

June 11, 1929.

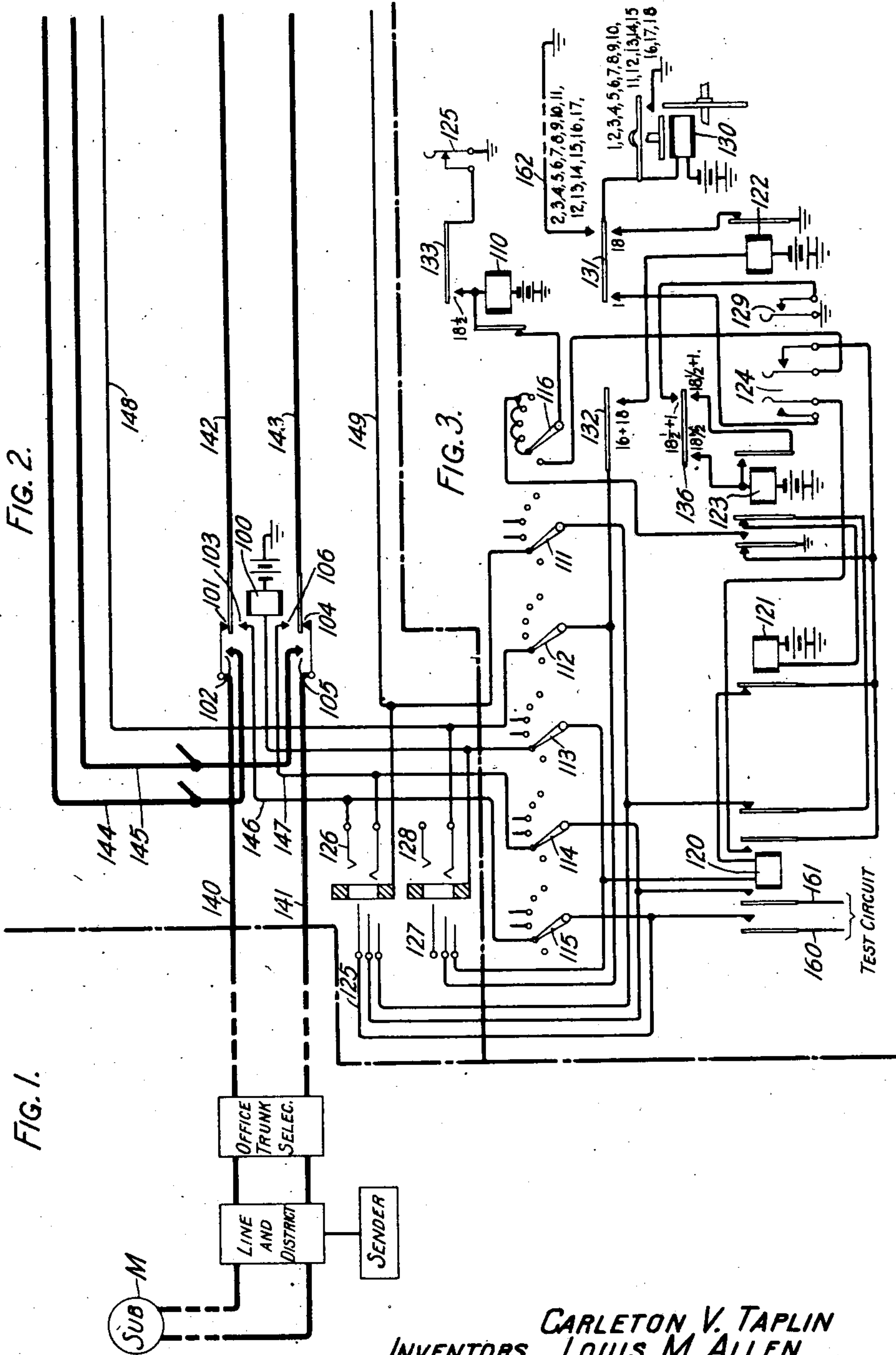
C. V. TAPLIN ET AL

1,717,074

TELEPHONE EXCHANGE MAINTENANCE SYSTEM

Filed Aug. 22, 1927

2 Sheets-Sheet 1



CARLETON V. TAPLIN
INVENTORS LOUIS M. ALLEN
ARNOLD S. BERTELS
By *E. W. Adams*
ATTORNEY

June 11, 1929.

