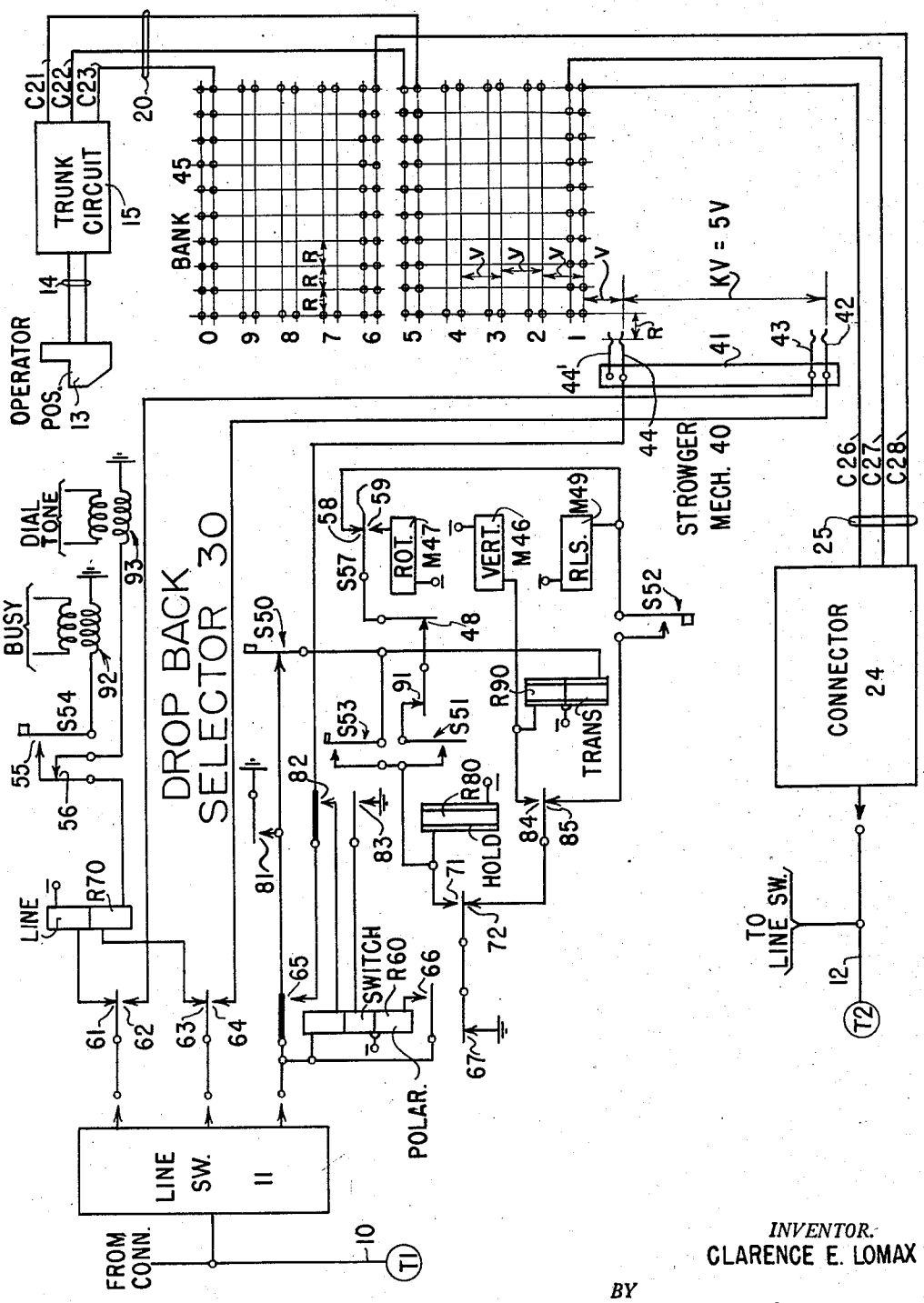
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TELEPHONE SYSTEM

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TELEPHONE SYSTEM

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The present invention relates to telephone systems and more particularly to drop-back selectors adapted to be incorporated in the switching apparatus of telephone systems of the automatic type.

Automatic telephone systems frequently comprise drop-back selectors of the primary-secondary motion Strowger type. A conventional drop-back selector of the type noted comprises a contact bank including two structurally separate and independent units, one unit terminating the line conductors of the various lines and the other unit terminating the control conductors of the various lines, the two units being arranged one above the other in spaced-apart relation. Also the drop-back selector comprises a wiper set including line and control wipers arranged in spaced-apart relation one above the other and adapted to cooperate with the two respective units of the contact bank. Further the wiper set has a normal position and is mounted for both primary or vertical and secondary or rotary step-by-step movements with respect to the associated contact bank.

In a small automatic telephone system of the type noted, it has been the customary practice to employ standard Strowger drop-back selectors in spite of the fact that only a fraction of the total number of individual contacts in the two units of the contact bank terminate the respective line and control conductors of the various lines; whereby there is a considerable number of unused contacts in the contact bank.

Accordingly, it is an object of the present invention to provide in a small automatic telephone system an improved drop-back seelctor which effects a considerable saving in the total number of contacts provided in the contact bank thereof, whereby only a minimum number of idle contacts appear therein, and which is of compact and economical construction and arrangement.

Another object of the invention is to provide a drop-back selector of the type noted, which comprises a contact bank including only one unit which terminates both the line and control conductors of the various lines.

A further object of the invention is to provide a drop-back selector of the type noted which also comprises a wiper set including line and control wipers which are adapted to cooperate with two respective sections of the associated unitary contact bank, whereby both the line and control wipers are moved adjacent the two respective sections of the contact bank only in the event a predetermined amount of primary movement is imparted to the wiper set, and wherein the wiper set is returned back to its normal position at the conclusion of the primary movement thereof in the event less than the predetermined amount of primary movement is imparted thereto.

Further features of the invention pertain to the particular arrangement of the circuit elements of the system, whereby the above-outlined and additional operating features are attained.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawing, in which the single figure illustrates the arrangement of a telephone system incorporating a drop-back selector embodying the present invention.

Referring now more particularly to the single figure of the drawing, there is illustrated a small automatic telephone system comprising an exchange terminating as many as four hundred subscriber lines, including the subscriber lines 10 and 12 illustrated. Also the system comprises an operator position 13 terminating as many as ten trunks, including the trunk 14. The subscriber lines 10 and 12 extend to subscriber substations T1 and T2, respectively, and terminate in individually associated line switches, the subscriber line 10 terminating in the individually associated line switch 11 and the subscriber line 12 terminating in the individually associated line switch, not shown. Each of the trunks 14, etc., terminating at the operator position 13 also terminates in a trunk circuit individual thereto, the trunk 14 terminating in the individually associated trunk circuit 15. Further, each of the trunk circuits 15, etc., is provided with an incoming trunk individual thereto, the trunk circuit 15 being provided with the incoming trunk 20 individual thereto.

