May 6, 1924. 1,492,655

S. SUEKOFF

TELEPHONE SYSTEM

Filed Sept. 11, 1920 2 Sheets-Sheet 1

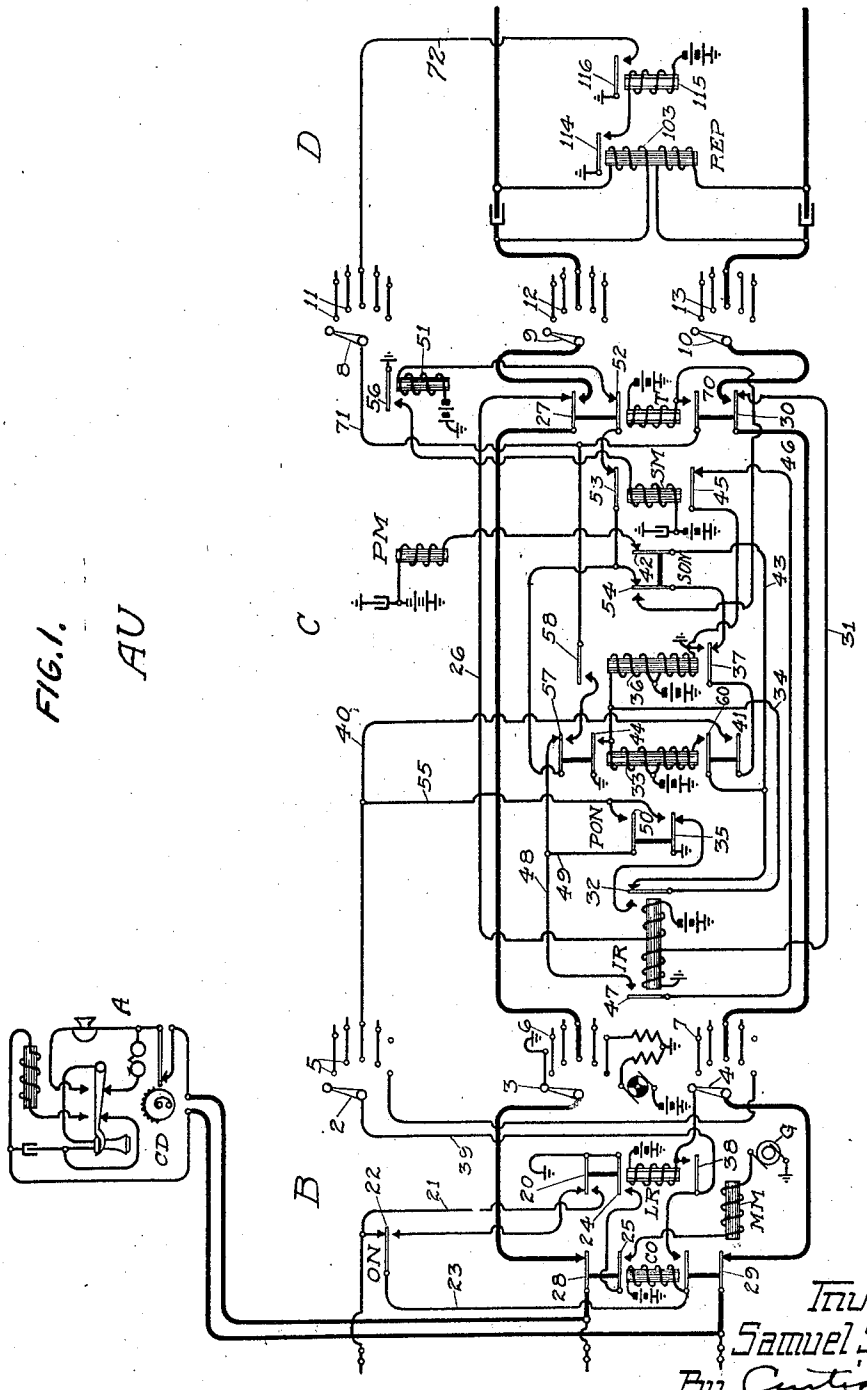

FIG. 1.

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Filed Sept. 11, 1920 2 Sheets-Sheet 2

