

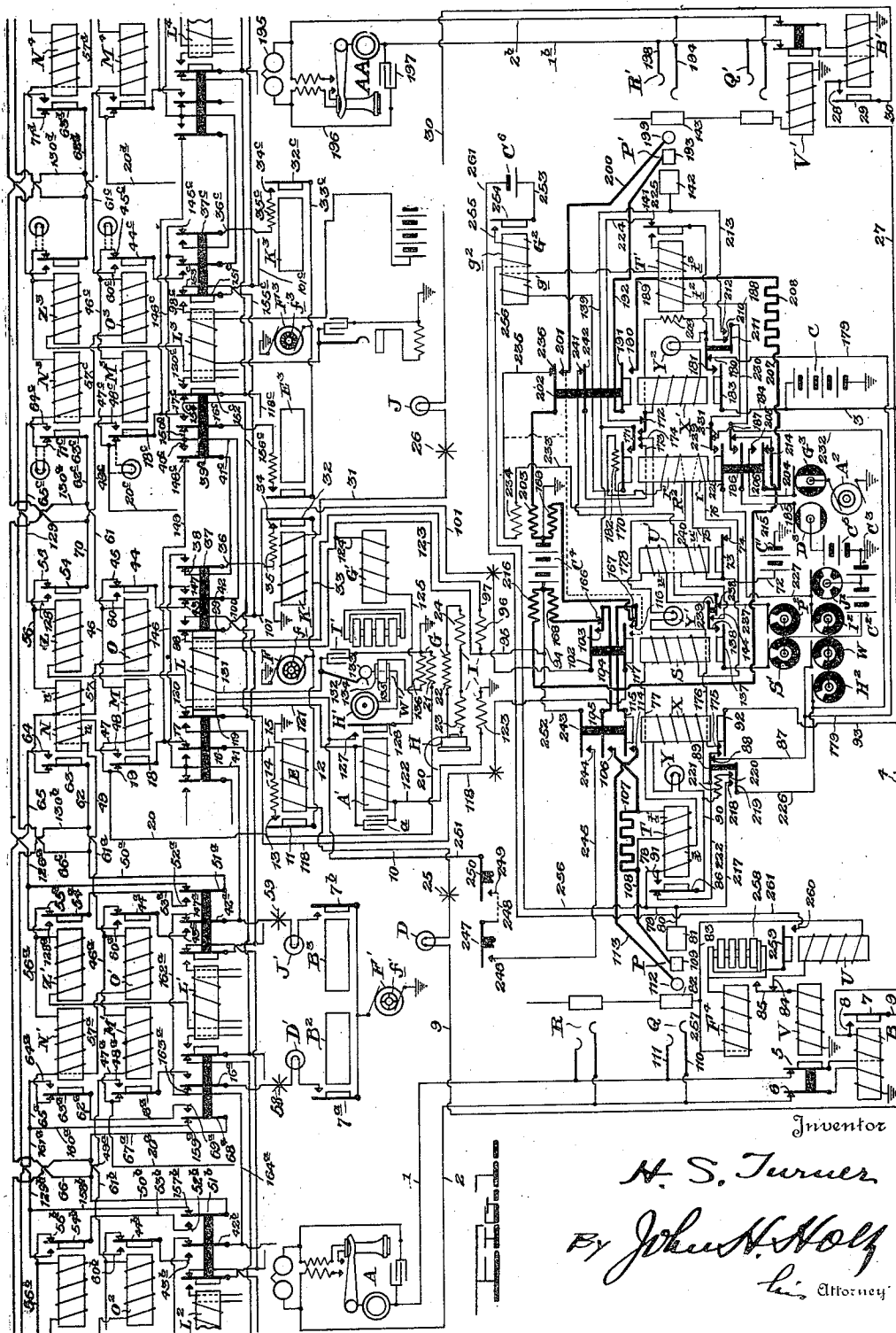
TELEPHONY.

APPLICATION FILED AUG. 12, 1915.

Patented July 4, 1922.

2 SHEETS—SHEET 1.

1,421,864.



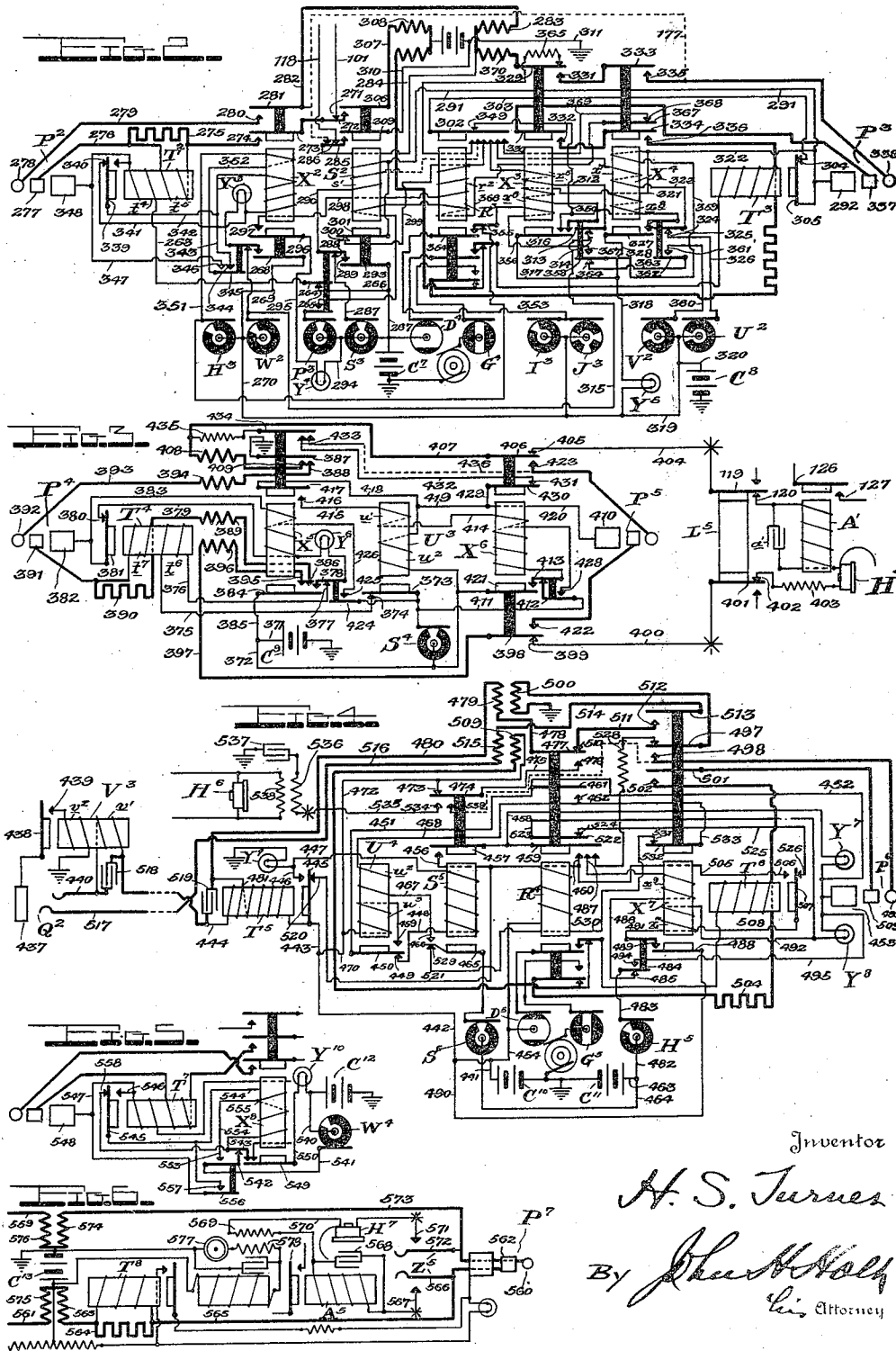
H. S. TURNER.
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2 SHEETS—SHEET 2.



Inventor

H. S. Turner

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UNITED STATES PATENT OFFICE.

HUBERT SYDNEY TURNER, OF WASHINGTON, DISTRICT OF COLUMBIA.

TELEPHONY.

1,421,864.

Specification of Letters Patent.

Patented July 4, 1922.

Application filed August 12, 1915. Serial No. 45,232.

To all whom it may concern:

Be it known that I, HUBERT SYDNEY TURNER, a citizen of the United States, residing at Washington, District of Columbia, have invented certain new and useful Improvements in Telephony, of which the following is a specification.

(1) The present invention has for one of its principal objects the provision of means whereby the usual busy tests made on a called for line are dispensed with, thereby effecting a great saving in the operator's time, an audible busy signal distinctive to the operating condition of the called for line being sounded in the calling party's telephone receiver if an operator establishes a connection to a busy line, whereupon the calling party will replace his receiver upon its switchhook, thereby obtaining an automatic disconnection from the called for line, or will wait until the called for line becomes idle, whereupon the busy signal ceases to be sounded in the receiver and the two lines are automatically connected, the called for party's call bell at the same time being automatically rung; the provision of means whereby if an operator establishes a connection to a busy line for which one or more calling parties, as the case may be, are waiting, the described busy signal will be sounded in the operator's telephone receiver, whereupon the connection will be taken down and report made to the calling party that one or more parties are already waiting upon the line in question; the provision of means whereby two or more calling parties may wait for a busy line to become idle, being automatically connected thereto, successively, in the same order in which their lines were connected to the busy line; the provision of improved means for preventing a telephonic connection to a busy line and for allowing a calling party to wait for a busy line to become idle; the adaptation of all of the above features to trunking connections between exchanges; the provision of improved means for operating an operator's transferable audible pilot signal, whereby the means for producing such signals are greatly simplified and rendered more efficient in operation; and improved means for operating a subscriber's and operator's call recording system. Other objects will be apparent from the specification.

(2) This invention is particularly applicable in some of its features to those telephone systems of the semi-automatic type, to which type, however, the invention is not to be restricted.

(3) In the following description reference will be had to my U. S. Patent No. 1,128,262, and my co-pending application, Serial No. 11046, as the present application in some of its aspects consists in improved means for accomplishing the results described therein.

(4) In order to more fully describe my invention reference will be had to the accompanying drawings forming a part of this specification, and wherein:

(5) Figure 1 is a diagram illustrating in one form the various features of my invention above mentioned, excepting the trunking system and the means whereby two or more parties may wait for a busy line to become idle; Figure 2 a diagram illustrating a modification of the link connector illustrated in Figure 1 and, in one form illustrating the means whereby two or more parties may wait for a busy line to become idle; Figure 3 a diagram illustrating in one form a modification of this invention adapted for use in those exchanges where all incoming calls are trunked; Figure 4, a diagram illustrating in one form a modification of this invention whereby all the features of the same are adapted to a trunking system; Figure 5, a diagram illustrating in modified form one of the relays used for preventing a telephonic connection to a busy line and for permitting a waiting connection to the same, and Figure 6, a diagram illustrating the means used whereby the disclosed operator's audible pilot signals may be adapted for use with a standard form of link connector circuit well known in the telephone art.

(6) Referring first to Figure 1, A and AA represent telephone substations of a form well known in the art. The removal of the telephone receiver at substation A closes a circuit for direct current through limbs 1 and 2 of the substation line, thereby causing the actuation of line relay B. The path for said circuit being from battery C, through 3, 4, right hand winding of B, 5, 1, through the substation telephone apparatus at A, 2, 6 and to ground through

the left hand winding of B. Therefore, armature 7 of relay B is attracted, establishing a circuit over the following path: battery C, 3, 4, 8, 7, 9, D, 10 and to ground through E. Lamp D is illuminated, and pilot relay E actuated by the current flowing in this circuit. The attraction of armature 11 of relay E establishes a circuit over the following path: generator F, 12, 11, 13, 14, 15, 16, 17, 18, 19, 20 and to ground through primary 21 of induction coil G. The segments of commutator *f* of generator F are such that a current of a fluctuating character is furnished. Therefore, primary 21 generates an alternating current in secondary 22 which is heard in the form of an audible signal by the operator wearing head receiver H, due to the inclusion of the latter in a circuit with secondary 22 and windings 23 and 24 of operator's repeating coil I. As primary 21 may be of a high resistance, it can consist of a great number of turns, and as transfer and re-transfer relays M, O, and N, Z, which at times are in circuit therewith, are of a sensitive type which permits windings of low impedance and few ampere turns, very slight fluctuations in the current flowing through said primary will produce the required audible signal in receiver H.

(7) I have shown in the center of the upper part of Figure 1, the complete apparatus common to each operator's position at the switchboard; to the left and right thereof, that part of said apparatus related to the right and left positions which is associated with the apparatus of the central position; denoting the left position by adding *a* and 1 as exponents to the reference characters, and the right position by adding *c* and 3. At the left and right of the last mentioned positions, I have shown a part of the associated apparatus of the next positions in line, denoting the same by the addition of *b* and 2, and *d* and 4, respectively, as exponents to the reference characters.

(8) In the preferred embodiment of my invention I take all the line lamps located with their corresponding answering jacks on the left side of each operator's position and connect them as indicated by the wires at 25, and as described in relation to line lamp D; while those located on the right side of each operator's position are connected, as indicated by the wires at 26, and as now to be described in relation to line lamp J. Lamp J is illuminated on the removal of the telephone receiver at substation AA in the same manner as described in relation to lamp D, the circuit being established over the following path: battery C, 3, 27, 28, 29, 30, J, 31, and to ground through K. Lamp J is illuminated, and pilot relay K actuated by the current flowing in this circuit. The attraction of armature 32 establishes a cir-

cuit over the following path: generator F, 33, 32, 34, 35, 36, 37, 38, 39^c, and if the operator at the next position to the right is on duty, then relay L^s is actuated (as will be hereinafter described), therefore the path proceeds by way of 40^c, 41^c, 42, 43, 44, 45, 46, relay M, 47, and to ground through 20 and primary 21, as described in relation to lamp D. Therefore, the same audible signal is produced in receiver H. However, the current controlled by pilot relay K has traversed transfer relay M, which is actuated thereby. Therefore, should lamp D or any other lamp on the left side of the central position be illuminated at the same time as lamp J, or any other lamp on the right side, the circuit for pilot relay E would be changed at armature 18 of transfer relay M, and the path for the current controlled by the same would proceed by way of armature 18, 48, winding *n* of relay N, 49, 50^a, to the operator's position at the immediate left, and if the operator there is on duty, then relay L' is actuated, therefore the path proceeds by way of 51^a, 52^a, 53^a, 54^a, 55^a, 56^a, N', 57^a, O' and then by way of 46^a, M', 47^a, 20^a, (corresponding to similar references at the central position) and to ground through the primary corresponding to 21, as shown at the central position. Therefore, the operator at the left or *a* position would receive the audible signal produced whenever lamp D or other left side lamp of the central position is illuminated, provided lamp J or other right side lamp is illuminated at the same time. Therefore, said operator would attend to the call, while the operator at the central position would attend to the call represented by the right side lamp, always giving preference to calls from the right side of that position, as the audible pilot signal from the left side is automatically transferred, as described, and the call attended to by the operator at the *a* position. Resistance 14 in series with contact 13 of pilot relay E, and resistance 35 in series with contact 34 of pilot relay K are used for preventing the short-circuiting of the windings of any of the relays N, Z, M or O, when relays E or K are operated.

(9) Lamps D' and J', corresponding to the *a* operator's position, are illuminated by the actuation of line relays B² and B³, in the same manner as described in relation to line relay B, excepting that the circuit for the lamps instead of passing through a pilot relay, such as E or K, is directly to the armature switches of relay L', thereby eliminating the pilot relays. If this form is used, generator F' is connected as shown to armatures 7^a and 7^b of line relays B² and B³. At 58 and 59 are shown the connecting leads of the corresponding lamps of that position.

(10) When the circuit from pilot relay E was transferred, as described, (paragraph 130

8), if lamp D' had been illuminated, the actuation of transfer relay M', due to the circuit traced therethrough, would have transferred the circuit connections of said lamp to the next position at the left, in the same way that the actuation of transfer relay M transferred the circuit connections from pilot relay E. In the same way, it will be seen, the circuit connections of any left side lamp at a position are changed, provided a transferred connection has been made from the position at the immediate right. Therefore, an audible signal is sounded in an operator's receiver by the circuit connections of a line lamp at the position to the immediate right in preference to a signal from the circuit connections of a line lamp at said operator's own position.

(11) The arrangement described in the preceding paragraphs, and to be described in the following ones, is purely optional, as the circuit connections of the transfer and re-transfer relays controlling the circuits from the line pilot relays or line lamps, as the case may be, may easily be changed to give other combinations. The arrangement, as described, has been selected to illustrate the invention on account of it being considered the most efficient means of obtaining adequate "team-work" among the operators at an exchange. As the left side of a position at the immediate right of an operator is practically as convenient of access as said operator's own position, the line lamps thereat as readily observable, and the answering jacks as easily connectible, said operator can attend to a call thereat in preference to a call at the position immediately in front of the operator, inasmuch as the latter will be attended to by the operator at the next position to the left.

(12) When the circuit from pilot relay E was transferred, as described (paragraph 8), if lamp J' had been illuminated, or becomes illuminated subsequently, the actuation of transfer relay O', due to the circuit traced therethrough, would have changed its circuit connections at armature 44^a, and the path for the current from lamp J' would proceed by way of armature 44^a, 60^a, 61^a, 62, armature 63 of re-transfer relay N, and as the latter is actuated, due to the current flowing through winding *n*, the path proceeds by way of 64, 65, 66, 50^b, 51^b, 52^b, 53^b, 54^b, 55^b and 56^b to ground through primary of operator's induction coil at the *b* position, over the same path as that followed by the circuit already traced through 56^a at the *a* position. Therefore, it will be seen that if a transferred connection is made from the left side of the central position to the *a* position by the operation of a line lamp on the right side, the audible line pilot signal connections of both sides of the *a* position are transferred to the *b* position, the operator

thereat attending to a call from either side, while the operator at the *a* position attends to the call at the left side of the central position, the operator at the latter attending to the call from the right side of said position. 70

(13) When the last described transference of an audible line pilot signal from the *a* to the *b* position takes place, any audible line pilot signals which may originate on either the right or left side of the *b* position are transferred to the next position at the left, and so on in succession, are transferred the signals from all positions to the left. The circuit for this transfer being over the same paths as those already traced in relation to the central and *a* positions. In the drawing only the right half of the *b* position is represented, but for the sake of clearness, the circuit for the last mentioned transfer will be traced over the following path: 85 from the pilot relay or line lamp, as the case may be, through 42^b, 43^b, 44^b, 60^b, 61^b, 67^a, 68^a, 69^a, 62^a, 63^a, 64^a, and 65^a, over the same path as traced for the transferred signal from the central position over wire 65. 90

(14) It will be noted that commutator *f'* of generator F' of position *a* consists of a lesser number of segments than commutator *f* of generator F of the central position, and as both generators produce a fluctuating current, the fluctuations are different from one another. Therefore, the signal sounded in receiver H varies according to which generator is in circuit with primary 21 of operator's induction coil G. Generator F³ of position *c* has a commutator *f*³ of more segments than either *f'* or *f*. Therefore, at the three adjacent positions the audible pilot signals are of a distinct character, an operator being able to determine by the character of the signal whether the same originates at that particular position or has been transferred thereto from either the left or right. Instead of using generators, as illustrated, interrupters connected to a battery may be used, as illustrated and described in my aforementioned U. S. Patent No. 1,128,262. 110

(15) At the central position, re-transfer relay N is shown as having two windings and a circuit has been traced through winding *n* which actuated said relay. The other re-transfer relays are shown without this double winding, as the same may or may not be used, as desired, it not being essential to the operation of the system. The purpose of this extra winding will now be explained. Referring to position *c* (to the immediate right of the central one) when both pilot relays E³ and K³ are energized, current flows from generator F³ over the same circuit as traced from generator F and therefore the circuit controlled by pilot relay E³ is changed at armature 18^c of transfer relay M³, as was the circuit at armature 18 of relay M of the central position. As the cir- 120 125 130

cuit connections between positions *c* and the central one illustrate an alternative form, (which may or may not be used) to that between the latter and position *a*, the path for the circuit will be traced from armature 18° of relay M³ through 18°, 48°, 49°, 70, 54, 55, 56 and proceeding through relays N, O and M of the central position as already traced in relation to position *a*. Now should a call originate at the central position and pilot relay K be actuated thereby, the path for the circuit traced through armature 44 of transfer relay O would be changed from contact 45 to contact 60 and the path would proceed as follows: 60, 61, 62°, 63°, (and as re-transfer relay N³ is not actuated as was relay N) 71°, 57°, O³, 46°, M³, 47° and 20° to ground through the primary of the operator's induction coil. The current passing through transfer relay O³ would actuate the same and the attraction of armature 44°, would change the path of the circuit controlled by pilot relay K³ from contact 45° to contact 60° and thence by way of 61°, 62°, 63°, 71° and 57° over a path already traced in relation to position *a*. Therefore, the audible pilot signal would be produced at position *d*. The current passing through relays O³ and M³ would produce an audible pilot signal at the *c* position characteristic to the central position, while the current passing through the corresponding relays of the central position would produce an audible signal characteristic to position *c*. As this would be an unnecessary reversal of signals, though in practice improbable of occurrence as it demands a simultaneous illumination of a right side lamp at the central position and a left and right side lamp at position *c*, by the use of the extra winding as shown at re-transfer relay N, the eventuality is avoided, as when lamps D and J are simultaneously illuminated relay N is actuated, as described, (paragraph 12), and a call from the right side of position *a* is transferred to position *b*. Even if such a winding is not used, the duties of the operators concerned would nevertheless not be interfered with as seeing a left side lamp burning at position *c*, the operator thereat would pay no attention to the audible signal characteristic of the central position. However, the double winding on re-transfer relay N is easily provided for.