Further the exchange comprises a group of drop-back selectors, including the drop-back selector 30, four groups of connectors, the first group of connectors including the connector 24. Each of the line switches 11, etc., has access to each of the drop-back selectors 30, etc.; and each of the drop-back selectors 30, etc., has access to each of the incoming trunks 20, etc., and to each of the groups of connectors. For example, the drop-back selector 30 has access to the incoming trunk 20 extending to the trunk circuit 15 and to a trunk 25 extending to the connector 24 included in the first group. Finally, each connector in each group has access to one hundred of the associated subscriber lines. For example, the

connector 24 included in the first group has access to the first group of one hundred subscriber lines, including the subscriber line 12.

Preferably, each of the subscriber substations T1, T2, etc., comprises conventional subscriber substation apparatus including a telephone instrument, a dial and a ringer; and the operator position 13 comprises conventional operator position equipment. Preferably, each of the line switches 11, etc., and each of the trunk circuits 15, etc., are of conventional connection and arrangement. Preferably, each of the connectors 24, etc., are of the conventional Strowger type

Preferably, each of the drop-back selectors is identical to the drop-back selector 30 illustrated, which comprises a Strowger mechanism 40 including a single unitary contact bank 45; the contact bank 45 including ten longitudinally or vertically spaced-apart laterally or circumferentially extending rows of ten pairs of contacts each, wherein each two adjacent rows of contacts are spaced apart a longitudinal or vertical distance substantially V and each two adjacent individual pairs of contacts in each row are spaced apart a lateral or circumferential distance substantially R. In the contact bank 45, the ten individual pairs of contacts in the first level or row terminate the line conductors of the ten trunks in the first group extending to the first group of connectors, including the connector 24; while the lower contacts of the ten individual pairs of contacts in the corresponding sixth level or row terminate the control conductors of the ten trunks in the first group extending to the first group of connectors, including the connector 24. For example, the tenth pair of contacts in the first level or row terminates the line conductors C26 and C27 of the trunk 25 extending to the connector 24; while the lower contact of the tenth pair of contacts in the corresponding sixth level or row terminates the control conductor C28 of the trunk 25 extending to the connector 24. Similarly, in the contact bank 45, the ten individual pairs of contacts in the second, third and fourth levels or rows terminate the line conductors of the ten trunks in the respective second, third and fourth groups extending to the respective second, third and fourth groups of connectors; while the lower contacts of the ten individual pairs of contacts in the corresponding seventh, eighth and ninth levels or rows terminate the control conductors of the ten trunks in the respective second, third and fourth groups extending to the respective second, third and fourth groups of connectors. Finally, in the contact bank 45, the ten individual pairs of contacts in the fifth level or row terminate the line conductors of the ten trunks in the group extending to the group of trunk circuits, including the trunk circuit 15; while the lower contacts of the ten individual pairs of contacts in the corresponding 0 level or row terminate the control conductors of the ten trunks in the group extending to the group of trunk circuits, including the trunk circuit 15. For example, the tenth pair of contacts in the fifth level or row terminates the line conductors C21 and C22 of the trunk 20 extending to the trunk circuit 15; while the lower contact of the tenth pair of contacts in the corresponding 0 level or row terminates the control conductors C23 of the trunk 20 extending to the trunk circuit 15.

Further the Strowger mechanism 40 comprises a wiper shaft 41 having a normal position and mounted for both longitudinal or vertical and lateral or rotary step-by-step movements. The wiper shaft 41 carries a wiper set including an upper pair of control wipers 44 and 44' and a lower pair of line wipers 42 and 43; the upper pair of control wipers being spaced apart with respect to the lower pair of line wipers a longitudinal or vertical distance substantially KV, wherein K is the whole number 5. Accordingly, the upper pair of control wipers is spaced from the lower pair of line wipers a distance substantially 5V; whereby the upper and lower pairs of wipers are adapted to cooperate simultaneously with the levels 6 and 1, 7 and 2, 8 and 3, 9 and 4, 0 and 5. Also it is noted that, when the wiper shaft 41 occupies its normal vertical and rotary positions, the control wiper 44 is spaced longitudinally or below the first level in the contact bank 45 the distance substantially V and is spaced laterally or circumferentially from the first pair of line contacts in the first level in the contact bank 45 the distance substantially R.

At this point it is noted that the upper control wiper 44' carried by the wiper shaft 41 is not utilized in the present arrangement. Similarly, the upper contacts of the various pairs in the sixth, seventh, eighth, ninth and 0 levels in the contact bank 45 are not utilized in the present arrangement. Finally the contact bank 45 comprises a lower line contact section including the first five levels 1 to 5, inclusive, and an upper control contact section including the second five levels 6 to 0, inclusive.

Further, the Strowger mechanism 40 comprises a vertical magnet M46 operative to drive the wiper shaft 41 step by step in the longitudinal or vertical direction the distance substantially V each step; a rotary magnet M47 operative to drive the wiper shaft 41 step by step in the lateral or rotary direction the distance substantially R each step; and a release magnet M49 operative to release the wiper shaft 41 and to cause it to be returned to its normal vertical and rotary positions. Also associated with the Strowger mechanism 40 are three sets of switch springs S50, S51 and S52 which are actuated when the wiper shaft 41 is driven in the vertical direction away from its normal vertical position; two sets of switch springs S53 and S54 which are actuated when the wiper shaft 41 is driven in the rotary direction eleven steps away from its normal rotary position; and a set of switch springs S57 which is actuated when the wiper shaft 41 is driven in the vertical direction six, seven, eight, nine or ten steps away from its normal vertical position.

Further the drop-back selector 30 comprises a relay group, including a switching relay R60, a line relay R70, a hold relay R80 and a transfer relay R90; a busy tone transformer 92; a dial tone transformer 93; and a control network connected and arranged in a manner more fully described hereinafter.

In view of the above description of the line terminal arrangement in the contact bank 45 of the Strowger mechanism 40, it will be understood that the directory number of the operator position 13 comprises the single digit 0; the directory number of the first, second, third and fourth groups of one hundred subscriber substations respectively comprise the digits 6XX, 7XX, 8XX and 9XX; while the set of switch springs S57 is not actuated when the first digit received by the drop-back selector 30 is 1, 2, 3, 4 or 5, whereby the wiper shaft 41 of the Strowger

mechanism 40 is operated a corresponding number of steps in the vertical direction away from its normal vertical position and is then dropped back to its normal vertical position. Accordingly, the digits 1, 2, 3, 4 and 5 are not assigned as first digits in the telephone system.

