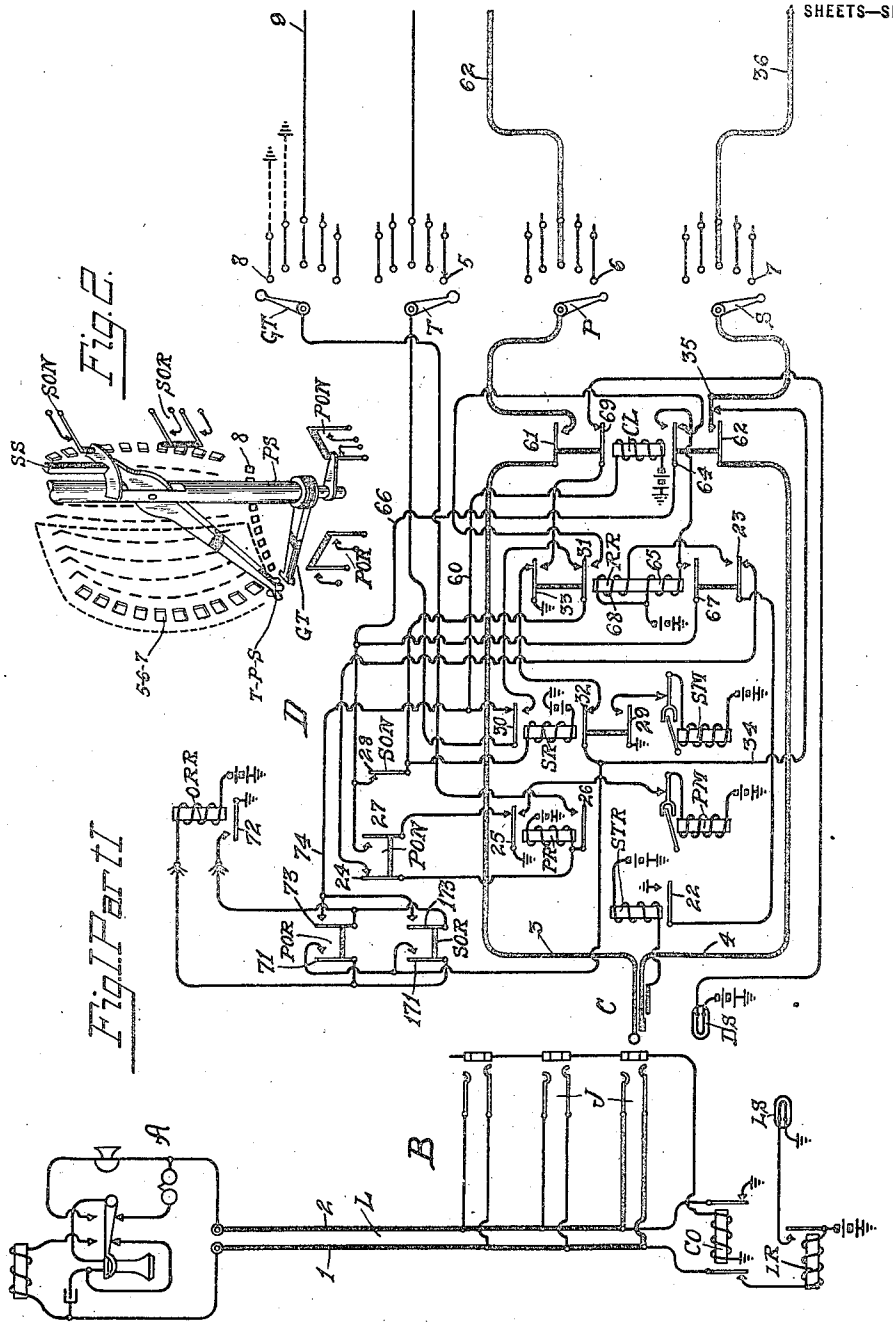
A. H. DYSON,

TELEPHONE CALL DISTRIBUTING SYSTEM.

APPLICATION FILED JAN. 30, 1913. RENEWED JAN. 22, 1916.

1,259,496. Patented Mar. 19, 1918.

4 SHEETS—SHEET 1.



Witnesses:

G. E. Mueller

Wm Berghahn.

Inventor:

Alfred H. Dyson

By Curtis B Camp

Attorney.

A. H. DYSON.

TELEPHONE CALL DISTRIBUTING SYSTEM.

APPLICATION FILED JAN. 30, 1913. RENEWED JAN. 22, 1916.

1,259,496.

Patented Mar. 19, 1918.

4 SHEETS—SHEET 2.

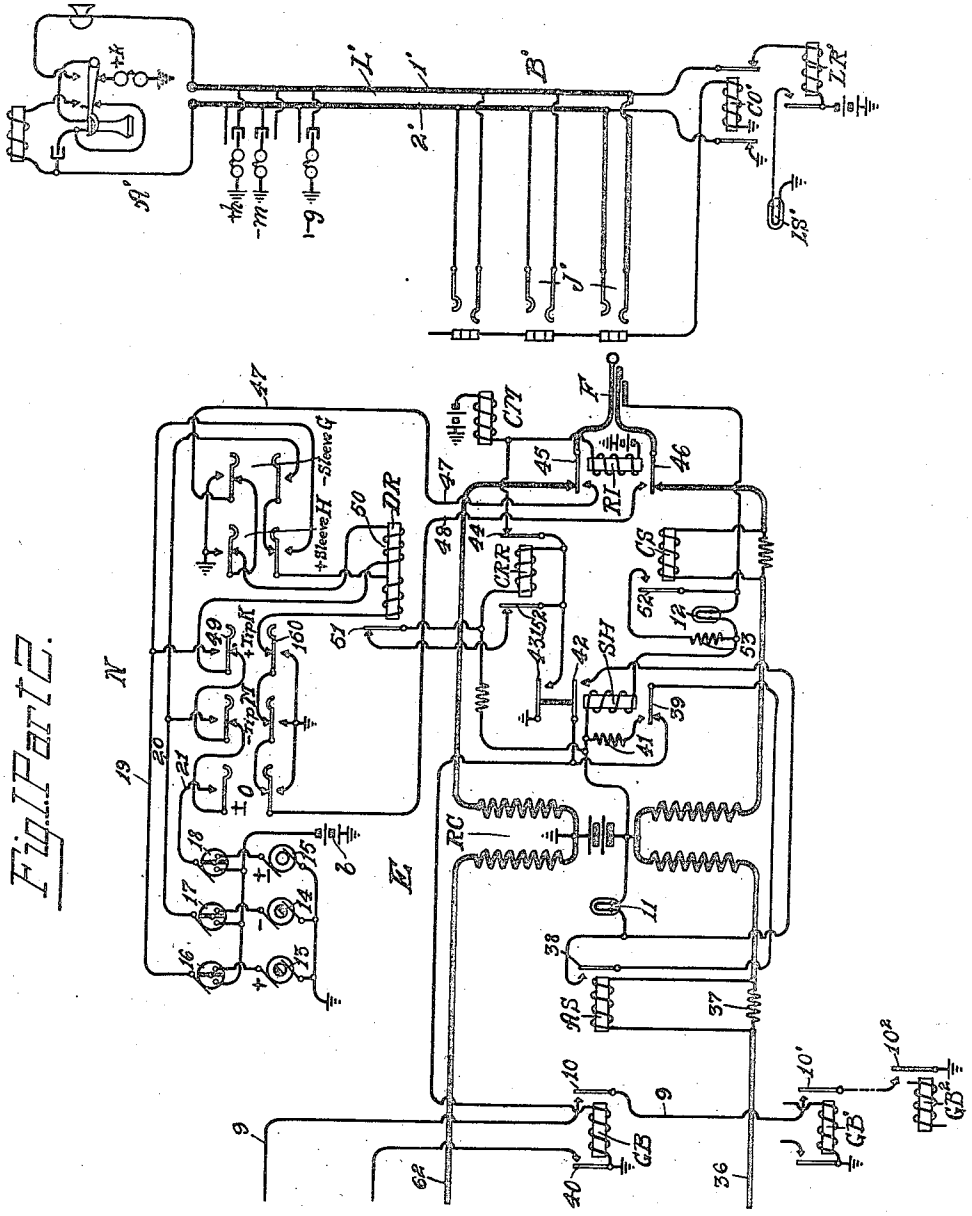


Fig. II Part 2.

Witnesses:

G. E. Mueller

Wm. Berghahn.

Inventor:

Alfred H. Dyson

By Curtis B. Camp

Attorney.

