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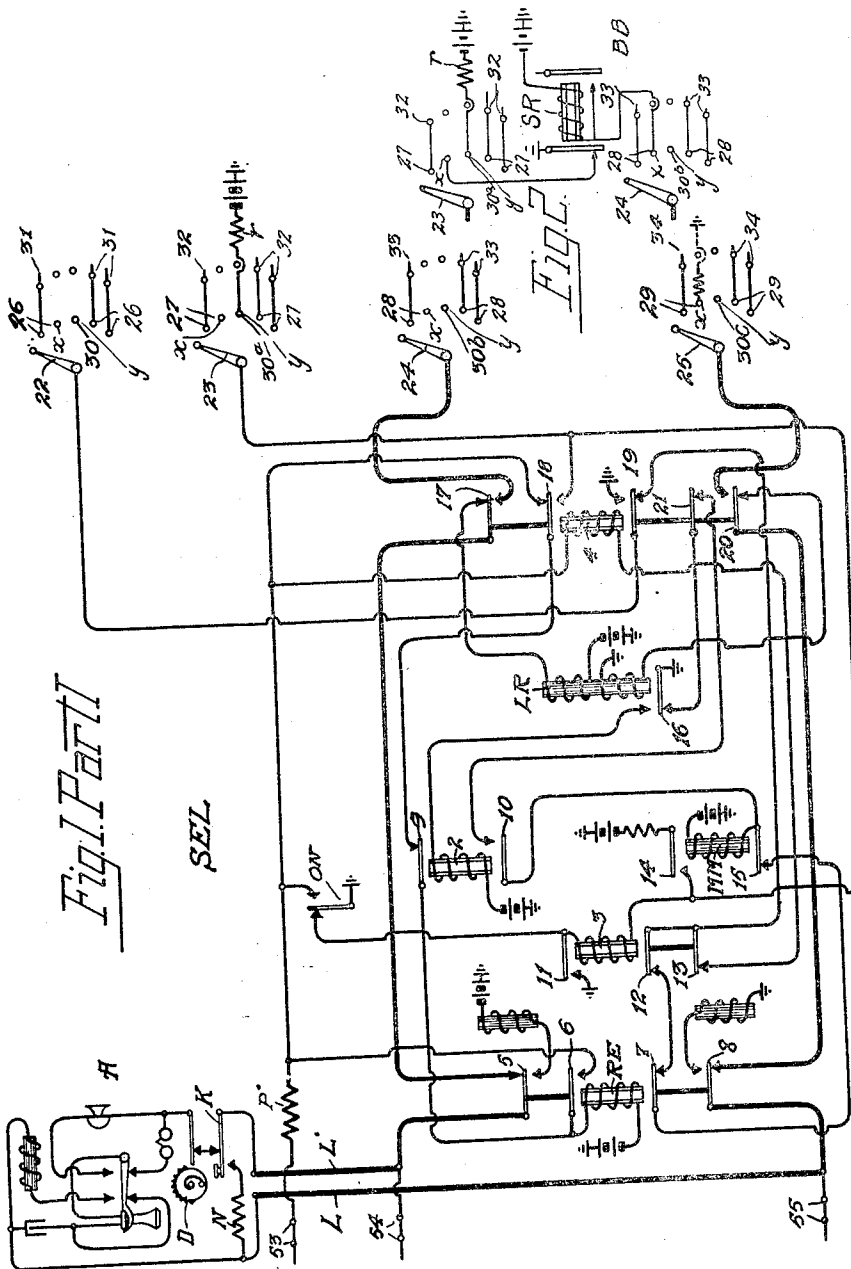
1,513,825