Considering now the general operation of the telephone system illustrated, a call may be initiated at any one of the subscriber substations, such, for example, as the subscriber substation T1. When the call is initiated at the calling subscriber substation T1, when the subscriber thereat removes the receiver of the telephone instrument from its associated switchhook, a circuit is closed between the calling subscriber substation T1 and the line switch 11 via the subscriber line 10, whereby operation of the line switch 11 is initiated. The line switch 11 operates to seize an idle one of the drop-back selectors in the associated group, such, for example, as the drop-back selector 30. More particularly, the line switch 11 seizes the drop-back selector 30 due to the absence of ground potential and the presence of battery potential upon the control terminal thereof; battery potential being applied by way of the lower winding of the transfer relay R90 and the set of switch springs S50 to the control terminal of the drop-back selector 30. When the line switch 11 seizes the line and control terminals of the drop-back selector 30, ground potential therein is applied to the control terminal, thereby to complete an obvious circuit, including the set of switch springs S59, for energizing the lower winding of the transfer relay R90, whereby the line switch 11 is switched through. When thus energized the transfer relay R90 operates. Also when the line switch 11 seizes the line terminals of the drop-back selector 30 a loop circuit is completed for energizing in series the upper and lower windings of the line relay R70; the above-mentioned circuit extends from ground by way of the secondary winding of the dial tone transformer 93, the contacts 56 of the set of switch springs S54, the lower winding of R70 and the contacts 63 to the positive line terminal, and from battery by way of the upper winding of R70 and the contacts 61 to the negative line terminal, the positive and negative line terminals being connected by way of the line switch 11 and the subscriber line 10 to the calling subscriber substation T1. When thus energized the line relay R70 operates and dial tone current is returned over the above-traced loop circuit from the secondary winding of the dial tone transformer 93, whereby the receiver of the telephone instrument at the calling subscriber substation T1 is operated in accordance with the dial tone in order to indicate to the calling subscriber thereat that he may proceed with the dialing of the directory number. Upon operating, the line relay R70 completes, at the contacts 71, an obvious circuit, including the contacts 67, for energizing the winding of the hold relay R80, thereby to cause the latter relay to operate and complete, at the contacts 81, an obvious multiple holding circuit for energizing the lower winding of the transfer relay R90 and an obvious path for applying ground potential to the control terminal. The application of ground potential to the control terminal retains the line switch 11 in its operated position. Further the hold relay R80 completes, at the contacts 81 and 82, an obvious path for applying ground potential by way of the upper winding of the switching relay R50 to the control wiper 44 of the wiper set for test purposes, in a manner more fully explained hereinafter. Finally the hold relay R80 completes, at the contacts 83, an obvious circuit for energizing the intermediate winding of the switching relay R60, thereby to render the latter relay exceedingly fast to operate when the upper winding thereof is subsequently energized, the switching relay R60 being of the polarized type. At this time the drop-back selector 30 has been seized by the line switch 11 and is in readiness to receive the first digit of the directory number dialed at the calling subscriber substation T1.

Now assume that the subscriber at the calling subscriber substation T1 dials the first digit of a directory number. When the subscriber at the calling subscriber substation T1 operates the associated dial in accordance with any digit, a corresponding number of impulses are transmitted over the loop circuit to the line relay R70, whereby the latter relay follows the impulses of the digit mentioned. Each time the line relay R70 restores and then reoperates it interrupts and then recompletes, at the contacts 71, the previously mentioned circuit for energizing the winding of the hold relay R80, whereby the latter relay remains operated during impulsing as it is of the slow-to-release type. Also each time the line relay R70 restores and then reoperates it completes and then interrupts, at the contacts 72, a multiple circuit, including the contacts 67 and 84, for energizing the upper winding of the transfer relay R90 and the vertical magnet M46, whereby the vertical magnet M46 operates and restores a corresponding number of times in order to drive the wiper shaft 41 a corresponding number of steps in the vertical direction away from its normal vertical position; and whereby the transfer relay R90 is retained operated during impulsing as it is of the slow-to-release type. When the wiper shaft 41 is driven one step in the vertical direction the sets of switch springs S50, S51 and S52 are actuated. More particularly, the set of switch springs S50 is actuated into disengagement, thereby to interrupt the previously traced original circuit for energizing the lower winding of the transfer relay R90; the set of switch springs S51 is actuated into engagement, thereby to prepare a common point in circuits traced hereinafter for respectively energizing the rotary magnet M47 and the release magnet M49; and the set of switch springs S52 is actuated into engagement, thereby to prepare a point in an alternative circuit traced hereinafter for energizing the release magnet M49.

At the conclusion of the first digit dialed at the calling subscriber substation T1, the line relay R70 and the hold relay R80 are retained in their operated positions and shortly thereafter the transfer relay R90 restores, the latter relay being of the slow-to-release type as previously noted. Upon restoring, the transfer relay R90 completes, at the contacts 91, one of the previously mentioned circuits for energizing either the rotary magnet M47 or the release magnet M49, depending upon whether or not the set of switch springs S57 was actuated in response to the movement of the wiper shaft 41 in the vertical direction away from its normal vertical position in response to the reception of the first digit by the drop-back selector 30. As previously noted,

the set of switch springs S57 is not actuated in the event the first digit of the directory number received by the drop-back selector 30 is one of the digits 1, 2, 3, 4 or 5; on the other hand, the set of switch springs S57 is actuated in the event the first digit of the directory number received by the drop-back selector 30 is one of the digits 6, 7, 8, 9 or 0.