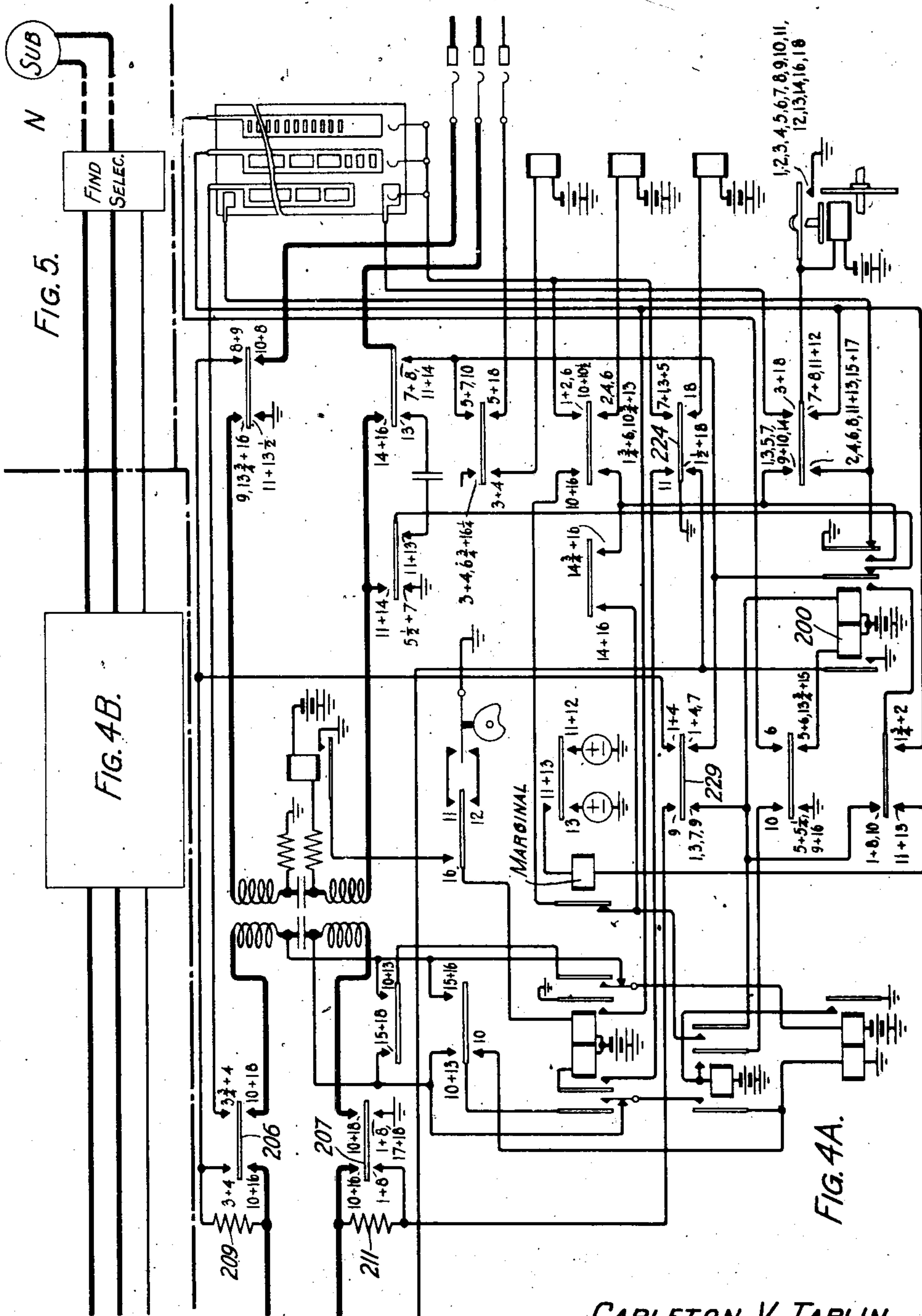
C. V. TAPLIN ET AL

1,717,074

TELEPHONE EXCHANGE MAINTENANCE SYSTEM

Filed Aug. 22, 1927

2 Sheets-Sheet 2



CARLETON V. TAPLIN
INVENTORS LOUIS M. ALLEN
ARNOLD S. BERTELS
BY *E. W. Adams*
ATTORNEY

UNITED STATES PATENT OFFICE.

CARLETON V. TAPLIN, OF EAST ORANGE, NEW JERSEY, LOUIS M. ALLEN, OF NEW YORK, N. Y., AND ARNOLD S. BERTELS, OF TENAFLY, NEW JERSEY; SAID TAPLIN ASSIGNOR TO THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK, AND SAID ALLEN AND BERTELS ASSIGNORS TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE MAINTENANCE SYSTEM.

Application filed August 22, 1927. Serial No. 214,520.

The present invention relates to maintenance systems in an automatic telephone exchange. More specifically, it relates to a maintenance system for automatic switches in one office connected over two conductor trunks to a distant office.

In multi-office automatic telephone areas interconnections are effected between offices over trunk conductors. Ordinarily, two conductor trunks are used for such interconnections. In accomplishing such an interconnection, the manipulation of the apparatus at a subscriber's station causes the automatically operable apparatus in one office to select terminals connected to a trunk which extends to a second automatic telephone office. Associated with the terminals connected to the two conductors of each trunk is a third terminal used for test purposes. It is, of course, necessary in making a selection of a trunk to test its condition in order to determine whether it is busy or idle. The busy or idle condition is determined by testing this third terminal. This terminal is not connected by a conductor to a distant office. The selection of switches located in a distant office is therefore made at the originating office and is controlled by the condition placed upon the test terminal in the originating office.

