

Nov. 14, 1944.

R. C. DAVIS ET AL

2,362,619

TELEPHONE SYSTEM

Filed Oct. 21, 1943

4 Sheets-Sheet 2

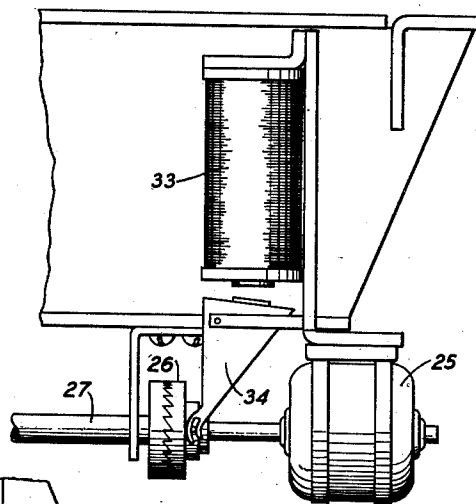


FIG. 2

FIG 3

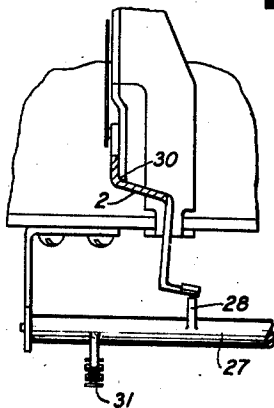


FIG. 4

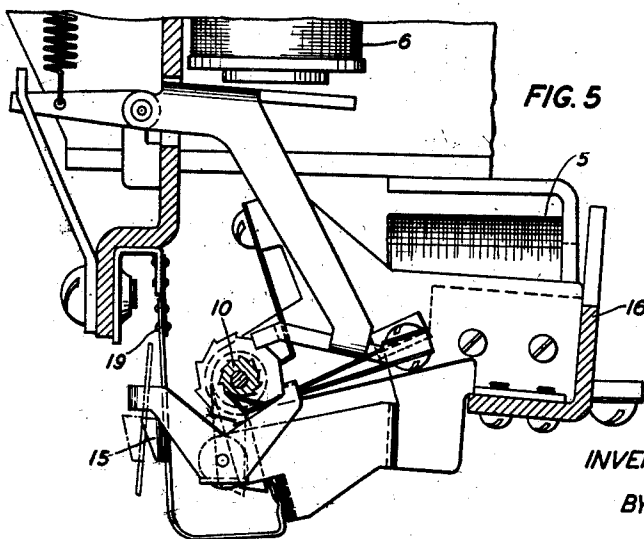
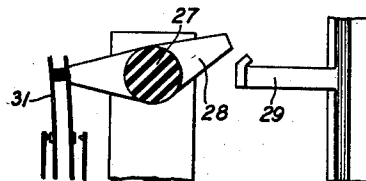


FIG. 5

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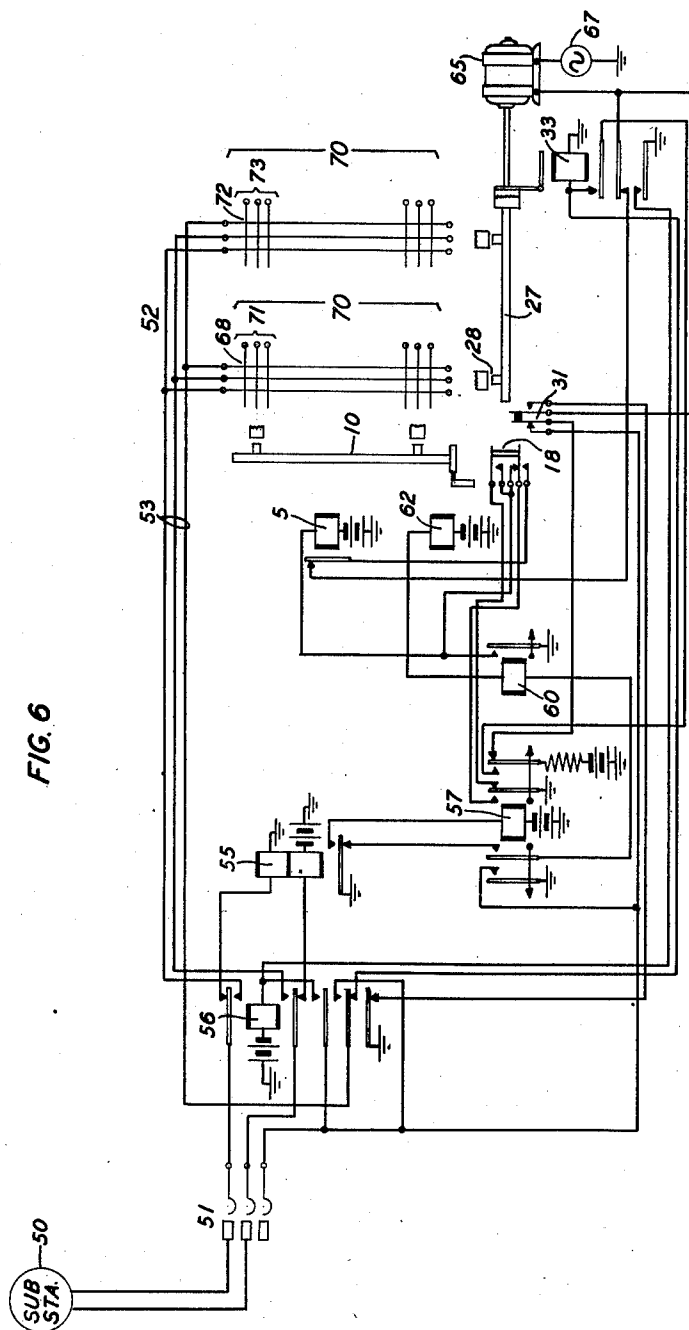
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4 Sheets-Sheet 3



