Oct. 20, 1936. E. WOCHINGER 2,057,868

TELEPHONE SYSTEM

Filed July 11, 1935 2 Sheets-Sheet 1

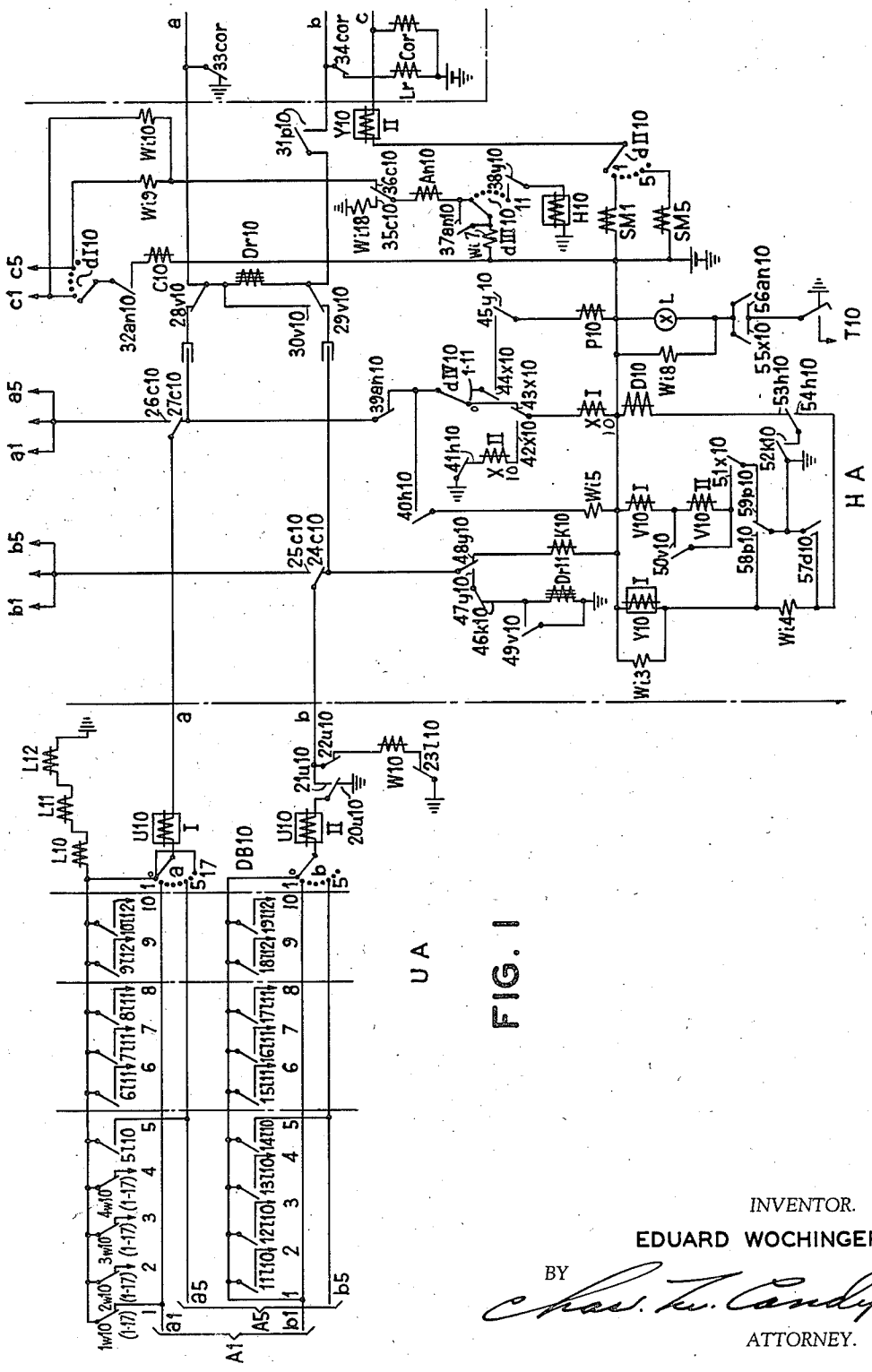


FIG. 1

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Filed July 11, 1935 2 Sheets-Sheet 2