L. D. KELLOGG

TELEPHONE SYSTEM

Filed Jan. 30, 1922

2 Sheets-Sheet 1



Inventor:
Leroy D. Kellogg
By Curtis C. Camp.
Attorney

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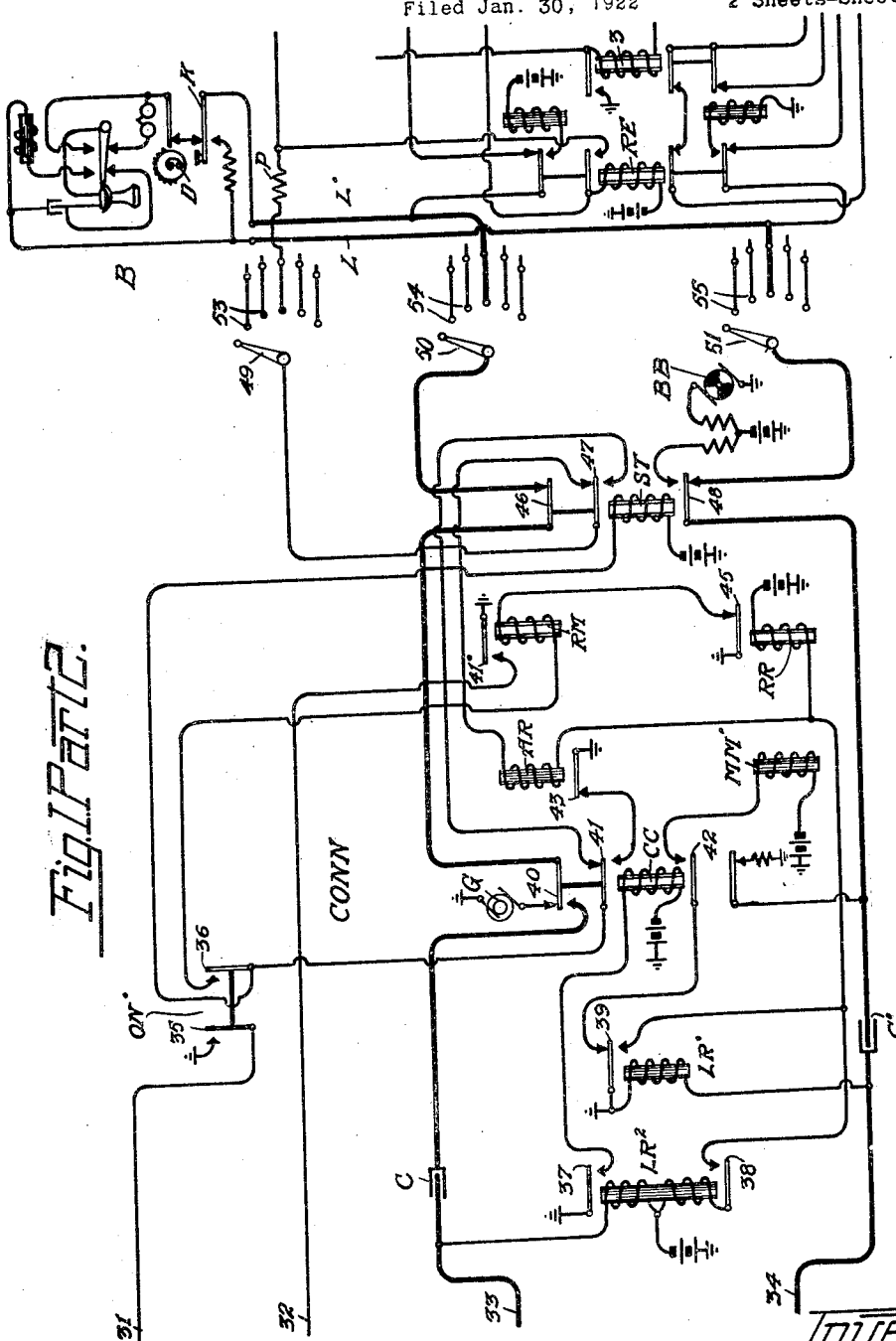
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Attorney.

UNITED STATES PATENT OFFICE.

LEROY D. KELLOGG, OF DEERFIELD, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

Application filed January 30, 1922. Serial No. 532,640.

To all whom it may concern:

Be it known that I, LEROY D. KELLOGG, a citizen of the United States of America, and a resident of Deerfield, county of Lake, 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 automatic telephone systems, and particularly to private automatic exchange (P. A. X.) systems employing preferably single level, spring-restored switches. Such a switch may have wipers on a rotary shaft, the shaft carrying a ratchet. A magnet having an armature with pawl to engage the ratchet drives the ratchet step by step, and so the wipers to engage successive contact sets in the arcuate bank. I prefer to have the ratchet driven on the back stroke of the armature. The customary off-normal contacts are provided. Such a structure is shown in an application filed by Ernest A. Bohlman, January 3, 1922, Serial No. 526,532, and also shown in an application filed by William Kaisling, July 9, 1920, Serial No. 394,889.

