June 8, 1926.

1,587,515

G. R. EATON

CALL DISTRIBUTING SYSTEM

Filed April 14, 1920

3 Sheets-Sheet 1

Fig. 1.

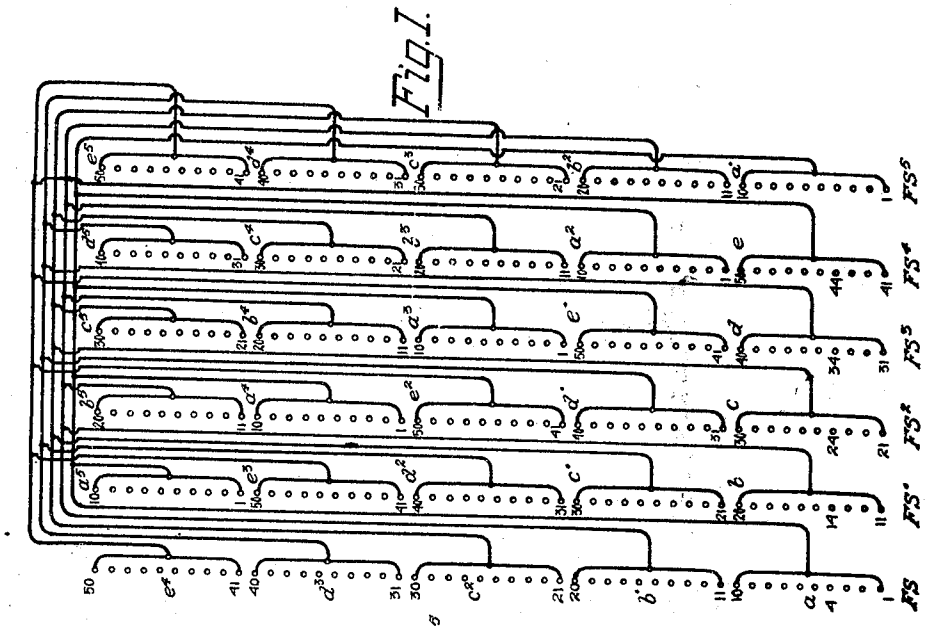
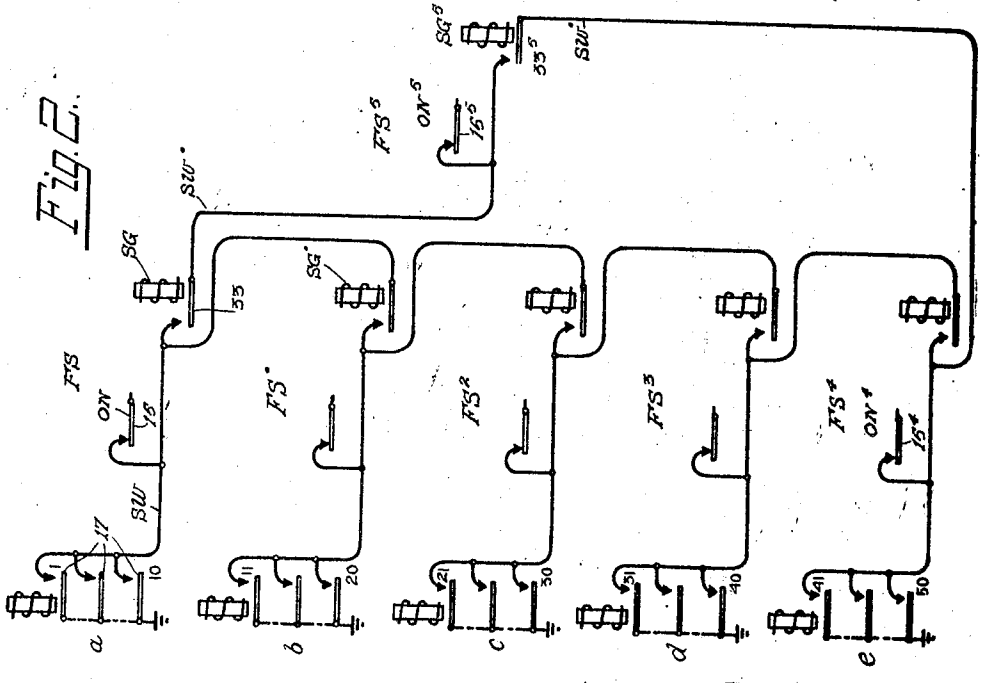


Fig. 2.



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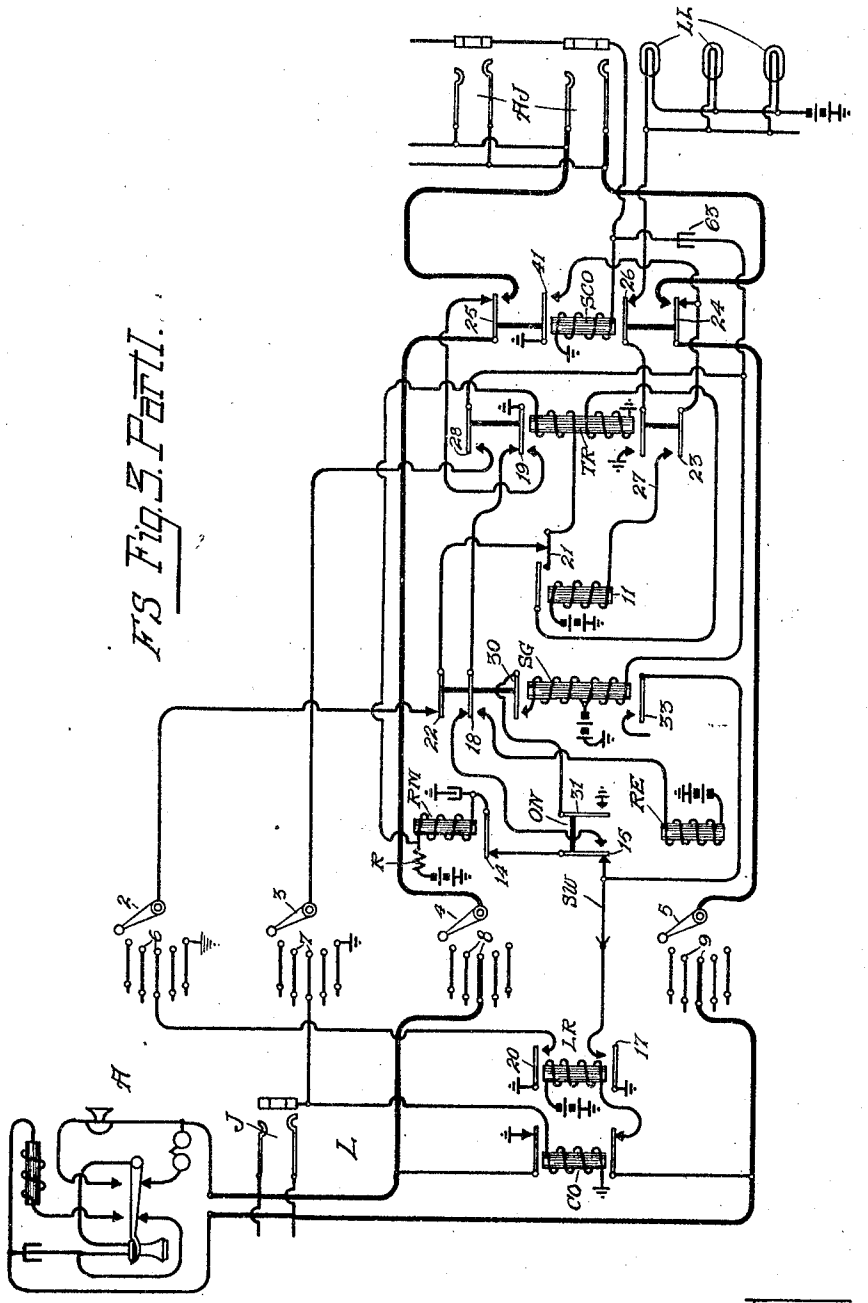
3 Sheets-Sheet 2