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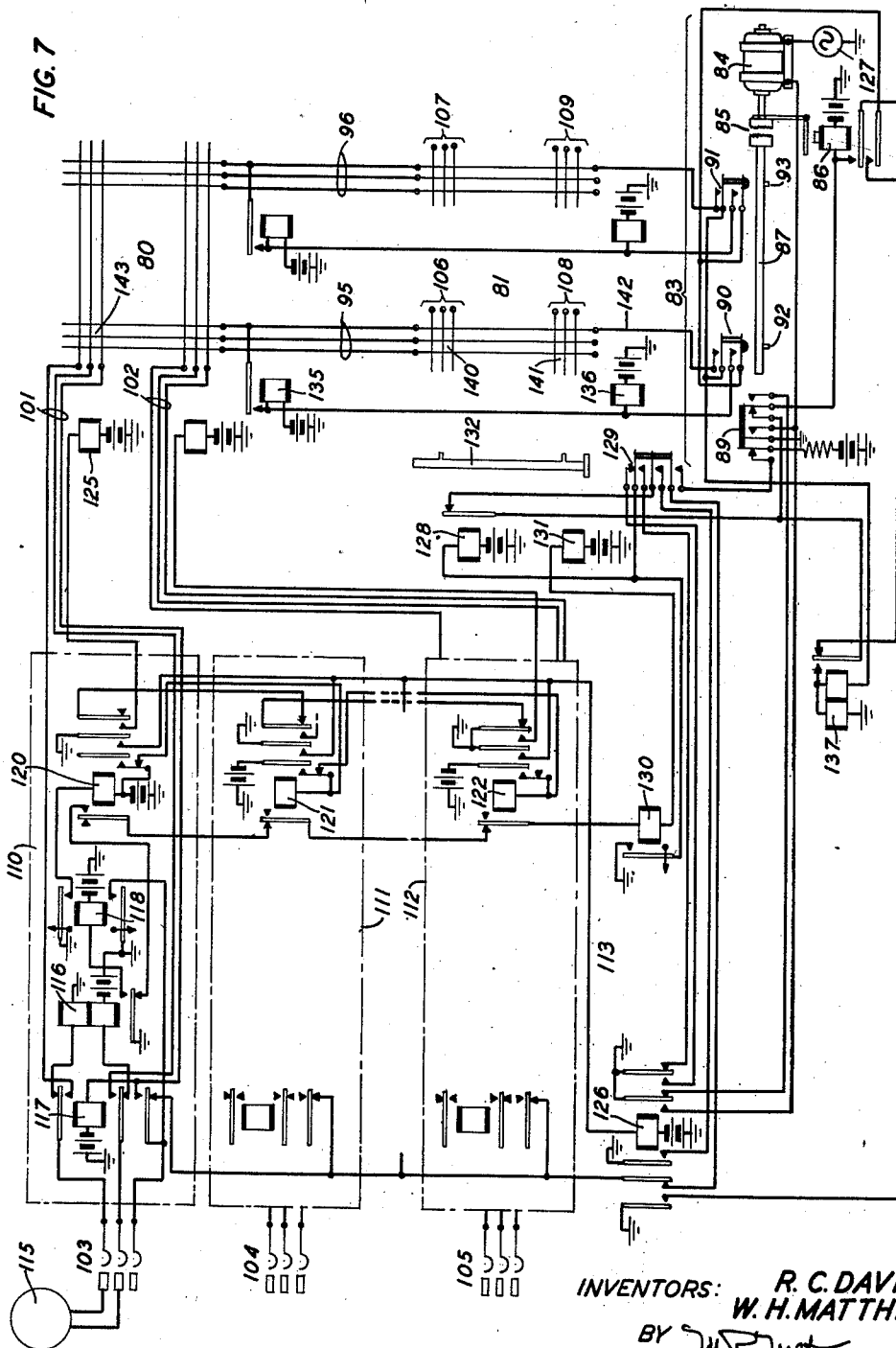
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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,362,619

TELEPHONE SYSTEM

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Application October 21, 1943, Serial No. 507,062

7 Claims. (Cl. 179—22)

This invention relates to telephone systems and particularly to improvements in automatic telephone systems employing cross bar switches.

