

Aug. 18, 1931.

T. A. LUNDELL

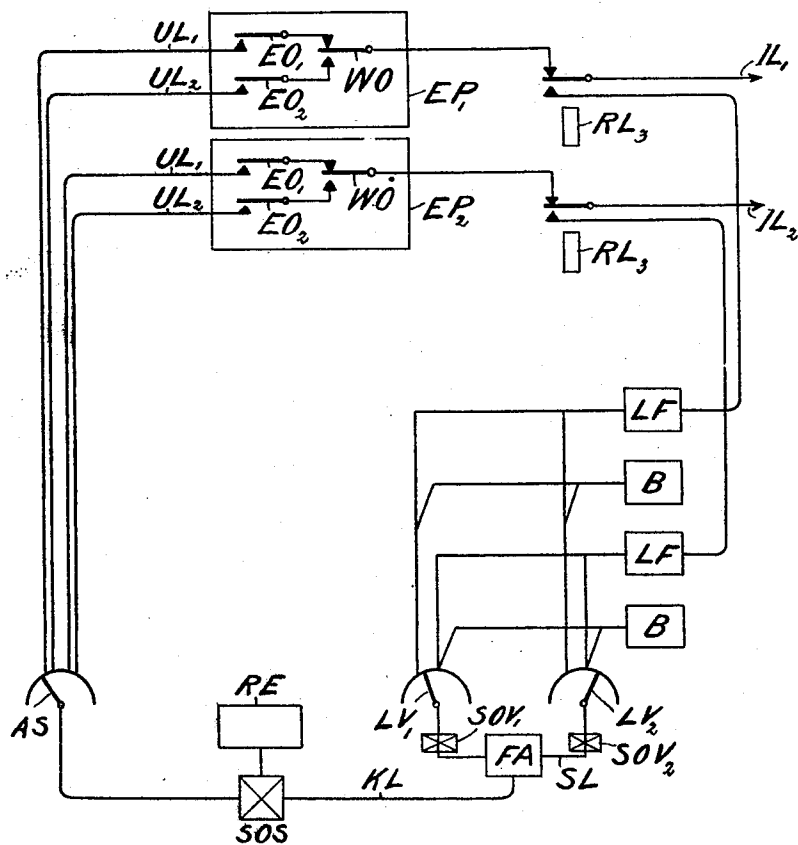
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TELEPHONE SYSTEM

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6 Sheets-Sheet 1

Fig. 1.



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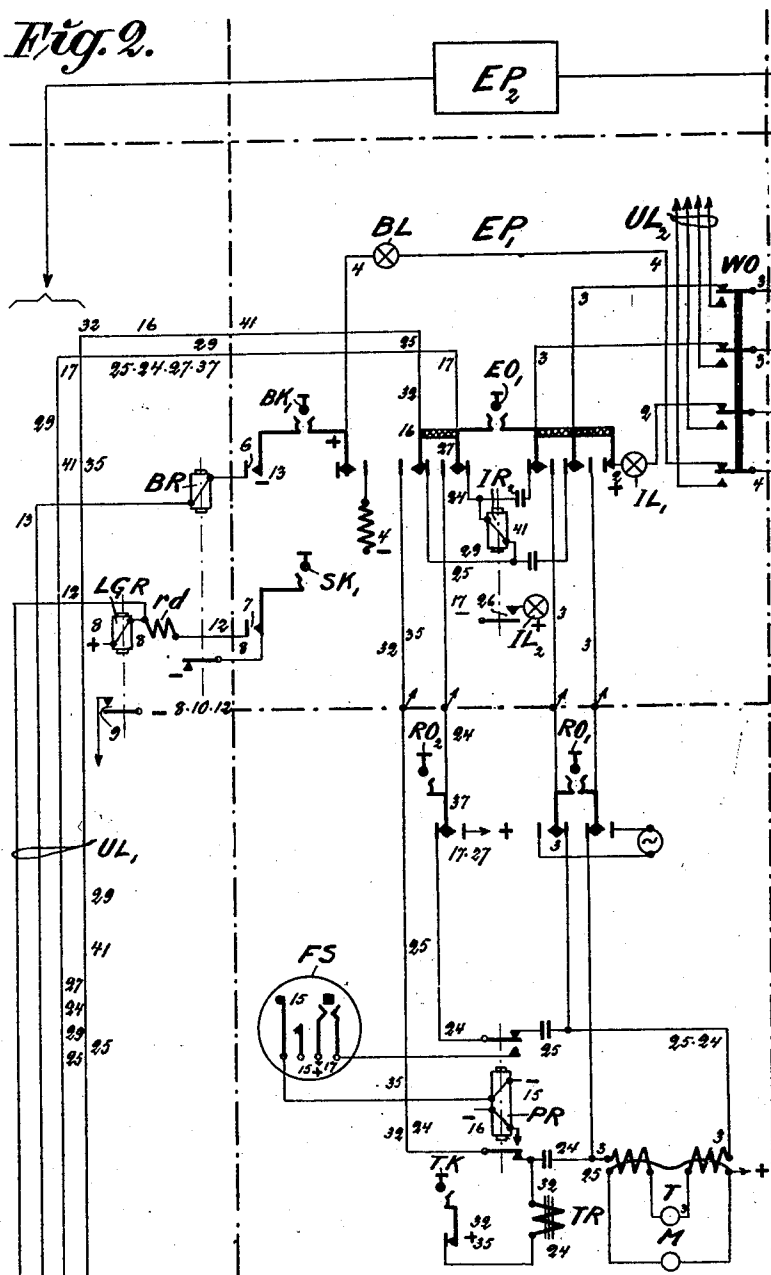
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Fig. 2.



