

H. G. WEBSTER;
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED MAY 20, 1914.

1,255,964.

Patented Feb. 12, 1918.

4 SHEETS—SHEET 1.

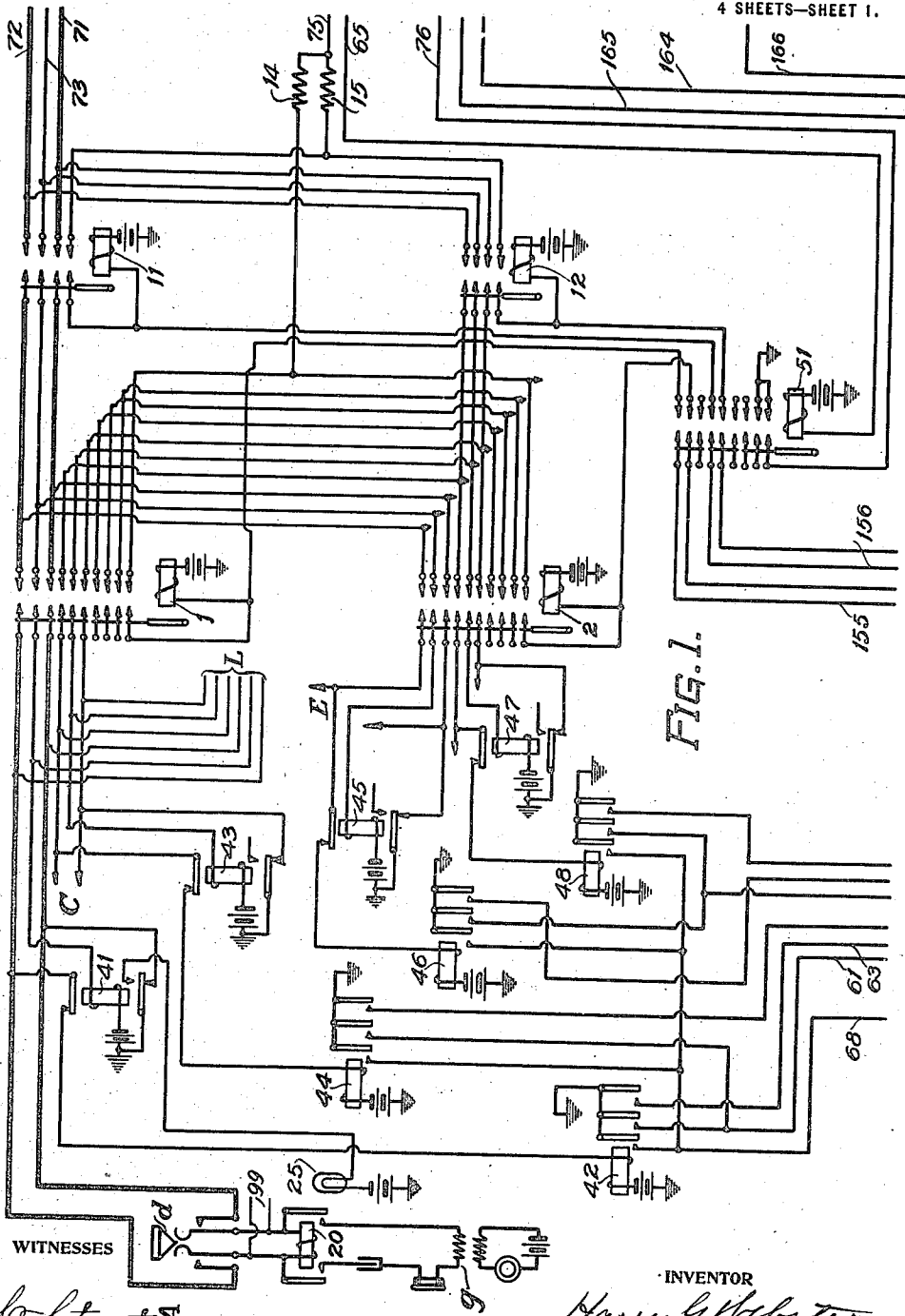


FIG. 1.