An object is to simplify cross bar switching mechanism and the circuit control means therefor for trunk group selections and trunk hunting operations.

Heretofore cross bar switches have been employed in which select rods and hold rods are coordinately arranged to operate contacts at the intersecting points of said two types of rods when actuated. In some instances a common step-by-step mechanism was provided for selecting and operating the select rods, and in other instances the hold rods were similarly selected and operated, while in still other cases both the select rods and the hold rods were selected and operated in this manner. Cross bar switches illustrating these types of mechanisms have been disclosed in the Patents 2,350,458 to F. H. Hibbard and 2,350,464 A. L. Keller.

It is to switches of these types that the applicants' invention may be applied. A feature thereof is in the selector arrangement of line connections and operating circuits whereby a group of outgoing lines may be selected by a calling incoming line and then by actually establishing a connection through the cross bar switch to the first line in this group, the sleeve conductor thereof may be tested to determine the idle or busy condition of said line. If the test shows that the first line is busy the switch is operated to perform the same test on the sleeve conductor of the next line, whereas in the case the test shows that the first line is idle, the connection through the switch to this line remains and the circuit between the calling incoming line and selected idle outgoing line is completed. To carry out this feature of the invention in its simplest form an incoming line may be connected to contacts at all the intersecting points of the two coordinate select and hold bars of the switch and each outgoing line connected to the contacts at a single cross-point, while the operating mechanism and control circuit arrangement may be such that when the incoming line is seized and a desired series of impulses is received by the stepping mechanism for the select bars, said mechanism will select a particular corresponding select bar and actuate it and thereby select a particular level or group of outgoing lines from which a first idle outgoing line will be chosen. The mechanism for this choosing of a first idle outgoing line may include a motor and camming mechanism whereby succeeding hold bars may be

operated to established connections at the cross-points between these bars and the actuated select bar from the calling incoming line and a succeeding outgoing line in the selected group. After the outgoing lines are multipled to other switches for connection to other incoming lines, some of said outgoing lines may be busy. Thus when the connection is established at the cross-point between the incoming line and the first outgoing line in the selected group and the outgoing line is found to be busy as indicated by a particular identifying potential on the sleeve conductor, the circuit control is such that the motor and camming mechanism are actuated to return the actuated hold bar to release this connection and to actuate the next succeeding hold bar to establish a connection to the next outgoing line. If the line is idle as indicated by a corresponding identifying potential on the associated sleeve conductor this mechanism will stop and hold the hold bar in actuated position and the connection is then cut through between the incoming line and this idle outgoing line at the contacts at this cross-point.

This invention may also be applied to selector arrangements of incoming lines and outgoing lines when organized in the well-known primary and secondary selector switching arrangement with intermediate links. The means and mechanism for accomplishing connections of this type embody another feature of the applicants' invention. In this case, a single switch may be arranged with a primary selector switch section and a secondary selector switch section, or separate switches may be employed if desired. The wiring arrangement, however, is such that each of a plurality of incoming lines terminates in contacts in a separate horizontal level or row of a switch, while the contacts of each link circuit are arranged in a separate vertical row with the contacts of the outgoing lines in each group arranged in a horizontal level or row so that a corresponding outgoing line in each group may be connected to a separate link. Thus a connection from a calling incoming line to an idle outgoing line may be established by the operation of a horizontal select bar for the calling line and the horizontal select bar for the group of outgoing lines in which the desired outgoing line is located and a vertical hold bar may be operated for selecting and connecting a particular link and thus connect the calling incoming line at one point to the link and this link at another point to the chosen idle outgoing line in the selected group.

To establish such a connection the seizure of an incoming line causes the corresponding horizontal select bar in the primary switch section to be operated by the associated select magnet. The subsequent reception of dial pulses over the incoming line causes the step-by-step mechanism for the secondary switch section to select a corresponding horizontal select bar to be operated to select the desired group of outgoing lines from which an idle outgoing line may subsequently be chosen. For this arrangement it becomes necessary to not only find an idle outgoing line but also an idle link to which to connect the calling line in the primary line section and the idle outgoing line in the secondary line section.

To accomplish the necessary testing and connecting in this case, instead of operating the hold bars in succession for the succeeding links to connect them with a calling line and the outgoing lines in the selected group, the usual hold magnets are provided for the operation of the hold bars in the primary switch section and in the secondary switch section and a special cam switch controlling contact sets in succession may be provided to test the sleeve conductors of the succeeding links and succeeding outgoing lines in the selected group. That is, if the sleeve conductor is found busy this busy condition may be because the link is engaged in a connection to an outgoing line in another group than the chosen group while the corresponding outgoing line in the chosen group having access to this link is idle, or else the link may be engaged with a busy outgoing line in the chosen group. In either case when a busy sleeve conductor is encountered by the contact set being tested by the cam mechanism, this mechanism will be actuated further to test the next succeeding contact set and associated sleeve conductor. When an idle sleeve conductor is found, the motor for actuating the cam mechanism is stopped and circuits provided through the actuated contact set whereby the hold magnets of the chosen link are operated to establish a connection between the calling incoming line and the link at the cross-point of the actuated select bar and hold bar in the primary switch section, and between this link and the outgoing line at the cross-point of the actuated select bar and hold bar in the secondary switch section. When these connections are established means are provided in the usual manner for completing the talking circuit between the calling line and the outgoing line.

