

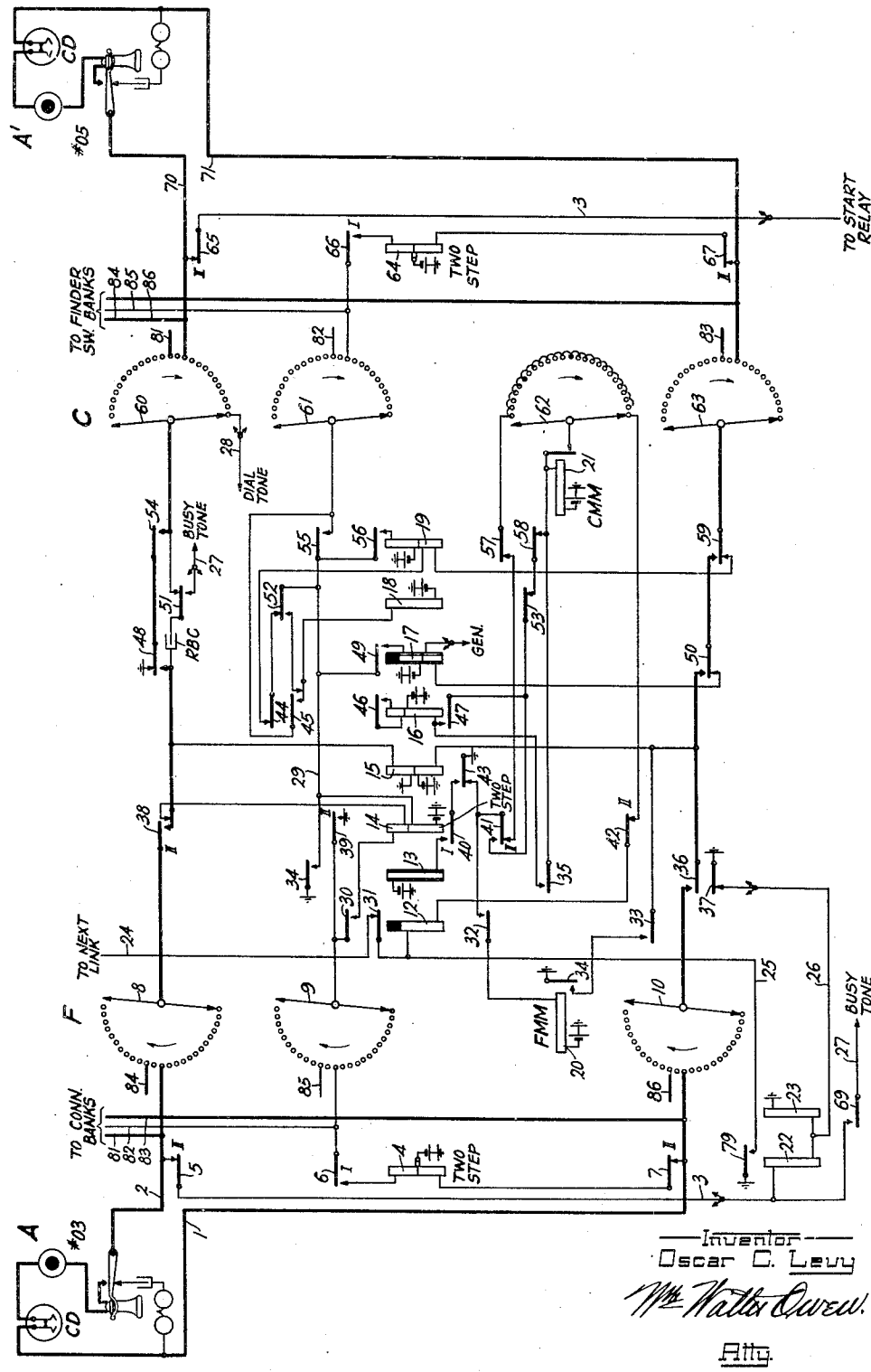
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TELEPHONE SYSTEM

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TELEPHONE SYSTEM

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This invention relates to automatic telephone systems in general, but relates more particularly to small systems of the character commonly known as private automatic exchanges. These systems are as a rule privately owned by individuals or corporations and are installed in factories and other establishments for providing local service between a small number of local telephone lines.

