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RALPH E. HERSEY, OF BROOKLYN, NEW YORK, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

TELEPHONE SYSTEM

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This invention relates to telephone systems and has for its object to facilitate the supervision of the service supplied by a group of instrumentalities.

More specifically the invention relates to means for giving an alarm whenever more than a certain number of demands have been made on a particular group of instrumentalities and remain unsatisfied, together with means to change the critical number when desired.

This invention has been specifically embodied in connection with the equipment provided at a panel machine switching office whereby an incoming or "B" operator may complete connections incoming from manual offices. Such an arrangement is disclosed in Patent No. 1,753,348, issued April 8, 1930, to J. B. Newsom. It comprises trunks incoming from a manual office which terminate in selectors, and link circuits which connect with the incoming trunk, find an idle operator and an idle sender and associate them in the proper sequence. During busy hours or during the night when the operating force is reduced, the calls may come in more rapidly than the operators can attend to them, at which time the links associated therewith will be arrested waiting for an idle operator. If such a condition arises often it is desirable to detect it in order that additional operators' positions may be placed in service for maintaining adequate service. To accomplish this, whenever a link is waiting for an idle operator, battery through a high resistance is connected to a lead extending to the arrangement of the present invention. This arrangement comprises a marginal relay and an interrupter for completing the circuit of the relay at predetermined intervals. The marginal relay is so adjusted that it will operate only if a predetermined number of link circuits are waiting for an operator. Since such a condition may occur momentarily without indicating slow service, this marginal relay controls a second relay through another interrupter which closes its contact at half minute intervals. If the condition continues so as to operate this other relay, an alarm is sounded to call attention to the fact

that the service is inadequate. By means of a key, a resistance may be connected in parallel with the winding of the marginal relay thus increasing the critical number of waiting links. In addition, if all of the operators' positions are busy the circuit of the position finder switch of each waiting link will be held open until a position becomes idle.

The object of the invention will be more clearly understood from a consideration of the following description in connection with the drawing, which shows portions of a number of link circuits and position equipments together with the equipment forming the subject of the invention.

As set forth in the above mentioned patent to J. B. Newsom when a call is to be extended to a subscriber in a dial office under the control of a B operator at that office, the seizure of a trunk by an operator at the manual office initiates the operation of a link circuit at the dial office and causes the advance of the link circuit sequence switch from position 1 to position 2. In position 2 the trunk finder of the link is operated to connect the link with the trunk which has been seized, and the finding of the trunk advances the sequence switch to position 3. In both positions 2 and 3 circuits are provided for hunting for and seizing an idle operator's position and the finding of the position advances the sequence switch to position 4 and connects the position equipment with the trunk. Subsequently, an idle sender is associated with the link, the sender is set under the control of the position equipment, the position equipment is disconnected from the link, and the sender controls the selector in which the trunk terminates and a final selector to select the wanted line. As soon as the line has been found the link and sender are disconnected from the trunk and the connection is placed under the control of the operator at the manual office.

Referring now more particularly to the drawing, there is shown portions of link circuits A, B, C, D, E, and F. There are also shown portions of two operators' positions M and N and the common equipment for carrying out the present invention. The numerals

employed on the drawing are the same as employed in the above identified Newsom patent with the addition of letter suffixes where the same apparatus is shown as it occurs in different link or position circuits. The numbers applied to common apparatus below the broken lines apply only to the present disclosure.

Referring first to link A, when the sequence switch 400 arrives in position 2, a circuit is closed from ground, over the contact of cam 432, left back contact of relay 514, winding of relay 513 to battery. Relay 513 in operating closes a circuit from battery, through the winding of relay 507, back contact of magnet 508, upper contact of cam 434, left front contact of relay 513, right back contact of relay 514, left back contact of relay 509 to ground. Relay 507 operates closing a circuit from battery, through the winding of magnet 508, left front contact of relay 507, lower contact of cam 434, left front contact of relay 513, right back contact of relay 514, left back contact of relay 509 to ground. Magnet 508 operates in this circuit in turn opening the circuit of relay 507 and relay 507 and magnet 508 operate and release, advancing switch 500 from position to position until an idle operator's position is found.