Objects of the invention are to provide for conveniently increasing the capacities of such systems, and to provide certain novel and advantageous circuit systems. The latter are available for such increasing, but are not necessarily limited thereto.

Commonly used P. A. X. systems having switches with single level banks, are of the so-called adding type when the numbers of subscribers served are over ten. Such systems are familiar to those skilled in the art, and briefly the adding feature is occasioned by the ten-impulse maximum of the customary substation call dial. The multiple terminals of subscribers' lines being in single groups in single level connector switch banks, if a called subscriber's contacts are the fifteenth from the zero position of such a switch, the calling subscriber must operate his dial twice, say to its full capacity of ten impulses the first time, and a second time to transmit five impulses more, when the switch will have traveled fifteen steps and be engaging the multiple contacts of the called line number fifteen. The calling subscriber then rings the called one by pressing a button.

In systems using single level switches, obviously with one pull of the dial the system

is limited to ten subscribers, with two pulls to twenty, and so on, and the practical capacity of such a system is soon reached because of the increasing multiplicity of digit numbers to be pulled.

According to the present invention, first selectors are inserted between calling lines and the connectors carrying the called contacts of subscribers' lines. These first selectors are single level bank switches and may be the same as the connectors mechanically, but have differently arranged controlling circuits.

The first selectors are of an adding type, as well as are the connectors, and adding type first selectors are believed to be new in the art.

In describing the present invention, a limit of four pulls of a subscriber's dial will be assumed as the maximum permissible, and this will give an exchange capacity of eighty subscribers as against forty in the present systems, using single level switches and employing the same numbers of dial pulls.

The eighty subscribers' lines will preferably be divided into three groups as called lines; two of these groups will have thirty lines each and the third will have twenty lines. The called multiple terminals of the lines of a particular group will appear in the banks of a certain number of adding type connectors assigned to that group. The terminal contacts of the first line of a group will at each connector be the contacts engaged when the connector makes its first step from normal, those of the second line will be engaged whenever a connector makes two steps from normal, and so on for the full number of lines in the group.

As a calling line each line may have its individual first selector in the shape of a switch with a single level bank containing, say, thirty sets of contacts. The first eight sets of contacts engaged by each first selector as it steps along its first eight steps from normal, may be multiple terminals of the eight connectors of the first group, the contact sets ten to eighteen may be multiple terminals of nine connectors assigned to group two, the ninth contact set will be for a purpose hereafter explained and contact sets nineteen to thirty may be multiple terminals of connectors assigned to the third group.

On the usual principle, a calling subscriber operates his dial to cause his first selector to select the group of terminals of connectors assigned to the line group including the called line; the first selector then selects automatically an idle connector, and the subscriber operates his dial to cause the connector to select the terminals of the wanted line. With the present system and with the grouping suggested above, the first digit of each line in the first group will be "1" and the calling subscriber will transmit one impulse to select the group. The first digit of each line in the second group will be "0" and the calling subscriber transmits ten impulses to select the group. The first two digits of lines of the third group will be "9.0." and the calling subscriber will transmit first nine impulses and then ten impulses to select the third group.

Referring now to Fig. 1, including parts 1 and 2, I have diagrammatically indicated two substations A and B of a well-known type, each having a call dial D and a ringing key K.

Each substation is connected with the exchange by line limbs LL', which terminate thereat in first selector circuits, those associated with substation A being shown complete. Those for substation B, although shown incomplete for lack of space, are in fact identical with those of A.

The first selector circuits, SEL, include a line relay LR to transmit impulses to motor magnet MM, relay LR receiving the substation impulses direct. Motor magnet MM serves to directively adjust wipers 22, 23, 24, 25 to select a group and the said magnet also serves to adjust the wipers in their travel seeking idle connector contacts. RE is a combined release magnet and line cut-off relay. The off-normal contacts are indicated at N. The function of relays 2, 3 and 4 can best be indicated in the narrative of operation. All apparatus is shown at normal.

