

Feb. 16, 1937.

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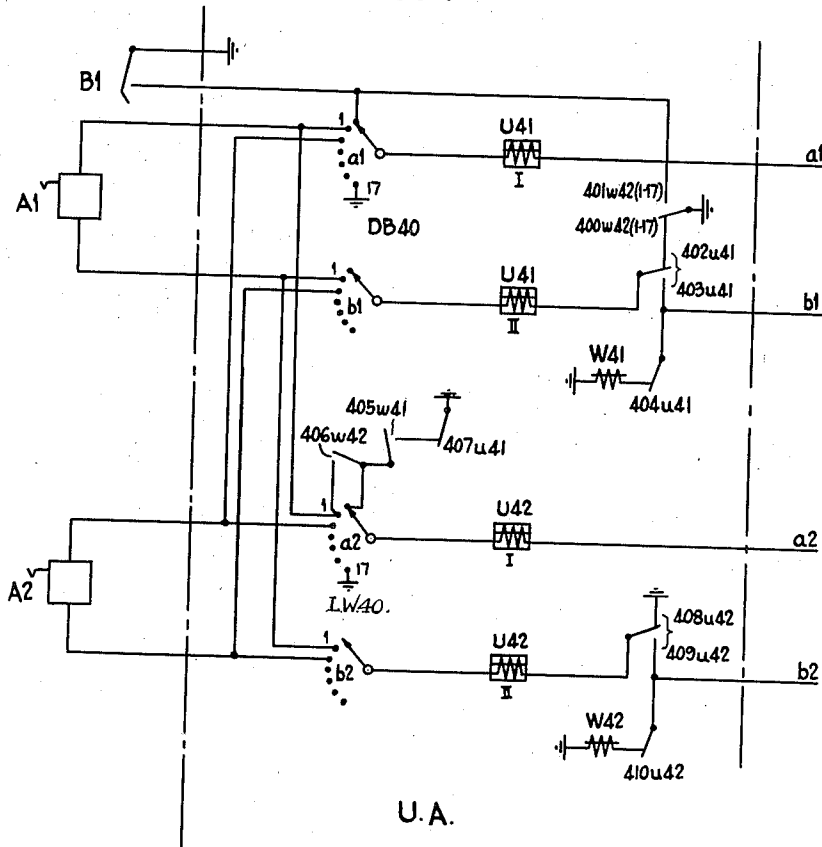
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TELEPHONE SYSTEM

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6 Sheets-Sheet 1

FIG. 1



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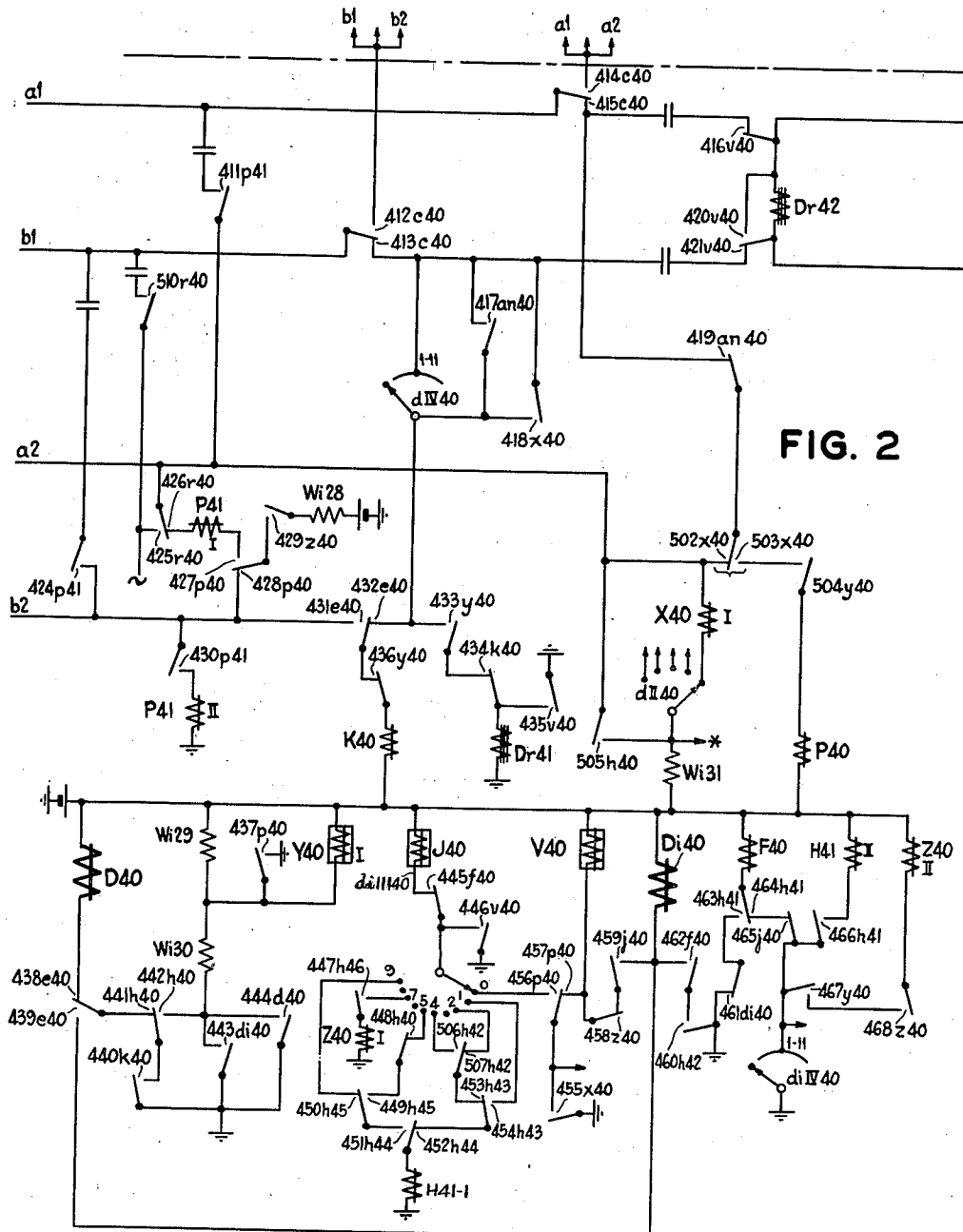


FIG. 2

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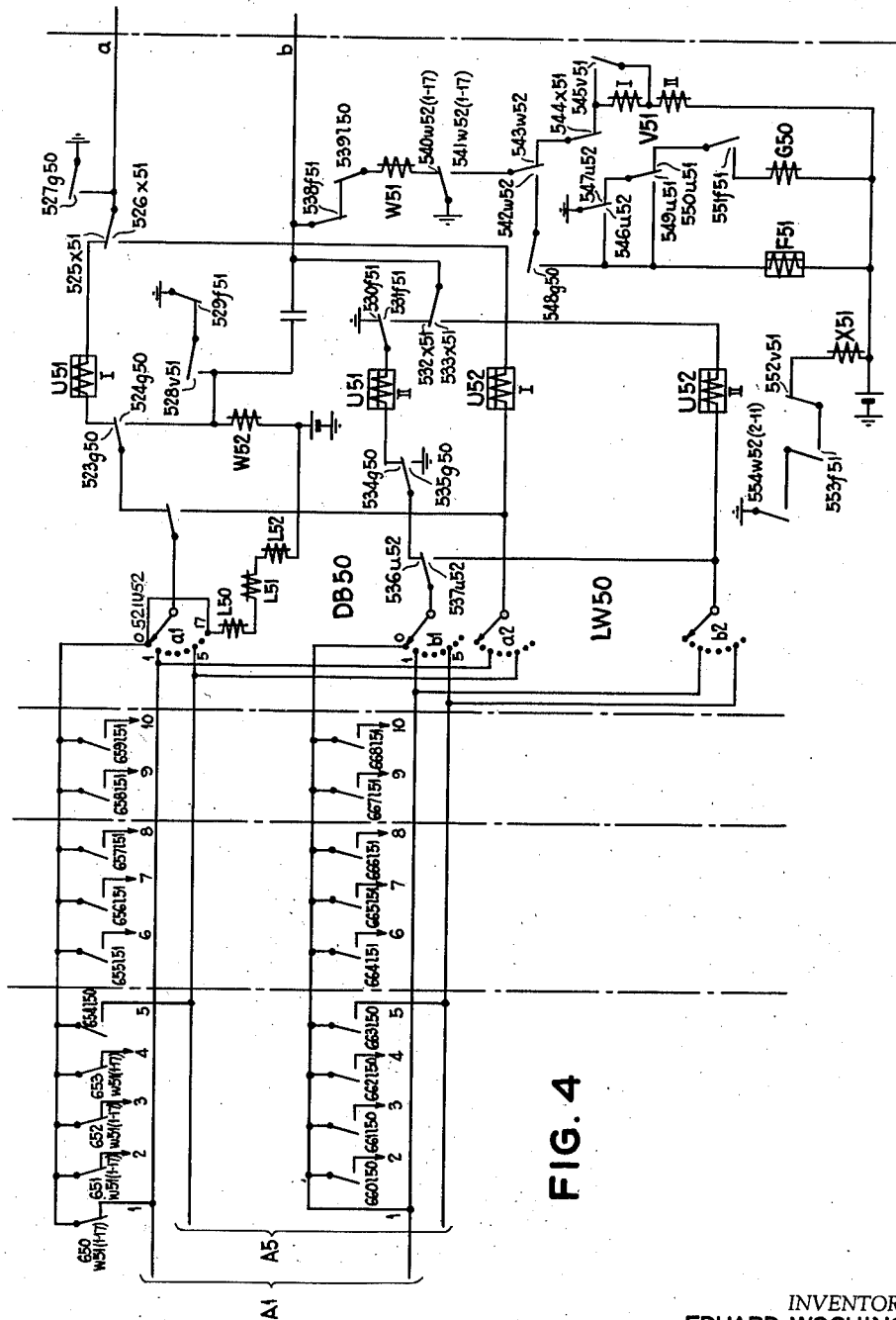
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6 Sheets-Sheet 4