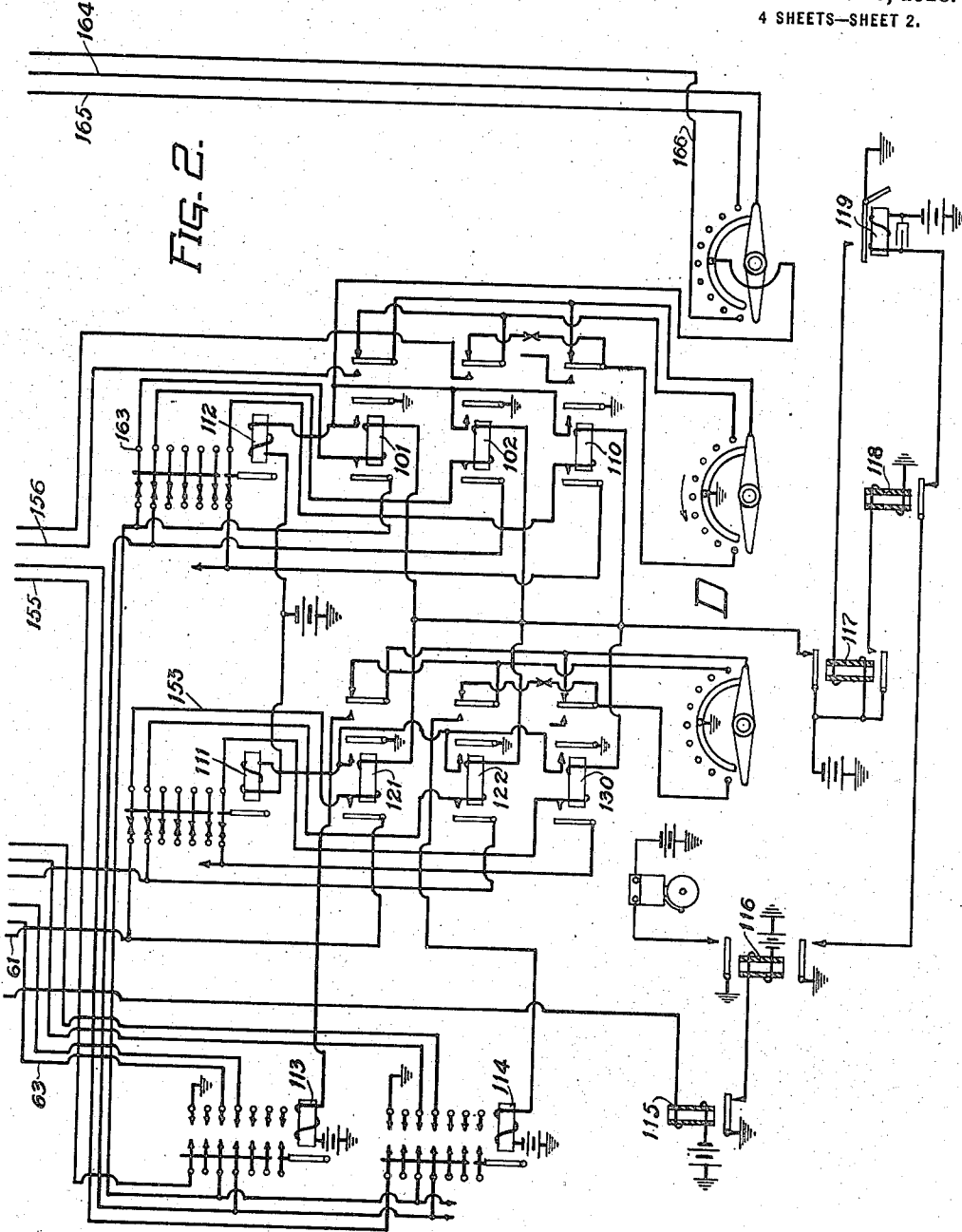
W. Stuart
J. D. Bonnar

INVENTOR
Harry G. Webster

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WITNESSES

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4 SHEETS—SHEET 3.

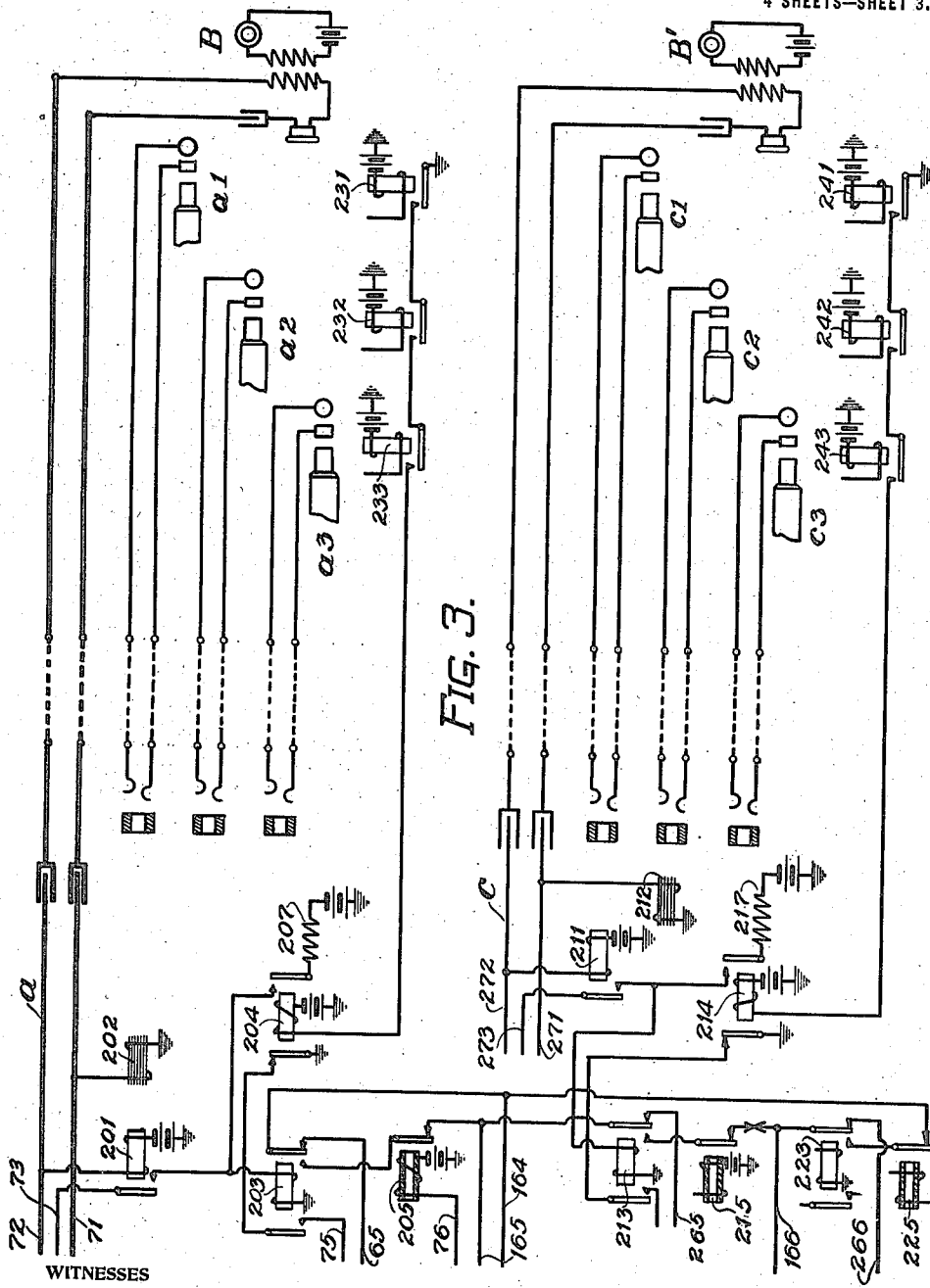


FIG. 3.