The object of the invention is to provide means whereby a minimum number of switching devices will be employed for completing the desired telephone connections, and which will enable the equipment to be manufactured very cheaply while retaining all the features necessary for modern high-class and dependable telephone service.

One of the features of the invention relates to the improved circuit arrangements of a finder-connector link circuit comprising a numerical forward selecting switch for connecting with a called line and a non-numerical line finder switch for finding the calling line.

Another feature of the invention is the provision of circuit arrangements whereby a relay first functions as an interrupter stepping-relay for the finder switch magnet, then functions as a test-stop relay when the finder finds the calling line, and then later functions as a line pulsing relay for directly operating the connector of the finder-connector link.

Another feature of the invention relates to an improved switch-through circuit which enables a straight multiple to be used between the banks of the hunting finder and the connector.

Other features, together with the ones named above, will be explained hereinafter, reference being had to the accompanying drawing which shows by means of the usual circuit diagrams a sufficient amount of apparatus to enable the invention to be understood.

The drawing diagrammatically shows two automatic substations, A and A', together with their individual cut-off relays 4 and 64, a line relay 22, and an all-trunks-busy relay 23, which are common to all the subscribers' lines, and a finder-connector link circuit. The line circuit of each subscriber's line terminates in the banks of the finders, such as the finder F, and in the banks of the connectors, such as the connector C. The automatic substations A and A' are similar to each other, and each has the usual signalling, talking, and switch-controlling instrumentalities.

The mechanism of the finders, such as F, and the connectors, such as C, is of the well-known rotary type, commonly used for rotary line-switches, and the wipers of which move in a forward direction only and remain in the position last used. The circuit details of the connector are somewhat different from the finders in that the wipers of the connector are directly op-

erated to a called line and are automatically restored to normal position after termination of the conversation.

In the case illustrated, Applicant has elected to show a system having a maximum of twenty-two local lines having telephone numbers 1 to 9, 01 to 09, and 001 to 004. The lines 1 to 9 terminate in the first nine contacts accessible to the wipers of the connectors, the lines 01 to 09 terminate in the eleventh to the nineteenth contacts accessible to the wipers of the connectors, and the lines 001 to 004 terminate in the twenty-first to the twenty-fourth contacts accessible to the wipers of the connectors. The tenth and twentieth contacts are left dead while the twenty-fifth contact is used for normal position of the connector wipers.

The subscriber's cut-off relays, such as 4 and 64, and relay 14, are two-step relays which close their contacts marked I in their first step and their contacts marked II in their second step. Relay 12 is a slow-to-operate relay which is also appreciably slow to release. Relay 13 is equipped with a copper sleeve around its core which renders the relay slow to release.

Having briefly described the apparatus involved in a system of this type, a detailed description of the operation will now be given. For this purpose, it will be assumed that subscriber A wishes to obtain connection with subscriber A'. When subscriber A removes his receiver to initiate a call, a circuit is completed for the common line relay 22 and cut-off relay 4 as follows: from ground at all armatures 37 in normal position, common conductor 26, winding of common line relay 22, common conductor 3, armature 5, conductor 2, through the calling substation loop, conductor 1, armature 7, and through the lower winding of cut-off relay 4, to battery. Cut-off relay 4 is so adjusted that when the circuit is closed through the lower winding armature 6 is the only armature operated. Relay 4 in operating its armature 6 marks the line as calling by connecting battery through its upper winding to the finder bank, and prepares a circuit for fully energizing itself over its upper wiper when the finder finds the calling line. Common line relay 22 is operated over the above traced circuit and closes a circuit for a start relay of an idle finder-connector link as follows: ground by way of armature 79, start lead 25, winding of slow-to-operate start relay 12, armature 42, twenty-fifth bank contact and wiper 62, interrupter springs of the connector motor magnet 21 and through the winding of magnet 21, to battery. Due to the high resistance of relay 12 the motor magnet 21 is not energized over this circuit, but start relay 12 energizes to start the finder.