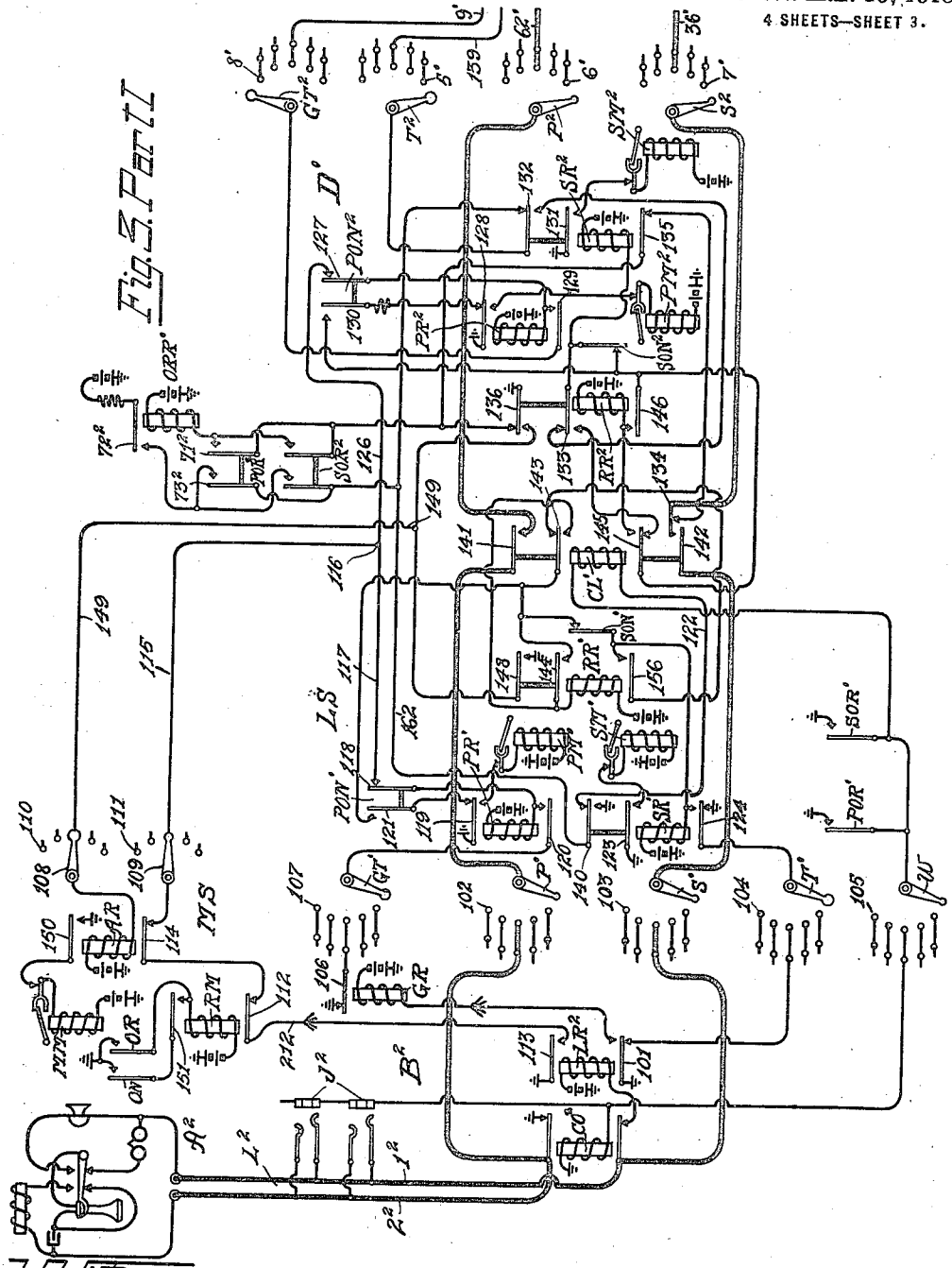
A. H. DYSON.

TELEPHONE CALL DISTRIBUTING SYSTEM.

APPLICATION FILED JAN. 30, 1913. RENEWED JAN. 22, 1916.

1,259,496. Patented Mar. 19, 1918.

4 SHEETS—SHEET 3.



Witnesses:

G. E. Mueller

Wm. Berghahn

Inventor:

Alfred H. Dyson

By Curtis B. Camp

Attorney.

A. H. DYSON.

TELEPHONE CALL DISTRIBUTING SYSTEM.

APPLICATION FILED JAN. 30, 1913. RENEWED JAN. 22, 1916.

1,259,496.

Patented Mar. 19, 1918.

4 SHEETS—SHEET 4.

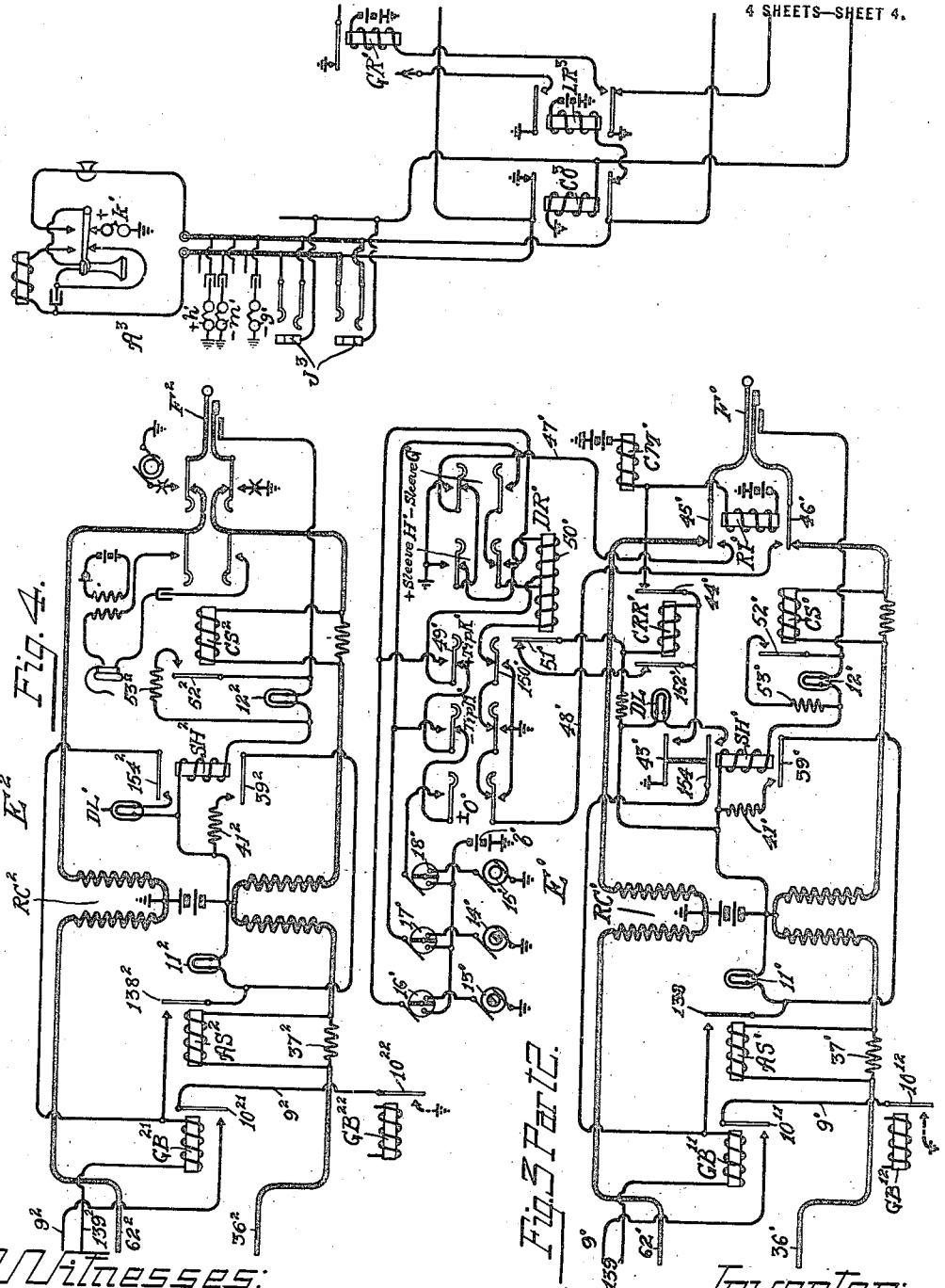


Fig. 4.

Fig. 3 Part 2.

Witnesses:

G. E. Mueller

Wm. Berghahn.

Inventor:

Alfred H. Dyson

By Curtis Blamp

Attorney.

UNITED STATES PATENT OFFICE.

ALFRED H. DYSON, OF NEW YORK, N. Y., ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE-CALL-DISTRIBUTING SYSTEM.

1,259,496. Specification of Letters Patent. Patented Mar. 19, 1918.

Application filed January 30, 1913, Serial No. 745,069. Renewed January 22, 1916. Serial No. 73,761.

To all whom it may concern:

Be it known that I, ALFRED H. DYSON, a citizen of the United States of America, residing in New York city, county of New York, and State of New York, have invented certain new and useful Improvements in Telephone-Call-Distributing Systems, of which the following is a specification.

My invention relates to telephone systems in general, certain features thereof being directed more particularly to telephone call distributing systems, an object being to provide a system as named which is readily applicable to operating exchanges of a well-known so-called three-wire type.

Where it is desired to change over an operating manual telephone system to a call distributing system it is apparent that it is a desirable feature to be able to change over the existing system at the lowest expense and at the same time secure a simple, positive and efficiently operative system, and to this end I have worked out my invention, several forms of which are shown in the accompanying drawings. The new features of my invention will be more definitely pointed out in the ensuing specification and claims.

Figure 1 comprising parts 1 and 2 illustrates one form of my invention.

Fig. 2 illustrates diagrammatically a contact bank and wiper arrangement of a preferred form of switch construction used with my invention.

Fig. 3 comprising parts 1 and 2 illustrates another embodiment of my invention and

Fig. 4 shows a cord circuit adapted for use with the system of Fig. 3.

Referring first to the system of Fig. 1 it comprises in general, substations A connected by line conductors L to line circuits B which terminate in jacks at a central office switchboard in a well-known manner. Each operator's position includes answering plugs C connected to an associated call distributing or cord selector switch D. These selectors D are divided into groups, each group having its bank terminals multiply connected and extending to calling cord circuits E which are also divided into groups and distributed among connecting operators' positions before which multiple terminals of the lines of the exchange are positioned. At the right end of Fig. 1, part 2 I have illustrated what we will assume as a called substation A^1, like reference characters being used to indicate parts corresponding to the calling substation and associated apparatus.