WITNESSES

INVENTOR

A. Stuart
J. D. Bonnar.

Harry G. Webster

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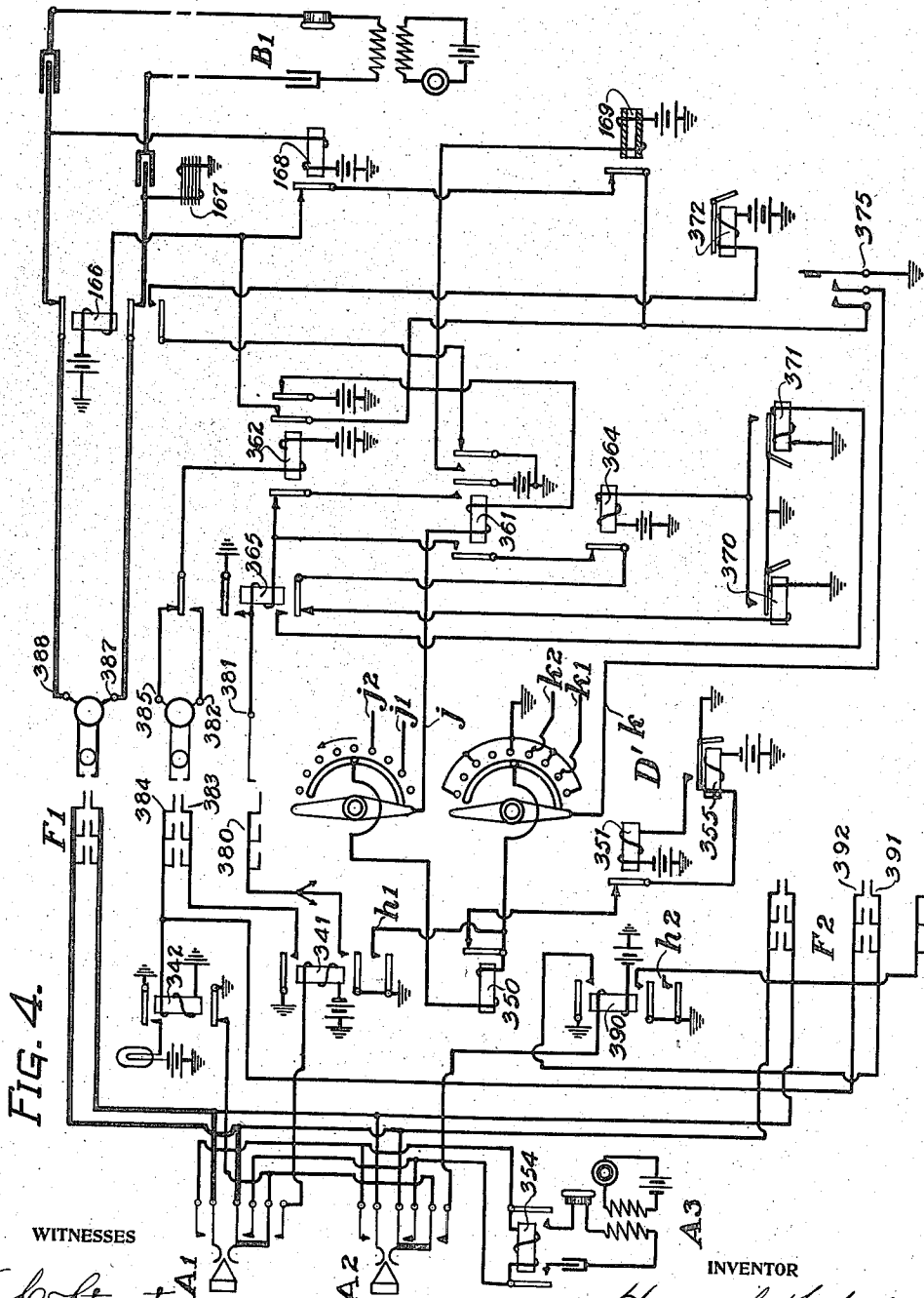


FIG. 4.

WITNESSES

W. B. Stuart
J. D. Bonmar

INVENTOR

Harry G. Webster

UNITED STATES PATENT OFFICE.

HARRY G. WEBSTER, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO
JAMES R. GARFIELD, TRUSTEE, OF CLEVELAND, OHIO.

TELEPHONE-EXCHANGE SYSTEM.

1,255,964.

Specification of Letters Patent. Patented Feb. 12, 1918.

Application filed May 20, 1914. Serial No. 839,743.

To all whom it may concern:

Be it known that I, HARRY G. WEBSTER, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Telephone-Exchange Systems, of which the following is a specification.

My invention relates to circuit selecting apparatus, and particularly to such apparatus applied to instruction circuits of telephone exchange systems. As here illustrated, the invention contemplates the use of automatic selecting mechanism in conjunction with instruction circuits or so-called "order wire circuits" extending from the positions of answering operators at one exchange to the positions of trunk or "B" operators in the same or a different exchange.