In case this finder-connector link is busy, then armature 42 would be opened and the wiper 62

would not be in normal position; therefore, the start circuit would extend to the next finder connector link by way of armature 31 and conductor 24. In case all of the finder-connector links are busy when a subscriber initiates a call, then the circuit for shunting all-trunks-busy relay 23 is opened at the armatures 37 of the busy finder-connector links and a circuit may be traced from ground through winding of relay 23, winding of relay 22, and thence over the above traced circuit to battery through the lower winding of the cut-off relay associated with the calling line. Due to the high resistance of relay 23, the subscriber's cut-off relay and relay 22 are not energized. Relay 23, however, energizes and at armature 69 connects the busy tone to the calling subscriber's line by way of conductor 3. The calling subscriber will then replace his receiver and call again after an interval.

Returning now to when start relay 12 was energized in response to subscriber A initiating a call, said relay at armature 30 prepares the test circuit for relays 14 and 15, at armature 31 opens the start circuit extending to the next finder-connector link, at armature 33 prepares a circuit for relay 15, and at armature 32 closes a circuit extending from armature 43 and its resting contact for energizing the finder motor magnet 20. Magnet 20 energizes to position its pawl preparatory to stepping the wipers of the finder and near the end of its stroke closes armature 34 to complete a circuit for energizing relay 15 by way of armature 33. Relay 15 energizes and at armature 43 opens the circuit extending to magnet 20 which deenergizes and operates the wipers of the finder one step. The deenergization of magnet 20 also opens the circuit of relay 15 at armature 34, and the latter relay deenergizes to again close the circuit to the motor magnet. This interaction between relay 15 and magnet 20 continues until test wiper 9 encounters a calling battery potential. When wiper 9 reaches the contact marked with calling battery potential a circuit may be traced for holding relay 15 energized and for energizing relay 14 as follows: from ground by way of the upper winding of relay 15, normally closed springs controlled by armature 38, upper winding of two-step relay 14, armature 30, test wiper 9 and engaged bank contact, armature 6 and through the upper winding of cut-off relay 4, to battery. The relay 15 is held energized over this circuit in order to prevent the magnet from energizing to step the wipers another step. Cut-off relay 4 energizes in its second step over the above-traced circuit. Two-step relay 14 energizes in its first step over the above-traced circuit to close only armature 40, which completes a circuit for energizing slow-to-release relay 13 by way of the working contact of armature 43. Slow-to-release relay 13 at armature 37 removes one of the ground connections for shunting relay 23, at armature 36 prepares a point in the talking circuit as well as preparing a point in the impulsing circuit for relay 15, at armature 35 prepares a circuit for series relay 16, and at armature 34 grounds hold conductor 29 and completes a circuit through the lower winding of two-step relay 14 for energizing said relay through its second step to operate armatures 38, 39, 41, and 42. At the normally closed springs controlled by armature 38 relay 14 opens the test circuit including the upper windings of relays 14 and 15, but these relays do not deenergize at this time because relay 14 is held over its lower winding while the subscriber's calling loop is now connected in bridge

of both windings of relay 15 to prevent its deenergization. At armature 39 relay 14 grounds wiper 9 to fully energize cut-off relay 4 in its second step and to make this line busy to both finder and connector switches, at armature 41 and its resting contact opens the restoring circuit of the connector, and at its working contact prepares a point in the impulsing circuit to the connector motor magnet 21. At armature 42 relay 14 opens the circuit of start relay 12, which deenergizes after a short interval to close the start circuit to another finder-connector link at armature 31, to open the circuit to the finder magnet 20 at armature 32, and to open the circuit to the lower winding of relay 15 at armature 33. Cut-off relay 4, upon energizing in its second step, disconnects the line conductors 1 and 2 from the lower winding of relay 4 and from common line relay 22, which deenergizes in case no other subscriber is initiating a call.

All of the operations just described has taken place responsive to the subscriber at substation A removing his receiver, and at this time dial tone is transmitted from conductor 28, normal contact and wiper 60, resting contact of armature 51 and said armature, the condenser, and thence over the calling subscriber's loop in the well-known manner.

Subscriber A may now dial the number of the desired subscriber's line, in this case number 05, since subscriber A' is the desired subscriber and such subscriber's line terminates in the fifteenth set of bank contacts accessible to the connector wipers.