This invention has been illustrated in the accompanying drawings, in which:

Fig. 1 discloses a cross bar switch arranged in accordance with the applicants' invention;

Figs. 2, 3, 4, and 5 show various details of the mechanism shown in Fig. 1;

Fig. 6 shows a circuit diagram of an automatic telephone system to which the applicants' invention has been applied employing a switch of the type disclosed in Figs. 1 to 5; and

Fig. 7 shows a similar circuit diagram for an automatic telephone exchange in which the applicants' invention has been applied to an arrangement using primary and secondary line switch sections and interconnecting links.

Referring now to the drawings and particularly to Figs. 1 to 5, these figures disclose a cross bar switch structure of the ordinary type with special camming mechanisms for controlling the operating bars. This cross bar switch includes select bars 1 and hold bars 2 arranged coordinately and with the usual mechanisms whereby

on the operation of a select bar followed by the operation of a hold bar, corresponding connections are closed between contacts at the intersecting point of said two bars such as for example are shown at the intersecting point marked 3. In this particular disclosure each select bar is arranged to serve two horizontal rows of contacts by being rotated in one direction or the other as is well known in the art. The operations of these select bars may be controlled by mechanisms of the type, for example, disclosed and described in detail in the above-mentioned Patent No. 2,350,458, F. H. Hibbard. That is, the individual magnets for the operation of the select bars are displaced by two common magnets 5 and 6 and a common mechanism marked generally by the numeral 7 which control the operations of the select bars to be operated in opposite directions to perform their selective functions. With this switch in which there are five select bars and ten hold bars, a vertical shaft is provided shown at one end of the select bars and provided with ten projections 11 thereon arranged in a helical formation, while each select bar is provided with a cross-piece 12 having oppositely extending arms 13 and 14 with each arm in a position in line with a corresponding projection 11 on the vertical shaft 10. This vertical shaft is rotatable in steps by a pawl and ratchet mechanism 15 controlled by the magnet 6. This magnet 6, pawl and ratchet mechanism 15, and shaft 10 are mounted on a frame 16 which may be shifted by the magnet 5 to swing away from the arms 13 and 14 on the select bars and to be returned to normal by a spring 17. The function of this mechanism is such that the frame 16, carrying the shaft 10 and the pawl and ratchet mechanism 15, and the magnet 6, is shifted in a position where the projections on the shaft would not interfere with the arms on the select bars. The shaft is then rotated in step until a certain projection on the shaft is placed opposite a particular arm. The frame is then released to normal position so that the selected projection will engage the corresponding arm on a corresponding select bar to rotate it in the proper direction. The shaft now remains in this rotated position after the operation of the select bar until it is restored to normal position at the time the connection through the switch has been completed when magnet 5 is operated through off-normal contact 18 controlled by shaft 10. That is, this succeeding operation of the magnet 5 shifts the frame again and a pawl mechanism 19 is provided which permits the shaft to return to its normal position under tension of the return spring 20 in readiness for succeeding rotation thereof by the pawl and ratchet mechanism 15 and magnet 6 to select and actuate another select bar. These operations will be described more fully hereinafter in connection with the circuits in Figs. 6 and 7.

To operate the hold bars 2 in this switch in succession in accordance with the applicants' invention, the arrangement is provided consisting of a motor 25 having a clutch mechanism 26 connected to a shaft 27. This shaft 27 is provided with helically arranged cams 28 which operate individually on levers such as 29 so that for a complete rotation of the shaft 27 the ten different levers have each been operated upon once. The operation of a lever 29 causes the associated bar 2 to be rotated on its usual knife edge mounting, such as 30, as in any other cross bar switch structure, for completing a selected connection at a cross-point of said bar and an operated select

bar. The shaft 27 has a normal position in which it acts on off-normal contacts 31 and the stopping of the shaft 27 in any particular position may be accomplished by the opening of the clutch 26 of a clutch magnet 33 and its armature and operating lever 37 so that if the motor 20 is started with the shaft 27 in normal position and the clutch is closed, the shaft may be rotated to cause levers 28 to rotate the hold bars 2 in succession until a certain desired hold bar is rotated when the clutch magnet 33 may be operated to open the clutch 26 so that the shaft will maintain this particular hold bar in operated position. Then when the connection held by this hold bar is to be opened, the magnet 33 may be deenergized to close the clutch to permit the motor to return the shaft to normal at which position the motor is stepped by the off-normal contacts opening the circuit therefor as will be described hereinafter.