When a position such as position M is occupied as indicated by the insertion of the telephone plug in the jack of the position, a circuit is closed from ground over the right winding of repeating coil 609—M, jack 605—M, plug 606—M, through the receiver of the head set 600—M, plug 607—M, Jack 608—M, winding of relay 604—M to battery. Relay 604—M when operated connects battery over its inner contact, the inner left back contact of relay 602—M, resistance 601—M, to the corresponding terminal in the bank served by brush 503. When the position is vacant this battery is removed from the terminal by the unoperated condition of relay 604—M. Similarly, if the position is busy the operation of relay 602—M will open this circuit and disconnect the battery.

In order to test for an idle position, relay 513 closes one circuit and prepares a second. The first circuit may be traced from battery through the middle winding of relay 514, contacts of cam 452, left winding of relay 514, right front contact of relay 513, contact of cam 432 to ground. Relay 514 does not operate in this circuit but is rendered quick to operate when the test circuit is closed. The second or test circuit extends from ground over cam 432, right front contact of relay 513, left winding of relay 514, right winding of relay 514, lower contact of cam 433 to brush 503. When brush 503 encounters battery indicating an idle position, this test circuit is completed and relay 514 operates, locking through its middle winding and right front contact to ground at the left back contact of

relay 509. It also connects ground through its right winding to brush 503, lowering the potential of the terminal of brush 503 so as to mark the position busy to any other position finders which may be hunting at the time. Relay 514 in operating closes a circuit from battery, through the winding of relay 437, left front contact of relay 514, contact of cam 432 to ground. Relay 437 operates and closes a circuit from ground, through the winding of relay 438, left contacts of relay 437, brush 505 to the terminal corresponding to position M, winding of relay 610—M to battery. Relay 438 is marginal and does not operate but relay 610—M does operate completing a circuit from battery, over the inner contact of relay 604—M, front contact of relay 610—M, winding of relay 602—M to the terminal of brush 504.

Relay 437 also closes a circuit from battery, through the winding of sequence switch magnet 400, right front contact of relay 437, to ground over cam 408, advancing sequence switch 400 to position 4. As soon as sequence switch 400 reaches position 3 $\frac{3}{4}$, the circuit above traced for relay 602—M is completed at the contact of cam 440 and relay 602—M operates disconnecting battery from the terminal of brush 503. Relay 437 also connects the operator's telephone to the trunk over circuits not shown.

While sequence switch 400 is standing in position 3 a circuit is closed from battery, resistance 495—A, contact of cam 486—A to conductor 521. This circuit extends over the contact of key 120, through the winding of relay 121, and when interrupter 122 closes its lower contact to ground over the interrupter. Relay 121 is marginal and will not operate in series with resistance 495—A. If link B should be hunting for an idle position and have its sequence switch standing in position 3 also, it will connect battery to conductor 521 through resistance 495—B in parallel with resistance 495—A. The resistance in series with the relay 121 under these circumstances will be one-half what it was when link A alone was hunting. Similarly, if links A, B and C should all hunt simultaneously, the resistance in series with relay 121 would be one-third that of a single link. In the system on which the present disclosure is based, relay 121 is so adjusted that it will operate only if four links simultaneously stand in position 3 and the resistance in series with it is one-fourth that of a single link.

Assume that such a condition has arisen and that relay 121 operated at the closure of the lower contact of interrupter 122. Very shortly after interrupter 122 closes its lower contact, it closes both its upper and lower contacts, completing a circuit from ground over the interrupter contacts, front contact of relay 121, winding of relay 124, resistance

123 to battery. Relay 124 locks over its inner left contact to ground. After a short measured interval interrupter 122 first opens the circuit of relay 124 and then that of relay 121. Relay 121 releases, but relay 124 remains locked. Approximately two seconds later interrupter 122 recloses its lower contact. If relay 121 is again operated at this closure, relay 124 remains operated. If, however, at this time the number of links in position 3 is less than 4 and relay 121 does not reoperate, a circuit is closed when the upper contact closes from ground, over the contacts of interrupter 122, back contact of relay 121, resistance 123 to battery, shunting relay 124 and causing it to release.