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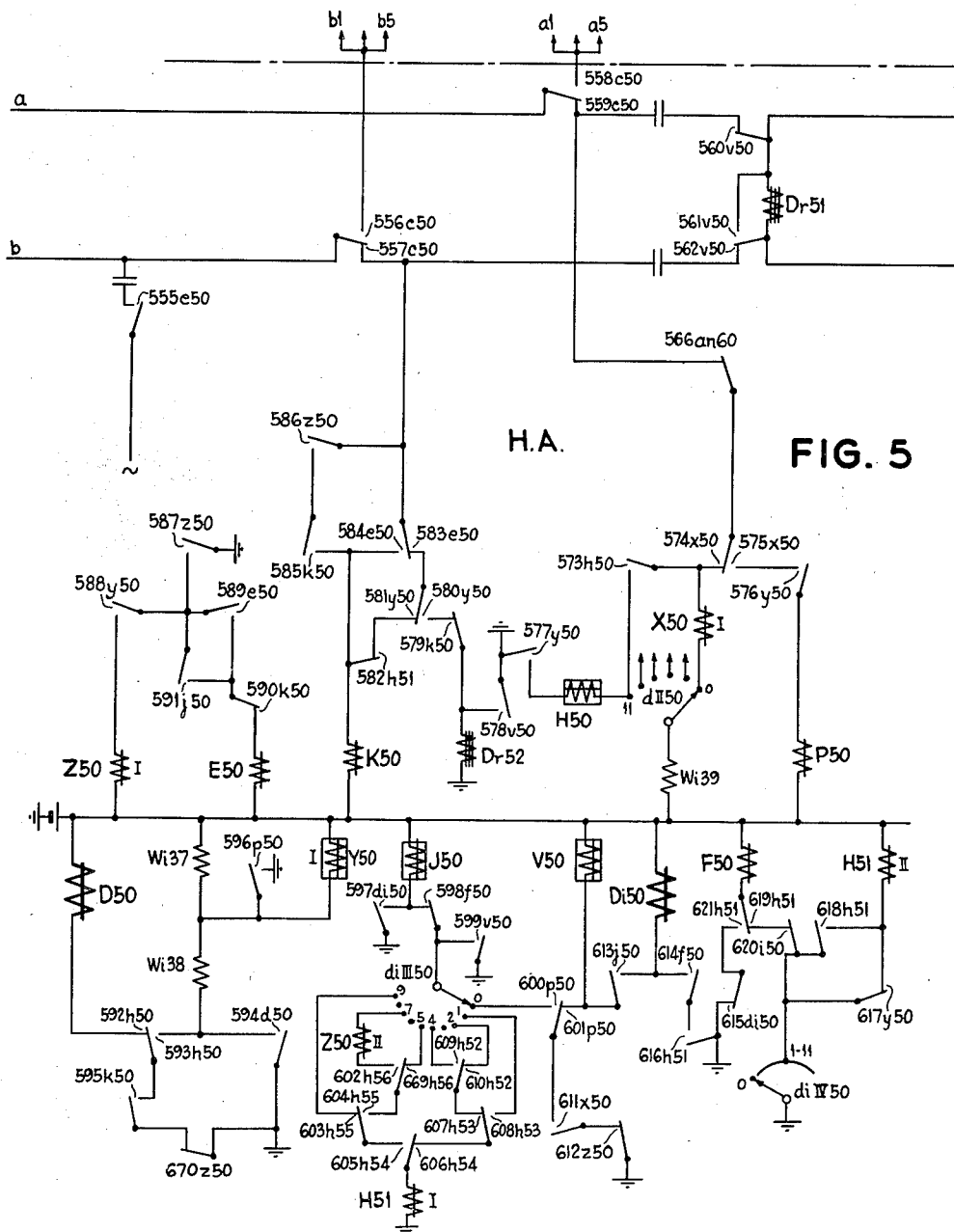
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TELEPHONE SYSTEM

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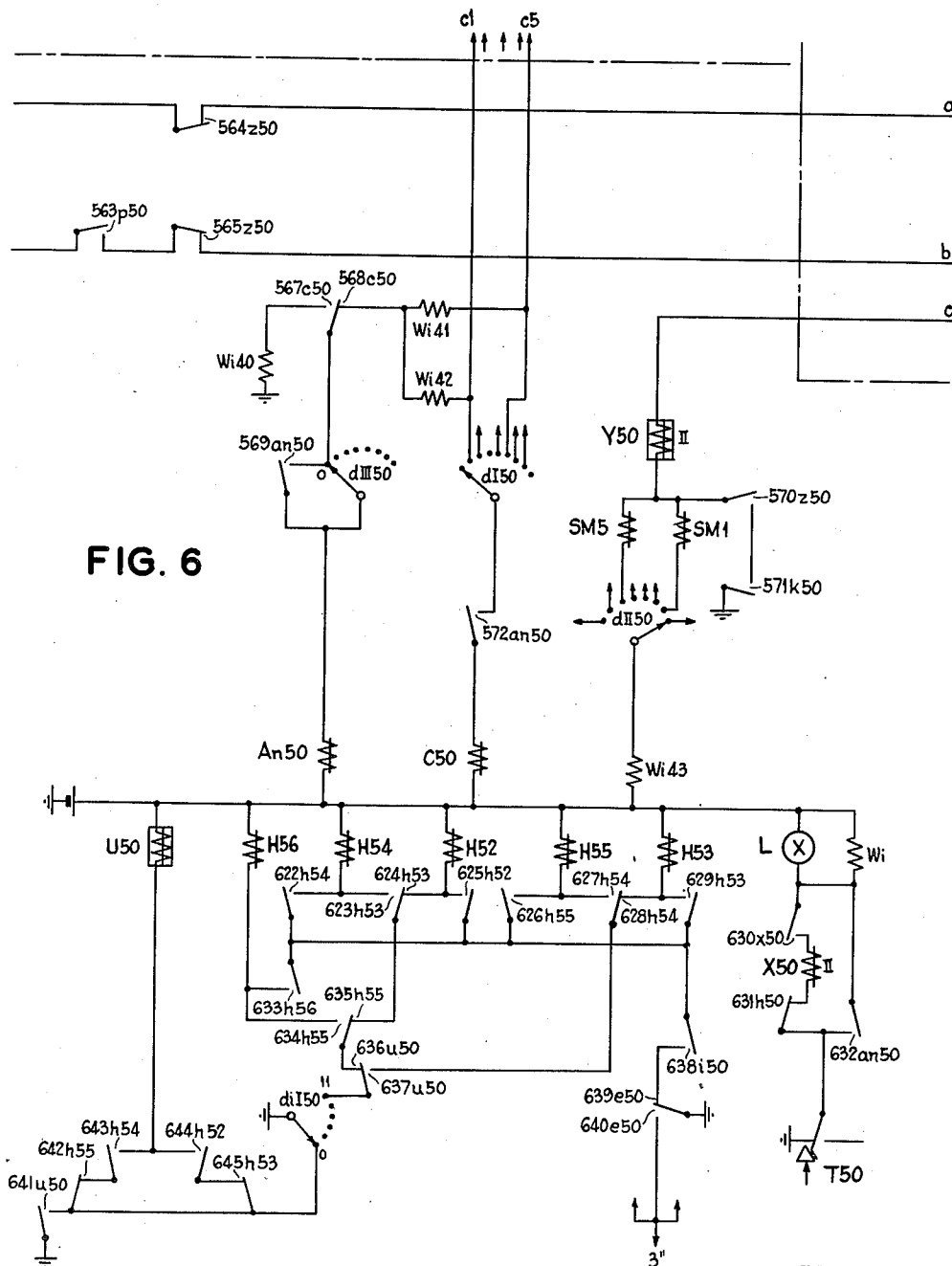
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TELEPHONE SYSTEM

