A. H. WEISS.

CALL DISTRIBUTING SYSTEM FOR TELEPHONE EXCHANGES.

APPLICATION FILED NOV. 4, 1911. RENEWED JULY 15, 1912.

1,187,947. Patented June 20, 1916.

3 SHEETS—SHEET 1.

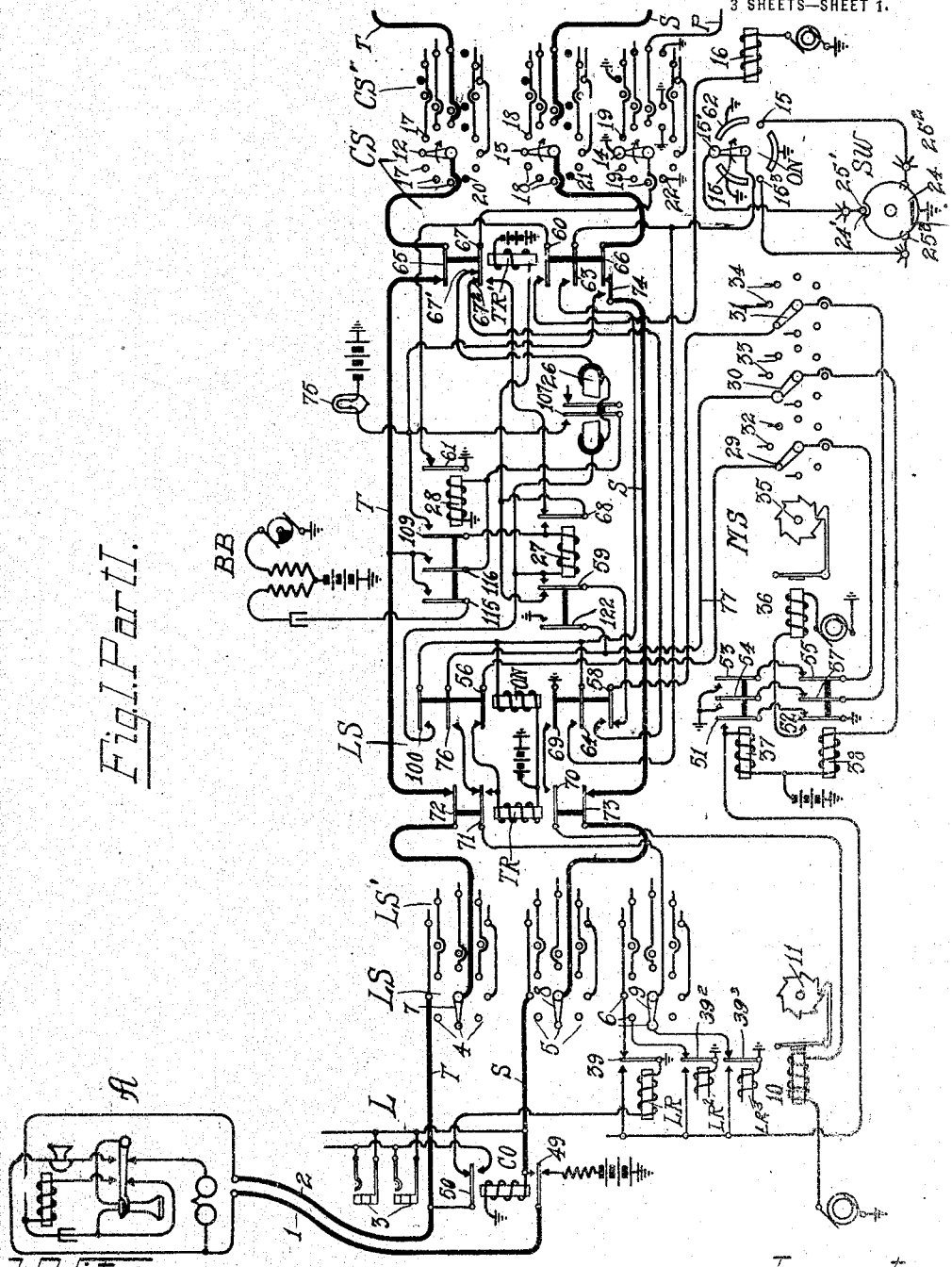

Fig. 1 Part I.

Witnesses:

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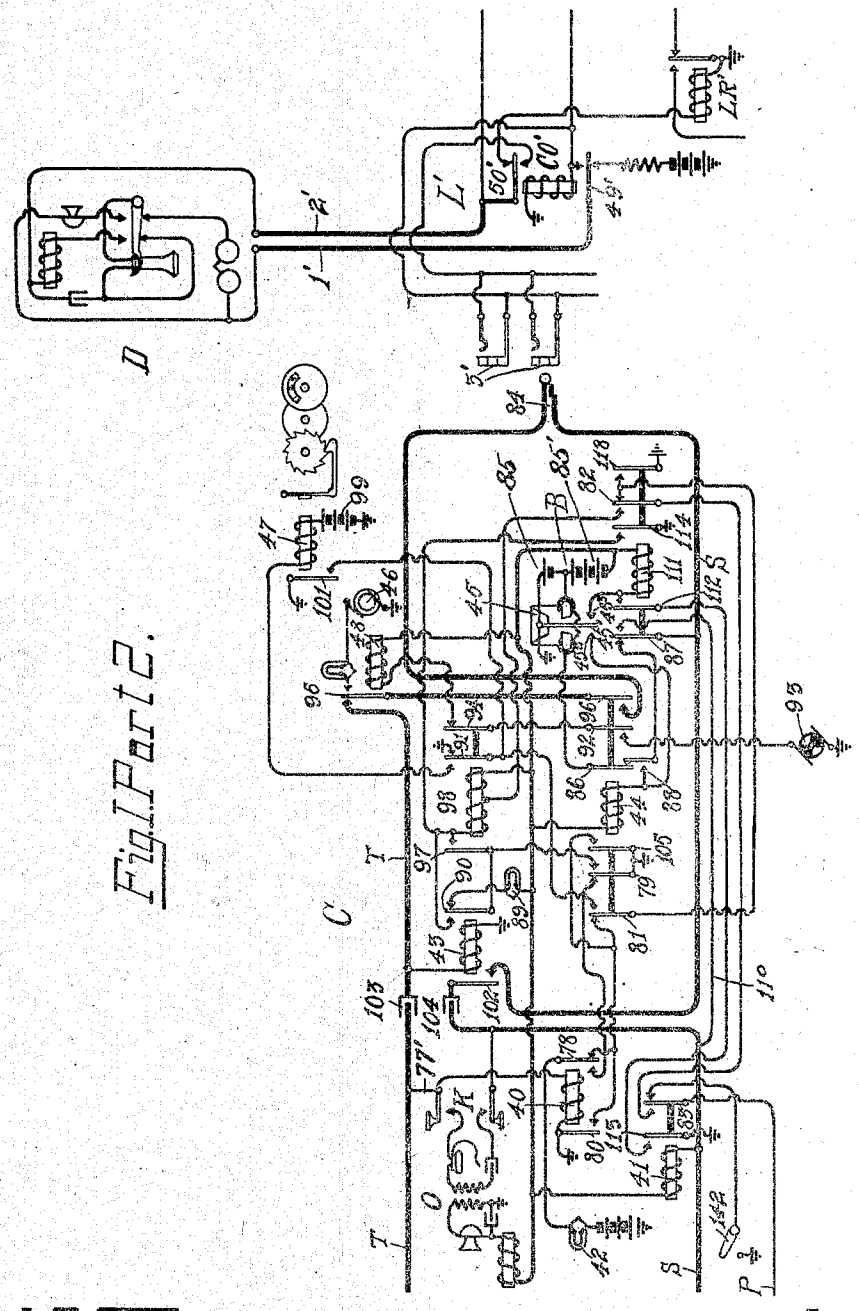

Fig. 1 Part 2.

