This invention relates in general to telephone systems and more particularly to switching systems therein. One of the earlier switches used in telephone, the plunger line switch, had the advantage of being associated with a particular subscriber line and was always standing opposite an idle trunk, thereby reducing to a minimum the time required to connect the calling line to a first numerical switch. However, the necessity for economy resulted in replacement of the line switch with a finder switch common to a group of lines, but the finders have had the disadvantage of a short time delay before connecting a calling line to a first numerical switch. The delay time was shortened somewhat by the use of double wipers hunting simultaneously over pairs of lines; but this resulted in the use of additional relays to prevent the finder from switching through to both of two calling lines, the time delay being dependent partly upon the operating time of said additional relays.

An object of this invention is to provide a new and novel switching system having means for more rapidly searching for and switching through to a desired line. A feature of this invention is the use of a new and novel finder-secondary switch link. A feature of this invention is the use of a new and novel switch of the type having a non-numerical or partially non-numerical function. Another feature is the use of a new and novel shunt-field driving magnet in a non-numerical or partially non-numerical switch. Another feature is the use of new and novel circuits with a shunt-field driving magnet. Another feature is the new and novel means for preventing the release of the cutoff relay of a busy line circuit until after the restoration of the switching relay of the finder to which said line circuit has been connected.

Further features of this invention will become evident upon a perusal of the following disclosure in which:

Fig. 1 shows a subsection of the line of circuit associated therewith and a finder having access thereto; Fig. 2 shows a secondary switch associated with the finder shown in Fig. 1; and Fig. 3 shows an allotment to which said finder and said secondary switch are available.

In the arrangement shown in the attached drawings, a shunt-field motor magnet with two windings and a single armature has been used for the first time in switches. A shunt-field relay has been previously used in conjunction with a driving magnet—e.g., the Martin Patent No. 1,564,487—but this resulted in a more expensive switch and in a slow operation of the switch. The present circuits have been arranged such that a magnet winding will be operated and the switching relay, associated therewith, short circuited if the test wiper associated with said winding and relay encounters ground. If said wiper encounters absence of ground, said relay will operate in series with said winding; but the winding will not operate. If both test wipers encounter absence of ground at the same time, that switching relay, which operates first, will open the operating circuit to the other relay to prevent its operation.

The shunt-field magnet will operate its armature to step the wipers only if both windings thereof are energized—as described in the Erickson Patent No. 1,544,300. It will be noted that the use of the shunt-field magnet need not be restricted to finders and secondary switches; rather it may be used in any non-numerical or partly non-numerical switch, such as an allotment or a selector, with variations in the circuits disclosed herein.

Off-normal springs 297, 298 and 299 are provided in the secondary switch to busy mark the link while it is in use and to cause the switch to return to home position when it is released. In this manner, the numerical switches accessible to the switch are taken into use in a definite order of priority. It may be of advantage, then, to make some of the selectors—those to be taken into use last—available from more than one group of lines, thereby to further reduce the number of selectors necessary in a system and increase the flexibility therein. A means, well known in the art, for kicking the allotter off a defective finder-secondary switch link is provided. When R330 operates in response to a call, it prepares at contacts 334 a circuit for operating kick-off relay R350. Timed impulses are received over conductors 398 and 399 from a timing device (not shown) common to all allotters. The first impulse received over conductor 399 after contacts 334 operate will operate R350. The next impulse received over conductor 396 and operated contacts 351 will operate M310 to step the allotter wipers to the next accessible link. This last impulse will shift short circuit R330; R330 will restore to open contacts 334;
R350 will restore; and R330 will reoperate when contacts 311 restore. Any one of several selectors well known in the art may be used with the switches disclosed herein—e.g. that shown in the Newsted Patent No. 2,529,409 which selector shall be used with respect to the description of the operation of the switches shown herein.