The operation of relay 124 connects ground over its outer contact to interrupter 125. If the condition continues until interrupter 125 closes its lower contact, a circuit will be closed thereover to the winding of relay 126 and battery. Relay 126 locks over its right contact to the contact of relay 124. Approximately half a minute later, interrupter 125 closes its upper contact. If relay 124 has remained operated throughout that interval so that relay 126 also remains operated, a circuit is closed from battery, through the winding of relay 127, contact of relay 126, upper contact of interrupter 125, to ground at the front contact of relay 124. Relay 127 also locks to the contact of relay 124. At its inner left contact relay 127 lights lamp 128 and at its outer left contact operates buzzer 129 over key 130. The person in charge of the office will then know that the number of operators' positions occupied is inadequate for the traffic and may take steps to remedy the condition. As soon as the condition ceases relay 121 fails to operate, relay 124 is shunted and released and the locking circuits of relays 126 and 127 are opened, extinguishing the lamp and silencing the buzzer. The buzzer may also be silenced by operating key 130.

The operation of key 132 connects resistance 133 in parallel with relay 121, thus increasing the margin of that relay so that the number of calls required to operate the relay is increased. In the system upon which the present disclosure is based the increase was from 4 to 7. The milliammeter 131 may be used to check the number of calls waiting where they are less than the number necessary to operate the alarm or after the operation of the alarm to ascertain the actual number waiting. The resistances are so proportioned to the battery voltage as to permit a flow of .01 ampere for each circuit standing in position 3. For example, if the battery voltage is 50, resistance 495—A will be 5,000 ohms, and the current flow will be .01 ampere. If a second resistance, for example, 495—B, is connected in parallel therewith, the effective resistance will be 2,500

ohms and the current flow will be .02 ampere, etc. If the current flow in this circuit becomes excessive the fuse 134 will open to operate buzzer 129. In that case, operating key 130 will fail to silence the buzzer and indicate a fuse failure.

It will be noted that the operation of relay 604—M, 604—N, etc., in any position due to the presence of an operator at that position connects ground over its middle contact to conductor 642, holding relay 110 operated. When an operator vacates her position, one operating ground for relay 110 is removed. Only if all positions are vacated, which may occur during the night, is relay 110 released. Similarly, when position M is occupied and idle, ground will be connected over the outer front contact of relay 604—M, and the outer back contact of relay 602—M to conductor 643 holding relay 100 operated. As each position becomes busy, the corresponding ground is disconnected from conductor 643 and if all positions become busy, relay 100 releases. Likewise if all positions become vacant, relay 100 releases. The release of relay 100 closes a circuit for relay 101 which operates, connecting ground over the winding of relay 111 to conductors 520—A, 520—B and so on. If, now, a call is extended to a trunk at this office, assuming that link A is used, sequence switch 400 advances to position 2 in the usual manner. As soon as it reaches position 2, a circuit is closed from battery, through resistance 519, winding of relay 509, contact of cam 487—A, conductor 520—A, front contact of relay 101, winding of relay 111 to ground. Relays 111 and 509 operate in this circuit and relay 509 removes ground from the circuit of relay 507 preventing the position finder from hunting until there is an idle position to be found. If relay 110 is also released, because all positions are vacant rather than busy, a circuit is closed from ground over the back contact of relay 110, front contact of relay 111 to ringer 112 and a source of ringing current, to warn the attendant that a call is awaiting attention. The operator may then insert her telephone in any convenient position jack, operating relays 100 and 110, silencing the ringer, releasing relay 509 and permitting the position finder 500 to extend the connection to her position.