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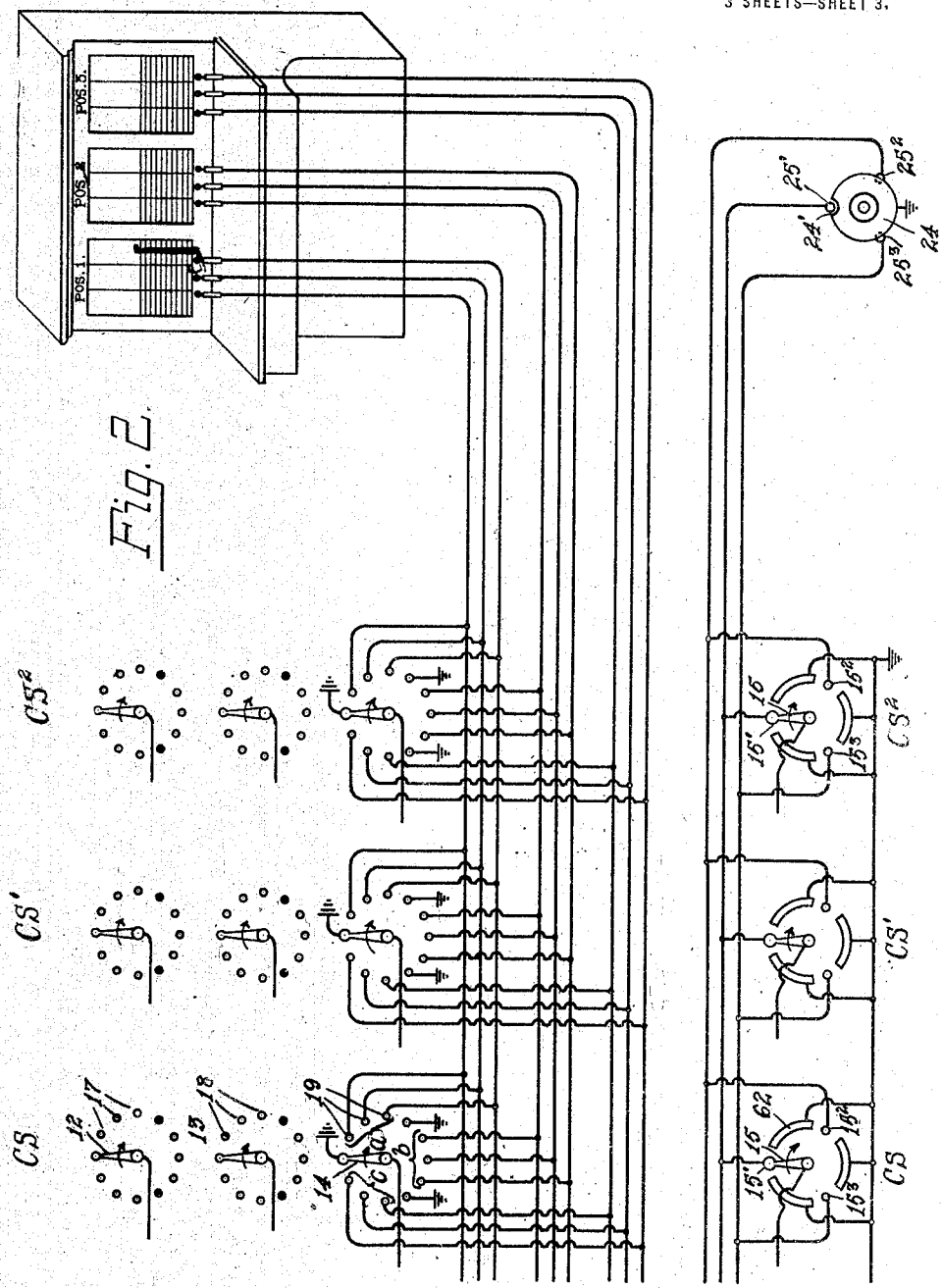

Fig. 2

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UNITED STATES PATENT OFFICE.

ALFRED H. WEISS, OF WILMETTE, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, A CORPORATION OF ILLINOIS.

CALL-DISTRIBUTING SYSTEM FOR TELEPHONE-EXCHANGES.

1,187,947. Specification of Letters Patent. Patented June 20, 1916.

Application filed November 4, 1911, Serial No. 658,510. Renewed July 15, 1912. Serial No. 709,579.

To all whom it may concern:

Be it known that I, ALFRED H. WEISS, residing at Wilmette, in the county of Cook and State of Illinois, have invented new and useful Improvements in Call-Distributing Systems for Telephone-Exchanges, of which the following is a specification.

My invention relates to call distributing systems for telephone exchanges in which the first idle cord circuit of a plurality of groups of cord circuits is automatically selected upon initiation of a call, and more particularly to means for changing the normal starting point of the selection of the cord circuits, so that the wear upon the switchboard apparatus may be equalized, an object being to provide such a system which is positive and efficient in operation, certain features and advantages thereof being pointed out in the specification and claims.

In call distributing or semi-automatic systems in which upon initiation of a call a traveling switch is set in motion to automatically connect the calling line with the first idle one of a plurality of cord circuits leading to different operators, the operator, having her cord circuits connected to the contacts nearest the normal point of the switch, will receive the greatest number of calls and it therefore follows that the apparatus at her position will receive the greatest wear, the next operator will receive the second greatest number of calls, the apparatus at her position thus receiving the second greatest amount of wear and so on along the different operators' positions. With such an arrangement it will be seen that the apparatus at certain sections of the switchboard will be exposed to more wear than others.

A feature of my invention is to provide operator controlled means whereby the cord circuits of any one of a group of operators' positions may be arranged to receive the first incoming call initiated by a subscriber's line having access to the group of operators' positions.

For a more complete understanding of my invention, reference is to be had to the accompanying drawings in which—

Figure 1 comprising parts 1 and 2 illustrates the circuit arrangement of apparatus used in establishing a connection between a calling and called substation. Fig. 2 illustrates diagrammatically several cord-selector switches with their associated cord-circuits distributed among several operators' positions at a switchboard.

