Aug. 26, 1947. F. P. GOHOREL 2,426,196

AUTOMATIC TELEPHONE SYSTEM

Filed Dec. 20, 1943 3 Sheets-Sheet 1

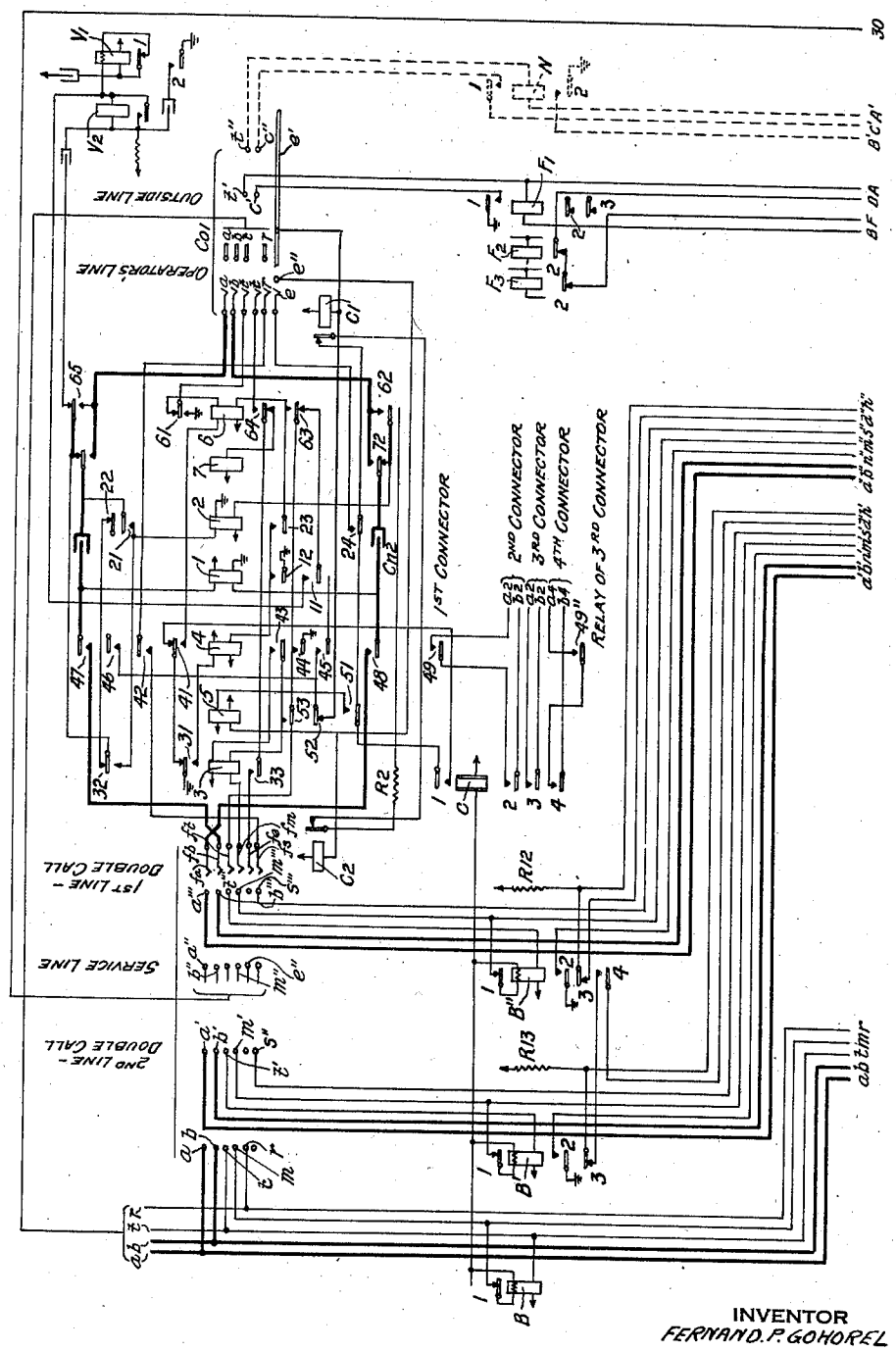

Fig. 1.

INVENTOR
FERNAND P. GOHOREL

BY Edward D. Phinney

AGENT

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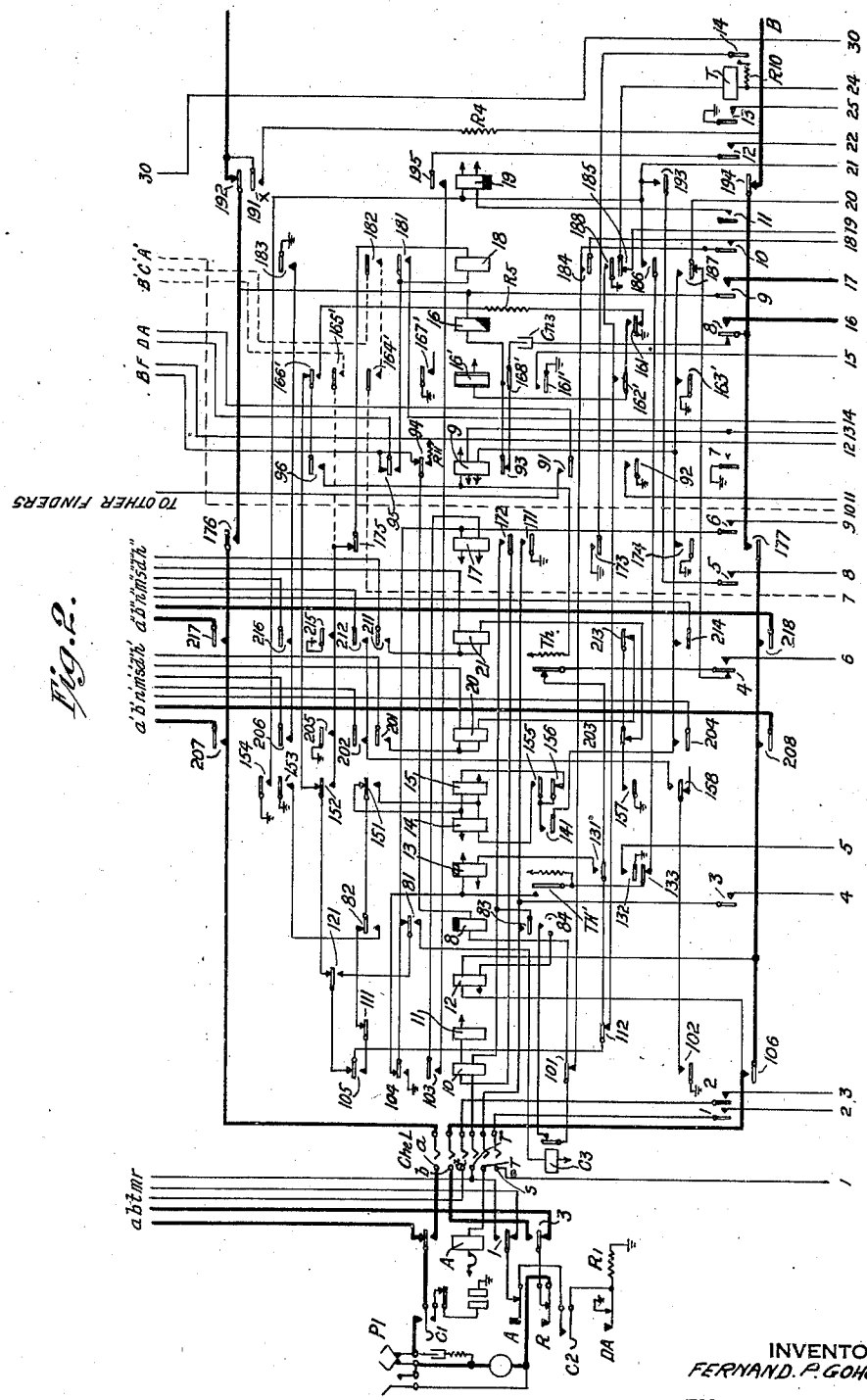

