

Sept. 8, 1931.

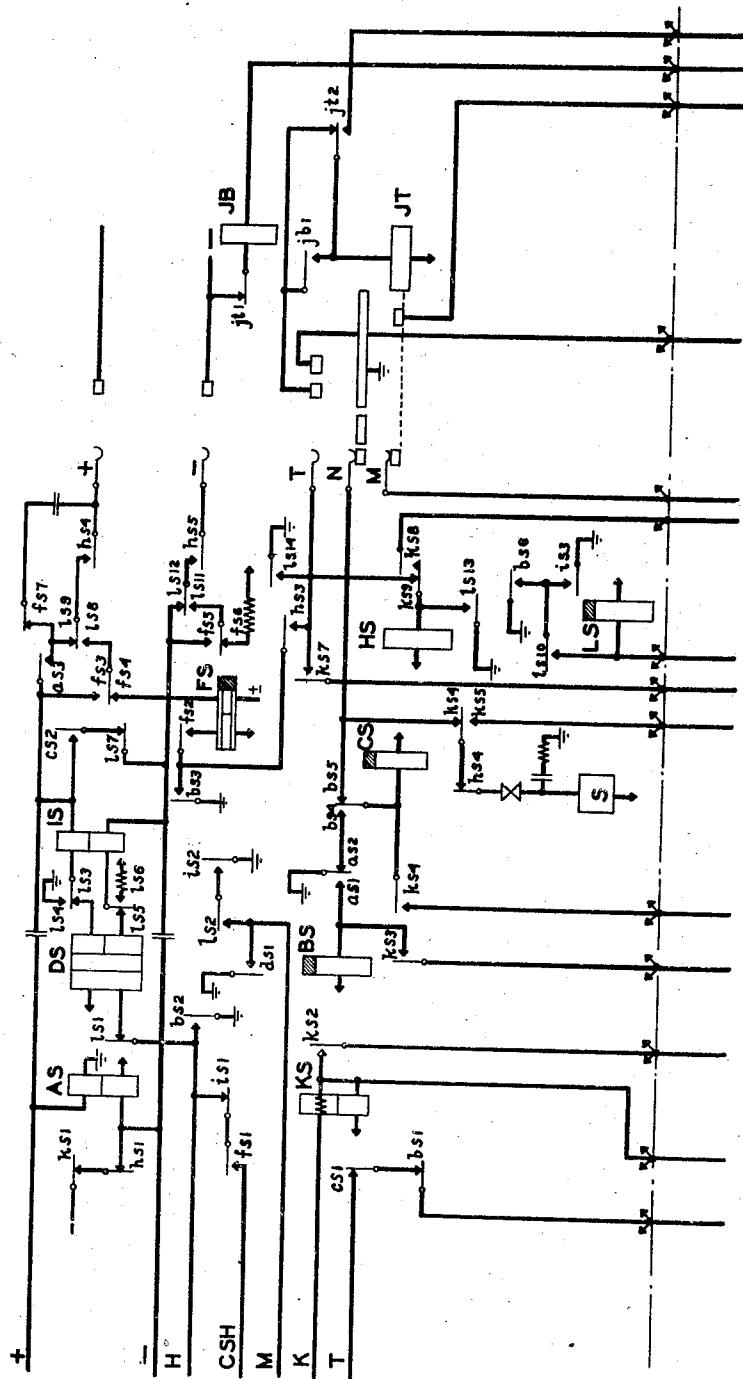
E. P. G. WRIGHT  
CIRCUIT ARRANGEMENT FOR AUTOMATIC AND SEMIAUTOMATIC  
TELEPHONE EXCHANGE SYSTEMS

Filed March 28, 1930

1,821,998

5 Sheets-Sheet 1

FIG. I-A



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CIRCUIT ARRANGEMENT FOR AUTOMATIC AND SEMIAUTOMATIC  
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5 Sheets-Sheet 2