In general the system of Fig. 1 operates as follows: Assuming a calling subscriber at A removes his receiver from its switch-hook to initiate a call, an associated line signal LS is operated before a distributing operator who inserts an answering plug C into an answering jack of the calling line whereupon the associated distributing switch D automatically distributes the call to an idle connecting cord circuit E before a connecting operator. The connecting operator in response to a signal 11 displayed at the seized connecting circuit E, ascertains by means of an operator's telephone circuit, not shown, the number of the wanted substation. The connecting operator then inserts the plug F of said connecting cord circuit into a jack of the wanted line and then applies ringing current to the terminals thereof.

After the subscribers have finished conversation they replace their receivers upon their respective switch-hooks whereby a disconnect signal is received at the cord circuit E and the connecting operator thereupon withdraws the connecting plug F from the jack of the called line, causing the display of a disconnect signal DS at the plug C whereupon the distributing operator withdraws the associated plug C from the jack of the calling line.

Before proceeding with a more detailed description of Fig. 1, I will refer to the selector mechanism of the distributing switch D, preferably employed.

For use with the selector and connector circuits of the system of Figs. 1 and 2, a switch such as is shown in an application of William Kaisling for automatic switch for telephone systems, Serial No. 600,664, Patent No. 1,131,140 filed January 3rd, 1911, may be used.

The switch referred to in the previous paragraph, in general comprises a bank of contacts made up of 100 sets of contacts with three contacts 5, 6, 7, to each set, and divided into ten groups of ten contact sets each as illustrated diagrammatically in Fig. 2. A set of wipers T, P, S, are provided, to cooperate with the bank contacts, a primary magnet (corresponding to PM of the switch circuits) being adapted to primarily adjust the wipers through the medium of a primary

shaft PS to select a group of contacts, and a secondary magnet (corresponding to SM of the switch circuits) is provided to step the wipers through the medium of a secondary shaft SS in a secondary direction in a plane at right angles to the primary, to select a contact set of the selected group. The switch construction is such that the wipers are advanced against the tension of a pair of so-called watch springs, one spring opposing each movement respectively.

For each row or group of contacts 5, 6, 7, a group contact 8 is provided and a group wiper GT is adapted to engage said group contacts 8. For each primary step of the switch, shaft PS advances wiper GT from one contact 8 to the next one, this movement also carrying wipers T, P, S, along from row to row. After the primary adjustment to select a row or group of contacts, wipers T, P, S, are rotated by a secondary adjustment to select a contact of the selected group.

To release the wipers, that is, to restore them to control, the secondary magnet is again actuated to step the wipers in a secondary direction beyond the last contact of the group whereby they are automatically restored to normal by the springs referred to, but over a different path than that taken by the wipers in the advance movement of the switch in selecting a contact, such a complete travel of the wipers being indicated by the dotted line in Fig. 2. Thus, in the operation of the switch the contacting ends of the wipers travel in a primary direction to select a group of contacts, then in a secondary direction to select a contact in the group, and in the release of the wipers this secondary travel is continued until the contacting ends have passed beyond the last contact in the group, whereby they are automatically released to continue their restoration to normal, this continued movement being in a plane parallel to the primary movement but in an opposite direction until they reach a point directly above the starting point when they are moved downward through a plane parallel to the secondary movement, but in a direction opposite to the secondary movement, until they reach their normal starting point.

A set of primary off-normal spring contacts PON are moved upon the first primary step of the switch while a set of secondary off-normal spring contacts SON are moved upon the first secondary step of the switch. If the primary adjustment of the switch is continued until the wipers have passed beyond the last contact 8 and row 5, 6, 7, a primary over-run switch POR is closed while if the secondary adjustment of the wipers T, P, S, is continued until they pass beyond a row, a secondary over-run switch SOR is closed, these over-run switches being restored in a manner as will be apparent from the drawing. It is to be understood that for a more complete understanding of this switch, reference is to be had to the above identified application, although of course I do not desire to be limited to the switch structure above referred to.

Referring now more in detail to the apparatus employed in Fig. 1 of my invention, it comprises a substation A, the one illustrated being of a well-known type, connected by a line L comprising conductors 1 and 2 to a line circuit B at a central office. Said circuit B comprises a line relay LR, a cut-off relay CO, answering and calling jacks J multiply connected to the line conductors 1, 2, and a line signal LS.

A plurality of answering plugs C are provided at each distributing operator's position, each one being connected by talking conductors 3, 4 to a distributing switch D. A third conductor of plug C is connected to a starting relay STR which relay energizes upon inserting plug C, to start the selecting operation of the associated distributing switch D.

As already outlined the distributing switch D has its bank terminals arranged in groups, and the wipers are adapted to be moved to select a group having an idle set of terminals and thereafter to such an idle set of terminals in the selected group. Each set of such terminals comprises a test terminal 5, a primary talking terminal 6 and a secondary talking terminal 7 there being preferably 10 such sets in each row as already outlined. For each such row of terminals a group terminal 8 is provided, and there being 10 rows of terminals 5, 6, 7, there are of course 10 group terminals 8 and a coöperating group wiper GT. A test wiper T is provided for the terminals 5, and primary and secondary wipers P and S for the terminals 6 and 7 respectively. The primary adjustment of the wipers in selecting a group is effected by a primary magnet PM, while the secondary adjustment of the wipers to select a contact of a group is effected by a secondary magnet SM. A primary relay PR controls the primary adjustment of the switch, while a secondary relay SR controls the secondary adjustment of the switch. Each switch D also has a release relay RR, and a talking circuit closing relay CL, said relay CL being energized after an idle cord circuit E is selected.

The off-normal and over-run switches are indicated by reference characters which will be clearly understood from the switch description already given. The over-run switches in conjunction with the over-run relay ORR are adapted to automatically restore switch D to normal, should all of the cord circuits to which it has access be busy. For instance should all of the cord circuits be busy at the time a switch D is started,

the group wiper GT will of course step beyond the last group contact 8 and at this point switch POR is moved to its alternate position causing the energization of relay ORR and thereby effecting the restoration of the switch. Should some of the cord circuits to which a started switch D has access be idle, group wiper GT would of course stop upon selecting the first group containing such an idle cord, but should all of the cords in this selected group of contacts be rendered busy before the test wiper T reaches them, the secondary adjustment of the switch is continued until wipers T, P, S, are advanced beyond the last contact in the group whereupon secondary over-run switch SOR is moved to its alternate position to effect the energization of ORR and the restoration of switch D.

As already outlined each row of switch contacts has preferably 10 sets of contacts 5, 6, 7 and there is a group contact 8 provided for each row. Therefore, means are provided to render a set of multiply connected group contacts 8 busy while the associated 10 cord circuits E are busy. To this end a group busy relay GB is provided for each cord circuit, said relay being energized as soon as its cord circuit is selected. A series busy circuit 9 extends in series through normally open contacts 10 of each group of ten relays GB, the last relay GB^2 of the set having its contact as 10^2 connected to ground so that as long as the ten relays GB are energized this ground connection from alternate contact 10^2 is maintained connected to its associated group contacts 8. It will be apparent that as long as any one or more of a group of relays GB are de-energized, this series circuit will be interrupted so that the associated group contacts 8 remain selectable.

Referring now to cord circuit E, it comprises a repeating coil RC connected in circuit with the talking conductors of the cord circuit, and a calling plug F. An answering supervisory relay AS is adapted to be energized upon selection of its cord circuit to light the calling signal 11. A calling supervisory relay CS is also provided which controls a supervisory signal 12. A shunt relay SH is energized upon inserting plug F in a called line, to efface signal lamp 11 while the ringing relay RI is adapted to apply ringing current to the terminals of the called line.

A ringing key N is provided for each cord circuit E said key being adapted to ring four party-line substations selectively or a single line substation. Five ringing contact sets O, M, K, H and G are connected to generators 13, 14, 15, by connections extending through the interrupters 16, 17, and 18. Generator 13 is adapted to provide positive pulsations, generator 14 negative pulsations, and generator 15 a suitable alternating ringing current. The interrupters 16, 17, 18, are constantly rotating and alternately connect the associated generator and battery *b* to the conductors 19, 20, 21. The ringing key N is so connected that when contacts O are operated, alternating current generator 15 is connected in bridge of the tip and ring contacts of plug F. When contact sets M are operated negative pulsations from generator 14 are connected to the tip of plug F. Contacts K are adapted for connecting positive pulsations from generator 13 to the tip of the plug, contacts H are adapted to connect positive pulsations from generator 13 to the ring of the plug and contacts G when operated connect negative pulsations from generator 14 to the ring of the plug. The five spring contacts are indicated by signs which readily show the current which is adapted to be connected and whether to the tip or sleeve side all of which will be apparent from the foregoing description. Key N is so arranged that when any of its plungers are actuated it will be held in its actuated position by clutch magnet CM until said magnet is de-energized. A ringing disconnect relay DR is connected in the ringing circuit and is adapted to be energized upon response of the called subscriber to effect the energization of clutch magnet control relay CRR and thereby release clutch magnet CM and ringing relay RI.

In connection with called line L^1, I have shown a substation A^1 having a call bell *k* which is connected to the tip side of the line and adapted to be operated by positive pulsations when key K is pressed. In a like manner bells *h*, *m*, and *g*, are adapted to be operated when their corresponding keys H, M or G are depressed. It will be noted that like reference characters indicate the corresponding keys and substations.

Operation.