Fig. 2.

INVENTOR
FERNAND. P. GOHOREL

BY
Edward D. Phinney
AGENT

Aug. 26, 1947. F. P. GOHOREL 2,426,196

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Filed Dec. 20, 1943 3 Sheets-Sheet 3

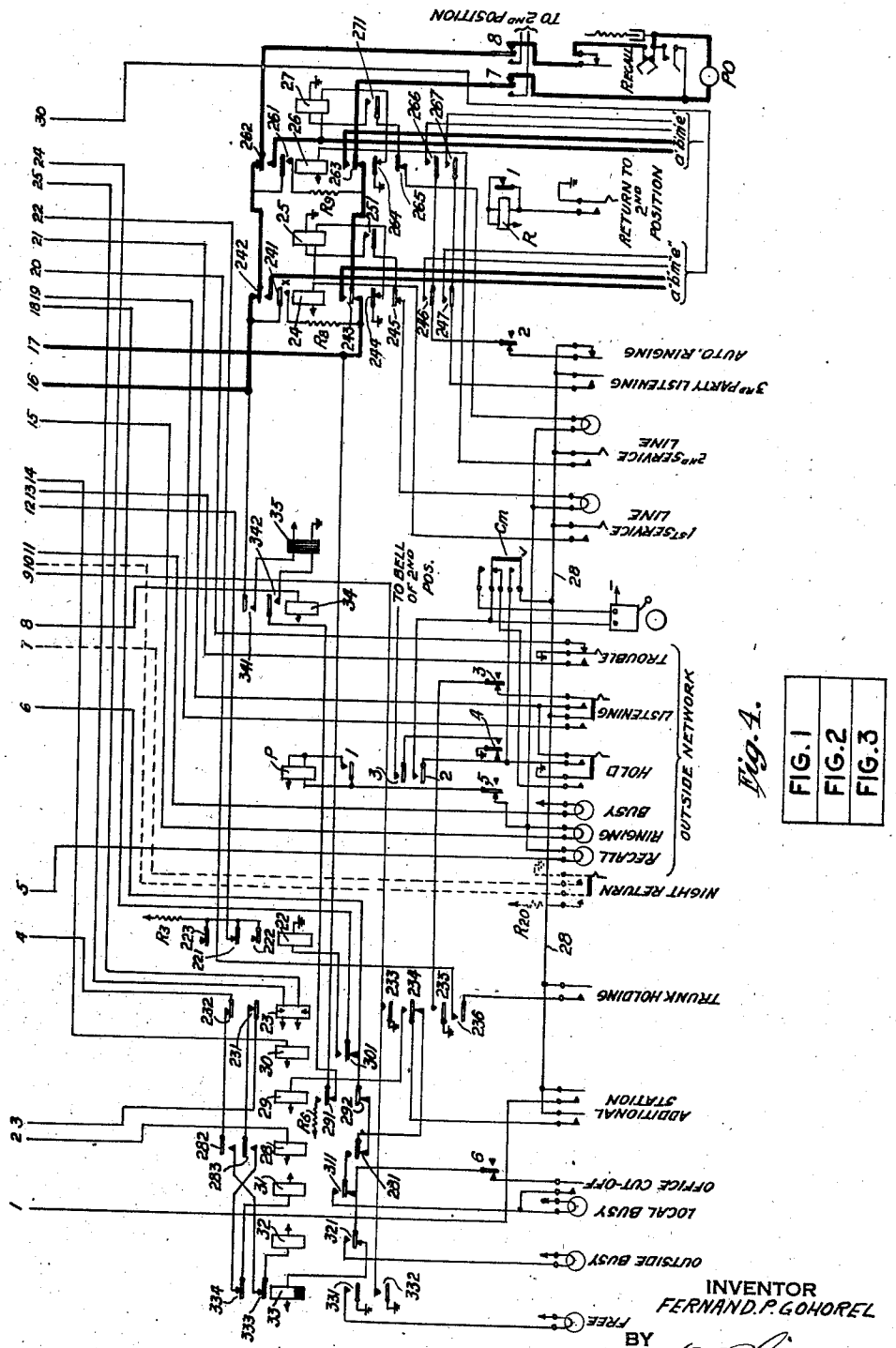

Fig. 3.

Fig. 4.

FIG. 1
FIG. 2
FIG. 3

INVENTOR
FERNAND P. GOHOREL
BY
Edward D. Kinney
AGENT

Patented Aug. 26, 1947

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UNITED STATES PATENT OFFICE

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AUTOMATIC TELEPHONE SYSTEM

Fernand P. Gohorel, Sceaux, France, assignor to International Standard Electric Corporation, New York, N. Y., a corporation of Delaware

Application December 20, 1943, Serial No. 514,931
In France November 3, 1938

7 Claims. (Cl. 179—27)

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The present invention relates to new and useful improvements in automatic telephone systems, and more particularly those for inside networks or P. B. X's in which the subscribers may communicate with subscribers of an outside network over one or more junction lines.