If reference is now made to Fig. 6, the applicants' invention may be embodied in the system in which the switch shown in Figs. 1 to 5 forms a part. In this case this switch acts as a selector switch in which a single incoming line may be connected to an idle outgoing trunk in any one of a plurality of groups of such trunks. A subscriber's line, such as 50, may terminate in a usual line switch 51 and the brushes thereof are connected to a trunk hunting selector switch 52 of the type disclosed in Figs. 1 to 5. These brushes are connected to a line 53 terminating in the vertical rows of contacts at all of the cross-points in this switch 52, while the outgoing trunks may be divided in groups. For example, if the switch is provided with ten horizontal and ten vertical rows of intersecting contacts, each horizontal row of contacts would constitute one group of outgoing trunks of ten trunks each, that is, each trunk is connected at but a single cross-point. The circuit arrangement is such that on the seizure of the line switch 51 by a calling subscriber 50, the selector 53 will operate to select by the reception of a particular number of impulses a corresponding horizontal level of trunks and hunt for an idle trunk in this level. The operations in this connection are as follows: When the line finder 51 is seized a connection is established for the operation of relay 55 from battery and ground through the windings of this relay, contacts of relay 56, line finder 51 over the loop at the subscriber's station 50. Relay 55 closes an obvious circuit for relay 57 and relay 57 in operating closes a circuit for the operation of the magnet 5 over a circuit from battery, winding of magnet 5, off-normal contacts 18 controlled by the shaft 10 and contacts of relay 57 to ground. This magnet 5 now moves the frame in the switch structure 53, shown in detail in Figs. 1 to 5, in preparation for selections through this switch, that is, this magnet when operating prepares the mechanism for the selection and operation of a desired select bar.

To this end the calling subscriber will not transmit a series of dial pulses which will operate and release relay 55 accordingly. On the first release of relay 55, the relay 60 operates and also the stepping magnet 6 from battery through the winding of this stepping magnet 6, winding of relay 60, contacts of relays 57 and 55 to ground. Relay 60 being slow to release remains operated during the pulsing. The succeeding operations and release of relay 55 operate and release the stepping magnet 6 to rotate the shaft 10 to select

a particular level of trunks in switch 53. It should be noted that relay 60 in operating closes a holding circuit for the magnet 5 as the assigned energizing circuit therefor is opened at the off-normal contact 18 on the first rotary step of the shaft 10. When all the impulses have been sent, the relay 60 releases and thereby causes the release of the magnet 5 so that the shaft 10 now causes a particular select bar to be rotated in the particular direction to select a particular level of trunks from which subsequently a first idle trunk will be chosen. The moment the magnet 5 releases, a circuit for the motor 65 is closed to start the trunk hunting. This circuit may be traced from the alternating current source 67 through this motor, contacts of clutch magnet 33, contacts of magnet 5, off-normal contacts 18, contacts of relay 57 to ground. The motor 65 now starts to rotate the shaft 27 through clutch 26 and causes the first cam 28 to operate on the first lever 29 to rotate the first hold bar 2 and thus cause this bar to establish a connection at the cross-point of this bar and the actuated select bar, for example, at the cross-point 3 in this figure through contacts marked 68. As is the general practice, the trunks 70 outgoing from the selector switches of this type are multiplied to corresponding contacts of other switches so that any one of these trunks may be engaged through some other switch. If trunk 71 to which the incoming line 53 is connected is busy, a ground will be found on the sleeve conductor and the clutch magnet 33 will therefore not be operated at this time but the motor 65 will continue to rotate the shaft 27 to operate the next succeeding hold bar 2. This rotation of shaft 27 will therefore continue until an idle outgoing trunk is found. When this takes place there will be a battery connection present on the sleeve conductor of the idle trunk which causes the operation of the clutch magnet 33 from this battery through the sleeve conductor and sleeve contact, for example, at the cross-point 72 for the trunk 73 through contacts of relay 56, winding of clutch magnet 33 to ground. The operation of this clutch magnet 33 now opens the clutch 26 to separate shaft 27 from the motor 65 so that this shaft will now come to rest and maintain the associated hold bar in actuated position to maintain the connection at the cross-point 72 for the trunk 73 to the incoming line 53. Clutch magnet 33 also opens the original energizing circuit for the motor 65 at its contacts but the motor will be maintained operated over a circuit from the source 67, winding of the motor, the off-normal contacts 31 controlled by the shaft 27 to ground at contacts of relay 56. The clutch magnet provides a locking circuit for itself from battery through the contacts of relay 57, contacts of clutch magnet 33, winding of this magnet to ground. As the connection to the outgoing trunk 73 is now ready for cutting through to the calling subscriber 50, the relay 56 operates over a circuit from battery, winding of this relay, contacts of clutch magnet 33 to ground. Relay 56 provides a locking circuit for itself from battery through its winding and its own contacts to ground on the sleeve conductor to the line finder 51. The above-mentioned operating circuit for the motor 65 is now opened and contact of relay 56 causes it to stop and magnet 56 also opens the circuit for the relay 65 which releases, causing the release of relay 57, which in turn causes the release of the clutch magnet 33. Relay 56 also extends the ground

connection from the line finder 51 to the sleeve of trunk 73. Relay 57 in releasing closes a circuit for the operation of magnet 5 from battery, winding of this magnet, off-normal contacts 18, contacts of relay 57 to ground. Magnet 5 in operating releases the shaft 10 to normal and the actuated select bar is thereby restored to normal. When shaft 10 is released the circuit for magnet 5 is opened at the off-normal contact 18. The circuits now remain in this position until the connection is broken down which is accomplished by the removal of ground from the sleeve conductors. The ground causes the release of the relay 56 and this closes the circuit for the motor 65 from source 67 through the motor, off-normal contacts 31 to ground at contacts of relay 56. As the clutch magnet 33 is released the motor 65 will rotate shaft 27 back to normal position until the off-normal contacts 31 are opened to stop the motor. The return of shaft 27 to normal will, of course, open the connection at the cross-point 72 to release trunk 73.