Now assuming that the first digit of the directory number dialed at the calling subscriber substation T1 was one of the unassigned digits 1 to 5, inclusive, such, for example, as the digit 5, the drop-back selector 30 operates in response to the first digit 5 in the manner explained above, whereby the wiper shaft 41 is driven five steps in the vertical direction away from its normal vertical position and the set of switch springs S57 is not actuated. At this time the pair of control wipers 44 and 44' of the wiper set is disposed adjacent the fifth level in the associated contact bank 45 and the pair of line wipers 42 and 43 of the wiper set is disposed the vertical distance substantially V below the first level in the associated contact bank 45. Accordingly, the wiper set carried by the wiper shaft 41 does not occupy a position wherein it can select a trunk and the Strowger mechanism 40 is released, whereupon it is dropped back to its normal vertical position incident to the restoration of the transfer relay R90. More specifically, in the present example, shortly following the conclusion of the first digit 5 dialed at the calling subscriber substation T1, the transfer relay R90 restores to complete, at the contacts 91, the previously mentioned circuit for energizing the release magnet M49. The above-mentioned circuit extends from ground by way of the contacts 67 and 71, the set of switch springs S51, the contacts 91 and 48, the contacts 58 of the set of switch springs S57 and the release magnet M49 to battery. When thus energized the release magnet M49 operates to release the wiper shaft 41, whereby it is returned to its normal vertical position. When the wiper shaft 41 is thus released the sets of switch springs S50, S51 and S52 are again actuated. More particularly, the set of switch springs S50 is actuated into engagement, thereby to recomplete the previously traced circuit for energizing the lower winding of the transfer relay R90, whereby the latter relay reoperates; the set of switch springs S51 is actuated into disengagement, thereby to interrupt the above-traced circuit for energizing the release magnet M49, whereby the latter magnet restores; and the set of switch springs S52 is actuated into disengagement, thereby to interrupt a further point in the previously mentioned alternative circuit for energizing the release magnet M49. At this time the above-traced loop circuit between the calling subscriber substation T1 and the line relay R70 including the secondary winding of the dial tone transformer 93 is still completed, whereby dial tone current is still returned to the calling subscriber substation T1 in order to indicate to the subscriber thereat that the first digit of the directory number dialed was an unassigned digit. Also at this time the Strowger mechanism 40 is completely released and the apparatus incorporated in the drop-back selector 30 occupies its initial seized position, whereby the drop-back selector 30 is again prepared to receive the first digit of a directory number dialed at the calling subscriber substation T1. Accordingly, in this case, the subscriber at the calling subscriber substation T1 again operates the dial in accordance with the proper and assigned first digit of the directory number.

Now assuming that the first digit of the directory number dialed at the calling subscriber substation T1 was one of the assigned digits 6 to 9, inclusive, such, for example, as the digit 6, the drop-back selector 30 operates in response to the first digit 6, in the manner explained above, whereby the wiper shaft 41 is driven six steps in the vertical direction away from its normal vertical position and the set of switch springs S57 is actuated. At this time the pair of control wipers 44 and 44' of the wiper set is disposed adjacent the sixth level in the associated contact bank 45 and the pair of line wipers 42 and 43 of the wiper set is disposed adjacent the first level in the associated contact bank 45. Accordingly, the wiper set carried by the wiper shaft 41 occupies a position wherein it can select a trunk and the Strowger mechanism 40 is not released incident to the restoration of the transfer relay R90. More particularly, the wiper set carried by the wiper shaft 41 occupies a position selecting the group of trunks extending to the first group of connectors, including the connector 24; and operation of the rotary magnet M47 is initiated incident to the restoration of the transfer relay R90. More specifically, in the present example, shortly following the conclusion of the first digit 6 dialed at the calling subscriber substation T1, the transfer relay R90 restores to complete, at the contacts 91, the previously mentioned circuit for energizing the rotary magnet M47. The above-mentioned circuit extends from ground by way of the contacts 67 and 71, the set of switch springs S51, the contacts 91 and 48, the contacts 59 of the set of switch springs S57 and the rotary magnet M47 to battery. When thus energized the rotary magnet M47 operates to drive the wiper shaft 41 one step in the rotary direction, whereby the idle or busy condition of the first trunk in the previously selected group is tested. More particularly, in the event the trunk mentioned is respectively idle or busy, battery or ground potential respectively appears upon the control conductor thereof and is applied to the control wiper 44 of the wiper set.

Assuming that the first trunk in the previously selected group is busy, ground potential appears upon the control conductor thereof and is applied to the control wiper 44 of the wiper set, as noted above; thereby to complete an obvious path, including the contacts 82 and 81, for short-circuiting the upper winding of the switching relay R60 in order positively to prevent operation of the latter relay at this time. Also, upon operating, the rotary magnet M47 interrupts, at the contacts 48, the previously traced circuit for energizing the rotary magnet M47, whereby the latter magnet restores. Upon restoring, the rotary magnet M47 again completes, at the contacts 48, the previously traced circuit for energizing the rotary magnet M47, whereby it reoperates in order to drive the wiper shaft 41 an additional step in the rotary direction; whereby the second trunk in the previously selected group is tested. In view of the foregoing explanation, it will be understood that the rotary magnet M47 operates intermittently, whereby the wiper shaft 41 is driven step by step in the rotary direction until the control wiper 44 of the wiper set tests an idle trunk in the previously selected group.

Assuming that the trunk 25 extending to the

connector 24 in the first group is the first idle trunk in the previously selected group, intermittent operation of the rotary magnet M47 continues until the wiper set selects the tenth contacts in the sixth and first levels respectively terminating the control conductor C28 and the line conductors C26 and C27 thereof. At this time battery potential appears upon the control conductor C28 of the trunk 25 extending to the connector 24 and terminated by the lower contact in the tenth pair in the sixth level of the contact bank 45 engaged by the control wiper 44 of the wiper set. Accordingly, battery potential is applied to the control wiper 44 of the wiper set, thereby to complete a circuit substantially identical to that previously traced and including the contacts 82 and 81 for energizing the upper winding of the switching relay R60. When thus energized the switching relay R60 operates exceedingly fast to complete, at the contacts 66, an obvious holding circuit, including the contacts 81, for energizing the lower winding thereof. Also the switching relay R60 completes, at the contacts 65, an obvious path, including the contacts 82, for short-circuiting the upper winding thereof and an obvious multiple path, including the contacts 81, for applying direct ground potential to the control wiper 44 of the wiper set. Further the switching relay R60 interrupts, at the contacts 67, the previously traced circuit for energizing the rotary magnet M47, thereby positively to arrest further operation thereof and consequent movement of the wiper shaft 41 in the rotary direction. Also the switching relay R60 interrupts, at the contacts 61 and 63, the previously traced loop circuit for energizing the upper and lower windings of the line relay R70, thereby to cause the latter relay to restore. Finally the switching relay R60 completes, at the contacts 62 and 64, an alternative loop circuit extending between the calling subscriber substation T1 and the connector 24. The above-mentioned loop circuit extends from the positive line conductor C26 of the trunk 25 by way of the line wiper 42 and the contacts 64 to the positive terminal of the drop-back selector 30 and from the negative line conductor C27 of the trunk 25 by way of the line wiper 43 and the contacts 62 to the negative terminal of the drop-back selector 30; the positive and negative terminals of the drop-back selector 30 being connected by way of the line switch 11 and the subscriber line 10 to the calling subscriber substation T1 and ground and battery potential being applied in the connector 24 to the positive and negative line conductors C26 and C27, respectively, of the trunk 25. When the above-traced loop circuit is completed between the calling subscriber substation T1 and the connector 24, the connector 24 operates to cause ground potential to be applied to the control conductor C28 of the trunk 25 and is conditioned to be responsive to the second digit of the directory number dialed over the above-traced loop circuit at the calling subscriber substation T1. The application of ground potential in the connector 24 to the control conductor C28 of the trunk 25 completes an alternative path, including the control wiper 44 of the wiper set and the contacts 65 of the operated switching relay R60, for applying ground potential to the control terminal of the drop-back selector 30, whereby the line switch 11 is retained in its operated position.

