit for energizing the winding of the test relay R110, thereby to cause the latter relay to operate. Accordingly, the rotary magnet M166 effects automatic operation of the Strowger mechanism 160 in the rotary direction until an idle trunk extending to an idle connector in the associated group, not shown, is selected in conformity with conventional practice; whereupon the test relay R110 operates. Upon operating the test relay R110 interrupts, at the contacts 111, the previously traced multiple circuits for maintaining operated the hold relay R140 and for operating the rotary magnet M166; whereby the hold relay R140 restores shortly thereafter, it being of the slow-to-release type, and further operation of the rotary magnet M166 is positively prevented. Also, upon operating the test relay R110 completes, at the contacts 112, an obvious circuit for operating the switch relay R120; whereby the latter relay interrupts, at the contacts 121 and 123, the previously traced loop circuit extending between the calling subscriber substation A and the upper and lower windings of the line relay R130, causing the latter relay to restore. Also, the switch relay R120 completes, at the contacts 126, a holding circuit, including the contacts 143, for energizing the winding thereof and completes, at the contacts 122 and 124, a further loop circuit extending from the calling subscriber substation A and, including the line wipers 181 and 182, to the connector, not shown, selected by the selector S100 at this time. Further, the switch relay R120 completes, at the contacts 127, a path, including the contacts 143, for applying direct ground potential to the control wiper C163, thereby to bring about complete seizure of the connector, not shown, selected at this time; whereupon ground potential in the connector mentioned is returned over the control wiper C163 in order to complete an alternative holding circuit, including the contacts 127 and 126, for maintaining operated the switch relay R120. Further, the switch relay R120 completes, at the contacts 127, a path, including the contacts 143 and 144, for short-circuiting the winding of the test relay R110, thereby to cause the latter relay to restore. Finally, the switch relay R120 prepares, at the contacts 128, a path for connecting the EC conductor C104, extending from the finder F100 into the selector S100, to the EC wiper 164; which connection is not completed at this time, as previously noted, since the set of switch springs S172 is not actuated. Upon restoring the hold relay R140 interrupts, at the contacts 143, the previously traced original holding circuit, for maintaining operated the switch relay R120; whereby the latter relay is maintained in its operated position at this time by virtue of the return of ground potential from the selected connector over the associated trunk to the control

wiper C163, as previously noted. Also, upon restoring the test relay R110 interrupts, at the contacts 112, the original circuit for operating the switch relay R120; which is without effect at this time.

At this time the selector S100 has operated to seize and idle one of the connectors, not shown, and has switched the loop circuit extending from the calling subscriber substation A through to the connector mentioned; whereby the next two digits dialed at the calling subscriber substation A are effected to bring about operation of the selected connector; all in a conventional manner. After the connection has been set up from the calling subscriber substation A via the finder F100, the selector S100 and the connector, not shown, to the called subscriber substation, and the connection is ultimately released, the connector mentioned is released; whereby ground potential is removed therein from the control wiper C163 bringing about the release of the switch relay R120 in the selector S100. Upon restoring the switch relay R120 completes, at the contacts 125, a circuit, including the contacts 111, 132, 142 and 153 and the set of switch springs S169 for operating the release magnet M168; whereby the wiper carriage of the Strowger mechanism 160 is released and returned to its normal position. At this time the sets of switch springs S169, S170 and S171 are actuated; and, also, the set of switch springs S172 is returned to its normal position in the event it occupies its operated position. More particularly, the set of switch springs S169 is actuated, thereby to interrupt the previously traced circuit for operating the release magnet M168. Also, the switch relay R120 recompletes, at the contacts 121 and 123, the connections between the upper and lower windings of the line relay R130 and the line conductors C101 and C102 extending to the finder F100. At this time the selector S100 is completely released and ground potential is removed from the control conductor C103 extending to the finder F100; whereby the finder F100 is released restoring the set of switch springs S169 to its normal position. At this time, the link 130 is completely released and available for further use. When the finder F100 is thus released the line circuit 41 is controlled, thereby to mark the subscriber line 40 extending to the subscriber substation A as idle to the connectors in the associated group having access thereto.

In view of the foregoing description of a local call from the calling subscriber substation A via the finder F100, the selector S100 and the connector, not shown, to a called subscriber substation in the central office 10, it will be understood that local calls from the subscriber substations B and C are extended in an identical manner to called subscriber substations in the central office 10. In this connection it is pointed out that the applications of no potential and direct ground potential respectively to the EC conductor C104 incident to the operations of the finder F100 to find the calling lines 50 and 60 respectively extending to the calling subscriber substations B and C, in the two cases, is without effect, since the set of switch springs S172 is not operated incident to the extension of local calls via the selector S100 from the calling subscriber substations B and C.

Trunk calls from the central office 10 to the distant exchange 20

First, assume that a call has been initiated at

the subscriber substation A in the ten-line group rendered non-restricted service in the central office 10; that the finder F100 of the link 100 has operated to find the subscriber line 40 extending to the subscriber substation A; that the selector S100 is conditioned to be responsive to the first digit dialed at the calling subscriber substation A; and that the call is to be extended to a called subscriber substation, such, for example, as the subscriber substation D in the distant exchange 20. The subscriber at the calling subscriber substation A proceeds to dial the first digit 2, thereby to bring about operation of the selector S100 in a manner substantially identical to that previously explained; whereupon the wiper carriage of the Strowger mechanism 160 is operated two steps in the vertical direction to select the group of trunks, including the trunk 210, and then operates automatically to select an idle trunk in this group. Assuming that the wiper carriage of the Strowger mechanism 160 selects the particular trunk 210 extending to the trunk circuit 300, the trunk 210 is marked as idle by the application of battery potential upon the control conductor C208 thereof, the battery potential being applied to the control conductor C208 by way of the right-hand winding of the answer relay R370 in the trunk circuit 300. When the wiper carriage of the Strowger mechanism 160 seizes the idle trunk 210, the selector S100 is switched through in the manner previously explained; whereby a loop circuit is completed from the calling subscriber substation A to the line conductors C206 and C207 of the trunk 210; which loop circuit extends by way of the contacts 312 and 314, the windings 381 and 382 of the repeater 380, and the upper and lower windings of the line relay R360 respectively to battery and ground potentials; whereupon the line relay R360 in the trunk circuit 300 operates. Upon operating the line relay R360 completes, at the contacts 351, an obvious circuit for operating the hold relay R350; and completes, at the contacts 362, a loop circuit including the line conductors C391 and C392 of the trunk line 390, the windings 393 and 394 of the repeater 380 and the left-hand winding of the answer relay R370 extending to the incoming connector 465 in the distant exchange 20; whereby the incoming connector 465 is conditioned to be responsive to the next digit dialed at the calling subscriber substation A. While the left-hand winding of the answer relay R370 in the trunk circuit 300 is energized over the above traced loop circuit including the line conductors of the trunk line 390, the latter relay is not poled to operate. Upon operating the hold relay R350 completes, at the contacts 351, a path, including the contacts 331 and 341, for applying ground potential in the trunk circuit 300 to the control conductor C208 of the trunk 210, thereby to energize the right-hand winding of the answer relay R370, to maintain the switch relay R120 in the selector S100 in its operated position, and to maintain the finder F100 and the line circuit 41 associated with the calling subscriber line 40 in their operated positions; all in the manner previously explained.

Incident to operation of the wiper carriage of the Strowger mechanism 160 in the selector S100 two steps in the vertical direction the set of switch springs S172 was actuated in order to close the contacts 174 thereof. Subsequently, when the switch relay R120 in the selector S100 operated, it completed, at the contacts 128, a connection between the EC conductor C104 and

the EC wiper 164, since the set of switch springs S172 was previously actuated. Thus, when the selector S100 is switched through the EC wiper 164 connected to the EC conductor C104 causes resistance ground potential to be applied to the EC conductor C209 of the trunk 210 effecting energization in series of the timer cutoff relay R320 and the release relay R330 in the trunk circuit 300, incident to operation of the hold relay R350 therein. This series circuit extends from ground by way of the resistor 190, the contacts 189 of the set of switch springs S186, the EC conductor C104, the contacts 128, the contacts 174 of the set of switch springs S172, the EC wiper 164, the EC conductor C209 of the trunk 210, the windings of R320 and R330 and the contacts 352 to battery. When this series circuit is completed the timer cutoff relay R320 operates; however, the release relay R330 does not operate since it is of the marginal type. Upon operating the timer cutoff relay R320 interrupts, at the contacts 321, a further point in a circuit traced hereinafter for operating the time release relay R340.