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7 Claims. (Cl. 179—18)

The present invention relates to telephone systems with main and subsidiary exchanges and automatic operation. In these systems the determination of the call direction in which a desired call is to be set up frequently takes place after the transmission of a varying number of impulse trains. For example, the discrimination of the call direction may take place after only one impulse train if the call is directed to a zone whose connecting lines are led off from the first numerical impulse receiver at the main exchange. If on the other hand the call is to remain in one of the exchanges within the region governed by the main exchange the discrimination of the call direction may take place only after two, three or still more impulse trains.

The present invention aims at increasing the efficiency of these systems by making the devices for discriminating between call directions as simple as possible. This is achieved in that a selector, arranged in the main exchange, which determines the call direction after having received one or more impulse trains, is brought back automatically to the normal position after each of the impulse trains which do not complete the determination of the call direction, and is set again from the normal position by the next impulse train.

In Figs. 1, 2, and 3 a system with main and subsidiary exchanges is illustrated as an embodiment of the invention, while Figs. 4, 5, and 6 are a modification thereof. Fig. 1 shows the devices arranged in the subsidiary exchange U. A., and Figs. 2 and 3 show those in the main exchange H. A. The switching arrangements of the system enable the establishment of outgoing and incoming calls (exchange calls) and also of internal calls. In order to be able to set up these calls, in addition to the selector DB40 which serves as a call finder for outgoing calls and as a final selector for incoming calls, an auxiliary selector LW40 is provided in the subsidiary exchange which is used as a final selector on setting up internal calls. This selector is connected with the main exchange over a special connecting line and is there connected to the connecting line seized by the calling subscriber when an internal call is set up. The differentiation between outgoing calls (exchange calls) and internal calls results from dialling special characterizing numbers which so operate a characterizing switch in the main exchange that this switch is operated from the normal position by each impulse train.

Outgoing traffic

When the subscriber A1 removes his receiver and operates key BL, the following circuit is set up: earth, key B1, wiper a1 of selector DB40, winding I of relay U41, lead a1 of the connecting line contacts 415c40, 419an40, 502x40, wind-

ing I of relay X40, wiper dII40 in position 0, resistance W31, battery, earth. Relay X40 locks up over its contact 492x40. By closing contact 418x40 the following circuit is completed: earth, magnet W41, contact 404u41, lead b1, contacts 413c40, 418x40, 432c40, 436y40, relay K40, battery, earth. In this circuit the magnet W41 and relay K40 energize. The selector in the subsidiary exchange thus makes one switching step. By the closing of contact 440k40 magnet D40 (wipers dI40—dIV40) is also operated so that the selector in the subsidiary exchange and the switching device in the main exchange take one switching step synchronously. Relay Y40 is switched on over contact 444d40 of magnet D40 and interrupts at contact 436y40 the energizing circuit for magnet W41 passing over the b-lead. Moreover, relay K40 is also deenergized, so that by opening contact 440k40 magnet D40 is also deenergized. By the opening of contact 444d40 relay Y40 is deenergized and thus a new energizing circuit is set up for magnet W41 in the subsidiary exchange. Through the re-energizing of relay K40 magnet D40 is also now energized once more. Thus mutual interaction continues until the calling subscriber is reached through selector DB40 in the subsidiary exchange. Since in the present case the calling subscriber is connected to the first contact, both the switching devices are only advanced one step. By the energizing of relay Y40 which occurs after each switching step relay P40 is connected each time to lead a1, so that on reaching the calling subscriber the following circuit is set up: earth, battery, relay P40, contacts 504y40, 503x40, 419an40, 415c40, lead a1 of the connecting line, winding I of relay U41, wiper a1 of selector DB40 in position I, subscriber A1, wiper b1 of selector DB40 in position I, winding II of relay U41, contacts 402u41, 400w42 (I—II), earth. By closing its contacts 437p40 relay P40 holds relay Y40 energized so that no further influencing of the switching device can occur. In the testing circuit described above relay U41 also energizes in the subsidiary exchange and at contact 403u41 switches through the connecting line to the main exchange, while through opening contact 404u41 magnet W41 is disconnected. By the closing of contact 455p40 relay J40 is energized. By the closing of contact 422p40 the loop to the connecting devices in the main exchange is closed, thus causing a connecting device to be seized by a pre-selector as in the case of an individual subscriber's call. When the calling subscriber receives dialling tone he can begin to dial.

On operating the dial, relay P40 in the main exchange, which serves as a testing relay in setting selector DB40, is deenergized according to the impulses, whereupon the impulses are transmitted to the connecting devices of the main

exchange through contact 422p40. On the first de-energizing of relay P40 relay V40 is energized over contact 457p40 and holds up during the impulse train since it is a slow-acting relay. The choke coil Dr42 is short-circuited by the closing of contact 420v40 so that by the simultaneous disconnection of the condensers in the speaking leads by the opening of contacts 416v40 and 421v40 the impulse emission is maintained free from distortion. It should be noticed that throughout the emission of the impulses relay U41 in the subsidiary exchange and relay Y40 in the main exchange are kept energized.

Until it has been established that an outgoing call is proceeding, the characterizing switching device (wipers dII40—dIV40) operated by the magnet Di40 is set with the setting of the connecting devices in the main exchange, magnet D140, since during the impulse emission relay J40 is kept energized over contact 446v40, being operated over the following circuit: earth, battery, switching magnet Di40, contacts 459/40, 458z40, 457p40, 455x40, earth. If now, for example, the digit first dialled is different from the internal characterizing digit, relay V40 deenergizes and opens contact 446v40, thus deenergizing relay J40, so that now relay F40 is operated over wiper DiIV40 (earth, battery, relay F40, contacts 464h41, 465j40, wiper dIV40 (I—I), earth). Contact 445f40 prevents relay J40 being operated again when the next impulse train is transmitted, so that the characterizing switching device is brought to rest.

The further impulses are extended in a similar way from relay P40 through contact 422p40 to the connecting devices in the main exchange, but now the characterizing switch in the main exchange is no longer influenced. After setting the connecting devices the desired subscriber may be rung by any desired means, with which we are not concerned, and conversation thus established.

On terminating the conversation, a metering impulse is transmitted to the meter of the calling subscriber, which is connected up in the main exchange through wiper dII40 of the switching device in the main exchange which is moved synchronously with the selector DB40 in the subsidiary exchange when the latter is set. During the metering impulse occurring over the c-lead, the connection is maintained, even when the calling subscriber replaces his receiver, in that relay Y40 which is connected in the c-lead is maintained energized over its winding II during the metering. The circuit flowing over the c-lead is only broken after the metering has been completed. It may be broken in any desired way. Relay Y40 thus can deenergize and, after the receiver has been replaced at the calling station, which causes relay U41 to deenergize and hence inter alia contact 404u41 to be closed, the following circuit serving to advance selector DB40 in the subsidiary exchange is closed by the closing of contact 436y40: earth, magnet W41, contact 404u41, lead b1 of the connecting line, contact 413c40, wiper dIV40 in positions I—I, contacts 432e40, 436y40, relay K40, battery, earth. Selector DB40 in the subsidiary exchange makes one switching step and by the closing of contact 440k40 the magnet D40 in the main exchange is operated so that this switching device is also advanced by one step. As in the case of setting up the connection of the calling subscriber with the main exchange, the switching device in the main exchange controls the switching device in