Upon restoring, the line relay R70 interrupts, at the contacts 71, the previously mentioned circuit for energizing the winding of the hold relay R80, thereby to cause the latter relay to restore shortly thereafter, the hold relay R80 being of the slow-to-release type. Upon restoring, the hold relay R80 interrupts, at the contacts 83, the previously mentioned circuit for energizing the intermediate winding of the switching relay R60; however, the latter relay remains in its operated position at this time due to the completed holding circuit for energizing the lower winding thereof. Also the hold relay R80 interrupts, at the contacts 81, the previously traced original path for applying ground potential to the control terminal of the drop-back selector 30 and prepares, at the contacts 85, a further point in the previously mentioned alternative circuit for energizing the release magnet M49. At this time the previously traced loop circuit is completed between the calling subscriber substation T1 and the connector 24; and the connector 24 is in readiness to receive the second digit of the directory number.

The subscriber at the calling subscriber substation T1 then dials the second and third digits of the directory number over the previously traced loop circuit, whereby the connector 24 is operated in accordance with conventional practice to select the corresponding subscriber line, such, for example, as the subscriber line 12, extending to the called subscriber substation T2. The connector 24 then operates in accordance with conventional practice to test the idle or busy condition of the selected subscriber line 12, whereby busy tone current is returned over the previously traced loop circuit to the calling subscriber substation T1 in the event the called subscriber substation T2 is busy at this time. On the other hand, the connector 24 operates in order to project ringing current over the subscriber line 12 to the called subscriber substation T2 and ring-back tone current over the previously traced loop circuit to the calling subscriber substation T1 in the event the called subscriber substation T2 is idle at this time. Assuming that the called subscriber substation T2 is idle at this time, when the subscriber thereat answers the call by removing the receiver of the telephone instrument from its associated switchhook, an obvious connection is completed between the calling subscriber substation T1 and the called subscriber substation T2; this connection including the subscriber line 10, the line switch 11, the drop-back selector 30, the trunk 25, the connector 24 and the subscriber line 12.

Subsequently, when the subscriber at the calling subscriber substation T1 initiates the release of the established connection by replacing the receiver of the telephone instrument upon its associated switchhook, the previously traced loop circuit extending to the connector 24 is interrupted, thereby to cause the connector 24 to be released, whereupon ground potential is removed from the control conductor C28 of the trunk 25. When the connector 24 is thus released the subscriber line 12 is marked as idle to the other connectors having access thereto, assuming that the subscriber at the called subscriber substation T2 has replaced the receiver of the telephone instrument upon its associated switchhook at this time. When ground potential is removed from the control conductor C28 of the trunk 25 and consequently from the control terminal of the drop-back selector 30, the line switch 11 is released, whereby the subscriber line 10 extending to the calling subscriber substation T1 is marked

as idle to the connectors having access thereto. Also, when ground potential is removed from the conductor C28 of the trunk 25, the previously traced holding circuit for energizing the lower winding of the switching relay R60 is interrupted, thereby to cause the latter relay to restore. Upon restoring, the switching relay R60 completes, at the contacts 67, the previously mentioned alternative circuit, including the contacts 72 and 85 and the set of switch springs S52, for energizing the release magnet M49, whereby the latter magnet operates in order to release the wiper shaft 41 and to cause it to be returned to its normal rotary and vertical positions. When the wiper shaft 41 is thus released the sets of switch springs S50, S51 and S52 are actuated, as previously explained. More particularly, the set of switch springs S52 is actuated into disengagement, thereby to interrupt the above-traced alternative circuit for energizing the release magnet M49, whereupon the latter magnet restores. At this time the drop-back selector 30 is completely released and available for further use.

In the foregoing explanation of the mode of operation of the drop-back selector 30 in response to the first digit 6 of the directory number dialed at the calling subscriber substation T1, it was assumed that there was an idle trunk in the first group extending to the first group of connectors, including the connector 24. However, it may occur that all of the trunks in the first group are busy at this time when operation of the rotary magnet M47 is initiated. In this event, the rotary magnet M47 operates intermittently, whereby the wiper shaft 41 is driven eleven steps in the rotary direction away from its normal rotary position, whereby the sets of switch springs S53 and S54 are actuated. More particularly, the set of switch springs S53 is actuated into engagement, thereby to complete an alternative circuit, including the contacts 67 and 71, for energizing the lower winding of the transfer relay R90 in order to cause the latter relay to operate. Upon operating, the transfer relay R90 interrupts, at the contacts 91, a further point in the previously traced circuit for energizing the rotary magnet M47, thereby positively to prevent further operation of the latter magnet at this time. When the set of switch springs S54 is actuated there is interrupted, at the contacts 56 thereof, the previously traced loop circuit extending to the calling subscriber substation T1 and including the secondary winding of the dial tone transformer 93, and there is completed, at the contacts 55 thereof, an obvious alternative loop circuit extending to the calling subscriber substation T1 and including the secondary winding of the busy transformer 92. The inclusion of the secondary winding of the busy transformer 92 in the above-mentioned alternative loop circuit extending to the calling subscriber substation T1 causes the receiver of the telephone instrument thereat to be operated in accordance with busy tone, thereby to indicate to the subscriber at the calling subscriber substation T1 that the desired connection may not be had immediately in view of the all-busy-condition. In this case, the subscriber at the calling subscriber substation T1 initiates the release of the drop-back selector 30 by replacing the receiver of the telephone instrument thereat upon its associated switchhook, whereby the previously mentioned alternative loop circuit for energizing in series the upper and lower windings of the line relay R70 is interrupted. The line relay R70 then restores, thereby to interrupt, at the contacts 71, the previously mentioned circuit for energizing the winding of the hold relay R80, whereupon the latter relay restores shortly thereafter. Upon restoring, the hold relay R80 interrupts, at the contacts 81, the previously mentioned path for applying ground potential to the control terminal of the drop-back selector 30 in order to effect the release of the line switch 11, in the manner previously explained. Also, upon restoring, the hold relay R80 completes, at the contacts 85, the previously traced alternative circuit for energizing the release magnet M49, whereby the latter magnet operates in order to effect the release of the wiper shaft 41 of the Strowger mechanism 40, in the manner previously noted. The remainder of the release of the drop-back selector 30 incident to the restoration of the hold relay R80 and the operation of the release magnet M49 is the same as that previously described. At this time the drop-back selector 30 is completely released and available for further use.