The prior practice with respect to order wire circuits has been to provide a talking circuit leading from the telephone of a "B" operator directly to keys located at the positions of a plurality of answering or "A" operators, and any such "A" operator by actuating her key could bridge her own telephone directly across this talking circuit and converse directly with the "B" operator, instructing her as to a line with which connection might be desired and receiving instruction as to which trunk to employ in establishing the connection. In case of a plurality of such order wires leading to "B" operators all located at the same exchange, then each "A" operator would have a key corresponding to each order wire; or the different order wires would be each assigned to the use of a particular group of "A" operators.

With the arrangement just described, it has been found that delay and interference results from the fact that a plurality of "A" operators can and do connect their telephones simultaneously with the same order wire, interfering with each other and thereby leading to confusion and a high percentage of error in completing trunk connections. An object of the present invention is to overcome this undesirable condition by individualizing the order wires with respect to the "A" operators, allowing but one "A"

operator at a time to have access to an order wire. A further object is the provision of means such that with a group of order wires an "A" operator, by pressing a single button, will be connected to an idle order wire in the group or to the first of the group to become disengaged. A further object is the provision of means whereby an order wire will be put out of service during those periods when all of the trunk circuits associated therewith are engaged for conversation. Other objects and improvements of my invention will be apparent from the following specification.

I have illustrated my invention by the accompanying drawings, in which Figure 1 indicates a plurality of "A" operators' telephones and groups of relays for connecting these telephones with an order wire circuit. Fig. 2 illustrates controlling relays and apparatus used in controlling the selective operations of the relays of Fig. 1. Fig. 3 illustrates two groups of trunk circuits extending from the "A" operators' positions of change, together with the order wire circuits associated with these trunk groups. In Fig. 4 I have illustrated a modification of my invention in which the selective association of the operator's keys with the order circuits is secured by traveling switches rather than by relays groups, illustrating also the use of order buttons or keys representing groups of trunks and order wires extending to different exchanges from a single "A" operator's position.

In that form of my invention illustrated in Figs. 1, 2 and 3, instead of carrying the talking wires of an order circuit directly to the "A" operator's keys, as heretofore, I provide each order circuit with a group of related so-called tens and units relays grouped generally as described in Patent No. 1,091,193 issued to Edward E. Clement March 24, 1914. Referring to Fig. 1, I have indicated at 1 and 2 a group of tens relays and at 11 and 12 a group of units relays. The talking conductors of the order wire circuit are shown at 71-72 extending to the telephone B of a trunk operator located at a distant

exchange. The interrupted portions of these conductors indicate the point of division between the two exchanges. An associated group of trunks extending from jacks multiplied before the several "A" operators' positions to plugs at the position of the trunk operator is indicated at a^1 , a^2 and a^3 , and the relays 231, 232 and 233 are respectively associated with the plugs of trunks a^1 , a^2 and a^3 and are to be understood as energized whenever the associated plug is in place in the spring jack of a line to which the trunk is connected. A second order wire is indicated in Fig. 3 extending by talking conductors 271—272 to a second trunk operator B' located at the same exchange as operator B. The associated group of trunks and trunk relays is indicated at c^1 — c^2 — c^3 and 241—242—243, respectively. At A, Fig. 1, I have indicated an answering operator's equipment comprising the telephone g , the relay 20, the order wire key d , and the lamp 25. The wires 99 are to be understood as extending to other keys d before the same operator for access to order wires leading to other exchanges than that indicated in Fig. 3. The equipment of operator A also includes the cut-off relay 41 and initiating relay 42. Other similar operators' equipments are indicated by the cut-off relays 43, 45, 47, and initiating relays 44, 46 and 48, and are to be understood as equipped similarly to operator A.

The relation and grouping of the tens and units relays indicated at 1—2 and 11—12, respectively, may be best explained by assuming that there are one hundred operators' keys d by means of which a corresponding number of operators secure access to the order wire circuits a and c leading to operators B and B' of Fig. 3. Under this assumption, the one hundred keys are to be regarded as numbered from 00 to 99, and to be sub-divided into groups of ten corresponding to the tens digit of their respective numbers. The first sub-group of keys would be those numbered 11, 12, 13, 14, 15, 16, 17, 18, 19 and 10, the second group those similarly numbered from 21 to 20, inclusive, and so on. Under this assumption, the key d of the drawing is key No. 11, that associated with relay No. 44 is key No. 12, that associated with relay No. 46 is key No. 21, and that associated with relay No. 48 is key No. 22. The relay 1 corresponds to the first sub-group of keys, relay No. 2 to the second group of keys, and so on through the entire hundred, there being ten of these so-called tens relays for each order wire when associated with one hundred keys. The units relays indicated at 11—12 correspond respectively with the units digits of the key numbers, relay No. 11 corresponding to keys numbered 11 and 21, and relay No. 12 to keys numbered

12 and 22. This arrangement is also carried out for the entire hundred keys, there being ten units relays for each order wire. Relays corresponding to those indicated at 113 and 114 are provided for each sub-group of ten keys, relay 113 corresponding to the group containing keys 11 and 12, relay 114 corresponding to the group containing keys 21 and 22, and so on for the entire one hundred keys. Each group of one hundred keys is also provided with a group of ten serially related relays corresponding to the tens digits of the key numbers and indicated by the relays 121 and 122 corresponding to the first two, and by relay 130 corresponding to the last of the serially related group. A similar group of serially related relays is provided corresponding to the units digit of the key numbers, relays 101 and 102 being the first two relays of this group and relay 110 being the last of the group. A relay 111 is associated with the tens serial group and a relay 112 with the units serial group.