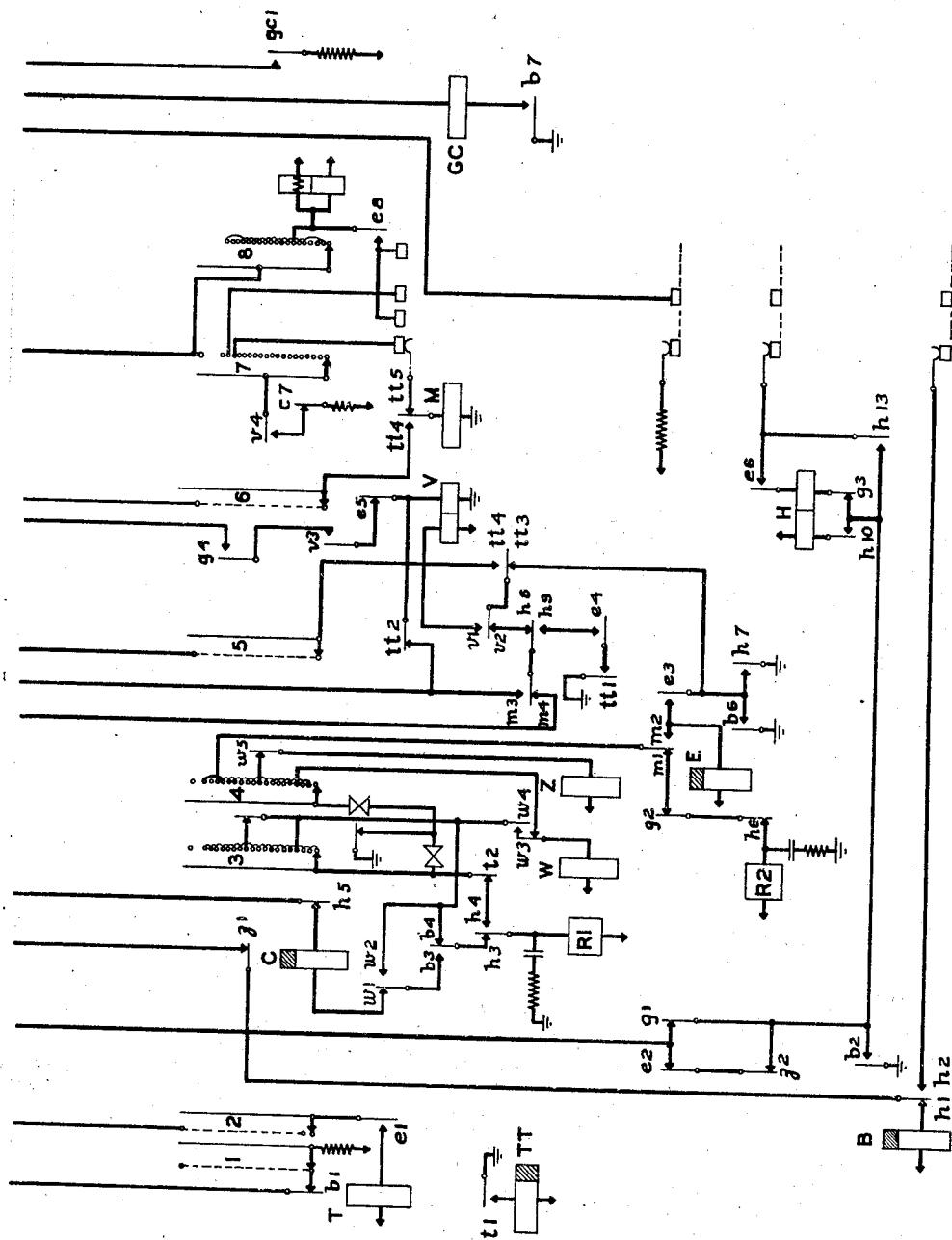


FIG. I-B

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5 Sheets-Sheet 3

FIG. 2

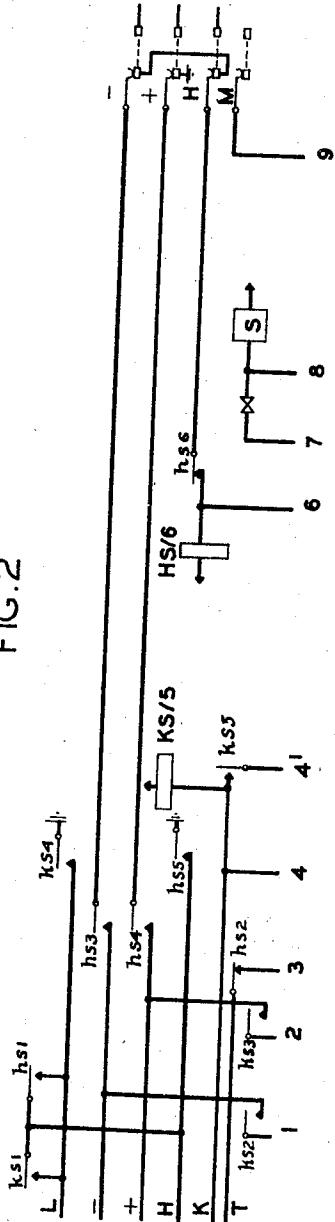
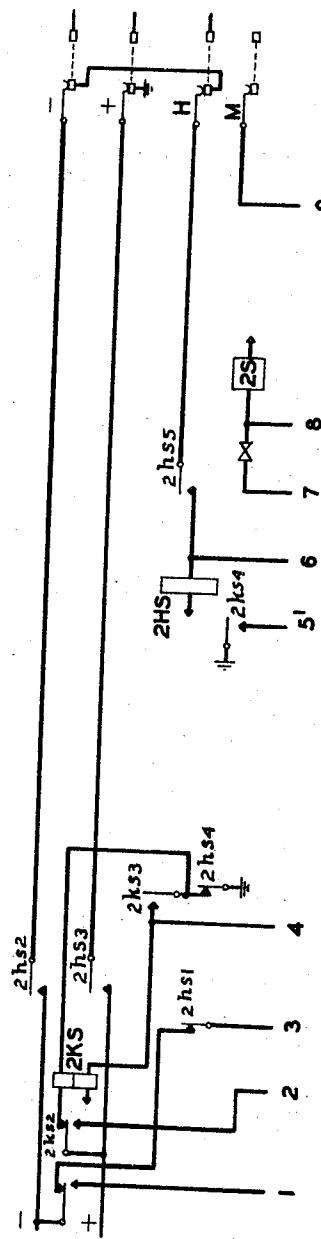


FIG. 3



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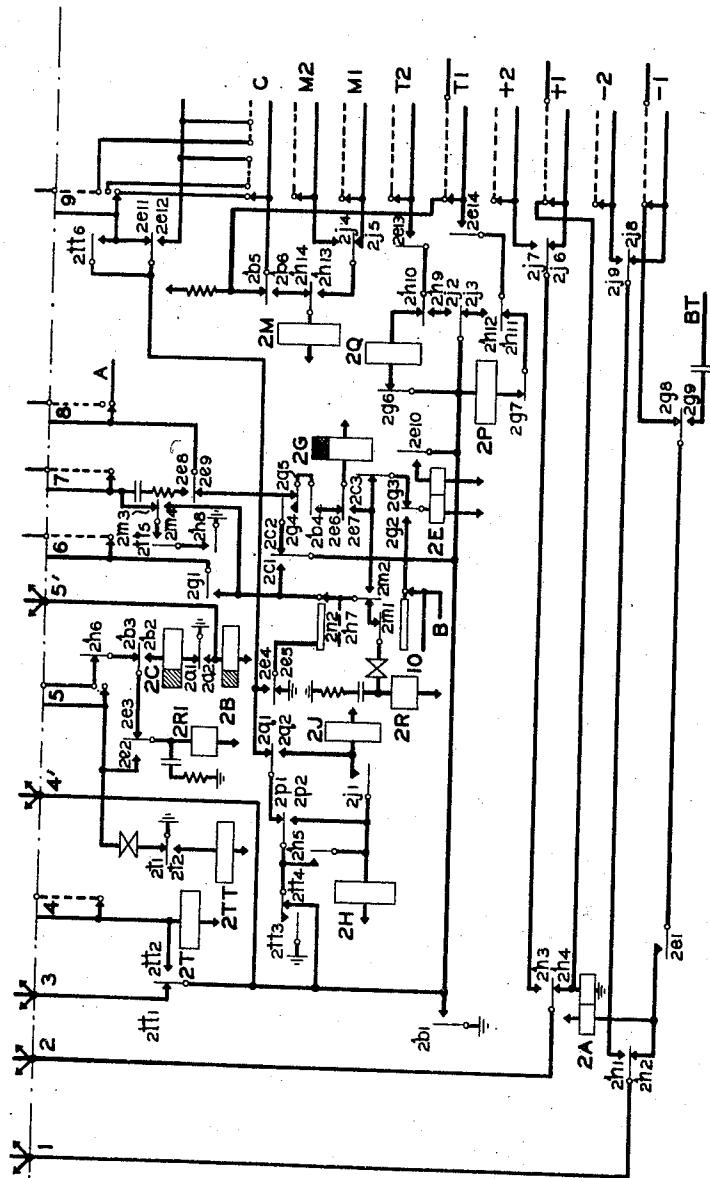
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FIG. 4