Referring now particularly to Fig. 1, parts 1 and 2, by placing part 2 to the right of part 1, the ensuing description of the said figure may be readily followed. The system there illustrated includes a calling substation A having line conductors 1 and 2 extending to the line circuit L at a central office, which terminates in stationary contacts of a plurality of line selector switches LS, each one of which is paired with a cord-selector CS having its stationary contacts terminating in cord-circuits C which are adapted for connection to called lines, one of which is illustrated comprising the substation D which is connected by means of line conductors 1′, 2′ to the line circuit L′. A master switch MS is associated with switches LS and CS of part 1, being common to a plurality of such pairs and adapted upon initiation of a call to automatically start a pair of such selectors LS and CS to connect a calling line with an idle cord-circuit. I have illustrated the apparatus for a single connection but assuming an exchange of one thousand lines, there would be one thousand line circuits L, preferably divided into ten groups of one hundred lines each, each group of lines being preferably provided with ten line-selectors LS which have their stationary contacts multiply connected to the associated group of lines, while each line selector LS is paired with a cord-selector CS. On a basis as above outlined, for the one thousand line, one hundred cord-circuits C are provided, being preferably divided into ten groups of ten cord-circuits each, each group of ten being preferably disposed before an operator's position. Each cord-selector CS, of which there are one hundred, is preferably arranged to have access to any of the ten groups of cord-circuits. Therefore, each cord-selector CS has one hundred sets of stationary contacts divided into ten groups of ten contact sets each, all of said cord-selectors having their contacts multiply connected. For each group of one hundred lines and associated ten line and cord-selectors, a master switch MS is provided which is adapted upon initiation of a call from any line of the associated group, to start an idle pair of the associated group of

line and cord-selectors to automatically connect the calling line with the first idle cord-circuit to which the calling line has access. In the illustration the cord-selectors CS are shown as having three circles or rows of stationary contacts and an associated wiper, each circle being divided into three groups of three contacts each with a normal contact between each group, but as we have assumed that each cord selector CS has access to one hundred cord circuits C, each said cord selector CS would have one hundred sets of stationary contacts divided into ten groups of ten contact sets each with a normal contact between each group. The wipers of the cord selectors travel in the direction of the arrows indicated thereon and when started continue until connection is made with an idle cord circuit, so that if all of the cord circuits of the first group are busy, a switch will continue in its travel to test the cord circuits of the second group and if they are busy continues in its travel until the contacts leading to an idle cord circuit are reached.

As is well known one of the principal objects of a call distributing system of the general type of the one herein illustrated, is to concentrate the calls at the least number of operators' positions capable of handling the calls, so that with systems of the type of the present application, all of the cord-selectors are preferably arranged, to test first the cord circuits leading to the first operator's position, as is more fully illustrated in Fig. 2.

Fig. 2 which illustrates more clearly a preferred arrangement and distribution of the cord circuits, shows three cord selector switches CS, CS′ and CS². Each switch CS has its contacts divided into three groups to correspond with the arrangement of Fig. 1, part 1, the first group or group *a* having its contacts connected to the cord circuits of position 1 at the switchboard, the contacts of group *b* being connected with cord circuits of position 2 and group *c* being connected with the cord circuits of position 3. It will be seen that with the switches arranged as in Fig. 2 that the cord circuits of position 1 will be tested first and therefore it follows will receive the greatest number of calls, position 2 the second greatest number, while the last position or position 3 will receive the least number of calls, thus causing most wear upon the apparatus of the first position, this wear occurring less as the positions advance. To provide against the disadvantages or objections to call distributing systems as just outlined, I provide means for shifting the normal positions of the switches CS, CS′, etc., this means including an operator controlled switch SW which is adapted to be rotated so that any one of its contacts may be left ungrounded, the ungrounded contact determining the normal resting position of the wipers of the associated cord selectors CS, CS′ and so on, as will be more particularly pointed out.

Equipment Fig. 1.—Referring now more particularly to the equipment of the circuits as illustrated in Fig. 1, which it is to be understood is duplicated as previously outlined, the calling substation A illustrated, is a well known form of substation comprising the usual switchhook and receiver hung thereon, thus maintaining the lower switchhook contacts normally closed, the removal of the receiver allowing the switchhook to move upward interrupting the lower contacts and closing the upper switchhook contacts. Substation A also includes the usual call bell, transmitter, impedance coil and condenser of the form of substation shown.

At the central office a line circuit L is connected to substation A by means of line conductors 1 and 2, the said circuit L including a line relay LR, a cutoff relay CO, and called line terminals, preferably jacks 3 multiply connected to the line and distributed so as to be accessible by the different operators at the switchboard. The tip and sleeve conductors T and S are multiply connected to the stationary terminals of line selectors LS, LS′, etc., which have access to said line, each line being multiply connected to ten such switches LS. Each switch therefore has one hundred sets of stationary contacts 4, 5, 6, connected to the associated group of one hundred lines. Line selector LS is a well known form of rotary switch having three circles or rows of one hundred contacts each. Each row of contacts 4, 5, 6, has a wiper 7, 8 and 9 respectively, all mounted upon a single shaft which is adapted to be rotated step by step by a motor magnet 10 and associated ratchet mechanism 11 which has its ratchet wheel rigidly secured to the shaft carrying the wipers 7, 8, 9. In the operation of the switch LS, magnet 10 steps the wipers around to the contacts of a calling line where they remain throughout the connection and are not restored to any normal point, but after disconnection remain in such a selected position, until the switch is started to connect with another calling line, thus the line selectors LS are preferably a non-restoring switch, although it is to be understood that other forms of line selectors may be used as my invention is not limited to this precise arrangement. Each line selector LS also includes a test relay TR which is energized to control the selection of terminals 4, 5, 6 of a calling line.

Each cord selector switch CS comprises four circles of contacts, each circle having a wiper such as 12, 13, 14, and 15, all mounted upon a single shaft and adapted to be stepped from contact to contact by means of a well known pawl and ratchet arrangement which is actuated by a motor magnet 16.

The three circles of contacts 17, 18 and 19 each comprises one hundred contacts divided into ten groups of ten each with a normal contact 20, 21, 22 between each group. The fourth circle of contacts, and which is associated with the wiper 15, is an off normal arrangement for controlling off normal relay ON and in conjunction with the hand operated switch SW controls the normal resting point of wipers 12, 13, 14 and 15 of the cord selectors.

As previously stated the line selectors and cord selectors are arranged in pairs, and each such pair is provided with a polarized relay 26 for controlling the release thereof or the application of a busy signal from busy back BB, and relays 27 and 28 which are also used in controlling the release and busy back signal.

Switch SW comprises a grounded plate 24 and associated contacts 25′, 25^2 and so on, there being as many contacts 25 as there are groups of contacts on the connector switches CS controlled thereby. One switch SW is provided for all of the cord selectors CS of a group, in the present instance there being one hundred cord selectors to the group, therefore contact 25′ is common to all of the contacts 15′ of the switches CS, contact 25^2, to all of the normal contacts 15^2, contact 25^3 is common to all of the contacts 15^3 and so on throughout the ten normal contacts. Plate 24 of switch SW is preferably arranged to be manually rotated so that its cutaway portion 24′ may be moved adjacent any of the associated contacts 25, so that any of the normal contacts 15′, 15^2 and so on may be made ungrounded, thereby determining the normal resting position of the one hundred cord selectors CS controlled by switch SW. For instance, with the apparatus arranged as illustrated, contact 15′ of all of the cord selectors is ungrounded. Therefore, when any of the switches CS are restored after having been used in establishing a connection, they return to the normal resting point 15′. With this arrangement as previously stated, it will be seen that cords leading to position No. 1 of the switchboard are always the first ones tested for selection.

Assuming now that it is desired to shift the incoming calls so that they will test the cord circuits of position No. 2 first, plate 24 of switch SW is rotated to unground its contact 25^2, this operation causing the grounding of its contact 25′ so that the normal resting position of the switches CS is moved from contact 15′ to 15^2 and thereafter when any of the switches are restored they will come to rest at the normal position 15^2, and thereafter when operated will start to test the cord circuits leading to position No. 2 first and if these cord circuits are busy, will continue over contacts leading to position No. 3 and so on. If all the cord circuits of the positions No. 4, 5, 6, etc., are busy, the switch will continue until its wipers reach the group of contacts leading to cord circuits of position 1 and if one of these is idle it will be selected.