Having described in general the apparatus of Fig. 1, the operation of the system will now be described. Assuming the subscriber at substation A removes his receiver to initiate a call, a circuit for line relay LR is established over the calling line, thereby energizing said relay and lighting the line signal LS. The distributing operator before whom the answering jack of substation A terminates, in response to said signal, inserts a plug C into the answering jack J of the calling line thereby connecting the talking contacts of plug C with the talking contacts of jack J, while starting relay STR is connected through the third conductor in series with cut-off relay CO thereby energizing both relays STR and CO. Relay STR therefore closes its alternate contact 22 establishing a circuit for primary relay

PR traced from ground at said contact 22, normal contact 23, normal contact 24, and the winding of PR to battery. Said relay PR therefore is energized closing its alternate contact 25, establishing an operating circuit for primary magnet PM. Said magnet therefore attracts its armature and causes a primary step of the switch wipers whereby group-test wiper GT is moved into connection with the first group contact 8 while wipers T, P, S, are moved opposite the first row or group of bank contacts 5, 6, 7. Assuming all of the cord circuits extending from this first group of bank contacts are busy, all of their relays GB are energized and therefore the first group contact 8 has a ground or busy potential connected thereto as is indicated diagrammatically in the drawing. Therefore, primary relay PR is maintained energized over a circuit traced from said grounded contact 8, alternate contact 26, the winding of PR to battery. Therefore, magnet PM causes another primary step of the switch and assuming the second group of bank contacts are busy a third primary step of the switch is effected. Assuming there is an idle cord circuit in this third group, there will be no busy potential upon its group contact 8 and therefore relay PR deënergizes interrupting its alternate contact 25 and preventing any further primary adjustment of switch D. Thus it will be seen that switch D has automatically selected the first group of bank contacts having an idle cord circuit.

The next step is to select the first idle cord of this selected group this being brought about as follows. Upon said deenergization of PR, its normal contact 25 closes establishing a circuit for secondary relay SR traced from said ground at normal contact 25, alternate contact 27, normal contact 28, winding of SR to battery. Relay SR therefore energizes closing its alternate contact 29 establishing an operating circuit for secondary magnet SM which attracts its armature and advances wipers T, P, S, into connection with the first set of contacts 5, 6, 7. Assuming this first set of contacts leads to a busy cord circuit, its test contact 5 will have a ground or busy potential connected thereto, (due to its relay GB, contact 40 being closed) and therefore a locking circuit for SR is established from said grounded test contact 5, test wiper T, alternate contact 30, normal contact 31, the winding of SR to battery. It will be noted that upon the first secondary step of the switch SON contact 28 is interrupted so that the initial circuit for SR is open. Relay SR remaining energized, magnet SM advances the wipers another secondary step and in fact continues to do so as long as test wiper T is engaging busy test contacts 5. Upon reaching the conductors leading to cord circuit E, which we will assume is the first idle one of the group, there being no busy potential upon its test contact 5 the circuit for SR is interrupted, deënergizing said relay to interrupt the circuit for SM and prevent any further secondary adjustment of switch D. It will be noted that during this secondary travel of the switch, secondary wiper S has its circuit interrupted at normal contact 32 of SR to prevent the ground from normal contact 33 of RR interfering with any existing connections with which wiper S may engage.

Switch D has now selected the first idle cord of the selected group and the next step is to signal the operator at the selected connecting cord circuit E. Upon said deënergization of relay SR, a circuit for answering supervisory relay AS is established traced from ground at normal contact 33 of RR, normal contact 32, conductor 34, normal contact 35, wiper S and contact 7, secondary conductor 36, the winding of AS and non-inductive resistance 37 in multiple, through a winding of repeating coil RC to battery. Relay AS is therefore energized closing its alternate contact 38 and establishing a circuit for signal 11 traced from battery through said signal 11, alternate contact 38, normal contact 39 and the winding of group busy relay GB to ground, this series circuit causing the illumination of lamp 11 and the energization of relay GB. Relay GB therefore closes its alternate contact 40 connecting ground to test contact 5 and rendering the particular cord circuit E busy and non-selectable. Alternate contact 10 of GB is also closed, thereby effecting a step in the closure of the series conductor 9, so that when all of the relays GB, GB^1, etc., in the series are energized, ground will be connected to the associated group contact 8 to render it busy. Of course as long as any relay GB of a series is at normal, this series conductor 9 is interrupted allowing its group to be selected.

Referring again to distributer switch D, upon the connecting of the ground or busy potential to the connected test terminal 5, a circuit for closing relay CL is established traced from said grounded contact 5, wiper T, normal contact 30, conductor 60 and the winding of CL to battery. Relay CL therefore energizes closing its alternate contacts 61, 62, and establishing the continuity of the talking conductors of switch D. Although the initial circuit for relay AS of cord circuit E is interrupted when normal contact 35 of CL is opened, said relay AS is maintained energized by the alternate path traced over the heavily marked conductors including the calling line and back over the tip or primary talking conductor 62 and a winding of repeating coil RC to ground. Thus

relay AS is now under the control of the calling subscriber. Also, responsive to the energization of CL its alternate contact 64 is closed establishing an energizing circuit for release relay RR traced from battery through winding 65 of RR, alternate contact 64, conductor 66, alternate contact 27 and normal contact 25 to ground. Relay RR is therefore energized closing its locking contact 67 and thereby establishing a locking circuit to the said grounded normal contact 25. Alternate contact 23 of RR is also closed thereby connecting winding 68 of RR in circuit with the grounded alternate contact 22 which establishes another energizing circuit for RR and prevents its restoration until plug C is withdrawn from its jack.

The connecting operator in response to said signal 11 connects her telephone circuit (not shown) to ascertain the wants of the calling subscriber and finding that connection is desired with substation A^1 inserts the plug F of the selected cord circuit E into a jack J^1 of the wanted line and thereafter depresses the plunger which actuates key contacts K. Upon connecting plug F to jack J^1, a series circuit including shunt relay SH, supervisory lamp 12 and cut-off relay CO^1 is established causing the energization of relays SH and CO^1 and the illumination of lamp 12. This circuit may be traced from ground through the winding of CO^1 third contacts of jack and plug, lamp 12 and the winding of SH to battery. Relay CO^1 is thus energized to remove the substation control of its line relay LR^1. The energization of shunt relay SH establishes a shunt circuit around the signal 11 causing its effacement, this shunt circuit being established from said lamp 11 alternate contact 38, alternate contact 39, which is now closed, resistance 41 to battery while the original circuit through lamp 11 is interrupted at normal contact 39 and replaced through alternate contact 42. Thus enough current is diverted through resistance 41 to cause the effacement of said signal 11. Also, responsive to energization of SH, its alternate contact 43 is closed establishing a circuit through normal contact 44 and the windings of electro-magnets CM and RI to battery causing their energization. The energization of clutch magnet CM is effective to hold the operated key K in its ringing position while the energization of ringing relay RI closes alternate contacts 45, 46, to connect ringing conductors 47, 48 in circuit with the terminals of the called line. The operator having actuated key K, a circuit for call bell *k* is established traced from pulsating generator 13, through interrupter 16, conductor 19, alternate contact 49, winding 50 of disconnect relay DR, upper normal contacts of keys H and G to conductor 47, alternate contact 45, tip of plug F, jack J^1 through the condenser and call bell *k* of substation A^1 to ground. Due to the operation of interrupter wheel 16, ringing pulsations and battery are alternately connected in circuit with the called line but due to interposition of the condenser at the called substation no battery flow is permitted.

Upon the removal of the receiver at A^1, in response to the call, a path for direct current is established at substation A^1 and therefore as soon as the battery segment of interrupter 16 is connected in circuit with the called line a flow of current through winding 50 of disconnect relay DR is established, traced from battery through said interrupter 16 to conductor 19, and then over the previously described path for ringing current to substation A^1 returning over conductor l^1, ring contacts of jack and plug, alternate contact 46, conductor 48 and alternate contact 150 of key K to ground. This flow of direct current causes the energization of disconnect relay DR whereby its normal contact 51 is interrupted, opening the direct shunt around the winding of relay CRR permitting the energization thereof whereby its normal contact 44 is interrupted, causing the restoration of ringing relay RI and clutch magnet CM. Relay CRR also opens its contact 152 upon its energization, thereby preventing a deënergization of the relay when disconnect relay DR subsequently restores following the restoration of RI.

The two sub-stations A and A^1 are now connected by a conversational circuit which is indicated by the heavily marked conductors and due to the supervisory relay CS being included in the circuit of the called line, upon the said removal of the receiver at substation A^1 this relay CS is energized closing its alternate contact 52 and thereby connecting resistance 53 in shunt of lamp 12 to cause its effacement.

Disconnection.

After the subscribers have finished conversation they will replace their receivers upon their respective switch-hooks, thereby causing the illumination of signals 11, 12 of cord circuit E, this being a well-known disconnect signal. The replacing of the receiver at substation A^1 of course restores calling supervisory relay CS whereby its contact 52 is interrupted to again cause the lighting of signal 12 while the replacing of the receiver at calling substation A causes deënergization of supervisory relay AS whereby its alternate contact 38 is interrupted, interrupting the shunt circuit including resistance 41, thereby causing the illumination of signal 11.

The connecting operator in response to this disconnect signal removes plug F from its jack, thereby interrupting the series cir-

cuit which included shunt relay SH, signal 12 and cut-off relay CO^1. Relay CO^1 of course restores thereby restoring the substation control to its line relay LR^1 while the restoration of SH interrupts the circuit for relay GB at alternate contact 42, and by the interruption of said contact 42 interrupts the circuit for signal 11 causing its effacement. Upon deënergization of relay GB, its alternate contact 10 is interrupted, rendering the associated group contact 8 selectable so far as the cord circuit E is concerned. The interruption of alternate contact 40 of GB causes the interruption of the circuit of closing relay CL whereby said relay restores interrupting the circuit through the heavily marked talking conductors at switch D.

At this time relay RR is still energized with its normal contact 33 interrupted so that a reoperation of relay AS of the connected cord circuit is prevented. The closing of normal contact 69 of relay CL establishes a circuit for disconnect signal DS while the closing of normal contact 64 of CL establishes a release circuit for relay SR this circuit being traced from battery through the winding of SR, alternate contact 31 of RR, normal contact 64, conductor 66, alternate contact 27, and normal contact 25 to ground. Relay SR, therefore energizes closing its alternate contact 29 whereby magnet SM advances the wipers in a secondary direction beyond the last contact of the row whereby they are automatically restored by spring tension as previously described in connection with the switch structure.