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FIG. 5

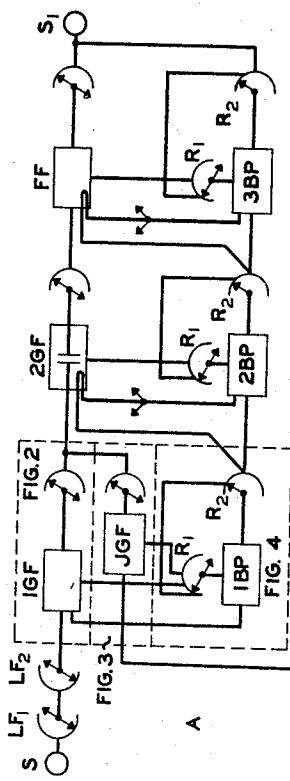


FIG. 6

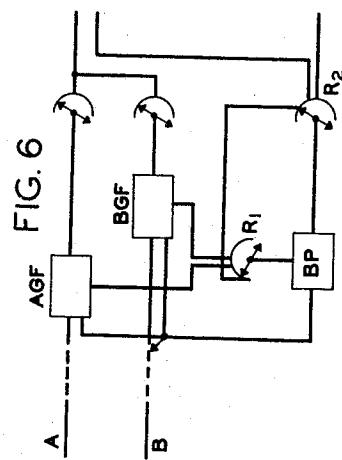


Diagram B shows a complex electronic circuit. At the top, a switch  $S_1$  is connected to a node. From this node, a line goes to a switch  $S_2$  (labeled  $SLF_1$ ), then to a switch  $S_3$  (labeled  $SLF_2$ ), then to a switch  $S_4$  (labeled  $SGF$ ). From  $S_4$ , the line goes to a switch  $S_5$  (labeled  $SFF$ ), then to a switch  $S_6$  (labeled  $R_1$ ), then to a switch  $S_7$  (labeled  $R_2$ ), then to a switch  $S_8$  (labeled  $SFBP$ ), then to a switch  $S_9$  (labeled  $SBP$ ), then to a switch  $S_{10}$  (labeled  $R_3$ ), then to a switch  $S_1$ . A feedback line from  $S_9$  goes to a switch  $S_{10}$  (labeled  $R_4$ ), then to  $S_1$ . The output line from  $S_9$  also goes to a switch  $S_1$ . The circuit includes various operational amplifiers (SFF, SFBP, SBP, SGF) and resistors (R1, R2, R3, R4).

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## UNITED STATES PATENT OFFICE

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CIRCUIT ARRANGEMENT FOR AUTOMATIC AND SEMIAUTOMATIC TELEPHONE EX-  
CHANGE SYSTEMS

Application filed March 28, 1930, Serial No. 439,727, and in Great Britain May 31, 1929.

This invention relates to automatic or semi-automatic telephone systems and more particularly to systems in which common control circuits are employed for controlling the operation of conversation selector switches.

According to the invention a common control circuit is so arranged that it is adapted to be operatively associated with any one of a group of conversation selector switches comprised partly of incoming selector switches located at the incoming ends of two wire junctions from a distant office and partly of local selector switches or incoming selector switches located at the incoming ends of two-wire junctions from another office.

In such arrangements provision must be made whereby such two-wire junctions are only taken into use at their outgoing ends if the incoming selector switch and its associated control circuit are free. According to a further feature of the invention therefore means is provided which operates on the seizure of an outgoing selector switch to first make a simultaneous test of the junctions and control circuits whereby idle junctions terminating in incoming selector switches associated with idle control circuits are marked selectable, the selector switch being subsequently caused to hunt for one of these marked junctions. When the primary test is made the control circuit or circuits associated with the incoming selector switches are rendered non-selectable for other offices.

The invention is more particularly applicable to satellite office systems. Satellite selectors have already been proposed comprising a single conversation switch which on being taken into use selects an idle junction to the main office. In such arrangements the first or the first and second digits have been transmitted to a discriminating switch and also repeated over the junction to the main office and if indicative of a call local to the satellite office the satellite selector has been further advanced to select an idle local trunk to a local switch. If the group to the main office junction is a large one and the selected junction was an early choice in the group and further if there are two or more groups

of local trunks accessible to the satellite selector the latter may not have sufficient time to advance over the intermediate junctions and trunks to select an idle trunk in a wanted local group before the next digit commences to come in. To obviate this objection it has been proposed to employ separate switches for selecting the main office junctions and the local trunks.

According to another feature of the present invention in combination with a plurality of conversation satellite office selector switches is provided a control circuit comprising discriminating means adapted to respond to one or more digits and if such digit or digits are indicative of a local call to cause a switching device associated with said control circuit to select an idle local trunk and provide a bye-path for succeeding impulses.

Referring now to the accompanying drawings:

Fig. 1—A shows a switching selector repeater for use in a satellite office and Fig. 1—B, which should be placed below Fig. 1—A, a control circuit common to a group of switching selector repeaters. The control circuit comprises a control switch R1, a bye-path switch R2 and an associated group of relays. The control switch R1 is equipped with wipers and banks 1 to 8 whilst the bye-path switch R2 is equipped with wipers and banks C, MC, TC-. Certain groups of positions of the switch R1 are used for discriminating purposes and for effecting a marking in the bank of the bye-path switch R2, whilst later positions are used for operatively associating the control circuit with a particular switching selector repeater over banks 2, 5 and 6. Bye-path conductors extend from the terminals of the bank of the switch R2 to control circuits associated with final conversation switches local to the satellite office and bye-path test wires extend from the terminals of the bank Tc to final conversation switches. The terminals in the marking bank MC of the switch R2 are multiplied to corresponding terminals in the marking banks M of the associated switching selector repeaters give access to a group of two-wire junctions extending to the main

office and to two or more groups of local trunk lines.

Fig. 2 shows a first conversation group finder switch for use in calls local to the 5 main office.

Fig. 3 shows an incoming conversation group finder switch for use at the incoming end of a two-wire junction from the satellite office.

10 Fig. 4 shows a control circuit which is common to one or more local first group finders as shown in Fig. 2 and one or more incoming group finders as shown in Fig. 3. The control circuit comprises a control 15 switch R1 equipped with wipers and banks 4, 5, 6, 7, 8 and 9 and a bye-path switch R2 equipped with wipers and banks C, M2, M1, T2, T1, +2, +1, -2, -1. Certain positions of the switch R1 are used for effecting a 20 marking in the bank of the bye-pass switch R2, contacts in the bank 9 in these positions being suitably strapped to the terminals in the control bank C of the switch R2, whilst other positions are used for operatively 25 associating the control circuit with a particular local or incoming group finder switch over banks 4, 6, 7, 8, 9. Bye-path conductors extend from the terminals of the banks -1, -2, +1, +2 of the switch R2 to control 30 circuits at the succeeding switching stage and bye-path test wires extend from the terminals of banks T1, T2 to conversation finder switches at the succeeding switching stage. The terminals in the marking banks M1, M2 35 are multiplied to corresponding terminals in the marking banks of the associated conversation switches.

Fig. 5 is a schematic layout diagram showing the apparatus involved in different types 40 of call and the relative positions of the apparatus illustrated in Figures 1 to 4. The apparatus located at the main office is shown above the broken line whilst that at the satellite office is shown below this line.

45 Figure 6 is a schematic diagram illustrating a further application of the invention.

A brief general description will first be given of the operation of the system shown in Fig. 5.