Tests of selector switches connected to two conductor trunks are ordinarily made from the originating office. A busy condition may thus be associated with the test terminal during the test of the switch at the distant office. Further, the condition of the selector switch to be tested must be determined before it is seized for test. An arrangement of this kind for selecting and testing selector switches is shown in Patent No. 1,573,412 issued to H. W. MacDougall et al. February 16, 1926. The automatically operable testing equipment as shown in the aforementioned patent, is located in the office in which the trunks originate in order to test selector switches over the two conductor trunks located in distant offices. Difficulties are encountered with this method of testing, for example, when a fault is encountered in the

selector switch under test it is necessary for the testing operator to notify a maintenance man in the distant office. The invention has for its object a more desirable arrangement for testing selector switches connected to two conductor trunks, wherein the testing equipment is located in the same office with the selector switches to be tested. This method of testing has not heretofore been used because of the difficulty in marking the trunk busy at the office in which the trunk originates.

In accordance with the present invention one auxiliary selector switch, the same as the selector switches connected to the two conductor trunks, is used as a substitute selector switch for a selector switch under test. A relay is associated with each two conductor trunk in the same office with the selector switches connected to the trunks. This relay is operable for disconnecting the trunk conductors from an associated selector switch and connecting the trunk conductors to the auxiliary selector switch. The auxiliary selector switch is provided for response to an incoming call over the trunk during the period of time that the selector switch, normally associated with this trunk, is being tested. The auxiliary selector switch under this condition performs the normal function of completing telephone connections to subscribers' stations.