In view of the foregoing explanation of the mode of operation of the drop-back selector 30 to select an idle trunk in the first group in response to the first digit 6 of the directory number dialed at the calling subscriber substation T1, it will be understood that it is operative in a substantially identical manner to select an idle trunk in the second, third or fourth groups in response to the first digits 7, 8 and 9 of the directory numbers dialed at the calling subscriber substation T1. Finally it will be understood that the drop-back selector 30 is operative in a manner substantially identical to that previously explained in response to the dialing of the single digit 0 at the calling subscriber substation T1, whereby an idle trunk in the group extending to the group of trunk circuits is selected. For example, the drop-back selector 30 may operate in response to the reception of the digit 0 dialed at the calling subscriber substation T1 to select the trunk 20 extending to the trunk circuit 15, whereby the switching relay R60 operates in order to complete an obvious loop circuit between the calling subscriber substation T1 and the trunk circuit 15. The trunk circuit 15 then operates in order to signal the operator at the operator position 13 over the trunk 14 terminating thereat. The operator at the operator position 13 then answers the call and communicates with the subscriber at the calling subscriber substation T1 in accordance with conventional practice. The subsequent release of this established connection between the calling subscriber substation T1 and the called operator position 13 is under the control of the subscriber at the calling subscriber substation T1 and is performed in the manner previously explained when the receiver of the telephone instrument thereat is replaced upon its associated switchhook.

While one embodiment of the invention has been disclosed, it will be understood that various modifications may be made therein which are within the true spirit and scope of the invention.

What is claimed is:

1. In a telephone system, a drop-back selector of the primary-secondary motion type having an incoming trunk and comprising a single unitary contact bank including first and second sections, said first section including a plurality of spaced-apart rows of control contacts and said second section including a plurality of spaced-apart rows of line contacts, a plurality of lines terminated by said contact bank, each of said lines including

control and line conductors respectively terminated by corresponding control and line contacts in corresponding rows in said first and second sections, a wiper set having a normal position and mounted for both primary and secondary movements with respect to said contact bank, said wiper set including a control wiper and a spaced-apart line wiper adapted to cooperate respectively with said first and second sections, means controllable over said incoming trunk for imparting selective primary movement to said wiper set, whereby said control and line wipers are both moved adjacent corresponding rows of contacts respectively included in said first and second sections only in the event at least a predetermined amount of primary movement is imparted to said wiper set, means for controlling the return of said wiper set back to its normal position following the primary movement imparted thereto, and means controllable only in the event at least said predetermined amount of primary movement is imparted to said wiper set for imparting selective secondary movement thereto, whereby said control and line wipers are moved to select corresponding control and line contacts in the adjacent rows respectively included in said first and second sections in order to cause said wiper set to select the associated terminated line.

2. In a telephone system, a drop-back selector of the primary-secondary motion type having an incoming trunk and comprising a single unitary contact bank including first and second sections, said first section including a plurality of spaced-apart rows of control contacts and said second section including a plurality of spaced-apart rows of line contacts, a plurality of lines terminated by said contact bank, each of said lines including control and line conductors respectively terminated by corresponding control and line contacts in corresponding rows in said first and second sections, a wiper set having a normal position and mounted for both primary and secondary movements with respect to said contact bank, said wiper set including a control wiper and a spaced-apart line wiper adapted to cooperate respectively with said first and second sections, means for connecting a dial tone voltage to said incoming trunk, impulse responsive means controllable over said incoming trunk for imparting selective primary movement to said wiper set, whereby said control and line wipers are both moved adjacent corresponding rows of contacts respectively included in said first and second sections only in the event at least a predetermined amount of primary movement is imparted to said wiper set, means controlled in the event less than said predetermined amount of primary movement is imparted to said wiper set for returning said wiper set back to its normal position, means controllable only in the event at least said predetermined amount of primary movement is imparted to said wiper set for imparting selective secondary movement thereto, whereby said control and line wipers are moved to select corresponding control and line contacts in the adjacent rows respectively included in said first and second sections in order to cause said wiper set to select the associated terminated line, and means controlled by the selection of said last-mentioned line by said wiper set for connecting said incoming trunk to said wiper set and for disconnecting the dial tone voltage from said incoming trunk.

3. In a telephone system, a drop-back selector of the primary-secondary motion type having an incoming trunk and comprising a single unitary contact bank including first and second sections, said first section including a plurality of spaced-apart rows of control contacts and said second section including a plurality of spaced-apart rows of line contacts, a plurality of groups of lines terminated by said contact bank, each of said groups of lines being terminated in two corresponding rows in said first and second sections and each of said lines including control and line conductors respectively terminated by corresponding control and line contacts in the two corresponding rows in said first and second sections, a wiper set having a normal position and mounted for both primary and secondary movements with respect to said contact bank, said wiper set including a control wiper and a spaced-apart line wiper adapted to cooperate respectively with said first and second sections, means for connecting a dial tone voltage to said incoming trunk, impulse responsive means controllable over said incoming trunk for imparting selective primary movement to said wiper set, whereby said control and line wipers are both moved adjacent corresponding rows of contacts respectively included in said first and second sections only in the event at least a predetermined amount of primary movement is imparted to said wiper set in order to cause said wiper set to select the associated group of terminated lines, means controlled in the event less than said predetermined amount of primary movement is imparted to said wiper set for returning said wiper set back to its normal position, means controllable only in the event at least said predetermined amount of primary movement is imparted to said wiper set for imparting selective secondary movement thereto, whereby said control and line wipers are moved to select corresponding control and line contacts in the adjacent rows respectively included in said first and second sections in order to cause said wiper set to select the associated idle terminated line in the event the previously selected group includes an idle line, means controlled by the selection of said last-mentioned idle line in the previously selected group by said wiper set for connecting said incoming trunk to said wiper set and for disconnecting the dial tone voltage from said incoming trunk, and means controlled in the event a predetermined amount of secondary movement is imparted to said wiper set when there is no idle line in the group previously selected thereby for disconnecting the dial tone voltage from said incoming trunk and for connecting a busy tone voltage thereto.