the subsidiary exchange. Both advance to position II under the influence of relays K40 and Y40. In this position relay E40 is operated over wiper dIII40 and contact 475x40. By closing contact 431e40 relay K40 is connected to lead b2, it being disconnected from lead b1 by the opening of contact 432e40. By the opening of contact 438e40 the magnet D40 is disconnected from the automatic impulse circuit, and the magnet Di40 of the characterizing switching device is connected to the latter by the closing of contact 439e40. The magnet W42 of the auxiliary selector LW40 is now energized over lead b2, whereupon relay K40 is influenced simultaneously in the main exchange. The magnet Di40 thus receives an impulse over contact 440k40 so that by closing contact 443di40 relay Y40 is energized and the advancing circuit for the auxiliary selector LW40 in the subsidiary exchange is again opened at contact 438y40. By this interaction both switching devices are advanced synchronously to position II. In this position relay H40 is now energized over: earth, wiper dII40 in position II, contact 476y40, relay H40, battery, earth. By the opening of contact 493h40 winding II of relay X40 is disconnected, and by opening contact 441h40 the magnet Di40 of the characterizing switch is disconnected from the automatic impulse circuit. The magnet W42 in the subsidiary exchange is now operated alone, without the magnet Di40 in the main exchange being operated, through the reciprocal play of relays K40 and Y40, in a corresponding way, until the wiper a2 in the subsidiary exchange reaches position I7. In this position earth is connected to the a2 lead, so that the following circuit is set up: earth, wiper a2 of auxiliary selector LW40 in position I7, winding I of relay U42, lead a2 of the connecting line, contact 505h40, resistance Wi31, battery, earth. Relay U42 energizes and disconnects the magnet W42 at contact 410u42. This is associated with the deenergizing of relays K40 and Y40, so that by the opening of contact 476y40 relay H40 is deenergized. By the opening of contact 505h40 winding I of relay U42 is deenergized, and by the closing of contact 441h40 the magnet Di40 of the characterizing switch is again connected to the circuit which is influenced by contact 440k40. The magnet W42 connected over contact 410u42 is now operated, as is also the magnet Di40 by way of relay K40, so that both switching devices make one switching step and thus move together into the normal position. Through relay Y40, which is operated after the switching step over contact 443di40, relay H40 is again operated after the switching step has been taken over the circuit: earth, wiper dII40 in position 0, contacts 477e40, 513x40, 476y40, relay H40, battery, earth. The locking circuit is then completed over: earth, contacts 512h40, 476y40, relay H40, battery, earth. By the opening of contact 478h40 relay E40 is deenergized so that by contact 439e40 the magnet Di40 is disconnected and thus the connection of magnet D40 is prepared at contact 430e40. Then after the deenergizing of relay Y40 on account of the opening of contact 440k40 selector DB40 in the subsidiary exchange is advanced into position I7, in that magnet W41 is energized in series with relay K40 over: earth, magnet W41, contact 404u41, lead b1, contact 413c40, wiper dIV40, contacts 432e40, 436y40, relay K40, battery, earth. Relay K40 again operates relay Y40 over contact 440k40, so that by the opening of contact 436y40 both relay K40 and the magnet W41 are deenergized.

Through this interaction the selector DB40 is thus advanced to position 17. In this position earth is connected to lead *a1* over wiper *a1*, so that relay U41 energizes over this lead and by opening contact 404u41 deenergizes the magnet W41 and relay K40. On account of contact 440k40 being held open relay Y40 is deenergized and hence also relay H40 (contact 476y40). By the closing of contact 441h40 magnet D40 is connected to the automatic impulse circuit. Meanwhile relay U41 is again deenergized by the opening of contact 505h40 so that over the *b1* lead the selector DB40 in the subsidiary exchange takes the last switching step together with the switching device, which is operated by magnet D40. Since wiper dIV40 has now left the segment I—II, further advancement is prevented. Only now can a new seizure of the connecting line take place.

Incoming traffic

If a connection with a subscriber of the subsidiary exchange is desired from the main exchange, seizure of a connecting line leading to the subsidiary exchange by a final selector of the main exchange over the testing lead (*c1*, *c2*, etc.) corresponding to the desired subscriber is only possible when wiper dI40 is in the normal position. In this case the final selector tests, assuming that subscriber A1 is wanted, over the test lead *c1*, resistance Wi34, contact 478c40, relay An40, wiper dI40 in position 0, contact 474an40, resistance Wi35, battery, earth. Relay An40 energizes in this circuit and by closing contact 473an40 locks up independently of wiper dI40. By the opening of contact 419an40 battery is disconnected from the *a1* lead so that a seizure of the connecting line on the part of the subsidiary exchange is prevented. Relay K40 is connected to the *b1* lead of the connecting line at contact 471an40 and hence the following circuit is set up: earth, magnet W41 in the subsidiary exchange, contact 404u41, lead *b1*, contacts 413c40, 417an40, 432e40, 436y40, relay K40, battery, earth. Magnet W41 and relay K40 are energized in this circuit. By the interaction, as has already been described in the case of outgoing traffic, a synchronous advancement of the selector DB40 by magnet W41 in the subsidiary exchange, with the switching device in the main exchange by magnet D40 which is operated over contact 440k40, is effected. Both switching devices are advanced until relay C40, which is connected to wiper dI40 over contact 472an40, reaches the test lead *c1* seized by the final selector. In the case considered this happens after the first switching step. By the energizing of relay C40 a further operation of magnet W41 is prevented by the opening of contact 413c40, and hence also, since relay K40 cannot energize again, magnet D40 in the main exchange is prevented from being influenced. Leads *a1* and *b1* are switched over on to the speaking leads of the final selector by the closing of contacts 412c40 and 414c40. Relay An40 is locked up, by the closing of contact 469c40, over the following circuit: earth, resistance Wi32, contact 469c40, relay An40, contact 473an40, resistance Wi35, battery, earth. The ringing current for calling the desired subscriber may be transmitted from the final selector of the main exchange in any desired manner. When the desired subscriber replies relay U41 energizes over the leads *a1* and *b1* and the potential at the final selector, and switches the *b1* lead through over contact 403u41.

Ringing current is cut off in the known way. The desired subscriber is now connected to the final selector of the main exchange just as a normal individual subscriber.

When the conversation has finished, the *c1* lead is cut off from the final selector in any desired way, so that relay C40 deenergizes. By opening contact 469c40 relay An40 is also deenergized. In the subsidiary exchange relay U41 is deenergized so that the magnet W41 is again connected to *b1* lead of the connecting line over contact 404u41. The return of the switching devices to the normal position now takes place in the same way as has been described in the case of the release of outgoing traffic.

Internal calls

The seizure of the connecting line leading to the main exchange by the calling subscriber A1 is accomplished in the same way as has been described for outgoing traffic. In order to reach a subscriber attached to the same subsidiary exchange the subscriber A1 must dial the complete normal number of this subscriber. In the present example the number 2419572 is chosen as the number of the desired subscriber A2. As mentioned above, after connecting the calling subscriber A1 to the connecting line by the energized relay P40; relay J40 is energized over contact 456p40, wiper dIII40 in position 0 and contact 455x40; and holds up during the individual impulses over contact 446v40 of relay V40 which is energized during the impulses.

Subscriber A1 thus first sends out two impulses, and hence by the operation of the corresponding contacts of relay P40, which previously operated as testing relay, magnet Di40 (impulse contact 457p40) is energized twice and accordingly advances the corresponding switching device by two switching steps whilst the seized connecting device of the main exchange likewise receives two impulses through contact 422p40. When relay V40 deenergizes at the end of the impulse train, relay J40 holds up over: earth, battery, relay J40, contact 445f40, wiper dIII40 in position 2, contacts 507h42, 453h43, 452h44, winding I of relay H41, earth. In this circuit relay H41 energizes and operates relay F40 over contact 463h41, and also locks up over its winding II by closing contact 466h41. By the closing of contact 462f40, magnet Di40 receives an impulse, so that the characterizing switch takes one switching step. Hereupon magnet Di40 opens its contact 461di40 so that relay F40 deenergizes. After the switching step has been taken and magnet Di40 is again deenergized by the opening of contact 462f40 so that contact 461di40 is again closed, relay F40 is again operated and causes the characterizing switch to be advanced again. This stepping is continued until the characterizing switch has reached the zero position, since in this case wiper dIIV40 has left the contact segment I—II and hence relay H41 is deenergized. Relay F40 is prevented from energizing by the opening of contact 463h41. In the zero position of the characterizing switch relay J40 again energizes over wiper dIII40. This operation just described occurs during the pause between two impulse trains. It may also be mentioned that in position II of wiper dIII40, during the advancement of the characterizing switch, relay H42 is operated and locks up over contacts 484h42, 489p41, and 490y40. Thus after the return of wiper dII40 to position 0, relay U40 is operated over contact 500h42, and is held in a

locking circuit independently of wiper *dII40* by closing contact *497u40*.