The subscriber at the calling subscriber substation A then proceeds to dial the second and third digits over the previously traced loop circuit including the line relay R360 in the trunk circuit 300; whereby the line relay R360 repeats the impulses of the second and third digits mentioned over the loop circuit including the trunk line 390 to the incoming connector 465 in the distant exchange 20. The incoming connector 465 responds to the two digits mentioned to select the subscriber line 470 extending to the called subscriber substation D therein; whereupon the idle or busy condition of the called subscriber line 470 is tested in a conventional manner. In the event the subscriber line 470 extending to the called subscriber substation D is tested by the incoming connector 465 as being busy, busy tone current is returned therefrom over the trunk line 390 and repeated by the trunk circuit 300 over the loop circuit extending to the calling subscriber substation A. On the other hand, in the event the subscriber line 470 extending to the called subscriber substation D is tested as being idle, the incoming connector 465 operates in order to project ringing current thereover and to return ring-back tone current over the previously traced connection to the calling subscriber substation A. Assuming that the called subscriber substation D is idle at this time, when the subscriber thereat answers the call the incoming connector 465 operates in order to complete a telephone connection between the calling subscriber substation A in the central office 10 and the called subscriber substation D in the distant exchange 20 and to effect the reversal of polarity over the line conductors of the trunk line 390. The reversal of polarity of the line conductors of the trunk line 390 poles the left-hand winding of the answer relay R370 in the trunk circuit 300 to operate. Upon operating the answer relay R370 completes, at the contacts 371, an obvious circuit for operating the reverse battery relay R310. Upon operating the reverse battery relay R310 reverses, at the contacts 311, 312, 313 and 314 the polarity of the loop circuit extending between the line relay R360 in the trunk circuit 300 and the calling subscriber substation A; which reversal of polarity over the loop circuit mentioned may be employed for metering purposes in a conventional manner. Also the answer relay R370 completes, at the

contacts 373, a path, including the contacts 354, for applying ground potential to the start conductor extending into the timer 385, thereby to initiate operation of the timer 385. After a predetermined time interval the timer 385 operates in order to connect the grounded commutator segment of the wheel 386 to the associated stop conductor; thereby to prepare a circuit, including the contacts 372 and 353, for operating the time release relay R340. However, the circuit mentioned is not completed by virtue of the operated position of the timer cutoff relay R320. More particularly, the operated timer cutoff relay R320 disables the timer 385 to prevent the release of the established connection, since the calling subscriber substation A involved in the established connection is rendered non-restricted service. Accordingly, the established connection between the calling subscriber substation A in the central office 10 and the called subscriber substation D in the distant exchange 20 persists for any desired time interval at the convenience of the subscribers at the substations mentioned.

At the conclusion of the connection when the subscriber at the called subscriber substation D in the distant exchange 20 replaces the receiver of the telephone instrument thereat upon its associated switchhook, the incoming connector 465 is controlled to bring about the reversal of polarity over the trunk line 390; whereby the left-hand winding of the answer relay R370 in the trunk circuit 300 is poled to restore. Upon restoring the answer relay R370 interrupts, at the contacts 371, the previously mentioned circuit for maintaining operated the reverse battery relay R310; whereby the latter relay restores effecting the reversal, at the contacts 311, 312, 313 and 314, of the polarity over the loop circuit extending between the calling subscriber substation A and the line relay R360 in the trunk circuit 300. Also, upon restoring the answer relay R370 interrupts, at the contacts 373, the previously mentioned path for applying ground potential to the start conductor extending into the timer 385; thereby to arrest further operation of the timer 385. This operation has no particular utility in the present example, since the present call was not timed; however, it is useful in another example described hereinafter wherein calls are timed. In other words, the completed connection must persist for a predetermined time interval in order to bring about operation of the timer 385 to effect operation of the time release relay R380 under certain conditions in conjunction with the example mentioned, as explained more fully hereinafter.

When the subscriber at the calling subscriber substation A in the central office 10 replaces the receiver of the telephone instrument thereat upon its associated switch-hook the previously traced loop circuit extending to the line relay R360 in the trunk circuit 300 is interrupted in order to cause the latter relay to restore. Upon restoring the line relay R360 interrupts, at the contacts 362, the previously traced loop circuit, including the trunk line 390, extending to the incoming selector 465 in the distant exchange 20; whereby the incoming selector 465 is released in order to operate the line circuit 471 associated with the subscriber line 470 bringing about marking of the subscriber line 470 as idle to the connectors of the link 400, etc., having access thereto. Also, the line relay R360 interrupts, at the contacts 361, the previously mentioned circuit for maintaining operated the

hold relay R350; whereby the latter relay restores shortly thereafter, it being of the slow-to-release type. Upon restoring the hold relay R350 interrupts, at the contacts 354, another point in the previously traced path for applying ground potential to the start conductor extending to the timer 375, thereby positively to arrest operation of the timer 385; and interrupts, at the contacts 352, the previously traced series circuit for energizing the windings of the timer cutoff relay R320 and the release relay R330, thereby to cause the timer cutoff relay R320 to restore. Finally, the hold relay R350 interrupts, at the contacts 351, the previously traced circuit for applying ground potential to the control conductor C208 of the trunk 210, thereby to deenergize the right-hand winding of the answer relay R370; whereby battery potential is applied by way of the right-hand winding of the answer relay R370 to the control conductor C208 of the trunk 210. When ground potential is removed from and battery potential is applied to the control conductor C208 of the trunk 210, the trunk 210 and the connected trunk circuit 300 are marked as idle to the selectors of the various links 100, etc., having access thereto. Also, when ground potential is removed from the control conductor C208 of the trunk 210, the previously traced circuit for maintaining operated the switch relay R120 in the selector S100 is interrupted; whereupon the latter relay restores effecting the release of the selector S100 and the finder F100 in the manner previously explained. At this time the link 100 is completely released and available for further use. When the finder F100 is thus released, ground potential is removed from the control conductor of the subscriber line 40; whereby the line circuit 41 is operated in order to mark the subscriber line 40 extending to the subscriber substation A as idle to the connectors in the associated group having access thereto.

Now assume that a call has been initiated at the subscriber substation B in the ten-line group rendered limited service in the central office 10; that the finder F100 of the link 100 has operated to find the subscriber line 50 extending to the subscriber substation B; that the selector S100 is conditioned to be responsive to the first digit dialed at the calling subscriber substation B; and that the call is to be extended to a called subscriber substation, such, for example, as the subscriber substation D in the distant exchange 20. The subscriber at the calling subscriber substation B proceeds to dial the first digit 2, thereby to bring about operation of the selector S100 to select an idle trunk in the group, including the trunk 210, in the manner previously explained. Assuming that the selector S100 seizes the particular trunk 210, the line relay R360 and the hold relay R350 in the trunk circuit 300 are operated, the line relay R360 effecting seizure over the trunk line 390 of the incoming connector 465 in the distant exchange 20; all in the manner previously explained.

In the present example the wiper carriage of the Strowger mechanism 181 in the finder F100 in the link 100 occupies its second vertical step seizing the subscriber line 50 extending to the calling subscriber substation B; whereby the set of switch springs S186 is operated in order to cause no potential to be applied to the EC conductor C104. Also, the set of switch springs S172 in the selector S100 is operated, causing no potential to be applied to the EC conductor C209 of the trunk 210; whereby neither the timer cutoff relay R320

nor the release relay R330 in the trunk circuit 300 is operated in the present example.

The subscriber at the calling subscriber substation B then proceeds to dial the second and third digits; whereby the line relay R360 in the trunk circuit 300 repeats the two digits mentioned over the trunk line 390 in order to bring about operation of the incoming connector 465 to seize the subscriber line 470 extending to the called subscriber substation D in the distant exchange 20; all in the manner previously explained. The operations of the incoming connector 465 to test and to project ringing current over the subscriber line 470 in the event it is idle are the same as previously explained; and when the subscriber at the called subscriber substation D answers the call about the incoming connector 465 is operated to bring about the reversal of polarity of the trunk line 390 effecting operation of the answer relay R370 in the trunk circuit 300, as previously explained. Upon operating the answer relay R370 completes, at the contacts 373, the previously traced path for applying ground potential to the start conductor extending into the timer 325, thereby to initiate operation of the timer 325. At any time should the subscriber at the called subscriber substation D replace the receiver of the telephone instrument thereat upon its associated switchhook, the incoming connector 465 is controlled to bring about reversal of polarity over the trunk line 390 in order to effect restoration of the answer relay R370 in the trunk circuit 300, and the consequent arresting of operation of the timer 325; all in the manner previously explained. Later, should the subscriber at the called subscriber substation D again remove the receiver of the telephone instrument thereat from its associated switchhook, the incoming connector 465 is controlled in order, again, to reverse the polarity of the trunk line 390, thereby to effect reoperation of the answer relay R370 in the trunk circuit 300 in order to initiate reoperation of the timer 325.