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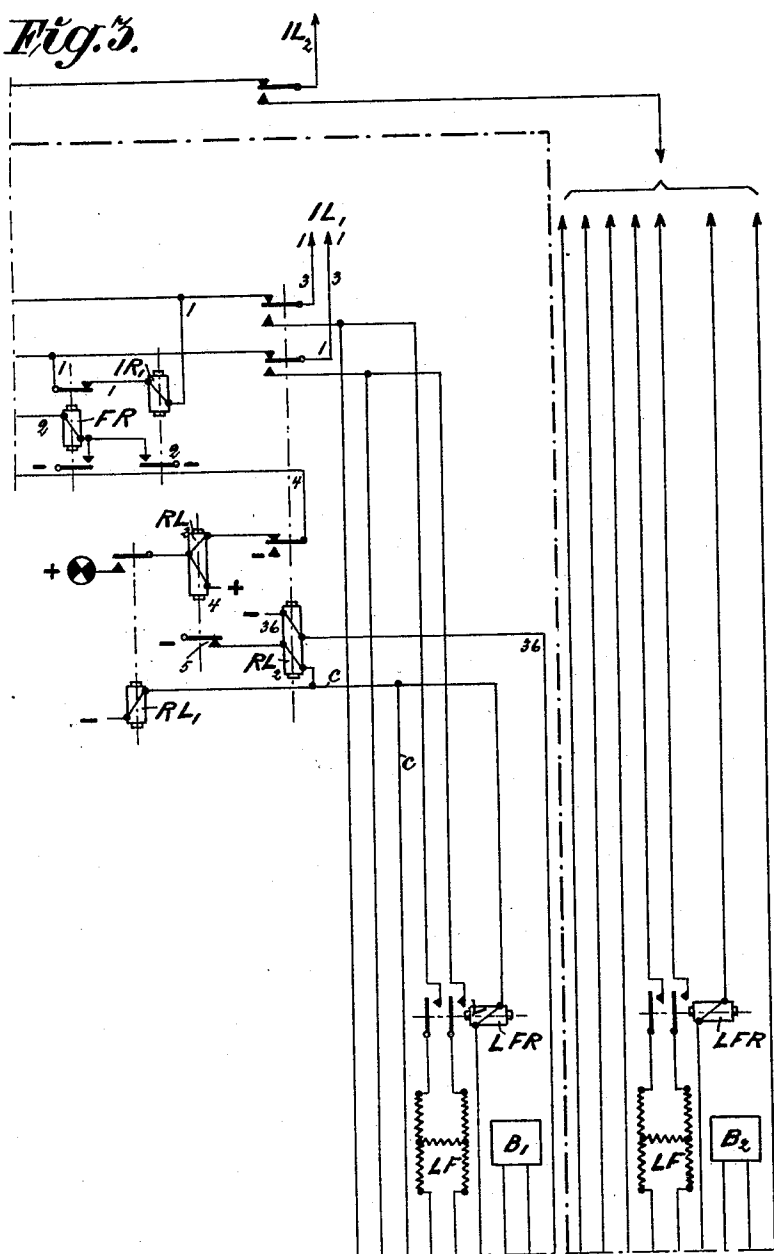
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Fig. 3.