4. A drop-back selector of the primary-secondary motion type comprising a single unitary contact bank including first and second sections, said first section including a plurality of spaced-apart rows of control contacts and said second section including a plurality of spaced-apart rows of line contacts, a wiper set having a normal position and mounted for both primary and secondary movements with respect to said contact bank, said wiper set including a control wiper and a spaced-apart line wiper adapted to cooperate respectively with said first and second sections, means for imparting selective primary movement to said wiper set, whereby said control and line wipers are both moved adjacent corresponding rows of contacts respectively included in said first and second sections only in the event at least a predetermined amount of primary movement is imparted to said wiper set, means for con-

trolling the return of said wiper set back to its normal position following the primary movement imparted thereto, and means for imparting selective secondary movement to said wiper set, whereby said control and line wipers are moved to select corresponding control and line contacts in the adjacent rows respectively included in said first and second sections.

5. A drop-back selector of the primary-secondary motion type comprising a single unitary contact bank including first and second sections, said first section including a plurality of spaced-apart rows of control contacts and said second section including a plurality of spaced-apart rows of line contacts, a wiper set having a normal position and mounted for both primary and secondary movements with respect to said contact bank, said wiper set including a control wiper and a spaced-apart line wiper adapted to cooperate respectively with said first and second sections, means for imparting selective primary movement to said wiper set, whereby said control and line wipers are both moved adjacent corresponding rows of contacts respectively included in said first and second sections only in the event at least a predetermined amount of primary movement is imparted to said wiper set, said predetermined amount of primary movement comprising movement of the wiper set away from normal a distance in excess of the distance between said wipers, means for controlling the return of said wiper set back to its normal position following the primary movement imparted thereto, and means controllable only in the event at least said predetermined amount of primary movement is imparted to said wiper set for imparting selective secondary movement thereto, whereby said control and line wipers are moved to select corresponding control and line contacts in the adjacent rows respectively included in said first and second sections.

6. A drop-back selector of the primary-secondary motion type comprising a single unitary contact bank including first and second sections, said first section including a plurality of spaced-apart rows of control contacts and said second section including a plurality of spaced-apart rows of line contacts, a wiper set having a normal position and mounted for both primary and secondary movements with respect to said contact bank, said wiper set including a control wiper and a spaced-apart line wiper adapted to cooperate respectively with said first and second sections, means for imparting selective primary movement to said wiper set, whereby said control and line wipers are both moved adjacent corresponding rows of contacts respectively included in said first and second sections only in the event at least a predetermined amount of primary movement is imparted to said wiper set, said predetermined amount of primary movement comprising movement of the wiper set away from normal a distance in excess of the distance between said wipers, means controlled in the event less than said predetermined amount of primary movement is imparted to said wiper set for returning said wiper set back to its normal position, and means controllable only in the event at least said predetermined amount of primary movement is imparted to said wiper set for imparting selective secondary movement thereto, whereby said control and line wipers are moved to select corresponding control and line contacts in the adjacent rows respectively included in said first and second sections.

7. A drop-back selector of the primary-secondary motion type comprising a single unitary contact bank including first and second sections, said first section including a plurality of spaced-apart rows of control contacts and said second section including a plurality of spaced-apart rows of line contacts, a wiper set having a normal position and mounted for both primary and secondary movements with respect to said contact bank, said wiper set including a control wiper and a spaced-apart line wiper adapted to cooperate respectively with said first and second sections, means for imparting selective step-by-step primary movement to said wiper set, whereby said control and line wipers are both moved adjacent corresponding rows of contacts respectively included in said first and second sections only in the event at least a predetermined plural number of steps of primary movement are imparted to said wiper set, means for controlling the return of said wiper set back to its normal position following the primary movement imparted thereto, and means controllable only in the event at least said predetermined number of steps of primary movement is imparted to said wiper set for imparting selective step-by-step secondary movement thereto, whereby said control and line wipers are moved to select corresponding control and line contacts in the adjacent rows respectively included in said first and second sections.

8. A drop-back selector of the primary-secondary motion type comprising a single unitary contact bank including first and second sections, said first section including a plurality of spaced-apart rows of control contacts and said second section including a plurality of spaced-apart rows of line contacts, a wiper set having a normal position and mounted for both primary and secondary movements with respect to said contact bank, said wiper set including a control wiper and a spaced-apart line wiper adapted to cooperate respectively with said first and second sections, means for imparting selective step-by-step primary movement to said wiper set, whereby said control and line wipers are both moved adjacent corresponding rows of contacts respectively included in said first and second sections only in the event at least a predetermined plural number of steps of primary movement are imparted to said wiper set, means controlled in the event less than said predetermined number of steps of primary movement are imparted to said wiper set for returning said wiper set back to its normal position, and means controllable only in the event at least said predetermined number of steps of primary movement is imparted to said wiper set for imparting selective step-by-step secondary movement thereto, whereby said control and line wipers are moved to select corresponding control and line contacts in the adjacent rows respectively included in said first and second sections.

9. A drop-back selector of the primary-secondary motion type comprising a single unitary contact bank including first and second sections, said first section including a plurality of spaced-apart rows of control contacts and said second section including a plurality of spaced-apart rows of line contacts, a wiper set having a normal position and mounted for both primary and secondary movements with respect to said contact bank, said wiper set including a control wiper and a spaced-apart line wiper adapted to cooperate respectively with said first and second sections, a first magnet operative to impart primary movement to said wiper set, means for selectively controlling the operation of said first magnet, where-

by said control and line wipers are both moved adjacent corresponding rows of contacts respectively included in said first and second sections only in the event at least a predetermined amount of primary movement is imparted to said wiper set, said predetermined amount of primary movement comprising movement of the wiper set away from normal a distance in excess of the distance between said wipers, a second magnet operative to effect the return of said wiper set back to its normal position, a third magnet operative to impart secondary movement to said wiper set, and means controlled in the event less than said predetermined amount of primary movement is imparted to said wiper set for operating said second magnet and controlled in the event at least said predetermined amount of primary movement is imparted to said wiper set for selectively operating said third magnet, whereby said control and line wipers are moved to select corresponding control and line contacts in the adjacent rows respectively included in said first and second sections in the event said third magnet is operated.

