G. DEAKIN.

AUTOMATIC TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED FEB. 2, 1911.

1,024,184.

Patented Apr. 23, 1912.

4 SHEETS—SHEET 1.

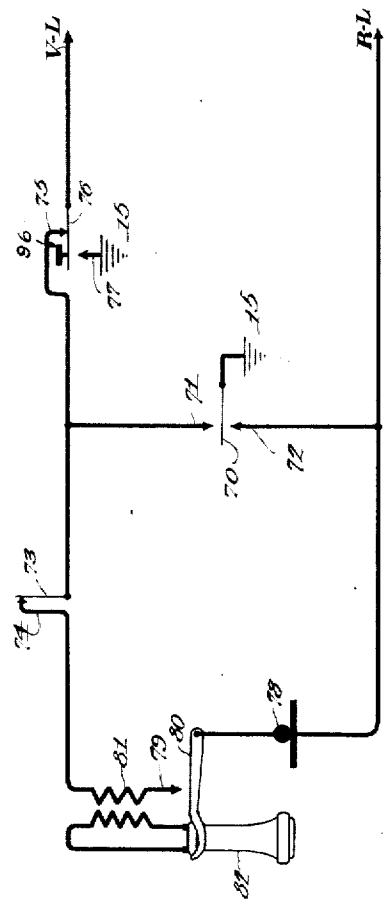

Fig. 1

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4 SHEETS-SHEET 2.

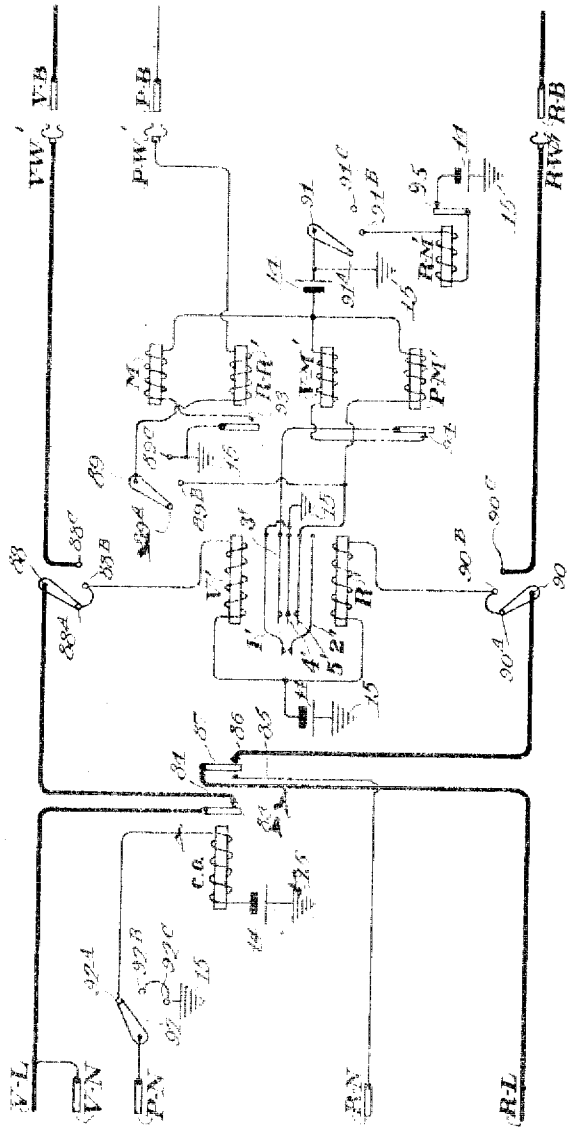

Fig. 2

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4 SHEETS—SHEET 3.

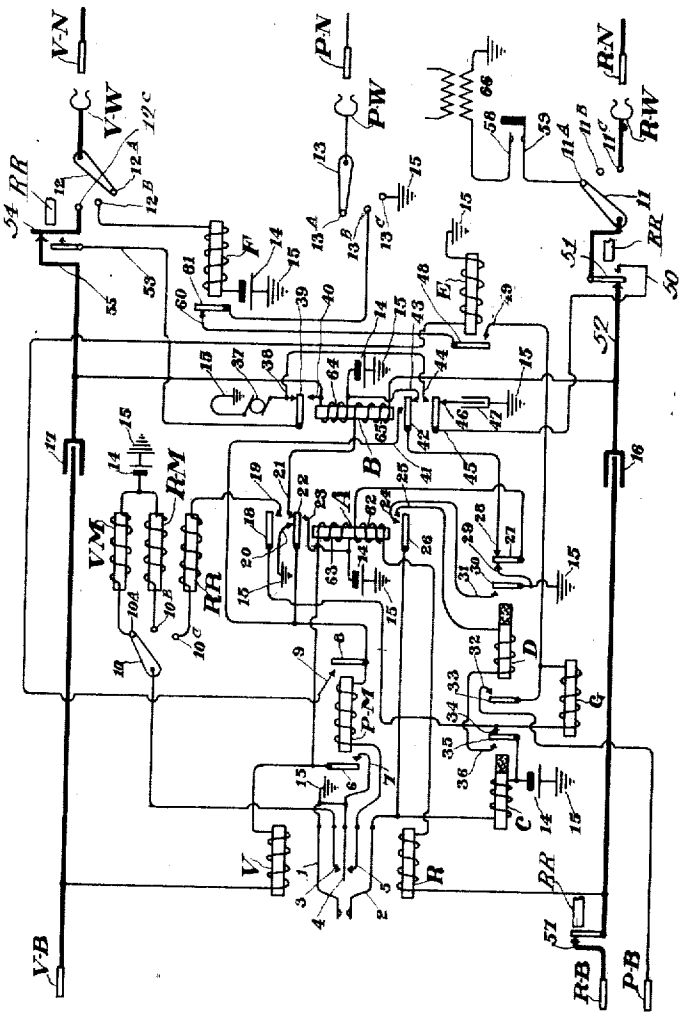

Fig. 3

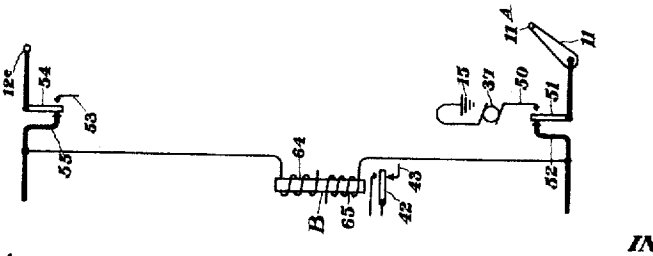

Fig. 3a

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4 SHEETS—SHEET 4.

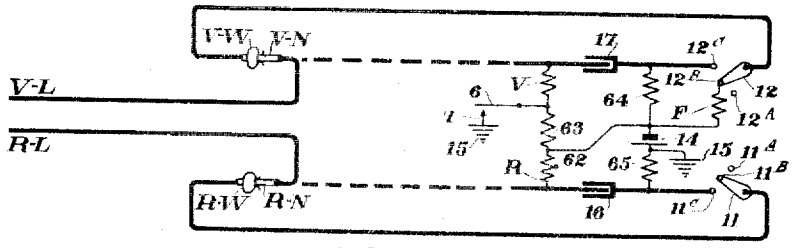

Fig. 4

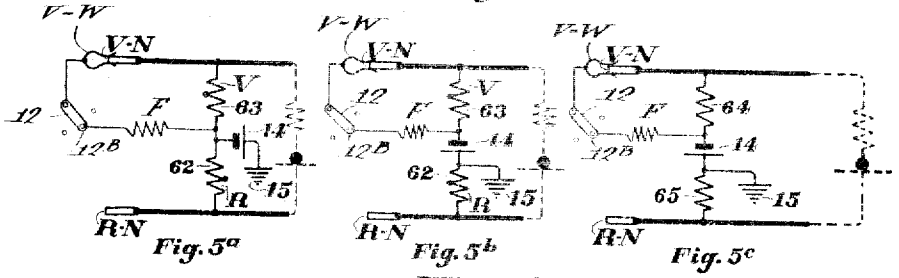

Fig. 5a Fig. 5b Fig. 5c

Fig. 5

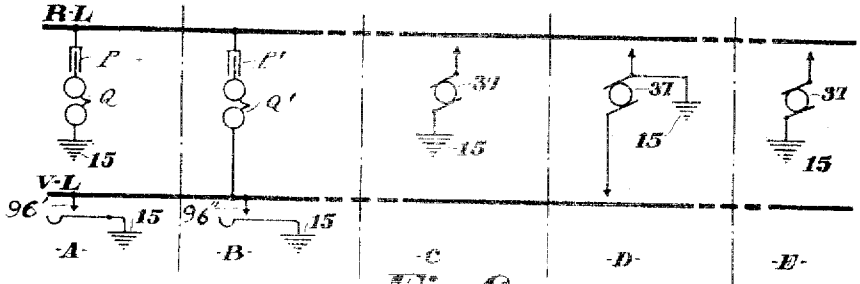

Fig. 6

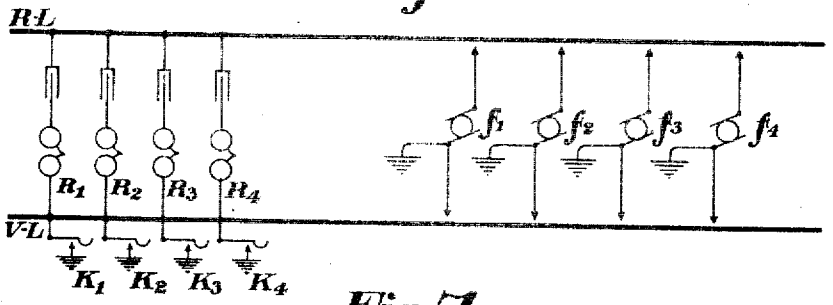

Fig. 7

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AUTOMATIC TELEPHONE-EXCHANGE SYSTEM.