In the event the established connection between the calling subscriber substation B in the central office 10 and the called subscriber substation D in the distant exchange 20 persists for a predetermined time interval, complete operation of the timer 325 takes place; whereby ground potential is applied to the associated stop conductor, thereby to complete a circuit, including the contacts 372, 353 and 324 for operating the time release relay R340. Upon operating the time release relay R340 interrupts, at the contacts 341, the previously traced path for applying ground potential to the control conductor C208 of the trunk 210 in order to bring about release of the selector S100 and the finder F100 in the link 100; all in the manner previously explained. When the link 100 is thus released, the line circuit 51 associated with the subscriber line 50 extending to the calling subscriber substation B, is locked out in the event the subscriber at the calling subscriber substation B has not replaced the receiver of the telephone instrument thereat upon its associated switchhook at this time; whereby the subscriber line 50 is marked as busy both to the finders of the links in the first group having access thereto and to the connectors in the associated group having access thereto. Also, when the link 100 is released the trunk circuit 300 is released and rendered available for further use; and the incoming connector 465 is released; all in the manner previously explained. When the incoming connector 465 is thus released, the line circuit 471 associated with the subscriber line

470 extending to the called subscriber substation D in distant exchange 20 is locked out in the event the subscriber at the called subscriber substation D has not replaced the receiver of the telephone instrument thereat upon its associated switchhook at this time; whereby the subscriber line 470 is marked as busy both to the finders and to the connectors of the links F400, etc., having access thereto.

Of course, it will be understood that the normal release of the established connection between the calling subscriber substation B in the central office 10 and the called subscriber substation D in the distant exchange 20 takes place in the normal manner when the subscriber at the calling subscriber substation B replaces the receiver of the telephone instrument thereat upon its associated switchhook. In other words, the forced release of the established connection under the control of the timer 325 takes place in the manner described above only in conjunction with established connections which persist for a predetermined and abnormally long time interval.

Finally, assume that a call has been initiated at the subscriber substation C in the ten-line group rendered restricted service in the central office 10; that the finder F100 of the link 100 has operated to find the subscriber line 60 extending to the subscriber substation C; that the selector S100 is conditioned to be responsive to the first digit dialed at the calling subscriber substation C; and that the subscriber at the calling subscriber substation C attempts the extension of a connection to a called subscriber substation in the distant exchange 20. The subscriber at the calling subscriber substation C proceeds to dial the first digit 2, thereby to bring about operation of the selector S100 to select an idle trunk in the group, including the trunk 210, in the manner previously explained. Assuming that the selector S100 seizes the particular trunk 210, the line relay R360 and the hold relay R350 in the trunk circuit 300 are operated, the line relay R360 effecting seizure over the trunk line 390 of the incoming connector 465 in the distant exchange 20; all in the manner previously explained.

In the present example, the wiper carriage of the Strowger mechanism 181 in the finder F100 in the link 100 occupies its third vertical step seizing the subscriber line 60 extending to the calling subscriber substation C; whereby the set of switch springs S186 is operated in order to cause direct ground potential to be applied to the EC conductor C104. Also, the set of switch springs S172 in the selector S100 is operated causing direct ground potential to be applied to the EC conductor C209 of the trunk 210; whereby both the timer cutoff relay R320 and the release relay R330 in the trunk circuit 300 are operated. The release relay R330 operates in the present example in the previously traced series circuit by virtue of the fact that direct ground potential is applied to the EC conductor C209 of the trunk 210, the release relay R330 being of the marginal type. Upon operating the release relay R330 interrupts, at the contacts 331, the previously traced path for applying ground potential to the control conductor C208 of the trunk 210; thereby to effect release of the trunk circuit 300 and the link 100 in the manner previously explained. When the trunk circuit 300 is thus released, the incoming connector 465 in the distant exchange 20 is released; and when the link 100 is thus released, the line circuit 51

associated with the subscriber line 60 extending to the calling subscriber substation C in the central office 10 is operated to lock out the subscriber line 60; whereby the subscriber line 60 is marked as busy both to the finder of the links in the first group having access thereto and to the connectors in the associated group having access thereto.

Trunk calls from the central office 10 to the, remote exchange 30

First, assume that a call has been initiated at the subscriber substation A in the ten-line group rendered non-restricted service in the central office 10; that the finder F100 of the link 100 has operated to find the subscriber line 40 extending to the subscriber substation A; that the selector S100 is conditioned to be responsive to the first digit dialed at the calling subscriber substation A; and that the call is to be extended to a called subscriber substation in the remote exchange 30. The subscriber at the calling subscriber substation A proceeds to dial the first digit 1, thereby to bring about operation of the selector S100 in a manner substantially identical to that previously explained; whereupon the wiper carriage of the Strowger mechanism 160 is operated one step in the vertical direction to select the group of trunks, including the trunk 205, and then operates automatically to select an idle trunk in this group. Assuming that the wiper carriage of the Strowger mechanism 160 selects the particular trunk 205 extending to the secondary trunk 200, the trunk 205 is marked as idle by the application of battery potential upon the control conductor C203 thereof, the battery potential being applied to the control conductor C203 by way of the contacts 221 and the resistor 222 in the secondary trunk 200. When the wiper carriage of the Strowger mechanism 160 seizes the idle trunk 205, the selector S100 is switched through in the manner previously explained; whereby a loop circuit is completed from the calling subscriber substation A to the line conductors C201 and C202 of the trunk 205; which loop circuit extends by way of the resistor 214 and the contacts 243 and 241 and the winding of the line relay R230 respectively to ground and battery potentials; whereupon the line relay R230 in the secondary trunk 200 operates. Upon operating the line relay R230 completes, at the contacts 231, a path, including the contacts 246 and 221, for applying ground potential to the control conductor C203 of the trunk 205, thereby to maintain operated the selector S100, the finder F100 and the line circuit 41 associated with the subscriber line 40 extending to the calling subscriber substation A; all in the manner previously explained.

Also, the line relay R230 completes, at the contacts 231 and 232, a path for applying direct ground potential to the upper terminal of the test relay R240; the lower terminal of the test relay R240 being connected by way of the contacts 276 and the magnet M275 of the hunt switch 270 to battery potential. Further, the line relay R230 completes, at the contacts 233, a path, including the contacts 247 and 261, between the lower terminal of the test relay R240 and the wiper 273 of the hunt switch 270. Assuming that the wipers noted of the hunt switch 270 happen to engage the tenth contacts in the associated contact banks at this time, ground potential appears upon the tenth contact engaged by the

wiper 273 of the hunt switch 270; thereby completing a path for short circuiting the winding of the test relay R240 and a direct circuit for operating the magnet M275. The path for short circuiting the winding of the test relay R240 extends from the grounded wiper 273 of the hunt switch 270 by way of the contacts 261, 247 and 233, the winding of R240 and the contacts 232 and 231 to ground; and the direct circuit for operating the magnet M275 extends from the grounded wiper 273 of the hunt switch 270 by way of the contacts 261, 247, 233 and 276 and the magnet M275 to battery. Accordingly, the test relay R240 being short circuited does not operate; whereas the magnet M275 operates. Upon operating the magnet M275 interrupts, at the contacts 276, the above traced operating circuit therefor; whereupon the magnet M275 restores to reprepare, at the contacts 276, the above traced circuit for operating the magnet M275 and to drive the wipers noted of the hunt switch 270 one step in the clockwise direction into engagement with the first contacts in the associated contact banks. At this point, it is noted that the group of seven incoming trunks 280, etc., extending to the group of seven trunk circuits 271, etc., terminating the group of seven trunk lines 282, etc., extending to the remote exchange 30 are terminated on the first seven contacts in the contact bank of the hunt switch 270; whereas the group of three incoming trunks 290, etc., extending to the group of three trunk circuits 291, etc., terminating the group of three trunks 292, etc., extending to the operator switchboard 295 are terminated on the last three contacts in the contact bank of the hunt switch 270; the hunt switch 270 being of the ten-point rotary type, as previously noted.