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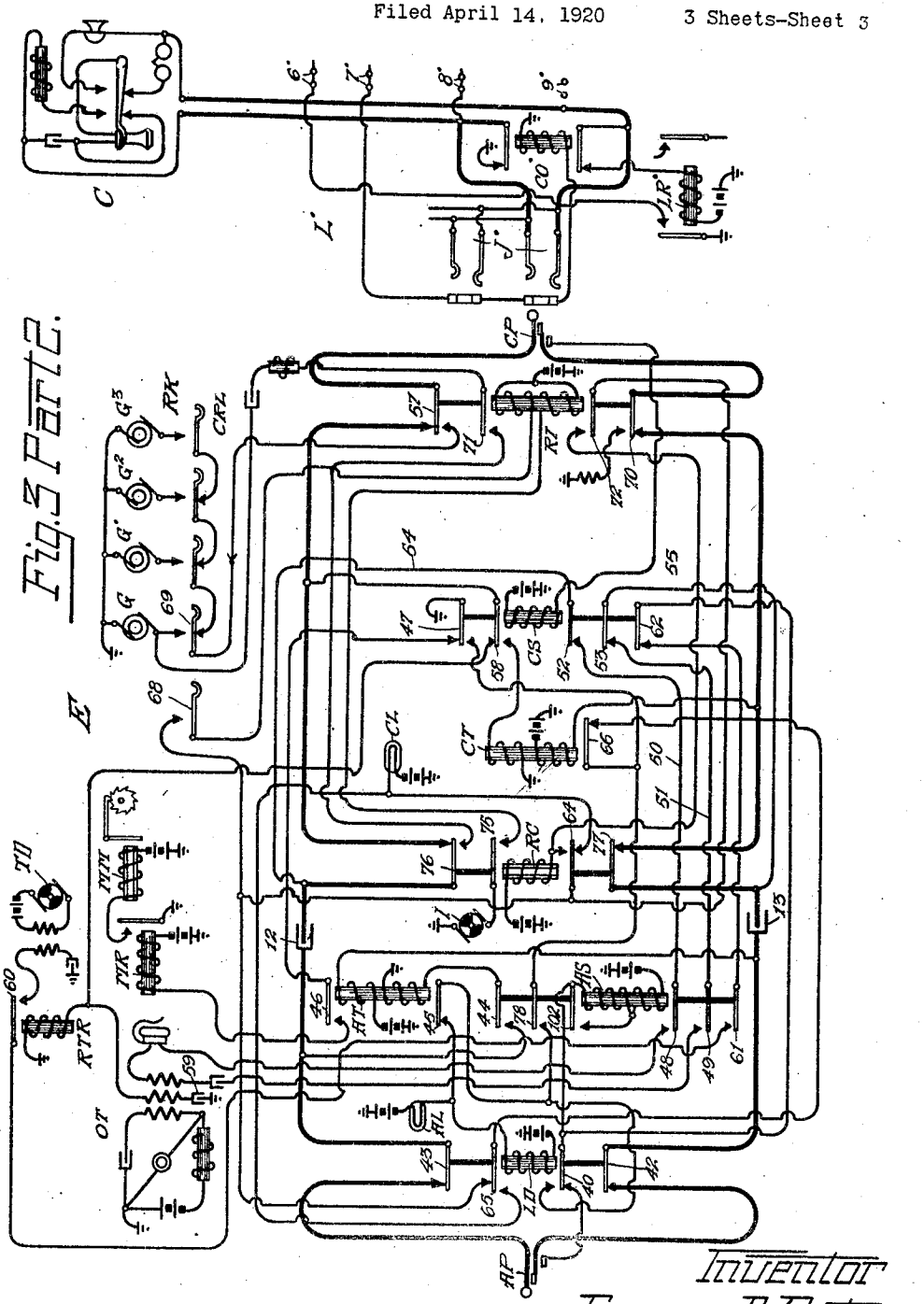
CALL DISTRIBUTING SYSTEM

Filed April 14, 1920 3 Sheets-Sheet 3

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Patented June 8, 1926. 1,587,515

# UNITED STATES PATENT OFFICE.

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## CALL-DISTRIBUTING SYSTEM.

Application filed April 14, 1920. Serial No. 373,943.

My invention relates to telephone systems in which link or trunk circuits are employed for interconnecting telephone lines, and has to do more particularly with that type of telephone system employing both manual and automatic apparatus.

An object of my invention is to provide an improved distribution and circuit arrangement for increasing the speed of connecting lines to trunks when finder switches are used to connect trunk circuits to calling lines.

Another object of my invention is to decrease the average number of steps a finder switch has to travel in connecting a calling subscriber's line to a connecting link or trunk circuit.

I preferably divide the subscribers' lines into groups of fifty and associate with each group of fifty lines six finder switches, any one of which may be started when a call is initiated to select back and connect to a calling subscriber's line. Of course, I can increase the capacity of the finder switches to one hundred or any desired number of bank contacts and provide as many finder switches for a group of lines as I find necessary and desirable to handle the traffic.