Each order circuit is to be understood as provided with ten of the relays 1—2, and with ten of the relays 11—12. The order circuit a is provided with relays 203 and 205 and with relays 201 and 204, all located within the same exchange as the keys d . A second order wire circuit similarly equipped and associated with the same keys d is indicated at c , and a third similar order wire circuit is indicated by the relays 223 and 225 corresponding respectively to relays 203 and 205. Wires 164, 165 and 166, respectively, lead from the circuits of the three order wires of Fig. 3 to the right hand group of bank contacts of the switch D. These order wires are serially related and their number may be increased as desired as indicated by the vacant contact points in the right hand group of switch D and by the break indicated in the wire extending between the contacts of relays 215 and 223. The serial relation may be characterized as a circular series relation as indicated by the circuit which may be traced with relays 203, 213 and 223 energized. Starting with the right hand contact lever of relay 203 through its forward contact, the contact of relay 205, the right hand lever and forward contact of 213, the contact of 215, thence through corresponding contacts of corresponding relays of other order wires in the group, thence through right hand lever and forward contact of relay 223, and through contact of relay 225 back to the lever of relay 203. As a result of this arrangement, the several order wire circuits of a group have a certain order of precedence depending upon the position in which the wipers of switch D may be resting, as will be apparent from the subsequent description.

The switch D may be any suitable type of rotary switch, driven one step forward on each retraction of the armature of its driving magnet 119. The switch wipers advance
 5 always in the same direction without restoring motion and are indicated as provided with ten stationary or bank contacts for each wiper. The left hand group of bank
 10 contacts correspond to the several relays of the tens serial group, those of the middle set correspond to the relays of the units serial group, while those of the right hand set correspond to the several order wires of a group. While I have indicated ten con-
 15 tacts in each set, the number of contacts may be made greater or less than this according to the size of the order wire group and according to the number and size of the sub-groups of keys *d*.

20 Assuming now that an operator at A has answered a calling subscriber using a cord pair in the customary manner, and learned that the desired subscriber is located at the exchange at which are located the trunk op-
 25 erators B and B', she actuates her key *d* corresponding to such exchange. A circuit is thereby closed which may be traced from battery through the winding of relay 42, the upper contact of relay 41, the left hand
 30 contact of key *d*, the winding of relay 20, the right hand contact of key *d*, the lower normally closed contact of relay 41, and thence to the return side of the central battery. It should be here stated that while
 35 the battery symbol has been repeatedly shown in the several drawings of this application, this has been for the sake of simplicity and it is to be understood that this battery symbol in each case indicates the
 40 common central battery of that exchange in which is located the apparatus directly associated with the particular symbol. As a result of current flowing in the circuit last traced, the relay 20 is energized connecting
 45 the operator's telephone *g* with the contacts of the key *d*, and the relay 42 is also energized. Relay 42 in operating closes at its left hand contact a guarding circuit to be subsequently explained. The closing of its
 50 center contact completes a circuit which may be traced from battery through the upper contact of relay 117, the winding of relay 121, wire 153, upper contact of relay 111, wire 61, and to the return side of the battery
 55 through the center contact of relay 42. The ensuing energization of relay 121 closes at its left hand contact a locking circuit in shunt of the upper contact of relay 111, and at its right hand contact a circuit leading
 60 from the winding of relay 113 to earth at the contact and left hand wiper of switch D. The closing of the middle contact of relay 121 completes the energizing circuit of relay 111, operating this relay to interrupt the

normal circuits extending to all relays of 65 the tens serial group indicated by 121, 122 and 130, preventing their subsequent operation until the release of relay 111, relay 121, however, remaining energized because of its locking circuit. The operation of relay 113 70 completes at its upper contact an earth connection leading by wire 155 to the upper terminal of relay 51. At the same time a circuit is closed leading from battery through the upper contact of relay 117, the winding of 75 relay 101, the upper contact of relay 112, and third contact down of relay 113, and by wire 63 to earth through the right hand contact of relay 42. The ensuing energiza- 80 tion of relay 101 completes at its left hand contact a locking circuit in shunt of the upper contact of relay 112; completes at its center contact the energization circuit of relay 112 thereby preventing the energiza- 85 tion of other relays of the units serial group, and at its right hand contact completes a circuit extending from earth at the center wiper of switch D by wire 156 to the fourth con- 90 tact down of relay 51. Each of the order wires *a*, *c*, etc., is provided with a relay 51, and the left hand contacts of all relays 51 are multiply related except for the two lower contacts shown. The upper ten of the con- 95 tacts of each relay 51 correspond to the tens relays of the order circuits, and the next ten contacts of the relays 51 correspond to the units relays of the order circuits.

By the operation of the middle contact of relay 101 last described, a circuit has been 100 closed for the operation of that relay 51 associated with the first disengaged order wire circuit in the group of serially related order wire circuits. The order of precedence as 105 between disengaged order wire circuits is determined by the position of switch D. The switch D does not operate except in case of interference or abnormal delay in selecting an order wire key, and the opera- 110 tion of a relay, as 101, of the units serial group closes circuit for relay 51 of that disengaged order circuit most directly associated with the contact upon which the right hand wiper of switch D is then resting. In the present instance, the relay 51 115 of order circuit *a* is energized over the circuit which may be traced from battery through the winding of relay 51, wire 65, right hand normally closed contact of relay 203, wire 164, contact and right hand wiper of switch D, and to earth through the now 120 closed center contact of relay 101. By the operations of relays 42, 121, 113 and 101, an earth connection has been applied to wires 155 and 156 leading to the corresponding left hand contacts of relay 51. The opera- 125 tion of relay 51 therefore completes at these contacts energizing circuits for relays 1 and 11. At the same time, a circuit is closed at