When the wipers noted of the hunt switch 270 engaged the first contacts in the associated contact bank, the first incoming trunk in the group of seven, including the incoming trunk 280, is selected and this trunk is tested. In the event the trunk mentioned is busy at this time, ground potential appears upon the control conductor thereof applying ground potential to the wiper 273 of the hunt switch 270; whereby the winding of the test relay R240 is again short-circuited and the magnet M275 is reoperated. On the other hand, in the event the trunk mentioned is idle at this time, battery potential appearing upon the control conductor thereof completes a path substantially identical to that previously traced for short circuiting the magnet M275; whereupon a circuit, including the contacts 231, 232 and 276, is completed for energizing the winding of the test relay R240 in series with the magnet M275; and a multiple circuit, including the contacts 231, 232, 233, 247 and 261, the wiper 273 of the hunt switch 270 and the control conductor of the trunk mentioned is completed for energizing the winding of the test relay R240 from battery potential appearing in the trunk circuit terminating the trunk mentioned. When the circuits mentioned are completed the test relay R240 operates shortly thereafter, it being of the slow-to-operate type. Assuming that all of the incoming trunks in the group, including the incoming trunk 280, and preceding the incoming trunk 280, are busy; and that the incoming trunk 280 is idle; the magnet M275 operates buzzer-fashion to drive the wipers noted into engagement with the contacts in the associated contact banks terminating the incoming trunk 280. Since it is assumed that the incoming trunk 280 is idle at this

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time, battery potential appears upon the control conductor thereof effecting short-circuiting of the magnet M275 and energization of the test relay R240; whereupon the test relay R240 operates shortly thereafter as previously noted. Upon operating the test relay R240 interrupts, at the contacts 247, the previously traced path for short circuiting the magnet M275; and completes, at the contacts 248, a path, including the contacts 231, 232 and 261, for applying direct ground potential to the wiper 273 of the hunt switch 270; whereby the trunk circuit 281, associated with the incoming trunk 280, is seized bringing about the application of ground potential therein to the control conductor of the incoming trunk 280, and consequently to the wiper 273 of the hunt switch 270 in order to complete a holding circuit substantially identical to that previously traced for energizing the winding of the test relay R240 in series with the magnet M275. When this holding circuit is completed the test relay R240 is maintained in its operated position; however, the magnet M275 does not operate due to the high series resistance of the winding of the test relay R240. Also, the test relay R240 completes, at the contacts 245, a path, including the contacts 221 and 261, for connecting the control conductor C203 of the trunk 205 to the grounded wiper 273 of the hunt switch 270, thereby to maintain operated the selector S100, the finder F100 and the line circuit 41, as previously noted. Further, the test relay R240 interrupts, at the contacts 246, the previously traced original path for applying ground potential to the control conductor C203 of the trunk 205; and interrupts, at the contacts 241 and 243, the previously traced original loop circuit for maintaining operated the line relay R230. Shortly thereafter, the line relay R230 restores, since it is of the slow-to-release type. Finally, the test relay R240 completes, at the contacts 242 and 244, an alternative loop circuit extending from the calling subscriber substation A to the wipers 271 and 272 of the hunt switch 270 and then to the line conductors of the incoming trunk 280; which loop circuit is completed in the trunk circuit 281 in order to bring about complete seizure of the trunk circuit 281 in the manner previously explained; whereby the trunk line 282 extending to the remote exchange 30 is seized in order to condition the automatic switching apparatus therein to be responsive to the following digits dialed at the calling subscriber substation A.

Incident to operation of the wiper carriage of the Strowger mechanism 160 in the selector S100 one step in the vertical direction, the set of switch springs S172 was actuated in order to close the contacts 174 thereof. Subsequently, when the switch relay R120 in the selector S100 operated it completed, at the contacts 128, a connection between the EC conductor C104 and the EC wiper 164, since the set of switch springs S172 was previously actuated. Thus, when the selector S100 is switched through, the EC wiper 164 connected to the EC conductor C104 causes resistance ground potential to be applied to the EC conductor C204 of the trunk 205 effecting energization in series of the timer cutoff relay R250 and the intercept relay R260 in the secondary trunk 200. This series circuit extends from ground by way of the resistor 190, the contacts 189 of the set of switch springs S186, the EC conductor C104, the contacts 128, the contacts 174 of the set of switch springs S172, the EC wiper 164, the EC conductor C204 of the trunk 205 and the windings of R250 and R260 to battery. When this series

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circuit is completed the timer cutoff relay R250 operates; however, the intercept relay R260 does not operate, since it is of the marginal type. Upon operating the timer cutoff relay R250 interrupts, at the contacts 251, a further point in a circuit traced hereinafter for operating the time release relay R220.

The subscriber at the calling subscriber substation A then proceeds to dial the remainder of the digits over the previously traced loop circuit into the trunk circuit 281; which digits are repeated thereby over the trunk line 282 into the switching apparatus in the remote exchange 30 in order to cause the subscriber line extending to the called subscriber substation in the remote exchange 30 to be seized and tested in a conventional manner. Assuming that the subscriber substation in the remote exchange 30 is idle at this time, the associated switching apparatus operates in order to cause ringing current to be projected thereover and ring-back tone current to be returned over the trunk line 282 to the trunk circuit 281 and thence repeated over the previously traced loop circuit to the calling subscriber substation A in the central office 10. Subsequently, when the subscriber at the called subscriber substation in the remote exchange 30 answers the call the associated switching apparatus operates in order to reverse the polarity over the trunk line 282 effecting operation of the answer relay in the trunk circuit 281 and the consequent reversal of polarity over the loop circuit extending to the calling subscriber substation A in the central office 10. When the polarity of the loop circuit extending to the calling subscriber substation A is thus reversed, the unidirectional current conducting device, or copper oxide rectifier 213 shunting the right-hand winding of the answer relay R210 in the secondary trunk 200 blocks the passage of current therethrough; whereby the current is diverted through the right-hand winding of the answer relay R210 effecting operation thereof. Upon operating the answer relay R210 completes, at the contacts 211, a holding circuit for energizing the left-hand winding of the answer relay R210 and including the grounded control conductor C203 of the trunk 205. Also, the answer relay R210 completes, at the contacts 212, an obvious path for applying ground potential to the start conductor extending to the timer 215, thereby to initiate operation of the timer 215. After a predetermined time interval the timer 215 operates in order to connect the grounded commutator segment of the wheel 216 to the associated stop conductor, thereby to prepare a circuit for operating the time release relay R220. However, the circuit mentioned is not completed by virtue of the operation of the timer cutoff relay R250. More particularly, the operated timer cutoff relay R250 disables the timer 215 to prevent the release of the established connection, since the calling subscriber substation A involved in the established connection is rendered non-restricted service. Accordingly, the established connection between the calling subscriber substation A in the central office 10 and the called subscriber substation in the remote exchange 30 persists for any desired time interval at the convenience of the subscribers at the substations mentioned.

At the conclusion of the connection when the subscriber at the called subscriber substation in

the remote exchange 30 replaces the receiver of the telephone instrument thereat upon its associated switchhook, the associated switching apparatus is controlled to bring about the reversal of polarity over the trunk line 282; whereby the trunk circuit 281 reverses the polarity over the associated incoming trunk 280 and the loop circuit extending to the calling subscriber substation A in the central office 10; whereupon the copper oxide rectifier 213 again shunts the right-hand winding of the answer relay R210 in the secondary trunk 200. However, the answer relay R210 remains in its operated position by virtue of the completed holding circuit for energizing the left-hand winding thereof. When the subscriber at the calling subscriber substation A in the central office 10 replaces the receiver of the telephone instrument thereat upon its associated switchhook, the previously traced loop circuit extending to the trunk circuit 281 is interrupted in order to cause ground potential to be removed from the control conductor of the incoming trunk 280, bringing about the restoration of the test relay R240 in the secondary trunk 200. Upon restoring the test relay R240 interrupts, at the contacts 245, a further point in the previously traced path, including the control wiper 273 of the hunt switch 270, for applying ground potential to the control conductor C203 of the trunk 205; whereby the selector S100 and the finder F100 are released in the manner previously explained. When the finder F100 is thus released, ground potential is removed from the control conductor of the subscriber line 40; whereby the line circuit 41 is operated in order to mark the subscriber line 40 extending to the subscriber substation A as idle to the connectors in the associated group having access thereto. Also, when the selector S100 is released, the previously traced circuit for applying resistance ground potential to the EC conductor C204 of the trunk 205 is interrupted effecting the restoration of the timer cutoff relay R250 in the secondary trunk 200. Also, when ground potential is removed from the control conductor C203 of the trunk 205, the previously traced holding circuit for energizing the left-hand winding of the answer relay R210 in the secondary trunk 200 is interrupted in order to cause the latter relay to restore. Upon restoring the answer relay R210 interrupts, at the contacts 212, the previously mentioned path for applying ground potential to the start conductor extending into the timer 215; thereby to arrest operation of the timer 215. At this time, the secondary trunk circuit 200 is completely released and battery potential is applied by way of the resistor 222 and the contacts 221 to the control conductor C203 of the trunk 205, thereby to mark the trunk 205 as idle to the selectors in the various groups having access thereto. It is noted that the hunt switch 270 is not of the homing type; whereby the wipers noted thereof remain operated to the last operated position selecting the incoming trunk 280 extending to the trunk circuit 281.

Also, when the loop circuit extending from the calling subscriber substation A in the central office 10 to the trunk circuit 281 is interrupted, the trunk circuit 281 is released; whereby battery potential is applied to the control conductor of the incoming trunk 280 in order to mark the incoming trunk 280 as idle to the hunt switches in the various secondary trunks having access thereto. Further, the trunk circuit 281 opens the

loop circuit extending over the trunk line 282 to the switching apparatus in the remote exchange 30, thereby to bring about the release of the switching apparatus mentioned and the consequent operation of the line circuit associated with the called subscriber line therein in order to mark this subscriber line as idle to the associated switching apparatus having access thereto.