With the old method of multipling the subscribers, lines are multipled straight through the bank contacts of the different finder switches, and only one master switch is provided, wich starts one finder switch after the other as the calls come in. With this method of connecting the subscribers' lines to the finder switch banks, it is obvious that it takes a longer time for the finder switch to connect to a subscriber's line that is connected to one of the last sets of contacts in the bank of contacts than it does for the finder switch to connect to a subscriber's line which is connected to one of the first sets of contacts in the bank of contacts. It often occurs that when a subscriber whose line appears in one of the last sets of contacts in the finder switch banks initiates a a call, and before the started finder switch has rotated far enough to connect to the calling line, a second calling subscriber initiates a call whose line appears ahead of the first calling line in the bank of contacts; consequently, the started finder switch connects to the second calling line and the first calling line has to wait until the master switch starts a second finder switch. In a straight multiple system of this kind the first subscribers of a group of subscribers will receive preference for the reasons above described, and to overcome this objectionable feature, one of the features of my invention is the provision of means whereby the bank multiple of the switches are slipped by smaller groups between the different finder switches of a group of finder switches.

Each group of fifty lines is further divided into five sub-groups of ten lines each, and the first ten lines in the first finder switch will occupy the first ten contact sets; in the bank of the second finder switch they will occupy contact sets 11 to 20, inclusive, and in the bank of the third finder switches they will occupy contact sets 21 to 30, inclusive, etc., as will be more fully hereinafter described.

I also arrange the finder switches so that when a subscriber initiates a call in the first sub-group of subscribers' lines, the first finder switch of the group is started; and when a subscriber initiates a call whose line appears in the second sub-group of subscribers' lines in the first finder switch the second finder switch of the group is started in whose bank the second sub-group of lines appear as the first sub-group of contacts so that the second finder switch only has to search through its first sub-group of contacts to find the calling line, etc., for the other sub-groups of lines.

If a call is initiated in the first sub-group of contacts, that is, in sub-group of lines numbered 1 to 10, the first finder switch will start and find the subscriber's line in its first sub-group of contacts. Now, if a second call is initiated in the same group, the sixth finder switch is started and will find the subscriber's line in its first-sub-group of contacts. If a third call is initiated in the same group, the fifth finder switch is started, and it will find the line in its second sub-group of contacts, etc. If five calls should be initiated at once, one in each sub-

group of lines, the first five finder switches will be started and each finder switch will find the call initiated in its sub-group in its first sub-group of contacts.

The above features, as well as others, will be more particularly pointed out in the ensuing specification and in the appended claims.

Referring now to the accompanying drawings,

Fig. 1 illustrates diagrammatically a group of six finder switches associated with a group of fifty lines and illustrating the manner of slipping the bank contacts;

Fig. 2 illustrates a skeleton arrangement of the line circuits and finder switches, showing the master starting conductor and its association with the finder switches;

Fig. 3, Part 1, illustrates diagrammatically a calling substation in association with a finder switch which terminates in a set of jacks and lamps; and

Fig. 3, Part 2, diagrammatically illustrates a cord circuit for extending a connection from a calling substation to a called substation.

Referring now to Fig. 1, I represent diagrammatically six fifty-point finder switches FS, FS′, FS², FS³, FS⁴, FS⁵, and I illustrate the lines preferably in a fifty-line group slipped in sub-groups of ten lines each. Lines 1 to 10 appear as group $a$ (bank contact sets 1 to 10, inclusive) in the bank of switch FS; appear as group $a'$ (bank contact sets 1 to 10, inclusive) in the bank of finder switch FS⁵; appear as group $a^2$ (bank contact sets 11 to 20, inclusive) in the bank of switch FS⁴; appear as group $a^3$ (bank contact sets 21 to 30, inclusive) in the bank of switch FS³; as group $a^4$ (bank contact sets 31 to 40, inclusive) in the bank of finder switch FS²; and appear as group $a^5$ (bank contact sets 41 to 50, inclusive) in the bank of finder switch FS′.

Lines 11 to 20 appear as group $b$ (bank contact sets 1 to 10, inclusive) in the bank of switch FS′; appear as group $b'$ (bank contact sets 11 to 20, inclusive) in the bank of switch FS; appear as group $b^2$ (bank contact sets 11 to 20, inclusive) in the bank of switch FS⁵; appear as group $b^3$ (bank contact sets 21 to 30, inclusive) in the bank of switch FS⁴; appear as group $b^4$ (bank contact sets 31 to 40, inclusive) in the bank of switch FS³; and appear as group $b^5$ (bank contact sets 41 to 50, inclusive) in the bank of switch FS².

Lines 21 to 30 appear as group $c$ (bank contact sets 1 to 10, inclusive) in the bank of switch FS²; appear as group $c'$ (bank contact sets 11 to 20, inclusive) in the bank of switch FS′; appear as group $c^2$ (bank contact sets 21 to 30, inclusive) in the bank of switch FS; appear as group $c^3$ (bank contact sets 21 to 30, inclusive) in the bank of switch FS⁵; appear as group $c^4$ (bank contact sets 31 to 40, inclusive) in the bank of switch FS⁴; and as group $c^5$ (bank contact sets 41 to 50, inclusive) in the bank of switch FS³.

Lines 31 to 40 appear as group $d$ (bank contact sets 1 to 10, inclusive) in the bank of switch FS³; appear as group $d'$ (bank contact sets 11 to 20, inclusive) in the bank of switch FS²; appear as group $d^2$ (bank contact sets 21 to 30, inclusive) in the bank of switch FS′; appear as group $d^3$ (bank contact sets 31 to 40, inclusive) in the bank of switch FS; appear as group $d^4$ (bank contact sets 31 to 40, inclusive) in the bank of switch FS⁵; and appear as $d^5$ (bank contact sets 41 to 50, inclusive) in the bank of switch FS⁴.

Lines 41 to 50 appear as group $e$ (bank contact sets 1 to 10, inclusive) in the bank of switch FS⁴; appear as group $e'$ (bank contact sets 11 to 20, inclusive) in the bank of the switch FS³; appear as group $e^2$ (bank contact sets 21 to 30, inclusive) in the bank of switch FS²; appear as $e^3$ (bank contact sets 31 to 40, inclusive) in the bank of group FS′; appear as group $e^4$ (bank contact sets 41 to 50, inclusive) in the bank of switch FS; and appear as group $e^5$ (bank contact sets 41 to 50, inclusive) in the bank of switch FS⁵.