(16) So far, it has only been explained how the audible pilot signals are transferred when one or more lamps on both sides of a position are illuminated simultaneously. As different transferring means are employed for the audible line pilot signals when an operator is engaged in answering a call or completing the same, this will now be fully explained. On hearing an audible pilot signal and seeing an illuminated lamp D, for instance, the operator at the central position inserts answering plug P of the illustrated link connector in line jack Q associated with the calling line, (Q and Q' may be considered as representing answering jacks and R and R' multiple jacks of the respective lines), a circuit is at once established over the following path: battery C', 72, 73, 74, 75, winding *r* of relay R², 76, S, 77, winding *t* of relay T, 78, 79, 80, 81, 82, 83, U, 84, 85 and to ground through cut-off relay V. The consequent actuation of cut-off relay V opens the circuit through line relay B and thereby extinguishes line lamp D controlled by the same. Relays T and S are actuated by the current flowing in the circuit traced through them, armature 86 of T being attracted and thereby establishing a circuit, the path for which is as follows: batteries C² and C³, interrupter W, 87, 88, 89, X, Y, 90, 86, 91, 78, 79, 80, 81, 82, 83, U, 84, 85 and to ground through cut-off relay V. The intermittent current allowed to pass through connecting relay X by interrupter W causes armature 92 to engage spring switch 89, thereby connecting battery C through wires 3 and 93 to connecting relay X. This current causes armature 92 to continue its movement, thereby removing spring switch 89 from contact 88 and thereby removing from the circuit batteries C² and C³ through interrupter W. Only the described connection of battery C is sufficient to cause the top armature switches of relay X to engage their contacts, thereby establishing a circuit, the path for which is as follows: battery C⁴, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107 and winding *t'* in multiple, 108, 109, 110, 2, substation apparatus at A, 1, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, A', 122 and to ground through 123. Relay A' which is shunted by condenser *a* to permit the passage of voice currents, is actuated by the current flowing in this circuit and another circuit is established, the path for which is as follows: battery C⁴, 94, 95, 123, 124, G', 125, 126, 127, Z, 56, winding *n'* of relay N, 57, O, 46, M, 47, 20 and to ground through primary 21. As transfer relays O and M are actuated by the current flowing through this circuit any further illumination of line lamps at the central position will not produce an audible pilot signal in head receiver H, as the attraction of armature 44 of relay O would transfer said signal circuit from the right side by way of 60, 61, 62, 62°, 63°, 71°, 57°, O³, 46°, M³, 47°, and 20° to the operator's induction coil at the *c* position; the attraction of armature 18 of relay M transferring said signals from the left side by way of 48, *n*, 49, 50°, 51°, 52°, 53°, 54°, 55°, 56°, N', 57°, O', 46°, M', 47° and 20° to the operator's induction coil at the *a* position. Operator's call recorder G' is actuated by the current flowing through this circuit and as the same cannot actuate until

relay A' actuates, which, in turn, cannot actuate unless a connection is actually made to a line initiating a call; said recorder furnishing a bona fide record of the calls answered by the operator, there being no way to make it record more than once for each connection made.

(17) Assuming that while the central operator is engaged in connecting to a calling line, as described (paragraph 16), and assuming that an audible line pilot signal, as also described therein, is transferred to the *a* or *c* positions or to both, then as the respective transfer relays at said positions are actuated and as the same control the circuit connections for said signals originating in said positions, any audible signal originating in either the *a* or *c* position is automatically transferred to the *b* position from the *a* one, and to the *d* position from the *c* one. Said transfer, in turn transferring the audible pilot signals originating in the *b* and *d* positions to those next in line, and so on.

(18) The N and Z re-transfer relays control the retransferring of the audible line pilot signals; or in other words, change the circuit connections, which are normally transferred to the right and left positions respectively from the two sides of a "busy" position, so that both sides are transferred to but one position according to whether the left or right position is "busy" also. Therefore, re-transfer relays N and Z of the central position being actuated, as described (paragraph 16), should transfer relay M² of the next position to the right be actuated, the audible signal, which might be transferred thereby through armature 18^c of the same, 48^c, 49^c, 70, 54 and 55 to receiver H at the central position, would be re-transferred through armature 54 of relay Z, contact 128, 129, 130^a and 62^a to the receiver at position *d* at the right of the originating position. In the same way, should transfer relay O' of the next position to the left of the central one be actuated, relay N would re-transfer the signal to the next position to the left of the originating position.

(19) Reference has been made and the circuits traced and described (paragraph 17), for the transference of the audible signal circuits originating in one position to the next in line when a signal circuit is transferred to the former from another position, the explanation having been made that an operator can always reach the left or right side or both sides, as the case may be, of the adjacent position, allowing the audible signals originating in that position to be, in turn, transferred to the next position. However, it is essential for the convenient working of the system, that this transference to a position shall not include a call originating in a position other than the adjacent

one, provided the operator thereat is on duty, as it would be difficult for an operator to reach over and beyond another operator to answer a call. This eventuality is provided for by separating the functions of the re-transfer relays from the functions of the transfer relays and limiting the functions of the two former to the re-transferring of the audible signal circuit connections and the two latter to the transferring of the signals originating in a position. The same thing is true when a position is "busy"; the audible signal circuit connections of that position are transferred to the adjacent positions, but the signal circuits transferred thereto are not transferred so as to pass an intermediate position. Referring to the circuits, as described (paragraph 16,) and assuming that the central and the *c* positions are both "busy", then the respective transfer and re-transfer relays are actuated and an audible signal from the right hand side of the central position would be transferred from armature 44 of transfer relay O over the following path: 60, 61, 62^c, 63^c, 64^c, 65^c, 66^c, 50^a, 51^a, 52^a, 53^a, 54^a and if the *a* position was idle would be sounded in the operator's head receiver at that position. At the same time, all the signals originating at that position would be transferred to the *b* position, as the central one is "busy". However, if the *a* position is busy also then armature 54^a of relay Z' is attracted and the path traced thereto would be diverted from contact 55^a to 128^a, 129^a and 130^a where it unites again with 62^c. Therefore, such a signal circuit from the central position can find no path, provided the left and right positions are also busy, but a path will be provided for the same at whichever of the three cited positions first becomes idle, and the signal will be sounded thereat. The same being true in regard to the signal circuit from the left hand side of the central position.

(20) In paragraph 16 a description was given of the means whereby the audible signals were transferred when a connection was made to a calling line. The circuit as traced therein through relays N, Z, M and O, and primary 21 of operator's induction coil G receives steady current from battery C⁴, therefore, no alternating current is produced in secondary 22 from this circuit, as was formerly produced by the current from the generators. As the circuit from substation A was traced through windings 96 and 123 of operator's repeating coil I and as said secondary and operator's head receiver H are in circuit with windings 23 and 24 of said coil, conversation may take place between substation A and the operator. The path for the operator's talking circuit is as follows: battery C⁴, 94, 95, 123, L, 131, 132, 133, H', 134, 135 and to ground through primary 136 of the operator's induction coil G.

Transmitter H' and primary 136 are shunted by condenser I', the arrangement shown being well known in the art, there being but one difference, namely, the winding of relay L acts as a substitute for the retardation coil generally used to impede cross talk in the transmitter circuit. It will be readily understood, however, that instead of making relay L of the required impedance, the usual retardation coil might be used in series with said relay.

(21) On obtaining the number with which the calling party desires to be connected, the operator inserts calling plug P' in multiple jack R' of the line in question. A circuit is thereupon established over the following path: batteries C² and C³, interrupter S', 137, 138, winding *u* of U', 139, 141, 142, 143 and to ground through cut-off relay V'. The intermittent current flowing in this circuit is sufficient to cause armature 73 of controlling relay U' to become separated from contact 74, thereby opening the circuit through relay S, which thereupon releases its various armature and spring switches. However, before armature 137 disengages spring switch 138, the latter becomes engaged with contact 144. Therefore, the path for the circuit through winding *u* of relay U' now proceeds through winding *u'* of the same, wire 72 and to ground through battery C'. Therefore, armature 73 of controlling relay U' remains disconnected from contact 74 as long as calling plug P' remains inserted in multiple jack R'. The disengagement of armature switches 102 and 117 from spring switches 103 and 116 of relay S, opened the circuit through operator's repeating coil I, as described (paragraph 16). Therefore, relay A', which controls the actuation of the transfer and re-transfer relays is de-energized, as are the latter, and operator's head receiver H will again receive the audible line pilot signals originating in the position, or transferred thereto.

(22) As described hereinbefore, the audible signal circuits have operated when all the illustrated positions were occupied by their respective operators. Whenever a position is vacated, the operator thereat, in order to disconnect the transmitter (shown diagrammatically at H') withdraws plug W' from its corresponding jack, and as jack spring 132 is thereby disconnected from ground through 133, H', 134, 135 and 136, there is then no path for direct current through relay L. Therefore, the latter is de-energized and releases its various armature switches. This condition is shown at the *c* position. Therefore, the changes in the circuit connections caused thereby will be followed in relation to that position. The engagement of armature switch 37° of relay L³ with contact 145°, changes the path

of the circuit for the audible signal controlled by pilot relay K³, so that the same now proceeds by way of 146°, 41°, 42 and 43 to armature 44 of relay O, from whence it proceeds, as described (paragraph 8). If this position had been vacant also, then instead of the path having been 42, 43 and 44, it would have been 42, 147, 146, 41 and 42^a, and thence according to whether the *a* position was vacant or not. Therefore, it will be seen that from any vacant position the audible signal circuits are transferred towards the left, and will be sounded in the operator's receiver at the first occupied position. The transference to the left from a vacant position is of course purely arbitrary, and can be towards the right if desired.

(23) Assuming that the central position is occupied, and that current is passing over the path, as described (paragraph 22), from the *c* position through armature 42 of relay L, 43, 44 and thence by way of 45, 46, and relay M to ground by way of 47, 20 and 21, then relay M would be actuated, and the circuit connection controlled by pilot relay K, as described (paragraph 8), through armature 39° of relay L³ is changed, by the deenergization of the latter, from contact 40° to contact 148°, and thence by way of 149 and attracted armature 18, to the next position at the left. The transfer of the calls from the left hand section of the central position takes place also inasmuch as pilot relay E connects generator F to the same armature 18 of relay M. Therefore, it will be seen that the transferred call from a vacant position transfers the calls originating at a position to the next one at the left and that said transferred calls cannot pass an occupied position to be sounded at another position. The audible signal circuit connection controlled by pilot relay E³ of the left side of the *c* position joins the traced circuit through wire 41°, as armature 16° has disengaged contact 17° and engaged contact 150° which is connected to said wire 41°. Armatures 151° and 152° control the connection of the leads 101° and 118° from the connecting means associated with the various link connectors at the position. They have nothing to do with the described audible signal circuits and may be dispensed with if desired, in which event lead 101 would be connected directly to winding 96 of operator's repeating coil I and lead 118 connected direct to relay A'. The advantage in using the connections as illustrated is that said armatures disconnect said leads at an idle position from contacts 98° and 120° which are connected to said windings of the operator's repeating coil at that position and connect the same to contacts 153° and 154° which are connected to said coil at the next position by wires 155°

and 156°. If that position is vacant the same are connected in the same way to the coil at the next position, and so on. Therefore, an operator can attend to a transferred call from any vacant position and use the link connectors thereat without having to change the transmitter or head receiver connections.

(24) As there are some slight differences between the connections controlled by the armature switches of relays L' and L^2 , and those controlled by the corresponding relays L , L^3 and L^4 , the differences will now be explained. The form used in the latter are intended for use where the operator's positions are always vacated in a regular manner from the right towards the left, or vice versa, as the case may be. The form shown in relays L' and L^2 being used when the positions are vacated, regardless of order, as the same provide means for transferring the signals originating at a position to the right of a vacant one, to a position to the right of the originating position, something which is unnecessary to do, if the first mentioned way of vacating positions is followed. It will readily be understood that the two forms may be combined to produce other transferring combinations.

(25) Assuming that the b position is vacant, and the a position occupied, the audible signal circuit controlled by armature 18^a of relay M' is transferred to the b position by way of contact 48^a and wires 49^a and 50^b. As armature switch 51^b of relay L^2 is engaged with contact 157^b instead of 52^b, the circuit is transferred to the next position to the right of the a position. The path for the same being as follows: 157^b, 158^b, 129^b, 130^b, 62, and over the path to ground, as described (paragraph 15).

(26) Assuming that the a position is the vacant one, and the b position is occupied, the audible signal circuit controlled by armature 44^b of relay O^2 , is transferred to the a position by way of contact 60^b and wires 61^b and 67^a. As armature switch 68^a of relay L' is engaged with contact 159^a, instead of 60^a, the circuit is transferred to the next position to the left of the b position. The path for the same being as follows: 159^a, 160^a and 161^a to the 51 armature switch of said position. The engagement of armature switch 42^a of relay L' with contact 147^a connected to wire 162^a and armature switch 16^a with contact 163^a transfers the audible signal circuits from the a position to wire 164^a, and thence to the b position. If visual pilot signals are desired, then lamps may be connected in series with the normal contacts of the transfer and re-transfer relays, as indicated at the c position by the lamps connected by the dotted lines. If the audible signal is not desired in connection therewith, then wire

20° would lead direct to ground, and a source of steady current could be used instead of generator F^3 .

(27) In paragraph 16 was described the means used for establishing a telephonic connection between a calling party and the operator, and in paragraph 21 was described the means used for disconnecting the operator when a connection is made to a called for line, namely, the de-energization of relay S . However, when armature switches 102 and 117 disengage spring switches 103 and 116, engagement is first made between said spring switches and contacts 166 and 167, which are connected, respectively, to windings 168 and 169 of the link connector repeating coil. Therefore, current from battery C^4 still flows through limbs 1 and 2 of the line of substation A , and consequently supervisory relay T is maintained actuated. The current flowing through the circuit traced through winding r or ringing relay R^2 , as described (paragraph 16), is sufficient only to cause armature 170 to engage spring switch 171, without causing the latter to engage spring switch 172, and contacts 173 and 174. Therefore, the insertion of calling plug P' in multiple jack R' , as described (paragraph 21), established a circuit which was not described therein, the path for the same being as follows: battery C , 3, 93, 92, 175, 176, Y' , 178, winding r' of ringing relay R^2 , 182, 170, 171, 139, 141, 142, 143 and to ground through V' . Cut-off relay V' is actuated and opens the connections to line relay B' as described in relation to line relay B . The current flowing through winding r' of relay R^2 is sufficient to completely actuate the latter and the engagement of spring switch 171 with spring switch 172, establishes another circuit, the path for the same being as follows: batteries C^2 and C^3 , W , 179, 180, 181, Y^2 , X' , 172 and to ground over the path already traced through spring switch 171. The intermittent current allowed to pass through connecting relay X' by interrupter W , causes armature 183 to engage spring switch 181, thereby connecting battery C through wire 184 to connecting relay X' . This current causes armature 183 to continue its movement, thereby removing spring switch 181 from contact 180 and removing from the circuit batteries C^2 and C^3 through interrupter W . Only the described connection of battery C causes the top armature switches of relay X' to engage their contacts, thereby establishing a circuit, the path for which is as follows: battery C^5 , D^2 , 185, 186, 187, 188, winding t^2 of relay T' , 189, 190, 191, 192, 193, 194, 2^b, 195, 196, 197, 1^b, 198, 199, 200, 201, 202 and to ground through 203. Another circuit is established in branch relation to the former, the path for which is as follows: generator A^2 , G^3 ,

204, 205, 206, 207, 208 and then proceeding through 189 over the path already traced. (Reference should be had to my aforementioned Patent No. 1,128,262 for a complete description of the functions of interrupters D^3 and G^3 and the full operation of the automatic ringing system, illustrated in the accompanying drawings.) The current from ringing generator A^2 flowing over this circuit actuates call bell 195 at substation AA and as the return path to ground is through winding 203 of the repeating coil, the calling party at substation A receives an audible signal through the telephone receiver thereat. Condenser 197 at substation AA does not allow a circuit to be closed through winding t^2 of calling supervisory relay T' , which is sufficient to energize the same when the brush of interrupter D^3 engages the metallic segments thereof.

(28) Interrupter D^3 may be connected as illustrated to a battery of lower voltage than battery C^4 , which furnishes the talking current to the substation, thereby preventing any slight tendency of relay T' to be partially energized due to the intermittent direct current flowing through the circuit including condenser 197. However, said interrupter can be connected to battery C^4 , if desired, as relay T' can readily be adjusted so as not to respond until condenser 197 is short circuited by a low resistance path when the receiver at substation B is removed from its switchhook.

(29) When the called party responds and the just mentioned low resistance path is formed, relay T' is actuated and a low resistance shunt is formed around ringing relay R^2 and lamp Y' from battery C over a path as follows: battery C, 184, 183, 181, armature switch and alternate contact of relay T' , winding t^3 of relay T' , winding g' of relay G^2 , completing the shunt. Due to the extremely low resistance shunt thus formed, relay R^2 is deenergized and when armature 170 disengages spring switch 171, the shunt is removed and the circuit opened through relay R^2 . As interrupted D^3 furnishes an intermittent current, the armature switch of relay T' might make and break its connection with its alternate contact and therefore the shunt circuit might be intermittently closed and opened. As this might need special adjustments of relay R^2 to obtain its de-energization when so shunted, the use of winding t^3 is preferred, as the energization of the same by the steady current from battery C, prevents the vibration of the former. However, I find that relays T' and R^2 can be so made and adjusted as to operate as desired without the use of winding t^3 .