the lower contact of relay 51 leading from battery through the winding of relay 205 and wire 76 to earth at said lower contact. Relay 205 is a sluggish relay and maintains its energization following the subsequent release of relay 51 for a sufficient period to hold its contact interrupted until after the restoration of relay 101 to prevent a false operation of that relay 51 associated with the next serially related order wire. The operation of relays 1 and 11 in response to the actuation of relay 51, completes the circuit of the talking conductors 71 and 72 extending between the operator at A and the operator at B. The completion of this circuit also establishes a circuit which may be traced from battery through the winding of relay 201, conductor 72, contacts of relays 11 and 1, winding of relay 20 returning by conductor 71 and to earth through impedance coil 202. Current in this circuit maintains the energization of relay 20 and energizes relay 201. The contact of relay 201 closes a circuit leading from battery through the winding of cut-off relay 41, the contacts of relays 1 and 11, conductor 73, contact of relay 201, and winding of relay 203 to earth. The ensuing energization of relay 41 disconnects and releases relay 42 thereby releasing relays 121, 113, 111, 101, 112 and 51. The controlling apparatus of Fig. 2 is thereby restored to normal and ready for another selective operation. The operation of the lower contact lever of relay 41 closes the circuit of lamp 25 indicating to operator A that she is connected with an order wire extending to an idle B operator. The operation of relay 203 at its right hand contact has interrupted the previous circuit through wire 65 to relay 51, and at its forward contact extended the circuit of wire 164 to the lever of relay 205, which, upon dropping back, brings into circuit relay 51 of the next idle order circuit of the serially related group. The operation of the left hand contact of relay 203 establishes locking circuits for relays 1 and 11 extending from ground at the left hand contact of relay 204 through contact of relay 203, wire 75, and non-inductive resistances 14 and 15 to locking contacts of relays 1 and 11, respectively.

While the operations above described required considerable time to explain, they have taken place within a period of a very small fraction of a second following the actuation of key *d*. The operator A immediately repeats to the operator at B the call number of the desired line, and this may be given before the A operator disconnects her telephone from the circuit of the calling subscriber, thus saving a second repetition of the call number and allowing the calling subscriber to check the call number as given to the B operator. The B operator there-

upon assigns a trunk as a^1 and the connection is completed in the well known manner. Upon releasing the key *d*, the interruption of the circuit through winding of relay 20 releases this relay disconnecting the operator A from the contacts of the key, and releases also relay 201. The ensuing interruption of the contact of relay 201 breaks at its contact the circuit of relays 41 and 203. The release of relay 41 reestablishes the normal condition of the apparatus at A, and the release of relay 203 interrupts at its left hand contact the locking circuit of relays 1 and 11 releasing these relays; and at its left hand contact again establishes the normal circuit of wire 164 to relay 51 of order wire a thereby placing the order wire in condition for the next call.

It will be apparent from the above description that because of the serial relation resulting from the arrangement of relays 203—205 and the corresponding relays of other order circuits, that upon the operation of a key *d* the operator A will be immediately connected to an idle order circuit of the plurality leading to the exchange indicated at the right of Fig. 3. If, at the time the key is actuated, all order circuits of the plurality be in use, then the operator A will be subsequently connected with that order circuit which is first to become idle and release its relay 51. It is further to be pointed out that the relay 204 of order wire a and corresponding relay 214 of order wire c serves to temporarily remove from service an order wire circuit when all of the trunks as a^1 , a^2 , a^3 associated with such order circuit are connected for conversation. Under this condition, the corresponding relays 231, 232 and 233 of such a group of trunks are all energized completing a circuit extending to the exchange of operator A for the energization of relay 204 under this condition. The operation of the right hand contact of this relay closes an energizing circuit for relay 203 including resistance 207 and interrupts at its left hand contact the locking circuit which would otherwise be closed by the energization of relay 203. The operation of the right hand contact lever of relay 203 disconnects the corresponding relay 51 and extends the circuit of wire 164 to the next order wire of the series. This operation prevents the further selection of the order wire a until relays 204 and 203 are subsequently released by the release of a relay as 231 at the disconnection of its associated trunk circuit.

Referring to the sluggish relays 115, 116, 117 and 118, Fig. 2, these are used in case of delay or interference in the selection of an actuated key *d*. Relay 116 is normally energized and its time characteristic is such that it will not be released due to any normal

interruption of its circuit at the contact of relay 115. The circuit of relay 115 is closed at the left hand contact of relays corresponding to relay 42, and if relay 42 remains energized for an abnormal period as due to a failure in selecting an actuated key, then the resulting abnormal interruption at the contacts of relay 115 will allow the release of relay 116. In this case, an alarm circuit is closed at the upper contact of relay 116 and a circuit extending through the winding of driving magnet 119 is closed at the lower contact. The energization of magnet 119 closes at its upper contact the energizing circuit of relay 117 which closes at its lower contact the circuit of relay 118, opening the circuit of driving magnet 119 and thereby causing the wipers of switch D to be advanced one step. This operation is repeated until the relay corresponding to 42 is released by the selection of the key circuit with which it is associated. The initial energization of relay 117 also breaks its upper contact disconnecting battery from any relays of the tens serial group or units serial group which have been previously energized. It will be noted that at each step of the switch D the earth connection leading to the right hand contact levers of these relays is shifted from relay to relay in each group, thus changing the order of precedence in each group with respect to which relay of a group shall be effective to apply ground at the forward contact engaged by its right hand contact lever. A similar change in the order of precedence as between the order wires of a group is made at the advance of the right hand wiper of the switch. As a result of this relation, when the switch D is advanced it will successively bring each order wire into direct relation with the units serial group of relays and so provide relief in case of a defective condition in the circuits of any particular order wire. It will also be evident that if the delay in releasing a relay 42 be due to a defect in the circuits of the key with which such relay is associated, then the stepping of switch D and the interruption of the battery circuit at the upper contact of relay 117 at each step will provide for the selection of other actuated keys in spite of the defective condition of a particular key circuit.