Referring now to Fig. 2, I illustrate diagrammatically five groups of ten lines each as $a$, $b$, $c$, $d$ and $e$ of a group of fifty lines. The three contacts of group $a$ are strapped together and represent a group of ten line relays associated with the group of lines 1 to 10; group $b$ represents a group of ten line relays associated with the group of lines 11 to 20; group $c$ represents a group of ten line relays associated with the group of lines 21 to 30; group $d$ represents a group of ten line relays associated with the group of lines 31 to 40; group $e$ represents a group of ten line relays associated with the group of lines 41 to 50. The switches FS, FS′, FS², FS³, FS⁴, and FS⁵ are shown associated with their associated groups of lines $a$, $b$, $c$, $d$ and $e$. The method for starting the different switches as the calls are initiated by the subscribers in the different groups of lines, will be more fully hereinafter described.

Referring now in general to the circuit arrangement as illustrated in Fig. 3, Parts 1 and 2, it illustrates the mechanism and the apparatus necessary to connect the calling substation A to called substation C. The calling substation A is of the well-known common battery type, connected by line limbs to the central office link circuit L, which includes a line relay LR, cut-off relay CO, together with multiple jacks J and the multiple bank contacts 6, 7, 8 and 9 of the finder switches as each subscriber's line appears in

the banks of six different finder switches, as already described. The finder switch FS terminates at its one end in multiple jacks AJ and in multiple line lamps LL, a jack AJ and a line lamp LL appearing at the different positions of the switchboard, that is, the jacks AJ and lamps LL associated with each finder switch appear in as many different positions on the switchboard as it is found desirable to multiple the lamps LL and jacks AJ to secure an adequate traffic distribution. The finder switch FS may be of any desired and suitable construction and is provided with a spring-restored switch shaft and wipers 2, 3, 4 and 5 and with four sets of bank contacts 6, 7, 8 and 9 of fifty contacts each, to which the fifty subscribers' lines are connected. A rotary step-by-step magnet RM is provided for rotating the switch shaft and wipers 2, 3, 4 and 5 by means of a ratchet and pawl mechanism. Sets of bank contacts 6, 7, 8 and 9 and a retaining pawl are also provided and adapted to be operated by the release magnet RE for permitting the switch shaft and wipers 2, 3, 4 and 5 to restore to normal by springs tension. The starting conductor SW is a common starting wire and is connected to a contact of each of the line relays LR of the group of subscribers which is associated with the finder switch FS. A sleeve cut-off relay SCO is adapted upon energization to connect the finder switch wipers 3, 4, and 5 through to the multiple jacks AJ. The starting relay SG extends the starting conductor SW through to the next finder switch FS (not shown) when the switch FS is taken for use. The finder switch FS also includes a double-wound test relay TR, a line relay 11 and a set of off-normal contacts ON.

The cord circuit E comprises an answering plug AP and a calling plug CP, the said answering plug AP and calling plug CP being connected by the heavily marked conductors and having the condensers 12 and 13 interposed. Associated with the answering end of the cord circuit E is an answering sleeve supervisory relay AS and an answering tip supervisory relay AT for controlling the circuit for the answering supervisory lamp AL. Relay AS also acts as a test relay for controlling the connection of the operator's telephone set OT of the talking conductors of the cord circuit E. A link disconnect relay LD is also associated with the answering end and provides the cord circuit E with instantaneous disconnect and recall. Associated with the calling end of the cord circuit E is a calling tip supervisory relay CT and a calling sleeve supervisory relay CS for controlling the circuit of the calling lamp CL. The calling sleeve relay CS also controls the disconnection of the operator's set OT from talking conductors of the cord circuit E. A party line ringing key RK is provided for connecting one of a plurality of generators G, G′, $G^2$ and $G^3$ with the common ringing conductor CRL and for controlling the ringing control relay RC. The ringing control relay RC controls the ringing interrupter relay RI, which through the medium of the constantly rotating interrupter RI applies ringing current to the common conductor CRL to the line of the called subscriber. Associated with the cord circuit E is a service meter device comprising a meter magnet MM having meter control relay MR. Associated with the operator's set OT is also a revertive tone relay RTR and a tone device TD. To the right of Fig. 2, Part 2, I show a called substation C similar to the calling substation A and terminating in a line circuit L′ which comprises the line relay LR, cut-off relay CO, multiple jacks J′ and multiple finder switch bank contacts 6′, 7′, 8′ and 9′.

Assuming now that the subscriber at the substation A wishes to initiate a call, upon the removal of the receiver thereat a circuit is closed through the line relay LR including the two sides of the subscriber's line circuit, in series, and the subscriber's substation instrument. The line relay LR upon energization places ground upon the starting conductor SW and a ground upon the common multiple test contacts 6, corresponding to the calling subscriber's line in the bank of the finder switches having access to the calling subscriber's line. The placing of ground upon the starting conductor SW closes an energizing circuit for the rotary magnet RM of the first finder switch FS of the series of finder switches associated with the calling subscriber's line over a circuit traced from battery, through the resistance R, through the rotary magnet RM, normal contact 15 of the off-normal contacts ON, starting conductor SW to ground at alternate contact 17 of line relay LR. Rotary magnet RM upon energizing steps the switch shaft and wipers 2, 3, 4 and 5 into engagement with the first set of bank contacts 6, 7, 8 and 9 of the finder switch FS and moves the off-normal contacts ON to their alternate position. The movement of the off-normal contacts ON shifts the normally closed contact 15 to its alternate position, which closure of alternate contact 15 closes a local substitute circuit for the magnet RM over a circuit extending from battery through the resistance R, through the winding of magnet RM, its interrupter contact 14, alternate contact 15 of off-normal contacts ON, normal contact 18 of the starting relay SG to ground at normal contact 19 of the test relay TR, thereby making the movement of the switch shaft and wipers 2, 3, 4 and 5 independent of the starting circuit so that no matter if the calling subscriber should immediately re-

place his receiver, the finder switch will operate to move the switch shaft and wipers step by step over the bank contacts 6, 7, 8 and 9 to the last contact set thereof, unless a grounded contact is engaged.