Now, assume that a call has been initiated at the subscriber substation B in the ten-line group rendered limited service in the central office 10; that the finder F100 of the link 100 has operated to find the subscriber line 50 extending to the subscriber substation B; that the selector S100 is conditioned to be responsive to the first digit dialed at the calling subscriber substation B; and that the call is to be extended to a called subscriber substation in the remote exchange 30. The subscriber at the calling subscriber substation B proceeds to dial the first digit 1, thereby to bring about operation of the selector S100 to select an idle trunk in the group, including the trunk 205, in the manner previously explained. Assuming that the selector S100 seizes the particular trunk 205, the line relay R230 in the secondary trunk 200 operates in order to initiate operation of the magnet M275 in conjunction with operation of the test relay R240; whereby the hunt switch 270 is controlled to select an idle incoming trunk in the group, including the incoming trunk 280 extending to an idle trunk circuit in the group including the trunk circuit 281. Assuming that the trunk circuit 281 is idle at this time, the incoming trunk 280 individual thereto is marked as idle by the application of battery potential upon the control conductor thereof; whereupon the test relay R240 may operate immediately prior to operation of the magnet M275 in the event the wipers noted of the hunt switch 270 engaged the sixth contacts in the associated contact bank terminating the incoming trunk 280. In any case, the magnet M275 operates in conjunction with the test relay R240 in order to bring about operation of the hunt switch 270 to select an idle incoming trunk in the group mentioned extending to an idle trunk circuit. Assuming that the hunt switch 270 selects the incoming trunk 280 extending to the trunk circuit 281, the test relay R240 operates in order to arrest further operation of the magnet M275; all in the manner previously explained. Further, the test relay R240, upon operating, effects holding of the selector S100, the finder F100 and the line circuit 51 in their operated positions in the manner previously explained. Also, the test relay R240 brings about the restoration of the line relay R230 shortly after operation of the test relay R240; whereupon a loop circuit is completed between the calling subscriber substation B and the trunk circuit 281. The trunk circuit 281 operates in order to bring about seizure over the trunk line 282 of the switching apparatus in the remote exchange 30; all in the manner previously explained.

In the present example the wiper carriage of the Strowger mechanism 181 in the finder F100 in the link 100 occupies its second vertical step seizing the subscriber line 50 extending to the calling subscriber substation B; whereby the set of switch springs S181 is operated in order to cause no potential to be applied to the EC conductor C104. Also, the set of switch springs S172 in the selector S100 is operated causing no potential to be applied to the EC conductor C204

of the trunk 205; whereby neither the timer cutoff relay R250 nor the intercept relay R260 is operated in the present example.

The subscriber at the calling subscriber substation B then proceeds to dial the following digits; whereby the trunk circuit 281 operates in order to repeat the digits mentioned over the trunk line 282 to the switch apparatus in the remote exchange 30 effecting operation thereof to seize the subscriber line extending to the called subscriber substation therein. The operations of the switching apparatus in the remote exchange 30 to test and to project ringing current over the subscriber line extending to the called subscriber substation, in the event it is idle, are the same as previously explained; and when the subscriber at the called subscriber substation in the remote exchange 30 answers the call the associated switching apparatus operates in order to reverse the polarity over the trunk line 282 causing the trunk circuit 281 to operate and reverse the polarity over the loop circuit extending to the calling subscriber substation B in the central office 10. When the polarity of the loop circuit extending to the calling subscriber substation B and the trunk circuit 281 is reversed, the copper oxide rectifier 213 blocks the passage of current therethrough effecting energization of the right-hand winding of the answer relay R210 in the trunk circuit 200 in the manner previously explained; whereupon the answer relay R210 operates completing, at the contacts 211, the previously traced holding circuit, including the grounded control conductor C203 of the trunk 205, for energizing the left-hand winding thereof, and initiating operation of the timer 215. At this time an established connection is completed between the calling subscriber substation A in the central office 10 and the called subscriber substation in the remote exchange 30. At any time should the subscriber at the called subscriber substation in the remote exchange 30 replace the receiver of the telephone instrument thereat upon its associated switchhook, the associated switching apparatus operates in order to reverse the polarity over the trunk line 282 causing the trunk circuit 281 to reverse the polarity over the loop circuit extending to the calling subscriber substation B. This operation is without effect, however, to control the answer relay R210, since a direct holding circuit is completed for the left-hand winding thereof, including the contacts 211 and the grounded control conductor C203 of the trunk line 205. Accordingly, operation of the timer 215 continues until the subscriber at the calling subscriber substation B in the central office 10 replaces the receiver of the telephone instrument thereat upon its associated switchhook in order to effect release of the equipment involved in a manner more fully explained hereinafter.

In the event the established connection between the calling subscriber substation B in the central office 10 and the called subscriber substation in the remote exchange 30 persists for a predetermined time interval, complete operation of the timer 215 takes place; whereby ground potential is applied to the associated stop conductor, thereby to complete a circuit, including the contacts 251, for operating the time release relay R220. Upon operating the time release relay R220 interrupts, at the contacts 221, the previously traced path for applying ground potential to the control conductor C203 of the trunk 205 in order to bring

about the release of the selector S100 and the finder F100 in the link 100; all in the manner previously explained. When the link 100 is thus released, the line circuit 51, associated with the subscriber line 50 extending to the calling subscriber substation B, is locked out in the event the subscriber at the calling subscriber substation B has not replaced the receiver of the telephone instrument thereat upon its associated switchhook at this time; whereby the subscriber line 50 is marked as busy both to the finders of the links in the first group having access thereto and to the connectors in the associated group having access thereto. Also, when the link 100 is released the secondary trunk 200 is released and rendered available for further use; and the trunk circuit 281 is released and rendered available for further use; all in the manner previously explained. When the trunk circuit 281 is released, the loop circuit extending therefrom by way of the trunk line 282 to the switching apparatus in the remote exchange 30 is opened, effecting release of the switching apparatus mentioned; whereby the line circuit, associated with the subscriber line extending to the called subscriber substation in the remote exchange 30, is locked out in the event the subscriber at the called subscriber substation mentioned has not replaced the receiver of the telephone instrument thereat upon its associated switchhook at this time; whereby the subscriber line extending to the called subscriber substation mentioned is marked as busy to the switching apparatus having access thereto.

Of course, it will be understood that the normal release of the established connection between the calling subscriber substation B in the central office 10 and the called subscriber substation in the remote exchange 30 takes place in the normal manner when the subscriber at the calling subscriber substation B replaces the receiver of the telephone instrument thereat upon its associated switchhook. In other words, the forced release of the established connection under the control of the timer 215 takes place in the manner described above only in conjunction with established connections which persist for a predetermined and abnormally long time.

Finally, assume that a call has been initiated at the subscriber substation C in the ten-line group rendered restricted service in the central office 10; that the finder F100 of the link 100 has operated to find the subscriber line 60 extending to the subscriber substation C; that the selector S100 is conditioned to be responsive to the first digit dialed at the calling subscriber substation C; and that the subscriber at the calling subscriber substation C attempts the extension of a connection to a called subscriber substation in the remote exchange 30. The subscriber at the calling subscriber substation C proceeds to dial the first digit 1; thereby to bring about operation of the selector S100 to select an idle trunk in the group, including the trunk 205, in the manner previously explained. Assuming that the selector S100 seizes the particular trunk 205, the line relay R230 in the secondary trunk 200 is operated in the manner previously explained.