A more detailed description of the operation of the system will now be made. When a subscriber lifts the receiver at subscriber 100 a circuit, including said subscriber and the line associated therewith, for operating line relay R120 is completed. At contacts 121 and 22, R120 removes ground from test contact 121 and places thereon battery from cutoff relay R110; at contacts 123, busy marks the line to all connectors having access thereto; and at contacts 125, completes a circuit, including start lead 171, relay R330, the winding of the allotter motor M310 and its self-interrupting contacts 311, for operating the allotter start relay R330. M310, however, does not operate. Assume allotter 300 has preselected idle finder 102 and idle secondary switch 200. At contacts 335, R350 completes an obvious circuit for operating hold relay R340; at contacts 335, grounds the all trunks busy conductor 175, thereby to maintain all trunks busy relay R320 operated—even though all other finders are in use—until finder 102 and secondary switch 200 complete their operations; and at contacts 356, completes a circuit over conductor 281 for operating the second relay R320 for the finder-secondary link. Hold relay R340 operates and at contacts 343 and 344 places an alternate ground on conductors 173 and 281.

Link start relay R210 operates; contacts 215 and 216 operate faster than contacts 213 and 214 to assure the short circuiting of the switching relays R130 and R140 prior to the completion of their operating circuits if the lines, upon which the finder wipers are standing, are non-calling lines so that the finder cannot falsely switch through to a non-calling line; and contacts 224 and 225 operate faster than contacts 211 and 212 to similarly prevent the secondary switch from falsely switching through to a busy numerical switch. R210 completes a circuit over contacts 212, relay R350, contacts 235, 229 and 271 and magnet M270 for operating the secondary switching relay R250, a similar circuit for operating the secondary switching relay R259; a circuit over contacts 213, conductor 179, R130, and contacts 146 and 152 for operating the finder switching relay R130, a similar circuit for operating the finder switching relay R140, and a circuit over contacts 218 and conductor 174 to maintain the allotter start relay operated until the secondary switch switches through connections to an idle trunk, if the finder switches through to the calling line to remove ground from start lead 171 before the secondary switch completes its operation.

If the finder wipers are standing on lines other than the calling line and that line paired therewith, the test wipers 166 and 168 will encounter ground on the test contacts. (Note that, when line circuit 101 is idle, ground over contacts 114 and 122 is placed on test contact 165. When a call has been initiated over line circuit 101 and extended by finder 102, ground is placed on contact 166 over contacts 134 and wiper 166. If a call has been extended to line circuit 101 over a connector, test to ground is placed on contact 165 over private conductor 103 and contacts 124 and 113.) Ground over wiper 166, conductor 152, contacts 126, conductor 183 and contacts 156 and 146 will short circuit R130 before it can operate and will energize the upper winding of finder motor magnet M150. Similarly, ground over wiper 168 will short circuit R140 and energize the lower winding of M150. When both of said windings are energized the armature of M150 operates, self-interrupting contacts 151 and 152 operate to open the energizing circuits of both windings, the windings will deenergize, and the finder wipers will be advanced one step. If the wipers do not encounter the calling line circuit 101, R150 will again be operated similarly to again advance the wipers. This will continue until the finder wipers encounter line circuit 101.

If, when start relay R210 operated, the finder wipers 162, 164 and 166 had been standing on contacts 161, 163 and 165 or if, thereafter, said wipers are advanced to said contacts, ground will not be found on test contact 165; as a result thereof, the upper winding of M150 will not be energized sufficiently to cause an operation of the magnet armature; and switching relay R130 will operate in series with the upper winding of M150. At contacts 131 and 132, R130 extends the calling battery conductors 176 and 177 to the secondary switch; at contacts 133 prepares a circuit for holding itself operated after the restoration of start relay R210; at contacts 134, completes a circuit over wiper 166 and contacts 121 for operating the relay relay R130; at contacts 135, opens the circuit for operating switching relay R140; at contacts 136, opens its original circuit to wiper 166, thereby to prevent the winding of R130 from being short-circuited after it has operated; at contacts 138, prepares a circuit for guarding relay 172 for busy marking the finder-secondary link, and at contacts 139, removes ground from all trunks busy conductor 173. Similarly, if a calling line is encountered by wipers 168, 169 and 170, switching relay R140 instead of R130 will operate and at its contacts 141 and 142 extend said last-mentioned calling line to secondary switch 200.