The finder switch wiper 2, upon engaging a grounded contact corresponding to the calling subscriber's line, which contact is grounded from the alternate contact 20 of the line relay LR associated with the calling subscriber A, closes an energizing circuit for the test relay TR traced from ground at alternate contact 20 of line relay LR, contact 6, wiper 2, normal contact 22 of the relay SG, make-before-break contact 21 of relay 11, through the upper winding of the test relay TR, which winding is of low resistance, through the resistance R to battery. The energizing circuit through the upper winding of the relay TR places a shunt around the winding of the rotary magnet RM, due to the low resistance path through the said upper winding, preventing further actuation of the said rotary magnet RM, which now remains at normal and prevents further movement of the switch wipers 2, 3, 4 and 5. Upon the energization of relay TR an energizing circuit for the relay 11 of the finder switch FS is established, traced from battery through the winding of the relay 11, alternate contact 23 of relay TR, normal contact 24 of relay SCO, wiper 5, contact 9, through the calling substation A and back through contact 8, wiper 4, normal contact 25 of relay SCO to ground at alternate contact 19 of relay TR. A further result due to the energization of relay TR is the closing of a circuit for the multiple line lamps LL over a path extending from battery, through the multiple line lamps LL at the different positions of the switchboard, normal contact 26 of relay SCO, to ground at alternate contact 27 of relay TR, thereby displaying a signal before each of the operators which have access to the multiple answering jacks AJ.

A further result, due to the energization of relay TR is the closing of a circuit through the starting relay SG and cut-off relay CO of the subscriber's line circuit in series over a path extending from battery, through the lower winding of the relay SG, alternate contact 28 of relay TR, wiper 3, contact 7 and through the cut-off relay CO to ground.

Again referring to the energization of the relay 11, this relay upon energizing closes a substitute locking circuit for the relay TR independent of its original energizing circuit, over a path extending from battery through the resistance R, through the upper winding of the relay TR, alternate make-before-break contact 21 of relay 11 to ground through the lower winding of relay TR, thereby making the energization of the relay TR dependent upon the relay 11. The relay SG upon energization closes a locking circuit for itself traced from battery, through its upper winding, its alternate contact 30 to ground at alternate contact 30 of the off-normal contacts ON. The relay SG upon energizing also extends the starting wire SW through its alternate contact 33 to the next finder switch and the opening of its normal contact 22 opens the test circuit, which extends from the wiper 2. The energization of the cut-off relay CO of the subscriber's line circuit opens the energizing circuit of the line relay LR, thereby removing ground from the starting conductor SW and from the bank contact 6 at contacts 17 and 20, respectively. The ground is removed from the starting conductor SW before the relay SG has connected the starting conductor SW through to the next finder switch, due to the contact 33 of the relay SG being so adjusted that the alternate contact 17 of relay LR is opened before contact 33 of the relay SG is closed.

Referring again to Fig. 2, assuming that the switches FS, FS′, etc., are at normal and a subscriber in the group *a* is initiating a call, this action brings about the closure of alternate contact 17 of its associated line relay to bring about the energization of the motor magnet RM of its associated finder switch FS, contact 15 of off-normal contacts ON, through its motor magnet RM to battery. The magnet steps the wipers of switch FS into engagement with contacts of the calling line. Likewise, when a subscriber in the group *b* initiates a call, the motor magnet of the group's associated switch FS′ is energized to select the contacts of the calling line. Initiation of a call in group *c* by a subscriber brings about the energization of its associated line relay which will start its associated finder switch $FS^2$ to select the contacts of the calling line. The initiation of a call in group *d* by a subscriber brings about the energization of its associated line relay, which will start its associated finder switch $FS^3$ to select the contacts of the calling line, and the initiation of a call in group *e* by a subscriber brings about the starting of its associate finder switch $FS^4$ to select the contacts of the calling line, thus providing a means for starting a selector or the entire group of selectors at one time, as follows:

Assuming lines 4, 14, 24, 34 and 44 all call at the same instant, selectors FS, FS′, $FS^2$, $FS^3$, $FS^4$ all start simultaneously and select the calling lines, and by referring to Fig. 1 it will be noted that the switches FS, FS′, etc., will move four steps into engagement with the contacts 4, 14, 24, 34 and 44, as the groups *a*, *b*, *c*, *d* and *e* are associated with the first ten contacts of each switch FS, FS′, etc.

Assuming that two calls are initiated in

the group $a$ and assuming that subscriber 4 calls first, the line relay LR extends ground over the starting wire SW to the motor magnet of the switch FS, and the magnet steps the wipers into engagement with the calling line. Upon engagement of the wipers with the contacts of the calling line an energizing circuit for the relay SG is brought about, as previously described, and the closing of its alternate contact 33 extends the starting conductor SW to the switch $FS^5$. The second call, which originates in the group $a$, upon the closing of the alternate contact 17 of its associated line relay, will extend ground through the said alternate contact 17 over the starting conductor SW, through alternate contact 33 of the relay SG of switch FS, over the starting conductor SW, through the normally closed contacts $15^5$ of the off-normal contacts $ON^5$, through the motor magnet of the switch $FS^5$ to battery. The motor magnet of switch $FS^5$ now steps the wipers of the said switch into engagement with the contacts of the second calling line and when the wipers of the switch $FS^5$ engage the contacts of said calling line, an energizing circuit for the relay $SG^5$ of switch $FS^5$ is brought about, as previously described, and extends the starting conductor SW through the now closed contact $33^5$ of the relay $SG^5$ to the next finder switch of the group, which is the finder switch $FS^4$.

Again, should a third subscriber of group $a$ immediately initiate a call, the ground will be extended from the alternate contact 17 of its associated line relay LR through alternate contacts 33 and $33^5$ of relay SG, $SG^5$ of switches FS, $FS^5$ through normal contact $15^4$ of off-normal contact $ON^4$ of switch $FS^4$ (assuming it is idle), through its associated motor magnet to battery. The switch $FS^4$ is now actuated to step its wipers into engagement with the contacts of the calling subscriber of the group $a$, and referring to Fig. 1, the wipers of the switch $FS^4$ are stepped to group $a^2$, which contains the contacts of the $a$ group of lines, which are lines 1 to 10.

Should a subscriber of the group $b$ initiate a call, the subscriber's line relay extends ground over the starting wire SW to the motor magnet of its associated finder switch FS′, through the normally closed contact 15′ of off-normal contacts ON′ of switch FS′. The motor magnet will step the wipers into engagement with the contacts of the calling line and when in engagement therewith the relay SG′ of the switch FS′ actuates, as previously described, and extends the starting conductor SW through its alternate contact 33′ to the next idle finder switch.