Master switch MS.—Each master switch MS, which as previously stated is associated with ten pairs of line selectors and the associated group of one hundred telephone lines, comprises three wipers 29, 30 and 31 and associated circles of contacts 32, 33 and 34, there being ten such contacts in each row, each set being connected with one of the associated ten pairs of switches LS and CS. The said wipers are mounted upon a single shaft having a ratchet wheel 35 rigidly mounted thereon and adapted to be rotated by means of the pawl controlled by motor magnet 36. Each energization and deënergization of magnet 36 effects one step of wipers 29, 30, 31 from one set of contacts to the next set. Each master switch MS includes a relay 37 which is common to and connected to the alternate contacts 39 of the line relays LR of the associated group of one hundred lines, this relay 37 being energized upon initiation of a call from any of said lines. A relay 38 is also provided for each switch MS, being adapted to effect the advancement of the wipers of the master switch to the next idle pair of line and cord selectors after an operated pair have been connected with a calling line.

Cord circuit C.—The preferred cord circuit arrangement as illustrated comprises a pair of answering supervisory relays 40 and 41 and supervisory lamp 42. An operator's circuit O is also provided, being adapted to be connected to the cord circuit strands by means of key K. The conductors T and S extend from contacts 17 and 18 respectively of the cord selectors and the third or test conductor P extends from contacts 19 of switches CS, to cord circuit C. An operator controlled switch 142 is connected through normal contact 83 of relay 41 to conductor P and is adapted to ground the said conductor to make its cord circuit C artificially busy and unselectable. A pair of supervisory relays 43 and 44 are also provided, being associated with the tip and sleeve strands respectively of the cord circuit.

Cord circuit C is adapted for automatic ringing and busy signal, being so arranged that the operator may make connection with a called line without first testing it for its idle or busy condition, and responsive to inserting the plug in the jack of the called line ringing current is automatically connected to the called line if idle or a busy signal is automatically transmitted to the calling substation if the called line is busy. To control the automatic application of ringing or busy currents, the polarized relay 45 is provided, being adapted to move its

armature to the left or to the right according to the electrical condition of the sleeve contact of the jack of the called line, thereby effecting the operation of the ringing or busy apparatus respectively. A ringing relay 48 is adapted to be operated if the called line is idle, to periodically connect ringing current from the ringing generator 46 to the terminals of the called line. A register magnet 47 and associated register mechanism of any well known type is also provided for each cord circuit being adapted to register the number of calls received at each cord circuit. Several other relays are provided and the functions of these will be more particularly pointed out in the description of operation.

The called substation D is equipped similar to substation A being connected by line conductors 1′, 2′, with a line circuit L′ similar to line circuit L, its equipment having the same reference characters as equipment of line circuit L but with the suffix prime.

Operation.

Assuming that a subscriber at substation A desires connection with another subscriber, by removing the receiver from his switchhook, a path for current through the line relay LR is established from battery through protective resistance and normal contact 49, line conductor 1, substation A, line conductor 2, normal contact 50 through the winding of relay LR to ground, energizing said relay thereby removing the ground connections from the test contacts 6 of the calling line and due to the closing of its alternate contact 39 closing a path for current through relay 37 of the master switch, causing its energization. Alternate contact 51 of relay 37 is thereby closed establishing a locking circuit for relay 37 to ground at normal contact 52. Also upon energization of relay 37 its alternate contacts 53 and 54 are closed to cause the starting of a pair of line and cord selectors LS and CS in the following manner: The test relays TR and TR′ are energized, the energizing path for TR being traced from ground through alternate contact 53, normal contact 55, wiper 29 and contact 32, normal contact 56 and the winding of relay TR to battery, causing its energization, but without effecting the operation of switch LS until relay ON energizes as will be described. Upon the closing of alternate contact 71 of relay TR, a locking circuit therefor is established from the grounded test contact 6 with which wiper 9 is in engagement. The energizing path for the current for relay TR′ is traced from ground through alternate contact 54, normal contact 57, wiper 31 and contact 34, normal contact 58, normal contact 59 and the winding of relay TR′ to battery, causing its energization whereby an energizing circuit for magnet 16 is closed, this circuit being traced from alternating current generator through the winding of magnet 16, alternate contact 60 and normal contact 61 to ground. Magnet 16 thereupon steps the wipers of switch CS into engagement with the first set of contacts, the wiper 15 moving into engagement with the first grounded plate 62, thereby closing a circuit for off normal relay ON traced from said grounded plate 62 over wiper 15, alternate contact 63 and the winding of relay ON to battery. Relay ON is thereby energized whereby its alternate contact 64 is closed, establishing a locking circuit for said relay ON to said contact 64 from the grounded wiper 15. The energization of relay ON effects the starting of the switch LS, but the operation of the cord selector CS will first be described although the two switches LS and CS are operating simultaneously.

The wipers of the switch CS it will be remembered, were stepped into engagement with the first set of contacts, and due to the opening of normal contacts 65, 66 the line wipers 12 and 13 are disconnected from the talking strands T and S so as not to interfere with any existing connections while the wipers of switch CS are being advanced. Assuming that the first set of contacts 17, 18 and 19 with which wipers 12, 13 and 14 engage, lead to a busy cord circuit, its test contact 19 is grounded so that a maintaining circuit for test relay TR′ is effected, traced from the said grounded contact 19, wiper 14, alternate contact 67, normal contact 68 through the winding of relay TR′ to battery. Magnet 16 therefore having its circuit maintained closed, advances the wipers 12, 13, 14 and 15 another step and continues to advance the wipers until an idle set of contacts are reached which we will assume are the contacts connected to the cord circuit C illustrated. The cord circuit C being idle, its test contact 19 is ungrounded and therefore the maintaining circuit for test relay TR′ is interrupted, causing its deënergization and thereby interrupting the circuit for magnet 16 whereby the wipers remain inert. It will be noted that normal contacts 22 of the circle of test contacts 19 are grounded, so that when wiper 14 passes from one group of contacts to the next, the maintaining circuit for relay TR′ will not be broken.

As previously described relay ON was energized upon the first step of off normal wiper 15, thereby closing an energizing circuit for magnet 10 of line selector LS traced from ground through alternate contacts 69, 70 and the winding of magnet 10 to alternating current generator, causing an operation of magnet 10 which advances wipers 7, 8 and 9 into engagement with the first set of contacts 4, 5 and 6 respectively. As

suming these contacts lead to a normal line circuit, the test contact 6 thereof will be grounded through the armature of the associated line relay LR³, thereby establishing a maintaining circuit for test relay TR traced from the said grounded contact 6 through wiper 9 and alternate contact 71 and the winding of relay TR to battery. Thus it will be seen that as long as wiper 9 is wiping over grounded contacts 6, relay TR is maintained energized and upon reaching the contact 6 of the calling line of substation A which we will assume is the first calling line reached, its contact 16 being ungrounded, relay TR has its circuit interrupted and therefore deënergizes interrupting circuit for magnet 10, whereby wipers 7, 8 and 9 remain in engagement with the terminals of the line of substation A. It will be noted that while switch LS is traveling, the normal contacts 72, 73 of relay TR interrupt the continuity of the talking strands T and S so that wipers 4—5 will not interfere with any existing connections. Upon deënergization of magnet TR and assuming that the cord selector switch CS is still traveling to seek connection with an idle cord, and therefore its relay TR′ still energized, a circuit for cut off relay CO is established from ground through the winding of relay CO, contact 5 and wiper 8, the lower heavily marked sleeve conductor S to alternate contact 74, through protective lamp 75 to battery. Upon energization of CO, the circuit for line relay LR is interrupted, due to the opening of normal contacts 49—50, whereupon relay LR deënergizes, closing its normal contact 39, thereby grounding the connected multiple test contacts 6 and preventing any other line selector which may be started, from making connection with this line. Although alternate contact 39 is interrupted at this time, relay 37 of the master switch does not deënergize, due to its locking circuit through alternate contact 51 as previously described, or from an alternate contact 39 of some other calling line of the group. Cut-off relay CO remains energized over the path just traced until the cord selector switch CS has operated, whereby a substitute path for current is supplied as will be described.