(30) Connecting relay X' is not de-energized with ringing relay R^2 as a connection from spring switch 172 to contact 142 of calling plug P' was made when armature 183

of relay X' was fully attracted. Therefore, a circuit was closed over a path as follows: 172, 209, 210, 211, 212, and 213 to contact 142. Resistance 209 is such that when the shunt is formed, as described (paragraph 29), enough current still flows through resistance 209 and relay X' to maintain the latter actuated. The purpose of using resistances 182 and 209, is to prevent the forming of a low resistance shunt around other relays corresponding to other link connectors which may be connected to line jacks of the same line, as hereinafter described. The de-energization of relay R^2 , as described (paragraph 29), causes armature switch 206 to disengage contact 205 and engage contact 214 and thereby connect non-inductive resistance 208 by way of wire 215, to winding 216 of the repeating coil, as spring switch 187 engages its normal contact also, which is connected to said contact 214, winding t^2 of supervisory relay T' is connected to the live pole of battery C^4 over the same path, and as said contact is made before armature switch 186 disengages spring switch 187, the circuit is uninterrupted through said winding.

(31) Telephonic connection is now established between substations A and AA, and when either party desires disconnection from the other, it can be brought about independent of the other party, and the continued engagement of the link connector with jacks Q and R' . At the same time either party will be automatically restored to the control of their respective line signals, and their lines released so that other telephonic connections may be made thereto.

(32) When the receiver at substation A is replaced on its switchhook, the circuit for direct current through limbs 1 and 2 is opened, and winding t of answering supervisory relay T is consequently deenergized and a short circuit is formed around connecting relay X and supervisory lamp Y, thereby causing the deenergization of said relay. The actuation of relay X, when connection was made to the calling line, as described (paragraph 16), made a connection to contact 81 of answering plug P in branch relation to that made through wire 90, armature 86 and contact 91 of supervisory relay T. This connection was made over the following path: 81, 80, 217, 218, 219, 220 and 221. Therefore when said armature 86 disengages contact 91, relay X is not de-energized, but as soon as said armature engages its normal contact, lamp Y and relay X are short-circuited, said contact being connected by wire 222 to spring switch 89. As soon as spring switch 219 disengages its contacts, current ceases to flow over this path. Resistance 221 is inserted to prevent a corresponding short-circuit of other relays of other link connectors which may be connected to line jacks of the same line, as hereinafter de-

scribed. This means for deenergizing relay X is preferred, as in practice it will be found that supervisory relay T, being of a necessarily sensitive type, is apt to momentarily release armature 86 from contact 91 if said relay accidentally receives a jar or blow. As this might deenergize relay X if there were no other connecting means to contact 81 of plug P, and consequently disconnect the calling and called parties, I have illustrated and described the aforementioned means wherein armature 86 must not only disengage contact 91, but engage its normal contact before deenergizing relay X. When spring switch 219 of relay X disengages contacts 218 and 220, battery current is cut off from contact 81 of plug P, therefore, cut-off relay V is de-energized, restoring line relay B to the control of substation A. Current is prevented from again flowing through relay V, winding t of relay T, relay S and winding r of relay R², until calling plug P' is removed from jack R', as controlling relay U' remains actuated as long as said plug remains in said jack.

(33) If connecting relay X had been deenergized as described (paragraph 32), previous to the response of the called for party, the disengagement of armature 92 from contact 175 would have opened the circuit through winding r' of ringing relay R², and consequently would have de-energized the same, thereby cutting off the impression of ringing current upon call bell 195 of substation AA. If this had taken place, the engagement of spring switch 172 of relay R² with its normal contact would have formed a short-circuit around the winding of lamp Y² and connecting relay X', and, therefore, would also de-energize the latter. This short-circuit is formed over the following path: said normal contact, 224, 225, and the armature switch of relay T'. As soon as spring switch 211 disengages its contacts, current ceases to flow over this path. Battery current is thereby cut off from contact 142 of calling plug P', except the small amount allowed to pass through the two windings of relay U', which together form a very high resistance. Therefore, cut-off relay V' is de-energized, and line relay B' restored to the control of substation AA, as said relay V' cannot maintain itself actuated by the current allowed to pass through relay U'.

(34) When the called for party replaces the receiver at substation AA on its switch-hook after having responded to a call, winding t^2 of supervisory relay T' is consequently de-energized, and the armature switch falling back and engaging contact 225 de-energizes connecting relay X' in the same manner as described (paragraph 33).

(35) The disengagement of armature switches 105 and 115 of connecting relay X from contacts 106 and 114, and 202 and 191 of connecting relay X' from contacts 201 and 190 disconnects the link connector repeating coil from connection with the contacts of plugs P and P', all the talking and operating circuits of said link connector being thereby restored to their normal open condition, only one link connector circuit remains closed, namely, that through controlling relay U', which on account of controlling but one contact, may be of an extremely sensitive type, allowing the combined windings to be of an extremely high resistance. In fact the resistance may be such that if several "idle" link connectors are allowed to remain connected to different multiple jacks associated with the same line, the multiplied resistances of all the relays U', will not be sufficiently low to allow relay V' to remain actuated, when the party at a substation connected to said line has replaced its receiver upon its switch hook.

(36) The automatic means by which telephonic connection to a busy line is absolutely prevented, and the means whereby an operator or a calling party can so "wait" on a busy line that a telephonic connection will be established only when the line becomes "idle," will now be described. When connecting relay X of the link connector (referred to hereinafter as link connector one) is actuated as described (paragraph 16), a connection was made that has heretofore not been described. This connection is that of interrupter H² to spring switch 219, by way of wire 226, and thence by way of contact 218 and wire 217 to contact 81 of answering plug P. Therefore, whenever the brush of interrupter H² engages its metallic segment, current flows from batteries C² and C³ directly to ground, through contact 82 of jack Q, 83 U, 84, 85 and cut-off relay V. Now, if a plug P of another link connector (referred to hereinafter as link connector two), is inserted in a multiple jack, such as R, lamp Y and connecting relay X (which are normally connected to the same batteries through spring switch 89, contact 88, wire 87 and interrupter W) will be short-circuited, as the respective brushes of interrupters W and H² engage their metallic segments at precisely the same time and all the current allowed to pass from ground through relays V and U to batteries C² and C³, naturally follows the direct path of practically no resistance offered by wire 217. Therefore, relay X of link connector two is not partially energized, and armature 92 cannot be attracted as long as relay X of link connector one remains energized.

(37) When connecting relay X' actuated, as described (paragraph 21), a connection was made that has heretofore not been described. This connection is that of interrupter I² by way of 227, 228, 229, 230, 211, 130

212 and 213 to contact 142 of calling plug P'. Therefore, whenever the brush of interrupter I² engages its metallic segment, current flows from batteries C² and C³ directly to ground through contact 143 of multiple jack R' and cut-off relay V'. Now if answering plug P of link connector two is inserted in a line jack, such as Q' or R', connecting relay X of said link connector will also be short circuited, and not energized, as described (paragraph 36), as the brush of interrupter I² engages its metallic segment precisely at the same time as interrupters H² and W. When ringing relay R² is de-energized, as described (paragraph 29), then spring switch 229 of said relay is disconnected from armature 228 after first having been connected to contact 231 which by way of wire 232 is connected to interrupter H². Therefore, a connection to a busy line by way of an answering plug P is positively prevented, regardless of whether the busy line is a calling or called for line, as the connection to limbs 1 and 2 of the line is open at armature switches 105 and 115 of relay X. There is no marginal action of a relay or resistance of a divided circuit, used to obtain this result. This feature is the specific difference in relation to this function between the present application and my afore-mentioned Patent No. 1,128,262.

(38) Should operating conditions require an operator to be notified as soon as a busy line becomes idle, the means as described (paragraphs 36 and 37), allow an operator to insert an answering plug P into a line jack of a busy line, and to proceed with other duties, for as soon as the busy line becomes idle, the disengagement of spring switch 219 from contact 218 of connecting relay X or spring switch 211 from contact 212 of relay X' of link connector one removes the short-circuit, as described (paragraph 36), and connecting relay X of link connector two would at once actuate. Therefore, supervisory lamp Y would be illuminated, indicating to the operator that the line was idle, and said actuation of relay X would prevent a telephonic connection from being made to the same line.

(39) If a calling plug P' is inserted in a line jack of a busy line, connecting relay X' of the link connector two will be short-circuited, and therefore rendered inoperative in the same manner as described in relation to an answering plug P (paragraphs 36 and 37), inasmuch as contact 180 of said relay is connected by wire 179 to interrupter W as is contact 88 of connecting relay X. Therefore, a telephonic connection to a busy line by means of a calling plug P' is positively prevented, regardless of whether the busy line is the calling or called for line, as the connection to limbs 1^b and 2^b of the called

for line is open at armature switches 191 and 202 of relay X'.

(40) It has been mentioned that one of the objects of the present invention is to eliminate the usual busy tests made by the operator on a called for line. Said tests are a necessary adjunct of the telephone exchange connecting means heretofore used, as if not used much confusion would arise if a calling party was telephonically connected to a line upon which a conversation was taking place, also secrecy between conversing substations would be impossible. The means used in the present invention as described (paragraphs 36, 37, 38 and 39), eliminate the possibility of such confusion or such lack of secrecy. Therefore, the operator may connect directly to a called for line without previously testing the same. However, some means should be provided for notifying the calling party that the called for line is busy, and this has been arranged for in the present invention in such a way that the calling party receives an audible signal in the telephone receiver at substation A, provided an operator connects to a called for line which is being rung upon, or receives an audible signal, distinct in character from the ringing signal, if the called for line is being used for conversational purposes. When the calling party hears either of said signals, he may either replace his receiver, thereby releasing his line, as described (paragraph 32), or may refrain from so doing, and "wait" for the called for line to be released, as described (paragraphs 32, 33 and 34), whereupon the "waiting" party will be automatically telephonically connected to the line waited upon and the call bell at a substation of the latter will be rung.

(41) Assuming that a called for line has either a plug P' or P' of a link connector one inserted in a line jack, associated with that line, and that the connecting relay X or X' has not been de-energized, then when calling plug P' of link connector two is inserted in a corresponding line jack, connecting relay X' will not actuate, as described (paragraph 39). As the connection to limbs 1^b and 2^b of the called for line is open at armature switches 191 and 202, and contacts 190 and 201, of relay X', no telephonic connection is made with said line. However, ringing relay R² will actuate as the same is not dependent on batteries C² and C³ through one of the interrupters for its actuating current, but receives the same direct from battery C, as described (paragraph 27). Relay U' is also actuated, as its actuating current emanates from interrupter S', as described (paragraph 21), which interrupter, notwithstanding its connection to batteries C² and C³, engages its brush at a different time interval from that in which

interrupters H^2 , W and I^2 engage their respective brushes. Therefore relay U' of link connector two is not short-circuited, as is relay X' of the same. The actuation of relay U' controls the removal of the operator's telephone set from connection with link connector two, and said operator has nothing else to do with the connection. However, the non-actuation of relay X' of link connector two, allows a small part of the current which flows from contact 142 of calling plug P' of link connector one through contact 82 or 143 of line jack Q or R' to be shunted from the path of ground through relays U and V or V' , to ground over the following path: Said contact 82 or 143, corresponding contact of line jack in which calling plug P' of link connector two is inserted, contact 142 of same, 141, 171, 174, 233, 234, 235, 236, 202 and to ground through 203. Resistance 234 is preferably in inductive relation with the link connector repeating coil, as shown. Its purpose is to increase the resistance of the described shunt circuit, so that enough current is not taken from cut-off relay V' to de-energize the same. However, said resistance is not absolutely essential. As the current impressed on contact 82 or 143 through link connector one is of a fluctuating character, due to the intermittent current from interrupters H^2 , W or I^2 , as described (paragraphs 36 and 37), this fluctuating current flowing in the described shunt circuit, induces a corresponding alternating current in windings 168 and 169 of the link connector repeating coil, which is heard as an audible signal in the receiver at substation A . If the "busy" line is being used for conversational purposes, the audible signal will be characteristic to interrupter H^2 . If the line is being rung upon, the audible signal will be characteristic to interrupters I^2 and J^2 . As the latter has more metallic segments than interrupter H^2 , the fluctuations of current are, therefore, more rapid, and the audible signal produced of a different character from that produced by interrupter H^2 . The number of metallic segments of interrupter J^2 , is purely arbitrary, as many may be used as desired, it being readily understood that the more metallic segments said interrupter contains, the greater the difference will be between the two audible signals. As the purpose of interrupter J^2 is to furnish the "ringing" busy signal only, it may be connected, as illustrated, to battery C^3 , or it may be connected to batteries C^2 and C^3 , like interrupter I^2 . The purpose in connecting interrupter J^2 , as illustrated, is to effect an economy in current consumption.

(42) On hearing the busy signal, if the calling party elects to "wait", then as soon as connecting relay X or X' , as the case may be, of link connector one is released, as described (paragraphs 32, 33 and 34), the short-

circuit around connecting relay X' of link connector two is removed and the same at once actuates, completing the telephonic connection to the formerly busy line. The disengagement of armature switch 202 of relay X' from contact 236, opens the audible busy signal circuit, and the cessation of the same and the substitution of the ringing audible signal, as described (paragraph 28), is the "waiting" party's assurance that the waited upon line has been released, and that a telephonic connection has been made thereto.

(43) When a "waiting" connection is made to a busy line, as described (paragraph 41), a circuit is established which has not yet been described, the path for the same being as follows: Batteries C^2 and C^3 , interrupter P^2 , 237, 238, 239, 240, 241, 242, 173, 171, 139, 141, 142, 143 and to ground through cut-off relay V' . Therefore, when a "waiting" connection has been established to a busy line by a link connector two, should another calling plug P' of another link connector (referred to hereinafter as link connector three) be inserted in a line jack of the same line, not only will connecting relay X' of the same be prevented from actuating, but controlling relay U' , as well as the latter, will be short-circuited when the connection is made, inasmuch as interrupters S' and P^2 engage their respective brushes precisely at the same time interval. The action being similar to that described (paragraphs 36, 37 and 39) in relation to interrupters H^2 and W . As the actuation of said relay U' is necessary to obtain the de-energization of relay S , and as the operator's telephone set is not disconnected from the calling substation until said relay is de-energized, the lack of the "click" in operator's receiver H , which indicates said disconnection, informs the operator that there is a party already waiting upon the called for line. Therefore, the operator can so inform the calling party, and either make a connection by means of calling plug P' of link connector three to another line, or take down the connection, according to the wishes of the calling party.

(44) Instead of the negative "waiting" busy signal for the operator, as described (paragraph 43), supplied by the lack of a "click," a positive audible signal can be produced in operator's receiver H when a link connector three is connected to a busy line. The circuit for this signal is in branch relation to the audible busy signal circuit, as described (paragraph 41), and is over the following path: From wire 235 over wires as indicated by the dotted lines connected to the left contact of armature switch 117 of relay S , 117, 118, 119, 120, 121, A' , 122 and to ground through 123. Therefore, the fluctuating current allowed to pass through

- resistance 234, has two paths to ground, one through winding 203 of the link connector repeating coil, and the other through winding 123 of operator's repeating coil I.
- Therefore, both the operator and the subscriber would receive the audible busy signal, and the operator would thereupon remove plug P' of link connector three from the line jack of the busy line, and could not only inform the calling party that another party was waiting upon said line, but could state whether the called for party had answered or not, as the audible signal would be either the "ringing" or "talking" one.
- (45) Just as soon as relay X or relay X' of link connector one is released, then relay X' of the "waiting" link connector two is energized, thereby disengaging armature switch 242 from contact 241, which opens the direct connection to interrupter P². Therefore, another "waiting" connection can be made to the same line, as the former link connector two has now become a link connector one, and relay U' will not be short-circuited when connection is made to the busy line. Also ringing current will again be impressed upon the waited for line, as described (paragraph 27).
- (46) Notwithstanding the fact that no busy test is necessary before connecting to a called for line, should the same nevertheless be desired, then a connection from tip contact 199 of calling plug P', through wire 200, may be made as indicated by the dotted line which connects wire 200 to the same contact of armature switch 117 of relay S which produces the "waiting" busy signal, and a path to ground through winding 123 of operator's repeating coil I, may thereby be provided, as described (paragraph 44). Therefore the fluctuating current from the tested contact 143 line jack R', as described (paragraph 41), would follow this path and provide the required busy test.
- (47) Answering supervisory signal or lamp Y, on account of being in series with connecting relay X, is energized as long as the calling party's receiver is off its switch-hook. Therefore, the de-energization of the same is the operator's signal that answering plug P may be removed, though it is not necessary to do so until the operator can conveniently attend to it. "Waiting" signal or lamp Y', on account of being in series with relay R², is energized whenever the calling party is waiting upon a busy line, indicating that condition to the operator. When relay X', is also energized, then signal or lamp Y² is also energized. Therefore, the energization of both Y' and Y² indicates to the operator that the called for line is being rung upon. When the called party responds, Y' is de-energized by the de-energization of ringing relay R². Therefore, the energization of Y² alone, indicates to the operator that the called for line has responded. When the called for party replaces the receiver, relay X' is de-energized, and consequently Y² also. The de-energization of Y, Y' and Y², indicating to the operator that both plugs P and P' may be removed. It will, therefore, be seen that the operator is fully advised of the various operating conditions of the link connector, and if desired, can remove plug P' and inform the calling party that there is no response from the line being rung upon, or that the line being waited upon is still busy, as the case may be; provided the signals are displayed for an inordinate length of time. The operator can do this without removing answering plug P from the answering jack of the calling line, inasmuch as relay U' is de-energized as soon as calling plug P' is removed from line jack R' and consequently relay S energized, connecting the operator's set to the calling line.
- (48) When connecting relay X actuates, armature switch 243 engages contact 244, which is connected by line 245 to contact 246, corresponding to relay X of the next link connector at the central operator's position. Armature switch 247 is connected to the contact corresponding to 246 of relay X of the next link connector, and the armature switch of the same corresponding to 247 connected similarly to the next contact. All the corresponding contacts and armature switches of the connecting relays X of all the link connectors at a position are similarly connected, the same being represented by dotted line 248. However, armature switch 250 of relay X of the last link connector is connected by wire 251 to relay Z, and as armature switch 243 of relay X of the first link connector is connected by wires 252, and 94 to battery C⁴, when said armature switch engages contact 244, 247 engages 246, 250 engages 249, and all the intermediate ones engage their respective contacts, battery current is impressed on relays Z, N, O and M, and the audible line pilot signals transferred, as described (paragraph 16). As the described connection to battery C⁴ takes place only when all the link connectors at a position are in active use, it will be seen that in such event no audible line pilot signal will be sounded in operator's receiver H, but said signals will be transferred to the adjacent positions. However, it will be readily seen that armature switch 243 and contact 244 of relay X can be done away with, should such a function not be desired.
- (49) F⁴ is a subscriber's service meter which is actuated only after the called for substation has responded to its calling signal. When calling supervisory relay T' is actuated, as described (paragraph 29), a circuit was traced through relay G². The con-

sequent actuation of this relay establishes a circuit over the following path: battery C⁶, 253, 254, 255, g², 256, 80, 81, 82, 257, F⁴, 258, 259, 260, and 261, to the other pole of battery C⁶. Service meter relay U was actuated, as described (paragraph 16), therefore the current thus allowed to flow through winding g² of relay G², maintains the same actuated after current ceases to flow through winding g¹ of the same. Service meter F⁴ is also actuated by the same current and after its recording mechanism 258 has once operated, the same engages spring switch 85, and then removes the latter from contact 84, thereby opening the circuit through service meter relay U. Armature 259 thereupon disengages contact 260, thereby opening the circuit through battery C⁶. Relay G² is consequently de-energized, and armature 254 disengages contact 255. The path for the circuit through cut-off relay V to ground, which was formerly by way of 85, 84, U and 83 to contact 82 of answering jack Q, is now by way of 85, 258, F⁴ and 257 to said contact 82, and as this latter path was established before the former was opened, the continued actuation of cut-off relay V is not disturbed. It will readily be seen that the circuit through battery C⁶ is only closed for a very brief interval, namely, that necessary for the recording mechanism 258 of service meter F⁴ to actuate. Said battery is of a preferably lower voltage than battery C. Reference should be had to my U. S. Patent No. 1,147,347, for a full description of this service meter system, as the same is only described herein in reference to the slight modifications made necessary by the use of the intermittent direct currents through the interrupters associated with the connecting relays. It will readily be understood that if service meter F⁴ is not used, the connection from contact 82 of answering jack Q to cut-off relay V, would be the same as that from contact 143 of answering jack Q' to cut-off relay V', and that relay G² would be eliminated.