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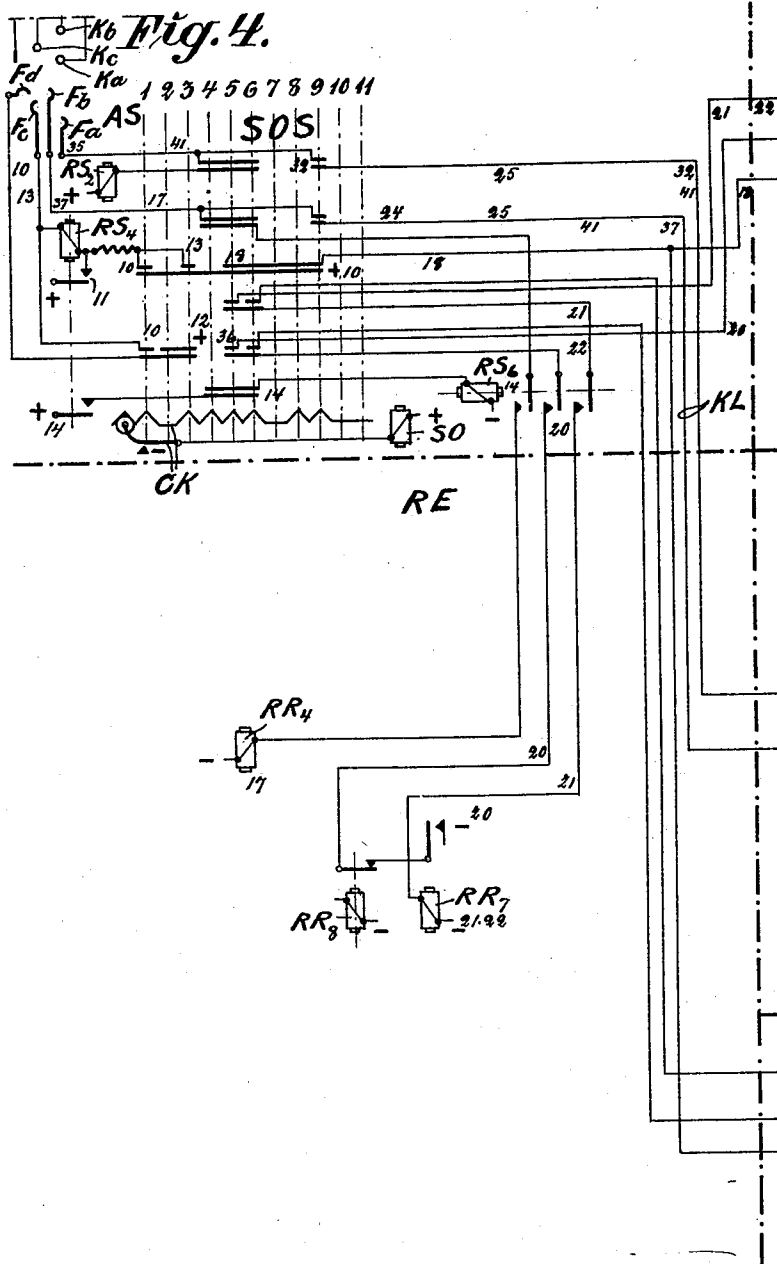
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TELEPHONE SYSTEM

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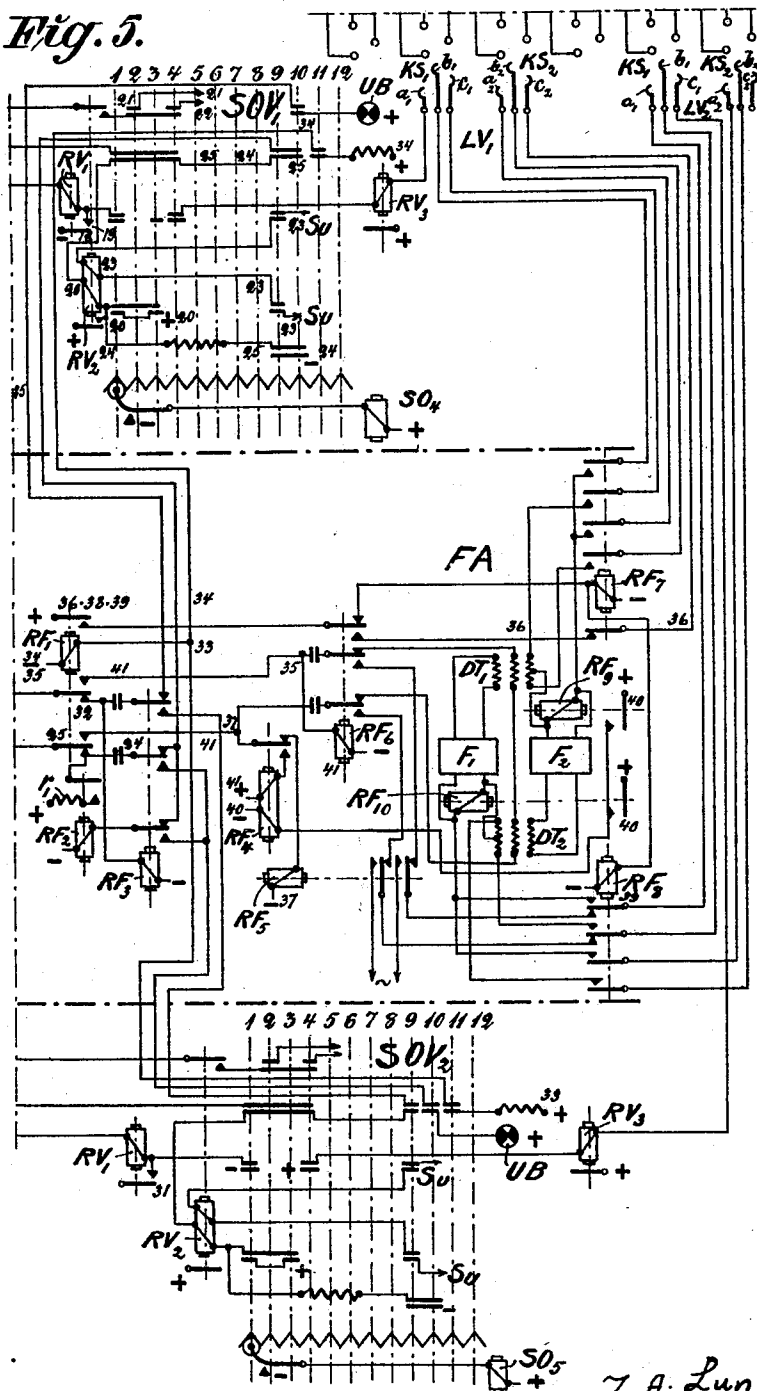
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TELEPHONE SYSTEM

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Fig. 5.