50 Assuming a subscriber S2 in the satellite office B removes his receiver to make a call his line is extended over first and second line finders SLF1, SLF2 to a free switching selector repeater SGF associated with a free 55 control circuit SBP. The switching selector repeater SGF selects a junction J terminating in an incoming group finder JGF having associated with it an idle control circuit 1BP at the main exchange A. The first digit is 60 repeated over the junction J and also advances the switch R1 of the control circuit SBP, and if this digit is not one signifying a call local to the satellite office B, the control circuit SBP is released and subsequent digits 65 are repeated over the junction J. If the first

digit corresponds to that signifying a local call, the control circuit SBP is held and the switch R1 responds to the second digit which is also repeated over the junction J. If this digit is not one of those allotted for local calls the control circuit SBP is released and the switch SGF functions solely as a repeater. If however the second digit is one of those which in combination with a particular first digit signifies a local call, the switch R1 of the control circuit marks a group of trunks in the bank of the switch R2, which advances to this group and hunts for an idle final finder switch SFF having an idle associated control circuit SFBP: On the engagement of such a final switch the switch R1 is again advanced to connect the control circuit SBP with the selector repeater SGF which is then advanced to the trunk selected by the switch R2. The third and fourth digits are repeated over a wiper of the switch R2 and a bye-pass conductor to the switch R1 of the control circuit SFBP which marks a wanted line S3 in the bank of the switch R2. When this line is engaged by the switch R2, the switch R1 associates the control circuit SFBP with the final finder SFF and a test is made of the condition of the wanted line in the control circuit SFBP. If the wanted subscriber is engaged, a busy signal is given from the switching selector repeater SGF whilst if the line is free the final finder SFF is advanced to it and ringing current is supplied from the selector repeater SGF. The control circuit SBP is released when the R1 switch of the control circuit SFBP has picked up the final finder SFF. The release of the control circuit SBP brings about the release of the control circuit SFBP. Talking current is supplied to both the calling and called parties from the selector repeater SGF.

Assuming that the call was to a subscriber S1 in the main office A the first digit dialled sets the switch R1 of the control circuit 1BP which marks the wanted group in the bank of the switch R2, which commences to advance immediately the impulses start arriving. The switch R2 searches for an idle second group finder 2GF having an idle associated control circuit 2BP and at the same time the switch R1 hunts for the first group finder JGF which is to replace the bye-pass. The group finder JGF is then set on the trunk selected by the switch R2. Meanwhile a second digit is passing over the bye-path switch R2 to the control circuit 2BP at the second switching stage, which operates in similar manner to the first stage selecting circuit. The control circuit 1BP at the first stage is released when the control circuit 2BP at the second stage has become operatively connected to the predetermined finder switch 2GF over the wipers of the R1 switch at that stage. The finder switch 2GF is then advanced to the trunk selected by the R2 switch 120 115 125 130

associated with the control circuit 2BF. At the final selecting stage the R1 switch of the selected control circuit 3BP responds to the tens and units digits and marks a wanted line 5 S1 in the banks of the R2 switch. When the wanted line is engaged by the R2 switch, the R1 switch associates the control circuit 3BP with the selected final finder FF and a test is made of the condition of the wanted line 10 in the control circuit 3BP. If the wanted line is busy, a busy signal is given from the switch 2GF, whilst if the line is idle the finder S3 is advanced to it and ringing current is applied from the switch 2GF. The control circuit 15 2BP is released when the R1 switch of the control circuit 3BP has picked up the final finder FF. The release of the control circuit 2BP brings about the release of the control circuit 3BP. Talking current is supplied to 20 the calling and called parties from the switches SGF and 2GF respectively.

In the case of a call from a main exchange subscriber S to another main exchange subscriber S1, the calling line is extended over 25 first and second line finders LF1, LF2 to an idle local first group finder 1GF associated with an idle control circuit 1BP. The control circuits 1BP are associated with both local group finders 1GF and incoming group 30 finders JGF the proportion of one to the other being governed by traffic requirements. The connection is extended over a second group finder 2GF and a final finder FF as described in the previous paragraph. Talking current 35 is fed to both parties from the switch 2GF.

The circuits will now be described in detail with reference to typical calls.

#### *Local call within satellite office*

40 The satellite selector repeater, Fig. 1—A with its associated control circuit Fig. 1—B, is taken into use from a preselector circuit and is tested through the wire T, contact  $c_1$  and  $b_1$  of the selector and contacts  $b_1$ , 45  $b_2$  the home contact and wiper 1 of the switch R1 of the control circuit through a protective resistance to battery. If the circuit is found to be free by the preselector circuit that circuit will reduce the potential on the common 50 point between contacts  $b_1$  and  $b_2$  and consequently cause the control circuit to test busy to other preselector circuits. When the preselector circuit has completed connection to the calling subscriber ground will be placed 55 on the wire K causing the operation of relay KS. A circuit is also completed for relay AS from battery and the lower winding of relay AS over the subscriber's loop to the upper winding of relay AS and ground. Relay AS 60 completes the obvious circuit for relay BS and at the same time the following circuit is completed for relay B:—Battery and winding of relay B contacts  $h_1$ ,  $e_1$ ,  $K_3$ ,  $a_1$ , to ground. Relay BS closes a circuit at contacts  $b_2$  for the left-hand winding of a shunt

field relay D.S. Relay B completes the circuit for the conversation switch magnet S through its interrupter springs  $h_2$ ,  $h_6$ ,  $m_4$ ,  $h_8$ ,  $v_2$ ,  $t_3$ , and  $b_6$  to ground, and at contacts  $b_2$  closes a locking circuit for relay 70 KS via contacts  $e_2$ ,  $e_2$ , (and  $g^1$  in parallel) and RS2. At the same time a testing circuit is prepared for relay V through its right-hand winding and contacts  $t_2$ ,  $K_7$  to the test wiper T of the selector repeater. Each of the 75 outgoing junctions from the satellite office to the main office is allotted a pair of relays JB and JT and when relay B of the control circuit operated a ground potential was placed over contact  $b_7$  and the winding of the common relay Gc on one side of all the relays JB which are normally connected to the negative sides of the respective junctions. All junctions which are engaged will be characterized by the fact that the JT relay is operated and in consequence if the junction is in use there will be no circuit for relay JB since its circuit will be open at contacts  $j_1$ . 80

Referring now to Figs. 3 and 4 which for the present case should be placed Fig. 3 above Fig. 4, the negative line will be connected (if the incoming conversation group finder is free) through contacts  $2K_1$ , Fig. 3 and  $2h_1$  to the test wire 3 of the control circuit Fig. 4 and if the latter circuit is free there 85 will be a battery potential applied to this test wire via  $2t_1$ ,  $2t_3$ ,  $2p_1$ ,  $2g_1$ ,  $2e_1$ ,  $2b_5$  which will cause the operation of relay JB in the satellite office. Relay Gc which is marginal will also operate from battery in the 90 control circuit associated with the incoming selector switch. Relay GG is so adjusted that two of these relays will not operate in multiple should a call be made simultaneously 95 from a second satellite office having junctions 100 terminating in incoming selectors associated with the same control circuit. Relay JB at contacts  $j_1$  prepares a circuit for relay JT over which relay V in the control circuit is 105 operated over a common lead, contacts  $g_1$  to battery when the test wiper of the selector repeater reaches an idle junction as indicated by the energization of relays JB and GC. Relay V in operating opens the driving circuit 110 of the selector S at  $v_2$  and closes a locking circuit for itself via its left-hand winding and contacts  $v_1$ ,  $t_3$ ,  $b_6$ . Relay JT which 115 operates in series with relay V, holds over a circuit through contacts  $j_2$  when the relay JB restores and a parallel circuit is closed 120 through the right-hand winding of relay V and contacts  $e_5$ ,  $v_3$ ,  $g_4$ ,  $R_9$  to relay Hs which also operates in series with relay V. Contacts  $h_3$ , places a ground potential from  $b_3$  125 on the test wiper T and also completes a loop over the negative and positive wires through  $h_4$ ,  $h_9$ ,  $a_3$ , upper winding of relay Is,  $h_3$ , right-hand winding of relay DS,  $h_6$ , lower winding of IS,  $h_1$  and  $h_5$  causing the operation of relay 2KS in the incoming conver- 130