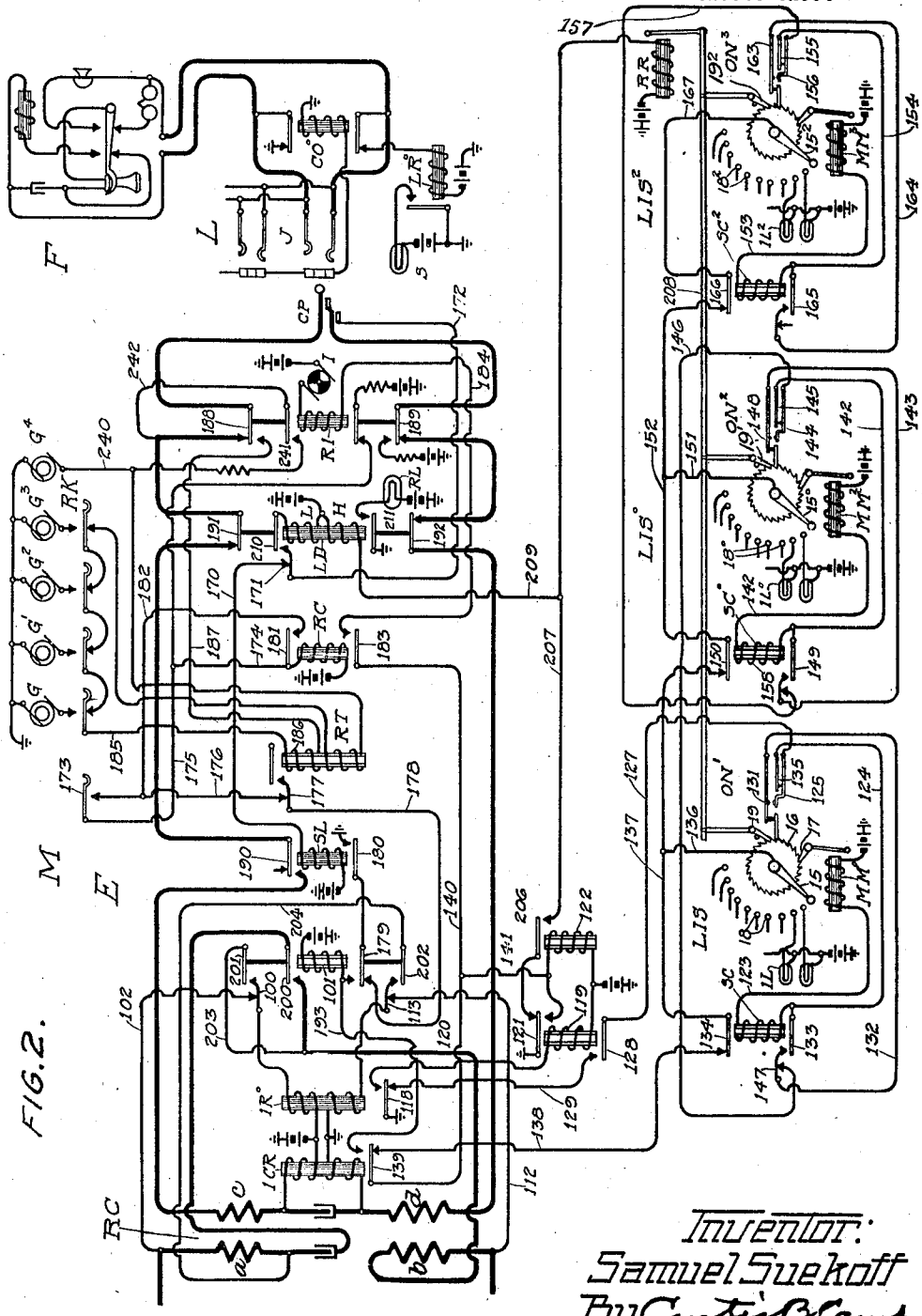

FIG. 2.

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Patented May 6, 1924. 1,492,655

UNITED STATES PATENT OFFICE.

SAMUEL SUEKOFF, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

Application filed September 11, 1920. Serial No. 409,650.

To all whom it may concern:

Be it known that I, SAMUEL SUEKOFF, a citizen of the United States of America, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Telephone Systems, of which the following is a specification.

My invention relates to telephone systems, and more particularly to systems for connecting between automatic and manual exchanges, and an object of my invention is the provision of an improved system of the above type, efficient and positive in its operation.

In a multi-office system in which there are both manual and automatic exchanges, it is desirable to list all subscribers, whether in manual or automatic exchanges, with numbers of equal digit series, so that all substations may be listed to have, say, six digits of suitable combinations, and when an automatic subscriber calls a number in a manual exchange he will call all the digits with his dial in the customary manner.

A feature of my invention is the provision of a plug-ended trunk, in a manual multiple switchboard in association with indicator lamp switches. The trunk of my invention comprises means responsive to impulses from the automatic subscriber's dial, which operate means to step the switches to register the digits in such a manner that a complete number will appear before the manual operator and indicate to her the number in the multiple into which she must insert the plug of the selected trunk.

Another feature of my invention is the provision of a call indicator in the form of lamp signals appearing before the operators at the manual exchange, and when an automatic subscriber calls a manual substation having a four digit number, the first one digit will select the zone or exchange in which the called manual subscriber is located, and the remaining three digits will operate the lamps of the call indicator, located in the keyshelf of the switchboard, and an idle operator at the manual exchange who sees the number set up before her will extend the connection to the manual called-for subscriber in the usual manner.

The above features, as well as others, will be more fully described in the ensuing specification.

For a more complete understanding of my invention, reference may be had to the accompanying drawings, which include Figures 1 and 2, which represents diagrammatically a system arranged in accordance with my invention, and in order to facilitate the proper understanding of the drawings, Figure 2 is to be understood to be a continuation to the right of the circuit shown in Figure 1. Figure 1 represents the automatic exchange AU, and I have shown a subscriber's substation A including the usual talking equipment of a common battery telephone with the addition of a calling device CD.

The line switch B is provided with wipers 2, 3, 4, controlled by motor magnet MM, line relay LR and cut-off relay CO. The line relay LR and cut-off relay CO both control holding pawls for the step by step element which actuates the wipers 2, 3 and 4, and the motor magnet controls the step-up pawl to move said wipers over contacts 5, 6, and 7. Off-normal contacts ON are provided, which assume their alternate position upon the first step of the switch wipers off normal.

The first selector C comprises an impulse relay IR, energized and de-energized by impulses from the calling device CD at the calling substation A, and the energizations and de-energizations of the relay IR being about actuations of the primary magnet PM to step the first selector wipers 8, 9 and 10 in a primary direction to a certain group of contacts. A secondary magnet SM is provided for the said selector C, which automatically steps the wipers 8, 9 and 10 in a secondary direction over the contacts 11, 12 and 13 in the selected group to seek an idle set of contacts leading to an idle trunk circuit, such as E at the manual exchange M. A switching relay T is also provided which, when energized, extends the connection of the calling substation A to the idle trunk E at the manual exchange M. Primary and secondary off-normal contacts PON and SON are also provided, the primary off-normal contacts PON assuming their alternate positions on the first step of the wipers in a primary direction, the secondary off-normal contacts SON assuming their alternate positions upon the first step of the wipers in a secondary direction.