In accordance with the invention, the subscribers of the inside P. B. X network may be connected directly with the lines of the outside network without the aid of an operator, either when calling or when answering a call coming from the outside network and when the operator who deals with outside calls is absent.

Moreover, the subscribers of the inside network are able during a conversation with the outside network to hold the outside lines and get into communication with another P. B. X subscriber of the inside network, and after this communication either to reconnect with the outside line, or to transfer it to a second P. B. X subscriber without the aid of the P. B. X operator.

The P. B. X operator can either terminate the conversation between two subscribers of the inside network in order to connect one of them with an outside line, or she may enter as third party into a conversation in order to warn one of the subscribers that a communication intended for him is waiting on the outside line.

The various characteristics of the invention will now clearly appear from the following description referring to the attached drawings which represent:

Fig. 1, the detailed diagram of a junction circuit of the automatic P. B. X;

Fig. 2, the detailed diagram of the equipment of a junction line with the outside network;

Fig. 3, the detailed circuit diagram of the equipment of the operator's position at the P. B. X; and

Fig. 4, the manner in which Figs. 1, 2 and 3, are to be connected.

In the following descriptions the letter R preceding the number of a relay contact spring, indicates that the contact is closed by this spring when the relay is in the normal position (not energized), and the letter T indicates that the contact is closed by this spring when the relay is in the operative position (energized).

I shall now explain in detail the operation of the system.

Calling an inside station.—Let us assume that the P. B. X subscriber P1 wishes to call another P. B. X subscriber. When P1 removes his handset, the following circuit is completed: earth, button DA in the normal position, contact C2 of the switch-hook, button A in the normal position, spring 1 of relay A, wire *m*, rest contact and spring 1 of the relay B, upper non-inductive winding of relay B, winding of common relay C and battery.

Relay C is energized and operates its contacts.

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In its spring 1 and its operative contact, it completes the following circuit: earth, R31, R41, spring 1 of relay C, and its work contact, contact of the rotary magnet C_1, of the connector Co_1, rest contact of magnet C_2 of finder Che_1, resistance R2, R62, lower winding of relay 2 and battery.

In its spring 3 and the work contact associated therewith, relay 3 completes a circuit identical with that which has just been indicated for the third connector. In its springs 2 and 4, and their work contacts, it prepares the same circuits of the connectors 2 and 4, said circuits being completed in the example shown only if the connectors 1 and 3 are already busy.

It will be assumed that the connectors 1 and 3 are free.

The relay 2 of connector Co_1 is energized over its lower winding in the circuit previously indicated. In the same way relay 2 of connector Co_3 (not shown) is energized over a similar circuit completed by contact 3 of the relay C.

Relay 2 in pulling up completes in its contact T24 the following step-by-step circuit of the connector Co_1: earth, R31, R41, spring 1 of relay C and its work contact, T24, wiper *e*, bank bus bar *e'*, of the connector Co_1, winding of magnet C_1 and battery.

The magnet C_1 will attract its armature and open its contact. The opening of said contact opens the circuit of the lower winding of relay 2 which falls back opening the circuit of magnet C_1 which releases its armature. The wipers of Co_1 advance one step. When C_1 releases its armature, it recloses its contact and the circuit of the lower winding of relay 2 is again completed. This relay pulls up and closes the circuit of magnet C_1.

It will be seen that under these conditions by the combination of the operation of relay 2 and of the opening of the contact of magnet C_1, the wipers of the connector Co_1 will advance step-by-step. The advancement of the wipers of connector Co_3 is effected in the same manner.

When one of the wipers *e* of the connectors arrives on the bank contact *e''*, the following circuit is completed (the circuit of magnet C_1 being open, the wipers of Co_1 remain in the position corresponding to *e''*): battery, magnet C_2 of the subscriber's line finder Che_1, bank contact *e''*, wiper *e* of Co_1, T24, spring 1 of C, and its work contact R41, R31 and earth.

Moreover, relay 5 is energized in the same circuit through its lower winding.

The operation of relay 2 and the closing and opening of the contact of magnet C_2, will close and open the energization circuit of the magnet which causes the step-by-step advance of the wipers and finders Che_1, in order to hunt for the calling subscriber's line.

When the wipers of Che_1 arrive on the bank contacts of the calling subscriber's line, the fol-

lowing circuit is completed: earth, button DA of the station P, contact C_2 of the switch-hook, button A normal, spring 1 of relay A and its rest contact, wire *m*, bank contact *m*, wiper *fm* of *Che*1, lower winding of stopping relay 3, T53, wiper *ft*, bank contact *t*, and battery through the lower winding of relay B.

The relays 3 and B are energized in series and the wipers of *Che*1 are stopped, the energizing circuit of magnet C_2 being opened at R31. The circuit of relay 5 is also open and it falls back a moment after the energization of the relays 3 and B.

At T31, relay 3 completes the circuit of the upper winding of relay 4, which pulls up and completes at T43 the holding circuit over the lower winding of relay 3.

The relay 2, the circuit of which is opened at R31, remains in the normal position. The relay B opens through its spring I and its work contact the circuit of relay C, which falls back and thus releases the other connectors.

When relay 5 falls back, relay B is maintained attracted by earth on T44.

The line conductors *a* and *b* of the calling station P_1 are connected to the windings of relay 1 through bank contacts *a* and *b*, the wipers *fa*, *fb* and T47 and T48. Relay 1 will be energized over the loop of the conductors *a* and *b*, closed at station P_1. The relay 1 closes through T12 a circuit for the lower winding of relay 4, and through T11, R63, T44, it closes the energizing circuit of relays V_1 and V_2.

The dial tone is sent to the calling subscriber through: R65, R71, condenser Cn_1, T47, wiper *fb* and bank contact *b*, whereupon the calling subscriber P_1 dials the desired subscriber's number.

Each time the loop is opened at the station P_1, relay I falls back and completes the following circuit for C_1 of the connector Co_1: earth, T44, R63, R11, T45, R52, magnet C_1 and battery.

When relay I is again energized, the circuit of C_1 is opened at T11, magnet C_1 releases its armature and the wipers of Co_1 advanced one step. The wipers will thus advance by a number of steps equal to the number of impulses transmitted by the dial of the subscriber P_1.