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TELEPHONE SYSTEM

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Fig. 6.

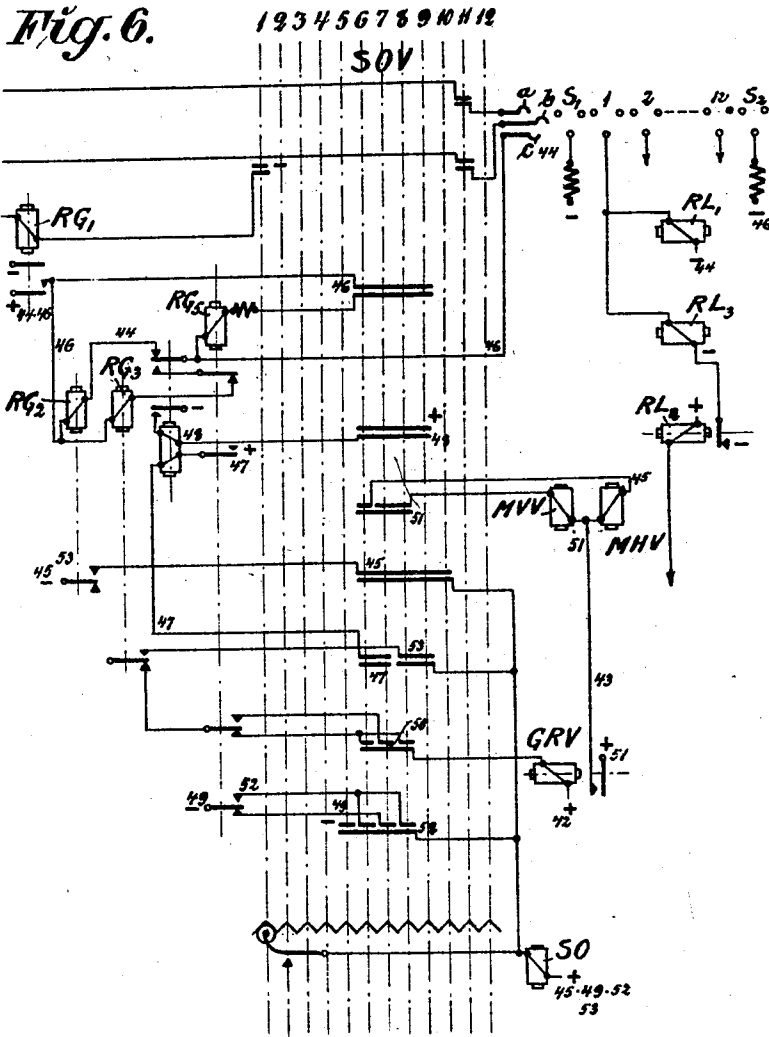


Fig. 7.

Fig. 2.	Fig. 3.
Fig. 4.	Fig. 5.

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UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

Application filed January 3, 1930, Serial No. 418,380, and in Sweden January 12, 1929.

The present invention relates to telephone exchanges having inter-office transit or through-traffic. More especially the invention relates to such telephone plants in which the inter-office communications are provided with repeaters or amplifiers disposed in the through-traffic exchange. The invention has for its object to simplify the manual operation of such plants by replacing as far as possible manual operation by automatic operation. According to the present invention the local operators' positions otherwise used in inter-office plants having through-traffic are replaced by an automatic exchange over which the connections in question may be established through the intermedium of the trunk or inter-office operator which thus alone mediates the establishment and the supervision of the inter-office communications.

The invention will be more closely described with reference to the accompanying drawings. Figure 1 is a diagrammatic representation of a plant according to the invention adapted to establish amplified through-communications. Figures 2, 3, 4 and 5 are circuit diagrams for a plant according to Figure 1. Figures 2 and 3 illustrate the arrangements in the manually operated position whereas Figures 4 and 5 show the parts of a talking connection extending through the automatic exchange. Figure 6 is a circuit diagram for the final selector. Figure 7 indicates the manner of combining Figures 2, 3, 4 and 5 to form a coherent circuit diagram.

In Figure 1 the talking lines are shown as single lines although each line in reality comprises two or more wires. The figure shows two inter-office lines IL_1 , IL_2 entering the telephone exchange which lines are connected to separate operators' positions EP_1 and EP_2 respectively over normally closed contacts of the switching relay RL_3 by means of which the lines may be switched into direct communication with the automatic telephone exchange. The operators' positions EP are provided with devices to prepare the establishment of another communication over an inter-office line during a conversation going on at the time being. For this purpose each

inter-office line in the operator's position may alternately be connected to the one or the other of two appertaining auxiliary lines UL_1 and UL_2 which at the other end are connected to the automatic exchange. The connection of the inter-office line to the auxiliary lines takes place over a switch WO and two speaking switches EO_1 , EO_2 . The operators' positions are provided with the necessary signalling devices to supervise the connections and numeral switching devices to establish the connections over the automatic exchange. The latter devices may, by way of example, consist of a finger disk or dial or a set of buttons of the kind used in semi-automatic telephone systems.