The trunk circuit E at the manual ex-

change M comprises a repeating coil RC comprising windings *a*, *b*, *c* and *d*. An impulse relay IR′ is provided which is energized and de-energized by impulses which are repeated from the repeater relay REP of the repeater D. A sleeve relay SL is also provided, which is energized when the calling plug CP is inserted in the jack of a called line. A party line ringing key RK is also provided for connecting the proper one of the harmonic generators G, G′, G², G³ or G⁴. A ringing trip relay RT controls the application of ringing current and a ringing interrupter relay RI, intermittently energized and de-energized by the constantly rotating interrupter I, intermittently applies ringing current of the selected frequency to the called substation. Ringing control relay RC controls the ringing current to be applied to the called substation. A link disconnect relay LD is also provided for purposes as will be more fully hereinafter described. I also provide a combined calling supervisory and indicator lamp control relay ICR, energized when the called subscriber answers, controlling the indicator lamps, as will be more fully hereinafter described.

To the right of the drawing I show a called substation F terminating at the exchange M into a line circuit L comprising the usual line relay LR′, cut-off relay CO′, line signals S and the multiple jacks J.

In the lower half of the drawing I illustrate a plurality of lamp indicator switches LIS, LIS′ and LIS², and as they are all similarly constructed, the description of switch LIS will suffice. The switch comprises a motor magnet MM′, which is energized and de-energized by impulses of current to step wiper 15 (through the agency of a ratchet 16 and pawl 17) from one contact 18 to the next, according to the number of impulses, to select a particular contact. Indicator lamps IL are also provided, and as there are ten contacts 18, there is a lamp IL for each contact 18 so that when a contact 18 is selected, its particular lamp IL is lighted. For the purpose of description I have assumed the manual exchange to comprise a thousand lines, and, therefore, there will be thirty lamps arranged as illustrated in Fig. 2, located in the keyshelf of the switchboard. The first row indicates the hundreds, the second row the tens, and the third row the units digits of the called number. A signal lamp control relay SC is also provided and controls the lighting of the lamps IL, for purposes as will be more fully hereinafter described. A set of off-normal contacts ON′ are also associated with the lamp indicator switch LIS, which contacts assume their alternate positions on the first step of the wiper 15 from normal. A release relay RR common to the switches controls retaining pawls 19, which relay RR, when energized, withdraws said pawls 19 from their respective ratchets 16 and permits the wipers 15 of the switches to be restored to normal.

Having described in general the apparatus used in establishing a connection between a calling and called substation, I will now describe in detail the operation of the circuits illustrated in Figures 1 and 2.

Assuming that a subscriber at the substation A initiates a call, the removal of the receiver thereat closes a circuit for the line relay LR, which upon energization closes a circuit from ground at alternate contact 20, over conductor 21, through the closed contact 22 of the off-normal springs ON, conductor 23, to battery and ground through the cut-off relay CO. The latter, upon energization, closes an energizing circuit for the motor magnet MM, from ground at alternate contact 24 of relay LR, contact 25, motor magnet MM, to the generator G, whereupon the motor magnet MM actuates to step the wipers 2, 3 and 4 to select a non-busy first selector. The first movement of said wipers allows the off-normal springs ON to assume their alternate position, and the opening of the normal contact 22 of the off-normal contacts ON opens the circuit through the cut-off relay CO, but the cut-off relay CO remains energized as long as the private wiper 2 finds a grounded private contact 5, thereby keeping the circuit through the motor magnet MM closed. When an idle selector is seized, the cut-off relay CO is de-energized and opens the circuit of the motor magnet MM at its contact 25. The line relay LR is a slow-acting relay and is held momentarily energized after the cut-off relay CO releases until a substitute circuit is established for it, as will now appear. As soon as the line wipers 3 and 4 of the line switch B reach the contacts 6 and 7 of the idle first selector, the impulse relay IR of the first selector C is energized over a circuit traced from battery through the right-hand winding of IR, conductor 26, normal contact 27 of the test relay T, bank contact 6, wiper 3, normal contact 28 of the cut-off relay CO, through the substation and back to normal contact 29 of relay CO, the wiper 4, bank contact 7, normal contact 30 of the relay T of the selector C, conductor 31 to ground through the left-hand winding of the interrupter relay IR. The closing of alternate contact 32 of relay IR establishes an energizing circuit for the relay 33, traced from battery through the upper winding of the relay 33, conductor 34, alternate contact 32 of impulse relay IR, to ground at normal contact 35 of the primary off-normal contact PON. An energiz-

ing circuit for the relay 36 is also established when the relay IR is energized, traced from battery through the upper winding of the said relay, to conductor 34, alternate contact 32 of the relay IR to ground at normal contact 35 of the primary off normal contacts PON. The closing of alternate contact 37 of the relay 36 establishes a substitute circuit for the line relay LR of the individual line switch B before it has time to de-energize, the said circuit being traced from battery, through the winding of the line relay LR, its alternate contact 38, conductor 39, wiper 2, contact 5, conductor 40, alternate contact 41 of relay 33, to ground at alternate contact 37 of relay 36, thus maintaining the line relay LR of the switch B continuously energized until conversation is terminated. The idle first selector C having been selected by the line switch B, the subscriber at the calling substation A now actuates his calling device CD, and assuming that the called subscriber is located in a manual exchange and the number is 3221, since the first digit of the number of the called subscriber indicates the exchange in which the called subscriber is located, the subscriber at A actuates his calling device to send three interruptions of current over the line, which bring about three successive de-energizations and energizations of the impulse relay IR. Upon the first of these, the circuit of the primary magnet PM is established, traced from battery, through the winding of the magnet PM, normal contact 42 of the secondary off-normal contacts SON, conductor 43, normal contact 32 of relay IR, conductor 34, to ground at alternate contact 44 of the relay 33. The primary magnet PM is enerized and de-energized three times, due to the opening and closing of the contact 32 of the impulse relay IR, and said magnet PM steps the wipers 8, 9 and 10 of the first selector C in a primary direction, to the third group of contacts, which contacts lead to the exchange in which the manual called subscriber is located. After the last interruption the relay 36 (which is differentially wound) de-energizes, due to a circuit being closed through the lower winding of said relay 36, traced from battery through the lower winding of the said relay 36, normal contact 45 of the secondary magnet SM, conductor 46, alternate contact 47 of the impulse relay IR, conductors 48 and 49, through alternate contacts 50 and 35 of the primary off-normal contacts PON to ground, the said primary off-normal contacts PON having moved to their alternate positions on the first step of the wipers 8, 9 and 10 of the first selector C. The circuit for the relay 36, just described, is closed upon the first step of the wipers off normal, but the relay 36 does not de-energize during the sending of the impulses due to the construction and adjustment of the said relay 36 and the shortness of the impulses.