(50) Reference is now made to Figure 2, in which the principal difference between the same and Figure 1 is that two parties may wait upon a busy line, being telephonically connected thereto, successively, in the same order in which connection was established to the line jacks of the busy line. By extending the means illustrated in Figure 2, and described hereinafter, and without departing from the principles involved, it will be evident that as many parties can be allowed to wait upon a busy line as may be desired, and that said parties will always be telephonically connected to the busy line successively in the same order as that in which connection was established thereto. An extra relay such as connecting relay X⁴ for each extra party it is desired to allow

to "wait," is all that would have to be added to the link connector circuit illustrated in Figure 2. Some of the relay connections shown are different from those illustrated in Figure 1, being alternative forms which may or may not be used. It is understood that different combinations may be effected by combining some parts illustrated in Figure 1 with some of those illustrated in Figure 2 and the other figures. Only those parts which vary from those described in relation to Figure 1 will be described, it being understood that those parts, shown but not described, function the same as similar parts in Figure 1.

(51) Relay S² combines the functions of relay S and controlling relay U' in Figure 1. When answering plug P² is inserted in an answering jack, the circuit through winding t⁴ of answering supervisory relay T² proceeds directly to battery C⁷ by way of 263, 264, 265, 266 and 267. The consequent actuation of relay T², actuates connecting relay X² in a similar way to that described (paragraph 16). However, it will be noted that armature 268 of relay X² is connected by way of 269 and 270 to battery C⁸, as are interrupters W² and H³, instead of to a separate battery such as C in Figure 1. The full actuation only of relay X² causes armature switches 273, 281 and 296 of the same to engage their respective contacts, thereby establishing a circuit from operator's induction coil I, over wires 118 and 101 in Figure 1, corresponding wires 118 and 101 in Figure 2, and then over the following path: 101, 271, 272, 273, 274, 275 and winding t⁵ in multiple, 276, 277, answering jack springs and substation apparatus, 278, 279, 280, 281, 282, 283, 284, 285 and 286 to line 118. Relay A' actuates, as described (paragraph 16), and the operator's telephone set is connected thereby to the calling substation by way of wires 118 and 101. The dotted line from armature 281 of relay X², and the contact connected thereto of spring switch 285 of relay S², represents a connection that may be used if it is wished to overcome the impedance to the voice currents offered by winding 283 of the repeating coil. When calling plug P³ is inserted in a multiple jack, a circuit is established, the path for which is as follows: battery C⁷ S³, 287, 288, 290, s', 291, 292, and to ground through the cut-off relay of the called for line. The intermittent current from interrupter S³ causes armature 293 to engage spring switch 289, and as said armature is connected direct to battery C⁷ by wire 267, said armature continues its movement and removes spring switch 289 from contact 288, thereby eliminating interrupter S³ from the circuit. Spring switch 264 is disengaged from contact 265, thereby opening the circuit through winding t⁴ of relay T². The

engagement of armature switch 306 with spring switch 272 first makes a connection from the same by way of wire 307 to winding 308 of the link connector repeating coil, and then removes 272 from engagement with contact 271. The engagement of armature switch 309 with spring switch 285, first makes a connection from the same by way of wires 310 and 311 to ground, and then removes 285 from engagement with contact 286. Therefore, the calling substation line is disconnected from the operator's repeating coil, and connected to that of the link connector. It will be readily understood that the means for making the connection to the link connector repeating coil may be as illustrated in Figure 1. As relay S^2 remains actuated as long as calling plug P^3 remains inserted in a link jack, the described circuit changes are maintained for that period.

(52) Another circuit is simultaneously established with that first described (paragraph 51), the path for which is as follows: Battery C^7 , 294, y^4 , 295, 296, 297, 298, r^2 , 299, 300, 301, and thence to ground, over the same path as traced from the upper terminal of winding s' of relay S^2 . Ringing relay R^3 is actuated, and armature 302 engaging the contact connected to wire 299, establishes another path to ground from said wire, as follows: 302, 303, 304, 305 and 292 to ground, through the cut-off relay. As armature 302 engages said contact before armature 301 of relay S^2 disengages contact 300, the circuit through relay R^3 is maintained. In order to evade any possibility of relay S^2 actuating previous to said engagement of armature 302, and at the same time allow winding s' to be of as high a resistance as that of relay U' in Figure 1, inasmuch as it remains in circuit after the parties have replaced their receivers as does said relay U' , a connection may be made to said winding s' , as indicated by the dotted line connected to the second contact of armature 302 of relay R^3 . The complete winding s' is then such that relay S^2 is not actuated until the upper portion is short-circuited when armature 302 engages said contact.

(53) The engagement of armature 302 of ringing relay R^3 , with the contact connected to the upper terminal of winding x^5 of relay X^3 , establishes a ground connection through the same, which continues by way of 312, 313, 314, 315 and interrupter W^2 to battery C^8 . Consequently, armature 316, which is connected to the same battery by way of 317, 318, Y^5 , 319 and 320, engages its spring switch, establishing a circuit, the path for which continues by way of winding x^6 , 321, 322 and 292 to ground. Therefore, relay X^3 is fully actuated.

(54) Another circuit is established with that described (paragraph 53) when arma-

ture 302 of relay R^3 engages the contact connected to the upper terminal of winding x^7 of relay X^4 , a ground connection through same being thereby made which continues by way of 323, 324, 325, 326 to battery C^8 through interrupter U^2 and 320. Consequently, armature 327 (which is connected to the same battery by way of 328, 318, Y^5 , 319 and 320) engaging its spring switch, establishes a circuit, the path for which continues by way of winding x^8 , 321, 322 and 292 to ground. Therefore, relay X^4 is fully actuated.

(55) Armature switches 329 and 330 of relay X^3 correspond in function to armature switches 202 and 191 of relay X' in Figure 1. However, their respective contacts 331 and 332, are connected to armature switches 333 and 334 of relay X^4 which must engage their respective contacts 335 and 336, before the connection is made to contacts 337 and 338 of calling plug P^3 . Therefore, both relays X^3 and X^4 must be actuated before a telephonic connection can be made to the called for line.

(56) When the called party responds, calling supervisory relay T^3 is actuated, as described (paragraph 29), and armature 305 disengaging contact 304, opens the circuit through ringing relay R^3 by way of 303 and 302. Therefore, said relay is de-energized and changes the circuit connections from the called for line from the ringing generator to the repeating coil, as described (paragraph 30). Connecting relays X^3 and X^4 are not deenergized as the connections from windings x^6 and x^8 to ground are through wires 321 and 322, direct to contact 292 of calling plug P^3 . Therefore, telephonic connection is now established between the calling and called for substations. When the receiver at substation A is replaced and answering supervisory relay T^2 is consequently de-energized, connecting relay X^2 is short-circuited and de-energized, when armature 339 of relay T^2 engages contact 340, inasmuch as wire 341 connects lamp Y^3 , by way of 340, 339, 342, 343, 344, 345, 346 and 347, directly to ground, through contact 348 of answering plug P^2 and the cut-off relay. Relay X^2 differs from connecting relay X in Figure 1, in this particular, inasmuch as lamp Y^3 acts as a substitute for resistance 221 of the latter. If relay X^2 had been de-energized previous to the response of the called for party, the dis-engagement of armature 296 from contact 297 would have opened the circuit through winding r^2 of ringing relay R^3 , and the relay would be de-energized, thereby cutting off the impression of ringing current upon the line of the called for substation. If this had taken place, the engagement of armature 302 with contact 349 would have short-circuited windings x^6 and x^8 of relays X^3 and X^4 , inas-

much as the battery current through lamp Y^5 would have had a direct path to ground through the cut-off relay by way of armature switch 316 of relay X^3 , and its left hand contact and armature switch 327 of a relay X^4 and its spring switch contact in branch relation thereto, wire 350, 349, 302, 303, 304, 305 and 292. Current ceases to flow over this path as soon as armatures 316 and 327 disengage their contacts. Supervisory lamp Y^5 , when connected as shown, takes the place of resistances 182 and 209 in Figure 1.

(57) When the called for party replaces the receiver, after having responded to a call, and relay T^3 is consequently de-energized, inasmuch as ringing relay R^3 is already de-energized, connecting relays X^3 and X^4 are de-energized, as described (paragraph 56). Therefore, the link connector is restored to its normal condition, as described (paragraph 35). Relay S^2 , which, as hereinbefore mentioned, combines the functions of relays S and U' in Figure 1, is the only relay which remains actuated after both parties have replaced their respective receivers. As described (paragraph 52), the upper part of winding s' may be of so high a resistance that it prevents the actuation of the relay until it has been short-circuited, nevertheless, having once actuated, said relay will remain actuated after said short-circuit is removed when relay R^3 is de-energized.

(58) The functional differences between Figures 1 and 2, in relation to the descriptive matter contained in paragraphs 36 and 37 will now be described. The current from interrupter H^3 , (corresponding to H^2 in Figure 1) passes by way of 351 through the upper winding of relay X^2 and wire 352 to spring switch 345 (corresponding to 219 in Figure 1). In Figure 1 the interrupters are connected to batteries C^2 and C^3 , while the windings of the connecting relays are connected to battery C , therefore said interrupters do not short-circuit said windings. As the form used in Figure 2 is intended to do away with the necessity of two batteries, some means must be used to maintain the relays actuated when the metallic segments of the interrupters engage their respective brushes. Therefore, the upper windings of relays X^2 and X^4 , and the lower windings of relays S^2 , R^3 and X^3 are of an extremely low resistance, thereby forming a low resistance shunt, which is practically the same as the short-circuit, as described (paragraph 36), yet at the same time they are such that the relays are maintained actuated when their other higher resistance windings are thereby practically short-circuited. As relays S^2 and R^3 are connected to battery C^7 , interrupters P^3 and S^3 (corresponding to P^2 and S' in Figure 1) are also connected thereto. Interrupters I^3 and J^3 correspond

to interrupters I^2 and J^2 in Figure 1, but the circuit from the same, by way of wire 353, through armature 354 and spring switch 355 of ringing relay R^3 , (corresponding to 228 and 229 of relay R in Figure 1) is through the lower winding of relay X^3 , 356, 357, 358, 359, upper winding of relay X^4 and 322 to contact 292. Therefore, said relays are not de-energized when virtually short-circuited by the current from said interrupters, yet their low resistance windings practically provides the short-circuit, as described (paragraph 37). In Figure 2, interrupters I^3 and J^3 are shown connected to the one battery, it being understood that the form shown in Figure 1 may be used.

(59) If a calling plug P^3 is inserted in a line jack of a busy line, connecting relay X^3 (corresponding to connecting relay X' in Figure 1) of the link connector two will be virtually short-circuited, as described (paragraph 39), inasmuch as contact 314 of said relay (corresponding to 180 of relay X' in Figure 1) is connected by wire 315 to interrupter W^2 . However, relay X^4 is actuated as winding x^7 , which is connected to interrupter U^2 , which engages its brush at a different time interval from the other interrupters, is not virtually short-circuited by the corresponding interrupter V^2 , a connection from said interrupter, by way of 360, 361, 362, 363 and 364, being broken when spring switch 358 of relay X^3 of link connector one disengaged contact 364. As the connection to the limbs of the called for line is open at contacts 331 and 332 of relay X^3 , no telephonic connections is made to said line.

(60) Assuming that a called for line has either a plug P^2 or P^3 of a link connector one inserted in a line jack associated with that line, and that relay X^2 or relays X^3 and X^4 have not been de-energized, then the action that takes place is similar to that described (paragraph 41). When calling plug P^3 of link connector two is inserted in a corresponding line jack, relay X^3 does not actuate, but relay X^4 does, as described (paragraph 59). However, ringing relay R^3 (corresponding to R^2 in Figure 1) actuates as the same is dependent on current direct from battery C^7 . Relay S^2 also actuates, as the same is not short-circuited. The actuation of relay S^2 removes the operator's telephone set from connection to the calling line. The subscriber's busy signal when a connection is made to a busy line operates similarly to the one described (paragraph 41). However, in Figure 2, resistance 365 (corresponding to 234 in Figure 1) is shown as not being in inductive relation to the windings of the repeating coil, as such relation may or may not be used.

(61) The calling party may "wait" upon the busy line, as described (paragraph 42).

Relay X^3 actuating as does relay X' in Figure 1.

(62) When a "waiting" connection is made to a busy line, as described (paragraph 60), the action that takes place differs from that described (paragraph 43). The actuation of relay X^4 and the non-actuation of relay X^3 establishes a circuit over the following path: battery C^3 , interrupter V^2 360, 361, 362, 363, 364, 358, 359, upper winding of X^4 , 322, and contact 292 to ground through the cut-off relay. The intermittent current traversing this upper winding prevents the de-energization of relay X^4 when its winding x^8 is thus virtually short-circuited by interrupter V^2 . However, if a calling plug P^3 of a link connector three is inserted in a line jack of the same line, not only will relay X^3 of the same be short-circuited, but relay X^4 also, as winding x^7 of the latter is connected by way of 323, 324, 325 and 326 to interrupter U^2 . However, relays R^3 and S^2 of the link connector three would be actuated, as described (paragraph 60). The non-actuation of relay X^4 establishes a circuit over a path, as follows: battery C^7 , interrupter P^3 , spring-switch connected thereto and its contact, lower windings of relays S^2 and R^3 , 366, 367, 368, 369, and the contact of relay R^3 connected thereto, 302, 303, 304, 305 and 292 to ground through the cut-off relay. The intermittent current flowing in this circuit through the lower windings of relays S^2 and R^3 prevents them from being short-circuited, but at the same time it prevents another relay S^2 of another link connector from being energized.

(63) Assuming the line to be in the described condition, with a link connector one, typifying a telephonic connection; a link connector two, typifying a "waiting" connection, and a link connector three typifying a "second waiting" connection, all connected thereto, then should a calling plug P^3 of still another link connector be inserted in a jack of the same line, not only will relays X^3 and X^4 of the same be prevented from actuating, but relay S^2 will also not actuate, due to the virtual short-circuit traced in the last part of the preceding paragraph. As the intermittent direct current flowing through resistance 365, as described (paragraph 60) proceeds by way of armature switch 329 of relay R^3 , repeating coil winding 370, 284, 285, 286, and line 118 to ground through the operator's repeating coil, the operator hearing the busy signal would know that there were two parties already waiting on the called for line, and would therefore withdraw plug P^3 from the line jack, and notify the calling party.

(64) Assuming the line to still be in the condition, as described (paragraph 62), then when relay X^2 or relays X^3 and X^4 of link connector one are deenergized, the vir-

tual short-circuit, as described (paragraph 59); around winding x^5 of relay X^3 of link connector two is removed, and therefore, the same at once actuates. Link connector two then becomes a link connector one, and the waited for substation call bell is rung again, as described (paragraph 27). Relay X^4 of link connector three thereupon actuates, as the virtual short-circuit around its winding x^7 , as described (paragraph 62), is removed when spring switch 358 of relay X^3 , of former link connector two, disengaged contact 364. Therefore, link connector three now becomes a link connector two, and will become, in turn, a link connector one, when the latter is released. When armature switch 367 of relay X^4 of former link connector three disengaged contact 368, the virtual short-circuit, as described (paragraph 63), is removed. Therefore, a link connector three may now be connected to the line in question.

(65) Though the connection of supervisory lamps or signals Y^3 , Y^4 and Y^5 , is different from the corresponding lamps Y , Y' and Y^2 , in Figure 1, as described (paragraph 47), their function is similar. As Y^5 is connected to ground through the cut-off relay by way of windings x^6 of relay X^3 and x^8 of relay X^4 in multiple relation to each other, said lamp will burn brighter when both of said relays have actuated than it will when only one has actuated, as the circuit resistance is thereby lowered. Therefore, an operator can tell whether a link connector is in a "waiting" or a "second waiting" condition. It will be readily understood that two lamps might be used, each in series with the respective armatures 316 and 327 of said relays. Connected as illustrated, the supervisory lamps act as a substitute for resistances 182, 209 and 221, in Figure 1, and described (paragraphs 30 and 32).

(66) If an operator's busy test is required, a connection is made from contact 338 of calling plug P^3 , as indicated by dotted line 177, thereby allowing the fluctuating currents from a tested busy jack to flow to ground through the operator's repeating coil, as described (paragraph 46).

(67) Reference is now made to Figure 3, which represents a link connector which may be used in those exchanges where all incoming calls are trunked to other operators. The insertion of answering plug P^4 in a line jack of the calling line, establishes a circuit over the following path: battery C^9 , 371, 372, S^4 , 373, 374, 375, winding t^6 of relay T^4 , 376, 377, 378, Y^6 , 379, 380, 381 and contact 382 to ground through the cut-off relay. The intermittent current thus allowed to pass through winding t^6 causes armature 381 of answering supervisory relay T^4 to disengage contact 380, thereby

opening the circuit through wire 379. However, a path for said current is still furnished through the winding of connecting relay X^5 and wire 383 to contact 382.

Therefore, said relay is actuated as soon as the short-circuit through 380 and 381 is removed. The intermittent direct current from interrupter S^4 causes armature 384, connected direct to battery C^0 through wires 385 and 371, to first engage spring switch 378 and then to remove the same from contact 377, thereby excluding winding t^6 of relay T^4 and interrupter S^4 from the circuit and substituting steady current for the intermittent. However, previous to said disengagement of 378 from 377, armature 384 also engages contact 386 and armature 387 engages contact 388. Therefore, a circuit is closed through winding t^7 of relay T^4 , which maintains the same actuated. The path for this circuit is as follows: battery C^0 , 371, 385, 384, 386, 389, winding t^7 and 390 in multiple, 391, engaged jack springs, substation line and apparatus, 392, 393, 394, 388 and to ground through 387. Relay L^5 is the same relay as shown at L in Figure 1. The only changes in the circuit connections of the same being those shown, it being understood that the other parts of said relay are as shown in said Figure 1. Therefore, the described actuation of connecting relay X^5 also closes a circuit over the following path: battery C^0 , 371, 385, 384, 395, 396, 397, 398, 399, 400, 401, 402, 403, H^4 , A' ; 120 and 119, representing similar references in Figure 1; 404, 405, 406, 407, 408, 409 and to ground through 387. The consequent actuation of relay A' causes armature 126 to engage contact 127, and close the same circuit controlling the audible line pilot signals, as described in relation to corresponding references in Figure 1. As operator's receiver H^4 is in circuit with windings 396 and 408 of the repeating coil, conversation can take place between the operator and the calling party, who is connected to the corresponding windings 389 and 394 of said repeating coil. The primary associated with secondary 403 and the operator's transmitter are not shown in Figure 3, the same being well known in the art, and are as illustrated in Figure 6. The winding of relay A' when used as shown in Figure 3, is preferably of an extremely high resistance, so that but little direct current can flow through receiver H^4 ; thereby avoiding the disagreeable click which is apt to be sounded therein when a large amount of direct current traverses the same. Condenser a' , which shunts said relay, allows the voice currents to pass around said winding.