The connector circuits at CONN include a pair of line relays LR' and LR'', the latter being differentially wound for purposes indicated later. MM' is the motor magnet; ON' indicates the off-normal contacts; G the ringing generator, and BB the busy-back apparatus. RR is the release relay controlling release magnet RM and CC and ST are control relays. The wipers are indicated at 49, 50 and 51 and multiple terminals of called line include each a contact 53, 54 and 55, these constituting a set of called line contacts. Each connector is connected to the first selector banks by its wires 31, 32, 33 and 34 terminating in said banks in multiple contacts 26, 27, 28 and 29, respectively. The grouping of lines as called lines, the location and arrangement of the contact sets 53, 54, 55 of called lines in the banks has hereinbefore been indicated, as has the arrange-

ment and location of the sets of connector terminals 26, 27, 28, 29 in the first selector banks.

Fig. 2 shows a modification of my invention for giving the calling subscribers a busy signal in case all of the connector switches of a selected group are found busy.

Narrative of operation.

In the following A will be the calling substation and B the called substation, and the number assigned to substation B will be assumed as 9098. As stated before, 90 means the third group, and as adding type connectors are employed, 98 must mean line 17 in that group, that is, the line whose terminal contacts are seventeen steps from the normal position of the connector wipers.

The calling subscriber at substation A removes his receiver and the switchhook contacts conductively unite line limbs LL', energizing relay LR by current from battery through the upper winding of LR, normal contacts 17 and 5, limbs L' and L, normal contacts 8 and 20, lower winding of relay LR to ground. Relay LR closes alternate contact 16, energizing slow release relay 2, it being understood that all relays, indicated by the symbol at 2, are constructed so as to release their armatures slowly after they are deprived of current.

Relay 2 attracts armatures 9 and 10. Subscriber at substation A now actuates dial D, so that in its return to normal it causes nine breaks and makes in the circuit of relay LR, and said relay de-energizes and energizes nine times, but so rapidly that relay 2 remains operated throughout. Each de-energization of relay LR transmits a current impulse from ground through normal contact 16, contacts 21 and 10 through motor magnet MM to battery, causing nine energizations and de-energizations of magnet MM. The first energization of motor magnet MM operates slow release relay 3 by current through contact 14 to ground at off normal contact ON. Relay 3 locks itself by contact 11 and remains operated during the nine vibrations of 14 because of its slow release construction, thus holding contacts 12, 13 open.

Each de-energization of motor magnet MM advances wipers 22, 23, 24, 25 a step and on the first step off normal contact ON disengages its normal contact and engages its alternate contact. At the end of the nine actuations of motor magnet MM, wipers 22, 23, 24, 25 will be engaging their ninth contact set in the switch bank, counting from normal. This ninth contact set does not form terminals of a connector, but is specially wired in order to make the first selector an adding one.

Such ninth set will be arranged as indicated at the contact set 30, 30^a, 30^b, 30^c, that is,

contacts 30, 30^b and 30^c will be left unwired, while contact 30^a will be permanently wired to battery through a non-inductive resistance, which may be individual to the first selector or common to three or four selectors.

At the end of the nine impulses, relay LR remains energized and motor magnet MM de-energized until the subscriber at substation A again operates his dial D, and contact 14 will be open during this time. Relay 3, however, is maintained energized in this interval by battery through resistance *r*, contact 30^a—23, through the said relay to ground at armature 11. Contacts 12 and 13 thus remain open and keep magnet MM disconnected from relay 4 to prevent a false operation of the system at this time.

The subscriber now operates his dial according to the "0" indication, which as usual causes ten breaks and makes in the substation circuit, and from the preceding it is apparent that relay LR and motor magnet MM are effective to step wipers 22, 23, 24, 25 ten more steps so that on the last step they will engage the nineteenth contact set, 26, 27, 28, 29, in their bank. After wiper 23 disengages contact 30^a, the vibrating armature 14 keeps relay 3 operated until after the last step is made.

After the last step the substation circuit remains closed until the subscriber again operates his dial, and during this time relay LR is energized and magnet MM de-energized. There is no battery connected to the contact 27 now engaged by wiper 23, the relay 3 de-energizes and contacts 12 and 13 close.

It will be remembered that set 19 in the bank is the first set of multiple contacts connected to a connector of the third group of lines.