As soon as the above-mentioned circuit through the lower winding of relay 36 is steadily closed, said relay permits its armatures to retract. The opening of contact 37 disconnects ground from conductor 40 at this point, but a substitute ground from alternate contact 35 of the primary off-normal contacts PON has been substituted before the said contact 37 opens. This ground also places a busy potential upon the private contacts 5, preventing any other individual line switch from selecting multiples of said contact and also maintains the line relay LR of line switch B energized. The differential relay 33 is not de-energized during the rapid operation of the relay IR, since the closure of circuit through its lower winding does not affect the said relay, owing to the construction and adjustment of the same and the shortness of the impulses. Upon the de-energization of the relay 36 as aforesaid, an energizing circuit for the relay 51 is established, traced from battery through the winding of the said relay 51, normal contact 52 of relay T, normal contact 53 of secondary magnet SM, normal contact 54 of the secondary off-normal contacts SON, normal contact 37 of the relay 36, alternate contact 41 of the relay 33, conductors 40 and 55, to ground at alternate contact 35 of the primary off-normal contacts PON. The energization of the relay 51 establishes an energizing circuit for the secondary magnet SM, traced from battery through the winding of the said magnet SM, to ground at alternate contact 56. The secondary magnet SM steps the wipers 8, 9 and 10 one step in a rotary secondary direction to engage the first set of contacts 11, 12 and 13. The energization of the secondary magnet SM brings about the restoration of the relay 51, due to the opening of normal contact 53 of the said magnet SM. The opening of normal contact 45 of magnet SM again permits the energization of the differential relay 36 by opening the circuit of its lower winding. The restoration of relay 51 opens its alternate contact 56, bringing about the restoration of secondary magnet SM. Meanwhile, upon the first step of the wipers 8, 9 and 10 in a secondary direction, the secondary off-normal contacts SON have assumed their alternate positions, and the opening of contact 54 opens the initial circuit of the relay 51, and should the private wiper 8 of the first selector C have now engaged a contact leading to a busy trunk in the selected manual exchange, an energizing circuit for the relay 51 is again established, traced from

battery through the winding of the said relay 51, normal contact 52 of the relay T, normal contact 53 of the magnet SM, alternate contact 57 of the relay 33, alternate contact 58 of the relay 36, wiper 8, to the grounded busy contact 11. The closing of alternate contact 56 of the relay 51 brings about the energization of the secondary magnet SM. The relay 51 and magnet SM are thus alternately energized and de-energized to step the wipers 8, 9 and 10 in a secondary direction to seek the contacts of an idle trunk leading to the selected manual exchange. When a contact 11 leading to an idle trunk is encountered by the wiper 8, the energizing circuit of the relay 51 remains open, and thereby further energizations of the secondary magnet SM are prevented and the wipers remain at rest. It will thus be seen that by the see-saw action of the relay 51 and secondary magnet SM, a positive driving operation of the secondary magnet is secured, and that it is impossible to stop the selector C on a busy contact or to drive the said selector past an idle contact, because unless relay 51 energizes, magnet SM cannot be energized and relay 51 can only energize when magnet SM is at normal and private wiper 8 is resting on a busy contact. The relay 36 does not de-energize during the secondary movement of the wipers, due to its adjustment and the rapidity of the interruptions of its circuit at the normal contact 45 of the secondary magnet SM. The closure of normal contact 45 of the secondary magnet SM, however, after its last de-energization, closes a circuit for the lower winding of the relay 36 long enough so that, due to its differential construction, it de-energizes, and an energizing circuit for the relay T is established, traced from battery, through the winding of the said relay T, alternate contact 54 of the secondary off-normal contacts SON, normal contact 37 of the relay 36, alternate contact 41 of the relay 33, to ground at alternate contact 35 of the primary off-normal contacts PON. The opening of normal contacts 27 and 30 of the relay T opens the energizing circuit of the impulse relay IR, and the closing of normal contact 32 of said relay IR closes a circuit through the lower winding of the relay 33, traced from battery through the said lower winding, its alternate contact 60, normal contact 32 of the said relay IR, to ground at alternate contact 44 of said relay 33. Relay 33, due to its differential winding, neutralizes and restores to normal, and in restoring opens the circuit of the relay 36, permitting said relay 36 to restore. The closing of alternate contacts 27 and 30 of relay T extends the connection from the calling subscriber of the substation A to the selected idle trunk in the manual exchange in which the called manual subscriber is located, and an energizing circuit is established for impulse relay IR′ of the trunk circuit E, traced from battery through the upper winding of the relay IR′, normal contact 100, conductor 102, through the relay 103 of the repeater D, contact 12 and wiper 9 of the selector C, alternate contact 27, contact 6 and wiper 3, normal contact 28, through the closed contacts of the switchhook of the substation A, back through normal contact 29 of relay CO, wiper 4, contact 7, alternate contact 30, wiper 10, contact 13, through the lower winding of the relay 103, conductor 112, normal contact 113, through the lower winding of relay IR′ to ground. The relay 103 of repeater D energizing over the path just described, closes alternate contact 114, energizing the relay 115 of the repeater D. The closure of alternate contact 116 of the relay 115 places ground upon the multiples of the private contacts 11 of the selected trunk, thus preventing any other selector from stopping on the seized trunk that leads to the trunk circuit E. The relay T has its initial energizing circuit opened upon the restoration of relay 33 of the selector C, but the relay T being slow to release is momentarily held energized until a substitute circuit is established for it, which may be traced from battery through the winding of the said relay T, its alternate contact 70, conductor 71, wiper 8, contact 11, conductor 72 to ground at alternate contact 116 of relay 115, the said relay remaining energized until the termination of conversation. The impulse relay IR′ closes its alternate contact 118, establishing an energizing circuit for the relay 119 of the trunk circuit E, and relay 119 closes its alternate contact 121.