sation finder, Fig. 3 from battery on the test wire 3.  $2hs1$ ,  $2ks1$ , negative line through the loop at the satellite selector repeater to the positive line, contacts  $2hs2$ , winding of  $2KS$ , contacts  $2HS4$  to ground. Relay  $2KS$  will operate and close its light contacts  $2KS5$  thereby completing a locking circuit for its lower winding. The negative and positive wires are switched through at contacts  $2hs1$ ,  $10 2hs2$  respectively to the control circuit associated with the incoming conversation switch where relay  $2A$  operates and closes an obvious circuit for relay  $2B$ . Where necessary this control circuit may be arranged to  $15$  feed back dialling tone which will be transmitted over the junction and through the satellite selector repeater to the calling subscriber.

If all the junctions are busy the selector  $20$  continues stepping until it engages the first idle local outlet beyond them, when relay  $V$  energizes in series with relay  $G$  over the circuit right-hand winding of  $V$ ,  $tt2$ ,  $Rs7$ , wiper  $T$  and test contact of selector, wiper  $25$  and contact of bank 8 of switch  $R1$ , and relay  $G$ . All the contacts of this bank 8 are strapped together except those in the positions corresponding to local calls. Relay  $G$  opens at contacts  $g4$  the circuit of relay  $HS$   $30$  which relapses, and at contacts  $g1$  opens one parallel path in the locking circuit of relay  $KS$ .

If the digits dialled indicate that the call is for the main office relay  $Z$  operates as already described and at contacts  $Z2$  opens the other parallel path in the locking circuit of relay  $KS$ , the relapse of which disassociates the control circuit. Busy tone is applied to the negative line over lead  $BT$   $40$  and contacts  $hs1$ ,  $hs1$ .

If the digits dialled indicate that the call is local to the satellite the switch  $R1$  is stepped to a position in which the circuit of relay  $G$  is opened at bank 8 and this relay  $45$  relapses before the release of relay  $C$ . Relay  $Z$  does not respond and the call proceeds in the usual manner.

When the calling subscriber commences dialling the relay  $AS$  responds and at each  $50$  impulse a circuit is made from the magnet  $R1$ , contacts  $hs$ ,  $b3$ ,  $w1$ , winding of relay  $C$ ,  $hs$ ,  $Rs4$ ,  $bs4$ ,  $as2$  to ground causing the switch  $R1$  to take one step for each of the impulses. The relay  $C$  is of the slow releasing type and remains up during the impulses. The forward loop to the incoming group finder, Fig. 3 interrupted at contacts  $as3$ . Relay  $CS$  is energized in parallel during impulsion and at contacts  $as2$  short circuits relays  $IS$ ,  $DS$  to improve the impulsion loop condition. If the first digit dialled is not one signifying a local call the wiper  $4$  of the switch  $R1$  will come to rest in a position to complete a circuit for the relay  $55$   $Z$  through contacts  $w5$ , bank contact and

wiper 4 of the switch  $R1$ , the interrupter springs  $RINT2$  of the switch  $R2$  contacts  $c1$  to ground. Relay  $Z$  in operating opens at contacts  $z1$  the circuit of relay  $B$  which at  $z2$  opens the locking circuit of relay  $KS$  causing the latter to release. Relay  $KS$  disconnects the control circuit and the relapse of relay  $C$  closes a restoring circuit for the switch  $R1$  over  $hs$ ,  $b4$ , off-normal contacts and wiper of bank 3, interrupter springs  $RINT1$  and  $c1$ . The satellite selector now acts solely as a repeater repeating the impulses at contacts  $as3$  over the forward loop.

If the first digit corresponds to that signifying the local call, in case illustrated the digit  $3$ , the switch  $R1$  of the control circuit, Fig. 1—B is advanced to a corresponding position and on the relapse of relay  $C$  completes a circuit for the relay  $W$  through contacts  $w3$  bank contact and wiper 4 of the switch  $R1$ , interrupter springs  $RINT2$  of the switch  $R2$ , contacts  $c1$  to ground. Relay  $W$  locks up through  $w4$ , the off normal contacts and wiper 3 of the switch  $R1$ , the interrupter springs  $RINT1$  of the switch  $R1$ , contacts  $c1$  to ground. A circuit is also closed for the magnet of the switch  $R1$  through contacts  $hs$ ,  $b3$ ,  $w2$ , the off normal contacts and wiper of the bank 3, interrupter springs  $RINT1$  of the switch  $R1$ , contacts  $c1$  to ground, which will cause the switch to step until it reaches position  $12$ , in which position the contact in bank 3 is not strapped to the other contacts since contacts  $w5$  are open. In this position also the locking circuit for relay  $W$  is opened causing that relay to release. The second set of impulses will cause the switch  $R1$  to step as before and if the second digit is not one signifying a local call the relay  $Z$  will be operated and cause the release of the control circuit as already described. If, however, the second digit corresponds with a second digit allotted to local calls, in the present instance the digit  $5$  or  $6$ , a circuit will be completed for the magnet  $R2$  through contacts  $hs$ ,  $g2$ ,  $m1$  bank contact and wiper 4, the interrupter springs  $RINT2$  of the switch  $R2$ , contacts  $c1$  to ground. The switch  $R2$  will continue stepping until its wipers arrive at the beginning of a group of outlets marked by the switch  $R1$  where a circuit is completed for the relay  $M$  through contacts  $tt5$ , wiper  $C$  of switch  $R2$ , marking wire to bank 7 of the switch  $R1$ ,  $v4$ ,  $e7$ , protective resistance to battery. When relay  $M$  operates the circuit for the magnet  $R2$  is opened at  $m1$  and a circuit is closed for the relay  $E$  which operates via  $m2$  and bank 4 of the switch  $R1$  and locks to ground through  $e3$  and  $b6$ . The operation of relay  $E$  opens a circuit for relay  $M$  at  $e7$  thus restoring the driving circuit of the magnet  $R2$  which continues stepping and testing each outlet via the following circuit:—Ground  $b2$ ,  $g3$ , right-hand winding of relay  $H$ ,  $e6$  to the test wiper  $TC$ . A free