Upon restoration of PON, its alternate contact 27 is opened thereby interrupting the circuit for SR to cause its deënergization and rendering magnet SM inert. The interruption of this alternate contact 27 interrupts the locking circuit through winding 65 of relay RR but said relay is maintained energized through its other winding 68 and alternate contact 22 of STR until plug C is withdrawn, this energization of RR preventing another selecting operation of switch D until another call is answered. Upon withdrawal of plug C the series circuit including relays CO and STR is interrupted causing the restoration of these relays, the restoration of STR interrupting the locking circuit through winding 68 of RR allowing it to restore. Switch D being at normal is now available for use in extending other connections.

Over-run switches.

Assuming now that at the time the distributing operator inserted plug C into a jack J of the calling line, all of the cord circuits to which it has access are busy, relay STR is of course energized followed by the energization of PR as before and the primary adjustment of the switch D is continued until the wiper GT has advanced beyond the last group contact 8 because all contacts 8 are grounded. There being no further locking circuit for relay PR, it restores to normal interrupting the circuit for PM and by the closing of its normal contact 25 establishes a circuit for SR as previously traced. Relay SR therefore energizes and closes a circuit through SM whereby the wipers receive a single secondary step which causes switch SON to interrupt its normal contact 28 and there being no locking circuit for relay SR (as test wiper T is not engaging a contact) said relay SR restores interrupting the circuit for SM. Thus the wipers are left off-normal and should be restored. To this end I provide the over-run switches and over-run relay ORR. The switch D having stepped beyond the last group of contacts in its primary adjustment, primary over-run switch POR has been moved to its alternate position. Therefore when relay SR restores as referred to a circuit for ORR is established traced from ground at normal contact 33 of RR, normal contact 32, alternate contact 71, and the winding of ORR to battery causing its energization. Its alternate contact 72 is therefore closed establishing a circuit for CL traced from said grounded contact 72, alternate contact 73, conductor 74, conductor 60, and the winding of CL to battery. Relay CL therefore energizes closing its alternate contact 64 and establishing an energizing circuit through winding 65 of relay RR over the previously described path to ground at normal contact 25. RR therefore energizes closing its alternate contacts 67 and 23 thereby locking relay RR in its energized condition as before described. Normal contact 33 of RR is therefore interrupted interrupting the circuit for ORR and causing its restoration whereby its alternate contact 72 is interrupted allowing restoration of CL. Normal contact 69 of CL is therefore closed and a circuit for disconnect signal DS is established over the previously described path from the alternate grounded contact 33. The closing of normal contact 64 of CL upon its said deënergization establishes a release circuit for SR over the previously described path which may be traced from battery through the winding of SR, alternate contact 31, normal contact 64, alternate contact 27 and normal contact 25 to ground. Relay SR therefore closes a circuit for SM whereby the wipers are advanced in a secondary direction until they have stepped to a point where the automatic release thereof is accomplished as already referred to.

It will be apparent from the above that when all of the cord circuits to which a switch D has access are busy when the op-

erator inserts plug C in a jack, lamp DS is lighted within a comparatively short time, depending upon the range of switch D. In the switch of the character referred to herein, this time between the plugging in and the lighting of lamp DS should not be greater than two seconds. Therefore, the operator will know that all of the trunks or cord circuits to which the selected switch D has access are busy and she may then try another plug and associated switch D. Of course it is applicant's intention to provide sufficient apparatus to take care of the incoming calls in a suitable manner.

Should switch D receive its primary adjustment to select a row of contacts having an idle contact set, and then before the wipers reach such an idle contact set (which we will assume is the only one in the selected row) said contact set or rather one of its multiples is seized by another distributer switch D, over-run switch SOR is brought into play. In such case all of the contact sets of the selected row being busy, the wipers would be stepped beyond the last contact of the row due to the fact that the locking circuit for secondary relay SR is maintained closed through the busy test contact 5. Upon the switch reaching this over-run point, contacts SOR are closed, so that when relay SR deënergizes, circuit for over-run relay ORR is closed traced from battery through the winding of said relay, alternate contact 171, normal contact 32 to ground at normal contact 33. Relay ORR therefore closes its alternate contact 72 establishing an energizing circuit for relay CL traced from said grounded contact 72, alternate contact 173, conductor 60 and the winding of CL to battery. Relay CL therefore closes its alternate contact 64 and establishes an energizing circuit for the winding 65 of relay RR traced from battery to said winding 65, line contact 64, conductor 66, alternate contact 27 to ground at normal contact 25. Relay RR therefore energizes closing its locking contact 67 and also connecting its locking circuit 68 through alternate contact 23 to ground at alternate contact 22. As soon as relay RR energizes it interrupts its normal contact 33 thereby interrupting the circuit for ORR which restores and due to the interruption of its alternate contact 72, causes restoration of relay CL. Relay CL being at normal and relay RR being still energized, a circuit for disconnect signal DS is established over the previously described path which includes normal contact 69 and alternate contact 33, and the operator observing this signal knows that the associated distributing switch D has failed to pick up an idle cord. The switch D having of course restored to normal cannot be operated again until plug C is withdrawn from the jack to cause deenergization of relay STR and thereby the restoration of release relay RR. The operator having observed the signal DS as already referred to may withdraw plug C from the jack and immediately insert it again to try switch D once more, or she may use another plug C and associated distributing switch D.

Fig. 3.

In Fig. 3, I have illustrated another embodiment of my invention, the connecting operation of the system shown therein differing in some respects from that of Fig. 1. In the system of Fig. 3, no distributing operator is required but a calling line has its circuit automatically extended to a distributing switch D^1, which switch extends the calling line circuit to an idle cord circuit E^1. In place of a plug C, a line selector LS is paired with each cord selector B^2 such an idle pair of switches LS and D^1 being selected and started through the medium of a master switch MS which is common to a group of lines and paired switches LS and D^1.

The present system is also readily applicable to installations having line circuits as B and cord circuits somewhat similar to E of Fig. 1, and in the present figure, that is Fig. 3, I have indicated the apparatus which corresponds to apparatus of Fig. 1, by like reference characters except for the suffix which has been added to the reference characters. In this way I believe the operation and similarity of the two figures will be more readily apparent.

In applying the present system to installations having line circuits as B of Fig. 1, the answering jacks, and line signals as LS may be removed and an additional contact 101 provided for the line relay. As I prefer to use 100 point selector switches LS I divide the lines into groups of 100 and for each such group of 100 lines, 10 line selectors LS are provided. The same switch construction as described in connection with Fig. 2 is used for the line selector LS except that four contacts 102, 103, 104, 105, are provided for each line circuit, and wipers P^1, S^1, T^1, and W respectively are provided for coöperating with said contacts. Each group of 100 lines is then multiply connected to the contact sets of the associated ten line selectors LS. The lines are then divided into minor groups of 10 lines each, these being preferably the 10 lines connected to each row of 10 contact sets and for each such minor group a group relay GR is provided being connected to the alternate contact 101 of the associated 10 line relays LR^2 so that each relay GR may be energized upon initiation of a call over any of its associated 10 lines. Each group relay GR then has its grounded normal contact

106 connected to the corresponding group contact 107 so that when the group relay GR is energized it removes ground from the multiply connected contacts 107 of the 10 associated line selectors to render them selectable when energized by group test wiper GT^1. The normal contact 101 of each line relay is connected to the corresponding line test contacts 104 of the 10 line selectors so that the started line selector will stop in its secondary adjustment when its test wiper T^1 reaches the ungrounded test contact 104 of the calling line. Wiper W and the associated contact 105 are provided whereby an energizing path for the cut-off relay CO^2 may be established when the calling line is seized, and also for operation of certain relays of the switches LS and D^1.

Master switch MS.

For each group of 10 paired line and cord selectors LS and D^1 respectively, a master switch MS is provided, having wipers 108, 109 with a simple rotary motion and adapted to connect with a plurality of sets of contacts 110, 111, said contact sets being equal in number to the number of associated paired selectors, which number is preferably 10, although more or less may be used, according to the traffic. A motor magnet MM and driving mechanism is provided for advancing the wipers 108, 109, in a step by step movement over the contacts 110, 111. An off-normal contact ON is provided which is adapted to be closed upon the wipers leaving their normal position, and an over-run contact OR is adapted to be closed upon the wipers stepping beyond the last or tenth contact of the set. A release magnet RM is also provided which is adapted to be energized when the wipers have stepped beyond the last contact of the row due to the closing of over-run contact OR, whereby a retaining pawl is withdrawn and the wipers 108, 109 restore to normal by spring tension where they engage the first set of contacts. Switch MS is preferably arranged to have its wipers 108, 109 resting upon contacts leading to an idle pair of switches so that upon initiation of a call, such a pair of idle switches is started, switch LS to select the calling line and switch D^1 to select the first idle cord circuit E^1. This starting circuit for the selector switches is controlled through the normal contacts 112 of magnet RM, said contacts being connected over common conductor 212 to the alternate contacts 113 of the 100 line relays LR^2 of the group. As soon as the calling line has been connected through the medium of a pair of switches LS and D^1 to a cord circuit E^1, the master switch advancing relay AR is energized and closes a circuit for motor magnet MM whereby the wipers are advanced and relay AR maintained energized until an idle set of contacts 110, 111, are engaged.

Operation of Fig. 3.