If the connector of this set is idle, its contact 26 will be on open circuit, and if it is busy contact 26 will be connected directly to ground. Assuming first that it is busy, circuit is traced from battery through magnet MM, normal contacts 15, 7, 12, 19, wiper 22, contact 26, and over a direct low resistance connection to ground.

Magnet MM now energizes, attracts armature 15, which de-energizes it, and thus steps the wipers to engage the second contact set of the third group. If this is busy the operation repeats and will continue until an idle set is encountered. During the stepping, relay 4 was connected with battery through magnet MM to ground at alternate contact of off normal contact ON via contacts 12 and 13, but said relay 4 was short-circuited by the grounds via contact 22—26 and did not receive enough current to operate. When wiper 22 engaged the idle, i. e., ungrounded, contact 26, relay 4 was no longer shunted and received enough current

through magnet MM to energize it, but owing to the resistance of 4, magnet MM does not energize at this time and the wipers remain at rest.

The closing of alternate contact 19 grounds the multiples of the selected connector, making it busy.

Armatures 17 and 19 disconnect relay LR and extend conductors L and L' to wires 34 and 33, while 21 opens a contact in the circuit of magnet MM. Armature 16 of relay LR dropping back, de-energizes relay 2.

If the first contact set of the third group had been idle when switch SEL came to rest, engaging it, it is apparent that no energization of magnet MM would have taken place, relay 4 would have had no short circuit to ground about it, and would thus have immediately energized in series with magnet MM, the latter remaining inert and the first connector of the third group would have been the one seized.

Substation A is now connected through to an idle connector CONN of the third group and the relays LR' and LR² energize over the calling line. Relay LR' closing alternate contact 39 energizes relay RR, which is of slow release construction. Relay LR² energizes by its upper winding, and closes contact 37, energizing slow release relay CC, whose contact 41 energizes relay ST. Armature 38 closes the lower differential winding of relay LR² to ground via alternate contact 39, but the upper winding of relay LR overpowers the lower winding and the relay remains operated.

The subscriber now operates his dial according to digit 9, and nine interruptions of the substation circuit de-energize relays LR' and LR² nine times, and the nine times retracted armature 39 energizes and de-energizes motor magnet MM nine times, since relay CC remains operated. The motor magnet MM accordingly steps wipers 49, 50, 51 nine steps from normal, wipers 50 and 51 being on open circuit at 46 and 48.

Subscriber A now operates his dial according to digit 8, and the connector steps ahead eight more steps, its wipers then engaging multiple contacts of the wanted line 9098.

Subscriber A now actuates ringing key K, which inserts resistance N into the line circuit. This reduces the current flow in the upper winding of relay LR² and in relay LR'. The latter still gets enough current to remain operated, but the reduction in relay LR² allows the lower winding to neutralize or slightly overbalance the effect of the upper winding and contacts 37, 38 open. The upper winding of relay LR² is not of sufficient power to re-operate the relay while N is in circuit, and the relay remains de-energized until the subscriber releases key K.

The opening of contact 37 de-energizes

relay CC, and the armature 41 shifts the connection of the already energized relay ST from ground at 43 to the wiper 49. Assuming first that the called line is idle, then the contacts 53, 54, 55 will be connected as shown in full in Fig. 1, part 1, that is, contact 53 will be clear of ground and connected to the combined release magnet and cut-off relay RE. Under these circumstances relay ST of the connector receives no operating current and de-energizes, its armature 47 disconnecting it from wiper 49 and connecting relay AR to said wiper. Contacts 46 and 47 now establish the talking circuit.

Circuit is now traced as follows: From ground at alternate contact 39, through relay AR, normal contact 47, contacts 49, 53, normal contact 18 of the called line circuit (referring for convenience to Fig. 1, part 1), normal contact 9 and to battery through relay RE of the called line. Relay AR of the connector and relay RE of the called line both energize, the latter cutting off the line relay LR and by armatures 5 and 8 bridging talking battery across the called line through the inductive resistances shown. Attracted armature 43 of relay AR prevents a false release when subscriber A releases key K, and the ground through said relay AR connected to wiper 49 and contact 53 and its multiples places the called line in condition to test busy. Due to resistance P and construction of relays 4 and RE of called line, relay RE energizes first and opens circuit of relay 4. Contacts *x* are the eighth group of contacts, and contacts *y* the ninth group of contacts.