outlet is characterized by a battery potential which will cause the operation of relay H which will lock up over its left-hand winding through h10 to ground at b2 B13 places a ground potential on the test wiper TC to mark that outlet busy to other control circuits. Relay H opens at h6 the circuit of the magnet R2 and at h4 a circuit is closed for the magnet R1 through contacts t2, interruper springs RINT1 of the switch R1, contacts e1 to ground causing the magnet to step round until the relay T is operated through contacts e1, wiper and contact 2 of bank 2 of the switch R1, Ks2, g1, b2, to ground. Relay T besides opening the driving circuit of the switch R1 at t2 closes at t1 an obvious circuit for relay TT. When the relay F operated the circuit or relay HS was opened at e5 and hs3 removes the ground from the test wiper T making relay JT dependent upon the circuit over the grounded winding of relay V and contacts tt7, Rs7. When relay TT operates the circuit for both windings of relay V is opened at contacts tt2 and tt3 and both the relays V and JT release. The operation of TT also closes the circuit for the magnet S of the selector through contacts hs2, Rs6, m4, h9, e4 and tt1 to ground, causing the selector to again commence stepping. The bank contacts of the selector engaged by the wiper M are multipled directly with the control bank contacts of the control switch R2 and when the selector reaches the terminal on which switch R2 is standing a circuit is completed for relay M through tt6, wiper and contact of bank 6 of the switch R1 and wiper and contact of bank M of the selector, bank contact and wiper MC of the switch R2, to protective resistance and battery. Relay M opens at m4 the circuit of the selector S and places a ground potential through tt1, e4, h9, m4 and Rs7 on the test wiper T. During this time the remaining digits will be passed forward to the final selector control circuit over the following impulse circuit:—as1, Rs3, z1, h2 and negative wiper of switch R2. The final selector which is identical with that shown in Fig. 4 of the copending application referred to, extends connection to and tests the wanted line as described in that specification. If the required subscriber's line is busy the final selector control circuit will remove the ground which it placed on the test wiper TC and cause the release of the relay H but no ground potential will be fed back to the test wiper T of the satellite selector and consequently when relay H releases relay KS will also release and busy tone will be fed out to the calling subscriber through contacts Rs1 and hs1. Relay KS disassociates the control circuit from the selector and the relapse of relay H closes a restoring circuit for the switch R1. The switch R2 is a non-homing switch. If, however, the called subscriber's line is free before the relapse of KS and H there will be a ground potential fed back over the test wiper T which will be extended through Ks7, m3, h8, v2, tt4 through wiper and contact of bank 5 of the switch R1 to the relay LS which will operate and lock through ls10 and Bs6 to ground. Relay LS will close an obvious circuit for relay HS which at hs1 disconnects busy tone. The ringing circuit is now completed through contacts fs4, ls8, hs4, positive line through the subscriber's loop to the negative line, contacts hs5, ls11, fs6 to ringing relay lead RR. When the called subscriber answers relay FS operates and locks up through fs2 and bs3 to ground. The calling subscriber's loop is extended through fs3 and fs5 to a transmission feed provided from contacts ls4 and ls5 through the windings of the relay IS. The operation of IS closes the circuit to the subscriber's message register through contacts ls2 and is2 and wire M. At the end of the conversation when the calling party hangs up, relays AS and BS release. The release of relays LS, IS, FS, HS follows and the homing circuit for the magnet S is closed through the interrupter springs, contacts hs2 Ks5, and wiper N and off normal bank contact to ground. A circuit is also closed for relay CS through contacts bs5 to ground through the wiper N. Relay CS remains operated until the switch has gone back to normal. Relay CS opens the incoming test circuit at CS1.

If all the outlets of a wanted group available to the switch R2 are engaged the wiper C closes the circuit for the relay G on the last contact of the group through the contacts e8. Relay G operates in series with the relay M which opens the driving circuit of the magnet R2 at m1. Relay g opens the test circuit at g3, at g4 unlocks relay HS and at g1 opens the locking circuit of the relay KS which releases, disconnects the control circuit and connects busy tone to the calling line, as already explained.

*Call from satellite office to main office*

In this case the junction to the main office is held and the switching selector repeater, Fig. 1—A acts solely as a repeater—as already explained.

When the relay 2B, Fig. 4, operated it closed at contacts 2b6 a circuit for relay 2M from battery and winding of relay 2M, 2h14, 2b6, wiper and home contact of the bank C, home contact and wiper of the bank 9, 2e11, 2q1, 2p1, 2tt3, 2b1, to ground. At the first impulse, relay 2A releases but relay 2B being of the slow release type, remains operated and completes a circuit for the magnet 2R1 through 2e3, 2b2, winding of relay 2C and 2a1 to ground. At the end of the impulse relay 2A reoperates and the switch 2R1 steps into position 2. In position 2 the circuit for relay 2M is opened by the wiper 9 and when

2M releases a circuit is completed for the magnet 2R2, through its interrupter springs, 2b7, 2m1, wiper and home position of the bank N2 of switch 2R2, 2C1, and 2b1, to ground. The switch 2R2 takes a step and continues stepping by means of its own interrupter springs and the off normal contacts of the bank N2, to ground at 2e5 until relay 2M reoperates. The switch 2R1 takes one step for each impulse received from the subscriber's dial and the strapping between the banks 9 and 2C is so arranged that the circuit for 2M is completed whenever the 2R2 switch reaches the commencement of the group corresponding to that on which the 2R1 switch is standing. When the digit is completed, relay 2C will release after a period and when relay 2M operates due to the switch 2R2 having reached the position indicated by the bank 9, relay 2M will operate as already described and a circuit will then be completed for relay 2E from battery and winding of relay 2E, 2g3, 2c3, 2m2, wiper and off normal contacts of the bank N2, E5 to ground. Relay 2E will close its light contact 2e10, and lock over its second winding to ground at 2b1. 2e11 opens the circuit for relay 2M which releases and recloses the driving circuit of the 2R2 switch through 2h7, 2m1, 2p1, 2q1, 2p1, 2t3, to ground at 2b1. Contacts 2e13 and 2e14 close the testing circuits for relays 2Q and 2P respectively, and one or both of these relays will operate if the outlets on which the wipers are resting are free. If relay 2P alone operates the driving circuit of the switch will be opened at 2p1 and at 2p2 a circuit will be closed for relay 2H which will lock up via 2H5 through 2t3 to ground at 2b1. If relay 2g operates a driving circuit of the switch will be opened at 2g1 and at 2g2 a circuit will be closed for relay 2J which will operate and closes at 2j1 a circuit for relay 2H which will also operate. 2h5 will provide a locking circuit for both the relays 2H and 2J. The proper wiper set will be connected up over contacts 2j4—2j8. If all the outlets of the group are engaged, the switch 2R2 will step eventually to the last contacts of the group in which position a circuit will be closed for the relay 2M through 2h14, 2b6, wiper and bank contacts C, 2e12, 2q1, 2p1, 2t3, 2b1 to ground.