Until the calling line is selected, the wipers of master switch MS remain in engagement with the contacts leading to the operating selector switches LS, CS, but upon switch LS connecting with a calling line and the consequent deënergization of test relay TR as described, the wipers of master switch MS are advanced until the contacts leading to another pair of selector switches LS, CS, are reached, this operation being as follows: As just described relays TR and LR deënergized, t[h]refore a circuit for relay 38 of master switch MS is established, traced from ground at normal contact 39 of relay LR, contact 6, wiper 9, normal contact 71, alternate contact 76, conductor 77, contact 33 and wiper 30, and the winding of relay 38 to battery, causing its energization and interrupting its normal contacts 52, 55 and 57, (the opening of normal contact 52 allowing relay 37 to deënergize if no other line of the group is calling) and closing its alternate contact 52 to establish a circuit for magnet 36, whereby said magnet is energized and advances wipers 29, 30 and 31 into engagement with the next set of contacts 32, 33, 34, respectively. If these contacts lead to a busy pair of line and cord selectors, they will have their test contact 33 grounded, whereby a maintaining circuit for relay 38 is established causing magnet 36 to advance the wipers of master switch MS another step and this advancement continues until wiper 30 engages an ungrounded contact 33, whereby the circuit for relay 38 is interrupted, causing its deënergization whereby the wipers of the master switch remain in engagement with the selected set of contacts leading to an idle pair of selector switches. Should another line in the group be calling, as previously stated, relay 37 is maintained energized from the grounded alternate contact 39 of the line relay of the calling line and therefore when the relay 38 deënergizes after an idle pair of selector switches have been selected as just described, it will be seen that the selected pair will be started to seek connection with the other calling line.

Returning now to the cord selector CS, it will be remembered that wipers 12, 13, 14 and 15 have been advanced to engage the contacts leading to the idle cord circuit C illustrated, and test relay TR′ therefore deenergized. The closing of normal contacts 65—66 of relay TR′ therefore establishes a continuity of the talking strands T and S from the cord circuit C to the calling substation A.

It will be remembered that cut-off relay CO was energized by current through alternate contact 74 of relay TR′, but upon the deënergization of this relay current is supplied from battery through the winding of relay 41 and along the sleeve conductor through the winding of cut-off relay CO to ground, causing the energization of relay 41, and this supply of current also flows through alternate contact 49, line conductor 1, substation A, conductor 2 and back over the tip conductor T to branch conductor 77′ and through supervisory relay 40 to ground, causing its energization, so that both supervisory relays 40 and 41 are energized. Supervisory lamp signal 42 is therefore energized by current over a path traced from battery through said signal 42, alternate contact 78, and normal contact 79 to

ground. Also upon energization of relays 40, 41, ground is connected to the test conductor P to render cord circuit C unselectable, this ground connection being traced from alternate contact 80 of relay 40, normal contacts 81, 82, alternate contact 83 and over conductor P to its multiple contacts 19 rendering them busy.

In the operation of the system as just described, it was assumed that line selector LS connected with the terminals of the calling line before its paired cord selector CS connected with the terminals of the cord circuit C. We will now assume that cord selector CS connects with cord circuit C before selector LS connects with the calling line. In that case, as soon as wipers 12, 13 and 14 connect with the terminals 17, 18 and 19 of cord circuit C, which is an idle cord circuit, relay TR′ deënergizes as before, closing its normal contacts 65, 66, but as switch LS has not completed connection with the calling line as yet its relay TR is still energized so that conductors T and S are still interrupted at contacts 72, 73 of said relay TR.

It will be remembered that in the previously described connection cut-off relay CO was initially energized by current from battery flowing through alternate contact 74 of relay TR′, but in the present case, TR′ having deënergized before the line selector connects with the calling line, relay CO depends for energizing current from battery flowing through supervisory relay 41 of the cord circuit. This occurs in the following manner: Upon connection of line selector LS with the terminals of the calling line, relay TR deënergizes thereby closing its normal contact 71 and effecting the advancement of the master switch wipers to the next idle pair of selectors in a manner as previously described. Also upon deenergization of relay TR its contacts 72, 73 are closed, and an energizing circuit for cut-off relay CO is provided by current flowing from battery through supervisory relay 41 back over sleeve conductor S, and through the winding of relay CO to ground energizing both relays 41 and CO, the energization of CO restoring relay LR as before. Following the energization of relay CO its alternate contact 49 is closed and therefore a branch path for said current is established out over the calling line and back along the tip conductor T and through tip supervisory relay 40 to ground, also causing its energization. It will be noted that relay 41 energized previous to relay 40 so that a battery impulse was connected to its conductor P flowing from battery through supervisory signal 42, normal contacts 78, 81, 82 alternate contact 83 to conductor P, and its multiple contacts 19, this flow of current continuing through wiper 14 to spring 67. From spring 67 it will be noted that a path extends through normal contact 67′, polarized relay 26, alternate contacts 100—64 to the grounded wiper 15, but to prevent a premature operation of polarized relay 26 at this time (which would effect the release of the selector switches) a shunt circuit is provided being traced from normal contact 67^2, alternate contact 58 and wiper 31, normal contact 57 and alternate contact 54 to ground, as it will be remembered that master switch MS does not move until the line has been selected, which in this case was subsequent to the selection of the cord circuit. From this it will be seen that due to the shunt path from ground to normal contact 67^2 polarized relay 26 is not prematurely operated, although current is connected to test conductor P as is done when a release is desired after conversation is completed. The operator in response to the signal 42, which is lighted in response to relays 40, 41, operates her listening key K, thereby connecting her telephone set O to the talking strands leading to the substation A, and finding that the calling subscriber desires connection with the substation D, inserts plug 84 in a multiple jack 3′ of the called line without any preliminary testing or subsequent operation of ringing keys, as it will be remembered that the cord circuit C is arranged for automatic ringing and busy.