Assuming that the three subscribers in the group $a$ have called and are still connected, as above described, should a second subscriber of the group $b$ initiate a call, the operation of the subscriber's associated line relay connects ground over the starting conductor SW through alternate contact 33′ of relay SG′ of switch FS′, alternate contact 33 of relay SG of switch FS, alternate contact $33^5$ of relay $SG^5$ of switch $FS^5$, alternate contact $33^4$ of relay $SG^4$ of switch $FS^4$ to the switch $FS^3$, which we are assuming is idle. The ground extending over the starting conductor from the second calling subscriber of the group $b$ now extends through normal contact $15^3$ of off-normal contacts $ON^3$ of the switch $FS^3$ through its motor magnet to battery. The motor magnet now steps the wipers into engagement with contacts of the second calling line of the group $b$, and as group $b$, which contains lines 11 to 20, is the group $b^4$ of the switch $FS^3$, the said wipers are stepped over thirty sets of contacts. Upon the thirty-first step of the wipers of the switch $FS^3$, they are placed in engagement with the first contact set associated with the group of lines containing lines 11 to 20. From the foregoing it may be seen that any line calling may use any finder switch, depending upon the idle or busy condition of said switches, and that the time interval between the number of calls coming in at the same instant has been materially reduced.

It will be seen that by slipping the bank multiple of the six switches according to my invention, the amount of work to be performed by the finder switches is minimized; that is to say, the finder switches are not compelled to move to the full limit of their range of adjustment as is often true of the usual multiple arrangement employed prior to my invention. In other words, each finder switch is enabled to perform the work imposed upon it without necessarily operating the full range of its switch adjustment, as is often true of such switches when the contacts or terminals thereof are multipled together in the old way. The wear and tear on the switches is materially reduced to a minimum. It will also be seen that by this arrangement of slipping the bank multiple of the switches, as previously described, all possibility of the burden of the work being placed upon some one particular switch, thus distributing the work throughout the different switches, regardless of whether the calls are all coming from one particular group of subscribers or more or less evenly from the subscribers throughout the entire group of fifty lines.

Again referring to the description of Fig. 3, parts 1 and 2, and assuming that the finder switch FS does not find a grounded bank contact 6, due to the fact that the calling subscriber has replaced his receiver and removed the ground from the bank contact of the finder switch FS before the said

switch has advanced to the said grounded bank contact, in a case of this kind the finder switch FS will advance step by step to its fully operated position, in which position a circuit will be closed through the upper winding of relay TR over a path extending from battery through resistance R, through the upper winding of the relay TR, make-before-break contact 21 of relay 11, normal contact 22 of relay SG, wiper 2, and the last contact 6 of the bank, which is grounded. Relay TR operating causes the energization of the relays SG and 11, as before described, the only difference being that in this instance the relay SG energizes over a path extending to the last contact of the bank of contact 7, over which the wiper 3 passes, this last contact being permanently connected to ground. Relay SG locks up, as before described, but the relay 11 does not remain energized, as before, due to the fact that its substitute circuit is opened at the calling subscriber's switchhook. The relay 11 de-energizing opens the locking circuit of the relay TR, due to the fact that contact 22 of relay SG has opened, permitting the said relay TR to de-energize. Relay TR de-energizing closes a circuit for release magnet RE over a path extending from battery through the winding of the said release magnet RE, alternate contact 18 of relay SG to ground at normal contact 19 of relay TR. The release magnet RE upon energization moves the retaining pawl from the ratchet, thereby permitting the switch shaft and wipers to restore to normal under spring tension. The release magnet RE is held energized as long as relay SG is held in its energized position, and the relay SG is held energized until alternate contact 31 of off-normal contacts ON is returned to its normal position. The off-normal contacts ON are restored to normal when the switch shaft assumes its normal position, thus placing the apparatus in condition to be used for other calls.

Returning now to the point when the finder switch FS was operated to select the subscriber at the calling substation A and to light the multiple line lamps LL at the different operators' positions, an idle operator noting the glowing of the line lamp LL before her inserts an answering plug AP of the cord circuit E into one of the multiple jacks AJ. The insertion of the plug AP in multiple jack AJ closes a series energizing circuit for the answering sleeve supervisory relay AS of the cord circuit E and the relay SCO of the finder switch FS; said circuit extending from battery through the windings of the relay AS, in series, normal contact 40 of the link disconnect relay LD, sleeve contacts of the connected plug AP and jack AJ to ground through the winding of the relay SCO. The relay AS energizing closes, providing that the cord circuit E is the first cord circuit to be connected to the jacks AJ, a shunt about the upper high resistance winding at its alternate contact 102, there placing the low resistance winding of said relay AS in series with the relay SCO of the finder switch FS. The low resistance winding of the relay AS creates a low resistance path and prevents a relay AS of another cord circuit from operatively energizing and connecting its associated operator's telephone set in circuit with the calling subscriber's line. The relay SCO of the finder switch FS upon energization connects the talking conductors of the finder switch FS through its alternate contacts 24 and 25 to the tip and ring contacts of the jack AJ and the opening of its normal contact 26 opens the circuit of the multiple line lamps LL, and the closing of its alternate contact 41 closes a substitute circuit for the relay 11 over a circuit extending from battery, through the winding of relay 11, alternate contact 23 of relay TR to ground at alternate contact 41 of relay SCO. This substitute circuit of relay 11 of the finder switch FS is independent of the original energizing circuit of relay 11, which included the calling substation.

Returning now to the cord circuit E, a further result due to the energization of the supervisory relay AS is the bridging of the answering tip supervisory relay AT across the subscriber's talking circuit, the circuit of the relay AT extending from battery through the upper winding of the said relay AT, normal contact 42 of the link disconnect relay LD, ring contacts of the connected plug AP and jack AS, alternate contact 24 of relay SCO, wiper 5, contact 9, through the calling substation A, back through contact 8, wiper 4, alternate contact 25 of relay SCO, tip contacts of the connected plug AP and jack AJ, normal contact 43 of the relay LD, alternate contact 44 of relay AS to ground through the lower winding of relay AT. The relay AT upon energization opens its normal contact 45 to prevent a premature lighting of the answering supervisory lamp AL and also to prevent a premature operation of the link disconnect relay LD. The closing of alternate contact 46 of relay AT closes a circuit for the meter relay MR, from battery through the winding of the meter relay MR, alternate contact 46 of relay AT to ground at normal contact 47 of the calling sleeve supervisory relay CS. The meter relay MR upon energization actuates the meter magnet MM to operate the registering apparatus.

A further result due to the energization of the relay AS is the bridging of the operator's telephone set OT across the talking conductors of the cord circuit E, through alternate contacts 48, 49 of the said relay AS,

over conductors 50, 51 through normal contacts 52, 53 of relay CS, conductors 54, 55 to the talking conductors of the cord circuit E. The operator is now connected to the talking conductors of the cord circuit E, thus being placed in connection with the calling subscriber at the substation A and now inquires the wants of the said calling subscriber.