When P_1 has finished dialling, the ringing of the desired subscriber is effected by operating button A which causes the opening of the circuit of relay 3. The relay 3 falls back and completes the following circuit: earth, R31, T41, upper winding of relay 6, R61, wiper *t* of Co_1, bank contact of the desired subscriber's line, battery through the lower winding of relay B of the desired subscriber.

The relays 6 and B (of the desired station) are energized and the buzzer *r* of the called station is operated over the circuit: earth, buzzer r_0, contact C_1 of the switch-hook in the position when the receiver is hung up, spring 2 of relay A and its rest contact, wire *a*, bank contact of the connector Co_1, and wiper *a*, T65, R32, R22, T46 and battery through the winding of magnet C_1 (magnet C_1 cannot attract its armature when it is in series with the buzzer of a station).

The called subscriber hearing the buzzer, replies by removing his receiver. The circuit of relay 2 is completed over the called loop through T65, and T62, the wipers and bank contacts of the connector Co_1. The ringing circuit is opened at R22.

The calling and called subscribers are now connected, the called subscriber's receiver being fed through the winding of relay 2.

At the end of the conversation, when the subscribers hang up their receivers, relays 1 and 2 fall back, which causes the release of the connector and the other switches and relays.

Communications with main network lines

It will now be explained how a P. B. X subscriber may be connected with the outside network without the aid of the P. B. X operator, this facility being reserved for the so-called supplementary subscribers' stations. A supplementary station has battery connected to the winding of its control relay A.

The calling subscriber P_1 removes his receiver and the same operations take place, as in the previous case, until the sending of the dial tone to the subscriber P_1.

The P. B. X subscriber dials the number allocated to the outside network. This causes the controlled advance of the wipers of the connector Co_1, which are stopped on the bank contacts of an outside line.

The calling subscriber P_1 operates button A of his set. The stopping relay 3 returns to normal and completes the following circuit: earth, R31, T41, upper winding of relay 6, R61, wiper *t* of Co_1, bank contact *t'* of the outside line, wire A, R91, R101, winding of relay 8, R94, R95, wire D, rest contact 2 of relays F2 and F3, wire F, wire 12, R221, and battery through resistance R_3. The relays 8 and 6 are energized.

The calling subscriber releases button A. Relay 3 is reenergized and earth on R31 is replaced by that on T61. By its contact T84, relay 8 closes the circuit of relay 12: battery, lower winding of relay 12, T84, contact of magnet C_3 of the finder *Che*L, R101, R91, wire A, bank contact *t'* of Co_1, wiper *t*, T61 and earth.

Relay 12 is energized and completes through T121 the following circuit of magnet C_3 of *Che*L: battery, winding of C_3, T81, T121, R195, rest contact of thermostat TH, spring 4 of relay T and its rest contact R187, wire 20, the out-of-order key in normal position, and earth.

The magnet C_3 is energized, attracts its armature and opens its contact, which opens the circuit of relay 12, which falls back, thus opening the circuit of the magnet which releases its armature, causing the advance by one step by the wipers of *Che*L. The armature of C_3 having returned to normal, its contact is closed and the circuit of relay 12 is again completed, which causes a fresh energization of C_3 and a fresh advance of the wipers, and so on.

The wipers of *Che*L thus advance step-by-step, hunting for the calling subscriber's line. When the wipers arrive on the bank contacts corresponding to the calling line, the following circuit is completed: battery, winding of control relay A of the calling subscriber P_1, bank contact *t* and corresponding wiper, T83, lower winding of relay 10, wiper and bank contact *r*, wire *r*, bank contact *r* of finder *Che*1, wiper *fe*, T33, T64, wiper C of connector Co_1, bank contact C', spring 1 of relay F_1 and its work contact, and earth.

The relays A and 10 are energized in this circuit and are maintained in the following circuit: earth on the rest contact of the button DA of station P_1, contact C_r of the switch-hook of the station, rest contact of button A, spring 1 of relay A and its work contact, bank contact *r* and wiper of *Che*L, lower winding of relay 10, T83, wiper of *Che*L, and bank contact T, winding of A and battery.

Over the springs 2 and 3 of relay A and their work contact, the line conductors of the station P_1 are connected to the network of Fig. 2. The finder *Che*L of said equipment is stopped, its circuit being opened at R105.

Relay 17 is energized over its upper winding on the earth at T164. Through T171 relay 17 completes a holding circuit of relay A. Relay 11 is energized in series with relay 10 in the circuit: battery, winding of relay 11, upper winding of relay 10, T172, lower winding of relay 10, wiper of *Che*L, and bank contact *r*, spring *o* of relay A and its work contact, button A, closed contact *Cr* of the switch-hook, button DA and earth.

Relay 9 is energized through its lower winding and earth on T174. The relays 12 and 8 fall back, their circuit being opened when 9 pulls up. Through T92 relay 9 applies earth to the wire 11, which causes the lighting of the busy lamp at the operator's position.

When the relay 17 pulls up, the conductors of the subscriber's station P_1 are connected through T176 and T177 to conductors A and B of the outside line.

From that time the subscriber P_1 may ring the called outside subscriber, the outside line being looped through station P_1.

If the outside network is automatic, the subscriber P_1 after having received the dialling tone dials the desired number. If the outside network is manual, the subscriber P_1 indicates to the operator the number of the desired subscriber.

At the end of the conversation, when subscriber P_1 hangs up his receiver, relays 10 and 11 fall back, their holding circuit being opened in the contact *cr* of the switch-hook, relays 17 and 9 then fall back and the busy lamp of the P. B. X goes out.

When 17 falls back the loop of the outside line is opened at T176 and T177, and the network is released. Moreover, the retraction of the relay 17 causes the de-energization of control relay A.

If the outside network is manual, it is necessary to allow a certain amount of time to pass between the release of the line and the return to the subscriber's disposal of the equipment for direct connection to the network, so that the operator of the exchange can see the end signal and proceed with the disconnection. For this purpose when the previous circuit indicated by the relay 9 is opened at R174, said relay remains attracted through its upper winding on the circuit: battery, upper winding of relay 9, T96, R166', R152, R121, R125, contact of the thermostat TH, spring 4 of relay T and its rest contact.

The heating circuit of the thermostat is then completed through: battery, winding of thermostat TH, T96 and earth, through the previously traced circuit.

After a certain time of heating, the thermostat opens its contact which has the effect of opening the circuit of relay 9. Relay 9 falls back and through R91 connects the starting circuit to the equipment of Fig. 2.