By dialling the second digit 4 the characterizing switch is brought to position 4. After the opening of contact *446v40* relay *J40* holds up over: earth, battery, relay *J40*, contact *445/40*, wiper *dII40* in position 4, contacts *506h42*, *453h42*, *452h44*, winding I of relay *H41*, earth. Relay *H41* energizes in this circuit, locks up over contact *466h41* and, as has been described above, causes the operation of the magnet *Di40* of the characterizing switch. This is then brought to the normal position by the alternate operation of relay *F40*. When wiper *dII40* again comes to position 11, relay *H43* is operated over: earth, battery, relay *H43*, contacts *487h44*, *514u40*, wiper *dII40* in position 11, earth. By the closing of contact *488h43* relay *H43* locks up. Relay *U40* is deenergized by the opening of contact *501h43*. When the calling subscriber dials the third digit which consists of one impulse, the characterizing switch stands on the first contact after the train has passed. The following circuit is set up: earth, battery, relay *J40*, contact *445/40*, wiper *dII40* in position 1, contacts *454h43*, *452h44*, winding I of relay *H41*, earth. By the energizing of relay *H41* relay *F40* is again operated and brings the characterizing switch into the zero position again. During this motion, when wiper *dII40* is in position 11, relay *H44* is operated over: earth, battery, relay *H44*, contacts *482h43*, *511h45*, *508u40*, wiper *dII40* in position 11, earth. By closing contact *H44* relay *H44* completes a locking circuit for itself independent of wiper *dII40*. In position 0 relay *U40* is again operated over contacts *499h44*, *498h45* and wiper *dII40* in position 0 and locks up over contact *497u40*.

In a similar manner, through the fourth impulse train (9 impulses), after relay *H41* has been operated on the 9th step, relay *H45* is energized on the advancement of the characterizing switch into the normal position, by relay *F40* in position 11, the circuit being: earth, battery, relay *H45*, contacts *486h44*, *507u40*, wiper *dII40* in position 11, earth. By the opening of contact *498h45* relay *U40* is deenergized. The characterizing switch has again reached position 0.

After the fifth digit has been dialled, which consists of five impulses, the characterizing switch stands on the fifth contact, so that after relay *H41* has energized in this switch position, relay *F40* is again energized and the characterizing switch is returned to the zero position. During this motion relay *H46* is energized over wiper *dII40* in the following circuit: earth, wiper *dII40* in position 11, contacts *508u40*, *509h45*, relay *H46*, battery, earth. By closing contact *490h46* this relay locks up. Meanwhile the characterizing switch reaches the zero position. After the dialling of the sixth digit which consists of seven impulses and hence moves the characterizing switch round seven steps so that its wiper reaches position seven, relay *Z40* is operated over: earth, battery, relay *J40*, contact *445/40*, wiper *dII40* in position 7, contact *447h46*, winding I of relay *Z40*, earth. By closing contact *468z40* relay *Z40* locks up over its winding II. By the opening of contact *458z40* further influencing of the characterizing switch by numerical impulses is prevented. Moreover it cannot be brought back to the normal position since relay *H41* is not operated.

When the calling subscriber dials the last digit, in the present case the digit 2, since contact

429z40 is now closed this is transmitted with the help of contact *428p40* to magnet *W42* over lead *b2* and thus the auxiliary selector *LW40* in the subsidiary exchange is set on the contact of the desired subscriber. The transmission of this impulse train to the connecting devices in the main exchange is prevented in that contact *423z40* has opened the impulse circuit and moreover has thereby released the connecting devices in the main exchange. Relay *R40* is brought under the influence of a switching device over contacts *496z40* and *495i40* every three seconds, and is thereby energized, so that every three seconds ringing current is transmitted to the desired subscriber over lead *a2* by the closing of contact *425r40*. The calling subscriber receives a portion of this ringing current over contact *510r40* as an indication that the line is free.

When the called subscriber replies, relay *P41* energizes in the ringing pause over: earth, battery, resistance *Wz29*, contacts *429z40*, *427p40*, winding I of relay *P41*, contact *426r40*, lead *a2* of the connecting line, winding I of relay *U42*, wiper *a2* of the auxiliary selector *LW40* in position 2, subscriber *A2*, wiper *b2* of the auxiliary selector in position 2, winding II of relay *U42*, contact *408u42*, earth. Through relay *P41* relays *H42* to *H46* are deenergized on account of the opening of contact *489p41*, so that by the opening of contact *447h46* relay *J40* is also deenergized. Accordingly relay *R40* cannot be further energized over contact *495i40*, so that the transmission of ringing current is interrupted. In the circuit closed when the desired subscriber replies relay *U42* energizes as well as relay *P41* and by closing contact *409u42* switches lead *b2* through to the main exchange. Both subscribers are connected together over contacts *411p41* and *424p41*, and current is fed from the main exchange. For the calling subscriber the current passes over relay *P40* and the choke coil *Dr41*, and for the called subscriber over windings I and II of relay *P41*.

The internal call is metered in that the meter *SM1* connected over wiper *dII40* corresponding to the movement of the switching device *DB40* in the subsidiary exchange is energized over contacts *471z40*, *491j40* and *490y40* on the reply of the desired subscriber.

When, after ending the conversation, the calling subscriber replaces his receiver, relay *P40* which is influenced over the subscriber's loop deenergizes. Thereupon relays *Y40* and *Z40* and also relay *P41* are deenergized. Relays *U41* and *U42* also deenergize. By the closing of contacts *436v40* and *404u41* the operating circuit for the magnet *W41* in the subsidiary exchange and for relay *K40* in the main exchange is closed, and thus the switching devices are released in a similar manner to that already described for the case of outgoing calls.

Had the desired subscriber not replied, relay *Y40* and then relay *Z40* would have deenergized when the calling subscriber replaced his receiver before contact *491j40* had been closed by the deenergization of relay *J40*, so that in this no metering would have taken place.

Special circuits

If the selector *DB40* in the subsidiary exchange is displaced from the normal position by hand, earth is connected to the *a2* lead over contact *495w41* and wiper *a2* of the auxiliary selector *LW40* in position 0, and hence relay *K40* is ener-

gized in the main exchange, so that, as in the case of a subscriber's call, an operating circuit is completed over contact 418x40 for magnet W41 in the subsidiary exchange and for relay K40 in the main exchange. The selector DB40 in the subsidiary exchange is prevented from being released, by magnet W41 being held energized in this circuit, until relay K40 also influences magnet D40 in the normal way and so also advances this switching device by one step. Relay Y40 is then again cut off from the operating circuit as in the case of setting up an outgoing call, so that the selector in the subsidiary exchange and the switching device in the main exchange are then advanced synchronously to position 11. In this position, as in the release motion for outgoing traffic, the magnet W42 is operated and brings selector LW40 to the zero position with the characterizing switch D40, whereupon selector DB40 is advanced to position 17 independently and then moves to the zero position together with the switching device controlled by magnet D40.

If the auxiliary selector LW40 is displaced from the zero position by hand, earth is connected over contact 401w42 (1-17) to the zero position of wiper a1 of selector DB40, so that in this case, as in the case of a subscriber's call, relay X40 is influenced in the main exchange. In this case also both switching devices rotate in the same way as has been described for the case of release. In order to prevent a subscriber, on removing his receiver, from causing the seizure of the connecting line, which in the case of dialling an internal call must result in a wrong selection since the auxiliary switch LW40 is displaced, earth is cut off from contact 402w41 by contact 400w42 (1-17), so that the testing relay P40 in the main exchange cannot test on the subscriber's contact.

If both switching devices in the subsidiary exchange are displaced from the normal position by hand, earth is again connected to the a2 lead so as to energize relay X40, over contact 407w41, since obviously relay X40 must be energized for every release of the switching devices in the subsidiary exchange because otherwise no control of those can take place over the main exchange. In this case also the earth is disconnected through contact 400w42 (1-17).

Thus as soon as the synchronism between the switching devices in the subsidiary exchange and the switching devices in the main exchange is destroyed, setting on a calling subscriber is no longer possible.