1,024,184. Specification of Letters Patent. Patented Apr. 23, 1912.

Application filed February 2, 1911. Serial No. 606,216.

To all whom it may concern:

Be it known that I, GERALD DEAKIN, a citizen of the United States of America, and a resident of Berkeley, Alameda county, California, have invented a new and useful Improvement in Automatic Telephone-Exchange Systems, of which the following is a specification.

My invention pertains to automatic telephone exchange systems in general, but more particularly to an improved electrical circuit for what is commonly called a "connector switch" or simply a "connector," of the general physical form described in Patent 815,176, granted to Messrs. A. E. Keith, J. Erickson and C. J. Erickson on March 13, 1906. These switching machines are electrically operated and by an endwise and rotatable step by step movement of a shaft are capable of making any one of a number of possible connections.

In any connector in which the releasing feature depends upon the simultaneous grounding of both sides of the calling line, it is desirable, in order to prevent a premature disconnection, due to a second party on the calling line attempting to call or otherwise grounding both sides of the calling line, that the connector shall not release following the simultaneous grounding of both sides of the calling line, unless the line circuit is open at all stations connected to it. In my improved circuit arrangement, I provide for this desirable feature.

In an automatic telephone exchange having party lines, facilities must be provided whereby a station on a party line may call any other station on the same line. Such connections as these are commonly called "reverting" connections or calls. It is, therefore, desirable that a connector shall be capable of making such connections in the usual manner, in addition to regular connections to non-busy lines. In other words, a connector must be capable of disregarding the "busy" guard on the line contacts when making reverting calls, but not on attempted connections to other busy lines. In my improved circuit I provide for such a connector.

In establishing two-party line service in an existing automatic telephone exchange, equipped exclusively for main line service; it is desirable to avoid the necessity of installing new or additional ringing machines at the central office, and replacing the ringers at the subscribers' stations. In my improved party line system, I provide for an arrangement, whereby a complete and efficient two-party line service may be rendered by the use of the old main line ringing equipment, it being unnecessary to replace either the ringing machines or ringers.

In the preferred form of my improved party line system, I terminate the line from the subscribers' stations at the central office either directly or indirectly on a "selector switch" or other similar piece of switching apparatus. For convenience, I will make use of, in describing my invention, the type of "selector" described in U. S. Patent No. 815321, granted to Messrs. A. E. Keith, John and Charles J. Erickson, on March 13, 1906. It should be understood that in the automatic telephone systems in commercial use to-day, the connector selects the last two digits of a number and that all previous digits are selected by selectors. Thus, in an automatic telephone exchange of a capacity requiring the use of four digits in all numbers, the first two digits in every case are selected by a first and second selector respectively, and the last two digits by a connector.

In the preferred form of my improved party line system, I provide for a plurality of classes of connectors, there being as many classes of connectors as there are stations on a party line. Each class of connector is arranged to call its corresponding class of station only, and each party line by the proper multiplying of connector "bank" contacts is made available to as many classes of connectors as there are classes of stations. Therefore, by assigning such numbers to the various stations on a party line as will cause the proper connector to be picked up automatically, during calling, no special operating methods are required on the part of the calling subscriber in establishing a connection to any station, party line or otherwise.

As previously stated, the connector selects the last two digits of a number and selectors all previous digits. Therefore, it may be said that the purpose of selectors is to select automatically, the proper connector. The selectors how in common use are arranged to select an idle trunk in anyone of ten groups of trunks, running to other selectors or connectors. The first group corresponds to the figure 1 and is selected by calling one on the subscribers' station dial;

the second group to the figure 2, and so on to the tenth group which corresponds to the figure 0. Since the connector must select the last two digits of every number it follows that each connector must have access to at least one hundred lines, *i. e.*, 00, 01 to 98, 99. In my improved party line system arranged for example, for the purpose of illustration, for four stations on a line, there would be four classes of connectors, each class having access to the same group of lines. This would be accomplished by multiplying the connector bank contacts, they being numbered from 00, 01 to 98, 99, before each class of connector. Now to permit the selection of the proper connector, it is only necessary to connect each class of connector to different groups of bank contacts or levels on the preceding selectors. Thus, in the particular case of the four party lines cited, the first class of connectors might be connected to the first group of trunk contacts, on the selectors, and the second class of connectors to the second group of contacts, and so on. In this manner, line 01, for example would be selected whenever the following last three digits were called, 101, 201, 301, 401, providing, of course, that any previous digits called are the same in all cases. In each case, however, a different group of connectors would be selected with a result that the corresponding station only, on the party line, would be called.

In Figure 1 is shown a diagrammatic circuit sketch of a simple form of an automatic telephone set. In Fig. 2 is shown a circuit sketch of a selector for extending a call from the subscribers' line to a connector or to another selector. In Fig. 3 is shown a circuit sketch of my improved form of party line connector. Fig. 3[A] shows a modification of the ringing circuit of the connector circuit shown in Fig. 3. In Fig. 4 is shown the line circuit condition with respect to the connector during the establishment of a reverting call. Figs. 5[A], 5[B] and 5[C] illustrate the line circuit conditions with respect to the connector met with in attempting to establish a connection with a busy line. In Fig. 6 is diagrammatically shown the ringer and ringing generator connections of a two-party line system, adapted for use with automatic apparatus. In Fig. 7 is diagrammatically shown the ringer and generator connections of a four or other multi-party line system, employing harmonic or other similar ringers requiring a different kind or arrangement of ringing generator current.

In the accompanying drawings, Fig. 1 is a simplified sketch of the general form of subscribers'- telephone circuit, required to operate the automatic central office apparatus, referred to hereinafter. It forms no part of my invention and is shown here, merely with the purpose of illustrating the operation of the selector and connector described later on. A detailed description of the full circuit will be found in U. S. Patent No. 866,639, granted to Edward D. Fales on September 24, 1907. In the figure, contact springs 70, 71 and 72 illustrate parts of both the calling and release circuits, but in reality, separate sets of springs are used. The calling circuit springs are controlled by the dial on the face of the subscribers' set, which dial affords the subscriber the necessary means for sending the proper impulses over the line to the central office apparatus. The release circuit springs are controlled by the switch hook. Contact springs 73 and 74 are controlled by the calling dial and break contact when the dial is moved out of its normal position. The object of these springs is to open the normally closed circuit through the telephone set while calling. A ringing key is shown at 96. When operated, it opens the telephone circuit through contact springs 75 and 76 and connects line VL to earth 15, at 77. A transmitter is shown at 78; an induction coil at 81; a switch hook and contact at 79 and 80 and a receiver at 82.

Fig. 2 illustrates a selector of the general type, described in U. S. Patent No. 815,321, granted to Messrs. Alexander E. Keith, John Erickson and Charles J. Erickson on March 13, 1906. This selector forms no part of my invention and is referred to herein for the purpose of illustrating the preferred form of my improved connector circuit and party line system. V′ and R′ are line relays, controlling springs 1′, 2′, 3′, 4′ and 5′. PM′ is a magnet, commonly known as the "private magnet," controlling side switches 88, 89, 90, 91 and 92. M is a release magnet; RR′ a release relay; VM′ is a magnet controlling the vertical movement of the wipers, RM′ is a magnet controlling the horizontal movement of the wipers. These magnets are commonly known as the "vertical" and "rotary" magnets respectively. VW′, PW′ and RW′ represent the vertical, private and rotary wipers respectively. VB, PB and RB represent the vertical, private and rotary selector bank contacts, which also form part of the connector circuit shown in Fig. 3. VL and RL represent the line wires from the subscribers' station. VN, PN and RN represent the vertical, private and rotary connector bank contacts also shown in Fig. 3. CO is a cut off relay.

Figs. 3 and 3[A] illustrate my improved connector circuit. VB, RB and PB represent the vertical, rotary and private selector bank contacts respectively, also shown in Fig. 2. V and R are line relays, controlling springs 1, 2, 3, 4 and 5. A is relay bridged across the calling line side of the connector and B a similar relay bridged across called line

side of the connector. C and D are slow acting relays, controlling the release circuit. The air gap of relay C is adjusted so that it is quicker in falling back than relay D. E and F represent relays associated with the busy release and the reverting non-release circuits. G represents the connector release magnet. VM the vertical step by step magnet; RM the rotary step by step magnet; RR the ringing relay controlling the three swinging springs 51, 54 and 56; 10, 11, 12 and 13 represent side switches controlled by the private magnet PM; VW, PW and RW represent the vertical, private and rotary wipers respectively, and are arranged to engage connector bank contact VN, PN and RN. The connector bank contacts are connected to the line side of the selector circuit as shown by corresponding letters in Fig. 2. Springs 58 and 59 represent contacts controlled by the connector shaft. These contacts close whenever a shaft is out of its normal position; 16 and 17 represent condensers through which conversation is carried on; 47 represents a condenser placed in the grounded side of ringing circuit; 66 represents a busy tone transformer or its equivalent.