(68) The means whereby the operator communicates with the trunking operator, known in the art as the B operator, and referred to herein as such, is not described, as the same forms no part of the present invention. When the connecting operator, known in the art as the A operator, and referred to herein as such, inserts calling plug P^5 in a trunk jack, a connection is made between contact 410 and ground. Therefore, a circuit is established over the following path: battery C^0 , 371, 373, S^4 , 411, 412, 413, X^6 , 414, winding u' of relay U^3 , 415, 416, 417, 418, 419, 420 and to ground through contact 410. The intermittent current flowing through connecting relay X^6 from interrupter S^4 , causes armature 421, connected direct to battery C^0 by way of wires 372 and 371, to first engage spring switch 413, and thereafter disengage the same from spring switch 412, substituting thereby direct current for the intermittent current. Due to the actuation of relay X^6 , armature switches 398 and 406 disengage contacts 399 and 405, and engage contacts 422 and 423, thereby disconnecting the operator's telephone set from the calling line, and connecting the latter through the repeating coil to the trunk line. Controlling relay U^3 is also actuated, when plug P^5 is inserted in the trunk jack, by the current flowing through winding u' , which is of a very low resistance.

(69) When the party at the calling substation replaces the receiver, answering supervisory relay T^4 becomes de-energized as current ceases to flow in winding t^7 . The engagement of armature 381 with contact 380 establishes a short-circuit around relay X^5 by way of wires 379 and 383, thereby de-energizing said relay. Current ceases to flow to ground through contact 382 of answering plug P^4 and the cut-off relay, when armature 384 disengaging spring switch 378, as the circuit through contact 377, winding t^6 and contact 374, is opened by the attraction of armature 373, when relay U^3 is actuated. Therefore, the cut-off relay is restored to normal, and the line relay restored to the control of the substation apparatus. Armature switches 387 and 384 disengaging their respective contacts, open the circuits through all the repeating coil windings, thereby disconnecting the connected lines from each other, armature switch 417 disengaging contact 416 opens the circuit through connecting relay X^6 to contact 410 of plug P^5 , thereby de-energizing said relay. Relay U^3 remains energized as long as plug P^5 remains in the trunk jack, as current flows through winding u^2 , which is of a high resistance over the following path: battery C^0 , 371, 372, u^2 , 419, 420 and contact 410 to ground. If a cut-off relay is used to form the ground connection at the trunk jack, the same does not remain actuated by the current flowing in this circuit.

(70) The means by which a connection is prevented from being made to a busy line is similar to the same means as already de-

scribed, with the difference that the connecting relays X^5 and X^6 show another variation in respect to their windings, and but one interrupter for furnishing the intermittent current is used. It will be evident that the means used in the connecting relays in Figures 1 and 2 would be applicable to Figure 3, as the means used in the latter would be applicable to the former. When relay X^5 actuates, spring switch 424 engages contact 425, which is connected by wire 426 to a point in the winding of relay X^5 . The resistance between said point and wire 383 is very low, but is sufficient to maintain the relay actuated, notwithstanding it forms a low resistance shunt or virtual short-circuit for the lower part of the winding or for the entire winding of another relay X^5 of another link connector. As spring switch 424 is connected to interrupter S^4 , a connection to a busy line is prevented in the same manner as has been described in reference to Figures 1 and 2.

(71) An accidental connection to a busy trunk is also prevented, as when connecting relay X^6 actuates, spring switch 412 engages contact 428, and a connection is made from interrupter S^4 , as described in relation to relay X^5 . Winding u' of relay U^3 is of so low a resistance as not to interfere with the virtual short-circuit, and at the same time maintains said relay actuated. Therefore, should plug P^5 be inserted in a jack connected to a busy trunk, relay X^6 would not actuate and a circuit for the fluctuating current, as described (paragraphs 40 and 41), would be established over the following path: 410, 420, 429, 430, 431, 432, 433, 434, 435, 408, 409 and to ground through 387. The fluctuating current thus allowed to flow through resistance 435 and repeating coil winding 408, produces an audible signal in operator's receiver H^4 , and the receiver at the calling substation. Hearing this signal, the operator would withdraw plug P^5 from the trunk jack in question. Resistance 435 is such that the desired signal is produced and at the same time the continued actuation of the cut-off relay is not impeded.

(72) If an operator's busy test is required, a connection is made from contact 423 of connecting relay X^6 , as indicated by dotted line 436, thereby allowing the fluctuating currents from the tested busy line to flow through armature 434 of relay X^5 , resistance 435 and to ground through winding 408 of the repeating coil.

(73) If the operator wishes to be advised when a line becomes idle she may insert answering plug P^4 in a line jack, and when the same becomes idle, and consequently relay X^5 actuated, supervisory lamp or signal Y^6 will be energized, indicating the idle condition to the operator. The connection of this lamp, as shown, furnishes the resistance

necessary to prevent the short-circuits, as described (paragraph 65).

(74) In Figure 4 I have illustrated one form of a trunk line circuit, embodying the features of this system, which may be used with any of the link connector circuits, as illustrated in the preceding figures. Some of the other trunk circuits which may be adapted for use therewith, are shown and described in my co-pending application Serial No. 11,046. All the link connector circuits illustrated would naturally require a ground connection at the trunk jacks, corresponding to that of the cut-off relay, in order to disconnect the operator's set from the line of the calling party, and operate the connecting relays. As it is one of the objects of the present invention, in relation to the trunk circuit illustrated, to eliminate the busy tests usually made by the trunk operator, and to provide the same "waiting" means for the trunk circuits, as has been hereinbefore described, by preventing the connection of ground at the trunk jack if the B operator connects to a line for which a party is waiting, I am enabled to produce an audible busy signal in the A operator's receiver, similar to that described when said operator connects directly to such a line. This signal being produced automatically, without any action on the part of the B operator, the latter has merely to insert the trunk plugs in the jacks of the lines called for, irrespective of the operating condition of the line. It will thus be seen that the work of the B operators is greatly reduced and simplified, no "busy back" connections having to be manually made and taken down by the B operator. The changes produced in the link connector circuits, when connecting to a called for line, via the trunk circuit, are the same as those described when connection is made direct thereto.

(75) The means by which the B operator receives the number of the called for line from the A operator, is not illustrated, as the same is well known in the art, and forms no part of the present invention. On receiving the designation of the trunk line which is to be used, the A operator inserts the calling plug of the link connector in trunk jack Q^2 . As contact 437 of the jack is not connected to ground through 438 and 439, until relay V^3 has actuated, the A operator's telephone set is not disconnected from the link connector. If this trunk circuit is used with the described link connector circuits, then the described operator's busy test connections for the latter are used, as illustrated, by dotted line in Figure 1, and described (paragraph 46); by dotted line 177 in Figure 2, and described (paragraph 66); by dotted line 436 in Figure 3, and described (paragraph 72). Therefore, the tip contact of the plug inserted in trunk jack Q^2 ,

and in contact with spring 440 thereof, establishes a ground connection through the repeating coil winding of the link connector. This establishes a circuit over the following path: battery C¹⁰, 441, 442, 443, T⁵, 444, v' and to ground through 440. Relay T⁵ is actuated by the current flowing through this circuit, but relay V³ is not actuated, as winding v' is such that it will not sufficiently energize the relay when the complete winding of relay T⁵ is included in circuit therewith. Therefore, when trunk plug P⁶ is inserted in a jack, a circuit is established by the actuation of relay T⁵ over the following path: battery C¹⁰, 441, 442, 443, 445, 446, 447, S⁵, 448, 449, 450, 451, 452 and ground through contact 453 and the cut-off relay of the called for line. Relay S⁵ is actuated by the current flowing in this circuit, and a circuit is established over the following path: battery C¹⁰, 441, 454, R⁴, 456, 457, 458, Y⁷ and to ground through 453. This actuates ringing relay R⁴ and armature switch 459, engaging contact 460, establishes a connection to its winding in branch relation to 456 and 457. After this connection is made armature switch 461 engages contact 462, which establishes a circuit over the following path: battery C¹¹, 463, 464, S⁶, 465, 466, 467, w², 468, 462, 461, 452 and ground through contact 453. The intermittent current flowing in this circuit through interrupter S⁶, is sufficient to actuate controlling relay U⁴, armature 450 disengaging contact 449 engages contact 469, thereby establishing a circuit over the following path: battery C¹⁰, 441, 442, 470, w³, 469, 450, 451, 452 and ground through contact 453. Armature switch 465 of relay S⁶ does not disengage contact 466 until this circuit is established, notwithstanding the circuit through the relay was opened when armature 450 of relay U⁴ disengaged contact 449. Consequently, winding w² remains energized until after winding w³ has been energized.

(76) The actuation of ringing relay R⁴ and the de-energization of relay S⁵, as described (paragraph 75), establishes a circuit, in branch relation to that traced through relay T⁵, over the following path: battery C¹⁰, 441, 442, 470, 472, 473, 474, 475, 476, 477, 478, 479 and 480 to the point 481 in the winding of relay T⁵. The resistance from the point 481 to wire 444 is low, while the resistance from point 481 to wire 443 is high; therefore, the latter part of the winding is now shunted by a low resistance path through winding 479 of the repeating coil. Relay V³ is actuated, thereby establishing a ground connection at the trunk jack which causes the removal of the A operator's telephone set from the link connector and permits the operation of all its other functions which rely on the ground connection for their operation. When armature 438 of re-

lay V³ engages contact 439, the current flowing to ground through winding v² maintains this relay actuated after current has ceased to flow through winding v'.

(77) The actuation of ringing relay R⁴, as described (paragraph 75), establishes a circuit over the following path: battery C¹¹, 463, 482, H⁵, 483, 484, 485, 486, w⁹, 487, 459, 458, Y⁷, and contact 453 to ground. The intermittent current flowing through interrupter H⁵ and winding w⁹ causes armature 488 to engage spring switch 489, thereby establishing a circuit over the following path: battery C¹⁰, 441, 490, 488, 489, 491, w¹⁰, 492, Y⁸ and ground through contact 453. The steady current flowing through winding w¹⁰ causes the full actuation of connecting relay X⁷. The disengagement of spring switch 484 from contact 485 opens the circuit through winding w⁹ and its engagement with contact 494 connects interrupter H⁵ by way of wire 495 to contact 453, thereby preventing the telephonic connection of another link connector to the same line, in the same way as has been described in reference to the preceding figures. The engagement of armature switch 497 with contact 498 connects contact 499 of trunk plug P⁶ to ground through winding 500 of the repeating coil. The engagement of armature switch 501 with contact 502, connects contact 503 of the plug to supervisory relay T⁶ and non-inductive resistance 504. Ringing current is impressed upon the line, as described (paragraph 27) in relation to Figure 1. As the ringing current returns to ground through winding 500 of the repeating coil, an alternating current is induced in the corresponding winding 479 which is heard as an audible signal in the receiver at the calling station by the A operator. The circuit for this signal would be over the path through the left hand portion of the winding of relay T⁵ and through spring 440 of the trunk jack Q², as described (paragraphs 75 and 76), the corresponding contact on the calling plug of the link connector being connected to the grounded winding of the repeating coil.

(78) When the called for party responds, supervisory relay T⁶ is actuated, as described (paragraphs 28 and 29) in relation to Figure 1. The winding of relay R⁴ is short-circuited, the path for the short-circuit being as follows: contact 460 of relay R⁴, 505, 506, 507, 508, 491, 488, 490 and 441 to battery C¹⁰. The consequent de-energization of relay R⁴ changes the connections of relay T⁶ and resistance 504 from that of the ringing interrupters to a multiplied connection to repeating coil winding 509, which is connected to battery C¹⁰, as described (paragraph 30) in relation to Figure 1. The engagement of armature switch 477 of relay R⁴ with contact 510 changes the connection

to battery from ground through spring contact 440 of trunk jack Q^2 and winding 479 of the repeating coil, to a connection through contact 511, 512, 513, 514, 515, 516, 517 and thence by way of contact 193 of calling plug P' in Figure 1 or 337 of plug P^3 in Figure 2, according to which link connector is used, through the calling supervisory relay T' or T^3 to battery. Therefore this relay is not actuated until the called for party connected to the other exchange has answered. The supervisory signals and circuit connections controlled thereby are the same as if a connection had been made by the A operator direct to the called for line. As repeating coil windings 479 and 515 are now connected together, and the called for substation is connected to the corresponding windings 500 and 509, conversation can take place between the calling and called for parties. Condenser 518 allows the voice currents to pass the winding of relay V^3 and condenser 519 allows them to pass that part of the winding of relay T^5 which is connected to the repeating coil. Non-inductive resistances may of course be substituted for said condensers. The right hand portion of the winding of relay T^5 may be of such impedance as not to allow perceptible leakage of the voice currents or to permit cross talk.

(79) The telephonic disconnection of the calling party is brought about, as described (paragraphs 31 and 32), in relation to Figure 1 and (paragraph 56) in relation to Figure 2. If the calling party had replaced the receiver previous to the response of the called for party, then relays R^2 and X' in Figure 1 would have been de-energized, as described (paragraph 33), or relays R^3 , X^3 and X^4 in Figure 2, as described (paragraph 56). Consequently, the circuit through relay T^5 in Figure 4 is opened and the engagement of armature 445 with contact 520, which is connected by wire 521 to the upper terminal of the winding of relay R^4 , would have short-circuited the latter. The consequent de-energization of relay R^4 would have short-circuited relay X^7 , as armature switch 522 which is connected by wires 523 and 492 to the upper terminal of winding x^{10} , engages contact 524, which is connected by 525, 526, 507 and 508 to the lower terminal of the winding. This de-energizes relay X^7 also. Ringing current is cut off from the line of the called for substation and the line restored to its normal condition as armature switches 497 and 501 have opened the circuit through plug P^6 .

(80) When the receiver is replaced at the called for substation, after a call has been responded to; supervisory relay T^6 is de-energized and relay X^7 short-circuited, as described (paragraph 78), when armature 507 engages contact 526, restoring the called

for line to its normal condition. The disengagement of armature 513 from contact 512, opens the circuit through windings 479 and 515 of the repeating coil, thereby de-energizing the calling supervisory relay of the link connector inserted in trunk jack Q^2 . The consequent extinguishing of the supervisory lamp would notify the A operator to take down the connection. At the same time relay V^3 would be de-energized in the same way that cut-off relay V' in Figure 1 was de-energized, as described (paragraph 35). Therefore, the trunk line could be used again, irrespective of whether the A operator had removed or not the link connector from the trunk jack. The extinguishing of supervisory lamp Y^8 would notify the AA operator that the connection could be taken down.

(81) The automatic means by which a telephonic connection to a busy line is prevented, and the "waiting" means used, are similar to those described (paragraphs 36, 37 and 39). Relay X^7 is shown as consisting of two windings, one energized by the intermittent current from interrupter H^5 , and the other by steady current from battery C^{10} . This is an alternative form from the connecting relays illustrated in the preceding figures, and may or may not be used. Relay R^4 in Figure 4 is shown without the connections to interrupters, such as I^2 and J^2 in Figure 1 which furnish the ringing busy signal, as such signal may or may not be used. If desired, such connections are made as illustrated in Figure 1, and as described (paragraph 41).

(82) The calling party's busy signal, as described (paragraph 40), is produced in a similar way to that described (paragraph 41). Resistance 528 in Figure 4 corresponds to resistance 234 in Figure 1, and is connected in the same way to winding 500 of the repeating coil, corresponding to winding 203 in Figure 1. Therefore, when a connection is made to a busy line, fluctuating current flows through winding 500, which induces an alternating current in winding 479. This current flows over the path, as described (paragraph 77) in relation to the audible ringing signal. Consequently, the calling party can elect to "wait," or can replace the receiver, thereby obtaining the described disconnection. If the calling party "waits," he is telephonically connected to the called for line, when it becomes idle, as described (paragraph 42).

(83) The AA operator is prevented from making a connection to a called for line with which a "waiting" connection has already been established, in a similar way to that described (paragraphs 43 and 44) in relation to Figure 1, the difference being that both the A and AA operators automatically receive an audible signal in their

respective receivers when such a connection is made. Therefore, the AA operator takes down the connection and the A operator reports to the calling party. When a "waiting" connection is made, a circuit is established over the following path: Battery C¹¹, 463, 464, S⁶, 465, 529, 530, 531, 532, 533, 462, 461, 452 and 453 to ground. Therefore, when another connection is made to a line jack of the same line, a short-circuit is formed around winding u² of controlling relay U⁴ and the latter cannot actuate, as described, (paragraph 75). Relay S⁵ is not de-energized, as described (paragraph 75), and armature switch 474 of the same remains engaged with contact 534. The path for the alternating current, induced in winding 479 of the repeating coil by the fluctuating current flowing in winding 500 is to ground through 534, 535, 536 and 537, instead of to ground through 473, 472, 470, 442, 441 and battery C¹⁰, as described (paragraphs 77 and 82). Primary 536 of the AA operator's induction coil induces a corresponding alternating current in secondary 538, which is heard as an audible signal in receiver H⁶. As the A operator's head receiver is still connected to the link connector circuit, inasmuch as relay V³ has not actuated, as described (paragraph 76); the signal is also produced therein. Condenser 537, in series with primary 536 of the operator's induction coil, is used to prevent direct current from flowing to ground therethrough from relay T⁵, instead of to ground through the grounded winding of the repeating coil of the link connector connected to trunk jack Q².

(84) Should the busy test be required, then a connection is made as indicated by dotted line 539, and the busy signals would be transmitted to both the A and AA operators, as described in the preceding paragraph.

(85) Supervisory lamps Y⁷ and Y⁸ correspond in function to Y¹ and Y² in Figure 1, described (paragraph 47). Supervisory lamp Y⁹ may or may not be used. If used with those trunking systems wherein the A operator selects an idle trunk and connects thereto, the energization of the same would act as a calling signal to the AA operator. Lamps Y⁷ and Y⁸, connected as shown, furnish the necessary resistance to prevent the short-circuits, as described (paragraph 65).

(86) Figure 4, as described, is arranged for the ringing apparatus to be located at the exchange where the trunk line terminates. However, the ringing can readily be controlled by the A operator and the ringing apparatus located at the exchange where the trunk line begins, should that be desired. For party line ringing the latter plan offers many advantages. As this trunk line circuit forms no part of the present invention, but is covered in a divisional application

hereof, no further reference thereto is made herein.

(87) Figure 5 is an illustration of another modification of the connecting relays, which may be used in conjunction with the link connectors illustrated in the preceding figures. As shown, it represents an adaptation to the answering end of the link connector shown in Figure 1, and includes an alternative form of means for connecting the answering supervisory lamp or signal, and illustrates the connections to be made when but one interrupter for furnishing the intermittent short-circuiting current is used. It will be readily understood, that this form is equally adaptable to the calling end of the link connector, and to the other circuits shown. But one battery is needed with this form, lamp Y¹⁰ taking the place of resistance 221 in Figure 1. The actuation of answering supervisory relay T⁷, establishes a circuit over the following path: battery C¹², 540, W⁴, 541, 542, 543, X⁸, 544, 545, 546, 547, 548, and to ground through the cut-off relay. Armature 549 thereupon engages spring switch 543, and thereby connects steady current from battery C¹², by way of Y¹⁰ and wire 550 to X⁸, subsequently removing 543 from 542 and opening the circuit to interrupter W⁴. The steady current flowing through relay X⁸ causes the full actuation of the relay. The short-circuiting current from interrupter W⁴, passes by way of spring switch 542, contact 553 and wire 554 to a point 555 in the winding of relay X⁸. From this point to wire 544, the winding is of very low resistance but of sufficient ampere turns so that the current from battery C¹², through interrupter W⁴, will maintain said relay actuated. From point 555 to spring switch 543, the resistance of the winding is high, so that the circuit through the first mentioned part forms a low resistance shunt or virtual short-circuit for the latter, or for the complete winding of another connecting relay of another link connector. The engagement of spring switch 556 with contact 557, establishes a connection to contact 548, in branch relation to that through armature 545, and contact 546 of supervisory relay T⁷. When relay T⁷ is de-energized, armature 545 engaging contact 558, connects wire 544 direct to spring switch 543, thereby completely short-circuiting the winding and de-energizing relay X⁸. As lamp Y¹⁰ is in circuit when said short-circuit is made, its resistance is sufficient to prevent a short-circuit of the relays of another link connector, which may be in a "waiting" condition.