Relay 2M will open the driving circuit of the switch 2R2 at 2m1 and close at 2m2 a circuit for relay 2G through 2e7. Relay 2G is of the slow to operate type and will not operate during the period when both relays 2E and 2M are operated during the initial operation of the former. However, on the last contacts of the group the circuit for relay 2G is maintained and this relay will eventually operate and connect at 2g9 the busy tone over wire BT to the calling subscriber.

When relay 2E operated a circuit was com-

pleted for the switch 2R1 through 2e2, the interrupter springs, and 2t1 to ground. This will cause the switch 2R1 to continue stepping until the relay 2T operates through wiper and bank contact 4, and contacts 2Ks3, 2h54. It will be understood that there is no more than one finder accessible to this control switch with a ground potential on a contact in bank 4. When relay 2T operates the obvious circuit is closed for the relief relay 2TT. At contacts 2t2 a locking circuit is provided for relay 2T. When both relays 2TT and 2H are operated due to the fact that the switch 2R2 has found a free outlet in the required group and the switch 2R1 has found the finder which it has been predetermined will complete the call, a circuit is completed for the finder magnet 2S through bank contact and 7, 2m3, 2t5, and 2h8 and at the same time a ground is extended through 2t6 and the wiper and bank contact 9, to the finder wiper 2M and when the finder wipers stand on the outlet corresponding to that on which the switch 2R2 has switched through, the ground on the finder wiper M will be extended to the control wiper M2 or m1, 2j4, 2j5, 2h13, to relay 2M. The operation of 2M opens the circuit for magnet 2S at 2m3 and closes the circuit for the relay 2G via 2e7, 2m2 the off normal bank N2, 2e4, 2q1, 2p1, 2t3 to the ground on the test wire. Relay 2G will operate and close the circuit for relay 2HS through bank contact and wiper 6, 2g1, 2m4, 2t5, 2h8, to ground. Relay 2HS will operate and 2h86 will extend ground over the H wiper to the H wire of the succeeding finder in order to mark that switch to the succeeding control. Contacts 2h82 and 2h83 will prepare the permanent circuit to replace the bye-path. The control switch does not release until the ground potential is removed from the T wire by the succeeding control circuit. When the relay 2H operated the circuit for relay 2A was opened and relay 2B released also after a short period. Relays 2E and 2T were maintained, however, over 2j2, 2h9, 2e13 or 2j3, 2h12, 2e14, by the ground potential on the test wire which is maintained by the succeeding control circuit under the control of the calling subscriber's loop. When the succeeding finder removes ground from the T wire, relays 2T and 2E release and subsequently relays 2TT, 2M and 2H release. When relay 2H releases the homing circuit for the switch 2R1 is completed through 2e3, 2b3, 2h6, off normal contacts and wiper of bank 5, interrupter springs, 2t1, to ground. In a similar way the homing circuit for the switch 2R2 is completed through 2h7, 2m1, wiper and off normal contacts N2, 2e5, to ground. When both these switches have returned to their home positions, the battery is re-connected to the test wire through 2b5.

Should it happen that the subscriber fails

to dial, a circuit will be completed from ground on the pulse lead A through the home contact and wiper of the bank 6, 2g3, 2b6, 2b7, to the relay 2G which will lock up to 5 2g4, 2e2, 2b1 to ground. After some predetermined period a second pulse will be received over the pulse wire B, wiper and home contact of bank 10 of the switch 2R2, 2g2, to relay 2E. Relay 2E on operating 10 will lock through 2e10 to ground at 2b1 and open the circuit for relay 2G at 2e6. Relay 2P will operate from ground at 2b1, through 2g7, 2h11, 2e14, wiper and home contact of the T1 bank to protective resistance 15 and battery. Relay 2P will cause the operation of relay 2H and the subscriber's loop will be switched via 2h1 and 2h3, 2j6 and 2j8 through the home contacts of the banks -1 and +1 2g8 and 2e1, back to the relay 20 2A. When relay 2E operated, it closed the driving circuit of the magnet 2R1, as already described and this switch will step forward until relay 2T operates. Relay 2T will close a circuit for the relay 2TT, as already 25 described, for the finder magnet 2S. When the finder has been driven to the terminals corresponding to those on which the switch 2R2 is standing (that is the home terminals), relay 2M will operate and a circuit will be 30 closed for relay 2G through 2e7, 2m2, wiper and home contact of the bank N2, 2m4, 2tt5, and 2h8 to ground. 2g1 closes a circuit for the relay 2HS which is maintained through 2hs6, H wiper and home contact of the finder 35 S, home contact and negative wiper 2hs2, subscriber's loop 2hs3, positive wiper and home contact, to ground. The operation of 2g8 opens the circuit for relay 2A which releases and opens the circuit for relay 2B. Relay 40 2B in turn opens the circuit for relays 2E, 2G, 2H and 2T causing the switch 2R1 to return to normal. The finder relay 2HS is maintained operated over the subscriber's loop until the subscriber releases. 45 The connection is extended over a penultimate group selector and a final selector in the manner described in British application No. 32648/28 with reference to Figures 3 and 4 of that specification. 50 It will be seen that the relay 2KS Fig. 3 remains locked up until relay 2HS operates. In the case of a premature release therefore provision must be made to ensure that the relay 2HS is operated. The contacts 2Ks4 55 holds the control circuit, Fig. 4, engaged by providing a holding circuit for relay 2B so that if the calling party releases prematurely the control circuit is held until the conversation finder has been advanced and the 60 switching relay 2HS is energized.

*Call between two subscribers in the main office A*

The calling line is extended over first and 65 second line finders in known manner a local

first group finder Fig. 2 with its associated control circuit Fig. 4 being tested over the wire T, Fig. 2 contacts hs2, conductor 3, 2tt1, 2tt4, p1, q1, 2e11, the wiper and home contact of the bank 9 of the switch R1, the home contact and wiper of bank C of the switch R2, 2b5 to protective resistance and battery. If the circuit is found to be free by the preselector circuit, that circuit will reduce the potential on the common point 70 between hs2 and 2tt1 and consequently cause the control circuit to test busy. When the preselector circuit has completed connection to the calling subscriber, a ground potential will be placed on the wire K causing the operation of relay KS. A circuit is now completed for relay 2A from battery and one winding of relay 2A, 2h2, conductor 1, Ks2, negative wire, subscriber's loop, position wire Ks3, conductor 2, 2h4, second winding of relay 2A to ground. Relay 2A completes the obvious circuit for relay 2B over 2a2 and relay 2B opens the testing circuit at 2b5 and closes a locking circuit for KS through 2b1, conductor 4<sup>1</sup> and Ks5. Relay Ks grounds the hold wire H over contacts Ks4 and Ks1. The control circuit, Fig. 4, receives the dialling impulses and controls the extension of the connection over the group finder, Fig. 2, as described for the previous call, the switching relay HS operating when the line selected by the R2 switch has been found and switching through the talking wires and grounding the hold wire H at contacts hs5 preparatory to the removal of the ground over the conductor 4<sup>1</sup> when the control circuit is released. 80

The remainder of the operations in extending the connection are similar to those described in the previous call.