Called line idle.—Assuming that the line of substation D is idle, the sleeve of jack 3′ is connected to ground through cut-off relay CO′, therefore when plug 84 is inserted in the jack, a flow of current through polarized relay 45 is established from the negative pole of section 85 of battery B, normal contacts 86, 87, sleeve conductor S, sleeve contacts of the plug and jack and the winding of relay CO′ to ground, this flow being in a direction to move the armature 45′ toward the left. A circuit for sleeve supervisory relay 44 is therefore established from ground through contacts 45′, 45^2 and the winding of relay 44 to battery B. Relay 44 is therefore energized closing its alternate contact 88 and connecting its winding through normal contact 87 in series with the winding of cut-off relay CO′, this circuit maintaining the two relays 44, CO′ energized. Upon energization of 44, its normal contact 86 being interrupted, polarized relay 45 returns to normal. Due to the opening of normal contact 79 of relay 44, signal 42 is effaced and upon the closing of alternate contact 79 supervisory signal 89 is lighted, this circuit being traced from ground at alternate contact 79, through normal contact 90 and signal 89 to battery B. Although the interruption of normal contact 81 of relay 44 disconnects the initial ground connection to the test contact P, the closing of alternate contact

81 connects ground from normal contact 91 to the test conductor P, thus maintaining it busy. The called line being idle, ringing current is now to be applied, this operation being effected by the closing of alternate contact 92 of relay 44 whereby relay 48 is periodically energized, its circuit being traced from ground through interrupter 93, alternate contact 92, normal contact 94 and the winding of relay 48 to battery, whereby the relay 48 has its armature periodically attracted to connect ringing current from generator 46 to the terminals of the called line. This circuit is traced from said generator 46 through protective lamp through alternate contact 95 each time relay 48 is energized, alternate contact 96, over the tip conductor to the tip contacts of the plug and jack, alternate contact 50′, line conductor 2′, condenser and call bell at substation D, returning over limb 1′, alternate contact 49′, sleeve contacts of the jack and plug, normal contact 87, the winding of relay 44 through battery B to ground. In response to the signal received, the receiver at substation D is removed and upon the following deënergization of ringing relay 48 a path for direct current is established to energize the tip relay 43 in the usual manner, this path for current being from ground through said relay 43, normal contact 95, alternate contact 96, tip contacts of plug and jack over the line conductors at substation D back through the sleeve contacts of jack and plug, sleeve conductor S, normal contact 87, alternate contact 88, and the winding of relay 44 to battery, whereby relay 43 is energized interrupting the circuit for signal 89 which is thereby effaced. The closing of alternate contact 90 of supervisory relay 43 establishes a circuit for relay 98, the path for current being traced from battery B through the windings of relay 98, alternate contact 90 to grounded alternate contact 79, energizing relay 98 and due to the closing of its alternate contact 97 a substitute locking path for itself is established from the grounded alternate contact 79. The energization of relay 98 causes the interruption of its normal contact 94, whereby the energizing circuit for the ringing relay 48 is interrupted and the said relay 48 remains inert. Also following the energization of relay 98, its alternate contact 91 is closed, thereby connecting battery 99 through the winding of relay 47 to the test conductor P in place of the ground at normal contact 91, so that the register magnet 47 is energized by current from said battery 99 flowing over the previously described path to conductor P, contacts 19 and wiper 14, normal armature 67, normal contact 67′ to winding of polarized relay 26, alternate contacts 100—64 to the grounded wiper 15, this flow of current energizing magnet 47, but being in a direction whereby the tendency of polarized relay 26 is to pull its armature toward the right. Upon the closing of alternate contact 101 of register magnet 47, it will be seen that a locking circuit for itself is established through alternate contact 91, this ground connection from alternate contact 101 at the same time restoring the grounded or busy condition of conductor P and its multiple contacts 19 and also shunting the winding of polarized magnet 26, whereby there is no attraction upon its armature.

Returning now to the tip relay 43, upon its energization its alternate contact 102 is closed, thereby establishing the continuity of the talking circuit between the substations A and D which may be traced over the heavily marked conductors and having the condensers 103 and 104 interposed. Talking current for substation A is supplied through relays 40—41 of cord circuit C, while talking current for substation D is supplied through relays 44—43 of cord C over the paths previously traced. The substations A and D are now connected for conversation.

Release.—After the subscribers have finished conversation they replace their receivers upon their respective switchhooks, the replacing of the receiver at substation D interrupting the circuit for tip relay 43 which deënergizes, closing its normal contact 90 and again lighting supervisory lamp 89 by current over the previously described path. The restoration of the receiver at substation A interrupts the flow of current through tip relay 40, causing its deënergization whereby supervisory lamp 42 is again lighted over a path traced from battery through lamp 42, normal contact 78 to ground at alternate contact 105. The operator in response to the two signals, withdraws plug 84 from its connected jack 3′ thereby interrupting the circuit of supervisory relay 44 and cut off relay CO′, relay CO′ deënergizing and restoring the line of substation D to normal. The deënergization of relay 44 interrupts the locking circuit for relay 98 at alternate contact 79, allowing said relay to restore, while the closing of normal contact 81 of relay 44 connects battery to the test conductor P, thereby effecting the energization of polarized relay 26 to cause the restoration of cord selector CS. The energizing path for said polarized relay 26 is traced from battery through supervisory lamp 42, normal contacts 78, 81, 82, alternate contact 83, conductor P, contact 19, and wiper 14, armature 67, normal contact 67′, the winding of polarized magnet 26, alternate contact 100, the winding of relay ON, and battery, to ground. It will be noted that the current just traced is in a direction opposite to that

when battery 99 (which is grounded oppositely to battery B) was connected with polarized relay as previously described, so that in this instance the armature of relay 26 is attracted toward the left closing its alternate contact 107, thereby connecting battery through lamp 75 and the winding of relay 28 to ground, causing its energization. Contact 109 is thereby closed effecting the energization of relay 27 by a flow of battery through protective lamp 75, said alternate contact 109, winding of relay 27, alternate contacts 100—64, to the grounded wiper 15, whereupon relay 27 energizes closing its alternate contact 68 and establishing a circuit for relay TR′ traced from battery through the winding of said relay TR′, alternate contact 68, winding of relay 27, through the previously described path including alternate contacts 100, 64, to the grounded wiper 15, whereby said relays TR′ and 27 are maintained energized over this series circuit.

Following the energization of relay TR′ its normal contact 67′ is interrupted, thereby causing the restoration of polarized relay 26 whereby the circuit for relay 28 is interrupted, causing its restoration. Also upon energization of relay TR′ its alternate contact 60 is closed, thereby again establishing an energizing circuit for motor magnet 16 over the previously described path from ground at normal contact 61, magnet 16, thereupon energizing and deënergizing by pulsations of current from the alternating current generator and advancing wipers 12, 13, 14 and 15 toward the normal resting point 15′. It will be noted that wiper 15 in passing from a grounded segment 62 to a grounded contact 15^2 and so on, makes before breaks, thus maintaining the circuit for off normal relay ON until the wiper 15 reaches the ungrounded contact at its normal position. It is to be remembered that relays ON, 27 and TR′ all were maintained energized during this releasing operation from the grounded wiper 15, so that upon its reaching the ungrounded contact these three relays restore to normal, the restoration of relay TR′ interrupting the circuit for motor magnet 16 and preventing any further advance of the wipers.

At the cord circuit C it will be remembered that although relay 40 was deënergized when the subscriber at A restored his receiver, relay 41 still remained energized due to the flow of current through its winding and cut off relay CO in series, but upon energization of relay TR′ this circuit for relay 41 was interrupted at normal contact 66, allowing relay 41 to restore, thus cord circuit C is again idle and in condition to be selected, as the grounded or busy condition was removed from the test contacts 19 by the energization of relay TR′. Although the energization of relay TR′ caused the restoration of relay 41 of the cord circuit, the closing of contact 74 of relay TR′ again connected battery through lamp 75 over the sleeve conductor to the cut-off relay CO maintaining it energized, but upon the final deënergization of relay TR′, that is, when switch CS has restored, the cut-off relay is restored, while upon deënergization of off normal relay ON, due to the interruption of its alternate contact 76 ground is disconnected from the test contact 33 of the master switch so that the paired line and cord selectors LS and CS respectively are again available to be started for establishing another connection. During the restoring movement of switch CS, relay 27 remaining energized as stated, its grounded alternate contact 122 maintains test contact 33 busy.