In the present example, the wiper carriage of the Strowger mechanism 181 in the finder F100 in the link 100 occupies its third vertical step seizing the subscriber line 60 extending to the calling subscriber substation C; whereby the set of switch springs S186 is operated in order to cause direct ground potential to be applied to the

EC conductor C104. Also, the set of switch springs S172 in the selector S100 is operated causing direct ground potential to be applied to the EC conductor C204 of the trunk 205; whereby both the timer cutoff relay R250 and the intercept relay R260 in the secondary trunk 200 are operated. The intercept relay R260 operates in the present example in the previously traced series circuit by virtue of the fact that direct ground potential is applied to the EC conductor C204 of the trunk 205, the intercept relay R260 being of the marginal type. Upon operating the timer cutoff relay R250 interrupts, at the contacts 251, a further point in the previously traced circuit for operating the time release relay R220; thereby to prevent operation of the latter relay in the present example. Upon operating the intercept relay R260 interrupts, at the contacts 251, the normally completed connection between the control wiper 273 of the hunt switch 270 and the lower terminal of the test relay R240; and completes, at the contacts 262, a connection, including the contacts 247 and 233, between the control wiper 274 of the hunt switch 270 and the lower terminal of the test relay R240. In the present case, the first seven contacts in the contact bank, associated with the control wiper 274 of the hunt switch 270, are connected directly to ground potential, thereby to short-circuit the winding of the test relay R240 and to cause intermittent operation of the magnet M275 in the manner previously explained; whereby the wipers noted of the hunt switch 270 are driven into engagement with the eighth contacts in the associated contact banks. When the control wipers 274 of the hunt switch 270 engage the eighth contacts in the associated contact bank, the first incoming trunk in the group of three, including the incoming trunk 290, is tested by the test relay R240. Assuming that the first trunk mentioned is busy, the winding of the test relay R240 is again short-circuited and the magnet M275 is reoperated; whereby the wipers noted of the hunt switch 270 are driven into engagement with the ninth contacts in the associated contact banks terminating the incoming trunk 290 extending to the trunk circuit 291. Assuming that the incoming trunk 290 is idle at this time, battery potential appearing upon the control conductor thereof completes a path substantially identical to that previously traced for short-circuiting the magnet M275; and completes one of the two previously mentioned multiple circuits for energizing the winding of the test relay R240. Accordingly, the test relay R240 operates to arrest further operation of the magnet M275, to effect restoration of the line relay R230 shortly thereafter, since it is of the slow-to-release type, and to switch the loop circuit extending from the calling subscriber substation through the hunt switch 270 onto the incoming trunk 290; whereby the loop circuit mentioned is recompleted in the associated trunk circuit 291. The trunk circuit 291 then operates to return ground potential over the control conductor of the incoming trunk 290, thereby to maintain operated the test relay R240 in the secondary trunk 200; whereby the selector S100, the finder F100 and the line circuit 61 associated with the subscriber line 60 extending to the calling subscriber substation C are maintained in their operated positions for the purpose previously explained. Further, the trunk circuit 291 operates to close the trunk 292 extending to the operator switchboard 295 in order to indicate to the operator thereat that a call is on the trunk

292 waiting to be answered. When the operator at the switchboard 295 answers the call on the trunk 292, a telephone connection is established to the calling subscriber substation C, and the subscriber thereat is advised that the call has been intercepted since calls from the subscriber substation C to the remote exchange 30 may not be set up directly by the subscriber at the calling subscriber substation C. The operator at the switchboard 295 may undertake the extension of the connection to the desired called subscriber substation in the remote exchange 30 or she may advise the subscriber at the calling subscriber substation C to release the present connection and initiate a direct call to a toll switchboard, not shown, provided in the central office 13.

Subsequently, at the conclusion of the connection the operator withdraws from the trunk 292 and later, when the subscriber at the calling subscriber substation C replaces the receiver of the telephone instrument thereat upon its associated switchhook, the loop circuit extending from the calling subscriber substation C to the trunk circuit 291 is interrupted; whereby the trunk circuit 291 operates to release the trunk 292, and to interrupt the application of ground potential to, and to return battery potential upon, the control conductor of the incoming trunk 290. When ground potential is removed from the control conductor of the incoming trunk 290, the previously traced circuit for maintaining operated the test relay R240 in the secondary trunk 200 is interrupted, causing the latter relay to restore effecting the release of the secondary trunk 200, the selector S100 and the finder F100 in the manner previously explained. When the finder F100 is thus released the line circuit 61 is controlled to mark the subscriber line 60 extending to the subscriber substation C as idle to the connectors in the associated group having access thereto.

Operation of the finders in the distant exchange 20

First, assuming that a call is initiated at a subscriber substation, such, for example, as the subscriber substation D in the ten-line group normally rendered non-restricted service in the distant exchange 20; the line circuit 471 is controlled over the associated subscriber line 470 and operates in order to place ground potential upon the start conductor C491 extending to the distributor 490 and to mark the particular rotary position of the contact sets terminating the subscriber line 470 in the contact banks of the Strowger mechanisms incorporated in the finders of the links in the group. The distributor 490 then operates in order to assign an idle one of the links in the group to find the calling line, such, for example, as the link 400. Also, the distributor 490 marks to the finder F400 of the link 400 the level of the contact set in the contact bank 485 of the Strowger mechanism 481 terminating the calling subscriber line 490; the first level in the present example. The finder F400 is then controlled by the distributor 490; whereby the wiper carriage of the Strowger mechanism 481 is driven one step in the vertical direction and then operated automatically in the rotary direction in search of the calling subscriber line 470.

When the wiper set of the Strowger mechanism 481 engages the tenth contact set in the first level in the contact bank 486 terminating the calling subscriber line 470, further operation thereof is arrested; the distributor 490 effects operation of the switch through relay R410 in the

finder F400 and is then released; and the line circuit 471, associated with the calling subscriber line 470, is controlled in order to mark the subscriber line 470 as busy to the connectors of the link in the group having access thereto. Upon operating the switch through relay R410 completes, at the contacts 415, a holding circuit, not shown, for maintaining it operated; and completes, at the contacts 411 and 412, a loop circuit, including the line wipers 482 and 483, extending to the calling subscriber substation D; which loop circuit is completed in the connector C400 to battery and ground potentials, and further includes the contacts 451 and 452, as well as the resistor 435 and the shunting unidirectional current conducting device, or copper oxide rectifier 434. It is noted that the right-hand winding of the answer relay R430 is bridged across the copper oxide rectifier 434 and is shunted thereby, at the present time, in order to prevent operation of the answer relay R430. Also, ground potential in the connector C400 is applied by way of the contacts 453 and 413 to the control wiper 484, thereby to maintain operated the finder F400 and the line circuit 471 as previously noted.

Also, incident to operation of the finder F400 to find the calling line subscriber line 470, the wiper shaft 488 actuates the set of switch springs S487 to close the contacts 489; whereby no potential is applied to the EC wiper 485 connected by way of the contacts 414 to the service relay R420; by virtue of the fact that the calling subscriber line 470 is terminated in the first level of the contact bank 486 of the Strowger mechanism 481. Also, the EC contact of the contact set terminating the subscriber line 470 extending to the calling subscriber substation D has no ground potential appearing thereon; whereby no potential in the contact bank 486 of the Strowger mechanism 481 is applied directly to the EC wiper 485. Hence, in the present example, the service relay R420 in the finder F400 is not operated, since the calling subscriber substation D is included in a ten-line group normally rendered non-restricted service and comprises an individual line in this group which is rendered non-restricted service. The failure of the service relay R420 to be operated at this time prevents timing of a connection, ultimately completed by way of the link 400, as explained more fully hereinafter.

Now, assuming that a call is initiated at a subscriber substation, such, for example, as the subscriber substation E in the ten-line group rendered limited service in the distant exchange 20; the line circuit 476 is controlled over the associated subscriber line 475 and operates in order to place ground potential upon the start conductor C491 extending to the distributor 490 and to mark the particular rotary position of the contact sets terminating the subscriber line 475 in the contact banks of the Strowger mechanism incorporated in the finders of the links in the group. The distributor 490 then operates in order to assign an idle one of the links in the group to find the calling line, such, for example, as the link 400. Also, the distributor 490 marks to the finder F400 of the link 400 the level of the contact set in the contact bank 486 of the Strowger mechanism 481 terminating the calling subscriber line 475; the second level in the present example. The finder F400 is then controlled by the distributor 490; whereby the wiper carriage of the Strowger mechanism is driven two steps

in the vertical direction and then operated automatically in the rotary direction in search of the calling subscriber line 475.

When the wiper set of the Strowger mechanism 481 engages the second contact set in the second level in the contact bank 486 terminating the calling subscriber line 475 further operation thereof is arrested; the distributor 490 then operates the switch through relay R410 and is released; and the line circuit 476, associated with the calling subscriber line 475, is controlled in order to mark the subscriber line 475 as busy to the connectors of the links in the group having access thereto. Also, at this time, a loop circuit is completed between the calling subscriber substation E and the connector C400; and the answer relay R430 is not operated; all in the manner previously described. Also, the connector C400 maintains operated the finder F400 and the line circuit 475, as previously noted.

Also, incident to operation of the finder F400 to find the calling subscriber line 475, the wiper carriage shaft 488 actuates the set of switch springs S487 to close the associated contacts 489; whereby direct ground potential is applied to the EC wiper 485 in order to complete a circuit, including the contacts 414, for operating the service relay R420. The operation of the service relay R420 in the finder F400 causes a connection, ultimately completed by way of the link 400, to be timed under the control of the interceptor 445 and the timer switch 440, as explained more fully hereinafter.