The operation of the system of Fig. 3, is as follows: Upon the subscriber at substation A^2 removing the receiver thereat from its switch-hook a circuit for line relay LR^2 is established over the calling line whereby said relay is energized, interrupting normal contact 101 and thereby removing ground from the line test terminals 104 of the calling line. Relay LR^2 also closes alternate contact 101 to cause the energization of its group relay GR whereby normal contact 106 is interrupted to remove ground from the group test contacts 107 corresponding to the group of 10 contact sets or line terminals with which the calling line is connected. Also upon energization of LR^2, alternate contact 113 is closed establishing a starting circuit for the idle pair of selectors LS and D^1 with which the wipers of master switch MS is then connected. This starting circuit is traced from ground at alternate contact 113, common conductor 212, normal contacts 112, 114, wiper 109 and the engaged contact 111, conductor 115, to connecting point 116, the starting circuit dividing at this point and including the primary relays PR^1, PR^2, of switches LS and D^1. The circuit for PR^1 is traced from said point 116, conductor 117, normal contact 118 and the winding PR^1 to battery causing the energization thereof and establishing an operating circuit for the primary magnet PM^1 from alternate contact 119. Magnet PM^1 thereby advances the wipers a single primary step whereby group wiper GT^1 engages the first group contact 107. Assuming there is no line seeking connection in either the first or second minor groups, the first two contacts 107 will be grounded through the connected group relays GR so that a locking circuit for primary relay PR^1 is established from said grounded contact 107, wiper GT^1, alternate contact 120 and the winding of PR^1 to battery. Relay PR^1 of course remains energized as long as wiper GT^1 is engaging grounded contacts 107 so that magnet PM^1 continues the primary adjustment of the wipers until the ungrounded contact 107 is reached whereupon relay PR^1 retracts its armature interrupting the circuit for magnet PM^1. Wipers P^1, S^1, T^1, W, have now been advanced to a point opposite the third group of contacts 102, 103, 104, 105, which is the sub-group containing the terminals of the calling line. The secondary adjustment of switch S is now effected, this occurring responsive to the deënergization of PR^1. Upon said deënergization of PR^1 a circuit for secondary relay SR^1 is established traced from ground at normal contact 119 of PR^1, alternate contact 121, normal contact SON^1,

and the winding of SR^1 to battery. Relay SR^1 therefore closes its alternate contact 123 establishing an energizing circuit for secondary magnet SM^1 whereby wipers P^1, S^1, T^1, W, receive a single secondary step advancing them into engagement with the first set of line contacts. Assuming the line of substation A^2 is the first line of this group seeking a connection, it will be the first line having its terminal 104 ungrounded so that upon wiper T^1 engaging the first contact 104 of the row or group, due to the ground connected thereto, a locking circuit for relay SR^1 is established through alternate contact 124 so that magnet SM^1 advances the wipers another secondary step and in fact continues this secondary adjustment until wiper T^1 engages the test contact 104 of the calling line. Upon reaching this contact the circuit for SR^1 is interrupted causing its deënergization whereby the circuit for SM^1 is interrupted and the switch wipers rendered inert, and in engagement with the terminals of the calling line. Thus, it will be seen how a calling line is selected by the line selector.

We will now take up the operation of the cord selector D^1. Returning to the starting circuit and to point 116, the ground connection over conductor 115 is extended toward the right over conductor 126, normal contact 127, and the winding of PR^2 to battery causing the energization of relay PR^2 whereby its alternate contact 128 is closed establishing an operating circuit for primary magnet PM^2. Magnet PM^2 upon its first energization advances the wipers of switch D^1 a single primary step whereby group test wiper GT^2 engages the first group contact 8^1 which we will assume has a ground or busy potential thereon due to the busy condition of the associated cord circuits E^1. Therefore a locking circuit for PR^2 is established from said grounded contact 8^1 through alternate contact 129, and the winding of PR^2 to battery so that magnet PM^2 advances the wipers another step and in fact continues this primary adjustment as long as wiper GT^2 is engaging busy contacts 8^1. Upon reaching the third contact 8^1 which we will assume has an idle cord circuit in its associated sub-group, circuit for PR^2 is interrupted causing the deënergization thereof, and the interruption of the operating circuit for PM^2 whereby any further primary adjustment of the switch D^1 is prevented. Thus by the primary adjustment of switch D^1, a sub-group of cord circuits with an idle circuit having been selected, a secondary adjustment of the switch is brought about to select such an idle cord circuit in this selected sub-group. Therefore upon deënergization of PR^2 its normal contact 128 is closed establishing a circuit for secondary relay SR^2 traced from grounded normal contact 128, alternate contact 130, contact SON^2, and the winding of SR^2 to battery. Secondary relay SR^2 is therefore energized closing its alternate contact 131 and establishing an operating circuit for secondary magnet SM^2 whereby wipers P^2, T^2, S^2 are advanced a single secondary step to engage the first set of contacts 5^1, 6^1, 7^1. Assuming this first set of contacts leads to a busy cord circuit E^1, the test contact 5^1 thereof has a ground or busy potential connected thereto so that a locking circuit for SR^2 is established traced from this grounded contact 5^1, wiper T^2, alternate contact 132, normal contact 133, and the winding of SR^2 to battery. Upon this first secondary step of D^1, contact SON^2 is interrupted just before wiper T^2 connects with contact 5^1 to prevent shunting the cut-off relay of a calling line connected therewith, by the ground from normal contact 128. Therefore, this secondary adjustment of the switch is continued until wiper T^2 reaches an ungrounded or idle test contact 5^1 which we will assume is the one leading to the cord circuit E^1 shown. Relay SR^2 therefore loses its energizing circuit and interrupts the circuit for SM^2 rendering the wipers inert.

Thus the calling line having been selected and an idle cord circuit E^1 having been selected, the connection will be completed by closing relay CL^1 and the line signal 11^1 operated. This is brought about upon the deënergization of SR^2 by a circuit for answering supervisory relay AS^1 and 37^1 in multiple, conductor 36^1, contact 7^1, wiper S^2, normal contacts 134, 135, 136, to ground whereby relay AS^1 is energized closing a series circuit including lamp 11^1, group busy relay GB^{11} closing relay CL^1 and cut-off relay CO^2, this circuit being traced from battery at E^1 through lamp 11^1, alternate contact 138, relay GB^{11}, conductor 139, contact 5^1, and wiper T^2, normal contacts 132, 140, winding of CO^2 to ground. These three relays CO^2, CL^1, and GB^{11}, are energized and signal 11^1 is illuminated to indicate the call to the operator. The energization of GB^{11} effects a step in the closing of the series circuit 9^1 toward rendering the corresponding group contacts 5^1 busy in a manner as already explained. The energization of CO^2 causes the interruption of the circuit for line relay LR^2 thereby closing normal contact 101 to render the associated test contact 104 unselectable, while the interruption of alternate contact 101 restores group relay GR, (providing no other line in the group of 10 is calling,) to restore the associated group contact 107 to a grounded or non-selectable condition. The interruption of alternate contact 113 of LR^2 removes ground from the starting conductor 212 and normal contact 112 until some other line in the group of 100 is calling. It will also be noted that due to the connection of battery to en-

ergize cut-off relay CO^2, the jack sleeves are raised to a busy potential. The energization of relay CL^1 closes alternate contacts 141 and 142, thereby extending the talking circuit of the calling line to the selected cord circuit E^1 whereby supervisory relay AS^1 is included in circuit with the calling line and maintained energized by current flowing over the heavily marked conductors. Also upon energization of CL^1 release relays RR^1 and RR^2 are energized, the circuit for RR^1 being traced from battery through the winding thereof, alternate contacts 143, 121 to ground at normal contact 119 causing the energization of RR^1 whereby its alternate contact 144 is closed, establishing a locking circuit for itself so that it will remain energized until the switch is restored and PON^1 restored. The circuit for RR^2 is traced from battery through the winding thereof, alternate contact 145, 130 to ground at normal contact 128 whereby alternate contact 146 of RR^2 is closed establishing a locking circuit for itself so that RR^2 remains energized until switch D^1 is restored and alternate contact 130 of PON^2 interrupted.

The connection from the calling line to an idle cord circuit E^1 having been completed, the master switch MS has its wipers advanced to the next idle pair of selector switches, this being brought about by the energization of relays RR^1 and RR^2. That is upon the closing of alternate contacts 148, 136 of these relays, or in fact either one of these contacts, ground is connected to conductor 149 whereby a circuit for advancing relay AR is established causing said relay to close its alternate contact 150 whereby motor magnet MM advances the wipers 108, 109 a single step. If the set of contacts then engaged lead to a busy pair of selectors LS, D^1, relay AR of course remains energized and magnet MM advances the wipers another step. Should all of the remaining sets of contacts 110, 111, be busy, upon the wipers 108, 109, advancing beyond the last contact of the set, over-run contact OR is closed establishing an energizing circuit for the release magnet RM which is therefore locked through its alternate contact 151 and upon the energization of RM a retaining pawl is withdrawn allowing the wipers 108, 109 to be restored to normal by spring tension, in which position they are engaging the first set of contacts 110, 111. If this first set of contacts is idle, relay AR of course does not energize and therefore the wipers remain inert, but if the first set of contacts are busy relay AR again energizes and the magnet MM advances the wipers until an idle set of contacts is reached. As already pointed out, relays RR^1 and RR^2 remain energized until their respective switches LS and D^1 are restored so that the conductor 149 is maintained grounded and non-selectable until the connected pair of switches LS and D^1 are again at normal.

The operator in response to the lighting of calling signal 11^1, connects her operator's telephone set (not shown) in bridge of the cord circuit E^1 and finding the substation A^3 is the desired one, she tests the jack J^3 thereof in the usual manner by touching the tip of the plug to the sleeve of the jack and finding the line idle she inserts plug F^1 to connect with the called line. Responsive to this connection a series circuit including relay SH^1, lamp signal 12^1 and cut-off relay CO^3 is established in a manner as described in connection with Fig. 1, whereby signal 12^1 is lighted and due to the closing of contact 39^1, resistance 41^1 is connected in shunt with signal 11^1 thereby effacing said signal.