It will be apparent that these circuits form a convenient and accurate check upon the efficiency of the service given.

What is claimed is:

1. In an electrical system, a plurality of similar elements, means to cause said elements to assume a plurality of different conditions, a circuit closed under the control of each of said elements when in a predetermined condition, and means responsive to the simultaneous closure of said circuit by a predeter-

mined number of said elements to sound an alarm.

2. In an electrical system, a plurality of circuit elements, means to operate each element through a plurality of different stages, means to indicate when each of said elements passes through a particular stage and means for sounding an alarm when a predetermined number of said indications occur simultaneously.

3. In an electrical system, a plurality of switches, means to operate each of said switches through a plurality of positions, means to indicate when each of said switches is in a particular position and means for sounding an alarm when a predetermined number of said switches are simultaneously in the same position.

4. In a switching system, a plurality of hunting switches, a plurality of elements accessible to said switches, means to mark said elements as selectable or non-selectable, means to cause said switches to hunt for a selectable element, and means to indicate when a predetermined number of said switches are hunting for selectable elements at the same time.

5. In a switching system, a plurality of hunting switches, a plurality of elements accessible to said switches, means to mark said elements as selectable or non-selectable, means to cause said switches to hunt for a selectable element, and means responsive when a predetermined number of said switches hunt for selectable elements simultaneously for more than a predetermined length of time to sound an alarm.

6. In a switching system, a plurality of hunting switches, a plurality of elements accessible to said switches, means to mark said elements as selectable or non-selectable, means to cause said switches to hunt for a selectable element, means responsive when a predetermined number of said switches hunt for selectable elements simultaneously for more than a predetermined length of time to sound an alarm, and means to render said alarm responsive when a different predetermined number of said switches hunt simultaneously.

7. In a switching system, a plurality of hunting switches, a plurality of elements accessible to said switches, means to mark said elements as selectable or non-selectable, means to cause said switches to hunt for a selectable element, an alarm, and means to sound said alarm when a predetermined number of said switches are hunting for selectable elements at the same time comprising a marginal relay, an interrupter and a circuit for said relay controlled by said switches and said interrupter.

8. In a switching system, a plurality of hunting switches, a plurality of elements accessible to said switches, means to mark said elements as selectable or non-selectable, means to cause said switches to hunt for a selectable

element, an alarm, and means responsive when a predetermined number of said switches hunt for selectable elements simultaneously for more than a predetermined length of time to sound said alarm, comprising a marginal relay, a first interrupter, circuits for said relay controlled by said switches and said interrupter, a second interrupter, and a circuit for said alarm controlled by said marginal relay and said second interrupter.

9. In an electrical system, a plurality of elements each having a plurality of possible conditions, and means for sounding an alarm when a predetermined number of said elements are simultaneously in the same predetermined condition comprising a marginal relay operable through a resistance of not more than a predetermined value, parallel circuits for said relay each containing a resistance having a value which is a multiple of said predetermined value closed by said elements when in said predetermined condition and an alarm responsive to said marginal relay.

10. In an electrical system, a plurality of elements each having a plurality of possible conditions, a marginal relay operable only through a resistance of not more than a predetermined value, parallel circuits for said relay extending to each of said elements, a resistance individual to each element of a value which is a multiple of said predetermined value, means in each element to connect said resistance in series with said relay over one of said parallel circuits when said element is in a predetermined condition, and means to complete the circuit of said relay, said means being effective to operate said relay only if a sufficient number of said elements are in said predetermined condition to reduce the resistance in series with said relay below said predetermined value.

11. In a telephone system, a plurality of link circuits, a plurality of operators' positions, means responsive to the extension of calls to said link circuits to cause said link circuits to hunt for operators' positions, means to render said operators' positions non-selectable when busy or vacant, a sequence switch associated with each link circuit, means effective to hold said sequence switch in a particular position until an idle operator's position has been found, and means effective if more than a predetermined number of said sequence switches are simultaneously in said particular position to sound an alarm.