Having set an automatically operable testing device for the selection of switches, the condition of each switch to be tested is determined by the testing equipment before seizure. In order to do this, a conductor is extended from the testing device to each selector switch in the office to be tested. The busy or idle condition of the selector switch is thus determined at the switch instead of at the originating office. When it is found that the selector switch associated with the testing circuit is idle the aforementioned relay is operated for disassociating the trunk from the selector switch to be tested and associating the trunk with the auxiliary selector switch. When the test of a selector switch is completed and the switch

restored to normal, the condition of the auxiliary switch is determined before it is disconnected from the trunk. This is accomplished with automatically operable apparatus in order that the auxiliary switch remain associated with a busy trunk until the trunk is released by the termination of a telephone conversation. In order to determine the condition of the auxiliary selector switch, a conductor is extended from the auxiliary switch to the testing apparatus. The selection and testing of selector switches is thus accomplished without reducing the number of switches available for telephone connections, and without limiting the selection of trunks or lines connected to said switches.

The figures of the drawing have been organized to illustrate an interconnection between two subscribers' stations M and N. Fig. 1 illustrates subscriber's station M connected to a district and sender in a machine switching office. The district is shown associated with an office trunk selector and a selected trunk is shown extending to a second machine switching office. Figs. 2, 3, 4^A, 4^B and 5 illustrate the apparatus of this second machine switching office. Fig. 2 comprises a trunk relay for replacing a service selector or switch, Fig. 4^A with the auxiliary selector switch Fig. 4^B and for associating the service selector switch with the testing equipment. Jacks are also shown connected to the conductors extending to this relay for connecting the testing circuit with any individual trunk. The apparatus shown in Fig. 2 is individual to each trunk extended from the first to the second office. Fig. 3 is a diagrammatic illustration of an automatically operable or manually operable testing circuit. This testing circuit may be of the type disclosed in Patent No. 1,573,412 issued to H. W. MacDougall et al. February 16, 1926, or of the type disclosed in Patent No. 1,617,405 issued to H. W. MacDougall February 15, 1927.

Fig. 4^A illustrates a selector switch of the type used for a first selector in a machine switching office and operable over trunk conductors incoming from a distant machine switching office. Fig. 4^B is a duplicate of Fig. 4^A and is therefore not shown in detail. Fig. 4^A illustrates one of a large plurality of like selectors operable for service telephone connections. Fig. 4^B may be used to replace any one of the plurality of service selectors. Fig. 5 illustrates diagrammatically a final selector and subscriber's station N. The circuits diagrammatically illustrated in Figs. 1 and 5 are described in detail in Patent 1,501,871 issued to F. A. Stearn July 15, 1924. It is therefore believed that further detailed explanation should not be required in this description.

The apparatus shown in the drawing is

well-known in the art. It may be stated, however, that the switch for associating the testing circuit with trunks may be of any type of switch known in the art for making such selections. The ordinary step-by-step switch is shown for the sake of simplicity in the disclosure.

The invention will be better understood from the following detailed description taken together with the illustrated embodiment.

Let it be assumed that the testing circuit shown in Fig. 3 is an automatically operable routine testing circuit of the type disclosed in the aforementioned Patent No. 1,573,412 excepting the method shown in this patent for selecting the switches to be tested. The contacts of switch 110 are associated directly with the selectors to be tested whereas in the aforementioned patent the connectors are associated with testing selectors for selecting the switches to be tested. To start an automatic routine test of the selector switches Fig. 4^A, key 124 is actuated. An energizing circuit is thus established for the operation of magnet 110 to rotate its brush assembly from position 0 to position 1 in which position it has been shown in the drawing. This circuit may be traced from ground through the left inner contact of relay 123, right contact of key 124, brush 116 and its associated contact in position 0, contact and winding of switch magnet 110 to battery. A test of the condition of the selector switch of Fig. 4^A is now made to ascertain whether it is idle or busy. If the switch of Fig. 4^A is connected in service a ground is associated with conductor 149 either through the contact of relay 200 or through the left lower contact of cam 224. The selector switch of Fig. 4^A is described in detail in the aforementioned Patent No. 1,501,871 to F. A. Stearn. The description of Fig. 4 of this patent will be found to accurately agree with Fig. 4^A with the exception of the left contact of relay 200 and the left lower contact of cam 224. It will be noted in the description of Fig. 4 of the aforementioned patent that relay 200 operates immediately upon the seizure of the switch for a service connection. The ground shown connected to the left contact of relay 200 has been used to indicate the busy condition of the switch to the testing device until such time as the sequence switch has rotated in the position 11½. The rotation of the sequence switch establishes a permanent busy ground to indicate the condition of the switch to the testing device until the switch has been restored to its normal position. When the testing device is associated with a busy switch the aforementioned ground is connected to the winding of relay 121, which operates. It will be noted that a circuit is established by the as-