Having assumed that the number of the called subscriber at the manual exchange is 3221, the subscriber at the automatic exchange operates the calling device CD to send two interruptions of current. The interruptions from the calling device bring about two de-energizations and energizations of the relay 103 of the repeater D and the impulse relay IR′ of trunk circuit E. Upon the first de-energization of relay IR′, its normal contact 118 is closed, energizing signal control relay SC and the motor magnet MM′ of the lamp indicator switch LIS by current from battery through motor magnet MM′, conductor 123, relay SC, conductor 124, contacts 125, 135 of the off-normal contacts ON′, conductor 127, alternate contact 128, conductor 129 to ground at normal contact 118. The motor magnet MM′ upon energization steps the wiper 15 of the switch LIS into engagement with the first contact 18. The switch upon its first step off normal allow the off-normal contacts ON′ to assume their alternate po-

sitions to close the contact 125, 131, and the next impulse of current extends from ground at normal contact 118, over conductor 129, alternate contact 128, conductor 127, through the now closed off-normal contacts 125 and 131, conductor 132, through alternate contact 133, through said relay SC, over conductor 123, through the motor magnet MM′ to battery. The motor magnet MM′ is thus energized to step the wiper into engagement with the second contact 18. The relays 119 and 122 have their energizing circuit opened upon each de-energization of the impulse relay IR′, but due to their slow release construction they are held up during the rapid interruptions of the contact 118. Relay SC of the lamp indicator switch LIS also remains energized during the rapid interruptions of current which pass therethrough due to its slow to release construction. After the first set of interruptions and after the last de-energization of relay IR′ of trunk E, the relay SC restores to normal and the closure of its normal contact 134 closes an energizing circuit for the indicator lamp IL, traced from battery through the said lamp IL, the contact 18, wiper 15, conductors 136 and 137, normal contact 134, conductor 138, normal contact 139 of the combined supervisory and indicator lamp control relay ICR, conductors 140 and 141, to ground at alternate contact 121 of relay 119. The indicator IL associated with the second contact of the switch LIS is now lighted, indicating the first numeral of the number of the called subscriber to the operator at the manual exchange. The normal contact 134 of relay SC was held in its alternate position during the stepping of the wiper of the switch LIS from one contact to the next during its selecting operation to prevent the indicator lamps IL associated with the contacts 18, over which the wiper 15 is wiping, from lighting.

The subscriber of the calling substation A now actuates his calling device CD to send two interruptions of current to bring about two de-energizations and energizations of the repeater relay 103 and the interrupter relay IR′, and upon the first de-energization of the relay IR′ an energizing circuit is established for the relay SC′ of the lamp indicator switch LIS′ and its motor magnet MM², traced from battery through the winding of the magnet MM², conductor 142 through the winding of the said relays SC′, the normal contacts 144 and 145 of the off-normal contacts ON², conductor 146, normal contact 147 of the relay SC, conductor 132, closed contacts 125, 131 of off-normal contacts ON′, conductor 127, alternate contact 128, conductor 129 to ground at normal contact 118 of relay IR′. The motor magnet MM² of the switch LIS′ is energized and de-energized twice, due to the two de-energizations and energizations of the interrupter relay IR′ to step the wiper 15′ of the switch LIS′ into engagement with the second contact 18′. Upon the first step of the switch LIS′ off normal, the off-normal contacts ON² assume their alternate position and the closure of off-normal contacts 144 and 148 closes an alternate path for the second impulse of the second digit transmitted to the manual station which is the third digit of the called number traced from battery through the winding of MM², conductor 142, the winding of relay SC′, alternate contact 149 of relay SC′, conductor 143, closed contacts 148 and 144 of off-normal contacts ON², to ground at normal contact 118 of relay IR′, over the previously described path. After the second set of impulses, the relay SC′ of the switch LIS′ restores, closing normal contact 150, and an energizing circuit for the indicator lamp IL′ traced from battery through the lamp IL′, contact 18′ wiper 15′, conductor 151, 152, normal contact 150 of the relay SC′, conductor 137, normal contact 134 of relay SC of the switch LIS, over the previously described path to ground, to alternate contact 121 of relay 119. The indicator lamp IL′ is now lighted and indicates the second numeral of the number of the called subscriber.

The calling subscriber at the substation A now actuates his calling device to send one interruption of current, which brings about one de-energization and energization of the interrupter relay IR′, and upon the de-energization of the said relay an energizing circuit is established for the relay SC² and the motor magnet MM² of the lamp indicator switch LIS², traced from battery through the winding of the motor magnet MM², conductor 153, through the winding of the relay SC², conductor 154, normally closed contacts 155 and 156 of the off-normal contacts ON², conductor 157, normal contact 158 of the relay SC′, conductor 143, through the now closed contacts 144 and 148 of the off-normal contacts ON², conductor 146, conductor 132, the now closed contacts 125 and 131 of the off-normal contacts ON′, conductor 127, alternate contact 128, conductor 129 to ground at normal contact 118 of relay IR′. The motor magnet MM² of the switch LIS² is energized and de-energized once, thus stepping the wiper 15² into engagement with the first contact 18².