The automatic exchange comprises distributing selectors in the form of call finders and also final selectors LV_1 , LV_2 . The auxiliary lines UL_1 , UL_2 are connected in multiple to the contact fields of the call finders whereas the inter-office lines are connected in multiple to the contact field of the line selector. Final selectors LV_1 and LV_2 are two and two mutually interconnected through cord lines SL in which repeater sets FA are included and over which the inter-office communications are completed by associating the one final selector LV_1 in a set of two selectors with the calling line and by associating the other final selector LV_2 with a line extending in the wanted direction. Each cord line is through an amplifier set and a line KL_1 connected to a call finder AS over which a connection may be established to the operator's position to set the final selectors and to supervise the connection.

The call finders and final selectors belonging to the automatic exchange may, of course, be of any arbitrary kind. In the following they are assumed to be provided with a wiper or contact arm adapted to be set in two directions, i. e. to perform a turning motion to select a contact row and a radial motion in the longitudinal direction of the wiper to select a certain line in the contact row. They are further assumed to be of the power-driven type and adapted to be set under the control of registers RE which in known manner may be associated with the line KL . The call

finders AS are in known manner provided with sequence switches SOS and the final selectors are provided with sequence switches SOV₁, SOV₂. Also the sequence switches are power-driven. At the establishment of amplified communications, line extensions LF and line balances B, Figure 3, are applied in a manner known per se which balances according to the invention are adapted to be connected to the lines by means of the same selectors LV₁, LV₂ through which the connections are established. The inter-office lines and their appertaining line balances are then assumed to be connected to the different sections in the contact field of the final selector in such a manner that the terminals of the lines and the balances in the corresponding sections take up the same relative positions. The final selectors LV₁, LV₂ are thus provided with two sets of contact fields KS₁, KS₂ disposed on the same movable switching member, Figure 5, of which the contact sets KS₁ bring about the connection to the line and its testing wire over the line extension LF whereas the contact set KS₂ serves to connect up the line balance B.

The system operates as follows. Upon a call being received in the operator's position EP₁ over the inter-office line IL₁ a call relay IR₁ is actuated over a circuit 1 which relay in turn closes a circuit 2 through a call lamp IL₁ and a relay FR which connects itself into a holding circuit and opens the circuit 1. The operator then shifts the speaking switch EO₁ to speaking position a speaking circuit 3 being then closed through the operator's set comprising the telephone receiver T and the microphone M. At the same time, the inter-office line IL₁ is marked as engaged by a circuit 4 being closed through a relay RL₂ which at its normally closed contact 5 disconnects the one of two relays RL₁, RL₂ associated in parallel with the testing wire *c* in such a manner that the resistance included between the testing wires and the negative terminal of the battery is increased to a corresponding degree. After the operator has been informed about the desired communication, she operates initially a switch BK₁ through which the testing wire of the auxiliary line UL₁ is connected to the negative terminal of the battery over a contact 6. Thereupon the operator actuates a switch SK₁ representing that exchange to which or over which the desired communication is to be established. Thereby the line UL₁ is marked as being calling in the group of call finders AS, the appertaining final selectors LV₂ of which may be connected to the lines extending to said exchange. The latter marking is effected by associating a fourth conductor *d* common to a group of auxiliary lines UL₁ with the negative terminal of the battery over a contact 7 of the switch SK₁. Said line *d* is connected to a contact bar K*d* appertaining to

the contact row Ka, Kb, Kc, Figure 4, containing the line in question UL₁. At the same time a circuit 8 is closed through a relay LGR which in turn closes a circuit over its contact 9 which circuit in known manner causes the starting of a plurality of call finders AS. Each call finder is provided with a set of contacts comprising four contact springs Fa, Fb, Fc and F*d*. During the turning motion of the call finders the contact spring F*d* successively contacts with the contact bars K*d* of the different contact rows. As soon as the call finder finds the contact row which contains the line UL₁ in question a current path 10 is closed through a relay RS₁ which is energized and connects itself into a holding circuit over its contact 11. Said relay RS₁ closes in a manner not shown here a circuit through the clutch magnet SO of the sequence switch SOS, whereby the sequence switch is brought to its third position. The circuit of the clutch magnet SO is controlled in a manner known per se by a centering device CK which holds the circuit of the clutch magnet closed until the sequence switch has been accurately set in the correct position.

In the third position of the sequence switch a circuit 12 is closed, whereby the relay LGR is short circuited and de-energized. Thereby all the call finders are brought to stop. That call finder which initially made contact with the contact bar K*d* is, however, now started in radial direction to search the line UL₁ marked as being calling. When the call finder finds this line, a circuit 13 is closed containing a relay BR which opens the circuits 8 and 12 whereby the selector is brought to stop. At the same time the clutch magnet of the sequence switch SOS receives a new current impulse whereby the sequence switch is shifted to the fourth position. In this position a circuit 14 is closed for a relay RS₂ which is energized and connects a speaking line to the register RE. At the same time, the sequence switch SOS is brought to the fifth position. In this position the operator receives a buzzer signal informing the operator that the register has been connected up. Thereupon the operator may send the impulses necessary to set the final selectors. In the shown example the operator for this purpose is using a finger disk or dial FS. It is assumed that each final selector is adapted to be set by means of three impulse series, the register RE being adapted to receive six current impulse series and thereupon in due order to control the setting of the selectors LV₁ and LV₂. When the finger disk is operated a circuit 15 is closed through the one coil of the relay PR which is energized and connects the other coil into a holding circuit 16 extending over the *a*-branch. At the same time an impulse circuit 17 is closed over the *b*-branch which circuit includes the impulse relay RR₁ of the register. By the impulses

sent over said impulse circuit the register is now set in known manner. In the meantime a circuit 18 has been closed through a relay RV₁ of the final selector which relay has connected itself into a holding circuit over its contact 19.