If said wipers encounter two calling lines simultaneously, whichever switching relay operates first will open the circuit for operating the other, thereby to prevent its operation. (It will be noted that the cutoff relays—e.g. R110—have high resistance windings so that a switching relay connected thereto—e.g. R131 and contacts 136, conductor 183, contact 216, conductor 182 and contacts 121—will not operate.) If it should happen that both switching relays operate simultaneously each of said relays will open the operating circuit of the other; and both will begin to de-energize. In practice, it has been found that only one of said switching relays will switch through connections from a calling line to secondary switch 200. When cutoff relay R110 operates in response to the operation of switching relay R130, it opens contacts 111 and 112 to restore the line relay R120 and locks itself operated over contacts 113 to prevent its restoration when R120 restores to open contacts 121. R120 restores to remove its ground at contacts 125 from the allotter start lead 171. The line is busy marked in the connector banks by ground over contacts 134, wiper 166, contacts 113 and restored contacts 124. If finder 162 switches through to the calling line before secondary switch 200 finds and switches through to an idle selector, and if no other call has been initiated in the meantime, ground will have been removed from start conductor 171; but start relay R330 will be maintained operated over a circuit including contacts 218, 238 and 255 and hold conductor 174. This circuit will be opened to cause R330 to restore only after one of the switching relays—R220 or R250—operate to open contacts 238 or 258. Therefore allotter 300 will not be moved from a finder-secondary link until after both switches have completed their functions.

As previously described, circuits for operating the switching relays R230 and R250 of secondary switch 200 are completed in response to operating the start relay R210. The private contacts of the selectors connected to secondary switch 200—e.g. contacts 293 and 295—will be marked with a ground potential if busy and an
absence of ground condition if idle. Secondary switch 200 will hunt for an idle selector and switch through connections to only one idle selector in a manner similar to that in which finder 102 hunts and switches through to one calling line as previously described.

Therefore, only if ground potential is encountered by wipers 294 and 296 on both of the pair of contacts they seize, will both windings of motor magnet M270 energize to advance the wipers one step—the upper winding of M270 being energized over a circuit extending from the ground wire 294 over contacts 224, 225, 225 and 226 to said upper winding and the lower winding of M270 being energized over a circuit extending from the grounded wire 296 over contacts 225, 226, 256 and 222 to said lower winding.

When an absence of ground condition is encountered by one or both of said secondary switch wipers—a. g. 296—the winding associated therewith will not be fully energized, the magnet will not operate, and the switching relay—e. g. R230—associated therewith will operate to switch through connections to the selector associated with said absence of ground condition.

Assuming that a call is initiated from substation 100, that finder 102 by means of R230 extends the line associated therewith to secondary switch 200 by way of conductors 176 and 177 and that switching relay R230 switches through contacts 224, 225, 225 and 226 to said upper winding and the selector associated with said absence of ground condition.

When R230 operated it opened contacts 238 to remove ground potential from the hold conductor 174. Ground over contacts 200 and 239, conductor 184, contacts 138, guard conductor 172 and contacts 341 energize the allotter motor magnet M310. If no other call is waiting, the allotter motor switches to remove ground from start conductor 171, start relay R330 restores. R340 will restore in response to the restoration of R330; M310 will restore to advance the allotter one step, thereby to preselect the next accessible finder. If said next finder is busy, ground over its guard conductor and contacts 331, 321 and 320 will energize M310, and self-interrupting contacts 311 will restore M310 to advance the allotter wipers to the next finder. In this manner, allotter 300 will preselect an idle finder. If all finders are busy, normally operated relay R320 will restore to open contacts 321 thereby to prevent needless operation of the allotter.

When relay R310 and secondary switch 200 extended the line associated with substation 100, another call was waiting on a line associated with allotter 300, ground will be maintained on conductor 171 after R120 restores by way of contacts—corresponding to 125—on the line relay associated with said last-mentioned line. R330 will still restore since its operating circuit will be opened at contacts 311 when M310 energizes, and M310 will restore when R340 restores to advance the allotter wipers as previously described. When an idle finder is found, it will be taken into use to extend said other call.