In the case of an automatic outside network, the thermostat TH is eliminated. When P_1 hangs up again all the elements return to normal and station P_1 is again connected to the private automatic switch as soon as relay A falls back.

In the case of a manual outside network, the equipment for direct connection is completed by additional equipment for the transmission of different ringing or signalling currents.

Routing of a call coming from the outside network

When a call is sent from the outside exchange through the line A—B it is received on the following circuit: line conductor A, R192, winding of alternating current relay 16, R93, condenser *Cn*3, spring 7 of relay T and its rest contact, R194, line conductor A.

Relay 16 is energized and at T161 completes the circuit of relay 16' which pulls up and completes its holding circuit through: T162', R112, thermostat TH, spring 4 of relay T and its rest contact, R187, wire 20 and earth on the trouble key.

Through its contact 161' relay 16' closes over wire 15 the circuit of the ringing lamp of the P. B. X of Fig. 3 through pilot relay P. At T163' it closes the circuit of the lower winding of relay 9 which is energized, and at T91 switches the starting wire on the next finder.

The operator replies by depressing the network listening key. The following circuit is then completed: earth, spring 4 of relay R and its rest contact, switch-hook *Cm* of the operator's set, work contact of the listening key, wire 19, R185, winding of relay T, wire 24, lower winding of relay 23 and battery.

Relays T and 23 are energized. Relay T applies earth through T13 to wire 25, thus completing the circuit of the upper winding of relay 23 the windings of which, being in opposition, the relay falls back. Relay T remains attracted.

The P. B. X operator of Fig. 3 is, from that time, in communication with the calling subscriber of the outside network through circuit: operator's station PO, spring 7 of relay R and its rest contact, R263, R243, conductor 17, spring 9 of relay T and its work contact, R192, conductor A, outside exchange, conductor B, R194, spring 8 of relay T and its work contact, conductor 16, R242, R262, spring 8 of relay R and its rest contact, operator's set P.

When the outside subscriber indicates the P. B. X subscriber with whom he wishes to talk, the P. B. X operator depresses the additional station key corresponding to the desired subscriber.

The following circuit is completed: earth, spring 4 of the relay R and its rest contact, work contact of the switch-hook *Cm*, wire 28, work contact of the additional station key, R234, R281, R292, R301, wire 18, spring 10 of relay T and its work contact, R101, winding of 8, T94, resistance R11 and battery.

Moreover, the following circuit is also completed: battery, lower winding of holding relay 19, springs 11 and 10 of relay T and their work contact, wire 18, and earth through the previously traced circuit.

Relay 19 is energized and holds the outside line by looping it over the resistance R4 through T191. At R192 and R194 it disconnects the line from the P. B. X equipment.

Relay 8 is energized and closes at T84 the circuit of the lower winding of relay 12 at R101 and earth on wire 18. Relay 12 is energized and the following circuit of the rotary magnet C3 of finder *Che*L is completed: battery, winding of magnet C3, T81, T121, R105, contact of the thermostat TH, spring 4 of relay T and its work contact, wire 6, R292, R281, R234 and earth on wire 28 through the depressed additional station key.

The magnet C3 is energized, attracts its armature and by the play relay 12, as previously explained, causes the advance of the wipers of finder *Che*L. When the wipers of *Che*L arrive on the bank contacts corresponding to the desired

P. B. X station, the following circuit is completed if the station is free: earth on wire 28, closed contact of the additional station key, wire 1, bank contact S of *Che*L, and the corresponding wiper, spring 1 of relay T and its work contact, wire 2, relay 28 and battery.

Relay 28 is energized and completes the following circuit for relay 33: battery, relay 33, R321, R311, T281, R34 and earth on wire 29 through the depressed additional station key.

At T331 relay 33 closes the circuit of the free lamp indicating to the operator that the desired P. B. X subscriber is free. Through T332 it completes the following circuit: earth, T332, wire 9, spring 6 of relay T and its work contact, upper winding of relay 17 and battery.

Relay 17 is energized. Through T171 it completes the following circuit of the control relay A of the desired P. B. X station: earth, T171, wiper and bank contact T, control relay A and battery.

Relay A is energized and through its springs 2 and 3 connects station P_1 to the conductors of the direct connection equipment through the wipers of *Che*L.

Through T171, relay 17 completes the following circuit: earth, T173, spring 14 of relay T and its work contact, resistance R18, wire 24, lower winding of relay 23 and battery.

The circuit of the upper winding of relay 23 is closed when free earth exists on wire 25, while its lower winding finds earth only through resistance R19. The action of the upper winding is, therefore, effective and said relay attracts its armature.

Relay 33 falls back, its circuit being opened at R234. Relay 19 is held on the following circuit: earth, T235, spring 3 of relay R and its rest contact, depressed additional station key, wire 21, upper winding of relay 19 and battery.

Relay 29 is energized by earth on wire 28 through T234 and the depressed additional station key.

Relay 34 is energized in the circuit: battery winding of relay 34, wire 8, spring 5 of relay T and its work contact, T193, wire 21, depressed "listen-in to network" key, spring 3 of relay R, and its rest contact, T235 and earth.

The circuit of buzzer 20 of the desired station P_1 is completed: battery, resistance R6, T291, wire 17, spring 9 of relay T and its work contact, T176, wiper and bank contact *a* of *Che*L, spring 2 of relay A and its work contact, contact C_1 of the switch-hook in position with receiver hung up, buzzer 20 and earth.

Upon the reply of the subscriber P_1 the operator can get in conversation with him over the following circuit: PO of the operator's set, spring 7 of the relay R and its rest contact, R263, R243, wire 17, spring 9 of relay T and its work contact, T176, wiper and bank contact *a* of *Che*L, spring 2 of relay A and its work contact, station P_1, rest contact of the button R, spring 3 of relay A and its work contact, bank contact *b* and wiper of *Che*L, T186, T177, spring 8 of relay 7, and its work contact, wire 16, R242, R262, spring 8 of relay R and its rest contact, operator's set PO.

When the desired subscriber replies, the operator releases the additional station key, which causes the retraction of relay 29. The operator's set PO is then fed through the self-inductance 35 on the one hand, and on the other hand through T342 and R291.

The operator announces to the inside subscriber that she is going to connect him with an outside subscriber, and hangs up her set. The network listening returns to normal, which causes the retraction of the relays 19 and 34.

The connection between the additional station P_1 and the outside line AB is established through R192 and R194.