Generator G is now in circuit with the called substation to ring its call bell.

When subscriber A releases K, resistance N is cut out, relay LR² energizes and in turn energizes relay CC, which by 40 completes the talking circuit, and as soon as subscriber B answers the ring, conversation can proceed.

When at the end of conversation the subscribers replace their receivers, the act at B does not release any switch. The replacing at A, however, de-energizes both relays LR' and LR², and relay LR' opens the circuit of relay RR, whose de-energization releases armature 45, which closes circuit through magnet RM and relay ST via contact 36. The release magnet RM withdraws the usual retaining pawl, and relay ST places the wipers on open circuit, and the connector spring restores to normal, whereby alternate contact of off normal contacts ON are shifted back to normal. In this connection it should be observed that motor magnet MM' will energize at the time of release, but no stepping ahead of the connector will occur for this reason: relay RR is slightly quicker to release than relay CC in order that the release magnet RM may

energize before relay CC de-energizes, and said magnet in withdrawing the retaining pawl also draws the driving pawl of motor magnet MM' out of effective relation with the ratchet so that when motor magnet MM' does de-energize, that is ineffective as to stepping.

The release magnet RM energizing connects ground wire 32 through alternate contact 41' of said magnet RM, circuit being now traced over 32, 27, 23, alternate contact 18 and normal contact 9 to battery through release magnet RE at switch SEL and due to the establishment of this circuit, said magnet RE energizes to withdraw the retaining pawl of the selector, which spring restores, the wipers being open at contacts 5 and 8, and all apparatus is at zero as soon as off-normal contacts ON shifts back to normal.

Called line busy.

If at the time subscriber A depressed key K, the line wanted was busy as a calling line, its multiples 53 would be grounded at alternate contact of off-normal contacts ON, or if busy as a called line, said multiples would be grounded from the wipers of the connector already making it busy via that connector's relay AR to ground at its alternate contact 39.

In either case relay ST of the testing connector would remain energized when it was connected to wiper 49, because of the aforesaid ground, so that the calling subscriber would, as soon as he released key K, hear the busy signal from apparatus BB, and knowing the called line was busy would replace his receiver and the resulting de-energization of relay RR would energize magnet RM and release would proceed as before. The resistance P is inserted to protect magnet RM from being short-circuited at time of release when the wanted line is busy as a calling line.

Having traced a connection to completion in the third group, which required the adding function of the selector which is not employed when the called line is in the first and second groups, the operations when the wanted line is in group one or two will be readily understood. For group 1, transmission of a single impulse places the selector in engagement with the first connector of group one, and there being no special contact 30^a to interfere, selection of an idle connector would proceed exactly as described hereinbefore as of the time when the selector had been connected to contact 19.

And so for the second group, the pulling of the dial according to digit 0 will step the first selector ten steps, and so beyond the special contact 30^a, and selection of an idle connector of group 2 will proceed as in the case of the first group after the pulling of a single digit.

Considering the system as a whole, it is apparent that to reach the first ten subscribers in group one, a calling subscriber will transmit two sets of digit impulses, those subscribers being numbered from 11 to 19 and then 10. The first ten subscribers in the second group would also be reached by two sets of impulses, their numbers being from 01 to 09, followed by 00, and it is apparent that the second and third ten lines of groups one and two will be reached by the transmission of three and four digit impulse sets, respectively. The first ten lines of group 3 will be reached by the transmission of three digit impulse sets and the second ten lines of group three by four sets.

In a private automatic exchange with the ample provision of connectors for the different groups outlined above, taken in connection with the amount of traffic that experience shows occurs in such systems, it would be of extremely rare occurrence that a seeking selector would find all the connectors of a group busy. If the condition did exist, the calling subscriber would get a wrong number and would call again later.

However, by making the eighth, the eighteenth and the twenty-ninth contact sets in the first selectors non-multiple and connecting the contacts 28 and 29 of these sets as indicated in Fig. 2, the possibility suggested above may be avoided, at the sacrifice of one connector in each of groups 1 and 2. With the arrangement as shown in Fig. 2 (it being understood that the arrangement shown in Fig. 2, will replace the two middle contact banks of switch SEL) and in case an overrun occurs, subsequent impulse sets will simply interrupt the circuit of the slow release relay SR which, however, holds itself operated during their transmission, and also while the key K is operated. The subscriber hears the usual busy signal, replaces his receiver and the selector restores to normal in an obvious manner.