Referring now to Fig. 7, the arrangement is such that a plurality of connections may be established to various groups of trunks from a plurality of different incoming lines. This figure therefore shows a primary selector switch arrangement 80, a secondary selector switch 81 and a special cam switching mechanism 83. The primary switch is of the regular standard type in which select magnets operate select bars and hold magnets operate hold bars to establish connections at cross-points. The secondary 81 is provided with a separate step-by-step mechanism such as was described in connection with Fig. 1 for the operation of select bars while the hold bars are controlled by the hold magnet with the aid of the special cam switching mechanism 83. This special cam switching mechanism 83 may consist of a motor 84 driving through a clutch 85 controlled by a clutch magnet 86, a shaft 87. The clutch 85 is normally open and is closed by clutch magnet 86 when it is energized. This shaft when in normal position actuates off-normal contacts 89 and when rotated actuates contacts such as 90 and 91 and others through cams, such as 92 and 93 spirally arranged on the shaft 87. That is, one of these sets of contacts and controlling cam are provided for each link such as 95 and 96 and others. The switch 80 may have ten lines such as 101 and 102, each incoming from a separate line finder such as 103, 104 and 105, and others, and terminating in ten horizontal rows of contacts with ten outgoing links terminating in ten vertical rows of contacts. Thus ten separate connections may be established through this switch. Each of these ten links terminates also in a vertical row of contacts in switch 81 and at each cross-point in each horizontal row of contacts is connected a separate trunk such as trunk 106, 107 of one group and 108 and 109 of another group in the same manner as the trunks are connected in the switch shown in Fig. 6. That is, there will be ten horizontal groups of trunks with ten trunks in each group by means of which therefore ten links may establish ten separate connections to any one of the ten trunks in the ten groups. Individual equipment is provided for each line incoming from a line finder. For example, the group of relays and the circuits shown at 110 are individual to the first line 101 and the groups 111 and 112 for other lines. These latter groups have been shown in skeleton form only. A common equipment is provided for all of the incoming lines and is indicated by the numeral 113.

If it is now assumed that the subscriber at 115 establishes a connection through the line finder 103 to the equipment 110, the first result of this connection will be the operation of relay 116 from battery and ground through contact of relay 117, line finder 103 over the loop at the station 115. Relay 116 in operating closes an obvious circuit for relay 118 which in turn closes an obvious circuit for relay 120. The operation of relay 120 prevents connections from any other line finder from being established while the connection from the line finder 103 is in progress as it removes battery connection from a common lead for operating the relay such as 121 or 122 in the line finder circuits 111 and 112 or other circuits. Similarly, if, for example, relay 121 had been operated, this relay would have removed battery from the circuit for relay 122, while on the other hand a chain circuit through the contacts of the relay would have been broken to prevent relay 120 from extending a connection to seize common equipment at 113. The operation of relay 120 closes an obvious circuit for the operation of the select magnet 125 for this incoming line 101 so that the connection will be established through contacts in this horizontal row in which this line 101 terminates. The circuit for this magnet may be traced from battery through the winding of this magnet, contacts of relay 120, over the chain circuit through contacts of the intermediate relays 121 and 122 to ground. Another circuit will be established by the operation of relay 120 from battery through the common relay 126, contacts of relay 120 to ground to prepare the special mechanism 83 of the switches 80 and 81 for the selection of an idle link and an idle outgoing trunk group. The immediate results of the operation of the relay 126 is the closing of a circuit from the source of current 127 through the motor 84 and contacts of relay 126 to ground for the starting of this motor and the operation of the magnet 128 from battery through the winding of this magnet, off-normal contacts 129 for the stepping mechanism and ground at contacts of relay 126.