sociation of brush 113 with terminal 1 for energizing relays 100 and 120. Because of the large number of springs associated with relays 100 and 120 they are slower to operate than relay 121. The operation of relay 121, from ground connected by a busy switch to conductor 149, opens the operating circuit for relays 100 and 120. The operation of relay 100 at this time would disassociate the trunk conductors from a busy selector switch. Under this condition relay 121 remains operated until the switch Fig. 4^A is restored. Relay 121 is then released to permit the operation of relays 100 and 120.

Let it be assumed that the selector switch Fig. 4^A is in its normal position and therefore a ground is not associated with conductor 149. Upon the association of brush 111 with conductor 149 a circuit is not established to operate relay 121. The contact of this relay remains normal and a circuit is established to operate relays 100 and 120. This circuit may be traced from battery through the winding of relay 100, brush 113 and its associated contact, winding of relay 120, normal contact of relay 121, to ground through the left inner contact of relay 123. The operation of relay 100 associates trunk conductors 140 and 141 with conductors 144 and 145 which are extended to the auxiliary selector switch Fig. 4^B. If the trunk represented by conductors 140 and 141 is now seized for service the telephone connection will be completed by the auxiliary selector switch Fig. 4^B and the final selector switch Fig. 5. The operation of relay 100 further associates testing circuit conductors 146 and 147 with conductors 142 and 143 extending to the selector switch to be tested. The operation of relay 120 completes the interconnection of the testing circuit with the selector switch Fig. 4^A. The operation of relay 120 opens the circuit for relay 121 at its right outer contact. A circuit is established through the right inner contact of relay 120 for energizing sequence switch magnet 130. This circuit may be traced from ground through this right inner contact of relay 120, left contact of key 124, lower contact of cam 131, winding 130 to battery. The sequence switch is thus driven from position 1 to position 2 in which position testing conditions are associated with conductors 160 and 161. A progressive test of the selector switch Fig. 4^A is now made as described in the aforementioned Patent No. 1,573,412. Upon the completion of each one of the progressive tests ground is associated with conductor 162 by the movement of testing circuit apparatus in order to reposition the sequence switch 130.

When the sequence switch 130 has rotated into position 16 the winding of relay 122 is connected through cam 132, brush 112 and its associated contact to conductor 148

which extends to the apparatus of the auxiliary switch Fig. 4^B. Conductor 148 is connected to apparatus of the auxiliary switch in the same manner as shown for conductor 149. If the auxiliary selector switch has been seized for service during the period of time that the selector switch 4^A is under test a ground is connected to conductor 148. This ground therefore completes a connection for the operation of relay 122 when the sequence switch 130 arrives in position 16. The sequence switch 130 may continue to rotate into position 18 but is prevented from moving out of position 18 by the operation of relay 122. The energizing circuit for magnet 130 in position 18 is held open at the right contact of relay 122. The sequence switch is thus held in position 18 until the auxiliary switch 4^B is released and returned to its normal position. This is done in order to prevent interference with service connections during the test of selector switches. When the auxiliary switch is restored to normal the ground is removed from conductor 148 causing the release of relay 122. The release of relay 122 establishes an energizing circuit through its right contact for sequence switch magnet 130. The sequence switch now rotates from position 18 to position 1. During the rotation of the sequence switch through position 18½ a circuit is established to energize and release switch magnet 110 through the contact of cam 133. The brushes of switch 110 are thus rotated one position for associating a different trunk and selector switch with the testing circuit.