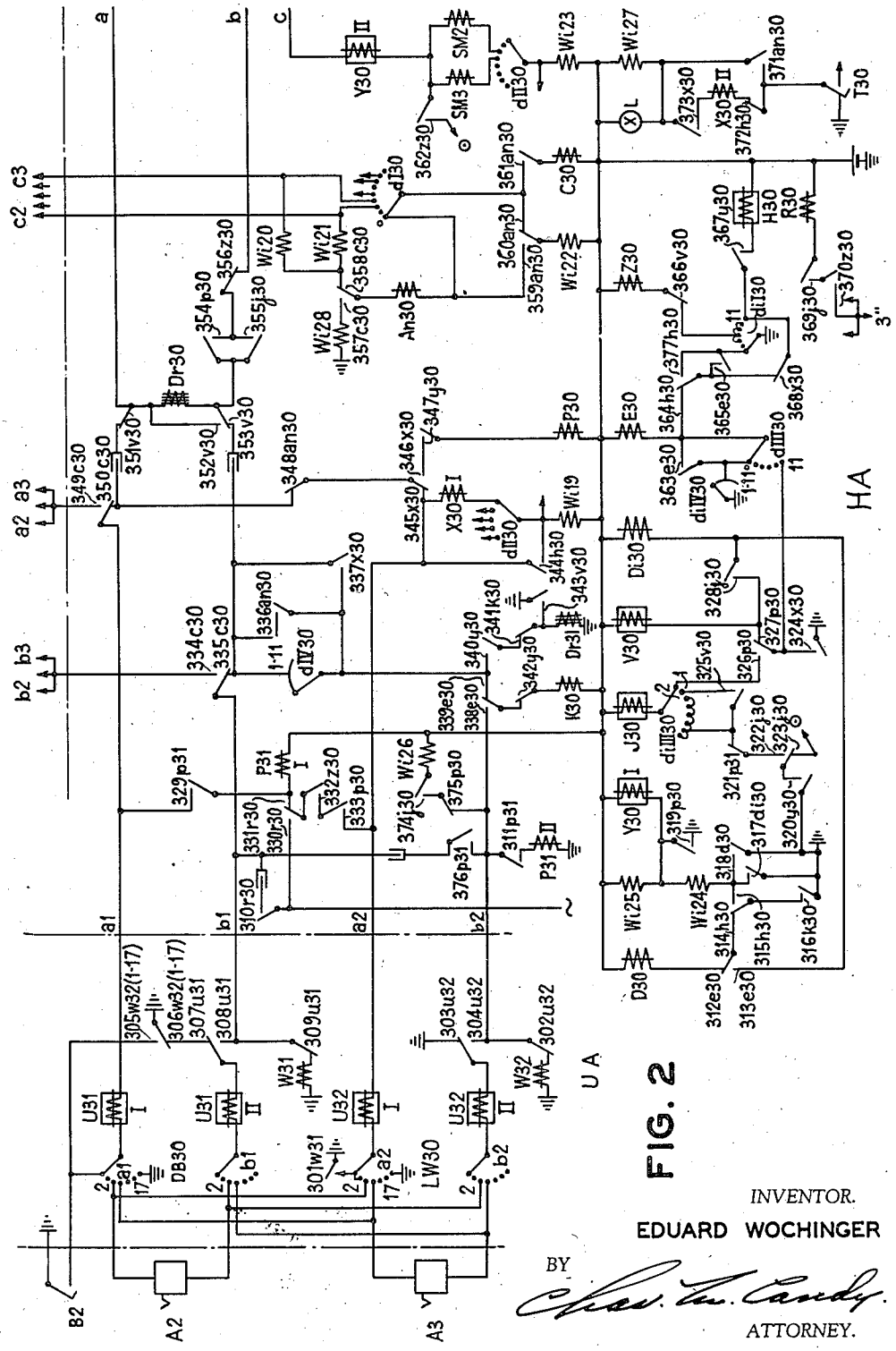


FIG. 2

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Patented Oct. 20, 1936

2,057,868

UNITED STATES PATENT OFFICE

2,057,868

TELEPHONE SYSTEM

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Application July 11, 1935, Serial No. 30,925
In Germany July 12, 1934

6 Claims. (Cl. 179—18)

The present invention relates to telephone systems with main and subsidiary exchanges and automatic operation, especially to systems in which selectors in the subsidiary exchange are set on both calling and called subscribers' lines and also into normal position by switching devices in the main exchange.