After completed setting of the register a circuit 20 is closed through a relay RV₂ of the final selector. Thereby the sequence switch SOV₁ of the final selector is brought to its second position in which the final selector is started. During the turning motion of the selector, back impulses are sent over a current path 21 which impulses in known manner control a back impulse relay RR₇ of the register RE. After completed turning motion a circuit 20 of the relay RR₈ of the register is opened, the relay RV₂ being then de-energized. The sequence switch SOV₁ is now brought to its third position. In this position the circuit 20 is again closed the sequence switch being then shifted to its fourth position in which the selector performs its radial motion. During said motion back impulses are sent over the circuit 22 through the relay RR₇ in the register. After completed setting of the final selector the relay RR₈ is again operated, the circuit 20 being then again opened and RV₂ then dropping its armature.

The sequence switch SOV₁ is then brought to its ninth position. At the same time also the sequence switch SOS is brought to its ninth position, which is the speaking position.

As will be more closely described in the following with reference to Figure 6 an inter-office line may be marked as engaged in two different manners. The line is namely marked as engaged in a certain manner when the line is engaged only by an existing talking connection and in another manner when besides another selector is associated with a line and standing by ready to connect itself to the line as soon as said line becomes free. If the line is engaged and besides the final selector in said manner is associated with the line the sequence switch SOV₁ stops in the ninth position as is readily understood by Figure 6. In this position a buzzer circuit 23 is closed through a winding of the relay RV₂. Said buzzer current induces a current in the operative winding of the relay which current passes through a circuit 24 including the operator's set. By this buzzer signal the operator's attention is called to the fact that the line is engaged and that another selector already is standing by ready to connect itself to the line as soon as said line becomes free. The operator therefore clears the established communication by restoring the switch BK₁ to normal position, the circuit 13 through the relay RS₄ being then opened. When the sequence switch SOS, as a consequence thereof, is restored to its starting position also the circuit 18 of the relay RV₁ is opened the sequence switch SOV₁ together

with the final selector LV₁ being then restored to normal position.

If the line is engaged but, on the other hand, no other selector is standing by connected into circuit in ready position the sequence switch SOV₁ stops at first in the tenth position. In said position a current path 25 is closed over the two line branches through the operator's set which path includes a periodical current interrupter UB which produces a cracking noise in the operator's set whereby the operator's attention is called to the fact that the line is engaged and that the final selector is standing by, associated with the line and ready to be connected into circuit as soon as the line becomes free. If now the operator while awaiting for the line becoming free desires to prepare another communication and for this purpose restores the speaking switch EO₁ a relay IR₂ is connected into circuit between the two line branches instead of the speaking apparatus. The latter relay is now operated by the impulses sent over the circuit 25 whereby the circuit for a signalling lamp IL₂ is alternately opened and closed at a contact 26 of said relay. Said lamp shows thus an unsteady light so long as the line still is engaged. When the line becomes free the sequence switch SOV₁ proceeds to its eleventh position which is the speaking position. Then the circuit 25 is opened and the lamp IL₂ is put out.

The cord line SL has now over the selector LV₃ been associated with the inter-office line IL₄ entering the operator's position EP₁. After completed setting of the selector LV₁ the sequence switch SOS is brought to its sixth position in which the final selector LV₂ is set in similar manner on that inter-office line, by way of example IL₄, with which communication is wanted. After completed setting of the selector LV₂ the sequence switch SOS is brought to its ninth position which is the speaking position. In said position the operator is connected over the lines UL₁ and KL to a set of relays belonging to the repeater FA said set comprising a relay RF₃ which is now energized over a current path 32. Thereby the line KL is associated with a sequence switch SOV₂. If the latter in this moment takes up anyone of the positions 9 and 10 the operator now receives a busy signal. It may, however, be assumed that the line is free and that the sequence switch SOV₂ thus takes up the eleventh position. In said position of the sequence switch the operator does not notice any signal which fact thus indicates that the line is free. If the operator wishes to ascertain if her own line is free this might be effected by operating a key TK₁ whereby a circuit 32 is opened and the relay RF₃ is de-energized. The operator is then connected to the sequence switch SOV₁ from which busy signals are obtained