Referring to Fig. 3, while I have shown the earth connection at 202 as including the winding of an impedance coil, it is obvious that in case it be desired to give the operator at B a signal on selection of her associated order wire, then it would require mere engineering skill to substitute a relay and lamp for the impedance coil 202, and to locate this relay and the adjacent condensers at the exchange in which the operator B is located, placing the lamp adjacent to the plugs

of trunks a^1 , a^2 and a^3 . It should also be pointed out that mere engineering skill would be required to carry the circuit of relay 204 through contacts of relays associated with the spring jack end of trunks a^1 , a^2 and a^3 energized while the plug of an answering operator's cord pair is resting in a multiple jack of the corresponding trunk. The advantage of the particular circuit shown for relay 204 over that last described resides in the fact that by carrying this circuit to the exchange at which the operator B is located, it is thereby possible to put such operator's position temporarily out of service by merely grounding the wire leading through the contacts of relays 231, 232 and 233.

In the modification of my invention shown in Fig. 4, I have indicated means for associating idle order wires with actuated order wire keys by means of traveling switches rather than by means of relay groups, as previously described. Referring to this figure, I have indicated at F^1 a plurality of traveling switches of that type described in United States Patent No. 977,536 issued to C. H. North December 6, 1910. Coöperating contacts are provided on the switch indicated at 380. These contacts are horizontally disposed and are engaged by the wiper 381 at each rotary step of the switch, there being one contact for each vertical row of bank contacts 383—384 on the switch, the contact opposite each vertical row being wired to the center contacts of those relays 341 corresponding to the keys represented by contacts 383 and 384 in such vertical row all in a manner well understood by those familiar with the type of switch described in the North patent before mentioned. A plurality of such switches is indicated by the plurality of bank contacts indicated in association with those conductors leading to the left, and each such switch is to be understood as representing a separate order wire circuit like that shown as extending to position B^1 of a trunk operator at a distant exchange. This group of switches is associated with the button A^1 before the position of answering operator A^3 and with corresponding buttons on the positions of other answering operators. A second button for operator A^3 is shown at A^2 , and this button represents another similar group of switches and order wires indicated at F^2 , and to be understood as leading to an exchange different from that at which operator B^1 is located. Similar buttons A^2 are provided for other answering operators. As indicated by the broken lines leading to B^1 , the apparatus shown on Fig. 4 is located all within the same exchange as buttons A^1 and A^2 , with the exception of the operator's telephone set shown below the broken lines. An initiat-

ing relay 341 is provided for key A^1 and a corresponding relay 390 for key A^2 , but the cut-off relay 342 is common to these keys and any other similar keys which it may be desired to provide for operator A^3 . The switch D' is driven by the magnet 355 on the retraction of the magnet armature; and is of the same type and method of operation as switch D of Fig. 2. The contacts 375 are contacts closed on the initial step of the one hundred point switch F^1 and thereafter remain closed until the final restoring motion of the switch resulting from energization of the release magnet 372. The switch F^1 is stepped in a rotary direction by the operation of magnet 370 and in a vertical direction by the operation of magnet 371 in the manner described in the patent last mentioned.

Assuming the operator at A^3 to have answered a call in the usual manner and desiring to complete a connection to a called subscriber in a distant exchange corresponding to key A^1 or A^2 , she actuates the key corresponding to the exchange of the desired subscriber, assumed in this case to be key A^1 . This operation completes a circuit leading from battery through the winding of relay 341, the lower contact of the actuated key, and to earth at the lower contact of relay 342. The wipers of switch D' are to be understood as resting on the contacts leading by wires k and j to the circuits of an idle switch F^1 , in which case the operation of relay 341 completes circuits as follows. At the upper contact of relay 341 ground is applied to the bank contacts 383 corresponding to the actuated key A^1 . At the middle contact of relay 341 ground is applied to the bank contacts 380 corresponding to the row of bank contacts in which contacts 383 and 384 are located. By the operation of the lower contact of relay 341, a circuit is completed which may be traced from battery through the right hand contact of relay 362, the winding of relay 361, the upper wiper of switch D' , the winding of relay 350, and to ground through wire k^1 and the lower contact of relay 341. Relays 350 and 361 are thereby energized and the operation of relay 361 closes at its right hand normally open contact a circuit for relay 169, and at its remaining contacts a circuit which may be traced from battery through the center contact of relay 361, the left hand contact of relay 362, the left hand contact of relay 361, the contact of relay 364, the lower contact of relay 365, and the winding of rotary magnet 370 to ground. The ensuing operation of magnet 370 causes the switch wipers to advance one step in a rotary direction followed by the energization of relay 364, the interruption of the circuit previously traced at the contacts of