If the switching device in the main exchange operated by magnet D40 is displaced from the normal position by hand the operating circuit for magnet W41 and relay K40 over lead b1 of the connecting line is completed over wiper d1V40 in positions 1-11, so that the switching devices return to the zero position as described above. Seizure of the connecting line by a subscriber who removes his receiver at this moment cannot occur because relay K40 is not energized and accordingly the testing relay P40 is not connected to lead a1 of the connecting line.

If on the other hand the characterizing switch is displaced from the zero position by hand, relay K40 energizes over wiper d1V40 positions 1-11, and connects a negative potential to lead b2 of the connecting line through contact 431e40 and relay K40, whereby magnet W42 is energized as well as relay K40. Both switching devices are then brought to the zero position synchronously,

as described above. Since relay E40 is energized during this motion, even if relay X40 is energized due to a new call occurring during this motion, the selector DB40 in the subsidiary exchange can only be set after the return to the normal position, since for the moment contact 432e40 is still open.

In the main exchange each seizure of the connecting line can be indicated by the lighting of the seizing lamp L. They can also be recorded by a special device. If it is desired to record incoming and outgoing seizures separately the contacts 492x40 and 494an40 can each be connected separately to a recording device.

In Figs. 4, 5, and 6 a system with a main and subsidiary exchange is illustrated as a further embodiment of the invention, in which a battery of low potential (12 volts) is provided in the subsidiary exchange (Fig. 4) which is charged by the battery at the main exchange over a lead of the connecting line leading to the main exchange (Fig. 5). In the charging circuit a relay L50 is included which is energized in the normal condition, and if necessary further relays (L51, L52) in case the contacts to be provided for each subscriber cannot be accommodated on one relay. These relays connect all the subscribers of the subsidiary exchange to the calling circuit, over their working contacts, and on the deenergizing occurring when a subscriber calls, cause such a switching over of the calling circuit that the individual subscriber can be tested. In order to have to provide as few relays of this sort as possible, contacts operated mechanically by selector DB50 of the subsidiary exchange, for example 650w51 (1-17) are used for the same purpose, which are opened on the first switching movement of selector DB50 and remain open until position 17.

The subscribers are connected to the line leading to the main exchange by selector DB50, which for outgoing and incoming calls is controlled by a switching device (wipers d150-d1V50) in the main exchange. It thus operates as a double purpose selector. For establishing internal calls a branch line is connected in the subsidiary exchange to the connecting line leading to the main exchange. With this a subsidiary selector LW50 is associated which only serves as a final selector on setting up internal calls. Its setting for internal calls takes place directly through the dialling of the calling subscriber, in local circuits of the subsidiary exchange.

The differentiation between outgoing exchange calls and internal calls is effected by a characterizing switch (wipers d150-d1V50) which is set by the various impulse trains, until the desired direction is characterized, in such a manner that it returns to normal position after each impulse train to be set again by the next impulse train.

In the normal condition of the system all the switching devices in the main exchange and in the subsidiary exchange are in the zero position, so that the following circuit is completed over the a lead of the connecting line: earth, battery (48 volts), resistance W39, wiper d1I50 in position 0, winding I of relay X50, contacts 574x50, 566an50, 559e50, lead a of the connecting line, contact 525x51, winding I of relay U51, contacts 523g50, 521u52, wiper a1 of selector DB50 in position 0, relays L50, L51, L52, battery (12 volts) earth. In this circuit which forms the charging circuit for the battery of the subsidiary exchange, relays L50, L51 and L52 are

energized. The number of L-relays is adjusted to the number of the subscribers. Relay X50 in the main exchange is not energized in the charging circuit.

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Outgoing traffic

When a subscriber of the subsidiary exchange, for example A1, removes his receiver, the following circuit is set up: earth, contact 530/51, winding II of relay U51, contacts 534g50, 536u52, wiper b1 of selector DB50 in position 0, subscriber's line, contact 650w51 (1-17), wiper a1 of selector DB50 in position 0, contacts 521u52, 523g50, winding I of relay U51, contact 525x51, lead a of the connecting line, contacts 559c50, 566an50, 574x50, winding I of relay X50, wiper dII50 in position 0, resistance W39, battery, earth. Besides a transitory energizing of relay U51 relay X50 energizes in this circuit. By closing contact 630x50 relay X50 locks up over its winding II. By opening contact 574x50 winding I of relay X50 is disconnected from the a lead, and the testing circuit for relay P50 is prepared by the closing of contact 575x50.

The L-relays (L50, L51, L52) in the subsidiary exchange deenergized. By the closing of contact 539/50 the magnet W51 of selector DB50 in the subsidiary exchange is connected by the b-lead of the connecting line. The following circuit is now set up: earth, contact 540w52 (1-17), magnet W51, contacts 539/50, 538/51, b lead of the connecting line, contacts 557c50, 583e50, 581y50, 582h51, relay K50, battery, earth. In this circuit magnet W51 and relay K50 are energized. The selector DB50 in the subsidiary exchange is advanced one step, as is also the switching device in the main exchange since the magnet D50 of the latter is energized over contacts 592h50, 595k50 and 670z50. Contact 594d50 is closed by the influence of magnet D50 and relay Y50 is thus energized over resistance W38. By opening its contact 581y50 this relay breaks the circuit passing over the b-lead. Magnet W51 in the subsidiary exchange and relay K50 in the main exchange are accordingly deenergized. By the opening of contact 595k50 magnet D50 is deenergized, which results in the deenergizing of relay Y50 by the opening of contact 594d50. This alternation which serves to advance the selector in the subsidiary exchange synchronously with the switching device in the main exchange proceeds until the calling subscriber is reached. In the present case both switching devices are only advanced one step since it is subscriber A1 who is calling. After this step has been executed the testing relay P50, is connected to the a-lead of the connecting line, this occurring after every switching step. Since the switching device DB50 is standing on the calling subscriber's line the following circuit is set up: earth, battery, relay P50, contacts 576y50, 575x50, 566an50, 559c50, lead a of the connecting line, contact 525x51, winding I of relay U51, contacts 523g50, 521u52, wiper a1 of selector DB50 in position 1, subscriber A1, wiper b1 in position 1, contacts 536u52, 534g50, winding II of relay U51, contact 530/51, earth. Relay P50 energizes in this circuit. Over contact 596p50 it maintains winding I of relay Y50 energized, so that since contact 581y50 is kept open further advancement of the switching device is prevented. By the closing of contact 580y50 earth is connected to lead b over the choke coil Dr52. In the testing circuit described above relay U51 is also influenced in the subsid-

iary exchange so that relay F51 is energized through contact 549u51, and by closing contact 531/51 in the subsidiary exchange switches through lead b to the main exchange. By the opening of contact 538/51 magnet W51 is cut off from the b lead. The testing relay P50 and relay U51 hold up in the feeding circuit of the calling subscriber. By contact 563p50 the loop is completed in the main exchange for the operation of a preselecting device for the purpose of seizing a free connecting device. When a free connecting device is reached in the main exchange, the subscriber receives dial tone in the known way and can commence dialling.

On operating the dial the feeding circuit is interrupted intermittently so that relay P50, which was previously used for testing, is deenergized in the main exchange according to the impulses, and transmits the impulses to the connecting devices of the main exchange by its contact 563p50. Furthermore in the first release of relay P50 relay V50 is operated over contact 601p50 so as to effect a clean transmission of the impulses by short circuiting the choke coil Dr51 (contact 561v50) and disconnecting the condensers by contacts 560v50 and 562v50. Relay U51 which is in the feeding circuit remains energized during the emission of the impulses.

Until it has been established that an outgoing call (exchange call) is occurring the characterizing switch is advanced in accordance with the dialling, for on the energizing of relay P50 relay J50 has been operated over contact 600p50 (earth, battery, relay J50, contact 598/50, wiper dIII50 in position 0, contacts 600p50, 611x50, 512z50, earth), so that on the first release of relay P50 magnet D50 is operated over contacts 612z50, 611x50, 601p50 and 613/50. After the impulse emission relay V50 deenergizes. If two impulses have been sent out, the characterizing switch will be standing on the second contact which corresponds to internal calls, and in this case relay J50 continues energized over winding I of relay H51, the circuit being: earth, battery, relay J50, contact 598/50 wiper dIII50 in position 2, contacts 610h52, 607h53, 606h54, winding I of relay H51, earth. By the closing of contact 621h51 relay F50 is operated, thus operating the magnet D50 over contacts 614/50 and 616h51 which is deenergized again after the deenergizing of relay F50 on the opening of contact 615d50. After the closing of contact 615d50 relay F50 again energizes, so that after closing contact 614/50 magnet D50 is also again influenced. Through this interaction the characterizing switch is brought into the rest position. The interaction is repeated after each impulse train until the digit sent out is different from the internal characterizing digit, this occurring at the latest at the sixth digit. If for example, the distinguishing digit is an 8, no matter in which impulse train out of the six impulse trains dialled it occurs the relay J50 can no longer hold up after the characterizing switch has reached contact 2 with its wiper dIII50, so that the characterizing switch stays in this position. The connection is then extended over connecting devices in the main exchange. The desired subscriber is rung by devices in the main exchange with which we are not concerned. When he replies relay Y50 is maintained energized in series with the meter SM1 corresponding to the calling subscriber, which is connected through the switching device of the main exchange, until the metering tak-

ing place over the *c* lead on the termination of the call is completed. Relay Y50 which is held energized during the metering prevents a premature release in the event of subscriber A replacing his receiver during the metering.