12. In a switching system, a plurality of hunting switches, a plurality of elements accessible to said switches, means to mark said elements as selectable or non-selectable, means to cause said switches to hunt for a selectable element, an alarm, and means responsive when a predetermined number of said

switches hunt for selectable elements simultaneously for more than a predetermined length of time to sound said alarm, comprising a marginal relay, parallel circuits for said relay, each controlled by one of said switches and each containing a predetermined resistance, and an interrupter for completing the circuit of said relay.

13. In a switching system, a plurality of hunting switches, a plurality of elements accessible to said switches, means to mark said elements as selectable or non-selectable, means to cause said switches to hunt for a selectable element, an alarm, and means to sound said alarm when a predetermined number of said switches are hunting for selectable elements at the same time comprising a marginal relay, an interrupter, circuits for said relay controlled by said switches and said interrupter, and means to render said alarm responsive when a different predetermined number of said switches hunt simultaneously.

14. In a telephone system, a plurality of link circuits, a plurality of operators' positions, means responsive to the extension of calls to said link circuits to cause said link circuits to hunt for operators' positions, means to render said operators' positions non-selectable when busy or vacant, a sequence switch associated with each link circuit, means effective to hold said sequence switch in a particular position until an idle operator's position has been found, and means effective if more than a predetermined number of said sequence switches are simultaneously in said particular position to sound an alarm, said means comprising resistances connected by each of said sequence switches in parallel with each other and a relay in series with said resistances operable only through said predetermined number of resistances.

15. In a telephone system, a plurality of link circuits, a plurality of operators' positions, means responsive to the extension of calls to said link circuits to cause said link circuits to hunt for operators' positions, means to render said operators' positions non-selectable when busy or vacant, a sequence switch associated with each link circuit, means effective to hold said sequence switch in a particular position until an idle operator's position has been found, and means effective if more than a predetermined number of said sequence switches are simultaneously in said particular position to sound an alarm, said means comprising resistances connected by each of said sequence switches in parallel with each other and a relay in series with said resistances operable only through said predetermined number of resistances, and means to render said alarm effective when a different predetermined number of said sequence switches are simultane-

ously in said particular position comprising a key-controlled shunt for said relay.

16. In a switching system, a plurality of hunting switches, a plurality of elements accessible to said switches, means to mark said elements as selectable or non-selectable, means to cause said switches to hunt for a selectable element, an alarm, and means to sound said alarm when a predetermined number of said switches are hunting for selectable elements at the same time comprising a marginal relay, an interrupter, circuits for said relay controlled by said switches and said interrupter, and means to render said alarm responsive when a different predetermined number of said switches hunt simultaneously comprising a key-controlled shunt for said relay.

17. In a switching system, a plurality of hunting switches, a plurality of elements accessible to said switches, means to mark said elements as selectable or non-selectable, means to operate each of said switches to hunt for a selectable element, means to disable said operating means if all of said elements are non-selectable, and means to indicate when a predetermined number of said operating means are disabled.

18. In a switching system, a plurality of elements, means for marking said elements as selectable or non-selectable, a switch, means to operate said switch to select one of said elements, and means individual to said switch to disable said operating means if all of said elements are non-selectable.

19. In a telephone system, a plurality of operators' positions, means to mark said positions as busy or idle, a switch for selecting an operator's position, and means to operate said switch to hunt for an idle operator's position, and means to disable said operating means if all of said positions are busy.

20. In a telephone system, a plurality of operators' positions, means to mark said positions selectable only when occupied and idle, a switch for selecting an operator's position, means to operate said switch to hunt for a selectable position, means to disable said operating means, and means to operate said disabling means if all of said positions are non-selectable, said last means being effective whether said positions are rendered non-selectable by being busy or by being unoccupied.