relay 364, and the dropping back of the armature of magnet 370. This operation is repeated, advancing the switch a series of rotary steps until wiper 381 engages the bank contact 380 now connected to earth at the middle contact of relay 341. At the same time a circuit has been closed leading from battery through the winding of relay 166, the middle contact of relay 362, and contacts 375 to earth, energizing relay 166 to disconnect the wipers 387 and 388 from the talking circuit leading to operator B^1 . When wiper 381 engages the grounded contact 380 relay 365 is energized by current flowing from battery through the center contact of relay 361, left hand contact of relay 362, winding of relay 365, wiper 381, bank contact 380, middle contact of relay 341 to earth. The energization of relay 365 now completes for itself a locking circuit at its center contact point; connects at its upper contact lever wiper 382 in circuit with the winding of relay 362, and by the operation of its lower contact lever substitutes vertical magnet 371 in place of magnet 370, thereby terminating the rotary advance of the switch. Magnet 371 now being in closed circuit, causes the switch to take a series of vertical steps until wiper 382 engages that contact 383 connected to ground at the upper contact of relay 341 corresponding to the actuated key A^1 . The circuit thus closed energizes relay 362 which, by the operation of its left hand armature breaks the battery circuit leading to magnet 371 and relay 365 stopping the vertical motion of the switch and releasing relay 365. The interruption at the middle contact of relay 362 releases relay 166 completing a talking circuit extending from operator B^1 through wipers 387 and 388 to the now closed upper and middle contacts of key A^1 . The actuation of the right hand contact lever of relay 362 interrupts the circuit previously existing for the windings of relays 350 and 361. The retraction of relay 350 now closes a circuit extending from battery through the winding of magnet 355, the contact of relay 351, the contact of relay 350, the lower wiper of D' , the contact now engaged thereby, and through wire k to earth at the right hand contact of springs 375. The energization of magnet 355 closes the circuit of relay 351 interrupting at its contact the circuit of magnet 355, causing the switch to advance one step at the retraction of the magnet armature. The common ground at the alternate contacts associated with the lower wiper of switch D' now causes the switch to advance a second step, and these operations are repeated until the lower wiper engages a wire corresponding to k^1 or k^2 leading to the contacts 375 of a switch F^1 resting in its normal posi-

tion, and therefore interrupted. Returning now to the release of relay 365 following the energization of relay 362, the restoration of upper contact of relay 365 has included the winding of relay 362 in circuit with the winding of relay 342 maintaining 362 energized and energizing relay 342. Relay 342 now closes at its upper contact the circuit of the signal lamp before operator A³, indicating that a connection has been established with a B operator at the desired exchange. The operation of the lower contact of relay 342 interrupts the previously existing circuit extending through the lower contact of key A¹ and the winding of relay 341 thereby releasing this relay and preventing the selection of key A¹ by a subsequently operated switch F¹. By the release of relay 166, a circuit has been closed extending from battery through the winding of relay 168, wiper 388, middle contact of key A¹, winding of relay 354, upper contact of key A¹, wiper 387, and winding of impedance coil 167 to ground. The operation of relay 168 at this time interrupts the circuit extending to the contact of relay 169, thereby preventing a premature release of the switch F¹ on release of relay 169. The energization of relay 354 connects the operator's telephone at A³ to the talking conductors now extending to operator B¹.

After having given the call number to the operator B¹ and receiving the trunk assignment, the operator A³ releases the key A¹ and completes the connection in the customary manner. At the release of key A¹ the previously existing circuit for relay 168 is thereby interrupted and the retraction of its armature closes a circuit leading from battery through winding of relay 166, contact of relay 168, contact of relay 169, to earth at contacts 375. The actuation of relay 166 closes at its lower contact an energizing circuit for release magnet 372 leading to earth at the right hand contact of relay 361, and the switch F¹ is thereupon restored in the manner described in the North patent previously mentioned. The interruption at contacts 375 as the switch reaches normal interrupts the circuits of relay 166 and magnet 372, and the switch and order wire are now in condition for another selection.

It will be seen from the above description that in each form of my invention here disclosed, the answering operators each have access to those order wires extending to distant exchanges, but in such manner that no two answering operators can be simultaneously connected with the same order wire. In addition, an answering operator may by means of a single key have access to all order wires of a group extending to a distant exchange, being automatically connected with an idle order wire or with that

order wire first becoming idle after the actuation of her key. These results I believe to have been first secured by myself, and while I have disclosed certain means for securing them, I do not wish to be limited to the particular means shown and described.

I claim:

1. In a telephone exchange system, a plurality of instruction circuits, switching operators' telephones associated therewith, automatic means for associating said instruction circuits with any one of a plurality of answering operators' telephones, means for placing such instruction circuits in service in regular sequence, and means responsive to an abnormal delay in the operation of such connecting means for changing such sequence.

2. In a telephone exchange system, a plurality of instruction circuits leading to switching operators' telephones, a plurality of answering operators' telephones, automatic means comprising quick-acting relays associated with each of such instruction circuits for connecting such instruction circuit with any one of such answering operators' telephones, means for preselecting an idle instruction circuit, manually operable means at such answering operators' positions adapted to actuate certain of such relays individual to the preselected instruction circuit to immediately connect the corresponding answering operator's telephone with the instruction circuit.

3. A telephone exchange system comprising a plurality of trunk lines, an instruction circuit associated therewith, and means responsive to the engaged condition of all of said trunk lines to exclude said instruction circuit from service.

4. A telephone exchange system comprising a plurality of operators' positions, a group of trunk lines extending therefrom, an instruction circuit for said group associated with said positions, and means effective responsive to the busy condition of all of said trunk lines to disassociate said instruction circuit from said positions.

5. A telephone exchange system comprising plural groups of trunk lines, associated instruction circuits for each of said groups, and means automatically effective responsive to the busy condition of all trunks of a group for excluding the instruction circuit of said group from association with the other of said instruction circuits.

6. A telephone exchange system comprising a group of trunk lines, an instruction circuit associated therewith, and means effective responsive to the busy condition of all of said trunk lines to substitute another group of trunk lines and associated instruction circuit therefor.

7. A telephone exchange system compris-

ing a plurality of operators' positions, a plurality of instruction circuits common to said positions and extending therefrom to different points, switches for each position corresponding respectively to said different points, and a controlling relay for each position common to the switches thereof.

8. A telephone system comprising a plurality of A operators' telephones, talking
10 conductors common to said telephones, normally inactive, selective means to connect

any one of said telephones with said conductors, means to initiate actuation of said selective means, and means to give at a connected telephone a characteristic signal 15 indicating such connection.

In witness whereof, I affix my signature in the presence of two witnesses.

HARRY G. WEBSTER.

Witnesses:

ETHEL A. NELSON,

A. C. STUART.