Upon the first step off normal, contacts ON² assume their alternate position to close the contact 156, 163. The last impulse now having been sent from substation A, relay IR′ remains energized and the opening of normal contact 118 allows relay SC² to restore, and by closing normal contact 166, energizes indicator lamp IL², from battery through the lamp IL², contact 18², wiper

15^2, conductor 167, normal contact 166, conductor 152, normal contact 150, conductor 137, normal contact 134, conductor 138, normal contact 139, conductors 140 and 141 to ground at alternate contact 121 of relay 119. The lamp IL^2 associated with the engaged contact 18^2 is now lighted and indicates the last numeral of the number of the called subscriber.

The indicator lamps IL, IL′ and IL^2 are lighted and appear before an operator and indicate to her that the number of the called subscriber (substation F) is 221. She now tests the mutiple jack J of the called line in the usual manner, and should the called line be busy, the operator will receive a click in her ear whereby she will know the line is busy and will inform the calling subscriber A that the called line is busy in the usual and well-known manner, assuming that the line is idle, the operator will insert the calling plug CP of the trunk E into the jack J of the wanted line, thus establishing a series energizing circuit for the sleeve relay SL of trunk E and the cut-off relay CO′ of the line circuit L, traced from battery through the winding of the said relay SL, conductor 170, normal contact 171, conductor 172, sleeve contacts of the connected plug CP and jack J to ground through the winding of the cut-off relay CO′.

The operator now actuates one of the key plungers of her party line ringing key RK, and assuming it is the generator G that has been connected, the actuation of the key plunger momentarily closes the end spring contact 173 of the ringing key, energizing the ringing control relay RC, from battery through the winding of the said relay, conductors 174 and 175, the closed contact 173 of the end spring of the ringing key RK, conductor 176, normal contact 177 of the ringing trip relay RT, conductor 178, normal contact 179 of the relay 101 to ground at alternate contact 180 of the sleeve relay SL. The closing of alternate contact 181 of the relay RC establishes a locking circuit for the said relay RC, traced from battery through its winding, its alternate contact 181, conductor 182, conductor 176, normal contact 177, conductor 178, normal contact 179 to ground at alternate contact 180 of the relay SL. The closing of contact 183 energizes the ringing interrupter relay RI, from battery through the constantly rotating interrupter I, through the winding of the relay RI, conductor 184, alternate contact 183 of the relay RC, conductors 140 and 141 to ground at alternate contact 121 of relay 119. The relay RI is thus intermittently energized and de-energized, and the ringing current flows from generator to the ungrounded pole of the generator G, the closed contact of ringing key plunger, conductor 185 through the upper winding 186 of the ringing trip relay RT, conductor 187, alternate contact 188 of the relay RI, tip contacts of the connected plug and jack CP and J, through the condenser and call bell of the substation of the called subscriber F, back over the ring contacts of the jack J and plug CP to battery and ground via alternate contact 189 of relay RI. The subscriber at the calling substation A also receives an audible ringing tone traced from the generator G^4, over conductor 240, alternate contact 241 of relay RI, conductor 242 to the tip conductor of the trunk E and back to the calling substation A, and thus knows that the called subscriber is being signaled. The call bell at the called substation F is thus intermittently actuated, and should the subscriber answer during the ringing period, the combined generator and battery flow through winding 186 (upon the closure of the switchhook contacts) brings about energization of the ringing trip relay RT. Said relay upon actuation opens its normal contact 177, destroying the locking circuit of the ringing control relay RC, which upon de-energization opens contact 183, which now interrupts the circuit of the ringing interrupter relay RI, and the opening of normal contact 188 prevents further application of ringing current to the called subscriber's line. Upon the restoration of relay RI, an energizing circuit is established for the combined supervisory and indicator lamp control relay ICR, traced from battery through the upper winding of the relay ICR, winding *c* of the repeating coil RC, the alternate contact 190, normal contact 191, normal contact 188, tip contacts of the connected plug CP and jack J, through the closed contacts of the substation switchhook, contacts of the jack J and plug CP, normal contact 189, normal contact 192, winding *d* of the repeating coil RC to ground through the lower winding of the relay ICR. Should the subscriber at the substation F answer during a silent period, the relay ICR is energized over a path just described, and the said relay ICR upon energization establishes an energizing circuit for the relay 101, traced from battery through the winding of the said relay, alternate contact 139, conductors 140, 141 to ground at alternate contact 121 of relay 119. The closing of the alternate contact 179 of relay 101 establishes a locking circuit for itself, traced from battery through the winding of the said relay, alternate contact 179 to ground at alternate contact 180. The opening of normal contact 179 of the relay 101 opens the locking circuit of the ringing control relay RC, and upon de-energization thereof contact 183 opens the energizing circuit of the ringing interrupter relay RI, and the relay RI remaining at normal further application of ringing current is prevented. The relay

ICR upon energization opens its normal contact 139, opening the multiple circuit through the lamps IL, IL′ and IL², thus effacing the said signals.

The relay 101 upon energization closes its alternate contact 200, establishing the continuity of the talking conductors, and the closing of alternate contacts 201 and 202 reverses the direction of battery flow through the calling end of the central office circuits and also over the calling subscriber's line. This reversal of battery may be for various uses, as is well understood in the art. The automatic subscriber at the calling substation A and the called subscriber at the called substation F are now in conversation, the said talking circuit being traced over the heavily marked conductors.