For fuller utilization of the connecting lines and devices and for quicker establishment of calls it is advantageous for the selectors of the subsidiary exchange and the switching devices of the main exchange in such systems, to be in such a condition during the release motion at the end of a call that calls occurring during this release motion can immediately be taken up. This, of course, must be prevented, however, in the case of the selectors and switching devices becoming out of step, when wrong connections and similar derangement of the working may occur. This is achieved by the invention in that switching means are provided which, when the selectors of the subsidiary exchange and (or) the switching device of the main exchange which control them have become out of step, prevent the establishment of an outgoing call over the selectors of the subsidiary exchange during the release motion of the selectors and switching devices which have become out of step.

Fig. 1 shows my invention applied to a system in which a subsidiary exchange is connected to a main exchange.

Fig. 2 shows my invention applied to a system in which calls may be established between subscribers in the subsidiary exchange as well as between a subscriber in the subsidiary exchange and a subscriber in the main exchange.

In Fig. 1 a subsidiary exchange UA without batteries is shown as an embodiment of the invention, which has access to a main exchange HA over the connecting line consisting of two leads. The connection of the subsidiary exchange subscribers to this connecting line takes place over a selector DB10 which for outgoing calls acts as a call finder, and for incoming calls is set by numerical impulses as a final selector. In the normal condition of the system relay L10, and further relays (L11, L12) in case the contacts to be provided for each subscriber cannot be operated by one relay, is operated over one lead of the connecting line. These relays connect all the subscribers of the subsidiary exchange in common to the calling circuit through their working contacts and on deenergizing which occurs when a subscriber calls, cause a switching over of the calling circuit so that the individual subscribers can be tested. In order to reduce the number of relays of this kind to a minimum, contacts operated mechanically by the selector of the subsidiary exchange are used for this purpose, for example *w*10 (1—17) and which are opened on the first switching motion of selector DB10 and remain open until position 17.

The setting of selector DB10 in the subsidiary exchange UA always takes place under the control of the main exchange HA, both in case of outgoing calls, when the selector is acting as a call finder, and also in the case of incoming calls when the selector is acting as a final selector.

As already mentioned, in the normal position of the system, relay L10, and, if present, also relays L11 and L12 are energized, over the circuit: earth, relays L12, L11, L10, wiper *a* in position 0, winding I of relay U10, lead *a* of the connecting line, contacts 27*c*10, 39*an*10, wiper *d*IV10 in position 0, contact 43*x*10, winding I of relay X10, battery, earth. In this circuit only relays L10, L11 and L12 are energized, while relay X10 does not receive sufficient current.

Outgoing traffic

When subscriber A1 of the subsidiary exchange takes up his receiver the following circuit is set up: earth, contact 20*u*10, winding II of relay U10, wiper *b* in position 0, lead *b*1, subscriber A1, lead *a*1, contact *w*10 (1—17), wiper *a* in position 0, winding I of relay U10, lead *a*, contacts 27*c*10, 39*an*10, wiper *d*IV10 in position 0, contact 43*x*10, winding I of relay X10, battery, earth. Besides the transitory energizing of relay K10 relay X10 also energizes in this circuit and locks up by the closing of contact 42*x*10 in series with its winding II. The circuit just described passing over the *a* lead is opened at contact 43*x*10. In the subsidiary exchange relays L10, L11, and L12 release so that the switching magnet W10 of the selector in the subsidiary station is connected to the *b* lead over contact 23*l*10. The following circuit is thus set up through the main exchange: earth, contact 23*l*10, switching magnet W10, contact 22*u*10, lead *b* contacts 24*c*10, 48*y*10, relay K10, battery, earth. In this circuit both the switching magnet in the subsidiary exchange and also relay K10 in the main exchange are energized so that the switching device in the subsidiary exchange is advanced one step. Contact 52*k*10 switches on the switching magnet D10 in the main exchange through contact 53*h*10, so that the wipers D I 10 –*d* IV 10 operated by this switching magnet also advance one step. Through contact 57*d*10, which is operated each