If the P. B. X station were already engaged in a network communication when the operator depressed the additional station key of this station, relay 28 would pull up and relay 32 would be energized in the circuit: battery, winding of relay 32, R333, T282, R232, wire 4, spring 3 of relay T and its work contact T83, lower winding of relay 10, wiper and bank *r* of *Che*$_1$, spring 1 of relay A and earth on button DA (normal). (The slow-acting relay 33 does not have time to be energized before relay 32.)

The busy network lamp of station P_1 lights up at the operator's position through the circuit: battery, busy network lamp, T331, R311, T281, R234, work contact of the depressed additional station key, and earth on wire 28.

The operator warns the outside calling subscriber and depresses the holding key corresponding to the calling network line. She recalls the additional station P_1 as soon as the busy network lamp is extinguished and completes the communication.

In the case in which the desired P. B. X subscriber is busy with another P. B. X subscriber, the relay 28 will be energized. Owing to the fact that the desired subscriber's line is busy on the private automatic switch, a free earth is applied to the wire *t*. Relay 31 is energized in the circuit: battery, winding of relay 31, R334, T283, R231, wire 3, spring 2 of relay T and its work contact, wiper and bank contact *t* of *Che*L, and earth on wire *t* in the private automatic switch (the slow-acting relay 33 does not have time to pull up before the energization of relay 71).

The local busy lamp of the operator's set lights up in the circuit: battery, lamp, T311, T281, R234, closed contact of the additional station key, and earth on wire 28.

The operator may now either interrupt the local connection and establish the network communication (office cut-off), or she may warn the network line and advise the P. B. X station of the waiting communication by cutting-in as a third party on the local connection (offer of communication).

If the operator wishes to cut the local connection, she depresses the office cut-off key, while maintaining the additional station key depressed.

Relay 33 is energized in the circuit: battery, winding of relay 33, R321, spring 6 of relay R and its rest contact, office cut-off key, T311, T281, R234 and earth. At R334 it opens the circuit of relay 31 which falls back.

The operator releases the office cut-off key; relay 33 is held in the circuit: R321, R311, T81, R234, closed contact of the additional station key, and earth on wire 28.

Through T332 relay 33 applies earth to wire 9 which, through spring 6 of relay T and its work contact, completes the circuit of the lower winding of relay 17. Relay 17 in pulling up completes the circuits which have just been described.

The P. B. X station P_1 is connected by the springs 2 and 3 of relay A and their work contact to the conductors of the equipment of Fig. 2. A busy signal is sent to the P. B. X subscriber with whom P_1 was in communication, and P_1 is connected to the outside subscriber when the operator hangs up her set.

If the operator wishes to warn the local subscriber that a communication intended for him is waiting on an outside line, she releases the additional station key and operates the key of one of the service lines, the key of the first service line, for example.

Relay 24 is energized through the key of the service line and on wire 28. The outside network line is held over T241 on the resistance R8, and the operator's set PO is connected to the private automatic switch through T242, T243.

The P. B. X operator hears the dialling tone and dials the desired subscriber's number.

The various operations in the private automatic switch take place in the same manner as in the case of connecting two P. B. X subscribers.

The relays 1, 2, 3, 4 and 5 are energized, but relay 6 remains at normal, the desired subscriber already being engaged in an inside communication.

The operator then depresses the third party listening key, and the following circuit is completed: earth on the wire 28, monitoring key depressed, T247, wire *e''*, bank and wiper *fe* of finder Che_1, T33, R64, winding of relay 7 and battery.

Relay 7 pulls up and through T71 and T72 connects the operator's set PO as a third party in the communication which is taking place through wipers of Co_1. The two P. B. X subscribers are warned that the operator is listening-in by the tone signal which they hear. The circuit of the vibrating relays V_1 and V_2 is closed through T44, R63 and T11.

The operator offers the outside communication to the desired subscriber. The P. B. X subscriber is connected with the outside line when the inside communication ends.

When a P. B. X subscriber is connected with the outside network he can recall the P. B. X operator by pressing button A, thus causing the temporary disconnection of the circuit of relay 10 which falls back and completes the following circuit of relay 13: battery, upper winding of relay 13, R104, R81, T121, R105, contact on thermostat TH, spring 4 of relay T and its rest contact, R187, wire 20, contact of the trouble key (normal), and earth.

Relay 13 pulls up; through T132 it applies earth to wire 5 which completes the lighting of the ringing lamp; through its contact 131 it closes its holding circuit.

The operator seeing the lighting of the ringing lamp depresses the network listening key corresponding to the lamp. Relays T and 23 are energized and the following circuit of relay 19 is completed: battery, upper winding of 19, wire 21, network listening key (depressed), spring 3 of relay R and its rest contact, T235 and earth.

Line AB is cut off from the equipment at R192 and R194 and the operator is connected with the P. B. X subscriber through springs 8 and 9 of relay T and their work contacts.

When the communication between the local subscriber and the operator is finished the subscriber is connected with the outside network when the operator hangs up her receiver.

The inside subscriber, after having been put in communication with the operator, can ask her to pass the outside communication on to another inside subscriber.

The operator then depresses the trunk holding key and completes the following holding circuit for the relay 17: earth on the wire 28, trunk holding key in depressed position, T236, wire 22, spring 12 of relay T, and its work contact T195, T103, lower winding of relay 17 and battery.

The P. B. X station which was in connection with the outside network hangs up and relays 10, 11, 12, 23 and 19 fall back.

The operator is then in communication with the outside line and can make a fresh connection with a P. B. X subscriber in the same manner as when routing a call from an outside line.

Double call

When a P. B. X subscriber is in communication with the outside network, he may hold the outside line, call another P. B. X subscriber, and then resume the communication with the outside subscriber.

In order to hold the line AB of the outside network and operate the private automatic switch, the subscriber presses button DA. Earth through resistance R1 is substituted for the free earth on the rest contact of this button. The intensity of the current in the circuit of relays 10 and 11 is reduced and its new value is such that relay 10 is maintained attracted, but relay 11 retracts. The following circuit is completed: battery, lower winding of relay 14, R151, R82, R111, T105, contact of thermostat TH, spring 4 of relay T and its rest contact, R187, wire 20 and earth on the contact of the trouble key.

Relay 14 is energized and completes the following circuit: battery, upper windings in series of relays 14 and 15, R156, T141, T174 and earth.

Relay 15 is energized in series with relay 14 and the two relays are maintained in the circuit: battery, upper windings in series of relays 14 and 15, T155, T141, T174 and earth.