Subscriber A will therefore dial the digits "0" and "5". Responsive to the operation of the calling device CD at substation A for the first digit, the circuit extending to relay 15 is opened ten times to deenergize relay 15 a corresponding number of times. At each deenergization of relay 15 the circuit of slow-to-release relay 13 is momentarily opened at armature 43 and its working contact, but said relay, due to the copper sleeve around its relay core, maintains its armatures attracted during the impulsing period. Each time relay 15 deenergizes, a circuit may be traced from grounded armature 43 and its resting contact, armature 41 and its working contact, armature 53, armature 58, and through the winding of magnet 21 to battery for energizing magnet 21 to operate its pawl preparatory to stepping the wipers of the connector. A branch of the above-traced circuit extends by way of armature 35 to the lower winding of series relay 16 for energizing the latter relay. Relay 16 at armature 44 opens a point in the circuit of switching relay 19, at armature 45 prepares a point in the circuit of busy relay 18, at armature 46 closes a short circuit around its upper winding to make relay 16 slow to release and so that it will maintain its armatures attracted during the impulsing period, and at armature 47 prepares a new impulsing circuit for magnet 21 independent of armature 53 which may be operated by busy relay 18 operating in response to test wiper 61 passing over busy grounded contacts. After the first impulse line relay 15 reenergizes and opens the circuit of magnet 21 which releases and steps the wipers one step. The remaining impulses of the first digit operate the line relay 15 and magnet 21 in the manner set forth to position the wipers 60 to 63, inclusive, on the tenth set of bank contacts. Since these contacts are left dead the wipers merely come to rest thereon until the second digit is dialled.

Responsive to subscriber A dialling the second digit, or digit 5 in this case, line relay 15, series relay 16, and magnet 21 operate in the same manner as previously set forth to position the wipers on the fifteenth set of bank contacts, or the contacts terminating the line of substation A'.

Assuming that substation A' is busy, then wiper 61 will encounter a ground connection on the fifteenth bank contact placed thereon by a finder or connector of another finder connector link. In this case busy relay 18 is energized over a circuit extending from the busy grounded contact, wiper 61, armature 45 and its working contact, and through the winding of busy relay 18, to battery. Busy relay 18, upon energizing, at armature 52 prepares a locking circuit for itself, at armature 53 opens a point in the initial impulsing circuit to magnet 21, and at armature 51 completes a circuit for transmitting busy tone over the talking conductors and ring-back condenser RBC, to subscriber A. A short time after the transmission of the last digit, series relay 16 deenergizes, and at the normally closed contacts controlled by armature 45 completes the locking circuit of busy relay 18 as follows: from grounded conductor 29, armature 52 and its working contact, normally closed springs controlled by armature 45, and through the winding of relay 18, to battery. When subscriber A hears the busy tone such subscriber will replace the receiver and release the connection in the same manner as will be described hereinafter.

Assuming now that substation A' is idle instead of busy, then wiper 61 will not encounter a grounded contact, and, therefore, busy relay 18 will not be energized. Therefore, when relay 16 denenergizes after the impulsing period, a circuit may be traced for energizing switching relay 19 to close its armatures 55 and 56 and for energizing cut-off relay 64 in its first step to close armature 66 as follows: from grounded conductor 29, armature 52 and its resting contact, armature 44, lower winding of switching relay 19, resting contact of armature 59 and said armature, lower talking conductor, wiper 63, conductor 71, armature 67, and through the lower winding of cut-off relay 64, to battery.

Cut-off relay 64 closes only its contacts 66 and switching relay 19 is adjusted to close only its armatures 55 and 56 at this time. When relay 19 closes its armature 55 a circuit may be traced for energizing relay 64 in its second step as follows: from grounded conductor 29, armature 55, wiper 61 and engaged contact, armature 66 and through the upper winding of relay 64, to battery. Relay 64 is fully operated over this circuit to operate its armatures 65 and 67 to disconnect the line conductors 70 and 71 from start conductor 3 and the lower winding of relay 64. At armature 56 relay 19 closes a circuit from grounded conductor 29 through its upper winding for fully operating its remaining armatures. Relay 19, upon fully operating, at armature 57 opens a point in the restoring circuit of the connector, at armature 58 opens a point in the impulsing circuit to magnet 21, and at armatures 54 and 59 connects generator GEN to the called line as follows: from ground at armature 48, armature 54, wiper 60 and engaged bank contact, conductor 70, switchhook, condenser and ringer at substation A', conductor 71, wiper 63, armature 59 and its working contact, armature 50 and its resting contact, and through the lower winding of ring-cut-off relay 17 to interrupted generator GEN. When subscriber A' answers by removing