(88) Figure 6 is an illustration of the change to be made in a well known link connector circuit, when the audible line pilot signals illustrated in Figure 1 are to be used, without at the same time using the described

link connector circuits. As the change relates to the calling end of the link connector, only that end of the same is illustrated, wire 559 leading to the answering plug contact 5 corresponding to contact 560 of calling plug P⁷ and wire 561 leading through a relay, corresponding to T⁸, to a contact corresponding to 562 of calling plug P⁷. With this well known type of link connector circuit, 10 the operator on observing a line signal inserts the answering plug in the answering jack of the calling line, and manipulates listening key Z⁵, thereby establishing a circuit over the following path: battery C¹³, 15 563, 564, 565, 566, 567, 568, 569, 570, H⁷, 571, 572, 573 and 574, completing the circuit through battery C¹³. The operator's receiver H⁷ and secondary 569 of the induction coil being thereby connected in circuit 20 with windings 563 and 574 of the repeating coil, a telephonic connection is established to the calling substation connected to windings 575 and 576 of the same repeating coil. The connection of the operator's transmitter 25 577 and primary 578 is a well known one in the art. The only change made in this well known circuit is in shunting condenser 568 with relay A⁵, whose winding is preferably of a extremely high resistance, so 30 that a disagreeable click is not produced in receiver H⁷ by an appreciable amount of direct current passing therethrough when a key Z⁵ is manipulated. The armature and contact of relay A⁵ close the same circuit as closed by armature 126 and contact 127 35 of relay A⁷ in Figure 1. Therefore, the audible line pilot signals are controlled in the same manner as described in relation to Figure 1, whenever a key Z⁵ is manipulated. 40 (89) Referring to the various short-circuiting current interrupters which have been described, it will be understood that the same might be dispensed with entirely, and the circuit connections made direct to the respective batteries. However, if this was 45 done, practically the only resistance in circuit would be that of the cut-off relay, and as that is usually of a low resistance, the current consumption would be large. Also, 50 a fluctuating current is required to operate the described audible busy signals. Therefore, by using said interrupters I am enabled to obtain said busy signals and at the same time reduce the consumption of current when 55 the short-circuits or low resistance shunts forming virtual short-circuits are made, as have been hereinbefore described. Taking the resistance of the cut-off relay as thirty-four ohms, for example, then if the interrupters are made as illustrated, wherein the 60 metallic segments of the same represent one-eighth of their circumference, the amount of current flowing through said relay intermittently would be equal to a circuit having a resistance eight times as great 65 through which the current flowed continuously. Therefore, the equivalent resistance added to the operating circuits by using the short-circuiting interrupters would be two hundred and seventy-two ohms. In practice it will be found the relays operate just as efficiently by using the intermittent current as if a steady current was used and that the metallic segments of the interrupters may be less than one-eighth of their circumference, thereby effecting still further economy in current consumption. Another advantage in using the interrupters is that if the cut-off relay windings are of a low resistance, they might become heated by the steady current flowing through them, when 80 practically no other resistance was in circuit. The intermittent current has no such heating effect as the seven-eighths of the time, or more, when no short-circuit exists dissipates the small amount of heat generated for the one-eighth time, or less, that the short-circuit continues. Figures 1 and 2 show the short-circuiting interrupters used in pairs, as H² and W, S⁷ and P²; Figures 3, 4 and 5, 90 show but one interrupter used for each short-circuiting function. This has been done, as it is a matter of choice which form is used. If but one interrupter is associated with each relay, then the circuits, including the 95 windings of said relays, when the latter are fully actuated, must all be practically of the same resistance. The reason for this is that a Wheatstone Bridge circuit is established, if other link connectors are connected 100 to calling and called lines, when a relay is in a "waiting" condition and the "waiting" relay is included, by way of the wire leading to said interrupter, in the bridge wire across the arms of said circuit; corresponding arms 105 of the same being formed by the respective cut-off relays and fully actuated relays. As the armature which connects steady current to the winding of said relays should preferably engage its spring switch when said 110 relay receives but a small amount of current (such as the intermittent current), if any of the relay circuits varied greatly in resistance, the bridge might become unbalanced and enough current flow through the "waiting" 115 relay to cause the actuation of the same, previous to the connected line becoming idle. If the interrupters are used in pairs, this bridge circuit cannot be formed. Therefore, it would be immaterial whether 120 the circuits including the relays varied in resistance or not. However, said circuits can readily be brought to approximately the same resistance, thereby allowing the single interrupters to be used. 125 (90) I have also shown in the various figures, many other modifications of circuit connections and forms of windings for the various relays. It will be understood that the same may be re-combined in other ways, 130

without departing from the spirit and scope of this invention.

(91) Referring to the described transferring means for the pilot signals, it will readily be understood that if the line lamps at the operator's positions are not divided into left side and right side groups, transfer relay O, and re-transfer relay N could be eliminated, as could the corresponding duplication of armature switches on relay L. In which event, the pilot signal produced by any line lamp at a position would be transferred to the right or left, according to the connections made.

(92) The various batteries shown, are purely diagrammatic, as their voltage may be as desired. As described hereinbefore, battery C³ in Figure 1 may be of a much lower voltage than battery C⁴, therefore, it is represented diagrammatically as being of less voltage.

(93) Ringing interrupters G³, G⁴ and G⁵, as shown, would produce continuous ringing signals at the called for substations. If periodic signals are desired, an interrupter is inserted in series therewith, as described in my aforementioned patent and application.

(94) In the following claims, I use the terms "telephonically connect," "telephonically connected" and "telephonic connection," etc., to distinguish a connection made by a link connector which permits talking or ringing therethrough from a mere physical connection made by the link connector being connected to contacts of a substation line.

(95) It will be noted that I have herein shown and described low resistance shunts as forming virtual short-circuits, and have also shown and described some absolute short-circuits, both in connection with the "connecting" and "controlling" relays. To avoid multiplying claims unnecessarily, I have used the term "low resistance shunt" therein as covering both of these.

What I claim is:

1. A telephone exchange system including telephone lines extending from substations to an exchange, link connectors to connect said substations, a relay for each of said link connectors, a source of intermittent current, means whereby current from said source initially energizes said relay when one of said link connectors is connected to an idle line, means other than said source to maintain said relay energized thereafter; and means to prevent said energization when said link connector is connected to a busy line.

2. A telephone exchange system including telephone lines extending from substations to an exchange, link connectors to connect said substations, a relay for each of said link connectors, a source of intermittent current, means whereby current from said source initially energizes said relay when one of said

link connectors is connected to an idle line, and means to prevent said energization when said link connector is connected to a busy line, a low resistance shunt, said last mentioned means comprising means for intermittently connecting said shunt around said relay in synchronism with the impressions of intermittent current through said relay from said source, said shunt being connected by the previous connection of another such link connector to the same line.

3. A telephone exchange system including telephone lines extending from substations to an exchange, link connectors to connect said substations, a relay for each of said link connectors, a source of intermittent current, means whereby current from said source initially energizes said relay when one of said link connectors is connected to an idle line, means to prevent said energization when said link connector is connected to a busy line, a low resistance shunt, said last mentioned means comprising means for intermittently connecting said shunt around said relay in synchronism with the impressions of intermittent current through said relay from said source, said shunt being connected by the previous connection of another such link connector to the same line, and means whereby said shunt is removed when said line becomes idle, thereby allowing said relay to be energized.

4. A telephone exchange system including telephone lines extending from substations to an exchange, link connectors to connect said substations, a relay for each of said link connectors, a source of intermittent current, a source of steady current, means whereby current from said first mentioned source initially energizes said relay when one of said link connectors is connected to an idle line and thereby substitutes current from said second mentioned source for said first mentioned current, and means to prevent said energization when said link connector is connected to a busy line.

5. A telephone exchange system including telephone lines extending from substations to an exchange, link connectors to connect said substations, a relay for each of said link connectors, a source of intermittent current, a source of steady current, means whereby current from said first mentioned source initially energizes said relay when one of said link connectors is connected to an idle line and thereby substitutes current from said second mentioned source for said first mentioned current, and means to prevent said energization when said link connector is connected to a busy line, a low resistance shunt, said last mentioned means comprising means for intermittently connecting said shunt around said relay in synchronism with the impressions of intermittent current through said relay from said

first mentioned source, said shunt being connected by the actuation of a relay of another link connector previously connected to the same line.

5 6. A telephone exchange system including telephone lines extending from substations to an exchange, link connectors to connect said substations, a relay for each of said link connectors, a source of intermittent
10 current, a source of steady current, means whereby current from said first mentioned source initially energizes said relay when one of said link connectors is connected to an idle line and thereby substitutes current
15 from said second mentioned source for said first mentioned current, means to prevent said energization when said link connector is connected to a busy line, a low resistance shunt, said last mentioned means comprising
20 means for intermittently connecting said shunt around said relay in synchronism with the impressions of intermittent current through said relay from said first mentioned source, said shunt being connected by the
25 actuation of a relay of another link connector previously connected to the same line, and means whereby said shunt is removed by the de-energization of said last mentioned relay when said line becomes idle,
30 thereby allowing said first mentioned relay to be energized.

7. A telephone exchange system including telephone lines extending from substations to an exchange, link connectors to connect
35 said substations, a relay for each of said link connectors, a source of intermittent current, a source of steady current, means whereby current from said first mentioned source initially energizes said relay when
40 one of said link connectors is connected to an idle line and thereby substitutes current from said second mentioned source for said first mentioned current, means to prevent said energization when said link connector
45 is connected to a busy line, a low resistance shunt, said last mentioned means comprising means for intermittently connecting said shunt around said relay in synchronism with the impressions of intermittent current
50 through said relay from said first mentioned source, said shunt being connected by the actuation of a relay of another link connector previously connected to the same line, and means under the control of apparatus at
55 a connected substation to de-energize the last mentioned relay, thereby removing said shunt and allowing said first mentioned relay to be energized.

8. A telephone exchange system including
60 telephone lines extending from substations to an exchange, link connectors to connect said substations, a relay for each of said link connectors, a source of intermittent current, a source of steady current, means
65 whereby current from said first mentioned

source initially energizes said relay when one of said link connectors is connected to an idle line and thereby substitutes current from said second mentioned source for said first mentioned current, means to prevent
70 said energization when said link connector is connected to a busy line, a low resistance shunt, said last mentioned means comprising means for intermittently connecting said shunt around said relay in synchronism with
75 the impressions of intermittent current through said relay from said first mentioned source, said shunt being connected by the actuation of a relay of another link connector previously connected to the same line
80 and including a winding of said relay for maintaining the same actuated when said shunt is formed, and means under the control of apparatus at a connected substation to de-energize the last mentioned relay,
85 thereby removing said shunt and allowing said first mentioned relay to be energized.

9. A telephone exchange system including telephone lines extending from substations to an exchange, link connectors to connect
90 said substations, a relay for each of said link connectors, a source of steady electric current, means for furnishing an intermittent current from said source; means to initially energize said relay, by closing a circuit including said intermittent current means and a
95 winding of said relay when a link connector is connected to an idle line, and thereby substitute said source for said intermittent current means in said circuit; a low resistance shunt, means for connecting said intermittent current means to another winding of
100 said relay of lower resistance than said first mentioned winding and also included in said circuit to form said shunt, whereby said first mentioned winding is intermittently shunted
105 by said second mentioned winding, said relay being maintained actuated when said shunt is formed by the current flowing through said second mentioned winding; means whereby, when another link connector is subsequently connected to the same line, a corresponding relay is connected in branch relation to said first mentioned relay
110 in said circuit and means whereby said low resistance shunt is intermittently formed in synchronism with the impression of said intermittent current through said last mentioned relay, thereby preventing said current from said intermittent current means
115 from initially energizing said last mentioned relay.

10. A telephone exchange system including telephone lines extending from substations to an exchange, link connectors to connect
125 said substations, a relay for each of said link connectors, a source of steady electric current, means for furnishing an intermittent current from said source; means to initially energize said relay, by closing a
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circuit including said intermittent current means and a winding of said relay when a link connector is connected to an idle line, and thereby substitute said source for said intermittent current means in said circuit; a low resistance shunt, means for connecting said intermittent current means to another winding of said relay of lower resistance than said first mentioned winding and also included in said circuit to form said shunt, whereby said first mentioned winding is intermittently shunted by said second mentioned winding, said relay being maintained actuated when said shunt is formed by the current flowing through said second mentioned winding, means whereby, when another link connector is subsequently connected to the same line, a corresponding relay is connected in branch relation to said first mentioned relay in said circuit, means whereby said low resistance shunt is intermittently formed in synchronism with the impression of said intermittent current through said last mentioned relay, thereby preventing said current from said intermittent current means from initially energizing said last mentioned relay, and means whereby the de-energization of said first mentioned relay when said line becomes idle removes said shunt and thereby allows said last mentioned relay to be energized.

11. A telephone exchange system including telephone lines extending from substations to an exchange, link connectors for connecting said substations, in combination with automatic means individual to the respective link connectors to prevent a telephonic connection between a calling line and a busy line, when one of said link connectors is connected to said busy line; means operative when such a connection is made, for sounding an audible signal in the telephone receiver at the calling substation, denoting that a substation of the busy line is being signaled, and for sounding another such signal, denoting that said substation has responded to its calling signal.

12. A telephone exchange system including telephone lines extending from substations having calling signal apparatus to a manually operated exchange, link connectors for connecting said substations in combination with automatic means to prevent a telephonic connection between a calling line and a busy line, when one of said link connectors is manually connected thereto; means operative when such a connection is made, for sounding an audible signal in the telephone receiver at the calling substation, denoting the busy condition of said line, and means for automatically stopping said signal and impressing signaling current on the called for line, when the same becomes idle, and thereafter discontinue such impression when the called for substation responds to

its calling signal, and means under the control of apparatus at the calling substation, operative previous to the response of the called for substation, to prevent said impression.

13. A telephone exchange system including telephone lines extending from substation to a multiple switchboard, link connectors for connecting said substations, in combination with automatic means individual to the respective link connectors, to prevent a telephonic connection between a calling line and a busy line, when one of said link connectors is connected to said busy line, and for sounding an audible signal in the telephone receiver at the calling substation denoting the busy condition of said line; said means comprising a relay the actuation of which establishes the telephonic connection through said link connector and stops the production of said audible signal, means for actuating said relay when a telephonic connection is established to an idle called for line, a low resistance shunt, and means whereby if another link connector is subsequently connected to the same line, said shunt is connected by said actuation around a relay of said last mentioned link connector, thereby preventing the actuation of said relay.

14. A telephone exchange system including telephone lines extending from substations to an exchange, link connectors to connect said substations, means associated with said link connectors for sounding an audible signal in a telephone receiver at a calling substation, a relay for each of said link connectors, the actuation of which prevents the sounding of said signal, a source of intermittent current, a source of steady current, means whereby current from said first mentioned source initially energizes said relay when one of said link connectors is connected to an idle line and thereby substitutes current from said second mentioned source for said first mentioned current, means to prevent said energization when said link connector is connected to a busy line, thereby sounding said signal, indicating the busy condition of said line, a low resistance shunt, said last mentioned means comprising means for intermittently connecting said shunt around said relay in synchronism with the impressions of intermittent current through said relay from said first mentioned source, said shunt being connected by the previous connection of another such link connector to the same line, and a circuit in inductive relation to said receiver, whereby said intermittent current is caused to produce said audible signal.

15. A telephone exchange system including telephone lines extending from substations to a multiple switchboard, link connectors for connecting said substations, in

combination with automatic means individual to the respective link connectors to prevent a telephonic connection between a calling line and a busy line, when one of said link connectors is connected to said busy line, means operative when such a connection is made for sounding an audible signal in the telephone receiver at the calling substation, denoting that a substation of the busy line is being signaled, and for sounding another such signal, denoting that said substation has responded to its calling signal; said means comprising a connecting relay the actuation of which establishes the telephonic connection through said link connector and stops the production of said audible signal, a source of intermittent current and a circuit for the same including said relay, another circuit of low resistance in comparison with said first mentioned circuit and including said source, a source of steady current and a circuit for the same also including said relay, means for closing said first mentioned circuit before a telephonic connection is established to an idle called for line, and means whereby the consequent actuation of said relay closes said second and third mentioned circuits, said circuit of low resistance thereby forming a low resistance shunt around a relay pertaining to another link connector, provided another connection is subsequently made to the same line, thereby preventing the actuation of said last mentioned relay, a shunt circuit established by the non-actuation of said last mentioned relay, whereby the intermittent current from said second mentioned circuit is caused to produce said second mentioned audible signal, another source of intermittent current, a ringing relay for impressing signaling current on the called for line, and means whereby the actuation of said relay substitutes said last mentioned source for said first mentioned source in said second mentioned circuit, thereby producing said first mentioned audible signal.

16. A telephone exchange system including telephone lines extending from substations to a multiple switchboard, a telephone set for each operator's position thereat, link connectors for connecting said substations, means for connecting said set to a calling line by way of one of said link connectors, automatic means to prevent a telephonic connection between a calling line and a busy line when one of said link connectors is connected to said busy line, means for disconnecting said set from said link connector when such a connection is made and for sounding an audible signal in the telephone receiver at the calling substation, denoting that a substation of the busy line is being signaled, and for sounding another such audible signal, denoting that said substation has responded to its calling signal.

17. A telephone exchange system including telephone lines extending from substations having calling signal apparatus to a multiple switchboard, a telephone set for each operator's position thereat, link connectors for connecting said substations, means for connecting said set to a calling line by way of one of said link connectors, automatic means to prevent a telephonic connection between a calling line and a busy line when one of said link connectors is connected to said busy line, means for disconnecting said set from said link connector when such a connection is made and for sounding an audible signal in the telephone receiver at the calling substation, denoting said busy condition of the called for line, means for automatically stopping said signal and impressing signaling current on said called for line, when the same becomes idle, and thereafter discontinuing said impression when the called for substation responds to its calling signal, and means under the control of apparatus at the calling substation, operative previous to the response of the called for substation, to prevent said impression.

18. A telephone exchange system including telephone lines extending from substations to a multiple switchboard, a telephone set for each operator's position thereat, link connectors for connecting said substations, means for connecting said set to a calling line by way of one of said link connectors, automatic means individual to the respective link connectors to prevent a telephonic connection between a calling line and a busy line when one of said link connectors is connected to said busy line, means for disconnecting said set from said link connector when such a connection is made and for sounding an audible signal in the telephone receiver at the calling substation, denoting the busy condition of said line, said means comprising a relay the actuation of which establishes the telephonic connection through said link connector and stops the production of said audible signal, means for actuating said relay when a connection is made to an idle called for line, a low resistance shunt, means whereby if another link connector is subsequently connected to the same line said shunt is connected by said actuation of said relay around a corresponding relay of said last mentioned link connector, thereby preventing the actuation of said last mentioned relay until said first mentioned relay is de-energized, whereby said audible signal is produced until said first mentioned relay is de-energized, and a relay the actuation of which is not prevented when said link connector is connected to a busy line, said actuation causing the disconnection of said set from said calling line.