The side switch of both the selector and connector consists of a number of movable springs and fixed contacts, and is controlled by the private magnet, the whole being so designed that the side switch is normally held in what is called its first or normal position under the tension of a spring or springs, which tend to force the side switch into its so called second and third positions. The private magnet of the connectors when first energized and then deënergized, operates an escapement, causing the side switch to step from its first or normal position into its second position. This means that the movable springs are caused to break connection with the first series of fixed contacts and make connection with the second series of fixed contacts. When the private magnet is energized and deënergized a second time, it causes the side switch to step from its second to its third or last position. The side switch of a selector steps into its second position when energized and into its third position when deënergized. The side switch is caused to resume its normal position by energizing the release magnet, which magnet in addition to forcing the side switch back into its normal position, releases the switch shaft to which the wipers are attached, allowing the shaft, first to rotate horizontally, and then drop vertically to its normal position, the shaft, as before stated, being capable of a vertical and horizontal motion.

In both the selector and connector, line relays V and V′ and R and R′ operate in the following manner: When relay of the connector V is energized, contact is made between springs 3 and 4. When relay R is energized contact is made between springs 4 and 5. When relays V and R are energized simultaneously, contact is made between springs 1 and 2 in addition to the contacts previously mentioned.

In Figs. 4, 5, 6 and 7 are illustrated line circuit conditions involved in my improved party line system. In Fig. 4 is diagrammatically illustrated the calling line circuit condition during a reverting call when the side switch of the connector is in its second position. In Figs. 5^A, 5^B and 5^C are illustrated diagrammatically, line circuit conditions of connector bank contacts of busy lines, such as met with in actual practice.

Fig. 5^A, represents the line circuit condition of a calling line before the called subscriber has answered. In Fig. 5^B is shown the circuit condition of the same line after the subscriber has answered. In Fig. 5^C is shown the line circuit condition of a called line during conversation. In Fig. 6 is illustrated diagrammatically, the subscribers' station ringer and central office ringing generator connections in my improved two-party line system, making use of the ordinary main line equipment. A and B represent the two stations. At station A, ringer Q is connected to ground 15, from line wire RL through condenser P. At station B, the ringer Q′, is bridged across line in series with condenser P′; 96′ and 96″ represent ringing key contacts; C represents the arrangement of the ringing circuit of a connector on a regular connection when station A only is to be called. At D is represented the arrangement of the ringing circuit of a connector on a regular connection when station B only is to be called. At E is represented the ringing circuit arrangement of the connector on a reverting call, when station A is calling station B or when station B is calling station A. It should be noted that when station A calls station B the ground required to operate ringer Q′, is supplied by ringing key 96′ of station A. In Fig. 7 is diagrammatically illustrated a four-party line system, employing harmonic or other special ringers, ringer R_1 being so designed as to operate only on current from ringing generator F_1; R_2 on current from ringing generator F_2 and so on. K_1, K_2, etc. represent ringing keys.

To establish a connection with the preferred form of my improved arrangement of equipment and circuits, the calling subscriber removes receiver, 82, Fig. 1, from switch hook 80, thereby closing the line circuit to the central office through contacts 79 and 80. The subscriber may now proceed to operate the calling dial as determined by the number of the station to be called. One action of the calling dial is to cause the

grounded spring 70, to make a series of contacts with spring 71, the number of contacts corresponding to the digit called. At the end of these series of contacts and just before the dial resumes its normal position, a momentary impulse is sent over the opposite side of the line by a momentary connection made between ground spring 70 and spring 72. The closing of contacts 70 and 71 causes current to flow from ground 15, Fig. 1, through 70, 71, 75, 76, line wire VL, to the central office, thence through 83 and 84, Fig. 2, 88, 88^A, winding of relay V', to battery 14, and thence to ground 15. The current thus caused to flow energizes relay V', Fig. 2, causing contact to be made between springs 3', and 4', with a result that a closed circuit is established from ground 15, Fig. 2 through 4', 3', 94, winding of vertical magnet, VM', battery 14, to ground 15. The energizing of the vertical magnet, VM', causes the selector shaft to step up one level, placing the vertical private and rotary wipers, VW', PW', and RW', respectively opposite the first level or horizontal row of selector bank contacts, VB, PB and RB. By sending a series of impulses over line wire VL, as above described, the vertical magnet VM', causes the selector shaft to step up one level for each impulse. As previously stated the final impulse sent over line wire VL, is followed by a similar one over line wire RL. A circuit being established from ground, 15, Fig. 1, through 70, 72, line wire RL, to central office, thence through 86, 87, Fig. 2, 90, 90^A, winding of relay R', to battery 14, and thence to ground 15. Relay R' now, operates and closes contact between springs 4', and 5', Fig. 2, with the result that a circuit is established from earth 15, Fig. 2, through 4', 5', winding of private magnet PM', battery 14, to earth 15. This causes the private magnet PM', to operate and open contact at 94 and step, so to speak, the five side switches, 88, 89, 90, 91 and 92 into their second position, thus connecting switch 88 to contact 88^B, 89, to 89^B, 90, to 90^B, 91 to 91^B, and 92 to 92^B. The closing of contact between 91 and 91^B, causes a current to flow from ground 15, through switch 91, 91^B, winding of rotary magnet RM', through vibrating contact 95, battery 14, to earth again at 15. The rotary magnet, RM', thus energized, causes the selector wipers to be rotated into connection with the first set of trunk contacts of the level to which they have been stepped. Should the first trunk be busy, a ground connection will be found upon the private bank contact PB. A current will now flow from PB to PW', through winding of relay RR', 89, 89^B, winding of magnet PM', battery 14, thence to ground 15. In this manner, the private magnet, PM', will remain energized and the rotary magnet will continue to cause the switch shaft and wipers to rotate. It should be stated that the winding of relay RR', is of a comparatively low resistance compared with the winding of magnet PM'. For this reason, relay RR', is not energized when a circuit is established from the ground on the private bank contact PB, through the windings of relay RR', and private magnet, PM', to battery 14. When a non-busy trunk is picked up, the ground connection on PB will not be found. The circuit thus opened allows the private magnet PM', to resume its normal position and in so doing causes the five side switches to assume their third position, connecting 88 to 88^C, 89 to 89^C, 90 to 90^C, 91 to 91^C and 92 to 92^C. The stepping of side switch 91 from its second position where it made contact with 91^B to its third position making contact with 91^C, opens the circuit through the rotary magnet RM', thereby causing the further rotation of switch shaft to cease. The stepping of side switch 89 into its third position placed a ground on the private wiper through the low resistance winding of relay RR'. In this manner the selector bank contacts picked up are made busy to all other selectors. The stepping of side switches 88 and 90 into their third position, removes line relays V' and R' from connection with the line wires VL and RL respectively, and in place thereof, connects the line wires VL and RL to the vertical and rotary wipers VW' and RW', respectively. To make the calling line busy to any other calling line, side switch 92, in its second and third positions, places a ground on the private contact PN, in the connector banks. Thus, should a connector attempt to select the calling line, the latter will be found busy and the former will fail to make connection, as described later on. The selector as above described is now in position to permit the next series of impulses to be passed on to the next selector or to a connector as the case may be.

In large exchanges, requiring the use of five digits in each number, first, second and third selectors are used to select the first three digits, after which the call is completed by a connector, and in my improved system under consideration, as follows: The subscriber in calling the first of the last two digits of the desired number, causes a series of impulses to be sent out over line wire VL, as previously described, a circuit being established during each impulse, from earth 15, Fig. 1, through 70, 71, 75, 76 Fig. 1, line wire VL, 83 and 84 Fig. 2, 88, 88^C, wiper VW', bank contact VB Figs. 2 and 3, winding of relay V, Fig. 3, winding 63 of relay A, battery 14 to earth 15. This causes relays V and A, Fig. 3, to operate with the result that a circuit is established from earth 15, through 4, 3, 10, 10^A, wind-