his receiver, the ring-cut-off relay 17 is energized over the substation loop and the circuit just traced. At armatures 48 and 50, relay 17 disconnects the ringing circuit and completes the talking circuit by way of the working contacts of armatures 48 and 50, and at armature 49 completes a locking circuit for itself to grounded conductor 29. The calling subscriber A and called subscriber A' are connected over the heavy talking conductors, each subscriber receiving talking battery from the windings of line relay 15.

After conversation and responsive to subscribers' A and A' replacing their receivers, line relay 15 deenergizes and at armature 43 opens the circuit of release relay 13, which deenergizes after a short interval. At armature 34 release relay 13 opens the locking circuits of relays 4, 14, 17, 19, and 64, and busy relay 18 in case of a busy call, whereupon said relays deenergize. A circuit may now be traced for restoring the wipers of the connector to normal as follows: from grounded armature 43 and its resting contact, armature 41 and its resting contact, multiplied contacts engaged by wiper 62 and said wiper, interrupter springs of magnet 21 and through the winding of magnet 21, to battery. Magnet 21 operates like a buzzer over the above-traced circuit until wiper 62 no longer engages a grounded contact, at which time the wipers of the connector stop and remain in normal position or the position shown in the drawing. The wipers of the finder remain in the positions last used, and, therefore, when the connector wipers reach their normal positions the finder-connector link is available for another call.

The operation of the finder-connector link for subscribers having telephone numbers 1 to 9, inclusive, is the same as that previously described with the exception that only one digit is dialled instead of two. In order to call a subscriber having telephone numbers from 001 to 004, inclusive, three digits are dialled by the calling subscriber to set the connector on dead bank contacts responsive to the first two digits, after which the last digit may be dialled to connect with the desired subscriber's line.

Having described the invention, what is considered to be new and is desired to have protected by Letters Patent will be set forth in the following claims:

What is claimed is:

1. In a telephone system, a link circuit comprising a finder switch and a connector switch, wipers on said switches, subscribers' lines accessible to said wipers, and means including a combined stepping, test, and line-pulsing relay for automatically stepping the wipers of the finder, for automatically stopping the wipers of the finder when the calling line is found, and for directive stepping the wipers of the connector to a desired called line.

2. In a telephone system, a link circuit comprising a finder switch and a connector switch, wipers on said switches, subscribers' lines accessible to said wipers, a relay in said link circuit, means for intermittently operating said relay to operate said finder wipers step-by-step in search of a calling line, a test circuit completed for maintaining said relay energized responsive to the finder wipers finding the calling line to prevent further operation of said finder wipers, and means for directive operating said relay to directive operate the connector wipers to a desired called line.

3. In a telephone system, a link circuit comprising a finder switch and a connector switch, wipers on said switches, subscribers' lines accessible to

said wipers, a motor magnet in said link for operating the wipers of said finder, a relay in said link circuit, means for energizing the finder magnet, means controlled by the energization of said
 5 finder magnet for energizing said relay, means controlled by the energization of said relay for deenergizing said magnet to step the finder wipers and to deenergize said relay whereby said magnet and relay intermittently operate to advance the
 10 wipers of the finders step by step in search of the calling line, a test circuit completed responsive to the wipers of the finder finding the calling line for maintaining said relay energized to maintain the wipers of the finder on the calling line, means
 15 operated responsive to the finder finding the calling line for connecting said relay in bridge of the calling line, subscriber-controlled means for thereafter directly operating said relay responsive to impulses transmitted over the calling line,
 20 and a motor magnet in said link circuit directly operated by said relay to step the wipers of the connector to a desired called line in response to said impulses.