Also upon energization of SH^1 its alternate contact 154 is closed connecting disconnect lamp DL in multiple with lamp 11^1 and resistance 41^1 but sufficient current does not flow through this lamp DL to cause its illumination until the calling subscriber restores his receiver to deënergize relay AS^1. The operator now depresses the proper ringing button whereby the bell of the called substation is operated and the automatic disconnection of the ringing current is effected upon response from the called substation in a manner as described in connection with Fig. 1. Upon response of the called subscriber at substation A^3, calling supervisory relay CS^1 is of course energized causing the effacement of the signal 12^1. The two substations are now connected for conversation, the talking circuit being traced over the heavily marked conductors.

Disconnection in Fig. 3.

After the subscribers have finished conversation they replace their receivers upon their respective switch-hooks, this act at substation A^3 causing relay CS^1 to deënergize and again light signal lamp 12^1 while the replacing of the receiver at T^2 interrupts the circuit for relay AS^1 causing its deenergization and the interruption of its contact 138. This interruption of contact 138 disconnects lamp 11^1 and resistance 41^1 from in shunt with disconnect lamp DL so that said lamp DL is connected in series with the relays GB^{11}, CL^1, and CO^2 causing the illumination thereof. Thus, lamps DL and 12^1 being illuminated the operator knows that the subscribers have replaced their receivers and removes plug F^1 from its jack, thereby interrupting the series circuit through relays SH^1, and CO^3, causing their deënergization. The restoration of SH^1 by the interruption of its alternate contact 154 opens the circuit through relays GB^{11}, CL^1 and CO^3 causing these three relays to restore, the restoration of GB^{11} removing the busy potential from the associated group

contact 8[1]. Upon restoration of CL[1] the heavily marked talking conductors are interrupted so that upon restoration of the wipers of the pair of switches LS and D[1], any existing connections over which these wipers may pass are not disturbed. Upon restoration of CL[1] a release circuit for switches LS and D[1] is brought about through the energization of the secondary relays SR[1] and SR[2] of these switches. Relay SR[1] is energized over a circuit traced from battery through the winding thereof, alternate contact 156, normal contact 143, alternate contact 121, normal contact 119 to ground. Relay SR[1] therefore closes its alternate contact 123 establishing an energizing circuit for SM[1] whereby the wipers are advanced to be automatically released as described in connection with the switch mechanism. Upon switch LS returning to normal, alternate contact 121 of PON[1] is interrupted, thereby interrupting the circuit for SR[1] which restores and switch LS is therefore at normal.

Now as to the restoration of cord selector D[1], its secondary relay SR[2] is energized upon said deënergization of relay CL[1], the circuit being traced from battery to the winding of SR[2] of alternate contact 133, normal contact 145, alternate contact 130 to ground at normal contact 128. Relay SR[2] therefore closes its alternate contact 134 establishing a release circuit for SM[2] so as to cause restoration of switch D[1]. Upon restoration of the wipers to normal, alternate contact 130 of PON[2] is interrupted thereby opening the circuit for SR[2] and RR[2] effecting the deenergization of these relays whereby switch D[1] is at normal. Relays RR[1] and RR[2] upon their deënergization disconnect ground from the conductor 145 leading to the master switch MS whereby the associated pair of selectors LS and D[1] are available for use in establishing other connections. Upon the said deënergization of CO[2] the line of substation A[2] is available for use in establishing other connections.

The system of Fig. 3 is also arranged to cause the automatic restoration of a pair of selectors LS and D[1] should such a pair be started and fail to connect a calling line and a cord circuit.

For instance should the receiver at substation A[2] be removed and immediately replaced, the associated line relay LR[2] will be energized sufficiently to ground the common starting conductor 212 and thereby start an idle pair of selectors LS and D[1], but due to the fact that relay LR[2] is only momentarily energized, ground is again connected to the group contact 107 associated therewith and individual test contact 104 so that this line which started a line selector is non-selectable. In such case, should no other line of the group be calling, all of the group contacts 107 are in a grounded or non-selectable condition so that the primary adjustment of switch LS is continued until the wipers have passed beyond the last group of the switch and the primary over-run contact POR[1] is closed. Upon the switch reaching this point, and relay PR[1] having deënergized due to the interruption of its maintaining circuit through the group wiper GT[1], a circuit for secondary relay SR[1] is closed from grounded normal contact 119 of PR[1] over the previously described path through SR[1] to battery whereby SR[1] is energized causing an operation of SM[1]. Upon the first secondary step of switch LS, the initial energizing circuit for SR[1] is interrupted at SON[1], and test wiper T[1] failing to connect with a contact 104, relay SR[1] immediately deënergizes interrupting the circuit for SM[1] and preventing any further secondary advance of the switch for the present. In the meantime assuming the cord selector D[1] has selected an idle cord circuit E[1], and its relay SR[2] has deënergized, a circuit including closing relay CL[1] and relay GB[11] of cord circuit E[1] is established from ground at POR[1] the winding of CL[1], normal contacts 140, 132, wiper T[2], and contact 5[1], conductor 139, the winding of GB[11], alternate contact 138 (which is closed due to the momentary energization of AS[1] through normal contact 135 of SR[2]) lamp 11[1] to battery. Relay CL[1] therefore energizes and closes circuit for relays RR[1] and RR[2] in a manner as previously described whereby these relays are energized and locked up as already pointed out. Upon said energization of CL[1] its normal contact 134 is interrupted thereby interrupting the circuit through AS[1] which deënergizes due to the fact that there is no substitute energizing circuit therefor over a calling line. Therefore relay AS[1] having failed to remain energized its contact 138 interrupts, again opening the circuit for CL[1] which restores to close energizing circuits through relays SR[1] and SR[2] in a manner as already described. That is relay SR[1] is energized due to the closing of normal contact 143 of CL[1] while SR[2] is energized due to the closing of normal contact 145 of CL[1]. Said relays SR[1] and SR[2] therefore close release circuits through the corresponding secondary magnets whereby switches LS and D[1] have their wipers advanced and then restored in a manner as previously described. Upon restoration of the wipers to normal relays SR[1], RR[1], RR[2], and SR[2] are returned to normal and the switches LS and D[1] are therefore available for establishing other connections. Although the operation just described causes a momentary flash of signal 11[1], the operator can be instructed to pay no attention to such signal or even should she connect her operator's telephone circuit with the associated cord circuit she would

receive no response and would know that no connection has been established.

Another operation of the system of Fig. 3 which may sometimes occur, is where a call has been initiated and the calling line selected by a line selector LS but the paired cord selector D^1 fails to select a cord circuit E either because all the cord circuits to which it has access are busy or because the primary adjustment of the switch D brings its wipers to a group of cord circuits having a cord circuit of the group idle when the group was selected but in which this idle cord circuit is seized by another selector D^1 before the present selector D^1 in its secondary travel reaches the terminals 5^1, 6^1, 7^1 thereof.

Assuming now that a call has been initiated at substation A^1 and that line L^2 has been selected by a switch LS but that the cord circuits to which the paired selector D^1 has access, are all busy. In this case the primary adjustment of switch D^1 is continued until the wipers are stepped beyond the last group of bank contacts and switch POR^2 is closed. Upon the wipers reaching this over-run position, and the circuit for PR^2 being interrupted, this relay PR^2 deenergizes closing its normal contact 128 and thereby closing the circuit for SR^2 which energizes and causes magnet SM^2 to advance the wipers a single secondary step and thereby interrupting contact SON^2 to open the initial energizing circuit of SR^2. Wiper T^2 having failed to engage a grounded contact 5^1 upon this first secondary step, relay SR^2 restores preventing any further secondary adjustment of the switch wipers for the present.

Upon the switch D^1 reaching its primary over-run position, contact 71^2 of POR^2 is closed whereby a circuit for over-run relay ORR is established traced from battery through the winding thereof, alternate contact 71^2 to ground at normal contact 136. Relay ORR therefore energizes closing its alternate contact 72^2 and establishing a series circuit including CO^2 and CL^1 traced from battery through said contact 72^2, alternate contact 73^2, conductor 162, normal contact 140, winding of CL^1, wiper W, contact 105, the winding of CO^2 to ground. Said relays CO^2, CL^1 are therefore energized, the energization of CO^2 causing the restoration of LR^2 and the interruption of the starting circuit over conductor 212 (providing no other line is calling at the time) while the energization of CL^1 causes the energization of RR^1 and RR^2 as already pointed out. Upon energization of RR^2 and the interruption of its normal contact 136, relay ORR^1 restores thereby interrupting the series circuit through relays CL^1 and CO^2, so that these relays restore, the restoration of CL^1 effecting the energization of the two secondary relays SR^1 and SR^2 as already described whereby the secondary magnets of the switches LS and D^1 are operated to cause a secondary advance of the wipers and the restoration thereof. Upon the wipers reaching normal the circuits for relays SR^1, RR^1, RR^2, and SR^2 are interrupted as before, whereby the switches LS and D^1 are at normal and available for other use.

Although the first pair of selectors LS and D^1 started failed to extend the calling line to an idle cord circuit E^1, the present system is so arranged that a second pair of such switches are automatically started to attempt to effect such a connection. That is, as soon as relays RR^1, RR^2, are energized, conductor 149 leading to master switch MS is grounded thereby causing switch MS to advance its wipers to the next idle set of contacts. Therefore upon restoration of CO^2 of the calling line when relay ORR^1 was deënergized as pointed out above, the line circuit still being closed at substation A^1, line relay LR^2 thereof is again energized and a starting circuit including conductor 212 is again closed to start the next set of idle selectors LS and D^1. Should this second pair of switches fail to establish a connection a third pair will be started and so on until one of such pairs of switches will connect the calling line with an idle cord circuit E^1.