The dialing of the desired groups of trunks now proceeds by the alternate operation and release of the pulsing relay 116. With each release of this relay a circuit is completed for the relay 130 and the stepping magnet 131 to battery through the windings of this magnet and relay, contacts of relays 122, 121 and 120 to ground at contacts of relay 116. Magnet 131 steps the shaft 132 to select a desired select bar in switch 81. Relay 130 remains operated during the dialing and this relay maintains the magnet 128 operated from battery through the winding of this magnet, contacts of relay 130 to ground as the assigned energizing circuit is opened at off-normal contact 129 on the first step of the shaft 132. When the dialing ceases, relay 130 released causing the release of the magnet 128 which now causes the corresponding select bar to be operated in a manner as described in connection with Fig. 1. The clutch magnet 86 is now operated from battery through the winding of this magnet, off-normal contacts 89, contacts of magnet 128, off-normal contacts 129 to ground at relay 126. Clutch magnet 86 provides a locking circuit for itself through its own contacts, contacts of relay 137 and magnet 128, off-normal contacts 129 to ground at contacts of relay 126. The operation of this clutch magnet causes the clutch 85 to close and thereby rotates the shaft 87 to hunt for an idle trunk and an idle link. The shaft 87

in rotating as stated will operate in succession the various groups of contacts 90, etc., associated with succeeding corresponding links. It should now be observed that the test performed by the various succeeding groups of contacts 90, etc., determines whether a link such as 95 or succeeding links are idle or busy and whether a trunk in the chosen group associated with an idle link is idle or busy.

If it is assumed that the two trunks 106 and 107 belong to the group of trunks chosen by the associated select bar and the first trunk 106 and the first link are busy by being connected at the cross-point 140 or the link 95 only is busy by being engaged for example at the cross-point 141 to trunk 108 while trunk 106 is idle, there will be in either case a ground on the sleeve conductor 142. This ground is present due to the fact that under either of these assumed busy conditions the hold magnets, such as 135, 136 for the switches 80 and 81, are in operated condition if it is assumed that the link 95 is engaged in a previous connection. Hence this previous connection from an incoming line to a trunk provides this ground from the sleeve conductor at the connected line finder over contacts of a relay corresponding to relay 117 in the individual circuit for the engaged incoming line through the established connection at a cross-point in the switch 80 over the sleeve conductor of the busy link 95 to contacts of the operated set, such as 90, to the winding of test relay 137. Therefore when contacts 90 are operated to test for these conditions the presence of this ground will prevent the operation of the test relay 137, the windings of which are also connected to ground. The motor 84 will therefore continue to rotate shaft 87 to actuate a next succeeding group of contacts such as, for example, contacts 91 and if the associated link 96 is also engaged the same test will be performed and the shaft 87 will be rotated further. On the other hand, if neither link 95 nor the trunk 106 is busy, then when contacts 90 are operated the associated hold magnets 135 and 136 will be actuated over a circuit from battery, windings of these magnets, contacts 90, contacts of clutch magnet 86 to ground at contacts of relay 126. These hold magnets in operating will actuate the associated hold bars and thus establish connections at the cross-points 143 and 140 respectively, and thus connect the line 101 over link 95 and trunk 106. These hold magnets in operating will close locking circuits for themselves through their own contacts to the sleeve conductor 142, contacts 90, windings of test relay 137 to ground. In this case test relay 137 will operate over this circuit and open the locking circuit for clutch magnet 86 and provide a circuit shunting the left-hand winding to ground over its own contacts, contacts of magnet 128, off-normal contacts 129 and contacts of relay 126. The clutch magnet in releasing will open the clutch 85 and thus shaft 87 is stopped when contacts 90 operate. As these connections are established, a circuit will now be completed for the operation of relay 117 from battery through the winding of this relay, sleeve contacts at the cross-point 143, sleeve conductor 142, contacts 90, one winding of test relay 137, contacts of magnet 128, off-normal contacts 129 to ground at relay 126. Relay 117 in operating completes the circuit from the calling subscriber's line at 115 over the tip and ring conductors to the trunk 106 and closes a locking circuit for itself through its contacts to ground on the sleeve at the line finder 103. This ground

will also now be transmitted over the sleeve connection to hold the hold magnets 135 and 136 actuated as long as the connection is maintained. Relay 117 also in operating opens the circuit for the relay 116 which releases and this relay in turn releases relays 118 and 120 and relay 120 in releasing releases relay 126. Relay 126 in releasing closes a circuit for the operation of magnet 128 which in operating releases the shaft 132 to normal and this circuit is then opened at the off-normal contact 129 to release magnet 128. Relay 126 also opens the circuit for the circuits for hold magnets 135 and 136 and ground on the sleeve permits relay 137 to release. The circuit for motor 84 is still closed at the off-normal contacts 89 and the clutch magnet 86 will now again operate from battery through the winding of this magnet, contacts 89, contacts of relay 26 to ground to again cause the clutch 85 to engage shaft 87 and rotate it back to normal position when the circuit for the motor 84 is opened at off-normal contacts 89 as well as the circuit for the clutch magnet 86 so that the shaft 87 will now remain in normal position and the common circuit control circuits 90 will be available for use in establishing other connections through the switches 80 and 81. When the subscriber at 115 relinquishes this connection by replacing his receiver on his switch-hook, the ground on the sleeve at the line switch 103 is removed causing the release of relay 117 and the release of this relay causes the release of the hold magnets 135 and 136 and switches 80 and 81 in releasing open the connection to the trunk 106 at the points 143 and 140.