ing of vertical magnet VM to battery 14 and earth 15. Thus energized, the vertical magnet VM causes the connector shaft to step up one level; likewise each succeeding impulse sent over line wire VL, causes the connector shaft to step up one additional level. Following the last of the series of impulses sent over line wire VL, an impulse, as previously described is sent over line wire RL, with a result that circuit is established from ground 15, Fig. 1, through 70, 72, line RL, 86 and 87 Fig. 2, 90 and 90', RW', to RB Fig. 3, 57, 56, winding of relay R, winding 62 of relay A, 27, 28, 42, 43 to battery 14 and earth 15. This causes relays R and A Fig. 3, to operate with a result that contact between springs 4 and 5 is made. Current now flows from earth 15, through 4, 5, winding of private magnet PM, 22, 23, 14 to earth 15. Private magnet PM now operates, closing contact between 6 and 7, 8 and 9 and causing the four side switches, 10, 11, 12 and 13 to step into their second position, making contact between 10 and 10^B, 11 and 11^B, 12 and 12^B, 13 and 13^B. The circuits closed at 6 and 7, 8 and 9 are of no importance at this time. The subscriber may now call the last digit of the desired number and in so doing, again sends a number of impulses over line wire VL as previously described. The result of energizing relay V in this case, is to cause the rotary magnet RM to operate and rotate the connector shaft and wipers to the desired contact in the connector banks, representing the last digit called. This is accomplished by closing of a circuit from earth 15, Fig. 3, through 3, 4, 10, 10^B, winding of rotary magnet RM, to battery 14, and thence to ground 15. The subsequent grounding of line wire RL causes relays R and A to operate and in turn energize the private magnet PM, as previously described. The result is that all side switches are stepped into their third position, 10 making a contact with 10^C, 11 with 11^C, 12 with 12^C and 13 with 13^C. The vertical, private and rotary wipers, VW, PW and RW are now in electrical contact with the vertical, private and rotary bank contacts, VN, PN and RN respectively, of the called line. These bank contacts, are as before stated, also associated with a selector as shown in Fig. 2, either directly or indirectly. Side switch 13 in its third position, causes a current to flow from earth 15, Fig. 3, through 13^C, 13, PW, PN to side switch 92, Fig. 2, 92^A, winding of cut off relay CO to battery 14 and earth 15. The cut off relay CO, of the called line is thereby energized and removes the associated selector mechanism from connection with the called line by opening the selector circuit at 83 and 84 and 86 and 87. The placing of a ground upon the private bank contact PN, Fig. 3, makes the called line busy to all other connectors. The stepping of side switches 11 and 12 into the third position, closes the talking circuit of the connector between the selector bank contacts VB and RB and the connector bank contacts VN and RN respectively. The stepping of side switch 10 into its third position, removes the rotary magnet RM from connection with the springs of line relay V and in place thereof connects the springs of relay V to the ringing relay RR. The connector has now picked up the called line, which in this case is not busy, and the calling subscriber may now proceed to ring the distant station, which he does by depressing ringing key 96, Fig. 1. This grounds line wire VL at 77, Fig. 1 with a result that relays V and A, Fig. 3 are energized and close a circuit from ground 15, Fig. 3, through 3, 4, 10, 10^C, winding of ringing relay RR, 19, 18, 34, 35, 14, 15. This energizes relay RR with a result that the swinging springs 54 and 51 (shown apart for convenience) break contact with springs 55 and 52, and make contact with springs 53 and 50 respectively. The closing of these contacts causes ringing generator current to be sent out over the called line, a circuit being established from ground 15, through ringing generator 37, 38, 39, 53, 54, 12^C, 12, wiper VW, bank contact VN, line wire to subscribers' station through customary ringer and condenser at distant station, back over line wire to bank contact RN, wiper RW, 11^C, 11, 51, 50, 45, 46, through condenser 47 to earth 15. Contact between springs 57 and 56 is also broken, but in this case, is of no importance. Upon releasing the ringing key at the calling station, it resumes its normal position and by opening the line circuit allows all relays on the connector to resume their normal position.

By changing the character of the ringing current supplied to contact springs 50 and 53, it is possible by the use of different groups of connectors, as previously referred to, to ring any one of a number of stations on a party line. Referring to Fig. 7 in which, for example is shown diagrammatically, a four party line system, R_1, R_2, R_3 and R_4 represent ringers so designed as to operate only on current from their corresponding ringing generator F_1, F_2, F_3 and F_4 respectively. In such a system, there would be at the central office, four groups of connectors, the first arranged to supply ringing current from ringing generator F_1, the second from ringing generator F_2, and so on. Condenser 47 in the ringing circuit is required merely for the purpose of avoiding a path for direct current on a reverting call. The called subscriber, upon answering, causes a current to flow from ground 15, Fig. 3, through 20, 22, 21, 65, 52, 51, 11, 11^C,

RW, RN, line wire to subscribers' telephone set, back over line wire to VN, VW, 12, 12c, 54, 55, 64, 14 to ground, 15. Relay B now operates, causing spring 42 to break connection with battery 14, through 43 and make connection with ground 15, through 41, 22 and 20. A current is now caused to flow from earth 15, Fig. 3, through 20, 22, 41, 42, 28, 27, 62, winding of relay R, 56, 57, RB, through selector and line wire RL, Fig. 2, through telephone set Fig. 1, back over line wire VL, through selector Fig. 2, through winding of relay V Fig. 3, 63, to battery 14, and earth 15. Relay V and R are thus energized. Relay A, however remains inert, owing to the fact that windings 62 and 63, under the condition described, oppose each other. By the simultaneous operation of relays V and R a circuit is established from earth 15, through 2, winding of relay C, 14 to 15. Relay C operates and causes spring 35 to break contact at 34 and make contact at 36. In this condition, the connector permits of conversation being carried on between the calling and called stations. Condensers 16 and 17 afford a path for the voice currents from the selector banks VB and RB to the connector wipers, VW and RW, respectively. At the end of conversation, the subscribers hang up. The release, however, is controlled entirely by the hanging up of the calling subscriber. The act of hanging up or pulling down the switch hook, momentarily grounds both sides of the line simultaneously. In other words, referring to Fig. 1, contact is made simultaneously between springs 70, 71, and 72. The result is that relay A, Fig. 3, operates, for the reason in case the called subscriber has not yet hung up, that one of its windings 62, is shunted out by the ground at subscribers' station, thereby nullifying the differential action of its two windings. Should the called subscriber have hung up first, relay B again resumes its normal position, thereby connecting winding 62 of relay A to battery through 27, 28, 42 and 43. Connected in this manner the two windings of relay A do not oppose each other. From the above, it will be seen that regardless of the condition of the called line, relay A is always energized immediately upon the simultaneous grounding of both sides of the calling line. Now consider again the case when the called subscriber has failed to hang up. The ground placed on both sides of the calling line at the subscribers' station, tends to shunt out relay R, at the same time it shunts out winding 62 of relay A. It is found in practice that the short circuiting of relay R as described above, results in it being made sufficiently slow acting to permit of contact between springs 1 and 2 being maintained until after relay A has operated. The result is that a circuit is established momentarily from ground 15, through 1, 2, 26, 25, winding of relay D, 36, 35, battery 14 to earth 15. Relay D now operates and makes contact between springs 30 and 31, thus placing a ground on 24, 25, and 26 and thereby sustaining both relays C and D as long as relay A remains energized. Should the called subscriber hang up first, relays V, R and A and B all resume their normal position for the reason that the circuit through relay B is opened at telephone of the called subscriber, thereby causing relay B to place an equal potential on both sides of the calling line, with the result that no current flows through relays V, R and A. This is accomplished by transferring spring 42 from connection with ground through spring 41, to connection with battery through spring 43. Incidentally it is by this means that the calling line is afforded supervision in cases where the call originates from a private exchange or other switchboard requiring supervision.

When the calling subscriber releases the connection under the conditions above described, the momentary grounding of both sides of the line causes the simultaneous operation of relays A, R and V with a result that relays C and D are energized as previously described. It should be noted, however, that winding 62 of relay A is transferred from battery connection to a ground connection by spring 27 breaking contact with spring 28 and making contact with spring 29. Therefore, should the ground on the calling line remain for any appreciable length of time, winding 62 of relay A and of relay R will be shunted out. The result is that contact will be broken between springs 1 and 2. Both relays C and D, however, will be sustained as long as the ground remains on the line, owing to the fact that relay A is still energized by winding 63, thereby closing the circuit including the windings of relays C and D at 24, 25 and 26. When the ground at the subscribers' station is removed from the calling line, relays V and A resume their normal position, thus opening the circuit through relays C and D at 26, 25 and 24. As previously stated, the air gap of relay C is adjusted so as to cause it to resume its normal position in a shorter time than relay D. The result is that the release circuit is momentarily closed at 34 and 35, a circuit being established from ground 15, through battery 14, 35 and 34, winding of release magnet G, 33, 32 to private bank contact PB, of the preceding selector, Fig. 2, thence through wiper of the selector, PW, Fig. 2, winding of release relay RR', 89, 89c to ground 15. The closing of the circuit operates the release magnet G, Fig. 3, which in turn releases the connector shaft which resumes its normal position and at the same

time kicks, so to speak all four side switches, 10, 11, 12 and 13 back into their normal or first position. Due to the low resistance of the release circuit, relay RR', Fig. 2 is also energized, with a result that a local circuit through the selector release magnet M is closed at 93, Fig. 2. The selector shaft is now released and allowed to resume its normal position. At the same time, the five side switches, 88, 89, 90, 91 and 92 are forced back into their first or normal position. Should additional selectors be involved in the connection the method of release is substantially the same. The connector and selectors are now in their normal position and the subscriber at the calling station may proceed to make other calls.

The description so far pertains to the setting up and releasing of a selector and connector on a regular connection to a non-busy line. The special features which form the body of my invention will now be more specifically described. First I will take up the non-interfering feature of the connector release circuit, which prevents a premature disconnection should a second party come in on the calling line and attempt to call or in any other way ground the calling line. It will be noted that the grounding of one side of the line when the telephone set of any station is bridged across the line, is equivalent to grounding both sides of the line, the ground supplied to one side of the line being transmitted to the other side through the closed circuit of the telephone set. It is for this reason that contact springs 73 and 74, Fig. 1, are arranged to open whenever the calling dial is moved out of its normal position. Consider the case when the calling subscriber is waiting for the called subscriber to answer. Under these conditions, all relays in the connector, Fig. 3, are inert, and all side switches, 10, 11, 12 and 13 are in their third position. A second party now comes in on the calling line and places a ground upon it thus operating relays V, R and A, Fig. 3, a circuit being established from the ground at the subscriber's station over the line wires, VL and RL, through the windings of relay V, R and A to battery. The operation of relays V, R and A results in simultaneous operation of relays C and D, a circuit being first established from ground 15, through 1 and 2, winding of C, 14 to 15. Relay C upon operating, causes another circuit to be closed from 15, through 1, 2, 26, 25, winding of D, 36, 35, 14 to 15. Relay D now operates and in so doing, causes swinging spring 27 to break contact at 28 and make contact at 29. The result is that winding 62 of relay A is transferred from a battery to a ground connection. Relay A, however, remains energized by virtue of current flowing through winding 63. The contact made between 30 and 31, places a ground upon armature 26, with the result that both relays C and D are sustained. The transferring of the battery connection to a ground connection at 29, causes relay R to fall back, thus breaking contact between springs 1 and 2.