The progressive testing of the selector switches throughout the entire telephone office may be accomplished in the manner described without reducing the number of selectable switches or trunks.

It may be desirable at times to test a particular one of the selector switches Fig. 4^A. For this purpose jacks 126 and 128 are associated with each trunk relay. Plugs 125 and 127 may be inserted in jacks 126 and 128. For such a test key 125 is operated in order that switch 110 will remain in its normal position zero. The key 124 is operated and allowed to remain operated until the sequence switch 130 has rotated out of position 1. Key 124 is then released to prevent the sequence switch from again moving out of position 1 when the test of the selector switch has been completed. The testing apparatus operates in the same manner for the test of a particular selector switch as here described for progressive tests in which the switch 110 is used.

It will be noted that the springs of relay 100 are arranged so that conductors 144 and 145 are associated with conductors 140 and 141 before conductors 140 and 141 are disassociated from conductors 142 and 143.

The purpose of this spring arrangement is to prevent the possibility of transmitting a false pulse to a sender that has at that moment seized the trunk conductors 140 and 141. A momentary time interval elapses between the seizure of the trunk and the operation of relay 200 in the selector switch. If during this time interval the loop circuit between the selector switch and the sender were allowed to be opened a false pulse would be registered in the sender. The registration of this false pulse would cause the auxiliary selector switch to be positioned upon the wrong terminals. A faulty connection would be the result of this incorrect recording of pulses.

If at any time it is desirable to restore switch 110 to its normal position from an intermediate testing position key 129 is operated. This key may be operated at any time during the test of a selector switch. When the test of the selector switch is completed and the sequence switch 130 rotates from position 18, a circuit is established in position 18½ to operate relay 123. This circuit may be traced from ground through the contact of key 129, right lower and upper contacts of cam 136 to battery through the winding of relay 123. A locking circuit for relay 123 is established through its right contact, left upper and lower contacts of cam 136 to ground through key 129. The operation of relay 123 disconnects ground from the operating circuit for the sequence switch magnet 130. The sequence switch therefore remains in position 1 and the relay 123 remains locked until the key 129 is restored. Ground is also removed from the operating circuit for magnet 110 so that it will remain in its normal position when restored. Ground is also removed from the operating circuit for relays 120 and 100. The operating circuit for relay 121 is opened at the left outer contact of relay 123. The operation of relay 123 further establishes an energizing circuit for switch magnet 110 from battery through the winding and contact of magnet 110, brush 116 and its associated contacts to ground through the left inner contact of relay 123. The switch 110 is thus restored to its normal position. During the restoration of this switch the conductors extending between the various trunk relays and the testing circuit apparatus are held open in order that no interference with operating circuits will be encountered. After switch 110 is restored to normal the start key 124 is released previous to the release of key 129.

Key 124 is permitted to remain in its operated position after key 129 is operated in order to prevent interference with service if the sequence switch 130 is in position 1. The release of key 129 causes the re-

lease of relay 123 for restoring the circuit to its normal condition.

It is not the intention to limit the use of this invention to the testing of apparatus connected to a distant point by a two-conductor trunk. The invention may be used for the inspection or test of any apparatus where it is desirable to maintain unrestricted selection of said apparatus.

What is claimed is:

1. In a system for inspecting a plurality of selectable apparatus, an automatically operable combination of devices including an apparatus for successively seizing said selectable apparatus for inspection and for rearranging the apparatus so that the number of apparatus available for selection is unchanged by said seizures.

2. In a system for inspecting a plurality of selectable switches, an automatically operable combination of devices including a switch for successively seizing said selectable switches for inspection and for rearranging the switches so that the number of switches available for selection is unchanged by said seizures.