Another non-selecting operation of a pair of started switches LS and D^1 may occur in which the line selector will pick up the calling line but the paired cord selectors D^1 will receive its primary adjustment to select a group of contacts having an idle set of contacts but before the wipers of this switch D^1 in their secondary adjustment, reach this set of contacts, some other switch D^1 having access to the connected cord circuit E^1 seizes these contacts and renders them busy. In such case, assuming there is no other idle set of contacts in the group, the secondary adjustment of the wipers is continued until they have passed into a secondary over-run position. In this case switch SOR^2 is closed connecting relay ORR^1 in circuit to cause the restoration of the paired switches LS and D^1 in a manner similar to that described when the over-run switch POR^2 is operated. Therefore switches LS and D^1 are restored to normal, and master switch MS advances to the next set of idle contacts to start another pair of switches to connect the calling line with an idle cord circuit D^1.

Fig. 4.

Fig. 4 illustrates a cord circuit E^2 adapted for use in place of cord circuit E^1, the circuit of Fig. 4 differing from cord circuit E^1 in that but single party line ringing is provided and without any automatic control. The control of the supervisory signals

of E^2 is the same as that of E^1 and I have indicated the like parts by like reference characters except for the use of a different suffix. The operation of E^2 will be apparent in view of the description of E^1 and it is thought that no further reference to E^2 is necessary for an understanding thereof.

Although in illustrating my invention I have shown a plurality of batteries, it is to be understood that these batteries may be one and the same in any exchange in accordance with common practice and although I have shown mechanical circuit interrupters on the operating magnets of the switches, I contemplate using either such interrupters or a source of alternating current. Furthermore, I am aware that many changes in the circuit arrangements will readily suggest themselves and therefore I do not desire to be limited to the exact arrangements as shown but aim to cover all that which comes 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. An automatic two-dimension call distributing switch comprising contacts arranged in groups and coöperating wipers, link circuits extending from said contacts, multiple connections for said contacts whereby the link circuits may be rendered busy, a starting circuit for said switch, and means whereby if all of said circuits are busy when said switch is started said wipers are operated to test all of said groups and automatically restore by both movements thereof.

2. An automatic two-dimension call distributing switch comprising contacts arranged in groups and coöperating wipers, link circuits extending from said contacts, other connections whereby the link circuits and contacts may be rendered busy, a starting circuit for said switch, means responsive to said starting circuit for causing a primary adjustment of the wipers to test all of said groups, and means effective if all of said groups are busy for automatically causing a secondary operation and restoration of said wipers to normal.

3. An automatic two-dimension call distributing switch comprising contacts arranged in groups and coöperating wipers, a primary magnet, a secondary magnet, link circuits extending from said contacts, other connections rendering all of said contacts and link circuits busy, a starting circuit for said switch, means responsive to said starting circuit for causing an automatic operation of said magnets whereby said wipers test said contacts for an idle circuit and are thereafter automatically restored to normal.

4. An automatic two-dimension call distributing switch comprising contacts arranged in groups and coöperating wipers, a primary magnet, a secondary magnet, link circuits extending from said contacts, other connections rendering all of said contacts and link circuits busy, a starting circuit for said switch, means responsive to said starting circuit for causing an automatic operation of the primary magnet whereby said wipers test said contacts for a group having an idle circuit, and means effective when none such idle circuit is found for causing an automatic operation of the secondary magnet to restore said wipers to normal.

5. A telephone system comprising telephone lines, answering jacks therefor, operators' link circuits including answering plugs, other links circuits, automatic switches responsive to the insertion of the answering plugs into the jacks of calling lines for extending the operator's link circuit of a plug to one of said other link circuits, and a disconnect signal for said answering plug responsive to a non-extension operation of the switch.

6. A telephone system comprising telephone lines, answering jacks therefor, operators' link circuits including answering plugs, other link circuits, an automatic switch responsive to the insertion of an answering plug into the jack of a calling line for connecting the operator's link circuit of said plug to an idle one of said other link circuits, a disconnect signal for said answering plug, and means for operating said signal upon failure of said switch to find an idle link circuit.

7. A telephone system comprising telephone lines, answering jacks therefor, operators' link circuits including answering plugs, other operators' link circuits including calling plugs, automatic switches equal in number to said first link circuits, and means responsive to the insertion of an answering plug into the jack of a calling line for causing one of such switches to extend the circuit of the operator's link circuit of said plug to an idle one of said calling link circuits.

8. A telephone system comprising a link circuit provided with an answering plug, a second link circuit provided with a calling plug, and means responsive to the insertion of said answering plug into the jack of a calling line for automatically selecting and connecting said second link circuit to said first link circuit.

9. A telephone system comprising a plurality of A-operators' link circuits provided with answering plugs, a plurality of B-operators' link circuits provided with calling plugs, and automatic means responsive to the insertion of a calling plug of one of said first link circuits into the jack of a calling line for connecting said link circuit to an idle one of said B-operators' links circuits.

10. A telephone system comprising an A-operator's link circuit and B-operators' link

circuits, manual means for directly connecting said A-operator's link circuit to a calling line, and automatic trunk selecting means individual to the A operator's link circuit responsive to said connection for automatically selecting and connecting said A-operator's link circuit to an idle one of said B-operators' link circuits.

11. A telephone system comprising a plurality of link circuits of one character and a plurality of link circuits of another character, manual means for interchangeably connecting said first link circuits and calling subscribers' lines, automatic means individual to said first link circuit and responsive to said connections for automatically interchangeably selecting and connecting the said first link circuits to idle ones of said other link circuits, and supervisory signals for both of said link circuits.

12. A telephone system comprising a link circuit, other link circuits, manual means for directly connecting said first link circuit to a calling subscriber's line, and automatic means responsive to said connection for connecting said link circuit to an idle one of said other link circuits.

13. A telephone system comprising a calling subscriber's line, a plug-ended link circuit, other link circuits, manual means for connecting said first link circuit to said calling subscriber's line via said plug, and automatic means responsive to said connection for connecting said link circuit to an idle one of said other link circuits.

14. A telephone system including a calling and a called subscriber's line, an operator's plug-ended link circuit, a second link circuit, means responsive to the manual connection of said first link circuits to said calling line for automatically completing connection between said pair of link circuits, means for connecting the other of said link circuits to said called line, and means responsive to the disconnection of said last link circuit from said called line for automatically interrupting connection between said pair of link circuits.

15. A telephone system including a calling subscriber's line and a called subscriber's line, an operator's link circuit, a second operator's link circuit, means responsive to the manual connection of said first link circuit to said calling line for automatically connecting said first link circuit to said second link circuit, means for connecting said second link circuit to said called subscriber's line, a supervisory signal for said first link circuit operable when said second link circuit is disconnected from said called subscriber's line, and operator-controlled means for then restoring said first link circuit.

16. A telephone system including a calling subscriber's line and a called subscriber's line, an operator's link circuit for connection to said calling subscriber's line, other operator's link circuits for connection to said called subscriber's line, automatic means associated with said first link circuit and responsive to the manual connection of said link circuit to said calling subscriber's line for connecting said link circuit to an idle one of said other link circuits, means for connecting the selected link circuit to said called subscriber's line, a supervisory signal for said first link circuit, and means for operating said supervisory signal when said selected link circuit is disconnected from said called line or if said automatic means does not find an idle link circuit.

17. A telephone system including a calling subscriber's line, an automatic switch, link circuits divided into groups and accessible to said automatic switch, manual means for connecting said switch to said calling subscriber's line, and means responsive to said connection for operating said switch to test said link circuits by groups until an idle group is found and for then testing the link circuits in the selected group until an idle link circuit is found.

18. A telephone system comprising a calling subscriber's line, an automatic switch, link circuits divided into groups and accessible to said switch, a contact for each of said groups, and means associated with each group of link circuits for making its respective contact test busy, and means responsive to the manual connection of said switch to said calling subscriber's line for operating said switch to test said link circuits by groups.

19. A telephone system comprising a calling subscriber's line, a link circuit, an automatic switch for said link circuit for extending a connection therefrom, means responsive to the connection of said link circuit to said calling subscriber's line for operating said automatic switch, independent means for releasing said automatic switch, and means for preventing a reoperation of said automatic switch until said link circuit is disconnected from said line.

20. A telephone system including a calling subscriber's line and a called subscriber's line, a pair of plug ended link circuits, automatic means responsive to the manual connection of one of said link circuits to said calling subscriber's line for establishing connection between said link circuits, means for connecting the other of said link circuits to said called subscriber's line, and means responsive to the disconnection of said last link circuit from said called subscriber's line to interrupt said connection between said link circuits.

21. A telephone system including a calling subscriber's line and a called subscriber's line, an operator's link circuit, a second

operator's link circuit, manual means for directly connecting said link circuits to said calling and called subscribers' lines respectively, automatic means for establishing connection between said link circuits, a pair of supervisory signals for said second link circuit under the control of the calling and called subscribers, and a disconnect signal for the said first link circuit responsive to the disconnection of said other link circuit from said subscriber's line.

22. A telephone system including a calling subscriber's line and a called subscriber's line, an operator's plug-ended link circuit, a second operator's plug-ended link circuit, means for connecting said link circuits to said calling and called subscribers' lines, respectively, automatic means for establishing connection between said link circuits, a pair of supervisory signals for said second link circuit under the control of the calling and called subscribers, and a disconnect signal for said first link circuit responsive to the disconnection of said second link circuit from said subscriber's line.

Signed by me at New York in the county of New York and State of New York in the presence of two witnesses.

ALFRED H. DYSON.

Witnesses:
W. F. HOFFMAN,
G. E. MUELLER.