Finally, assuming that a call is initiated at a subscriber substation, such, for example, as the subscriber substation F in the ten-line group rendered non-restricted service, but which individual subscriber substation is rendered restricted service, in the distant exchange 20; the line circuit 481 is controlled over the associated subscriber line 480 and operates in order to place ground potential upon the start conductor C491 extending to the distributor 490 and to mark the particular rotary position of the contact sets terminating the subscriber line 480 in the contact banks of the Strowger mechanisms incorporated in the finders of the links in the group. The distributor 490 then operates in order to assign an idle one of the links in the group to find the calling line, such, for example, as the link 400. Also, the distributor 490 marks to the finder F400 of the link 400 the level of the contact set in the contact bank 486 of the Strowger mechanism 481 terminating the calling subscriber line 480; the first level in the present example. The finder F400 is then controlled by the distributor 490; whereby the wiper carriage of the Strowger mechanism 481 is driven one step in the vertical direction and then operated automatically in the rotary direction in search of the calling subscriber line 480.

When the wiper set of the Strowger mechanism 481 engages the ninth contact set in the first level in the contact bank 481 terminating the calling subscriber line 480, further operation thereof is arrested; the distributor 490 effects operation of the switch through relay R410 and is released; and the line circuit 481, associated with the calling subscriber line 480, is controlled in order to mark the subscriber line 480 as busy to the connectors of the links in the group having access thereto. Also, at this time, a loop circuit is completed between the calling subscriber substation F and the connector C400; however,

the answer relay R430 is not operated; all as previously explained.

Also, incident to operation of the finder F400 to find the calling subscriber line 481, the wiper carriage shaft 488 actuates the set of switch springs S487 to close the associated contacts 489'; whereby no potential is applied thereat to the EC wiper 485. However, in the present example, the EC wiper 485 engaged directly the grounded EC contact of the contact set in the contact bank 486 of the Strowger mechanism 481 terminating the subscriber line 480 extending to the calling subscriber substation F; whereby direct ground potential appearing upon the EC wiper 485 completes the previously mentioned circuit, including the contacts 414, for operating the service relay R420 in the finder F400. The operation of the service relay R420 in the finder F400 causes a connection, ultimately completed by way of the link 400, to be timed under the control of the interrupter 445 and the timer switch 440 as explained more fully hereinafter.

Completion of connections in the distant exchange 20

First, assume that a call has been initiated at the subscriber substation D in the ten-line group normally rendered non-restricted service in the distant exchange 20; that the finder F400 of the link 400 has operated to find the subscriber line 470 extending to the subscriber substation D; that the connector C400 is conditioned to be responsive to the first digit dialed at the calling subscriber substation D; and that the call is to be extended to a called subscriber substation, such, for example, as the subscriber substation E in the distant exchange 20. The subscriber at the calling subscriber substation D proceeds to dial the two digits comprising the directory number of the called subscriber substation E; whereupon the connector C400 operates to seize the subscriber line 475 extending to the called subscriber substation E. The connector C400 then tests the idle or busy condition of the called subscriber line 475, returning busy tone current to the calling subscriber substation D in the event the called subscriber substation E is busy at this time, and projecting ringing current over the called subscriber line 475 and returning ring back current over the calling subscriber line 470 in the event the called subscriber substation E is idle at this time. Assuming that the called subscriber substation E is idle at this time, when the call is answered thereat the connector C400 operates to complete a telephone connection between the calling subscriber substation D and the called subscriber substation E, and to effect the reversal of polarity over the loop circuit extending to the calling subscriber substation D. When the polarity of the loop circuit extending to the calling subscriber substation D is thus reversed, the copper oxide rectifier 434 blocks the passage of current therethrough; whereby the right-hand winding of the answer relay R430 in the finder F400 is energized. The answer relay R430 operates to complete, at the contacts 431, a holding circuit for energizing the left-hand winding thereof; and to prepare, at the contacts 432, a circuit for energizing the rotary magnet M442 of the timer 440 from the interrupter 445; which circuit is not completed at this time by virtue of the fact that the service relay R420 is not operated, since the wiper carriage of the Strowger mechanism 481 occupies its first vertical step selecting the subscriber line

470 extending to the calling subscriber substation D closing the contacts 489' and placing no potential upon the EC wiper 485.

More particularly, the restored service relay R420 disables the timer switch 440 to prevent the release of the established connection, since the calling subscriber substation D involved in the established connection is rendered non-restricted service. Accordingly, the established connection between the calling subscriber substation D and the called subscriber substation E persists for any desired time interval at the convenience of the subscribers at the substations mentioned. At the conclusion of the connection when the subscriber at the called subscriber substation E replaces the receiver of the telephone instrument thereat upon its associated switchhook, the connector C400 operates to effect the reversal of polarity over the loop circuit extending to the calling subscriber substation D; which operation is without effect, since the answer relay R430 is retained in its operated position by the completed holding circuit for energizing the left-hand winding thereof. When the subscriber at the calling subscriber substation D replaces the receiver of the telephone instrument thereat upon its associated switchhook, the previously traced loop circuit extending to the connector C400 is interrupted; whereby the connector C400 is released interrupting the application of ground potential upon the control wiper C484 causing the finder F400 to be released; whereupon the switch through relay R410 and the answer relay R430 are restored. When the connector C400 is thus released, the line circuit 476 is operated to mark the subscriber line 475 extending to the called subscriber substation E as idle to the connectors C400, etc., having access thereto; and when the finder F400 is released, the line circuit 471 is operated in order to mark the subscriber line 470 extending to the calling subscriber substation D as idle to the connectors C400 etc., having access thereto.

Now assume that a call has been initiated at the subscriber substation E in the ten-line group rendered limited service in the distant exchange 20; that the finder F400 of the link 400 has operated to find the subscriber line 475 extending to the subscriber substation E; that the connector C400 is conditioned to be responsive to the first digit dialed at the calling subscriber substation E; and that the call is to be extended to a called subscriber substation such, for example, as the subscriber substation D in the distant exchange 20. The subscriber at the calling subscriber substation E proceeds to dial the two digits comprising the directory number of the called subscriber substation D, thereby to bring about operation of the connector C400 to seize the subscriber line 470, to test the idle or busy condition of the called subscriber line 470, to return busy tone current or to project ringing current and to return ring-back tone current, under the various conditions in a conventional manner. When the subscriber at the called subscriber substation D answers the call the connector C400 switches through in order to bring about operation of the answer relay R430 in the finder F400 in the manner previously explained.

In the present example the wiper carriage of the Strowger mechanism 481 in the finder F400 in the link 400 occupies its second vertical step seizing the subscriber line 475 extending to the calling subscriber substation E; whereby the set of switch springs S487 is operated in order to close

the contacts 489 thereof and to effect operation of the service relay R420 in the manner previously explained. Accordingly, when the answer relay R430 operates, it completes, at the contacts 432, the previously mentioned circuit, including the contacts 421 and the interrupter 445, for operating intermittently the rotary magnet M442 of the timer switch 440. More particularly, the interrupter 445 completes intermittently the circuit mentioned for operating the rotary magnet M442; whereby the wiper 441 of the timer switch 440 is driven step by step in the clockwise direction away from its home position. When the wiper 441 is driven away from its home position, the set of switch springs S444 is actuated for a purpose more fully explained hereinafter.

In the event the established connection between the calling subscriber substation E and the called subscriber substation D in the distant exchange 20 persists for a predetermined time interval the wiper 441 of the timer switch 440 is driven six steps in the clockwise direction away from its home position to engage the sixth contact in the associated contact bank, thereby to complete an obvious circuit for operating the time release relay R450. Upon operating the time release relay R450 interrupts, at the contacts 451 and 452, the loop circuit extending between the calling subscriber substation E and the connector C400; and interrupts, at the contacts 453, the previously traced path for applying ground potential to the control wiper 434. Accordingly both the connector C400 and the finder F400 are released in the manner previously explained. When the link 400 is released, the switch through relay R410, the service relay R420 and the answer relay R430 are restored to their normal positions. Upon restoring the answer relay R430 completes, at the contacts 433, a circuit, including the set of switch springs S444, for operating the release magnet M443 of the timer switch 440; whereby the wiper 441 of the timer switch 440 is released and returned to its home position causing the time release relay R450 to restore. When the wiper 441 of the timer switch 440 is returned to its home position, the set of switch springs S444 is actuated, thereby to interrupt the circuit for operating the release magnet M443. At this time the switch 440 is completely released.

When the link 400 is thus released, the line circuit 476, associated with the subscriber line 475 extending to the calling subscriber substation E is locked out in the event the subscriber at the calling subscriber substation E has not replaced the receiver of the telephone instrument thereat upon its associated switchhook at this time; whereby the subscriber line 476 is marked as busy both to the finders and to the connectors of the links 400, etc., in the group having access thereto. Also, when the link 400 is released, the line circuit 475, associated with the subscriber line 470 extending to the called subscriber substation D, is locked out in the event the subscriber at the called subscriber substation D has not replaced the receiver of the telephone instrument thereat upon its associated switchhook at this time; whereby the subscriber line 470 is marked as busy both to the finders and to the connectors of the links 400, etc., in the group having access thereto.