When the ground from the interfering station is removed from the calling line, current is caused to flow from ground 15 Fig. 3, through 29, 27, 62, winding of R, 56, 57, RR to selector Fig. 2, line wire RL, through closed telephone circuit of calling station Fig. 1, back over line wire VL to selector Fig. 2, then through winding of relay V, Fig. 3, 63, battery 14 to earth, 15. The result is that relay R is again energized and contact made between springs 1 and 2. As previously stated, the windings of relay A act differentially when connected to ground and battery respectively. Therefore, relay A now resumes its normal position, with a result that contact is broken between springs 24, 25, and 26. This opens the circuit through relay D which now resumes its normal position and in so doing transfers the ground connection of winding 62 at 29, to a battery connection at 28. In this manner, both sides of the calling line are again placed at the same potential, thus causing relays V and R to resume their normal position, thereby opening contact between 1 and 2 and deënergizing relay C. It will be noted that relay C on resuming its normal position does not close the release circuit through release magnet G, since the latter circuit is open at relay D. Now consider a case where the called subscriber has answered. In this case, relays V, R and C are energized. The result of grounding the calling line by an interfering station, is to cause the operation of relay A which further results in the operation of relay D and of the deënergizing of relay R, all as previously stated. The connector circuit remains in this condition until after the interfering ground is removed from the calling line, after which relays V and R again operate, and relay A resumes its normal position, also as previously described. Relay D now resumes its normal position and the condition of the connector is the same as before disturbing ground was applied to the calling line.

From what has been said, it will be seen that the connector circuit is such as to make a premature disconnection impossible, and that a disconnection can take place only when the calling line is opened immediately following the simultaneous grounding of both sides of the calling line. Should the called line be busy, the connector will release automatically except on a reverting call in which case the called line is also the calling line. When the final ground is placed upon

line wire RL, Fig. 1 at the subscribers' station, the four side switches of the connector Fig. 3, are in their second position. Therefore, when the private magnet, PM, is energized by the operation of relays R and A, a circuit is established through relay E, from ground 15, winding of E, 9, 8, 22, 23, 14 to 15. Relay E operates and closes contact between springs 48 and 49. Since the called line is busy, an earth connection will be found on the private bank contact, PN, for reasons previously given, thereby establishing a circuit from the grounded bank contact PN, through PW, 13, 13^B, 61 60, 48, 49, winding of release magnet G—34, 35, 14 to 15. The result is that the connector releases, causing the connector shaft and the side switches to resume their normal positions. Thus, when the calling subscriber attempts to ring, which he does by depressing ringing key, 15, Fig. 1, grounding line wire VL and causing relays V and A, Fig. 3, to operate, the vertical magnet, VM is stepped up one or more levels. All side switches, however, remain in their first position, owing to the fact that the ground applied to the vertical wire VL, is not followed by a similar ground on the rotary wire, RL, as is the case when calling with the dial. The stepping up of the connector shaft out of its normal position, causes contact to be made between springs 58 and 59, thereby transmitting the busy tone connected to spring 58, to the rotary side of the line through side switch 11 in its first position. The busy tone thus applied, passes through the subscribers' set on the calling line and is heard by the subscriber, upon the receipt of which he hangs up, the disconnection taking place as previously described. Should the call have been a reverting call, that is, should the called line have been the calling line, the operation of the connector up to the point where relay E is energized, is the same as above described. However, on a reverting call, relay F is also energized, thereby opening the release circuit between springs 60 and 61 and allowing the connector to step into its third position as on the regular connection.

In Fig. 4 is shown diagrammatically, the circuit condition of the calling line on a reverting connection with the side switches in their second position. VL and RL represent the line wires to the subscribers' station; VN and RN the calling line contacts in the connector banks; the dotted lines represent the established circuit through the intermediate selectors; V, R, 62 and 63 represent the bridged windings of relays V, R and A; 64 and 65 represent the bridged windings of relay B; F represents the winding of relay F. Other parts may be identified by their corresponding numbers in Fig. 3. VW and RW represent the connector wipers which on a reverting call are in contact with connector bank contacts of the calling line, VN and RN. When the connector is in the position shown in Fig. 4 and the final ground is supplied to the rotary side of the line RL, relays R and A, Fig. 3, operate in the usual manner, causing in turn the operation of private magnet, PM, with the result that contact is made between springs 6 and 7, Fig. 4, causing a current to flow from ground 15, through 7, 6, winding of V to bank contact VN, thence to wiper VW, through 12, 12B, winding of F, battery 14 and again to earth, 15. Relay F is now energized and opens the connector release circuit at 60, 61, Fig. 3, permitting the connector to step into its third position. Since relay F is always connected to the vertical wiper VW when the side switch is in its second position, it is necessary that the circuit be so designed as to permit the wipers to pass over or select busy and non-busy contacts other than of the calling line, in the connector banks, without energizing relay F. This is accomplished by making the winding of relay F of such a resistance, preferably high, compared with the resistance of the windings of bridged relays V, R, A and B, so that relay F will not operate when shunted by the windings of the former relays.

In Fig. 5 is shown diagrammatically, three possible circuit conditions of the connector bank contacts of busy lines, met with in actual practice and in connection with which relay F, Fig. 3 must not operate.

Fig. 5^A, represents the line circuit operation of a set of connector bank contacts of a busy calling line before the called subscriber has answered. In this figure, V, R, 62 and 63 represent the windings of relays V, R and A, Fig. 3. Should wiper VW, with side switch 12 in its second position, pass over bank contact VN under the conditions shown in Fig. 5^A, relay F will obviously not operate for the reason that no current flows, it being understood that the batteries shown are of the same potential.

Fig. 5^B represents the line circuit condition of a set of connector bank contacts of a busy calling line, after the called subscriber has answered. Here relay B of the connector, Fig. 3, has operated, substituting ground for battery on the rotary side of the calling line. Should wiper VW pass over bank contact VN, Fig. 5^B, relay F will not operate, owing to the shunting effect of the winding of relay V and winding 63 on relay F, the shunt circuit being established as follows: from ground 15, Fig. 5^B, through winding 62 of relay A, winding of relay R, to bank contact RN, thence through the calling subscribers' telephone set back to vertical bank contact VN. At this point, the current divides, part going to battery 14,

through winding of relay V and winding 63 of relay A, Fig. 5[B], and part through wiper VW, 12, 12[B] and winding of relay F.

Fig. 5[C] represents the line circuit condition of a connector bank contact of a busy called line, 64 and 65 represent the bridged windings 64 and 65 of relay B, Fig. 3. Should wiper VW pass over bank contact RN, winding 61, Fig. 5[C], will shunt out relay F, as 63 and V do in Fig. 5[B].

From the above it will be seen that the circuit arrangement is such as to cause relay F to distinguish between a regular busy condition and a reverting busy condition. On a reverting call, when the side switches are in their third position, relays B and A are connected in multiple, since wiper VW is in contact through the intermediate selectors with bank contact VB and wiper RW in contact with bank contact RB, Fig. 3. The result is that relays V, R and B operate simultaneously, relay C following. Relay A remains inert owing to the differential action of its windings 62 and 63. To ring back on the calling line to call the desired station, the ringing key at the subscribers' station is depressed in the usual manner. The result is that relays V, A, B and RR are energized and relay R falls back. Relay D does not operate owing to the fact that the opening of line by the depressing of the ringing key allows relay R to fall back before relay A is energized by the subsequent grounding of the line wire VL. Therefore, a current does not flow through relay D when contact is made between springs 25 and 26. The opening of contact between springs 1 and 2 also allows relay C to fall back. A circuit is established from the ground at the subscribers' station over line VL, through winding of relay V, winding 63 of relay A, to battery 14, thence to ground 15. This in turn closes a circuit from ground 15, through 4, 3, 10, 10[C], winding of RR, 19, 18, 34, 35 to battery 14 and ground 15. Relay RR is now energized and operates swinging springs 51, 54 and 56. Relay B remains energized since the ground placed on vertical line wire VL is transmitted from contact VB to wiper VW, thence to springs 53 and 54, which are adjusted to make contact before contact between 54 and 55 is broken. Therefore, when ringing relay RR is energized, relay B is sustained by the closed circuit from the subscribers' station ground to wiper VW, through 12, 12[C], 54, 53, 39, 40, winding 64 to battery 14 and ground 15. The simultaneous operation of relays B and RR causes ringing current to be sent out over the rotary side of the line from ringing generator 37, through 44, 45, 50, 51, 11, 11[C], RW, rotary side of the line, thence through ringer at subscribers' station to ground, as explained later. Upon releasing the ringing key at the subscribers' station, relays A and RR resume their normal position, relays V and B remain energized and relays R and C are again energized. The connector remains in this condition during conversation. At the end of conversation, the connector disconnects when the last of the two stations hang up, the disconnection taking place substantially as previously described for disconnection on a regular connection when the calling subscriber hangs up first.