Called line busy.—Assuming now that the connection has been extended from a calling substation A to the cord circuit C as previously described, and the operator inserts plug 84 in a jack 3′ of the line of substation D which is busy. If the line of substation D be busy as a calling line, its cut-off relay CO′ is energized by current from battery B flowing through the winding of a supervisory relay 41, while if busy as a called line, its relay CO′ is energized by current from battery B through a relay 44. Therefore, upon insertion of plug 84 into jack 3′, the potential at the sleeve of the jack is greater than the sleeve of the plug, due to the connection from the sleeve of the plug through polarized relay 45 to a middle point at battery B while the sleeve of the jack is connected to section 85′ of battery B, therefore, a flow of current will be effected in such direction that the armature 45′ of relay 45 is attracted toward the right, making connection with alternate contact 45^3 and establishing a circuit for relay 111 which is energized, closing its contact 112 thereby establishing a locking circuit for itself to ground at alternate contact 113 of relay 41, and due to the interruption of its normal contact 87 the energizing circuit for relay 45 is interrupted allowing the restoration thereof. The closing of contact 114 of relay 111 establishes a circuit for relay 98 traced through the windings of said relay to battery B, while the closing of alternate contact 82 of relay 111 connects battery B through the right hand winding of relay 98 through alternate contact 83 of relay 41 to conductor P, then over contact 19, wiper 14, armature 67, normal contact 67′, winding of polarized relay 26, alternate contacts 100 and 64 to the grounded wiper 15, this flow of current being in a direction to cause polarized relay 26 to attract its armature toward the left and close alternate contact 107 to cause the

application of a characteristic busy signal to the calling line, as will be described.

Returning now to relay 98 which was energized responsive to energization of relay 111, due to the closing of its alternate contact 97, a path for current through signal 89 is established, traced from battery B, signal 89, normal contact 90 and alternate contacts 97, 114 to ground, lighting said signal 89.

Returning now to polarized relay 26, upon its energization as previously described, a circuit for relay 28 is established through contact 107, relay 28 to ground, thereby closing its alternate contacts 115, 116, and connecting the winding of relay 28 to the tip conductor T. Said relay 28 is therefore maintained energized by current over the calling line, being traced from battery through the winding of supervisory relay 41, over the sleeve conductor S, over the line conductors and to substation A, returning over conductor T through alternate contact 116, and the winding of relay 28 to ground, thus placing this relay under the control of the subscriber at substation A. The closing of alternate contact 109 of relay 28 effects the energization of relay 27 by current flowing from battery through lamp 75, the winding of relay 27, and alternate contacts 100—64, to the grounded wiper 15, as previously described, followed by the energization of relay TR′ due to the closing of alternate contact 68 of relay 27, whereby relays 27 and TR′ are connected in series as previously described. It will be remembered that in the previously described operation of relays 27, TR′ that switch CS immediately started its restoring movement, but in the present case it will be remembered that relay 28 is maintained energized over the calling line, holding its contact 61 open so that motor magnet 16 of switch CS is not operated until relay 28 deënergizes. Upon energization of relay TR′ its normal contacts 65—66 are interrupted, thereby disconnecting the initial flow of current through relay CO, but the closing of alternate contact 74 establishes a substitute path from battery through lamp 75 to maintain the cut-off relay CO and relay 28 energized. Also upon energization of relay TR′ the circuit for polarized relay 26 is interruped at contact 67′ causing its restoration.

From the operation as just described, it will be seen that no ringing current was applied to the called for line which was busy, so that the calling subscriber must be notified of its busy condition, this being accomplished by the application of a characteristic busy signal from apparatus BB which is connected to the tip conductor T through alternate contact 115 of relay 28, the current from said apparatus BB then flowing over the line conductor 2, the receiver of substation A returning over line conductor 1, winding of cut-off relay CO to ground, thus indicating to the calling subscriber that the line of the called substation is busy.

Returning to cord circuit C it will be remembered that the signal 89 is lighted, so that when the relay TR′ opens its normal contact 65—66 interrupting the energizing circuit for relay 40, the said relay deënergizes closing its normal contact 78, and establishing a circuit for supervisory signal 42 from battery through said signal 42, normal contacts 78—81 to ground at alternate contact 118. Although the initial energizing circuit for relay 41 is interrupted when normal contact 66 of relay TR′ is interrupted, a substitute path for said relay 41 was provided upon energization of relay 111 due to the closing of its alternate contact 87, whereby current flows through relay 41, conductor 119, alternate contact 87 and then through the sleeve contacts of the plug and jack and winding of cut-off relay CO′ to ground. The operator noting the illumination of the signals 42, 89, withdraws the plug 84 from the connected jack, whereby the circuit for relay 41 is interrupted, allowing it to restore. Its contact 113 is thus interrupted allowing the restoration of relay 111, followed by the restoration of relay 98 due to the interruption of alternate contacts 82 and 114. The apparatus of cord circuit C is now in its normal condition, and the ground or busy condition having been removed from conductor P, and its connected contacts 19, cord circuit C is available for other connections.

The calling subscriber at A in response to the busy signal replaces his receiver upon its switch hook, whereby the circuit for relay 28 is interrupted, causing its restoration and the closing of its normal contact 61, whereby an energizing circuit for motor magnet 16 is established, and as before, causing the restoration of wipers 12, 13, 14, 15 to normal. Upon reaching normal, the locking circuit for relays ON, 27 and TR′ is interrupted, due to the wiper 15 reaching a normal ungrounded contact, thus causing these relays to restore as before. Upon restoration of said relays, the ground connected to contact 33 of master switch MS is removed as before, thus placing switches LS and CS in condition to be started again to establish another connection. The restoration of relay TR′ also interrupts the energizing circuit for cut-off relay CO, due to the interruption of alternate contact 74, allowing said relay CO to deënergize and restoring the substation control of line circuit L. All of the apparatus used in establishing the connection having been restored, it is now available for further use in establishing other connections.

Due to the definite normal relation between the wipers of the cord selectors and

their contacts and connected cord circuits with the hand switch SW in the position as illustrated, it will be seen that the cord circuits of position No. 1 would, no doubt, receive the greatest number of calls, position No. 2 a less number and so on along the board. Should it be desired to change the order of testing the cord circuits, and assuming that the cord circuits of position No. 2 are to be tested first when a line is calling, switch SW is rotated so that contact 25^2 is ungrounded whereby the normal resting point of selectors CS controlled thereby will be changed, this change being effected upon the subsequent operation of the selectors in the following manner: Assuming, as stated, the switch SW was moved and contact 15^2 ungrounded, upon the subsequent operation of switch CS, it will be advanced to the first idle cord circuit as usual which we will assume is cord circuit C connected with the first group of contacts 17, 18, 19. Thereafter when the switch CS is released its wipers are advanced until wiper 15 reaches the ungrounded contact 15^2 whereby the locking circuit for the relays of selectors LS and CS is interrupted as before, thereby stopping switch CS with its wipers resting at normal point 15^2. Thus it will be seen that due to the operation of switch SW, the normal relation between the cord selector wipers and their contacts and connected cord circuits has been changed, causing a different order of testing when a cord selector is started to seek an idle cord circuit.

While I have illustrated a plurality of batteries, it is to be understood that all of the batteries with the exception of battery 99 may be one and the same, as it will be noted that battery 99 has a negative pole grounded, while the other batteries have a positive pole grounded, the plurality of batteries having been shown that the drawings might be simplified.