When the calling subscriber replaces his receiver, since the feeding circuit over leads *a* and *b* is interrupted, relay P50 in the main exchange and relay U51 in the subsidiary exchange deenergize. The latter relay by opening contact 549z51 disconnects relay F51. The transitory energizing of relay G50 which then occurs is of no significance. When the metering is completed, relay Y50, which has held energized over the *c*-lead, deenergizes so that relay H51 is operated over contact 617y50. This relay by means of contact 582h51 keeps the operating circuit for magnet W51 in the subsidiary exchange and for relay K50 in the main exchange broken until the characterizing switch has reached the zero position corresponding to the motion described above under the control of relay F50 which was energized over contact 621h51. The circuit for relay H51 is broken through the wiper dIIV50 leaving the contact segment I—II, so that the relay releases and by closing contact 532h51 closes the operating circuit passing over the *b*-lead. In this circuit magnet W51 in the subsidiary exchange and relay K50 in the main exchange are now again energized so that the selector DB50 and the switching device in the main exchange controlled by magnet D50 are advanced synchronously as described above in the case of a subscriber calling. If during this return to normal a subscriber of the subsidiary exchange removes his receiver, as soon as the selector DB50 comes to the position to which the calling subscriber's line is connected, a new seizure can take place, in which the corresponding meter is correctly connected up, since the switching device in the main exchange and the selector in the subsidiary exchange run synchronously. If such a call does not occur, relay H50 energizes over wiper dII50 when both switching devices have reached position II (contact 577Y50 is closed after each switching step) and brings the switching device in the main exchange to rest by opening contact 592h50. Relay X50 is deenergized by the opening of contact 631h50.

Selector DB50 in the subsidiary exchange is now advanced alone by relays K50 and Y50 in the main exchange, in that relay K50 now causes the impulses for magnet W51 to be produced directly through relay Y50, over contacts 595c50, 593h50, and 670z50 without the intermediate switching of contact 594d50. Magnet W51 is influenced under the control of contact 581y50 until the selector DB50 has been brought to position II. In this position the following circuit is now set up: earth, battery (48 volts), resistance W39, wiper dII50 in position II, contacts 573h50, 574x50, 566an50, 559c50, lead *a* of the connecting line, contact 525x51, winding I of relay U51, contacts 523g50, 521u52, wiper aI in position II, relays L50, L51, L52, battery (12 volts), earth. Relay L50 energizes together with the other L-relays. By the opening of contact 539f50 the magnet W51 in the subsidiary exchange and also relay K50 in the main exchange are disconnected. Accordingly relay Y50 also remains deenergized so that by the opening of contact 577y50 relay H50 is deenergized. By the opening of contact 573h50 the potential connected to the *a* lead of the connecting line is cut off, so that now the L-relays in the subsidiary exchange again deen-

energize. Magnet W51 is consequently again connected to lead *b* of the connecting line over contact 539f50. The operating circuit for magnet W51 and for relay K50 is again closed. Selector DB50 thus executes one further step into the zero position. Since, however, contact 592h50 is likewise closed again, magnet D50 is also influenced again through contact 595c50, so that the switching device in the main exchange also steps into the zero position. The switching device in the subsidiary exchange and the switching device in the main exchange thus make the last step into the zero position together. Since in the zero position the relays L50, etc., energize again in the charging circuit further advancement is prevented. A new seizure of the connecting line can now take place in each call direction.

Incoming traffic

A seizure of the connecting line leading from the main exchange to the subsidiary exchange by a final selector of the main exchange over the testing leads C1, C5, etc., can only take place when wiper dIII50 is in the zero position. If, for example, subscriber A5 of the subsidiary exchange is desired, the final selector is set by numerical impulses in any desired manner, in such a way that it can test on lead c5. Relay An50 is energized in the main exchange over this testing lead. By closing contact 569an50 relay An50 locks up independently of wiper dIII50 in a circuit passing over the testing lead c5. The calling circuit is opened at contact 566an50 so that the L-relays release in the subsidiary exchange and thus the connecting line is prevented from being seized by the subsidiary exchange. By the closing of contact 539f50 magnet W51 in the subsidiary exchange is connected to the *b* lead of the connecting line, so that as in the case of a call proceeding from the subsidiary exchange, the operating circuit for magnet W51 in the subsidiary exchange and relay K50 in the main exchange, which passes over the *b*-lead, is completed. The selector DB50 in the subsidiary exchange and the switching device operated by magnet D50 in the main exchange are now advanced synchronously, as has been described in the case of outgoing traffic, until wiper dI50 of the switching device in the main exchange reaches the testing lead c5 seized by the final selector. At this moment relay C50 which is connected to wiper dI50 over contact 572an50 is energized. By the opening of contact 557c50 the operating circuit for the magnet, which is completed over the *b*-lead, is broken and by the closing of contacts 556c50 and 558c50 the speaking leads of the connecting line are switched over on to the speaking leads seized by the final selector. Relay An50 is connected in a new locking circuit. The desired subscriber is now rung in the known manner from the final selector. When he replies the ringing current is cut off in the final selector in the known way, whereupon relay U51 is energized over the speaking leads and the potential applied in the final selector, and by closing contact 549u51 operates relay F51. The latter relay by closing contact 531f51 also switches through the *b*-lead in the subsidiary exchange. The desired subscriber is now connected directly to the final selector just as is a normal individual subscriber.

At the end of the conversation the testing lead c5 seized by the final selector is cut off, so that relay C50 deenergizes and by opening contact 567c50 deenergizes relay An50. By the opening

of contacts 556c50 and 558c50 relay U51 in the subsidiary exchange is deenergized and by opening contact 549u51 deenergizes relay F51 also. By the closing of contact 538/51 the operating circuit completed over the b-lead is again closed, and the selector of the subsidiary exchange is brought back to the normal position together with the switching device in the main exchange, as described in the case of outgoing traffic.

Internal calls

When subscriber A1 of the subsidiary exchange removes his receiver for the purpose of setting up an internal call, selector DB50 in the subsidiary exchange is set on the line of the calling subscriber under the control of the main exchange, in the same way as for the case of an outgoing call, so that after reaching the calling subscriber's position the switching device in the main exchange which is moved synchronously with the selector in the subsidiary exchange, connects up the meter SM1 corresponding to the calling subscriber, over wiper d1150. In order now to be able to reach subscriber A5 who is connected to the same subsidiary exchange, the calling subscriber must dial the complete number of this subscriber. In the present embodiment this number is taken to be 2419575.

As described above, relay J50 is energized after the energizing of testing relay P50 in the main exchange. While the impulses are being transmitted it is held energized over contact 599v50 of relay V50 which is operated during the dialling.