What is claimed is:

1. In a telephone system, a cross bar switch having horizontal and vertical bars, a stepping mechanism for selecting and actuating any horizontal bar, a common mechanism for actuating the vertical bars in succession, contacts at each cross-point of said coordinate bars, each set actuated on the operation of the associated horizontal and vertical bars, an incoming line connected to contacts at each cross-point of said bars, outgoing lines each connected at a separate cross-point to contacts thereat, circuit means responsive to impulses received over the incoming line for actuating the stepping mechanism to select and actuate a corresponding horizontal bar, and means thereafter operative for actuating the common mechanism to operate the vertical bars in succession to connect the incoming line with succeeding outgoing lines until an idle outgoing line is found.

2. In a telephone system, a cross bar switch having horizontal and vertical bars, a stepping mechanism for selecting and actuating any one of said horizontal bars, a motor mechanism for actuating succeeding vertical bars, contact sets at each cross-point of said bars, each set actuated on the operation of the corresponding horizontal and vertical bars, an incoming line connected to contacts at each cross-point of said bars, outgoing lines each connected at a separate cross-point to contacts thereat, means responsive to impulses received over said incoming line for actuating the stepping mechanism to select and actuate a corresponding horizontal bar, means for thereafter operating the motor mechanism to actuate a vertical bar to test if the outgoing line at the cross-point of said vertical bar and said operated horizontal bar is idle or busy and to stop the motor mechanism if this outgoing line is idle and to continue to operate the motor mechanism to succeeding outgoing lines if said first line is

busy until an idle line is found and then connect said incoming line to said idle outgoing line.

3. In a telephone system, a cross bar switch having select bars and hold bars coordinately arranged, contacts at each cross-point of said bars, an incoming line terminating in contacts at each cross-point, outgoing lines each terminating in contacts at a separate cross-point, means responsive to impulses received over the incoming line for selecting and operating a corresponding select bar, means responsive after a select bar has been operated for actuating the hold bars in succession until a connection is established between the incoming line and a first idle outgoing line over the contacts at the cross-point of said operated select bar and hold bar.

4. In a telephone system, a cross bar switch having select bars and hold bars coordinately arranged, contacts at each cross-point of said bars, an incoming line terminating in contacts at each cross-point, outgoing lines each terminating in contacts at a separate cross-point, means responsive after a select bar has been operated for temporarily actuating one hold bar after another to establish a connection between the incoming line contacts and succeeding outgoing line contacts at the cross-points of said operated select bar and said succeeding actuated hold bars to test for busy outgoing lines and when an idle outgoing line is found to maintain the established connection between the contacts at the cross-point of said hold bar and said actuated select bar and the complete talking connection between said lines.

5. In a telephone system, a cross bar switch having horizontal and vertical cross bars, contacts at each cross-point of said bars, a plurality of incoming lines each terminating in contacts at the cross-points between a particular horizontal bar and all vertical bars, a plurality of groups of outgoing lines, each outgoing line in a group terminating at an individual cross-point between a common horizontal bar to said group and all vertical bars, a plurality of links each terminating in contacts at the cross-points between a particular vertical bar and all horizontal bars, means responsive to the seizure of an incoming line for actuating the horizontal bar associated with the contacts in which said line terminates, means responsive to impulses received over said seized line for selecting and actuating the horizontal bar associated with the terminals of a particular group of outgoing lines, means thereafter operative for testing succeeding links to determine whether they are idle or busy and operative when a first idle link is found for actu-

ating the associated vertical bar to connect the calling incoming line with an outgoing idle line in the group selected through the contacts at the cross-points of said vertical bar and said two actuated horizontal bars.

6. In a telephone system, a cross bar switch having select bars and hold bars coordinately arranged, contacts at each cross-point of said bars, incoming lines terminating in contacts at the cross-points of said bars, outgoing lines arranged in groups and terminating in contacts at the cross-points of said bars, links in said switch each having access at the cross-points to all of the incoming lines and to one outgoing line in each group, means responsive to the seizure of an incoming line for actuating a corresponding select bar, means responsive to impulses received over said seized incoming line for selecting a group of outgoing lines by the operation of a corresponding select bar, and means thereafter operating to test for and select the first idle associated link and outgoing line in said selected group and connect said idle outgoing line to said incoming line over said idle link by the operation of a corresponding hold bar.

7. In a telephone system, a cross bar switch having a first and a second group of select bars, a common group of hold bars crossing all of said select bars, contacts at each cross-point of said two types of bars, incoming lines each terminating in the contact at the cross-points where a particular select bar of the first group crosses all of said hold bars, outgoing lines arranged in groups with the outgoing lines of each group terminating at individual contacts at the cross-points where a particular select bar of the second group crosses all of the hold bars, links in said switch each terminating in the contacts at the cross-points where a particular hold bar crosses all the select bars, means responsive to the seizure of an incoming line for actuating the corresponding select bar in the first group, means responsive to impulses received over said incoming line for actuating a particular select bar of the second group to select a corresponding group of outgoing lines, and means thereafter operative for testing for a first idle link and a first idle outgoing line in the selected group of outgoing lines, and then actuating the corresponding hold bar to establish a connection at the cross-points where the actuated select bars cross the actuated hold bar to extend the said incoming line over the select link to the selected outgoing line in the selected group.

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