Although I have incorporated my invention in a particular telephone system, it is apparent that it may be applied to systems of various characters. Also with reference to the grouping of the cord circuits at the selectors and the division of the cord circuits at the different operators' positions, it is to be understood that various changes and modifications thereof may be made, and therefore I do not desire to be limited to the exact arrangement of my invention as illustrated, but aim to cover all those changes and modifications as come within the spirit and scope of the appended claims.

What I claim as new and desire to secure by United States Letters Patent is:

1. A telephone system comprising a plurality of cord circuits, an automatic traveling switch for testing said cord circuits in regular order for connection thereto, whereby a certain one is tested first when said switch is started, and operator controlled means for varying the starting point of said switch whereby others of said cord circuits will be the first ones tested.

2. A telephone system comprising a plurality of cord circuits, an automatic traveling switch having stationary contacts connected to said cord circuits, a normal starting point for said switch whereby certain ones of said cord circuits are tested first when the said switch is started, and operator controlled means for varying the starting point of said switch whereby others of said cord circuits will be the first ones tested.

3. A telephone system comprising a plurality of cord circuits distributed among operators' positions at a switchboard, an automatic traveling switch having stationary contacts connected in regular order to said cord circuits, a normal starting point for said switch whereby a certain one of said cord circuits is tested first when the said switch is started, and manually controlled means for varying the starting point of said switch whereby others of said cord circuits will be the first ones tested.

4. A telephone system comprising a plurality of cord circuits, an automatic traveling switch having stationary contacts divided into groups and connected to said cord circuits, a normal starting point for said switch whereby the cord circuits of a certain group are tested first when said switch is started, and operator controlled means for varying the starting point of said switch whereby the cord circuits of any other group will be the first ones tested.

5. A telephone system comprising groups of cord circuits distributed among operators' positions at a switchboard, an automatic traveling switch having stationary contacts connected to the groups of cord circuits, a normal starting point for said switch whereby the cord circuits of a certain group are tested first when said switch is started, and manually controlled means for varying the starting point of said switch whereby the cord circuits of other groups will be the first ones tested.

6. A telephone system comprising a plurality of cord circuits distributed among operators' positions at a switchboard, an automatic traveling switch having stationary contacts connected to said cord circuits, a traveling wiper for connecting to said stationary contacts, there being a definite normal relation between said wiper and said contacts whereby the cord circuits of a certain group are tested first when said switch is started, and operator controlled means for varying the normal relation between said wiper and said cord circuits whereby the cord circuits of any other group will be the first ones tested.

7. A telephone system comprising tele-

phone lines, a plurality of cord circuits, a cord selector switch for connecting said lines with said cord circuits, said cord circuits being connected to stationary contacts of said selector, a wiper for said switch, resting at a normal starting point on said switch, means for operating said wiper to test said cord circuits in a certain order of rotation, whereby a definite cord circuit is tested first each time the switch is operated, and operator controlled means for varying the normal starting point of said wiper whereby another one of said cord circuits will be the first one tested when said switch is operated.

8. A telephone system comprising telephone lines, groups of cord circuits, a cord selector for interconnecting said lines and cord circuits, said cord circuits being connected to groups of stationary contacts of said selector, a wiper for said switch resting at a normal starting point, means for operating said wiper to test said cord circuits whereby the cord circuits of a certain group are tested first when the switch is operated, and manually controlled means for varying the normal starting point of said wiper whereby the cord circuits of another group will be the first ones tested when said switch is operated.

9. A telephone system comprising a group of telephone lines, a plurality of cord circuits, cord selectors for interconnecting said line and cord circuits, said cord circuits being multiply connected to symmetrically disposed stationary contacts of said selectors, a wiper for each selector resting at a normal starting point thereon, all of said wipers being similarly related to their respective multiple contacts, means for operating said wipers to test said contacts in a certain order of rotation whereby a definite cord circuit is tested first each time they are operated, and operator controlled means for varying the normal starting point of said wipers whereby another one of said cord circuits will be the first one tested when said wipers are operated.

10. A telephone system comprising telephone lines, a plurality of cord circuits, cord selectors for interconnecting said lines and cord circuits, said cord circuits being multiply connected to symmetrically disposed groups of stationary contacts of said selectors, wipers for said selectors resting at a normal starting point symmetrical with certain multipled groups of contacts, means for operating said wipers to test their respective contacts whereby the cord circuits of a certain group are tested first, and operator controlled means for varying the starting point of all of said wipers whereby the cord circuits of another group will be the first ones tested when a selector is operated.

11. A telephone system comprising a plurality of link circuits, an automatic traveling link selector having stationary contacts connected with said link circuits, a wiper included in said switch for connecting with said contacts, said wiper having a definite normal relation to its contacts and link circuits, electrical apparatus for driving said wiper and testing said link circuits, and a manually operated switch at the exchange electrically connected with said selector adapted when operated to change the normal or unoperated relation between said wiper and link circuits.

12. A telephone system comprising a plurality of cord circuits, a traveling cord selector having stationary contacts connected with said cord circuits, a wiper for said selector having a definite normal relation to its contacts whereby when operated said contacts and link circuits are tested in a predetermined order, means for operating said wipers, and means for varying the normal position of said wiper.

13. A call distributing system comprising a plurality of operators' link circuits, a traveling selector, having stationary contacts connected with said link circuits and divided into groups, a wiper for said selector, normally resting before one of said groups of contacts whereby when operated the said contacts and link circuits are tested first, means for operating said wiper, and operator controlled means whereby the normal position of said wiper may be shifted to engage others of said group first when operated.

14. A call distributing system, comprising a plurality of cord circuits divided into groups and each group terminating at a different operator's position, a traveling cord selector having stationary contacts connected with said cord circuits, a wiper for said selector having a definite normal relation to its contacts whereby when operated the said contacts and link circuits are tested in a predetermined order as to groups, means for operating said wiper, and means for varying the normal position of said wiper whereby other groups of said contacts and link circuits will be the first ones tested.

15. A telephone system comprising telephone lines, operators' link circuits, automatic switches for interconnecting said lines and link circuits, means whereby said link circuits are connected to said lines in a certain order of precedence, and an operator controlled electrical switch for varying the order of precedence and maintaining the link circuits selectable.

16. A call distributing system comprising a plurality of operators' link circuits divided into groups, a traveling cord selector having stationary contacts connected with said link circuits, a wiper for said selector having a definite normal relation to its contacts whereby when operated the said contacts

and the link circuits are tested in a predetermined order, and an operator controlled electrical switch for varying the order of testing and maintaining the link circuits selectable.

17. A telephone system comprising a plurality of link circuits, an automatic traveling switch for testing said circuits in regular order for connection thereto and whereby a certain one is tested first when said switch is started, and an operator controlled electrical switch for varying the order of testing and maintaining the link circuits selectable.

18. A telephone system comprising telephone lines, operators' link circuits divided into groups, automatic switching mechanism for interconnecting said lines and link circuits, means whereby said automatic switching means connects said lines to said link circuits in a certain order of precedence, and an operator controlled electrical switch for varying the order of precedence whereby different groups of link circuits are first taken for use.

Signed by me at Chicago, county of Cook, and State of Illinois, in the presence of two witnesses.

ALFRED H. WEISS.

Witnesses:
GEORGE E. MUELLER,
CARRIE E. ANDERSON.