When subscriber A1 dials the first digit 2 the magnet D150 of the characterizing switch is operated twice, so that the wiper of the characterizing switch moves on to the second contact. In this contact position relay J50 is held energized in the same way as in the case of outgoing calls, and also relay H51 is operated (winding I). The latter relay locks up over contact 618h51. By the closing of contact 621h51 relay F50 is operated and by interaction with magnet D150 causes the characterizing switch to be advanced to the normal position. Before reaching the rest position relay H52 is operated in position 11 over wiper d1150 (earth, wiper d1150 in position 11, contacts 636u50, 635h55, 624h53, relay H52, battery, earth). This relay locks up in the circuit: earth, battery, relay H52, contacts 625h52, 638h50, 639c50, earth. On reaching the normal position relay U50 is influenced over contacts 644h52 and 645h53, and locks up over contact 641u50. The different digits of the calling number 4, 1, 9, and 5 now operate successively on the characterizing switch and cause relays H53—H56 to be energized in position 11 after each return of the switching device (wiper d1150) to the normal position. The characterizing switch is thus brought back to the normal position after setting by each digit so long as this digit is not a critical one and is then in a position to be set again by the following impulse train. On dialling the penultimate digit 7 the characterizing switch (wiper d1150) reaches the 7th contact over which, since contacts 602h53, 604h55 are closed, relay Z50 is operated and by opening contact 565z50 causes a release of the connecting devices in the main exchange. Relay Z50 is held operated over its winding I over contacts 587z50 and 588z50. In the energizing circuit of winding I of relay Z50 relay H51 is also influenced through its winding I and by operating relay F50 over contact 621h51 causes the characterizing switch to return to

normal, the magnet D150 being controlled over contacts 614/50 and 616h51. On the termination of this impulse train relay J50 releases and cannot be energized after the characterizing switch has returned to the normal position, since the earth is disconnected at contact 612z50. It should be noticed that before the release of relay J50 relay E50 was operated and locked up over its contact 589e50 independently of contact 591z50. At contact 583e50 the earth which is connected over the choke coil Dr52 to the b lead during dialling is disconnected so that the loop completed over the connecting line and leading to the calling subscriber is cut off. Relay U51 in the subsidiary exchange is thus caused to deenergize. Since relay F51 is energized, relay G50 is operated over contact 550u51 and connects earth directly to the a lead of the connecting line, over contact 527g50, so that the relay P50, which was transitorily deenergized by the disconnection of earth over the choke coil Dr52, again energizes. Relay Y50 which is influenced over contact 596p50 remains energized during the short interruption. Moreover, by the closing of contacts 524g50 and 535g50 a local circuit is completed over the loop of the calling subscriber for magnet W52 of the auxiliary selector LW50 in the subsidiary exchange. This selector thus makes one switching step but this is of no importance because no subscriber is connected to contact 1. When the subscriber dials the last digit (5) the magnet W52 of the auxiliary selector LW50 is operated directly and the selector is thus set on the desired subscriber's (A5) line. During the first release of contact 543w52, relay V51 is operated, since contact 541w52 (1—17) was closed on the first switching step of the auxiliary selector LW50, and holds up during the impulse train. At the end of the impulse train relay V51 deenergizes, so that now relay X51 energizes over contact 552x51 and contact 554w52 (2—11) which was closed after the second switching step. The line of the desired subscriber is now connected to the a and b leads of the connecting line by the closing of contacts 526x51 and 533x51. Through the previous energizing of relay E50 in the main exchange the ringing machine is set in operation over contact 640e50, which connects ringing current to the b lead leading to the subsidiary exchange, every three seconds over contact 555e50 so that the bell of the desired subscriber is operated.

If the desired subscriber does not reply and the calling subscriber therefore replaces his receiver, the magnet W52 is deenergized and consequently also relay F51 by the opening of contact 542w52. By means of contacts 529/51 and 528v51 the magnet W52 rotates the selector back into the normal position with the interaction of relay V51. After the closing of contact 540w52 (1—17) in the normal position, the operating circuit for magnet W51 passing over the b lead is again closed, so that, as in the case of the release of outgoing calls, selector DB50 and the switching device in the main exchange operated by magnet D50 are released in the manner described. If the called subscriber replies relay U52 in the subsidiary exchange and relay K50 in the main exchange energize in series. Contact 571k50 transmits a metering impulse to the meter SM1 of the calling subscriber, whilst by the opening of contact 590k50 relay E50 is deenergized and the ringing current is thus cut off. After the opening of contact 584e50 relay K50 holds up

over contacts 586z50 and 585z50 until relay G50 has deenergized by the opening of contact 547u52 in the subsidiary exchange and hence the direct earth is disconnected from the a lead at contact 527g50. Relays K50 and P50 deenergize, but only transitarily in the case of P50. As soon as contact 579z50 has connected earth to the b lead over the choke coil Dr52, relay P50 again energizes so that a release of the call is prevented. Contacts 522u52 and 537u52 in the subsidiary exchange maintain the calling and called subscribers connected in parallel, both subscribers obtaining their feeding current over relay P50 and the choke coil Dr52 in the main exchange.

The release of the connection only occurs when both subscribers have replaced their receivers, for then in this case relay P50 deenergizes, so that relay Y50 is also deenergized by the opening of contact 596p50, and closes the operating circuit for magnet W51 in the subsidiary exchange again at contact 581z50. Thus selector DB50 is switched into the normal position synchronously with the switching device operated by magnet D50 in the main exchange, in the manner already described.

During the return motion a fresh seizure from the subsidiary exchange is possible, whilst a seizure from the main exchange is prevented so long as the switching device operated by magnet D50 is away from the normal position. The release of the auxiliary selector LW50 has already been described for the case in which the desired subscriber does not reply. It takes place after the deenergizing of relay F51 in the circuit: earth, contacts 529z51, 528v51 (control contact), magnet W52, battery, earth.

Special circuits

If selector DB50 in the subsidiary exchange is displaced from the zero position by hand the L-relays deenergize so that the operating circuit is closed over contact 539z50 for magnet W51 in the subsidiary exchange and for relay K50 in the main exchange. By the closing of contact 595z50 in the main exchange magnet D50 is operated and the switching device is thus advanced one step. Both switching devices are now returned to the zero position in the known way. During this return motion seizing cannot take place since relay X50 has not been energized so that the testing circuit is not prepared at contact 575z50.

If the auxiliary selector LW50 is displaced from the zero position by hand, relay V51 energizes over contact 540w52 (1—17) and connects magnet W52 in a local circuit over contacts 529z51 and 528v51 which is alternately broken and closed by relay V51.

If the switching device in the main exchange operated by magnet D50 is displaced from the normal position by hand, the L-relays in the subsidiary exchange are deenergized and connect magnet W51 to the b-lead, so that again selector DB50 and the switching device operated by magnet D50 in the main exchange are brought to the zero position. In this case also seizure from the subsidiary exchange during the return motion is not possible.

If the characterizing switch is displaced from the normal position by hand, relay H51 energizes over wiper dIV50 and advances this into the normal position by means of relay F50 energized over contact 621h51 by interaction with the characterizing switch magnet D50.

Each seizure is indicated at the main exchange

by a seizing lamp L. Each seizure can also be recorded by the connection of a recording device. If it is desired to record incoming and outgoing seizures separately the contacts 630x50 and 632an50 are connected to separate recording devices.

What is claimed is:

1. In an automatic telephone system, a main exchange and a sub-exchange connected by a trunk line, a register switch in said main exchange for determining when a call originated by a sub-exchange subscriber is to be routed back to the sub-exchange, means for operating said register switch from normal position each time a series of impulses is transmitted over said trunk line from the sub-exchange in response to a sub-exchange subscriber making a call to another subscriber's line, and means for automatically restoring said register switch to normal position after each series of impulses which do not determine that the call is to be routed back to the sub-exchange.

2. In an automatic telephone system as claimed in claim 1 including registering means associated with said register switch, and means for operating said registering means during each release of said register switch to register the value of each transmitted series of impulses.

3. In an automatic system as claimed in claim 1 including means for preventing the automatic restoration of said register switch in response to the receipt of the series of impulses which determines that the call is to be routed back to the sub-exchange.

4. In an automatic telephone system as claimed in claim 1 including discriminating means operated in accordance with the different positions said register switch has been operated to for enabling the call to be routed back to the sub-exchange.

5. In an automatic telephone system as claimed in claim 1 including switching means operated in accordance with the positions said register switch has been operated to for enabling the call to be routed to the sub-exchange, and a final selector in the sub-exchange thereafter operated in accordance with a subsequent series of impulses to complete the call to a called sub-exchange subscriber's line.

6. In an automatic telephone system as claimed in claim 1 including switching means operated in accordance with the positions said register switch has been operated to for enabling the call to be routed to the sub-exchange, a final selector in the sub-exchange thereafter operated in accordance with a subsequent series of impulses to complete the call to a called sub-exchange subscriber's line, and an impulsing relay in the main exchange for controlling the operation of both said register switch and said final selector in accordance with the series of impulses transmitted over said trunk line.

7. In an automatic telephone system as claimed in claim 1 including a second trunk line connecting said exchanges, a switching means operated in accordance with the positions said register switch has been operated to for enabling the call to be routed back to the sub-exchange over said second trunk line, and a final selector in the sub-exchange thereafter operated over said second trunk line in accordance with a subsequent series of impulses to complete the call to a called sub-exchange subscriber's line.