Assuming that it is the subscriber at the substation C that is wanted, the operator tests the line of the called subscriber at *c*, as to its idle or busy condition, and if the said line is idle she then inserts the calling plug CP into a jack J′ connected to the line circuit L′ of the called substation C. If the line of the called substation C is busy, the touching of the tip plug CP to the sleeve of the jack J′ will close a circuit from the busy or battery potential upon the sleeve of the jack J′ to the tip of the plug CP, contact 57 of relay RI, through contact 58 of the sleeve supervisory relay CS and through the tertiary winding of the operator's induction coil and condenser 59 to ground, thus giving the operator a busy click in her head receiver and notifying her of the busy condition of the called line. The operator thereupon notifies the calling subscriber that the called subscriber's line is busy.

Assuming that the called subscriber at *c* is a subscriber whose substation is connected to a party-line of which the calling subscriber is a party, the touching of the sleeve multiple jack J′ of the calling subscriber's line by the calling plug CP closes a circuit from battery or busy potential found upon the sleeve of the multiple jack J′ through the tip of the plug CP, contact 57 of relay RI to contact 58 of relay CS, through the revertive tone relay RTR to ground. The relay RTR upon energizing closes a circuit from the tone device TD to alternate contact 60 of relay RTR through contact 61 of the answering sleeve supervisory relay AS, the normal contact 62 of the calling sleeve supervisory relay CS, through normal contact 40 of the link disconnect relay LD, the sleeve of the plug AP and the sleeve of the multiple jack AJ, through the condenser 63 and through alternate contact 28 of the relay TR of the finder switch FS, wiper 3, the engaged contact 7, thence through the sleeve of the jack J, which is being engaged by the tip of the calling plug CP, through the tip of the plug CP, contact 57 of the relay RI, through contact 58 of the relay CS, through the tertiary winding of the operator's induction coil, through the condenser 59 to ground, thereby giving the operator a revertive tone test from the tone device TD. The operator then notifies the calling subscriber at the substation A to replace his receiver upon the switchhook for a moment so that the called subscriber may be signaled, as will be more fully hereinafter described.

Assuming that the line of the called subscriber at substation C is idle, the insertion of the calling plug CP into the jack J′ of the called subscriber's line closes a series energizing circuit for the calling sleeve supervisory relay CS and cut-off relay CO′ over a path traced from battery through the winding of the said relay CS, the sleeve contacts of the connected plug CP and jack J′ to ground through the winding of the cut-off relay CO′. The relay CO′ upon energizing disconnects the line relay LR from the line circuit of the called subscriber. The calling sleeve supervisory relay CS upon energization disconnects the operator's set OT from the talking conductors of the cord circuit E at its contacts 52 and 53, and the opening of its normal contact 58 opens the circuit of the revertive test relay RTR, and the closing of its alternate contact 47 closes a circuit for the calling supervisory lamp CL traced from battery through the said lamp, normal contact 64 of ringing control relay RC, normal contact 65 of link disconnect relay LD, normal contact 66 of the calling tip supervisory relay CT to ground at the alternate contact 47 of relay CS. The circuit of meter relay MR is also opened when the normal contact 47 of the relay CS assumes its alternate position, and the meter relay MR de-energizing opens the circuit of the meter magnet MM, allowing the same to de-energize. The operator next depresses one of the ringing key plungers of the ringing key RK to connect one of the ringing generators G, G′, G², G³ to the common ringing conductor CRL and to initiate the operation of the automatic ringing equipment. The operation of the end spring 68 of the ringing key RK when a key plunger is depressed closes a circuit for the interrupter relay RI, extending from battery, through the upper winding of said relay RI, momentarily closed and spring contact 68, normal contact 65 of the link disconnect relay LD, normal contact 66 to the calling tip supervisory relay CT and alternate contact 47 of the calling sleeve supervisory relay CS to ground. The relay RI upon energizing connects the selected generator, which we will assume is the generator G, to the common ringing conductor CRL, the circuit being traced from the ungrounded pole of the generator G, through alternate contact 69 of the depressed ringing key plunger, over common ringing conductor CRL, alternate contact 57 of relay RI, tip contacts of the connected plug CP and jack J′, through the call bell at the called substation C, back through the ring contacts of the connected plug CP and jack J′ to ground

at alternate contact 70 of relay RI, and this passage of ringing current the instant a plunger is depressed assures a preliminary ring of the call bell at the called substation the instant that the ringing key RK is operated.

A further result due to the energization of the relay RI is the connection of an audible ringing tone to the calling subscriber's line, through the alternate contact 71 of relay RI, to indicate to the calling subscriber that the call bell at the called substation is being operated.

A further result, due to the energization of the relay RI, is the closure of an energizing circuit for the ringing control relay RC extending from battery through the winding of the relay RC, alternate contact 72 of relay RI, normal contact 65 of the link disconnect relay LD, normal contact 66 of the relay CT to ground at alternate contact 47 of relay CS. The relay RC upon energization closes a locking circuit for itself, traced from battery through the winding of the said relay RC, its alternate contact 64, normal contact 65 of relay LD, normal contact 66 of relay CT to ground at alternate contact 47 of relay CS. The relay RC upon energization opens its normal contact 64 to open the circuit of the calling supervisory lamp CL, and the closure of its alternate contact 75 connects the constantly rotating interrupter I in circuit with the ringing interrupter relay RI, the circuit being traced from battery through the lower winding of the relay RI, through alternate contact 75 of relay RC, through the interrupter I to ground. The ringing relay RI is thus intermittently energized and de-energized to connect ringing current over the previously described path to operate the call bell at the called subscriber's substation C.

Upon the response of the called subscriber at the called substation C, a circuit is closed through the called tip supervisory relay CT, traced from battery through the lower winding of the said relay, normal contact 70 of ringing interrupter relay RI when the said relay RI is in one of its de-energized positions, through the ring contacts of the connected plug CP and jack J′, through the now closed contacts of the substation switchhook, back through the tip contacts of the connected jack J′ and plug CP, normal contact 57 of relay RI, alternate contact 58 of relay CS to ground through the upper winding of relay CT. The relay CT upon energization opens the locking circuit of the ringing control relay RC at its normal contact 66, thereby preventing further applications of ringing current to the called subscriber's line. The relay RC de-energizing closes the talking conductor strands at its normal contacts 76 and 77, through to the called subscriber at the called substation C, and the opening of alternate contact 75 disconnects the interrupter I from the ringing interrupter relay RI. The subscribers at the calling substation A and called substation C are now in conversational circuit and said talking circuit may now be traced over the heavily marked conductors.