10. A drop-back selector of the primary-secondary motion type comprising a single unitary contact bank including first and second sections, said first section including a plurality of spaced-apart rows of control contacts and said second section including a plurality of spaced-apart rows of line contacts, a wiper set having a normal position and mounted for both primary and secondary movements with respect to said contact bank, said wiper set including a control wiper and a spaced-apart line wiper adapted to cooperate respectively with said first and second sections, a first magnet operative to impart primary movement to said wiper set, means for selectively controlling the operation of said first magnet, whereby said control and line wipers are both moved adjacent corresponding rows of contacts respectively included in said first and second sections only in the event at least a predetermined amount of primary movement is imparted to said wiper set, a second magnet operative to effect the return of said wiper set back to its normal position, a third magnet operative to impart secondary movement to said wiper set, a set of springs normally enabling said second magnet and operative to disable said second magnet and to enable said third magnet, means controlled in the event at least said predetermined amount of primary movement is imparted to said wiper set for operating said set of springs, and means controlled shortly following the conclusion of the primary movement of said wiper set for operating said second magnet in the event it is enabled or for selectively operating said third magnet in the event it is enabled, whereby said control and line wipers are moved to select corresponding control and line contacts in the adjacent rows respectively included in said first and second sections in the event said third magnet is operated.

11. An automatic switch comprising a single unitary contact bank including a plurality of longitudinally spaced-apart laterally extending rows of contacts, wherein each two adjacent rows of contacts are spaced apart a longitudinal distance substantially V and each two adjacent individual contacts in each row are spaced apart a lateral distance substantially R, a wiper set associated with said contact bank and mounted for both longitudinal and lateral movements with respect thereto, said wiper set including a control wiper and a line wiper longitudinally spaced apart a distance substantially KV, where K is equal to a whole number, means for moving said wiper set longitudinally step by step a distance V each step, means for moving said wiper set laterally step by step a distance R each step, whereby the control and line wipers of said wiper set respectively engage in said contact bank two corresponding contacts disposed in two rows longitudinally spaced apart the distance substantially KV when said wiper set is moved both longitudinally a variable number of steps and laterally a variable number of steps, and a plurality of lines terminated by said contact bank, each of said lines including a control conductor and a line conductor respectively terminated in said contact bank by two corresponding contacts disposed in two rows longitudinally spaced apart the distance substantially KV.

12. An automatic switch comprising a single unitary contact bank including a plurality of vertically spaced-apart circumferentially extending rows of contacts, wherein each two adjacent rows of contacts are spaced apart a vertical distance substantially V and each two adjacent individual contacts in each row are spaced apart a circumferential distance substantially R, a wiper set associated with said contact bank and mounted for both vertical and rotary movements with respect thereto, said wiper set including a control wiper and a line wiper vertically spaced apart substantially KV, where K is equal to a whole number, means for moving said wiper set in the vertical direction step by step a distance V each step, means for moving said wiper set in the rotary direction step by step a distance R each step, whereby the control and line wipers of said wiper set respectively engage in said contact bank two corresponding contacts disposed in two rows vertically spaced apart the distance substantially KV when said wiper set is moved both in the vertical direction a variable number of steps and in the rotary direction a variable number of steps, and a plurality of lines terminated by said contact bank, each of said lines including a control conductor and a line conductor respectively terminated in said contact bank by two corresponding contacts disposed in two rows vertically spaced apart the distance substantially KV.

13. In an automatic switch, stationary contacts arranged in a plurality of horizontal rows so that all adjacent rows are spaced apart by the same distance and so that the corresponding end contacts of all rows are in vertical alignment, a pair of wipers disposed one above the other and separated by a fixed distance equal to an integral multiple of the distance between adjacent rows of said contacts, said wipers normally occupying a position such that both are below the level of the lowest row of said contacts, electromagnetically operated mechanism for moving said wipers step by step as a unit from their normal position along a vertical path parallel and adjacent to the line in which said end contacts lie, said mechanism effective at times to terminate such movement before the lower one of said wipers has reached the level of the lowest row of said contacts and effective at other times to terminate such movement when each of said wipers is at the same level as a row of contacts, electromagnetically operated mechanism for moving said wipers horizontally at said other times thereby to bring each wiper into engagement with the end contact of the row with which that wiper is level, and means for disabling said

last mechanism at said first times thereby to prevent such horizontal movement.

14. In an automatic switch, stationary contacts arranged in a plurality of parallel rows so that all adjacent rows are spaced apart by the same distance and so that the corresponding end contacts of all rows are in alignment, a pair of wipers movable with respect to said stationary contacts but fixed in their relationship to each other, said relationship being such that said wipers are spaced apart from one another by a distance which is an integral multiple of the distance between adjacent rows of stationary contacts, means for moving said wipers, with one wiper trailing the other, along a path parallel to the line in which said end contacts lie, said means effective at times to terminate such movement when both of said wipers occupy positions opposite rows of said contacts and effective at other times to terminate such movement when only one of said wipers occupies a position opposite a row of said contacts, means effective at said first times for moving said wipers along the rows opposite which they are positioned at the conclusion of said first movement, and means for disabling said last moving means at said other times.

15. In an automatic switch, two spaced apart wipers, means for moving said wipers as a unit with one wiper trailing the other, two groups of stationary contacts beside the path travelled by said wipers during such movement, said groups so related in position to one another and to said path that the leading one of said wipers must pass beside one of said groups during said movement before it reaches a position beside the other group and so that the trailing one of said wipers reaches a position beside said one group at the same time said leading wiper reaches a position beside said other group, means for at times moving said wipers as a unit in a direction transverse to the path travelled by them when moved by said first mentioned means, means for rendering said last mentioned moving means operative only when said leading wiper has been positioned beside said other group and said trailing wiper has been positioned beside said one group, and means for controlling said last mentioned moving means to bring each of said wipers into engagement with any contact of the group beside which that wiper has been positioned.

16. In an automatic switch, two spaced apart wipers, means for moving said wipers as a unit with one wiper trailing the other, two groups of stationary contacts beside the path travelled by said wipers during such movement, said groups so related in position to one another and to said path that the leading one of said wipers must pass beside one of said groups during said movement before it reaches a position beside the other group and so that the trailing one of said wipers reaches a position beside said one group at the same time said leading wiper reaches a position beside said other group, said means effective at times to halt said movement when said leading wiper reaches a position beside said one group and effective at other times to halt said movement when said trailing wiper reaches a position beside said one group, means effective if said first movement has been halted with said trailing wiper beside said one group for moving said wipers as a unit in a direction transverse to the path travelled by them under control of said first means, thereby to bring each of said wipers into engagement with any contact of the group beside which that wiper was positioned, and means disabling said last means if said first movement has been halted with said leading wiper beside said one group.

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