When relays R30 and R230 operate, they remove at contacts 130 and 240 multiple ground potentials from the all tracks busy conductor 173. After the calling line has been extended to an idle selector by finder 102 and switch 200, connections to a called line are completed over a switch train in a manner well known in the art. Holding ground for the switching relays R130 and R230 is provided from the connector in the switch train. When the call is termi-
It operated to operate one of said relays if the wiper set connected thereto encounters a condition other than said particular potential condition.

5. In a switch as claimed in claim 4, means operated and effective for preventing the operation of one of said relays when both wiper sets encounter conditions other than said particular condition on a pair of lines.

6. In a telephone system having a plurality of pairs of lines and a potential condition normally connected to each of said lines, a calling one of said lines; means for changing the potential condition associated with said calling line; a finder switch with two sets of wipers having access to said pairs of lines, said finder comprising a magnet with two windings and a single armature, each of said windings corresponding to one set of said wipers; a switching relay corresponding to each set of said wipers; means for connecting said windings and said relays to the wiper sets corresponding thereto; circuit means operated and effective in response to either set of said wipers encountering a condition other than said normal potential condition for operating the relay connected thereto and operated and effective in response to either set of said wipers encountering a non-calling line; armature-controlled means operated and effective only in response to energization of both windings for advancing the wipers one step, the wipers thereby being advanced when the wipers encounter a pair of idle lines and being stopped when only one of said windings is energized; and contacts operated in response to the operation of the switching relay connected to said one set of wipers for switching through connections to said calling line.

7. In a combination as claimed in claim 6, said finder also comprising means operated in response to said wipers encountering a pair of calling lines for preventing the operation of one of said switching relays, whereby connections are switched through to only one of said pair of calling lines.

8. For use in a telephone system having a plurality of pairs of lines and having one potential condition connected to some of said lines, a switch with two test wipers for simultaneously testing pairs of lines for said conditions, said switch comprising a magnet with two windings and a single armature; a switching relay connected to each of said windings; circuits including the winding of each one of said relays and the magnet winding connected thereto for operating each relay; means for completing both of said circuits and for connecting each of said test wipers to one of said circuits at the relay and magnet winding wherein; said one potential encountered by a test wiper energizing the magnet winding connected thereto and preventing an operation of the relay connected thereto; armature-controlled means operated only in response to the energization of both magnet windings for advancing the wipers one step to the next pair of lines, said wipers thereby advancing each time both of said test wipers encounter said one potential condition on a pair of lines and stopping when one of said test wipers encounters a condition other than said one potential condition at which time the switching relay connected to said last mentioned test wiper operates over its operating circuit.

9. In a switch as claimed in claim 8, means operated in response to both of said test wipers encountering a condition other than said one potential condition for preventing the operation of one of said switching relays.

10. In a telephone system having a plurality of pairs of subscriber lines over which calls are made, a finder switch having two sets of wipers having access to said pairs of lines; a secondary switch, connected to said finder switch, having two sets of wipers; a plurality of pairs of trunks accessible to said secondary wipers; each of said switches including a motor magnet having two windings and a single armature and each including two switching relays; means for connecting each wiper set to a corresponding relay and winding; circuit means operated and effective in response to the initiation of a call for energizing each winding of the finder magnet whenever the finder wiper set connected thereto encounters a non-calling line; means also operated and effective in response to the initiation of said call for energizing each winding of the secondary magnet whenever the secondary wiper set connected thereto encounters a busy trunk; armature-controlled means in each of said switches operated and effective only to the energization of both magneto windings therein for advancing said wiper sets therein one step, said further wipers advancing only when a pair of non-calling lines are encountered and said secondary wipers advancing only when a pair of busy trunks are encountered; circuit means operated and effective in response to one of said finder wiper sets encountering said calling line for operating the finder switching relay connected thereto; and means operated and effective in response to one of said secondary wiper sets encountering an idle one of said trunks for operating the secondary switching relay connected thereto; and contacts on said operated finder and secondary switching relays operated for connecting said calling line to said one idle trunk by way of the wiper sets connected thereto.

11. In a combination as claimed in claim 10, means responsive to said finder wiper sets encountering a pair of calling lines for operating only one of said finder switching relays and means responsive to said secondary wiper sets encountering a pair of idle trunks for operating only one of said secondary switching relays.

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