Groupings other than that hereinbefore suggested may be used. For example, but four connectors might be assigned to each group of lines, and with this number five groups could be selected by the selectors, two groups with one actuation of the dial and the other three groups with two actuations. Such an arrangement would increase the capacity afforded by four actuations of the dial to 120 subscribers, divided into two groups of 30 each and three groups of 20 each. This and other modifications will readily suggest themselves, and I do not wish to be limited to the precise structures shown and described, but what I claim is:

1. A telephone system comprising subscribers' lines divided into groups as called lines, adding type connectors divided into

corresponding groups, adding type selectors operable in a single plane only for interconnecting calling lines with idle connectors of desired groups, and impulse mechanism for transmitting directive impulses to selectors and connectors.

2. A telephone system including subscribers' lines divided into groups, connectors in corresponding groups for connecting directly to called lines, selectors operable in a single plane only for interconnecting calling lines with idle connectors of desired groups, adjusting apparatus for a selector, means for actuating said apparatus by a plurality of sets of digit impulses, said selector traveling in response to each set of said plurality, and apparatus automatically serving to cause said selector to pick out an idle connector after the transmission of the last impulse sets.

3. A selector for automatic exchanges or the like comprising contact sets in a single level on the selector bank, contact makers for said selector adjustable responsive to a plurality of sets of digit impulses, a single driving magnet for adjusting said contact makers, and automatic seeking means operative after the transmission of the last set of said plurality to select an idle set of contacts in said level.

4. A selector for automatic exchanges or the like including contact sets arranged in groups in a single level on the selector bank, directive impulse transmitting and receiving means including a single driving magnet to adjust the selector to select various groups, automatic selecting mechanism including said driving magnet for the selector operative to cause it to pick out an idle contact set of the selected group, said mechanism effective to initiate its operation under one condition after transmission of one set of directive impulses and under another condition after the transmission of a plurality of sets of impulses.

5. A selector for automatic exchanges having a bank with contact sets arranged in groups, digit impulse transmitting mechanism, means for causing automatic selection by said selector of idle contacts of selected groups, electromagnet apparatus including a single driving magnet for the selector to receive the digit impulses and adjust said selector in response thereto, said selector selecting certain groups responsive to a single digit impulse set and others in response to a plurality of digit impulse sets, and a special contact set preventing initiation of said automatic selection between the transmission of certain digit impulse sets.

6. An adding type selector including contact sets and mechanism including a single driving magnet responsive to digit impulses to select groups of said contact sets and then automatically an idle set of the selected

group, apparatus for initiating the automatic selection after a group has been selected in response to a single digit impulse set, said apparatus also initiating automatic
5 selection after a group has been selected in response to a plurality of digit impulse sets.

7. A selector for automatic exchanges or the like comprising a plurality of contact sets arranged in groups on the selector bank,
10 mechanism including a single driving magnet responsive to digit impulses to select groups of contact sets and then automatically an idle set of the selected group, apparatus for initiating such automatic selection
15 in some cases after transmission of one digit impulse set, and means for preventing such initiation in other cases after one impulse set and causing such initiation after a plurality of digit impulse sets are transmitted.

20 8. An automatic telephone system comprising telephone lines divided into groups as called lines, connectors, including multiple terminals of said lines, arranged in cor-

responding groups, directive impulse adjusting apparatus for a connector operative to
25 connect with terminals of some of said lines in response to the transmission of a single digit impulse set, and with terminals of other lines in response to the transmission of a plurality of digit impulse sets, selectors
30 operable in a single plane only, multiple terminals of said connectors at said selectors arranged in groups, directive impulse adjusting mechanism for a selector operative to select a certain group of said terminals in
35 response to the transmission of a single digit impulse set, and another group in response to the transmission of a plurality of digit impulse sets, and mechanism for the selector to enable it to select idle contacts of a
40 selected group of terminals automatically operative after the selection of the group.

Signed by me at Chicago, in the county of Cook and State of Illinois, this 27 day of January, 1922.

LEROY D. KELLOGG.