19. A telephone exchange system includ-

ing telephone lines extending from substations to a multiple switchboard, a telephone set for each operator's position thereat, link connectors for connecting said substations, means for connecting said set to a calling line by way of one of said link connectors, automatic means to prevent a telephonic connection between a calling line and a busy line, when one of said link connectors is connected to said busy line, means for disconnecting said set from said link connector when such a connection is made and for sounding an audible signal in the telephone receiver at the calling substation, denoting said busy condition of the called for line, said automatic means comprising a relay for each of said link connectors the actuation of which establishes the telephonic connection through said link connector and stops the production of said audible signal, a source of intermittent current, a source of steady current, means whereby current from said first mentioned source initially energizes said relay when one of said link connectors is connected to an idle line and thereby substitutes current from said second mentioned source, means to prevent said energization when said link connector is connected to a busy line, thereby preventing said telephonic connection and sounding said signal, a low resistance shunt, said last mentioned means comprising means for intermittently connecting said shunt around said relay in synchronism with the impressions of intermittent current through said relay from said first mentioned source, said shunt being formed by the telephonic connection of another link connector to the same line, and a circuit in inductive relation to said receiver at said substation, whereby said intermittent current is caused to produce said audible signal.

20. A telephone exchange system including telephone lines extending from substations having calling signal apparatus to a multiple switchboard, a telephone receiver for each operator's position thereat, link connectors for connecting said substations, means for connecting said receiver to a calling line by way of one of said link connectors, means to disconnect said receiver when said link connector is connected to a called for line, and means for preventing said disconnection provided another line is already telephonically connected to the called for line and still another calling line is waiting to be connected thereto.

21. A telephone exchange system including telephone lines extending from substations having calling signal apparatus to a multiple switchboard, a telephone receiver for each operator's position thereat, link connectors for connecting said substations, means for connecting said receiver to a calling line by way of one of said link connectors,

means to disconnect said receiver when said link connector is connected to a called for line, and means for preventing said disconnection provided another line is already telephonically connected to the called for line and still another calling line is waiting to be connected thereto, and means operative when said disconnection is prevented to sound an audible signal in said receiver, denoting such condition of the called for line.

22. A telephone exchange system including telephone lines extending from substations having calling signal apparatus to a multiple switchboard, a telephone receiver for each operator's position thereat, link connectors for connecting said substations, means for connecting said receiver to a calling line by way of one of said link connectors, means to disconnect said receiver when said link connector is connected to a called for line, and means for preventing said disconnection provided another line is already telephonically connected to the called for line and still another calling line is waiting to be connected thereto; and means operative when said disconnection is prevented to sound an audible signal in said receiver, denoting such condition of the called for line, and also denoting that a substation thereof is being signaled, and to sound another such audible signal denoting that said substation has responded to its calling signal.

23. A telephone exchange system including telephone lines extending from substations to a multiple switchboard, a telephone receiver for each operator's position thereat, link connectors for connecting said substations, means for connecting said receiver to a calling line by way of one of said link connectors, means to disconnect said receiver when said link connector is connected to a called for line, and means for preventing said disconnection provided another line is already telephonically connected to the called for line and still another calling line is waiting to be connected thereto, said means comprising a relay the actuation of which causes the disconnection of said receiver, means for actuating said relay when a calling line is connected to a called for line for which another calling line is not waiting; and another relay associated with the same link connector, the actuation of which is prevented when a connection is made to a busy line, and means whereby provided another link connector is subsequently connected to the same line, a low resistance shunt is formed, around a corresponding first mentioned relay of said last mentioned link connector by said actuation and non-actuation of said relays, thereby preventing the actuation of said corresponding relay and preventing the consequent disconnection of said receiver.

24. A telephone exchange system including

ing telephone lines extending from substations to a multiple switchboard, a telephone receiver for each operator's position thereat, link connectors for connecting said substations, means for connecting said receiver to a calling line by way of one of said link connectors, means to disconnect said receiver when said link connector is connected to a called for line, and means for preventing said disconnection provided another line is already telephonically connected to the called for line and still another calling line is waiting to be connected thereto, whereby an audible signal is sounded in said receiver, denoting such condition of the called for line, said means comprising a relay the actuation of which causes the disconnection of said receiver and stops the production of said audible signal, means for actuating said relay when a calling line is connected to a called for line for which another calling line is not waiting, and another relay associated with the same link connector, the actuation of which is prevented when a connection is made to a busy line, and means whereby, provided another link connector is subsequently connected to the same line, a low resistance shunt is formed around a corresponding first mentioned relay of said last mentioned link connector, by said actuation and non-actuation of said relays, thereby preventing the actuation of said corresponding relay and preventing the consequent disconnection of said receiver and stopping of said signals.

25. A telephone exchange system including telephone lines extending from substations to a multiple switchboard, a telephone receiver for each operator's position thereat, link connectors for connecting said substations, means for connecting said receiver to a calling line by way of one of said link connectors, means to disconnect said receiver when said link connector is connected to a called for line, and means for preventing said disconnection provided another line is telephonically connected to the called for line and still another calling line is waiting to be connected thereto, whereby an audible signal is sounded in said receiver, denoting such condition of the called for line, said means comprising a relay for each of said link connectors the actuation of which causes the disconnection of said receiver and stops the production of said audible signal, a source of intermittent current, a source of steady current, means to initially energize said relay by current from said first mentioned source when one of said link connectors is connected to a called for line for which another calling line is not waiting and thereafter substitute current from said second mentioned source, means to prevent said energization when said link connector is connected to a called for line for which an-

other calling line is waiting, thereby preventing said disconnection of said receiver and sounding said signal, a low resistance shunt, said last mentioned means comprising means for intermittently connecting said shunt around said relay in synchronism with the impressions of intermittent current through said relay from said first mentioned source, said shunt being connected by the telephonic connection of another link connector to the same line, and a circuit in inductive relation to said receiver, whereby said intermittent current is caused to produce said signal.

26. A telephone exchange system including telephone lines extending from substations to a multiple switchboard, a telephone receiver for each operator's position thereat, link connectors for connecting said substations, means for connecting said receiver to a calling line by way of one of said link connectors, means to disconnect said receiver when said link connector is connected to a called for line, and means for preventing said disconnection provided another line is already telephonically connected to the called for line and two other calling lines are waiting to be connected thereto.

27. A telephone exchange system including telephone lines extending from substations to a multiple switchboard, a telephone receiver for each operator's position thereat, link connectors for connecting said substations, means for connecting said receiver to a calling line by way of one of said link connectors, means to disconnect said receiver when said link connector is connected to a called for line, and means for preventing said disconnection provided another line is already telephonically connected to the called for line and two other calling lines are waiting to be connected thereto, whereby an audible signal is sounded in said receiver, denoting such condition of the called for line.

28. A telephone exchange system including telephone lines extending from substations to a multiple switchboard, a telephone receiver for each operator's position thereat, link connectors for connecting said substations, means for connecting said receiver to a calling line by way of one of said link connectors, means to disconnect said receiver when said link connector is connected to a called for line, and means for preventing said disconnection provided another line is already telephonically connected to the called for line and two other calling lines are waiting to be connected thereto, whereby an audible signal is sounded in said receiver, denoting such condition of the called for line, said means including a controlling relay the actuation of which causes the disconnection of said receiver and stops the production of said audible signal, means for

actuating said controlling relay when a calling line is connected to a called for line for which two other calling lines are not waiting, and two connecting relays associated with the same link connector, means whereby the actuation of one of said relays is prevented when a connection is made to a busy line, and means whereby the actuation of both of said relays is prevented when a connection is made to a line for which another calling line is waiting, a low resistance shunt, and means whereby, provided still another link connector is subsequently connected to the same line, said shunt is connected around a corresponding controlling relay of said last mentioned link connector, by said actuation of said controlling relay and the non-actuation of both of said connecting relays, thereby preventing the actuation of said controlling relay of said last mentioned link connector and the consequent disconnection of said receiver and stopping of said signal.

29. A telephone exchange system including telephone lines extending from substations to a multiple switchboard, a telephone receiver for each operator's position thereat, link connectors for connecting said substations, means for connecting said receiver to a calling line by way of one of said link connectors, means to disconnect said receiver when said link connector is connected to a called for line, and means for preventing said disconnection provided another line is already telephonically connected to the called for line and a plurality of other calling lines are waiting to be connected thereto, whereby an audible signal is sounded in said receiver, denoting such condition of the called for line.

30. A telephone exchange system including telephone lines extending from substations to a multiple switchboard, a telephone receiver for each operator's position thereat, link connectors for connecting said substations, means for connecting said receiver to a calling line by way of one of said link connectors, means to disconnect said receiver when said link connector is connected to a called for line, and means for preventing said disconnection provided another line is already telephonically connected to the called for line and a plurality of other calling lines are waiting to be connected thereto, whereby an audible signal is sounded in said receiver, denoting such condition of the called for line, said means including a controlling relay the actuation of which causes the disconnection of said receiver and stops the production of said audible signal, means for actuating said controlling relay when a calling line is connected to a called for line for which all of said plurality of calling lines are not waiting, and a connecting relay for each of said plurality of waiting lines associated with the

same link connector, means whereby the actuation of one of said relays is prevented when a connection is made to a busy line, means whereby the actuation of two of said relays is prevented when a connection is made to a line for which another calling line is waiting and means whereby the actuation of the other such relays are successively so prevented according to the number of said plurality of calling lines so waiting, a low resistance shunt, and means whereby, provided another link connector is subsequently connected to the same line, said shunt is connected around a corresponding controlling relay of said last mentioned link connector by said actuation of said controlling relay and the non-actuation of all of said connecting relays, thereby preventing the actuation of said controlling relay of said last mentioned link connector and the consequent disconnection of said receiver and stopping of said signal.

31. A telephone exchange system including telephone lines extending from substations to a multiple switchboard, link connectors for connecting said substations, means for connecting a plurality of calling lines to a busy line by way of said link connectors without establishing telephonic connection therebetween, but establishing telephonic connection, when said busy line is telephonically disconnected from another line, from the formerly busy line to each such calling line successively, in the same order in which said link connectors were connected to said busy line.

32. A telephone exchange system including telephone lines extending from substations to a multiple switchboard, link connectors for connecting said substations, means for connecting a plurality of calling lines to a busy line by way of said link connectors without establishing telephonic connection therebetween, but establishing telephonic connection, when said busy line is telephonically disconnected from another line, from the formerly busy line to each such calling line successively, in the same order in which said link connectors were connected to said busy line, and means under the control of apparatus at a substation of said busy line to obtain said telephonic disconnection and thereby allow one of said calling lines to become telephonically connected thereto.

33. A telephone exchange system including telephone lines extending from substations to a multiple switchboard, link connectors for connecting said substations, means for connecting a plurality of calling lines to a busy line by way of said link connectors without establishing telephonic connection therebetween, but establishing telephonic connection, when said busy line is telephonically disconnected from another

line, from the formerly busy line to each such calling line successively, in the same order in which said link connectors were connected to said busy line, means under the control of apparatus at a substation of said busy line to obtain said telephonic disconnection and thereby allow one of said calling lines to become telephonically connected thereto, and means under the control of apparatus at a waiting substation, operative previous to the response of the called for substation, to prevent said connection.

34. A telephone exchange system including telephone lines extending from substations to a multiple switchboard, calling signal apparatus at said substations, link connectors for connecting said substations, means for connecting a plurality of calling lines to a busy line by way of said link connectors without establishing telephonic connection therebetween, but establishing telephonic connection, when said busy line is telephonically disconnected from another line, from the formerly busy line to each such calling line successively, in the same order in which said link connectors were connected to said busy line, means under the control of apparatus at a substation of said busy line to obtain said telephonic disconnection and thereby allow one of said calling lines to become telephonically connected thereto, and means whereby said calling signal apparatus at a substation of said busy line is operated by the impression of signaling current on said line each time such a telephonic connection is made, the subsequent response at said substation preventing said impression and establishing a talking connection to the connected calling substation.

35. A telephone exchange system including telephone lines extending from substations to a multiple switchboard, link connectors for connecting said substations, means for connecting a plurality of calling lines to a busy line by way of said link connectors without establishing telephonic connection therebetween, but establishing telephonic connection, when said busy line is telephonically disconnected from another line, from the formerly busy line to each such calling line successively, in the same order in which said link connectors were connected to said busy line, said means comprising a plurality of connecting relays associated with the same link connector, means whereby the actuation of one of said relays is prevented when a connection is made to a line telephonically connected to another line, and means whereby the actuation of two of said relays is prevented when connection is made to a line for which another calling line is waiting, and means whereby the actuation of the other such relays are successively so prevented according to the

number of said plurality of calling lines so waiting, means under the control of apparatus at a substation of said busy line to obtain said telephonic disconnection and thereby allow one of said calling lines to become telephonically connected thereto, said last mentioned means comprising means whereby said connecting relays are successively actuated as the telephonically connected line is disconnected, the actuation of all of said plurality of relays establishing the telephonic connection between the calling and called substations.

36. A telephone exchange system including telephone lines extending from substations to a multiple switchboard, calling signal apparatus at said substations, means for connecting a plurality of calling lines to a busy line by way of said link connectors without establishing telephonic connection therebetween, but establishing telephonic connection, when said busy line is telephonically disconnected from another line, from the formerly busy line to each such calling line successively, in the same order in which said link connectors were connected to said busy line, means to operate said calling signal apparatus at a substation of said busy line by the impression of signaling current on said line each time such a telephonic connection is made, means operated by the subsequent response at said substation to prevent said impression and establish a talking connection to the connected calling substation, said first mentioned means comprising a plurality of relays associated with each of said link connectors, means to permit the actuation of one of said relays when a link connector is connected to a called for line telephonically connected to another line, means to prevent the actuation of two of said relays when a connection is made to a line for which another calling line is waiting, and means whereby the actuation of the other such relays are successively so prevented according to the number of said plurality of calling lines so waiting, means to successively actuate said relays, as said waiting calling lines are successively telephonically connected to the called for line, the actuation of all such relays being necessary in order to establish a telephonic connection through said link connector and thereby operate said calling signal apparatus; said means to operate said calling signal apparatus comprising a ringing relay individual to each of said link connectors, and a circuit controlled by the actuation of the same for impressing said signaling current on said line and means under the control of apparatus at a called for substation to de-energize said ringing relay, thereby preventing said impression and establishing said talking connection.

37. A telephone exchange system including

ing telephone lines extending from substations to an exchange, link connectors for connecting said substations in combination with automatic means individual to the respective link connectors to prevent a telephonic connection between a calling line and a line telephonically connected to another line and to subsequently establish such a connection when said busy line becomes idle, said automatic means comprising a relay for each of said link connectors, the actuation of which establishes the telephonic connection through said link connector, a source of intermittent current, a source of steady current, means whereby current from said first mentioned source initially energizes said relay when one of said link connectors is connected to an idle line and thereby substitutes current from said second mentioned source, means to prevent said energization when said link connector is connected to a line already telephonically connected to another line, thereby preventing said telephonic connection, a low resistance shunt, said last mentioned means comprising means for intermittently connecting said shunt around said relay in synchronism with the impressions of intermittent current through said relay from said first mentioned source, said shunt being connected by the previous actuation of a relay of another link connector previously connected to the same line, and means to remove said shunt by the de-energization of said last mentioned relay when said line becomes idle, thereby allowing said first mentioned relay to be energized and the telephonic connection to be established.

38. A telephone exchange system including telephone lines extending from substations to an exchange, link connectors for connecting said substations, signals individual to the respective link connectors, means to prevent the energization of one of said signals when one of said link connectors is connected to a busy line and to subsequently energize said signal when said line becomes idle, said means comprising a relay for each of said link connectors, the actuation of which energizes said signal, a source of intermittent current, a source of steady current, means whereby current from said first mentioned source initially energizes said relay when one of said link connectors is connected to an idle line and thereby substitutes current from said second mentioned source, means to prevent said energization when said link connector is connected to a busy line, thereby preventing said energization of said signal, a low resistance shunt, said last mentioned means comprising means for intermittently connecting said shunt around said relay in synchronism with the impressions of intermittent current through said relay from said first mentioned source,

said shunt being connected by the previous actuation of a relay of another link connector previously connected to the same line, and means to remove said shunt by the de-energization of said last mentioned relay when said line becomes idle, thereby allowing said first mentioned relay and said signal to be energized.

39. A telephone exchange system including telephone lines extending from substations to an exchange switchboard, a telephone set for each operator's position at said switchboard, link connectors for connecting said substations, means for telephonically connecting said set to a calling line by way of one of said link connectors, and means to prevent a telephonic connection of said set to a busy line, said means comprising a relay for each of said link connectors, the actuation of which establishes said telephonic connection by way of said link connector, a source of intermittent current, a source of steady current, means whereby current from said first mentioned source initially energizes said relay, when one of said link connectors is connected to an idle line and thereby substitutes current from said second mentioned source, means to prevent said energization when said link connector is connected to a busy line, thereby preventing said telephonic connection, a low resistance shunt, said last mentioned means comprising means for intermittently connecting said shunt around said relay in synchronism with the impressions of intermittent current through said relay from said first mentioned source, said shunt being formed by the telephonic connection of another link connector to the same line.

40. A telephone exchange system including telephone lines extending from substations to an exchange, link connectors for connecting said substations, in combination with automatic means to prevent a telephonic connection by way of one of said link connectors between a substation and a substation already telephonically connected to another substation, said means comprising a relay for each of said link connectors the actuation of which establishes said telephonic connection by way of said link connector, a source of intermittent current, a source of steady current, means whereby current from said first mentioned source initially energizes said relay when one of said link connectors is connected to an idle line and thereby substitutes current from said second mentioned source, means to prevent said energization when said link connector is connected to a busy line, thereby preventing said telephonic connection, a low resistance shunt, said last mentioned means comprising means for intermittently connecting said shunt around said relay in synchronism with

the impressions of intermittent current through said relay from said first mentioned source, said shunt being formed by the telephonic connection of another link connector to the same line.

41. A telephone exchange system including telephone lines extending from substations to an exchange, a source of electric energy, link connectors to connect said substations and inductive talking means individual thereto, an operator's telephone set and inductive talking means individual thereto, means to telephonically connect a substation line to said source by way of said first mentioned inductive means, and means to connect said line to said source by way of said second mentioned inductive means, whereby the telephone apparatus at a substation of said line is operable by the current from said source when either of said connections is made and said operator's telephone set is telephonically connected to said substation only when said second mentioned inductive means is connected thereto.

42. A telephone exchange system including telephone lines extending from substations to an exchange switchboard having a line signal individual to each substation line, a pilot signal individual to each operator's position at said switchboard and operated thereat upon the energization of one or more of said line signals of the lines assigned to said position for answering, means to operate said pilot signal at another operator's position, and means at said second mentioned position operative when said last mentioned pilot signal is operated thereat to operate the pilot signal individual to said second mentioned position at still another operator's position.

43. A telephone exchange system including telephone lines extending from substations to an exchange switchboard having a line signal individual to each substation line, an audible pilot signal individual to each operator's position at said switchboard and operated thereat upon the energization of one or more of said line signals of the lines assigned to said position for answering, means to transfer said audible signal to another operator's position, means to cause said transfer to transfer the audible pilot signal individual thereto to another operator's position, and means whereby the audible pilot signals of all the operator's positions at said switchboard are successively so transferred.