Relay 19 is energized by its upper winding on earth at T154, holds the outside line through T191 on resistance R_4, and at R192 and R194 cuts off the outside line AB from the P. B. X equipment.

If the first double call line is free, relay 21 is energized on the circuit: earth, T157, R203, windings of relay 21 in series, wire *d''*, spring 3 of relay B'', and its rest contact, resistance R12 and battery.

If the first double call line is engaged the relay B'' pulls up and the relay 20 of the second double call line would be energized through the spring 4 of the relay B'' and its work contact.

Relay 21 closes its holding circuit through T211, on its lower winding. Relay C is energized in the circuit: battery, winding of relay C, upper non-inductive winding of relay B'', wire *m''*, T212, T158, T102 and earth.

The station P_1 is thus connected through the equipment of Fig. 1 over T217 and T218 and the double call line to the private automatic switch.

When relay C pulls up it starts the connector Co_1 and finder Che_1.

When the wipers of Che_1 arrive on the bank contacts of the first double call line relay B'' pulls up on its lower winding in series with the lower winding of relay 3 stopping the finder.

The subscriber P_1 then proceeds to dial the number of the desired local subscriber.

When the local conversation is finished and P_1 wishes to be connected again with the outside subscriber, he presses button DA.

The resistance R_1 is again placed in series in the holding circuit of relay 11 which falls back and completes the following circuit: common point of the lower windings of relays 14 and 15, T151, R82, R111, T105, contact of thermostat TH,

spring 1 of relay T and its rest contact, R187, wire 20 and the earth on the trouble key.

The winding of relay 14 being short-circuited, it falls back opening at R141 the holding circuit of 15 which falls back and opens at T154 the holding circuit of relay 19, and through T157 that of relay 21.

When the relay 19 falls back the local subscriber P_1 is again put in connection through R192 and R194 with line AB of the outside network.

When relay 21 retracts, the line network equipment of Fig. 2 is cut off from the private automatic switch which is thus released.

It will now be explained how it is possible for a P. B. X subscriber in communication with an outside line to transfer the connection to another P. B. X subscriber.

By means of a double call operation a P. B. X station is selected to which the outside connection will be transferred. The outside line is held and the P. B. X subscriber first called hangs up his receiver.

Relays 10 and 11 fall back and also relay 17, of which the holding circuit was completed through T104. Relay A of the first called P. B. X station falls back, its circuit being opened at R171.

Relays 14 and 15 remain energized on their lower windings through T214 and earth on wire *m''*. The relay 9 is maintained attracted on its lower winding by earth on T214.

The following circuit of relay 18 is completed: earth, T215, R175, winding of relay 18, T95, wire D, spring 2 of relays F_2 and F_3, and their rest contacts, wire F, wire 12, R221, resistance R3 and battery.

Through T183 relay applies earth through T216 to wire S''. Earth applied to T187 on wire 20 replaces that of T174 for the holding of relays 14 and 15.

The following circuit is completed: earth, T215, R175, winding of relay 18, T181, wire 14, winding of relay 30 and battery.

Relay 30 is energized in series with relay 18, and completes the following circuit of relays 8 and 22 which are energized in series: earth, winding of relay 22, T301, wire 18, T184, R101, winding of relay 8, T94, resistance R11 and battery.

Through T84 relay 8 completes the circuit of relay 12 which is energized completing the following circuit of magnet C3 of finder C*he*L: battery, winding of magnet C3, T81, T121, R105, R112, T188 and earth.

Magnet C3 by the play of its contact and of relay 12 causes the advance of the wipers of C*he*L.

When the wipers of C*he*L arrive on the contact bank of the P. B. X line to which the transfer is to be effected the following circuit is completed: battery, relay A of the desired P. B. X station, bank contact T and wiper of C*he*L, T83, lower winding of relay 10, wiper of C*he*L and bank contact *r*, wire *r*, bank contact *r* and wiper of the connector Co1, T42, wiper *fs* of Che_1, contact *s''*, wire *s''*, T216, T183 and earth.

Relays A and 10 are energized. Relay 17 is energized on earth applied at T104.

Upon the energization of relay A the second P. B. X station is connected by the springs 2 and 3 and their work contacts to the equipment of the network line, and consequently it is disconnected from the private automatic switch which returns to normal.

Relay 18 falls back, its circuit being opened at R175. Relays 14 and 15 fall back, their holding circuit being opened by the return to normal of spring 2 of relay B".

Relays 21 and 19 fall back, and the second P. B. X station is connected with waiting outside line.

At the end of the communication the release of the network equipment is effected as previously explained.

If for any reason the connection cannot be transferred either because the desired P. B. X station had not been warned or because he was busy, the following circuit is completed: earth, T154, T186, winding of thermostat TH' and battery.

The thermostat TH' is heated and at the end of a certain time closes its contact which completes the circuit of the upper winding of relay 13 through R133. Relay 13 completes its holding circuit on its lower winding through T131, R112, T188 and earth.

At R133 relay 13 opens the circuit of thermostat TH', which cools again and opens its contact; at T132 it applies earth to wire 5 which causes the lighting of the re-call lamp at the operator's position.

The operator being warned gets on to the outside line A-B and deals with the waiting connection as it seems to her best.

P. B. X subscribers may also answer directly outside calls without the intervention of the P. B. X operator who has depressed the night-return key.

A second position is provided on the connectors Co1 for outside lines which may be reached by any P. B. X subscriber dialling the number of this position.

As in the previous case when the operator's station is in use, the ringing current received causes the energization of relays 16, 16'.

At 161' relay 16' closes the circuit of the ringing lamp and of pilot relay P, which completes the circuit (not shown) of the ringing mechanism arranged at the P. B. X stations equipped for answering outside calls.

It will be assumed that the subscriber P_1 is answering the outside call by dialling the number corresponding to the special position of Co1 whose wipers will be moved to the contacts *t''*, *e''*.

The subscriber P_1 then presses his button A. The stopping relay 3 returns to normal and the following circuit is completed: earth, R31, T41, upper winding of relay 6, R61, wiper *t* of Co_1, bank contact *t''*, winding of relay N, wire A', wire 10, contact of the night-return key, resistance R20 and battery.

Relays 6 and N are energized. The subscriber P_1 releases button A. Relay 3 is energized again and earth on wiper *t* through R31 is replaced by that of T61.

When relay 16' pulls up it completes at T163' the circuit of the lower winding of relay 9 which is energized.