Assuming now that the conversation has terminated, the subscriber at the substation A upon replacing his receiver upon its switchhook opens the energizing circuit of the answering tip supervisory relay AT. The relay AT upon de-energizing closes an energizing circuit for the link disconnect relay LD at its normal contact 45, said circuit being traced from battery through the winding of the said relay LD, normal contact 45 of relay AT, alternate contact 78 of relay AS to ground at alternate contact 47 of the calling sleeve supervisory relay CS. The relay LD upon energization opens the series energizing circuit for the relay AS of the cord circuit E and relay SCO of the finder switch FS at its normal contact 40, and closes a substitute energizing circuit of the answering sleeve supervisory relay AS extending from battery through the lower winding of the relay AS, alternate contact 102 of the relay AS, alternate contact 40 of relay LD, alternate contact 78 of relay AS to ground at alternate contact 47 of relay CS. The relay AT de-energizing closes a circuit for the answering supervisory lamp AL, traced from battery through the said lamp AL, normal contact 45 of relay AT, alternate contact 78 of relay AS to ground at alternate contact 47 of relay CS.

A further result due to the energization of the link disconnect relay LD is the opening of its normal contacts 42 and 43 disconnecting the tip and ring conductors of the cord circuit E from the tip and ring conductors of the jacks AJ, thereby operatively disassociating the calling subscriber's line and the finder switch FS from the link circuit E. The relay SCO of the finder switch FS de-energizing opens the energizing circuit of the relay 11 at its alternate contact 41, which relay upon de-energizing opens the energizing circuit of the relay TR at its alternate make-before-break contact 21, permitting the said relay TR to de-energize. The relay TR upon its de-energization closes an energizing circuit for the release magnet RE over a path extending from battery through the winding of the said release magnet RE, alternate contact 18 of relay SG to ground at normal contact 19 of relay TR. The release magnet RE upon energization moves the retaining pawl from engagement with the switch shaft ratchet, thereby permitting the shaft and wipers 2, 3, 4 and 5 to restore to normal.

The called subscriber C upon replacing his

receiver upon the switchhook opens the circuit of the calling tip supervisory relay CT at the substation switchhook contacts. The relay CT upon restoration closes a circuit for the calling supervisory lamp CL, the said circuit being traced from battery through the said lamp CL, through alternate contact 65 of relay LD, normal contact 66 of relay CT to ground at alternate contact 47 of relay CS. The operator noting the glowing of the answering supervisory lamp AL and the calling supervisory lamp CL removes the answering plug AP from the jack AJ and the calling plug CP from the jack J′ which opens the series energizing circuit of the calling sleeve supervisory relay CS and cut-off relay CO′ of line circuit L′ associated with the called substation C. The relay CS upon de-energization opens its alternate contact 47, allowing the link disconnect relay LD to de-energize. The answering supervisory relay AS also de-energizes and brings about the effacement of the supervisory lamps CL and AL. The relays LD and AS upon de-energization restore the apparatus of cord circuit E to normal, rendering it available for connecting other subscribers' lines.

Should the calling subscriber at the substation A desire to recall before the answering plug AP is removed from the jack AJ, he may do so. The subscriber upon removing his receiver for a recall again energizes the line relay LR, thereby grounding the common starting wire SW and starting another finder switch FS or the same finder switch of such recalling subscriber's line. As soon as the finder switch finds the contacts of the calling subscriber's line, the connection is completed the same as before described. If the finder switch is started which was used in the previous connection, the finder switch FS upon finding the calling subscriber's line will again cause the multiple line lamps LL to glow, and either the same operator or another operator may seize the call.

In working out my invention, I have employed preferred circuit arrangements and also a certain number of switches for handling the calls from a particular number of lines. I do not wish to be limited to the exact circuit arrangement as shown or the number of switches specified, but aim to cover all such 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 including a major group of lines divided into sub-groups of lines, an automatic switch having a set of wipers operable in but one plane associated with each of said sub-groups, an auxiliary automatic switch associated with said switches, means whereby if a connection is desired with one of the lines in one of said sub-groups its associated switch is operated to effect such connection, and if a second connection is desired with a second line in the said sub-group said auxiliary switch is operated to effect the connection.

2. A telephone system including a major group of lines divided into sub-groups of lines, an automatic switch associated with each of said sub-groups having a single set of contact wipers operable in a single plane, an auxiliary automatic switch associated with said switches having a single set of contact wipers operable in one plane only, means whereby if a connection is desired with a line in one of said sub-groups its associated switch is operated to effect such connection, and if a second connection is desired with a line in the same sub-group the switch associated with a second sub-group is operated to effect such connection, said auxiliary switch having its bank contacts so connected that it first has access to the lines of one sub-group and then to lines of the other sub-groups.

3. A telephone system including lines divided into sub-groups, a switch associated with each sub-group having access to all the lines of the different sub-groups through its single set of wipers which have motion in one plane only, an auxiliary switch, circuit connections whereby the switch associated with the first sub-group first has access to the lines of its sub-group, and circuit connections whereby if said switch is busy the auxiliary switch is operated, said auxiliary switch also first having access to the lines of said sub-group through its single set of wipers.

4. A telephone system including lines divided into sub-groups *a*, *b* and *c*, a switch associated with each of said sub-groups, an auxiliary switch, the banks of the switch associated with sub-group *a* being so arranged that it first has access to the lines of sub-group *a*, then to the lines of sub-group *b*, and then to the lines of sub-group *c*, the switch associated with sub-group of lines *b* first having access to the lines of sub-group *b*, then to the lines of sub-group *c* and then to the lines of sub-group *a*, and the bank of the auxiliary switch being so connected that it first has access to the lines of sub-group *a*, then to the lines of sub-group *b* and then to the lines of sub-group *c*.

5. A telephone system including a group of lines divided into sub-groups, a plurality of automatic switches each having access to the said groups of lines said switches being provided with but a single set of contact wipers and operable in one direction only, the bank contacts of said switches being so connected that one switch first has access to the lines of one sub-group and then to the

lines of the other sub-groups through its said wipers, the second switch being so connected that it first has access to the lines of a different sub-group and then to the lines of the other sub-groups through its said wipers, etc., and an auxiliary switch associated with said first switches having its bank contacts so connected that it first has access to the lines of one sub-group and then to the lines of the other sub-groups.

Signed by me at Chicago, in the county of Cook and State of Illinois, this 12th day of April, 1920.

GEORGE R. EATON.