44. A telephone exchange system, including telephone lines extending from substations to an exchange having a line signal individual to each substation line, a telephone receiver for each operator's position at said exchange, means common respectively to groups of said line signals to sound an audible signal in said receiver simultaneously with the operation of any line signal in a

corresponding group, said means including a primary circuit comprising a source of fluctuating current, a secondary circuit associated with said primary circuit and including said receiver, and operator controlled means to discontinue said signal by opening said primary circuit.

45. A telephone exchange system, including telephone lines extending from substations to an exchange having a line signal individual to each substation line, a telephone receiver for each operator's position at said exchange, means common respectively to groups of said line signals to sound an audible signal in said receiver simultaneously with the operation of any line signal in a corresponding group, said means including a primary circuit comprising a source of fluctuating current, a secondary circuit associated with said primary circuit and including said receiver, and means to transfer said primary circuit from association with said secondary circuit to association with a secondary circuit including a receiver at another operator's position, thereby sounding said signal in said last mentioned receiver instead of in said first mentioned receiver.

46. A telephone exchange system, including telephone lines extending from substations to an exchange having a line signal individual to each substation line, a telephone receiver for each operator's position at said exchange, means common respectively to groups of said line signals to sound an audible signal in said receiver simultaneously with the operation of any line signal in a corresponding group, said means including a primary circuit comprising a source of fluctuating current, a secondary circuit associated with said primary circuit and including said receiver, means to transfer said primary circuit from association with said secondary circuit to association with a secondary circuit including a receiver at another operator's position, thereby sounding said signal in said last mentioned receiver instead of in said first mentioned receiver, and means at said second mentioned position to transfer said primary circuit from association with said secondary circuit thereat, to association with a corresponding secondary circuit at still another operator's position.

47. A telephone exchange system, including telephone lines extending from substations to an exchange having a line signal individual to each substation line, a telephone receiver for each operator's position at said exchange, means common respectively to groups of said line signals to sound an audible signal in said receiver simultaneously with the operation of any line signal in a corresponding group, said means including a primary circuit comprising a source of fluctuating current, a secondary circuit associated with said primary circuit and including said receiver, and operator controlled means to discontinue said signal by opening said primary circuit.

- tuating current, a secondary circuit associated with said primary circuit and including said receiver, means to transfer said primary circuit from association with said secondary circuit to association with a secondary circuit including a receiver at another operator's position; thereby sounding said signal in said last mentioned receiver instead of in said first mentioned receiver.
- 10 means at said second mentioned position to transfer said primary circuit from association with said secondary circuit thereat, to association with a corresponding secondary circuit at still another operator's position;
- 15 means at said third mentioned position to prevent the sounding thereat of said signal, and means whereby said signal will be sounded in the receiver at said first, second or third mentioned position, according to which position first restores to normal the aforementioned means thereat.
48. A telephone exchange system including telephone lines extending from substations to an exchange switchboard having a line signal individual to each substation line; a primary source of fluctuating current; transferring means, a telephone receiver, and a circuit including said source and controlled by said means for each operator's position at said switchboard; means under the control of apparatus at a calling substation to operate said line signal and close said circuit, thereby causing said fluctuating current to sound an audible pilot signal in said receiver, and automatic means, when a call is being attended to at said position, to operate said transferring means to transfer said circuit to another operator's position and causing said signal to be sounded in the receiver thereat and also to re-transfer to still another operator's position another circuit including said source of fluctuating current, which may be transferred to said first mentioned position, to cause said signal to be sounded in the receiver at said third mentioned position.
49. A telephone exchange system, including telephone lines extending from substations to an exchange switchboard having a line signal individual to each substation line, a primary source of fluctuating current; a transfer relay, a telephone receiver, a circuit including said source and controlled by said transfer relay for each operator's position at said switchboard; and means under the control of apparatus at a calling substation to operate said line signal and thereby close said circuit, causing said fluctuating current to sound an audible signal in said receiver.
50. A telephone exchange system, including telephone lines extending from substations to an exchange switchboard having a line signal individual to each substation line, a primary source of fluctuating current; a transfer relay, a telephone receiver, a circuit including said source and controlled by said transfer relay for each operator's position at said switchboard; means under the control of apparatus at a calling substation to operate said line signal and thereby close said circuit, causing said fluctuating current to sound an audible signal in said receiver, and automatic means, operative when a call is being attended to at said position, to actuate said relay, to open the circuit for said fluctuating current, thereby preventing the sounding of said audible signal.
51. A telephone exchange system, including telephone lines extending from substations to an exchange switchboard having a line signal individual to each substation line, a primary source of fluctuating current; a transfer relay, a telephone receiver, a circuit including said source and controlled by said transfer relay for each operator's position at said switchboard; means under the control of apparatus at a calling substation to operate said line signal and thereby close said circuit, causing said fluctuating current to sound an audible signal in said receiver, and automatic means operating when a call is being attended to at said position, to actuate said transfer relay to transfer the connection of said circuit and cause said fluctuating current to sound said signal in the telephone receiver at another operator's position.
52. A telephone exchange system, including telephone lines extending from substations to an exchange switchboard having a line signal individual to each substation line, a primary source of fluctuating current; a transfer relay, a re-transfer relay, a telephone receiver, a circuit including said source and controlled by said transfer relay for each operator's position at said switchboard; means under the control of apparatus at a calling substation to operate said line signal and thereby close said circuit, causing said fluctuating current to sound an audible signal in said receiver, and also actuate said retransfer relay, to retransfer a transferred connection of said circuit and causing said fluctuating current to sound said signal in the telephone receiver at still another operator's position.
53. A telephone exchange system, including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, a plurality of operator's positions at said switchboard, each position having a right and left group of said line signals assigned to it, a primary source of fluctuating current, a right transfer relay, a left transfer relay, a right re-transfer relay, a left re-transfer relay, a telephone receiver,

said relays and receiver being individual to each of said positions, a circuit including said source and controlled by said right transfer relay, a circuit including said source and controlled by said left transfer relay, means under the control of apparatus at a calling substation to operate a line signal pertaining to either of said groups and thereby close said circuit controlled by the corresponding transfer relay, causing said fluctuating current to sound an audible signal in said receiver, and automatic means, operating when a call is being attended to at said position, to actuate all of said relays, to transfer the connection of said circuit controlled by said right transfer relay to the next position at the right and the connection controlled by said left transfer relay to the next position at the left, the actuation of said right re-transfer relay re-transferring to the next position to the right of said right position, said circuit connection transferred therefrom and the actuation of said left re-transfer relay, re-transferring to the next position to the left of said left position said circuit connection transferred therefrom, said fluctuating current thereupon sounding said signal in the telephone receiver at the position to which it is ultimately transferred.

54. A telephone exchange system, including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, a plurality of operator's positions at said switchboard, each position having a right and left group of said line signals assigned to it, a primary source of fluctuating current, a right transfer relay, a left transfer relay, a right re-transfer relay, a left re-transfer relay, a telephone receiver, said relays and receiver being individual to each of said positions, a circuit including said source and controlled by said right transfer relay, a circuit including said source and controlled by said left transfer relay, means under the control of apparatus at a calling substation to operate a line signal pertaining to either of said groups and thereby close said circuit controlled by the corresponding transfer relay, causing said fluctuating current to sound an audible signal in said receiver, and automatic means, operating when a call is being attended to at said position, to actuate all of said relays, to transfer the connection of said circuit controlled by said right transfer relay to the next position at the right and the connection controlled by said left transfer relay to the next position at the left, the actuation of said right re-transfer relay re-transferring to the next position to the right of said right position, said circuit connection transferred therefrom, the actuation of said

left re-transfer relay, re-transferring to the next position to the left of said left position said circuit connection transferred therefrom, and means whereby, if a call is being attended to at said position, said circuit connection will be completed at the first of the three positions to become idle, said fluctuating current thereupon sounding said signal in the telephone receiver at said position.

55. A telephone exchange system, including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, a plurality of operator's positions at said switchboard, each position having a right and left group of said line signals assigned to it, a primary source of fluctuating current, a right transfer relay, a left transfer relay, a right re-transfer relay, a left re-transfer relay, a telephone receiver, said relays and receiver being individual to each of said positions, a circuit including said source and controlled by said right transfer relay, a circuit including said source and controlled by said left transfer relay, means under the control of apparatus at a calling substation to operate a line signal pertaining to one of said groups and thereby close said circuit controlled by the corresponding transfer relay, causing said fluctuating current to sound an audible signal in said receiver, and automatic means, operating when a call is being attended to at said position, to actuate all of said relays, to transfer the connection of said circuit controlled by said right transfer relay to the next position at the right and the connection controlled by said left transfer relay to the next position at the left, the actuation of said right re-transfer relay re-transferring to the next position to the right of said right position, said circuit connection transferred therefrom and the actuation of said left re-transfer relay, re-transferring to the next position to the left of said left position said circuit connection transferred therefrom, said fluctuating current thereupon sounding said signal in the telephone receiver at the position to which it is ultimately transferred, and means other than said relays, when one of said positions is vacated, for maintaining all of said transfers until said position is re-occupied.

56. A telephone exchange system, including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, a plurality of operator's positions at said switchboard, each position having a right and left group of said line signals assigned to it, a pilot signal and a circuit therefor individual to each of said positions, means under the control of apparatus at a calling

substation to operate a line signal pertaining to one of said groups and thereby close said pilot signal circuit, and means whereby the operation of said line signal will transfer to another operator's position said pilot signal circuit closed by a line signal of the other group.

57. A telephone exchange system, including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, a plurality of operator's positions at said switchboard, each position having a right and left group of said line signals assigned to it, a transfer relay associated with one of said groups and a pilot signal and a circuit therefor, individual to each of said positions, means under the control of apparatus at a calling substation to operate a line signal pertaining to one of said groups and thereby close said pilot signal circuit, and means whereby the operation of said line signal actuates said transfer relay and causes the same to transfer to another operator's position said pilot signal circuit closed by a line signal of the other group.

58. A telephone exchange system, including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, a plurality of operator's positions at said switchboard, each position having a right and left group of said line signals assigned to it, a pilot signal and a circuit therefor individual to each of said positions, means under the control of apparatus at a calling substation to operate a line signal pertaining to one of said groups and thereby close said pilot signal circuit, means whereby the operation of a line signal pertaining to one of said groups will transfer to another operator's position said pilot signal circuit closed by a line signal of the other group, and means whereby said transfer causes said pilot signal circuits closed by the line signals at said second mentioned position to be transferred to another operator's position.

59. A telephone exchange system including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, a plurality of operator's positions at said switchboard, each position having a right and left group of said line signals assigned to it, a telephone receiver individual to each of said positions, means under the control of apparatus at a calling substation to operate a line signal pertaining to one of said groups and thereby close a circuit including said source, said circuit being associated with said telephone receiver, whereby an audible signal is sounded therein, and means whereby the operation of a line signal pertaining to one of said groups will transfer said audible

signal produced by a line signal of the other group to another operator's position and sound said audible signal in the receiver thereat.

60. A telephone exchange system including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, a plurality of operator's positions at said switchboard, each position having a right and left group of said line signals assigned to it, a transfer relay associated with one of said groups and a telephone receiver individual to each of said positions, means under the control of apparatus at a calling substation to operate a line signal pertaining to either of said groups and thereby close a circuit including said source, said circuit being associated with said telephone receiver, whereby an audible signal is sounded therein, and means whereby the operation of a line signal pertaining to one of said groups will actuate said transfer relay and thereby transfer said audible signal produced by a line signal of the other group to another operator's position and sound said audible signal in the receiver thereat.

61. A telephone exchange system including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, a plurality of operator's positions at said switchboard, each position having a right and left group of said line signals assigned to it, a telephone receiver individual to each of said positions, means under the control of apparatus at a calling substation to operate a line signal pertaining to one of said groups and thereby close a circuit including said source, said circuit being associated with said telephone receiver, whereby an audible signal is sounded therein, means whereby the operation of a line signal pertaining to one of said groups will transfer said audible signal produced by a line signal of the other group to another operator's position and sound the same in the receiver thereat, and means whereby said transfer causes the audible signal originating in said second mentioned position to be transferred to another operator's position.

62. A telephone exchange system, including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, a pilot signal circuit operated by said line signals, a second pilot signal circuit, the closure of which transfers said first mentioned circuit to another operator's position, a third pilot signal circuit, the closure of which transfers said first and second mentioned circuits to other operators' positions, a fourth pilot signal circuit, the closure of which transfers said first, second and third

mentioned circuits to other operators' positions, and a circuit the closure of which transfers all of said circuits to other operators' positions.

5 63. A telephone exchange system, including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, a telephone receiver at each operator's position of said switchboard, an audible pilot signal circuit, operated by said line signals, an audible second pilot signal circuit, the closure of which transfers said first mentioned circuit to another operator's position, 10 a third audible pilot signal circuit, the closure of which transfers said first and second mentioned circuits to other operators' positions, a fourth audible pilot signal circuit, the closure of which transfers said first, second and third mentioned circuits to other operators' positions, and a circuit the closure of which transfers all of said audible signal circuits to other operators' positions, means under the control of apparatus at a calling substation to operate its individual line signal, thereby closing one of said audible signal circuits and sounding an audible signal in said receiver at one of said positions.

30 64. A telephone exchange system including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, a pilot signal individual to one of the operator's positions at said switchboard and operative by one or more of said line signals assigned to said position, a similar signal individual to another of said positions, means operative when said first mentioned position 40 is vacated by the operator thereat, for transferring said first mentioned signal to said second mentioned position, and means whereby the operation of said transferred signal transfers said second mentioned signal to another of said positions.

45 65. A telephone exchange system including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, a pilot signal individual to one of the operator's positions at said switchboard and operative by one or more of said line signals assigned to said position, a similar signal individual to another of said positions, means operative when said first mentioned position is vacated by the operator thereat, for transferring said first mentioned signal to said second mentioned position, means whereby the operation of said transferred signal transfers said second mentioned signal to another of said positions, means whereby if said second mentioned position is vacated both of said signals are so transferred to another position, means whereby the operation

of said transferred signal similarly transfers the pilot signal of said third mentioned position to still another position, and means for successively so transferring said signals to the next position when said positions are so vacated.

70 66. A telephone exchange system including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, a pilot signal individual to one of the operator's positions at said switchboard and operative by one or more of said line signals assigned to said position, a similar signal individual to another of said positions, means operative when said first mentioned position is vacated by the operator thereat, for transferring said first mentioned signal to said second mentioned position, and means whereby the operation of said transferred signal transfers said second mentioned signal to another 85 of said positions, said first mentioned means comprising a relay to control said transfers, an operator's telephone transmitter, an operator's transmitter plug and jack and the primary of an induction coil, a circuit including said relay, transmitter, plug, jack and primary, so connected and arranged that the withdrawal of said plug from said jack when the position is vacated opens the circuit through said relay and de-energizes 95 the same.

67. A telephone exchange system including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, link connectors for connecting said substations, and an operator's telephone set individual to each operator's position at said switchboard, means to telephonically connect said set to any of said link connectors pertaining to said position, and means operative, when said position is vacated, whereby said link connectors become connective to the operator's set of another of said positions.

110 68. A telephone exchange system including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, link connectors for connecting said substations, and an operator's telephone set individual to each operator's position at said switchboard, means to telephonically connect said set to any of said link connectors pertaining to said position, means operative when said position is vacated, whereby said link connectors become connective to the operator's set of another of said positions, and means, when said second mentioned position is also vacated, whereby said link connectors pertaining to said first and second 125 mentioned positions are connective to the operator's set of another of said positions, and means for successively so connecting

said link connectors as the remaining positions at said switchboard are vacated.

69. A telephone exchange system including telephone lines extending from substations to a multiple switchboard having a line signal individual to each substation line, link connectors for connecting said substations, and an operator's telephone set individual to each operator's position at said switchboard, means to telephonically connect said set to any of said link connectors pertaining to said position, and means operative when said position is vacated, whereby said link connectors become connective to the operator's set of another of said positions, said first mentioned means comprising a relay to control said transfers, an operator's telephone transmitter, an operator's transmitter plug and jack and the primary of an induction coil, a circuit including said relay, transmitter, plug, jack and primary so connected and arranged that the withdrawal of said plug from said jack when the position is vacated opens the circuit through said relay and de-energizes the same.

70. A telephone exchange system including telephone lines extending from substations to an exchange switchboard, link connectors to connect said substations, a relay individual to an operator's position at said switchboard, a pilot signal circuit, a source of electric energy; means operative, when one of said link connectors is connected to a calling line, for closing a circuit including substation apparatus of said line, said relay and said source, whereby said relay is actuated, thereby opening said pilot signal circuit.

71. A telephone exchange system including telephone lines extending from substations to an exchange switchboard, link connectors to connect said substations, a relay individual to an operator's position at said switchboard, pilot signal transferring means, a source of electric energy; means operative, when one of said link connectors is connected to a calling line, for closing a circuit including substation apparatus of said line, said relay and said source, whereby said relay is actuated, thereby operating said pilot signal transferring means.

72. A telephone exchange system including telephone lines extending from substations to an exchange switchboard, link connectors to connect said substations, a relay individual to an operator's position at said switchboard, pilot signal transferring means, a source of electric energy; means operative, when one of said link connectors is connected to a calling line, for closing a circuit including substation apparatus of said line, said relay and said source, whereby said relay is actuated, thereby operating said pilot signal transferring means, means operative thereafter when said link con-

necter is connected to a called for line, for opening said circuit, thereby de-energizing said relay and restoring said transferring means to its normal condition, and means for preventing the closure of said circuit if said link connector is first connected to a line other than a calling line, whereby said transferring means is not operated.

73. A telephone exchange system including telephone lines extending from substations to an exchange switchboard, individual line signals for said lines, link connectors to connect said substations, a pilot signal operated at an operator's position at said switchboard by said line signals, a pilot signal transferring means, a source of electric energy; means operative, when all the link connectors assigned to said position are telephonically connected to substations, to operate said transferring means, thereby operating said pilot signal at another operator's position.

74. A telephone exchange system including telephone lines extending from substations to an exchange switchboard, individual line signals for said lines, link connectors to connect said substations, a pilot signal operated at an operator's position at said switchboard by said line signals, a pilot signal transferring means, a source of electric energy; means operative, when all the link connectors assigned to said position are telephonically connected to substations, to operate said transferring means, thereby operating said pilot signal at another operator's position, and transferring thereto, pilot signals transferred to said first mentioned position from another operator's position.

75. A telephone exchange system including telephone lines extending from substations to an exchange, an operator's telephone receiver, the secondary of an induction coil, a condenser, a relay in multiple relation to said condenser, a source of direct electric current, link connectors for connecting said substations, a listening key individual to each of said link connectors, means whereby the manipulation of any of said keys closes a circuit for voice currents including said receiver, secondary, condenser and a substation connected to the corresponding link connector, and means whereby said manipulation of said key also closes a circuit which includes said receiver, secondary, relay and source, whereby said relay is actuated.

76. A telephone exchange system including telephone lines extending from substations to an exchange, an operator's telephone receiver, the secondary of an induction coil, a condenser, a relay in multiple relation to said condenser, pilot signal transferring means, a source of direct electric current, link connectors for connecting said substations, a listening key individual to each of

said link connectors, means whereby the manipulation of any of said keys closes a circuit for voice currents including said receiver, secondary, condenser and apparatus at a substation connected to the corresponding link connector, and means whereby said manipulation of said key also closes a circuit which includes said receiver, secondary,

relay and source, whereby said relay is actuated, thereby operating said pilot signal transferring means.

In testimony whereof I have affixed my signature in presence of a witness.

HUBERT SYDNEY TURNER.

Witness:

FRANCIS T. MAGUIRE.