4. In a telephone system, a switch having wipers, subscribers' lines each including a pair of
 25 talking conductors and a test conductor terminating in the banks of said switch, means for operating the wipers of said switch to engage the conductors of one of said subscriber's lines, a
 30 switching relay in said switch and a line cut-off relay individual to said subscriber's line partially operated over a circuit including one of the talking conductors of said subscriber's line in response to said engagement, contacts on said relays oper-
 35 ated responsive to the partial operation of said relays for closing circuits for fully operating said relays, the circuit for fully energizing said cut-off relay including the subscriber's test conductor, and other contacts on said relays operated in re-
 40 sponse to the full operation of said relays for completing a telephone connection to the subscriber over the subscriber's talking conductors.

5. In a telephone system, a switch having wipers, subscribers' lines each including a pair of
 45 talking conductors and a test conductor terminating in the banks of said switch, means for operating the wipers of said switch to engage the said conductors of a subscriber's line, means only partially operated over one of the talking con-
 50 ductors of said subscriber's line in response to said engagement for completing an operating circuit over said subscriber's test conductor, and said means thereafter fully operated over said test conductor to cause said switch to switch through
 55 and complete a connection to said subscriber's line.

6. In a telephone system, a switch having wipers, subscribers' lines each including a pair
 60 of talking conductors and a test conductor terminating in the banks of said switch, means for operating the wipers of said switch to engage the conductors of one of said subscribers' lines, a line cut-off relay individual to said subscriber's line
 65 partially operated over a circuit including one of the talking conductors of said subscriber's line in response to said engagement to connect said relay to said subscriber's test conductor, and means for thereafter fully operating said relay over a
 70 circuit including the test conductor of said subscriber's line.

7. In a telephone system, a link circuit comprising an automatically operated hunting finder switch and a directly operated connector switch, subscriber's lines each including a pair

of talking conductors and a test conductor terminating in the bank contacts of said connector switch, and straight multiple connections connecting the conductors of said subscribers' lines
 80 terminating in the bank contacts of said connector switch to corresponding bank contacts in said finder switch.

8. In a telephone system, a plurality of subscribers' lines, a plurality of finders having access
 85 to said subscribers' lines, a relay common to said lines and finders, a short circuit around said relay closed by each finder in normal position, means for removing said short circuit from around said relay only when all said finders are busy, means
 90 for thereafter energizing said relay responsive to one of said subscribers initiating a call at a time when all said finders are busy, and contacts on said relay for connecting a busy tone source to said calling line.

9. In a telephone system, a plurality of subscribers' lines, a plurality of finders having access
 95 to said lines, a relay common to said lines and finders normally inoperative as long as any one of said finders is idle, means for operating said relay in response to one of said subscribers initiating
 100 a call only in case all of said finders are busy, and contacts on said relay for connecting a busy tone source to said calling line.

10. In a telephone system, a plurality of subscribers' lines, a plurality of finders having access
 105 to said lines, a start relay, a busy relay, and a start conductor common to said lines and finders, said relays connected in a series circuit to said start conductor, means for energizing only said start relay over said conductor responsive to one
 110 of said subscribers initiating a call, means controlled by said start relay for starting an idle one of said finders to find the calling line, means for energizing only said busy relay over said conductor responsive to one of said subscribers
 115 initiating a call when all said finders are in use, and means controlled by said busy relay for connecting a busy tone source to said calling subscriber's line over said conductor.

11. In a telephone system, subscribers' lines, 120 switches for use by calling subscribers for extending a connection in the direction of a called line, other switches for use in completing connections to called lines, a pair of talking conductors and a test conductor for each subscriber's line
 125 terminating in the bank contacts of said other switches, and straight multiple connections connecting the conductors of said subscribers' lines terminating in the bank contacts of said other switches to corresponding bank contacts in said
 130 first switches.

12. In a telephone system, a non-numerical hunting switch, a directly operated connector switch, subscribers' lines each including a pair
 135 of talking conductors and a test conductor terminating in the bank contacts of said connector switch, and straight multiple connections connecting the conductors of said subscribers' lines terminating in the bank contacts of said connector switch to corresponding bank contacts in said
 140 non-numerical hunting switch.

13. In a telephone system, a plurality of link circuits each comprising a finder switch and a
 145 connector switch, a start relay individual to each finder switch, and a start circuit for each start relay including a wiper of the associated connector switch.

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