Relay N in pulling up completes through its spring 2 and its work contact the following circuit of relay 18: earth, spring 2 of relay N and its work contact, wire B', T165', R175, winding of relay 18, T95, wire D, spring 2 of relays F_2 and F_3 and their rest contact, wire F, wire 12, R221, resistance R3 and battery.

Relay 18 pulls up.

The following circuit of relays 30 and 18 is completed: battery, winding of relay 30, wire 14, T181,

winding of 18, R175, T165', B', spring 2 of relay N and its work contact.

Although relay 30 is shunted by resistance R3 it pulls up and completes the following circuit of relays 8 and 22: earth, winding of relay 22, T301, wire 18, T184, R101, winding of relay 8, T94, resistance R11 and battery.

Relays 8 and 22 pull up. Through T84 relay 8 closes the energizing circuit of the lower winding of relay 12. The energizing circuit of magnet C3 of *Che*L is completed through: battery, winding of magnet C3, T31, T121, R105, R112, T188 and earth.

By the play of relay 12 and the contact of magnet C3 the wipers of *Che*L advance step-by-step in search of the P. B. X line.

It will be noted that when relay N has pulled up earth was applied to the bank contact *r* of *Che*L corresponding to the line of the subscriber P_1 through the circuit: earth, closed contact of the key night-return, wire 7, T164', T182, wire C', spring 1 of relay N and its work contact, bank contact C'' of Co_1, wiper C, T64, T33, wiper *fe*, of Che_1, bank contact *r* of Che_1, wire *r*, bank contact of *r* of *Che*L.

When the wipers of *Che*L arrive in the position corresponding to the line of the subscriber P_1 the circuit of relays A and 10 is completed to the earth on the bank contact *r*.

Relay 10 pulling up stops the wipers of *Che*L. At T104 it completes the circuit of the upper winding of relay 17 which pulls up.

When relay A pulls up it transfers through its springs 2 and 3 the station P_1 of the private automatic switch to the equipment of the network line. Through its spring 1 and its work contact relay A through the button DA, switch-hook C*r*, button R and button A applies a fresh earth to the bank contact *r* in order to replace that applied through spring 1 of relay N which will be eliminated when the private automatic switch is released.

After the retraction of 8 of which the circuit has been opened at R101, relay A is maintained on earth at T171 and relays 11 and 10 in series on earth at the bank contact *r* through T172.

The P. B. X subscriber P_1 is in communication with the network line through T176—T177 and R192—R194.

At the end of the communication of release of the equipment of Fig. 2 is effected when the subscriber P_1 hangs up his receiver.

It is, of course, understood that the embodiments have been given by way of non-limiting examples, and it would in particular be possible to combine all or some of them with more complicated embodiments, to replace certain elements or groups of elements by others, giving the same results and without departing from the scope of the invention.

What is claimed is:

1. In a telephone system, a plurality of subscribers' lines, means including paired line finder and connector switches for interconnecting calling and called lines, each of said switches having brushes and stationary terminals cooperating therewith, means responsive to the initiation of a call to move the brushes of a connector, means operative thereupon for actuating the line finder paired with the operated connector to seize the calling line, and means at the seized calling line for controlling over the line finder the brushes of the connector to select the called line.

2. In a telephone system, a plurality of subscribers' lines, means including paired line finder and connector switches for interconnecting calling and called lines, each of said switches having brushes and stationary terminals cooperating therewith, means responsive upon the initiation of a call to move the brushes of a plurality of connectors, means operative upon the selection of a certain terminal in one of the connectors for actuating the line finder paired therewith to seize the calling line, means for releasing the other operated connectors, and means at the seized calling line for controlling over the line finder the paired connector to select the called line.

3. In a telephone system, a main exchange, a P. B. X, subscribers' lines terminating at said exchanges, trunks interconnecting said exchanges, paired line finder and connector switches in the P. B. X, means responsive to the initiation of a call on a P. B. X line for operating one of said connectors, means operative thereupon for actuating the line finder paired therewith to select the calling line and to connect it with the operated connector, means controlled by the calling subscriber for operating the last-mentioned connector to select the desired line, connections to said trunks selectable by said connectors, a special P. B. X switch in which each trunk terminates, P. B. X subscribers' lines connections selectable by the special switches, means controlled by a calling P. B. X station for operating the special switch in which the trunk terminates the selection of which it had controlled to connect the last-selected trunk with the calling P. B. X line, and means operative thereupon for releasing the operated finder and connector pair used in the selection of the trunk.

4. In a telephone system, a P. B. X, a main exchange, lines terminating at each exchange, trunks interconnecting said exchanges, an operator's position at said P. B. X, line finder and connector switches at the P. B. X, means controlled by a calling P. B. X subscriber for actuating a line finder and a connector to establish connections between calling and called P. B. X lines and between a calling P. B. X line and one of said trunks, a plurality of special finders in the P. B. X, each having wipers in which a trunk terminates and terminals connected to the lines of certain P. B. X stations, means controlled by the operator for actuating the special finder on whose trunk a call comes in from the main exchange for selecting a P. B. X station, and means controlled by the operator for actuating a line finder and a connector for connecting a trunk with a P. B. X station.

5. In a telephone system, a P. B. X, a main exchange, lines terminating at each exchange, trunks interconnecting said exchanges, an operator's position at said P. B. X, pairs of line finder and connector switches at the P. B. X, means controlled by a calling P. B. X subscriber and means controlled by the operator for actuating a pair of line finder and connector switches to establish connections between calling and called P. B. X lines and between a P. B. X line and one of said trunks, a plurality of special finders in the P. B. X, each having wipers in which a trunk terminates and terminals connected to the lines of certain stations, and means controlled by the operator for actuating the special finder on whose trunk a call comes in from the main exchange for selecting a P. B. X station.

6. In a telephone system, a main exchange, a P. B. X, lines terminating at said exchanges, trunks interconnecting said exchanges, line find-

er and connector switches in said P. B. X for establishing connections between P. B. X subscribers, a special finder in the P. B. X for each trunk, means for operating said special finder for connecting a trunk with a P. B. X station, means controlled by a P. B. X station connected with a trunk over the special finder for holding said trunk and for connecting it with one of said line finders, means for operating the last-mentioned line finder to select said trunk, and means operative thereupon under the control of a P. B. X subscriber for actuating the connector associated with the last-mentioned line finder to select a P. B. X station.

7. The system according to claim 6 and means

controlled by the last-mentioned P. B. X subscriber's station for actuating the special finder connected with said trunk to connect therewith.

FERNAND P. GOHOREL.

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