in position 9 and 10 in above described manner in case the line should be engaged. If the line is free the sequence switch takes up the position 11 in which position no signal is sent. If now also the own line is free two circuits 33, 34 are closed over contacts in the sequence switches SOV_2 and SOV_1 and through the relay RF_1 which is so adjusted that it is energized at first when both of said circuits are simultaneously closed. When the relay RF_1 is energized the line KL is disconnected from the sequence switches SOV_2 , SOV_1 and instead connected to the repeater FA . Then a circuit 35 is closed comprising a relay RF_6 which disconnects the repeater and connects the supervisory line KL to the called inter-office line. At the same time a circuit 35 is closed including a differential coil of the relay RL_3 which so counteracts the previously energized operative winding of the same relay that the relay is de-energized, the inter-office line IL_1 being then again associated with the operator's position. The operator may now listen directly to both lines and send call signals. To send a call signal in the line IL_1 the switch RO_1 is actuated. By actuating a switch RO_2 a circuit 37 is closed including a relay RF_5 which connects IL_1 to a call bell current source. As soon as the operator has ascertained that an answer is obtained in both lines she restores the speaking switch EO_1 to normal position the relay RF_6 then being de-energized and restoring the communication with the repeater. At the same time, the circuit 36 is interrupted, the relay LR_3 again being energized and associating the inter-office line IL_1 to the final selector. At the same time two circuits 38, 39 are closed through two relays RF_7 and RF_8 which are energized and unite the two lines over the repeater and the appertaining line balances. The repeater may be of any arbitrary kind and consists substantially of two amplification devices F_1 , F_2 and two differential transformers DT_1 , DT_2 .

A clearing signal from the one or the other line operates a relay RF_9 or RF_{10} respectively which in turn closes a circuit 40 through a coil of the relay RF_4 which then connects its holding coil into a circuit 41 which also includes the relay RF_6 . The latter relay is, however, not energized in this case. On the other hand, the relay IR_2 of the operator's position is actuated which relay over its contact 26 connects the signalling lamp IL_2 into circuit. The operator may now by shifting her speaking switch EO_1 in the above described manner put herself into communication with both lines. Finally the automatic connection is interrupted by restoration of the switch BK_1 to normal position.

It has been assumed above that the final selectors are set on a certain definite line.

In reality the final selector has to choose between a plurality of lines extending to the same exchange and the selector will for this reason upon being set on the first of the lines extending to the exchange in question, automatically search a line free for the time being. The system is, according to the invention, so arranged that in case all outgoing lines should be engaged the selector is set in a stop position immediately after the contacts of the last line whereupon the selector returns over the same contacts while testing the lines anew. In said position the testing circuit of the selector has, however, been shifted in such a manner that the selector during its return motion may be set on a line engaged for the time being without establishing communication with said line. At the same time said line is blocked for other selectors in such a manner that only one selector may remain standing by in the line, ready to be associated as soon as the line becomes free. The testing arrangement is then of such a nature that the selector during its return motion is passing such lines on which another selector already is set in ready position. During the return motion the selector may, of course, also stop on a line which meanwhile has been made entirely free.

Said switching operation is illustrated in Figure 5 showing only those circuits which have any relation to the testing. After completed setting of the selector on the first of the lines extending to the wanted exchange which line is connected to a contact position, designated 1 on the drawings, the sequence switch SOV is shifted to its sixth position in which position the selector is again started to search a free line, in case the first line should be engaged. The starting is effected by a circuit 42 which actuates a magnet GRV which, in turn, closes a circuit 43 of the clutch magnet controlling the motion of the selector into the contact field in radial direction. As is readily understood from Figure 2, a line is marked as engaged as soon as the relay RL_2 is energized. When testing the line there takes place a flow of current 44, Figure 5, through the testing relay RG_2 , but this flow of current is insufficient to actuate RF_2 . First when the selector reaches a free line the testing relay RF_2 is sufficiently energized as the test wire of the line in this case is connected to the negative terminal of the battery over both relays RL_1 , RL_3 . If the line should be engaged by a communication not passing through the operator's position, by way of example an amplified communication, the testing relay RG_2 may, anyhow, not attract its armature, because said relay is then connected in parallel with a similar relay in another selector and hence does not obtain sufficient current. As soon as the selector finds a free line the re-

lay RG_2 however, operated, the clutch magnet of the sequence switch then being energized over a current path 45 so as to bring the sequence switch to its eleventh position being the speaking position.

If all the lines should be engaged the selector continues its motion until it reaches its stop position which in Figure 5 is designated S_2 . In said position a circuit 46 is closed which is branched in parallel through the relays RG_2 and RG_5 which now both attract their armatures. When the relay RG_5 attracts its armature a circuit 47 for the relay RG_4 is closed which relay is now energized and locks itself over a circuit 48. At the same time the relay RG_2 is disconnected. Further a circuit 49 is closed through the clutch magnet of the sequence switch whereby the sequence switch is brought to its seventh position. In said position the magnet GRV is energized over the contact 50 in the sequence switch a circuit 51 being then closed through the magnet MVV which causes a reversing of the motion of the selector, the selector now moving backward in the same contact row. When the selector leaves the stop position the relay RG_5 is de-energized whereby the test wire is connected to a testing relay RG_3 . The latter relay is so dimensioned that it may attract its armature even if the line, for the time being, is engaged by a communication. On the other hand, it may not attract its armature if the line is engaged by a communication and at the same time another selector is associated with the line in ready position. In the latter case the c -wire of the line is namely connected both to the negative terminal of the battery over a relay RL_1 if the line is engaged by a communication passing through the own operator's position, and to the positive terminal of the battery over a relay RG_2 in a selector in ready position. If the line should not be engaged in the own operator's position the test wire of the line is connected to the positive pole of the battery over two parallel-connected relays RG_2 . In both cases the current received by the testing relay RG_3 is insufficient to operate the relay and the selector continues its motion until it finds either a line which in the meantime has become entirely free or a line which is engaged and on which no selector is set in ready position. Should all the lines during the return motion be marked as entirely engaged, i. e. if the selector is set in ready position on each one of the lines the selector continues its return motion until it reaches the stop position S_1 immediately in front of the first position. In said position the relays RG_3 and RG_5 obtain sufficient current to be actuated the sequence switch being then operated over a circuit 52 and, as a consequence, brought to its ninth position in which position the