Of course, it will be understood that the normal release of the established connection between the calling subscriber substation E and the called subscriber substation D in the distant exchange 20 takes place in the normal manner when the subscriber at the calling subscriber substation E re-

places the receiver of the telephone instrument thereat upon its associated switchhook. In other words, the forced release of the established connection under the control of the timer switch 440 takes place in the manner described above only in conjunction with established connections which persist for a predetermined and abnormally long time interval.

Finally assume that a call has been initiated at the subscriber substation F in the ten-line group normally rendered non-restricted service, but at the particular subscriber substation F that is rendered limited service, in the distant exchange 20; that the finder F400 of the link 400 has operated to find the subscriber line 480 extending to the subscriber substation F; that the connector C400 is conditioned to be responsive to the first digit dialed at the calling subscriber substation F; and that the call is to be extended to a called subscriber substation, such, for example, as the subscriber substation D in the distant exchange 20. The subscriber at the calling subscriber substation F proceeds to dial the two digits comprising the directory number of the called subscriber substation D; whereby the connector C400 operates to seize the subscriber line 470 extending to the called subscriber substation D; all in the manner previously explained.

In the present example, the wiper carriage of the Strowger mechanism 481 in the finder F400 in the link 400 occupies its first vertical step seizing the subscriber line 480 extending to the calling subscriber substation F; whereby the set of switch springs S487 is actuated to close the contacts 489 in order to cause no potential to be applied to the EC wiper 485; however, the wiper set of the Strowger mechanism 481 engages the ninth contact set in the first level seizing the subscriber line 480 extending to the calling subscriber substation F, whereby ground potential appearing upon the EC contact of the contact set mentioned is applied directly to the EC wiper 485 in order to bring about operation of the service relay R420. Thus, in the present example, the set of switch springs S487 is operated to establish a first control indicating that the calling subscriber substation F is rendered non-restricted service, since it is included in the ten-line group normally rendered non-restricted service. However, the provision of direct ground potential upon the EC contact of the particular contact set terminating the subscriber line 480 extending to the calling subscriber substation established a second and overriding control indicating that the particular calling subscriber substation F is rendered limited service notwithstanding the circumstance that it is included in the ten-line group normally rendered non-restricted service.

When the subscriber at the called subscriber substation D answers the call, the answer relay R430 in the finder F400 operates in order to bring about operation of the timer switch 440, since the service relay R420 in the finder F400 occupies its operated position. In the event the established connection between the calling subscriber substation F and the called subscriber substation D persists for a predetermined time interval, the timer switch 440 effects operation of the time release relay R450 in order to bring about the forced release of the established connection; all in the manner previously explained. Of course, it will be understood that the normal release of the established connection between the calling subscriber substation F and the called subscriber substation D in the distant exchange 20 takes

place in the normal manner under the control of the subscriber at the calling subscriber station F.

Conclusions

In view of the foregoing, it is apparent that there has been provided an automatic telephone system including finders, characterized by a plurality of different primary operations thereof to select corresponding ones of a plurality of groups of lines and by a plurality of different secondary operations thereof to select corresponding ones of the lines in the previously selected one of the groups of lines; wherein different classes of service are normally rendered to subscriber lines in the different groups of lines, as determined by the primary operations of the finders.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a telephone system including a plurality of groups of lines, a finder having access to said lines, said finder being characterized by a plurality of different primary operations thereof to select corresponding ones of said group of lines and by a plurality of different secondary operations thereof to select corresponding ones of the individual lines in the previously selected one of said groups of lines, trunks, and automatic switching apparatus associated with said finder and operative to extend connections from calling ones of said lines to called ones of said lines and to said trunks; a control conductor, means selectively controlled by first and second predetermined primary operations of said finder to select corresponding first and second groups of said lines for establishing corresponding first and second controls upon said control conductor, a test device, means controlled by operation of said switching apparatus to extend a connection via one of said trunks for connecting said control conductor to said test device, said test device being operated in first and second manners respectively in response to said first and second controls upon said control conductor, and means governed by operation of said test device in said first manner for causing said switching apparatus to render a corresponding first class of trunk service to any line in said first group of lines selected by said finder and governed by operation of said test device in said second manner for causing said switching apparatus to render a corresponding second class of trunk service to any line in said second group of lines selected by said finder.

2. In a telephone system including a plurality of groups of lines, a finder having access to said lines, said finder being characterized by a plurality of different primary operations thereof to select corresponding ones of said groups of lines and by a plurality of different secondary operations thereof to select corresponding ones of the individual lines in the previously selected one of said groups of lines, trunks, and automatic switching apparatus associated with said finder and operative to extend connections from calling ones of said lines to called ones of said lines and to said trunks; a control conductor, means selectively controlled by first and second predetermined primary operations of said finder to se-

lect corresponding first and second groups of said lines for establishing corresponding first and second controls upon said control conductor, a test device, means controlled by operation of said switching apparatus to extend a connection via one of said trunks for connecting said control conductor to said test device, said test device being operated in first and second manners respectively in response to said first and second controls upon said control conductor, a timer operative to time the duration of a trunk connection, and means governed by operation of said test device in said first manner for preventing operation of said timer and governed by operation of said test device in said second manner for causing operation of said timer.

3. In a telephone system including a plurality of groups of lines, a finder having access to said lines, said finder being characterized by a plurality of different primary operations thereof to select corresponding ones of said groups of lines and by a plurality of different secondary operations thereof to select corresponding ones of the individual lines in the previously selected one of said groups of lines, trunks, and automatic switching apparatus associated with said finder and operative to extend connections from calling ones of said lines to called ones of said lines and to said trunks; a control conductor, means selectively controlled by first and second predetermined primary operations of said finder to select corresponding first and second groups of said lines for establishing corresponding first and second controls upon said control conductor, a test device, means controlled by operation of said switching apparatus to extend a connection via one of said trunks for connecting said control conductor to said test device, said test device being operated in first and second manners respectively in response to said first and second controls upon said control conductor, a timer operative to time the duration of a trunk connection, means governed by operation of said test device in said first manner for preventing operation of said timer and governed by operation of said test device in said second manner for causing operation of said timer, and means responsive to a predetermined operation of said timer for releasing said finder and said switching apparatus.

4. In a telephone system including a plurality of groups of lines, a finder having access to said lines, said finder being characterized by a plurality of different primary operations thereof to select corresponding ones of said groups of lines and by a plurality of different secondary operations thereof to select corresponding ones of the individual lines in the previously selected one of said groups of lines, and automatic switching apparatus associated with said finder and operative to extend a connection from a line selected by said finder; a control conductor, means selectively controlled by first and second predetermined primary operations of said finder to select corresponding first and second groups of said lines for establishing corresponding first and second controls upon said control conductor, means controlled by a predetermined secondary operation of said finder following said first predetermined primary operation thereof to select a corresponding one of the lines in said first group of lines for establishing said second control overriding said first established control upon said control conductor, and means governed by said first established control upon said control

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conductor for causing said switching apparatus to render a corresponding first class of service to a line selected by said finder and governed by said second established control upon said control conductor for causing said switching apparatus to render a corresponding second class of service to a line selected by said finder.

5. In a telephone system including a plurality of groups of lines, a finder having access to said lines and provided with a plurality of groups of contact sets, the individual contact sets in each of said groups of contact sets respectively terminating the individual lines in the corresponding one of said groups of lines, said finder being characterized by a plurality of different primary operations thereof to select corresponding ones of said groups of contact sets and by a plurality of different secondary operations thereof to select corresponding ones of the individual contact sets in the previously selected one of said groups of contact sets, and automatic switching apparatus associated with said finder and operative to extend a connection from a line selected by said finder; a control conductor, means selectively controlled by first and second predetermined primary operations of said finder to select corresponding first and second groups of said contact sets for establishing corresponding first and second controls upon said control conductor, means for placing said second established control directly upon a predetermined one of said con-

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tact sets in said first group of contact sets so that said second established control overrides said first established control upon said control conductor when said finder is operated to select said one contact set in said first group of contact sets, and means governed by said first established control upon said control conductor for causing said switching apparatus to render a corresponding first class of service to a line terminated by a contact set selected by said finder and governed by said second established control upon said control conductor for causing said switching apparatus to render a corresponding second class of service to a line terminated by a contact set selected by said finder.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,256,126	Goodrum	Feb. 12, 1918
1,468,078	Ray et al.	Sept. 18, 1923
1,567,240	Carpenter	Dec. 29, 1925
1,649,494	Smith	Nov. 15, 1927
1,678,185	Harper	July 24, 1928
2,333,039	Peterson	Oct. 26, 1943
2,375,514	Bakker	May 8, 1945