The connectors shown in Fig. 3 and partially in Fig. 3[A], are particularly adapted for use with a two party line system, employing the ordinary main line ringers at the subscribers' station, and ordinary ringing machines at the central office. In Fig. 6 is diagrammatically shown the ringing circuit of such a two-party line system. At A is shown the method of connecting the ringer to the line at one of the two stations. The ringer Q, is connected to ground through condenser P, from the rotary side of the line RL. At B is shown the method of connecting the ringer to the line at the other station. The ringer Q', at this station is bridged across the line in series with condenser P'. On a regular connection to a non-busy line, a connector arranged as shown in Fig. 3, supplies generator current to the line as shown at D, Fig. 6. The current so supplied will operate the ringer at the station B only. No appreciable amount of current will pass through the ringer at station A, owing to the fact that ground 15, placed on the rotary line wire RL at D, acts as an effective shunt around condenser P, and ringer Q at station A. On a regular connection to a non-busy line, a connector with ringing circuit modified as shown in Fig. 3[A], supplies generator current to the line as shown at C, Fig. 6. In this case ringer Q at station A only will be rung, the return circuit of ringer Q' at station B in this case being open. On reverting calls, regardless as to whether the connector is arranged as per Fig. 3 or 3[A], generator current is supplied to the rotary side of the line RL, as shown at E, Fig. 6. Should the station A, be calling station B, the bell at station B will be rung, a circuit being established from ringing generator 37, at E, over line RL through condenser P', ringer Q', at station B, then over line VL, through ringing key 96', to ground 15 at station A. It will be noted that in this case the ringing key at station A supplies the necessary ground to close the ringing circuit of station B. Should the station B be calling the station A, ringing generator current is supplied from generator 37 at E to line RL, whence it passes through condenser P, ringer Q, to ground 15 at station A.

By the use of a harmonic or similar ringers and their corresponding ringing generators, it is possible to provide for un-

limited party line service, such as for example is illustrated by the four party line system shown diagrammatically in Fig. 7 and previously described. Here, as before stated, each ringer is designed to operate only on current from its corresponding ringing generator at the central office. In this system there would be four groups of connectors, each group being arranged to supply a distinctive kind or arrangement of ringing generator current. The circuit of these connectors would be substantially as shown in Fig. 3, the difference being in the method of connecting the ringing generator to springs 50 and 53 of the ringing relay RR and to the springs of relay B. To meet the conditions shown in Fig. 7, each group of connectors would have the non-grounded pole of the source of ringing generator current connected directly to contact spring 50 Fig. 3, the grounded pole of the ringing generator current being connected to spring 53 through swinging spring 39 and relay B. In this manner the ground connection would be removed from the vertical line wire VL on a reverting connection the ground necessary for the operation of the ringers at the subscribers' stations, being supplied by the ringing key K_1, K_2, etc. shown in Fig. 7.

The object of condenser 47 Fig. 3 in the connector ringing circuit shown in Fig. 3, is as before stated, to prevent a path for direct current during the operation of the connector on a reverting call, when the ringing key is released. When the ringing key is depressed, relays V, A, B and RR are energized. When the ringing key is released, the ground is removed from line wire VL, allowing relays V, A and B to drop back which they do, since relay RR is controlled by relays V and A it does not drop back until later, therefore, contact is not made between springs 56 and 57, with the result that no current flows in the calling line during the interval between the falling back of relays V, A and B and relay RR. Should, therefore, condenser 47 be omitted, a current would flow from ground 15, Fig. 3, through 46, 45, 50, 51, 11, 11^c, RW, RN, over calling line wire RL to subscribers' station, through telephone set back over calling line wire VL through selector Fig. 2, to VB Fig. 3, thence through winding of relay V, winding 63 of relay A, battery 14 to earth 15. The result would be the locking up of relays V, A, and RR.

The object of connecting winding 65 of relay B, Fig. 3 to ground 15, through cut off contacts 21 and 22 on relay A, is to prevent chattering of relays A and B when a reverting connection is established. If the cut off contacts referred to were not provided and ground 15 were permanently connected to winding 65, a circuit for a current flow would be established on reverting calls from the ground on winding 65, through winding 65, 52, 51, 11, 11^c, RW, RN, through selectors back to RB, through 57, 56, winding of R, winding 62 of relay A, 27, 28, 42 43, battery 14 to earth 15. The result is that both relays A and B are energized. The operation of relay B, however, transfers spring 42 from connection with battery 14, through 43 to a ground connection 15, through 41. A ground connection now exists at each end of the circuit just described, causing the current flow to cease with a result that both relays drop back to their normal position, again creating the condition causing their operation. In this manner, relays A and B will chatter indefinitely.

In the preceding specification, the term battery as used includes any suitable source of constant potential direct current.

What I claim as my invention is:

1. In an automatic telephone exchange system, the combination of a calling telephone line, a called telephone line, a connector for completing connection from the calling line to the called line, trunk lines and a plurality of trunking switches for extending the connection from the calling line to said connector, a grounded source of current for energizing said connector and trunking switches, a means of grounding both sides of calling line, a means of releasing the connection following the grounding of both sides of the calling line only when said calling line is open and clear upon removal of said ground.

2. In an automatic telephone exchange system, the combination of a calling telephone line, a called telephone line, a connector for completing connection from the calling line to the called line, trunk lines and a plurality of trunking switches for extending the connection from the calling line to said connector, a grounded source of current for energizing said connector and trunking switches, a means of grounding both sides of calling line, a train of relays associated with said connector, arranged to release the connection following the grounding of both sides of the calling line, only when said calling line is open and clear upon removal of said ground.

3. In an automatic telephone exchange system, the combination of a calling telephone line, a called telephone line, a connector for completing the connection from the calling line to the called line, trunk lines and a plurality of trunking switches for extending the connection from the calling line to said connector, a grounded source of current for energizing said connector and trunking switches, a means of releasing the connection following the grounding of both sides of the calling line providing

said calling line is open and clear upon removal of said ground, but also arranged not to release the connection if, upon the removal of said ground a closed circuit is maintained between the wires of the calling line.

4. In an automatic telephone exchange system, the combination of a calling telephone line, a called telephone line, a connector for completing the connection from the calling line to the called line, trunk lines and a plurality of trunking switches for extending the connection from the calling line to said connector, a grounded source of current for energizing said connector and trunking switches, a train of relays associated with said connector arranged to release the connection following the grounding of both sides of the calling line, providing said calling line is open and clear upon removal of said ground, but also arranged not to release the connection if upon removal of said ground a closed circuit is maintained across the wires of the calling line.

5. In a connector for automatic telephone exchange systems, two bridged calling line relays, a double wound relay connected in series with said line relays, a source of current for energizing said relays, a connector release circuit, a train of relays controlling the connector release circuit, said train of relays being energized by the simultaneous operation of the line and double wound relays, thereby transferring one winding of said double wound relay from connection with the pole of said source of current to which it is normally connected to connection with the opposite pole of said source of current.

6. In a connector for automatic telephone exchange systems, two bridged calling line relays, a double wound relay connected in series with said line relays, a source of current for energizing said relays, a connector release circuit, a train of relays controlling the connector release circuit, said train of relays being energized by the simultaneous operation of the line and double wound relays and when energized, transferring one winding of said double wound relay from connection with the pole of said source of current to which it is normally connected to connection with the opposite pole of said source of current, thereby placing the windings of the double wound relay in such relation to each other as to cause them to oppose each other when a current flows through the windings.

7. In a connector for automatic telephone exchange systems, two bridged calling line relays, a double wound relay connected in series with said line relays, a connector release circuit, a train of two relays controlled by said line and double wound relays, one arranged to open the connector release circuit when energized and the other arranged to close the connector release circuit when energized, a source of current for energizing said relays, the relay arranged to close the connector release circuit being slower in resuming its normal position after being energized than the relay arranged to open the connector release circuit, thus permitting the closing of the connector release circuit for an interval of time equal to the difference in the time taken by the aforesaid two relays to resume their normal position.

8. In a connector for automatic telephone exchange systems two calling line wires, two bridged calling line relays, a double wound relay connected in series with said line relays, a grounded source of current for energizing said relays, a means of grounding both sides of calling line, a connector release circuit, a means of controlling said connector release circuit arranged to create the necessary release circuit conditions preparatory to releasing the connector only when both the calling line wires are grounded, but not releasing the connector while the ground remains on one or both of the calling line wires.

9. In a connector for automatic telephone exchange systems, two calling line wires, two bridged calling line relays, a double wound relay connected in series with said line relays, a grounded source of current for energizing said relays, a means of grounding both sides of calling line, a connector release circuit, a means of controlling said connector release circuit arranged to create the necessary release circuit conditions preparatory to releasing the connector only when both the calling line wires are grounded, but not releasing the connector when said ground is removed if at that time there exists a closed circuit between said calling line wires.

10. In a connector for automatic telephone exchange systems, two calling line wires, two bridged calling line relays, a double wound relay connected in series with said line relays, a grounded source of current for energizing said relays, a means of grounding both sides of calling line, a connector release circuit, a means of controlling said connector release circuit arranged to create the necessary release circuit conditions preparatory to releasing the connector only when both line wires are grounded, and to release the connector when said ground is removed from both wires, but not releasing the connector if at the time said ground is removed there exists a closed circuit between the wires of the calling line.