21. In a telephone system, a link circuit, a finder switch individual to said link circuit, a plurality of operators' positions, means to mark said positions as busy or idle, means for operating said finder switch to hunt for an idle operator's position, means to disable said operating means, and means to operate said disabling means if all of said positions are busy, said last means being effective only during the time said operating means is effective.

22. In a telephone system, a link circuit, a sequence switch individual to said link circuit, a finder switch individual to said link circuit, a plurality of operators' positions, 5 means to mark said positions as busy or idle, means effective in a particular position of said sequence switch to operate said finder switch to hunt for an idle operator's position, means to disable said operating means, 10 means to operate said disabling means if all of said positions are busy, said last means being effective only if said sequence switch is in said particular position.

23. In a telephone system, a plurality of 15 link circuits, a sequence switch individual to each link circuit, a plurality of operators' positions, means to mark said positions as busy or idle, means effective in a particular position of each sequence switch to operate 20 the corresponding finder switch to hunt for an idle operator's position, means individual to each switch to disable said operating means, means to operate said disabling means if all of said operators' positions are busy, 25 said last means being effective on the disabling means of those link circuits only whose sequence switches are standing in said particular position.

In witness whereof, I hereunto subscribe 30 my name this 7th day of June, 1928.

RALPH E. HERSEY.

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DISCLAIMER

1,792,538.—*Ralph E. Hersey*, Brooklyn, N. Y. TELEPHONE SYSTEM. Patent dated February 17, 1931. Disclaimer filed March 22, 1932, by the assignee, *Bell Telephone Laboratories, Incorporated*.

Hereby enters this disclaimer to the said claims of said Letters Patent which are in the following words to wit:

"1. In an electrical system, a plurality of similar elements, means to cause said elements to assume a plurality of different conditions, a circuit closed under the control of each of said elements when in a predetermined condition, and means responsive to the simultaneous closure of said circuit by a predetermined number of said elements to sound an alarm."

"4. In a switching system, a plurality of hunting switches, a plurality of elements accessible to said switches, means to mark said elements as selectable or non-selectable, means to cause said switches to hunt for a selectable element, and means to indicate when a predetermined number of said switches are hunting for selectable elements at the same time.

"5. In a switching system, a plurality of hunting switches, a plurality of elements accessible to said switches, means to mark said elements as selectable or non-selectable, means to cause said switches to hunt for a selectable element, and means responsive when a predetermined number of said switches hunt for selectable elements simultaneously for more than a predetermined length of time to sound an alarm."

"7. In a switching system, a plurality of hunting switches, a plurality of elements accessible to said switches, means to mark said elements as selectable or non-selectable, means to cause said switches to hunt for a selectable element, an alarm, and means to sound said alarm when a predetermined number of said switches are hunting for selectable elements at the same time comprising a marginal relay, an interrupter and a circuit for said relay controlled by said switches and said interrupter.

"8. In a switching system, a plurality of hunting switches, a plurality of elements accessible to said switches, means to mark said elements as selectable or non-selectable, means to cause said switches to hunt for a selectable element, an alarm, and means responsive when a predetermined number of said switches hunt for selectable elements simultaneously for more than a predetermined length of time to sound said alarm, comprising a marginal relay, a first interrupter, circuits for said relay controlled by said switches and said interrupter, a second interrupter, and a circuit for said alarm controlled by said marginal relay and said second interrupter.

"9. In an electrical system, a plurality of elements, each having a plurality of possible conditions, and means for sounding an alarm when a predetermined number of said elements are simultaneously in the same predetermined condition comprising a marginal relay operable through a resistance of not more than a predetermined value, parallel circuits for said relay each containing a resistance having a value which is a multiple of said predetermined value closed by said elements when in said predetermined condition and an alarm responsive to said marginal relay."

"18. In a switching system, a plurality of elements, means for marking said elements as selectable or non-selectable, a switch, means to operate said switch to select one of said elements, and means individual to said switch to disable said operating means if all of said elements are non-selectable."

[*Official Gazette April 12, 1932.*]