It will be appreciated that the method of testing for idle junctions terminating in incoming finders with free control circuits may also be applied in arrangements where incoming group finders at the incoming ends of junctions from two or more distant offices 85 are associated with the same control circuits. Figure 6 shows such an arrangement in layout. A number of junctions A from one office terminate in incoming group finders AGF similar to that shown in Figure 3 and a number of junctions B from another office terminate in incoming group finders BGF also similar to that shown in Figure 3. The finders AGF and BGF are associated with a number of control circuits BF comprising the usual R1 and R2 switches, each control circuit serving a number of junctions from each of the offices A and B. In this manner the junctions are arranged in large groups with respect to the control circuits BP this arrangement permitting the use of fewer control circuits than would be the case if control circuits were provided individual to the junctions from the respective offices. 90

What is claimed is:

1. In or for an automatic or semi-automatic telephone system one or more conversation selector switches for use at the incoming end of a two wire junction from a distant office, one or more conversation selector switches for completing local connections and one or more common control circuits associated with and arranged to control the operation of both the incoming and local conversation selector switches. 70
2. In or for an automatic or semi-automatic telephone system, one or more conversation selector switches for use at the incoming end of a two-wire junction from a distant office one or more conversation selector switches for use at the incoming end of a two-wire junction from a second distant office and one or more common control circuits associated with and arranged to control the operation of the selector switches at the incoming ends of the junctions from both offices. 75
3. In a circuit arrangement comprising a selector switch having access to a group of junctions terminating in incoming selector switches which are operated under the control of common control circuits means operated on the seizure of said selector switch for first making a simultaneous test of said junctions and control circuits whereby idle junctions terminating in incoming selector switches associated with idle control circuits are marked selectable and means for causing said seized selector switch to conduct a hunt for one of said marked junctions. 80
4. The combination with a plurality of conversation satellite office selector switches having access to office junctions and to local trunks of a control circuit comprising discriminating means adapted to respond to one or more digits and if such digit or digits are indicative of a local call to cause a switching device associated with said control circuit to select an idle local trunk and provide a bye-path for succeeding impulses. 85
5. In or for an automatic or semi-automatic telephone system a plurality of conversation satellite office selector switches having access to office junctions and to one or more groups of local trunks, a control circuit common to said conversation selector switches and provided with means for testing said local trunks, means for causing a conversation selector switch to make a search for an idle office junction when taken into use, and discriminating means in said control circuit which responds to one or more digits and either causes said control circuit to be freed or causes a switch in said control circuit to select an idle local trunk and to provide a bye-path for succeeding impulses. 90
6. A telephone system comprising a distant office, a local office, two wire junctions extending between said offices and incoming selector switches, local selector switches and common control circuits for said switches at said local office and means adapted to prevent the selection of a two wire junction to an incoming selector switch or a trunk to a local selector switch when the control circuit associated with the incoming or local selector switch has been taken for use with another associated incoming or local selector switch. 95
7. A telephone system comprising a plurality of distant offices, a local office, two wire junctions extending between the local office and said distant offices, incoming selector switches and common control circuits therefor at said local office and means adapted to prevent the selection of a two wire junction from either of the distant offices when the control circuit associated with the incoming selector switch has been taken for use with another associated selector switch at the incoming end of a junction from either of said distant offices. 100
8. A telephone system comprising a distant office, a local office, two wire junctions extending between said offices, and incoming selector switches, local selector switches and common control circuits for said switches at said local office wherein a switch comprised within one of the common control circuits is adapted under the control of received impulses to select a trunk which serves as a bye-path for succeeding impulses until a predetermined associated selector switch has advanced to the selected trunk. 105
9. A telephone system according to claim 8 having a relay in said control circuit wherein said selected trunk is adapted to be marked in the bank of said predetermined associated selector switch over a wiper of the switch in the common control circuit and wherein said predetermined associated selector switch is adapted to be advanced to said marked trunk under the control of said relay. 110
10. A telephone system comprising two offices, two wire junctions extending therebetween, selector switches and common control circuits therefor at one of said offices and means adapted to test said junctions and said control circuits simultaneously. 115
11. A telephone system comprising a plurality of offices, two wire junctions extending therebetween, incoming selector switches and outgoing selector switches in which said junctions terminate and means whereby the free or engaged condition of said junctions is not indicated in the banks of the outgoing selector switches until one of the latter is taken into use. 120
12. A telephone system comprising a plurality of offices, two wire junctions extending therebetween, incoming and outgoing selectors in which said junctions terminate and common control circuits therefore wherein a battery potential is adapted to be normally 125

applied to one of the talking conductors of a junction from the control circuit associated with an incoming selector if both said selector and control circuit are free, a relay having its winding normally connected to said conductor at its outgoing end and means adapted to connect a ground potential to said winding when an outgoing selector is taken in use, said relay being adapted to apply a selectable potential to a test contact in the bank of the outgoing selector.

13. A system in accordance with claim 12, wherein said ground potential is adapted to be applied from a common control circuit associated with the outgoing selector switch.

14. A system in accordance with claim 12 having a second relay, wherein said selectable potential is adapted to be applied over a winding of said second relay, and wherein 20 said second relay is adapted to be operated when the corresponding junction is selected and to disconnect said first mentioned relay from the junction to hold the junction busy from its outgoing end.

25 15. A system in accordance with claim 4 wherein said control circuit is provided with a switch, said switch being adapted to respond to one or more digits to bring about the release of said control circuit.

30 16. A telephone system comprising a main office, a local office, junctions extending therebetween, main office and local office selectors at said local office having common control circuits associated therewith, one of the control circuits for the main office selectors having two switches, one of said switches adapted to respond to one or more digits to cause the second of said two switches to select an idle trunk to an idle local office selector which

35 40 has associated therewith an idle control circuit which is adapted to control the setting of the selector at the next selecting stage.

17. A system in accordance with claim 16 wherein in the case of a local call said first 45 mentioned switch is adapted to mark a wanted group of local trunks in the contact bank of the second mentioned switch, causing the latter to select an idle trunk therein.

18. A system in accordance with claim 16 50 wherein said first mentioned switch after responding to a first digit is adapted to move to a predetermined intermediate position and wherein, in response to a second digit said switch is adapted to be advanced to a further 55 position in which a group of trunks in the contact bank of said second mentioned switch is marked.

19. A system according to claim 4 wherein 60 said control circuit is provided with a relay and wherein means is provided which, after an idle local trunk has been selected from said control circuit is adapted to mark the selected trunk in the contact bank of the selector switch which has been taken for use, 65 and wherein said switch is adapted to be ad-

vanced to the selected trunk under the control of said relay.

20. A system according to claim 16 wherein 70 said selectors are each provided with an impulse responding relay which is adapted to repeat impulses directly to the stepping magnets of the first mentioned switch of said two switches comprised within the control circuit.

21. A telephone system comprising a main office, a satellite office, local selectors and control circuits therefor at the satellite office wherein talking current is fed from a local selector for a talking connection set up between two subscribers associated with said satellite office.

In witness whereof I hereunto subscribe my name this sixth day of March 1930.

ESMOND PHILIP GOODWIN WRIGHT.

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