11. In an automatic telephone exchange system, the combination of a calling line, a

plurality of stations on said calling line, a called line a connector for completing a connection from one station on said calling line to another station on said calling line and from the calling line to the called line, trunk lines and a plurality of trunking switches for extending the connection from said calling line to said connector, a connector release circuit, a means of closing said connector release circuit on an attempted connection with said called line if "busy," a plurality of calling line terminals, a plurality of called line terminals, a plurality of wipers forming part of said connector arranged to engage in electrical contact said terminals of either the calling or called lines, a relay adapted to be connected to one of said wipers, arranged to open the connector release circuit on an attempted connection with said calling line, thereby permitting the connector to establish a connection with said calling line, but not opening the connector release circuit on an attempted connection with said called line, thereby causing connector to release if called line is already engaged in some other connection, a source of current for energizing said connector and relay.

12. In an automatic telephone exchange system, the combination of, a calling line, a plurality of stations on said calling line, a connector for completing a connection from one station on said calling line to another station on said calling line, trunk lines and a plurality of trunking switches for extending the connection from the calling line to said connector, a connector release circuit, a plurality of calling line terminals, a plurality of wipers, forming part of said connector, arranged to engage in electrical contact said terminals of calling line, a grounded source of current for operating said connector and trunking switches, a means of releasing the connection following the grounding of both sides of the calling line, only when said calling line is open and clear upon removal of ground, a means of automatically opening the connector release circuit on an attempted connection with the calling line, thereby permitting the connector to establish a connection with the said calling line.

13. In an automatic telephone exchange system, the combination of, a calling line, a plurality of stations on said calling line, a connector for completing a connection from one station on said calling line to another station on said calling line, trunk lines and a plurality of trunking switches for extending the connection from said calling line to said connector, a connector release circuit, a plurality of calling line terminals, a plurality of wipers forming part of said connector, arranged to engage in electrical contact said terminals of said calling line, a grounded source of current for energizing said connector and trunking switches, a means of releasing the connection following the grounding of both sides of the calling line, providing said calling line is open and clear upon removal of ground, but also arranged not to release the connection, if upon removal of said ground, a closed circuit is maintained between the wires of the calling line, a means of automatically opening the connector release circuit on an attempted connection with the calling line, thereby permitting the connector to establish a connection with said calling line.

14. In an automatic telephone exchange system, the combination of a calling line, a plurality of stations on said calling line, a called line, a connector for completing a connection from one station on said calling line to another station on said calling line, and from said calling line to said called line, trunk lines and a plurality of trunking switches for extending the connection from said calling line to said connector, a connector release circuit, a means of closing said connector release circuit on an attempted connection with called line if "busy," a plurality of calling line terminals, a plurality of called line terminals, a plurality of wipers, forming part of said connector, arranged to engage in electrical contact, said terminals of either the called or calling lines, a grounded source of current for operating said connector and trunking switches, a means of releasing the connection following the grounding of both sides of the calling line, only when said calling line is open and clear upon removal of ground, a means of automatically opening the connector release circuit on an attempted connection with the calling line thereby permitting the connector to establish a connection with the said calling line, but not opening the connector release circuit on an attempted connection with said called line, thereby causing the connector to release if called line is already engaged in some other connection.

15. In an automatic telephone exchange system, the combination of, a calling line, a plurality of stations on said calling line, a called line, a connector for completing a connection from one station on said calling line to another station on said calling line, and from said calling line to said called line, trunk lines and a plurality of trunking switches for extending the connection from said calling line to said connector, a connector release circuit, a means of closing said connector release circuit on an attempted connection with called line if the latter is "busy," a plurality of calling line terminals, a plurality of called line termi-

nals, a plurality of wipers, forming part of said connector, arranged to engage in electrical contact said terminals of either the called or calling lines, a grounded source of current for energizing said connector and trunking switches, a means of releasing the connection following the grounding of both sides of the calling line, providing said calling line is open and clear upon removal of ground, but also arranged not to release the connection, if, upon removal of said ground a closed circuit is maintained between the wires of the calling line, a means of automatically opening the connector release circuit on an attempted connection with said calling line, thereby permitting the connector to establish a connection with the said calling line, but not opening the connector release circuit on an attempted connection with said called line, thereby causing the connector to release if said called line is already engaged in some other connection.

16. In an automatic telephone exchange system, a combination of a calling line, a plurality of stations on said calling line, a ringer at each station, arranged to ring only when supplied with a particular kind or arrangement of ringing generator current, a plurality of connectors for completing connection from any station on said calling line to any other station on said calling line, each connector being arranged to supply a particular kind or arrangement of ringing generator current for the operation of its corresponding ringer, trunk lines and a plurality of trunking switches for extending the connection from the calling line to the proper connector, each connector having a release circuit, a plurality of calling line terminals, a plurality of wipers forming part of each connector and arranged to engage in electrical contact said terminals of said calling lines, a grounded source of current for operating said connectors and trunking switches, a means of releasing the connection following the grounding of both sides of the calling line, only when said calling line is open and clear upon removal of ground, a means of automatically opening the connector release circuit on an attempted connection with the calling line, thereby permitting the connector to establish a connection with the calling line, a means of causing each connector to supply its particular kind or arrangement of ringing generator current to the calling line.

17. In an automatic telephone exchange system, a combination of, a calling line, a plurality of stations on said calling line, a ringer at each station, arranged to ring only when supplied with a particular kind or arrangement of ringing generator current, a plurality of connectors for completing connection from any station on said calling line to any other station on said calling line, each connector being arranged to supply a particular kind or arrangement of ringing generator current for the operation of its corresponding ringer, trunk lines and a plurality of trunking switches for extending the connection from the calling line to the proper connector, each connector having a release circuit, a plurality of calling line terminals, a plurality of wipers forming part of each connector and arranged to engage in electrical contact said terminals of said calling line, a grounded source of current for operating said connectors and said trunking switches, a means of releasing the connection, following the grounding of both sides of the calling line, provided said calling line is open and clear upon removal of ground, but also arranged not to release the connection if upon removal of said ground, a closed circuit is maintained between the wires of the calling line, a means of automatically opening the connector release circuit on an attempted connection with the calling line, thereby permitting the connector to establish a connection with said calling line, a means of causing each connector to supply its particular kind or arrangement of ringing generator current to the calling line.

18. In an automatic telephone exchange system, the combination of, a calling line, a plurality of stations on said calling line, a plurality of called lines, a plurality of stations on each of said called lines, a ringer at each station of said called and calling lines, arranged to ring only when supplied with a particular kind or arrangement of ringing generator current, a plurality of connectors for completing a connection from any station on said calling line to any other station on said calling line or said called lines, each connector being arranged to supply a particular kind or arrangement of ringing generator current for the operation of its corresponding ringer only, trunk lines and a plurality of trunking switches for extending a connection from the calling line to the proper connector, each connector having a release circuit, a set of calling line terminals, a plurality of sets of called line terminals, a plurality of wipers forming part of each connector, arranged to engage in electrical contact said terminals of either the calling or called lines, a grounded source of current for operating said connectors and trunking switches, a means of releasing the connection following the grounding of both sides of the calling line, only when said calling line is open and clear upon removal of ground, a means of automatically opening the connector release circuit on an attempted connection with the calling line, thereby per-

mitting the connector to establish a connection with the calling line, a means of causing each connector to supply its particular kind or arrangement of ringing generator current to the calling and called lines.

19. In an automatic telephone exchange system, the combination of, a calling line, a plurality of stations on said calling line, a plurality of called lines a plurality of stations on each of said called lines, a ringer at each station of said called and calling lines, arranged to ring only when supplied with a particular kind or arrangement of ringing generator current, a plurality of connectors for completing a connection from any station on said calling line to any other station on said calling line or on said called lines, each connector being arranged to supply a particular kind or arrangement of ringing generator current for the operation of its corresponding ringer only, trunk lines and a plurality of trunking switches for extending a connection from the calling line to the proper connector, each connector having a release circuit, a set of calling line terminals, a plurality of sets of called line terminals, a plurality of wipers forming part of each connector, arranged to engage in electrical contact said terminals of either the calling or called lines, a grounded source of current for operating said connectors and trunking switches, a means of releasing the connection following the grounding of both sides of the calling line, providing said calling line is open and clear upon removal of ground, but also arranged not to release the connection if upon removal of said ground, a closed circuit is maintained between the wires of the calling line, a means of automatically opening the connector release circuit on an attempted connection with the calling line, thereby permitting the connector to establish a connection with the calling line, a means of causing each connector to supply its particular kind or arrangement of ringing generator current to the calling and called lines.

20. In an automatic telephone exchange system, the combination of, a calling line, a plurality of stations on said calling line, a plurality of called lines a plurality of stations on each of said called lines, a ringer at each station of said called and calling lines, arranged to ring only when supplied with a particular kind or arrangement of ringing generator current, a plurality of connectors for completing a connection from any station on said calling line to any other station on said calling line or on said called lines, each connector being arranged to supply a particular kind or arrangement of ringing generator current for the operation of its corresponding ringer only, trunk lines and a plurality of trunking switches for extending a connection from the calling line to the proper connector each connector having a release circuit, a means of closing the connector release circuit on an attempted connection with a "busy" called line, a set of calling line terminals, a plurality of sets of called line terminals, a plurality of wipers forming part of each connector, arranged to engage in electrical contact said terminals of either the calling or called lines, a grounded source of current for operating said connectors and trunking switches, a means of releasing the connection following the grounding of both sides of the calling line, only when said calling line is open and clear upon removal of ground a means of automatically opening the conductor release circuit on an attempted connection with the calling line, thereby permitting the connector to establish a connection with the calling line but not opening the connector release circuit on an attempted connection with a called line, thereby causing the connector to release if said called line is already engaged in some other connection, a means of causing each connector to supply its particular kind or arrangement of ringing generator current to the calling and called lines.