The subscribers having finished conversation, the replacing of the receiver at the called substation F opens the energizing circuit of the relay ICR, and the closing of its normal contact 139 again closes the circuit through the lamps IL, IL′ and IL², but this lighting of the said lamps at this time is only incidental. The subscriber at the calling substation A replacing his receiver opens the circuit of the relay IR′, and said relay upon de-energization opens alternate contact 118, interrupting the energizing circuit of the slow-acting relay 119, which in restoring opens alternate contact 121, interrupting the energizing circuit of the relay 122. The latter being a slow-acting relay, it therefore is momentarily held actuated, and a circuit is established for the release relay RR of the lamp indicator switches LIS, LIS′ and LIS², said circuit being traced from ground at normal contact 121 and through alternate contact 206. The relay RR attracts its armature and actuates the release bar, which bar withdraws the retaining pawls 19, 19′ and 19² of the respective switches LIS, LIS′ and LIS², and thus allows the said switches to restore to normal under spring tension. This momentary ground at normal contact 121 also extends over conductor 209 through the lower winding of relay LD to battery, and the relay LR upon energization closes its alternate contact 210, establishing a locking circuit for itself traced from battery through its upper winding, alternate contact 210, conductor 172, sleeve contacts of the connected plug CP and jack J to ground through the cut-off relay CO′. The opening of normal contact 171 of relay LD opens the energizing circuit of the sleeve relay SL, and the relay SL upon de-energization opens contact 180, and relay 101 restores to normal.

The replacing of the receiver at the calling substation A has also de-energized the repeater relay REP, and the opening of its alternate contact 114 de-energizes relay 115, which opens contact 116, removing ground from the multiples of private contact 11 and from the locking circuit of relay T. The latter, upon restoration, closes contact 52, establishing a circuit for relay 51, traced from battery through said relay, normal contact 52, normal contact 53, normal contact 57, conductors 48 and 49, through alternate contacts 50 and 35 of contacts PON. Contact 56 of relay 51 again brings about the energization of the secondary magnet SM, and the magnet SM and relay 51 are alternately energized and de-energized, the secondary magnet thus stepping the wipers 8, 9 and 10 beyond the last set of contacts in the bank, from which point the wipers are restored to normal by spring tension.

By this operation of the switch C just described secondary off-normal contacts SON and primary off-normal contacts PON are restored to normal, and the shifting to normal of contact 35 of contacts PON opens the locking circuit of line relay LR, which upon restoration closes an energizing circuit for the cut-off relay CO from battery, through the winding of relay CO, conductor 23, alternate contact 22 of off-normal contacts ON to ground at normal contact 20 of relay LR. LR being now at normal and CO energized, the retaining pawls are withdrawn and the wipers 2, 3 and 4 are restored to normal under spring tension.

Again referring to the trunk E at the manual exchange, the relay LD, upon energization, closed alternate contact 211, lighting release lamp RL. The lamp RL may be of a distinctive color, such as red, and when lighted gives the operator an indication that conversation has terminated and the subscribers have replaced their receivers. The relay LD is initially energized through its lower winding and is locked up through its upper winding. The upper winding of said relay is of a very high resistance so that, even though the plug CP is left in the jack, the line will test idle when another operator tests it, and the line of the substation F can be connected to as a called line. The lighted lamp RL being noted, the calling plug CP is withdrawn from the jack J, and the apparatus used in establishing a connection is now at normal and available for use in establishing other connections.

Should the operator fail to immediately remove the plug CP from the jack J when the release lamp RL is lighted, another call may be extended to the operator as the relay 101 is at normal, and the impulses from the automatic exchange may now operate the relay IR′ of the trunk E, as previously described, and when the full number is set up before the operator, the removal of the plug

from the last connected jack will bring about the de-energization of relay LD and efface the lamp RL, and the insertion of the plug into the jack of the now wanted line will allow the circuit to again function as previously described.

It will be understood, of course, that where my invention is employed there will be at least one exchange in which the subscribers establish the desired conversational circuits wholly by automatic means. In this exchange each subscriber will have a substation outfit like that shown in Fig. 1, and an individual line switch such as there shown, and assuming a 10,000 line automatic exchange, there will be a suitable number of first selectors C and also second selectors and connectors arranged in the usual manner. Such selectors and connectors may be of the kind illustrated and described in a Patent Number 1,402,936 issued to Harry H. Ide, January 10, 1922.

In the manual exchange each subscriber will have a substation of the sort illustrated at F and his own line circuit L. For establishing connections from manual lines to manual lines, the operators will have a suitable number of the usual type of common battery cord circuits, and these may be of the kind illustrated and described in patent to Currier and Ide, No. 1,311,156, dated July 29, 1919.

While I have illustrated and described one particular embodiment of my invention, it is to be understood that I am not limited to the precise structures and method of operation shown and described, nor to the particular environment in which I have disclosed them, but obviously the invention may be used in various ways, and modifications will readily suggest themselves to those skilled in the art, and in the appended claims my aim is to cover the invention broadly, and not to be limited to the structures known and described.

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

1. In a telephone system, including a connecting circuit, means associated with said connecting circuit and operable by numerical current impulses over said connecting circuit from a calling station to visually indicate to an operator the number wanted, an operator-controlled terminal for said connecting circuit adapted to be applied to the called line to complete connection from said calling station, a disconnect signal for the operator, and link disconnect means for said connecting circuit controlled from said station for controlling said disconnect signal and also for freeing the called line from said connecting circuit while said connecting circuit remains physically connected to said called line.

2. In a telephone system, means operable by numerical current impulses from a calling station to visually indicate to an operator the number wanted, an operator-controlled terminal adapted to be applied to the called line to complete connection from said calling station, other means including a numerical switch responsive to current from a station to automatically select said first means, and means controlled by the calling subscriber for releasing said first means to permit the same to restore to normal.