3. In a system for inspecting a plurality of switches automatically selectable by other switches, an automatically operable combination of devices including a switch for successively seizing said selectable switches for inspection and for rearranging the switches so that the number of switches available for selection is unchanged by said seizures.

4. In a system for inspecting apparatus that are selectable by automatically operable selectors, an automatically operable device for progressively seizing said apparatus for inspection and for substituting like apparatus for selection during said inspection.

5. In a system for inspecting electrically operable apparatus connected to and operable over a plurality of lines, said lines being selectable by automatically operable selectors, an automatically operable device for progressively seizing said apparatus for inspection and at the same time maintaining unrestricted selections of said lines.

6. In a system for inspecting electrically operable apparatus connected to and operable over a plurality of lines for service connections to other lines, said first lines being selectable by automatically operable selectors, an automatically operable device for progressively seizing said apparatus for inspection and at the same time maintaining the lines connected to said apparatus selectable for service connections.

7. In a system for progressively inspecting a plurality of apparatus, an auxiliary apparatus, and means automatically operable for replacing the apparatus being inspected by said auxiliary apparatus and for in-

versely replacing the auxiliary apparatus by the apparatus inspected.

8. In a telephone exchange system, a plurality of automatic switches, an auxiliary automatic switch, automatically operable means for progressively securing said automatic switches for inspection, for replacing an automatic switch secured for inspection by said auxiliary automatic switch and for inversely replacing the auxiliary automatic switch by the automatic switch inspected.

9. In a telephone exchange system, a plurality of automatic switches for telephone service, an auxiliary automatic switch, automatically operable means for removing an automatic switch from service for inspection and for replacing it by said auxiliary automatic switch, and automatically operable means for inversely replacing the auxiliary automatic switch by said automatic switch upon the completion of said inspection.

10. In a telephone exchange system, automatic switches connected to incoming lines operable over said incoming lines for connection to outgoing lines, an auxiliary automatic switch, means for disconnecting an automatic switch for inspection and for connecting in its place said auxiliary automatic switch, and automatically operable control means for determining the condition of said automatic switch before it is disconnected.

11. In a telephone exchange system, a device for testing automatic switches connected to incoming lines for service operation, an auxiliary automatic switch, means for disconnecting an automatic switch from a line and for connecting in its place said auxiliary automatic switch, means for inversely disconnecting the auxiliary automatic switch and connecting in its place said automatic switch upon the completion of said test, and automatically operable control means for preventing interference with telephone service connections.

12. In a telephone exchange system, a device for testing automatic switches used for telephone connections, an auxiliary auto-

matic switch, means automatically operable for seizing an automatic switch and replacing it by said auxiliary automatic switch, and means automatically operable to determine whether said switch is busy in service before making said seizure.

13. In a telephone exchange system, a device for testing automatic switches connected to incoming lines, an auxiliary automatic switch the same as the automatic switches connected to said lines, and means for disassociating an automatic switch from a line associating said switch with said testing device and associating said auxiliary switch with said line.

14. In a system for testing automatic switches connected to incoming lines, an auxiliary automatic switch the same as the automatic switch connected to said lines, a testing device, means automatically operable for determining the condition of a switch to be tested, and means automatically operable in response to certain operations of said determining means for disassociating an automatic switch from a line associating said switch with said testing device and associating said auxiliary switch with said line.

15. A system for testing automatic switches in a telephone exchange office connected to two conductor lines incoming from a distant telephone exchange office, an auxiliary automatic switch the same as the automatic switches connected to said lines, a testing device, means for determining the service condition of a switch to be tested, and means for disassociating the automatic switch to be tested from an incoming line associating said switch with said testing device and associating said auxiliary switch with said incoming line.

In witness whereof, we hereunto subscribe our names this 9th day of August, A. D. 1927.

CARLETON V. TAPLIN.
LOUIS M. ALLEN.
ARNOLD S. BERTELS.