21. In an automatic telephone exchange system, the combination of, a calling line, a plurality of stations on said calling line, a plurality of called lines a plurality of stations on each of said called lines, a ringer at each station of said called and calling lines, arranged to ring only when supplied with a particular kind or arrangement of ringing generator current, a plurality of connectors for completing a connection from any station on said calling line to any other station on said calling line or on said called lines, each connector being arranged to supply a particular kind or arrangement of ringing generator current, for the operation of its corresponding ringer only, trunk lines and a plurality of trunking switches for extending a connection from the calling line to the proper connector, each connector having a release circuit, a means of closing the connector release circuit on an attempted connection with a busy called line, a set of calling line terminals a plurality of sets of called line terminals, a plurality of wipers forming part of each connector, arranged to engage in electrical contact said terminals of either the calling or called lines, a grounded source of current for operating the connectors and trunking switches, a means of releasing the connection following the grounding of both sides of the calling line, providing said calling line is open and clear upon removal of ground, but also arranged not to release the connection if upon removal of said ground, a closed circuit is maintained between the wires of the calling line, a means of automatically opening the connector release circuit on an attempted connection with the

calling line, thereby permitting the connector to establish a connection with the calling line, but not opening the connector release circuit on an attempted connection with a called line, thereby causing the connector to release if said called line is already engaged in some other connection, a means of causing each connector to supply its particular kind or arrangement of ringing generator current to the calling and called lines.

22. In an automatic telephone exchange system, the combination of, a calling line, a plurality of stations on said calling line, a ringer at each station, arranged to ring only when supplied with a particular kind or arrangement of ringing generator current, a plurality of connectors for completing a connection from any station on said calling line to any other station on said calling line, each connector being arranged to supply a particular kind or arrangement of ringing generator current for the operation of its corresponding ringer, trunk lines and a plurality of trunking switches for extending the connection from the calling line to the proper connector, each connector having a release circuit, a plurality of calling line terminals, a plurality of wipers, forming part of each connector, arranged to engage in electrical contact said terminals of said calling line, a relay adapted to be connected to one of said wipers of each connector, arranged to open automatically the connector release circuit, thereby permitting the connector to establish a connection with said calling line, a source of current for energizing said connectors, trunking switches and relays, a means of causing each connector to supply its particular kind or arrangement of ringing generator current to said calling line.

23. In an automatic telephone exchange system, the combination of, a calling line, a plurality of stations on said calling line, a plurality of called lines a plurality of stations on each of said called lines, a ringer at each station of said called and calling lines, arranged to ring only when supplied with a particular kind or arrangement of ringing generator current, a plurality of connectors for completing a connection from any station on said calling line to any other station on said calling line or on said called lines, each connector being arranged to supply a particular kind or arrangement of ringing generator current for the operation of its corresponding ringer only, trunk lines and a plurality of trunking switches for extending a connection from the calling line to the proper connector, each connector having a release circuit, a set of calling line terminals, a plurality of sets of called line terminals, a plurality of wipers forming part of each connector, arranged to engage in electrical contact said terminals of either the calling or called lines, a relay adapted to be connected to one of said wipers of each connector, arranged to open the connector release circuit on an attempted connection with the calling line, thereby permitting the connector to establish a connection with said calling line, a source of current for energizing said connectors, relays and trunking switches, and a means of causing each connector to supply its particular kind or arrangement of ringing generator current to said calling and called lines.

24. In an automatic telephone exchange system, the combination of a pair of line wires, a ringer bridged across said line wires and a ringer connected from one of said line wires to ground, a source of grounded ringing generator current, a means of supplying said grounded source of ringing generator current to the line wire connected to the grounded ringer thereby operating the grounded ringer but not the bridged ringer, a means of supplying said grounded source of ringing generator current to the line wire not connected to said grounded ringer and a ground connection to the remaining line wire, thereby operating the bridged ringer but not the grounded ringer, the grounded ringer being shunted by a parallel circuit to ground formed by the line wire to which it is connected, a means of supplying said source of grounded ringing generator current to the line wire connected to the grounded ringer and a ground to the remaining line wire, thereby operating either or both ringers.

25. In an automatic telephone exchange system the combination of a pair of line wires, a ringer bridged across said line wires, and a ringer connected from one of the said line wires to earth, a source of grounded ringing generator current, a means of supplying said grounded source of ringing generator current to the line wire connected to the grounded ringer thereby operating the grounded ringer but not the bridged ringer, a means of supplying said grounded source of ringing generator current to the line wire not connected to said grounded ringer and a ground connection to the remaining line wire, thereby operating the bridged ringer but not the grounded ringer, the grounded ringer being shunted by a parallel circuit to ground formed by the line wire to which it is connected, a means of supplying said source of grounded ringing generator current to the line wire connected to the grounded ringer and a ringing key associated with each ringer arranged to ground the remaining line wire, thereby operating either or both ringers.

26. In a connector for telephone exchange systems, a calling line branch, a called line

branch, two speech current conductors connecting said calling and said called line branches, two calling line terminals, two wipers forming part of said called line branch and adapted to be connected with said speech current conductors, a connector release circuit, a grounded source of current for operating said connector, a means of applying a ground to one of said wipers, a relay adapted to be connected to the remaining wiper and arranged to open said connector release circuit when said ground is applied and when said wipers are in electrical contact with said calling line terminals, substantially as shown and described.

27. In a connector for telephone exchange systems, a calling line branch, a called line branch, two speech current conductors connecting said calling and said called line branches, two calling line terminals, two called line terminals, two wipers forming part of said called line branch and adapted to be connected with said speech current conductors, a connector release circuit, a means of closing said connector release circuit on an attempted connection with said calling line terminals if busy, a grounded source of current for operating said connector, a means of applying a ground to one of said wipers, a relay adapted to be connected to the remaining wiper and arranged to open said connector release circuit when said ground is applied and when said wipers are in electrical contact with said calling line terminals, but also arraged not to open said connector release circuit when said wipers are in electrical contact with said called line terminals, thereby causing said connector to release if said called line terminals are already engaged in some other connection, substantially as shown and described.

28. In a telephone exchange system, the combination of, a calling telephone line, a called telephone line, a plurality of calling line terminals, a plurality of called line terminals, a connector completing connection between the calling and called telephone lines, and comprising a plurality of bridged relays arranged to supply current for speech transmission to the calling and called telephone lines, a second connector with a plurality of wipers arranged to engage said calling and called line terminals, each connector having a release circuit, a means of closing said release circuit of the second connector when said connector attempts connection with said called or calling line terminals, a relay when energized opening the release circuit of said second connector, but so arranged as to receive insufficient current to be energized when the wipers of said second connector are in contact with said called or calling line terminals engaged in some other connection, due to the shunting effect of the windings of the bridged relays of the connector, engaged in establishing said connection between the called and calling lines, substantially as shown and described.

29. In an automatic telephone exchange system, the combination of a calling line, a plurality of stations on said calling line, a connector for completing a connection from one station on said calling line to another station on said calling line, trunk lines and a plurality of trunking switches for extending the connection from said calling line to said connector, a connector release circuit, a plurality of calling line terminals, a plurality of wipers, forming part of said connector, arranged to engage in electrical contact said terminals of said calling line, a means within the connector arranged to open automatically the connector release circuit on an attempted connection with the calling line thereby permitting the connector to establish connection with said calling line.

30. In an automatic telephone exchange system, the combination of a calling line, a plurality of stations on said calling line, a called line, a connector for completing a connection from one station on said calling line to another station on said calling line and from the calling line to the called line, trunk lines and a plurality of trunking switches for extending the connection from said calling line to said connector, a connector release circuit, a plurality of calling line terminals, a plurality of called line terminals, a plurality of wipers forming part of said connector arranged to engage in electrical contact said terminals of either the calling or called lines, a means within the connector, arranged to open the connector release circuit on an attempted connection with the calling line, thereby permitting the connector to establish a connection with said calling line.

31. In an automatic telephone exchange system, the combination of a calling line, a plurality of stations on said calling line, a called line, a connector for completing a connection from one station on said calling line to another station on said calling line and from the calling line to the called line, trunk lines and a plurality of trunking switches for extending the connection from said calling line to said connector, a connector release circuit, a means of closing said connector release circuit on an attempted connection with said called line if "busy", a plurality of calling line terminals, a plurality of called line terminals, a plurality of wipers forming part of said connector arranged to engage in electrical contact said terminals of either the calling

or called lines, a means within the connector arranged to open the connector release circuit on an attempted connection with said calling line, thereby permitting the connector to establish a connection with said calling line, but not opening the connector release circuit on an attempted connection with said called line, thereby causing the connector to release if called line is already engaged in some other connection.

Signed by me at San Francisco, this 28th day of January, 1911.

GERALD DEAKIN.

Witnesses:
F. A. McGann,
Pauline J. Glauch.