selector stops and a busy signal is sent to the operator.

If the selector during its return motion should find a line which is engaged but on which no other selector is set in ready position the relay RG_3 is sufficiently energized over the test wire to be able to attract its armature the sequence switch then receiving current over a circuit 53 and thereby being brought to its tenth position in which position the selector remains standing by in ready position until the line becomes free. In the tenth position of the sequence switch, the circuit 48 is interrupted and the relay RG_4 consequently de-energized. The relay RG_3 has thus now been disconnected and instead the testing relay RG_2 has been associated with the test wire. When the line becomes free, the relay RG_2 attracts its armature which results in that the sequence switch is brought to its eleventh position which is the speaking position.

I claim:

1. A switching arrangement to establish inter-office transit or through-communications between the lines entering a telephone exchange from other telephone exchanges and more especially inter-office communications having repeaters or amplifiers, characterized in that said lines are associated in multiple with final selectors which are two and two mutually interconnected through cord lines in which amplifiers may be included and over which the inter-office communications are established by the one final selector in a selector pair being connected to the calling line and the other line selector to a line extending in the wanted direction, said cord lines being adapted to be connected over distributing selectors to auxiliary or supervisory lines extending from the inter-office operators, positions over which lines the selectors may be operated and the inter-office communications supervised.

2. A switching arrangement as claimed in claim 1 in which the final selectors are set under the control of registers, characterized in that the registers are adapted to receive impulses, sent from the inter-office operator and corresponding to the number of both the lines to be connected with one another, and to control, in order of sequence, the setting of the two final selectors, belonging to the same selector pair.

3. A switching arrangement as claimed in claim 1, characterized in that each selector pair is provided with a sequence switching device whereby the switching is controlled in such a manner that the junction line is initially connected in turn to the two selectors to set said selectors and thereupon connected to the amplifier to control the communication.

4. A switching arrangement as claimed in claim 1, characterized in that the calling line is adapted to be associated alternately to the

inter-office operator's position and to the final selector multiple by means of a switching arrangement adapted to be controlled from the operator's position.

5 5. A switching arrangement as claimed in claim 1, characterized in that line balances B appertaining to the inter-office line are adapted to be associated with the lines by means of selectors LV adapted to be set from the inter-office operator's position.

6. A switching arrangement as claimed in claim 1, characterized by an arrangement to switch the testing circuit of those line selectors which establish communication with a wanted line said switching arrangement when all lines extending in the wanted direction are engaged, bringing about such an alteration in the testing circuit that the selector may be set in ready position on an engaged line without establishing communication therewith.

7. A switching arrangement as claimed in claim 1 characterized in that the calling line is adapted to be associated alternately to the inter-office operator's position and to the final selector multiple by means of a switch arrangement adapted to be controlled by the operator's position, said switching arrangement being adapted to be operated from the operator's position of the supervisory line.

8. A switching arrangement as claimed in claim 1, characterized in that the line balances appertaining to the inner-office line are adapted to be associated with the lines by means of selectors adapted to be set from the inner-office operator's position, the line balances being adapted to be conducted by means of the same final selectors by means of which communications are established.

9. A switching arrangement as claimed in claim 1, characterized in that the line balances appertaining to the inner-office line, are adapted to be associated with the lines by means of selectors adapted to be set from the inner-office operator's position, characterized in that the lines and their balances are connected to separate sections in the contact field of the final selector in which sections the terminals of the lines and the balances take up the same relative positions.

10. A switching arrangement as claimed in claim 1, characterized by an arrangement to switch the testing circuit of those line selectors which establish communication with a wanted line, said switching arrangement, when all lines extending in the wanted direction are engaged, bringing about such an alteration in the testing circuit that the selector may be set in ready position on an engaged line without establishing communication therein, the disposition of the selector being such that the selector when searching a wanted line, passes such lines in which another selector already is set in ready position.

65 11. A switching arrangement as claimed in

claim 1, characterized by an arrangement to switch the testing circuit of those line selectors which establish communication with a wanted line, said switching arrangement, when all lines extending in the wanted direction are engaged, bringing about such an alteration in the testing circuit that the selector may be set in ready position on an engaged line without establishing communication therewith, wherein those arrangements in the final selector by means of which the talking connection is completed are adapted to be controlled by a relay included in the testing circuit in such manner that said connection is completed automatically when the existing connection is opened.

In testimony whereof I affix my signature.

TORSTEN ADIL LUNDELL