3. In a telephone system, means operable by numerical current impulses from a calling station to visually indicate to an operator the number wanted, an operator-controlled terminal adapted to be applied to the called line to complete connection from said calling station, a numerical selecting switch operating responsive to numerical impulses from said calling station to connect with said means, and means controlled by the calling subscriber for releasing said first means to permit the same to restore to normal.

4. In a telephone system, including a connecting circuit, means associated with said connecting circuit operable by numerical current impulses from a calling station to visually indicate to an operator the number wanted, an operator-controlled terminal for said connecting circuit adapted to be applied to the called line to complete connection from said calling station, mechanism adapted to operate responsive to numerical impulses to select a group including a plurality of said means, other mechanism adapted to select an idle means from the selected group, and means controlled by the calling subscriber for releasing said first means to permit the same to restore to normal.

5. In a telephone system, a device directively operated by current impulses sent over the calling subscriber's line to visually set up the number wanted, a plurality of groups of operator-controlled link circuits, a plurality of groups of said devices, the link circuits of a group and the devices thereof adapted to be operatively connected and disconnected, automatic selecting mechanism whereby a calling line may seize an idle circuit and device, and automatic means controlled by the calling subscriber for automatically releasing said device to permit said device to restore to normal.

6. In a telephone system, a device directively operated by current impulses sent over the calling subscriber's line to visually set up the number wanted, a plurality of groups of operator-controlled link circuits, a plurality of groups of said devices, the link circuits of a group and the devices thereof adapted to be operatively connected and disconnected, electromagnetic apparatus to connect and disconnect said circuits and said

devices, and means controlled over the calling subscriber's line for releasing said devices to permit the same to restore to zero.

7. In a telephone system, a device directively operated by current impulses to visually set up the number wanted, a plurality of groups of operator-controlled link circuits, a plurality of groups of said devices, the link circuits of a group and the devices thereof adapted to be operatively connected and disconnected, automatic selecting mechanism including a non-numerical line switch and a numerical selector switch whereby a calling line may seize an idle circuit and device, electromagnetic apparatus to connect and disconnect said circuit and said device, and means controlled over the calling subscriber's line for releasing said device to permit the same to restore to zero.

8. In a telephone system, a device directively operated by current impulses sent over the calling subscriber's line to visually set up the number wanted, a plurality of groups of operator-controlled link circuits, a plurality of groups of said devices, the link circuits of a group and the devices thereof adapted to be operatively connected and disconnected, electromagnetic apparatus to connect and disconnect said circuits and devices, and means controlled from the calling line to restore the set up device to zero.

9. In a telephone system, a device to visually indicate to an operator a wanted number, comprising successively adjusted impulse-controlled mechanisms controlled over the calling subscriber's line, a link circuit, a calling station and automatic means including a numerical selector switch to interconnect said circuit and said station, a called station adapted to be connected to said circuit, switches at said stations respectively adapted to control the circuit connections of said device, and link disconnect means for said link circuit controlled by the calling subscriber for freeing the line of said called station from said link circuit while a physical connection of said link circuit and the called line remains.

10. In a telephone system, a device to visually indicate to an operator a wanted number, said device comprising a plurality of progressive elements, impulse-adjusted in succession, a common release mechanism common to said elements for restoring said elements, a selector operable from a calling station to connect with said device, a link circuit, automatic means for connecting and disconnecting said device and said circuit, and connections whereby said release mechanism is controlled from the calling station.

11. In a telephone system a device operable by impulses sent over the calling subscriber's line to visually indicate to an operator a wanted number, a link circuit, connections operatively associating said device and said circuit, a calling and a called station switched together by said circuit, switch mechanism at said stations respectively adapted to control said connections, and release mechanism for said device controlled by the calling subscriber for releasing said device to permit said device to restore to normal.

12. A telephone system comprising automatically equipped telephone lines and manually equipped telephone lines, calling subscriber impulse-controlled switches for interconnecting automatically equipped lines, operator-controlled mechanism for interconnecting manually equipped lines, means for connecting a calling automatic line with a called manual line, said means including link circuits and a device to set up the wanted number before an operator and adjusted by impulse current sent over the calling line by the calling subscriber, connections between said circuits and said device controllable by currents over the calling and the called lines respectively, and automatic release means for said device to restore the same to normal when the calling subscriber signals for disconnection.

13. A telephone system including a calling automatic line and a called manual line connected for conversation, the connection including an automatic selector circuit and an operator-controlled circuit, an impulse-adjusted called-line-number indicator associated with said link circuits, means for effacing the called number controlled from one of said lines, and means for restoring said indicator to zero controlled from the other line.

14. In a telephone system a plurality of one-level step-by-step switches, means including a set of off-normal contacts for successively adjusting them, and a single release magnet to mechanically and simultaneously release them whereby they restore simultaneously by spring tension.

15. In a telephone system a plurality of advancing switches provided with a set of off-normal contacts and adapted to be adjusted by directive impulse sets of different decimal places respectively, a release magnet and mechanical connections from said magnet to said switches whereby said magnet simultaneously restores them.

16. In a telephone system a plurality of single-level selectors adapted for successive operation by numerical current impulses sent over the calling subscriber's line to respectively set up the digits of the called number before an operator, a single impulse circuit for said selectors, and means for switching it from one selector to the next, said means comprising off-normal contact springs and a slow release relay.

17. A telephone system including a plurality of advancing switches successively op-

erated by current impulses sent over the calling subscriber's line to set up before an operator successive digit numbers of the called line, a single impulse circuit for said selectors, and means for switching it to successive selectors including off-normal contacts for the first selector of the series to establish a new path for current impulses after the first impulse, and a slow release relay serving to close a locking contact in its circuit whereby said path is extended.

Signed by me at Chicago, in the county of Cook and State of Illinois, this 7th day of September, 1920.

SAMUEL SUEKOFF.