time switching magnet D10 energizes, relay Y10 is energized over: earth, contact 57*d*10, resistance W*i*4, winding I of relay Y10, battery, earth. Thereupon the energizing circuit of switching magnet W10 and relay K10, completed over the *b*-lead of the connecting line, is broken at contact 48*y*10. Switching magnet D10 is likewise disconnected by the opening of contact 52*k*10. The interaction would, if necessary, be repeated again and accordingly both the switching device DB10 in the subsidiary exchange and also the switching device in the main exchange would be advanced in step. Since, however, the subscriber A1 of the subsidiary exchange, connected to the first contact is calling, the testing relay P10, which after the occurrence of each step is connected to the *a*-lead over contact 45*y*10, is energized in the main exchange after the first step. This testing circuit is completed through: earth, contact 20*u*10, winding II of relay U10, wiper *b* in position 1, lead *b*1, subscriber A1, lead *a*1, wiper *a* in position 1, winding I of relay U10, lead *a*, of the connecting line, contacts 27*c*10, 39*an*10, wiper *d*IV10 in positions 1—11, contacts 44*x*10, 45*y*10, relay P10, battery, earth. In the same circuit relay U10 is energzied in the subsidiary exchange. By the closing of contact 58*p*10, relay Y10 is next maintained energized over its winding I, while by the opening of contact 22*u*10 the switching magnet W10 of the switching device in the subsidiary exchange is cut off. The earth previously connected over contact 20*u*10 is replaced by earth connected over contacts 24*c*10, 47*y*10, 46*k*10 and choke coil Dr11, by the opening of contact 20*u*10 and the closing of contact 21*u*10, so that complete symmetry exists between the two speaking leads, and no unbalance occurs in the subsidiary exchange. By the closing of contacts 31*p*10 a loop is also closed for seizing the exchange connecting devices, so that for example a preselector can be set in operation after whose setting relay C*or* is energized. The subscriber receives a dialling signal. He can then commence dialling.

On operating the dial the relay P10 in the main exchange used for testing while the selector is being set releases intermittently according to the impulses, while relay U10 in the subsidiary exchange remains energized on account of its construction as a slow acting relay. Relay Y10 similarly holds up in the main exchange during the impulse emission. Contact 31*p*10 transmits the impulses to the connecting devices of the main exchange by interrupting the line loop. On the first release of relay P10 relay V10 is influenced since contact 51*x*10 is also closed. The latter relay ensures a clean transmission of the impulses by short circuiting the choke coil Dr10 at contact 30*v*10 during the emission of the impulses, and disconnecting the condensers (contacts 28*v*10 and 29*v*10).

The connecting devices of the main exchange are set in the desired direction by the various impulse trains in any suitable manner, with which we are not concerned, and the desired subscriber is then rung in the known way.

It should be noted that the meters of the subsidiary exchange subscribers are centralized in the main exchange. In order now to be able to influence the corresponding meter when a subscriber sets up a call the meter is connected over a wiper of the switching device in the main exchange which controls the setting of the selector in the subsidiary exchange and is thus advanced in step with the latter. When the conversation has finished a meter impulse is transmitted over the lead *c*, in any way, with which we are not concerned, which influences the meter SM1 allocated to the calling subscriber. A second winding of relay Y10 lies in the meter circuit and on energizing maintains the connection existing between the main exchange and the subsidiary exchange so that even when the calling subscriber replaces his receiver no release of the selector DB10 in the subsidiary exchange or of the switching device in the main exchange can take place during the metering process. If at the moment that the selector of the subsidiary exchange is engaging a subscriber's line during the further switching after the termination of the conversation the subscriber of the line in question takes up his receiver, the connecting line leading to the main exchange can immediately be seized again. Since the selector of the subsidiary exchange has advanced in step with the switching device in the exchange, in this case also the meter corresponding to the subscriber reached is again connected to the *c*-lead.

If a new call does not take place, both switching devices are advanced to position 11 through the alternating play of the above mentioned relay. In the main exchange relay H10 energizes in this switching position over contact 38*y*10, wiper *d* III 10 and resistance W*i*7, and by opening contact 53*h*10 prevents the switching magnet D10 from being operated again and the consequent further switching of the corresponding wiper. The switching magnet W10 in the subsidiary exchange is further operated, however, by the alternate play between relays K10 and Y10, since the corresponding selector has to carry out 17 steps to reach the zero position. This is continued until the selector DB10 in the subsidiary exchange reaches position 17. In this position relays L10, and L11 and L12 now energize over: earth, relays L12, L11, L10, wiper *a* in position 17, winding I of relay U10, lead *a* of the connecting line, contacts 27*c*10, 39*an*10, 40*h*10, resistance W*i*5, battery, earth. Relay L10 cuts off the operating circuit of switching magnet W10, at contacts 23*l*10, so that relays K10 and Y10 in the main exchange can also no longer energize. By the opening of contact 38*y*10 relay H10 deenergizes and opens the circuit for the L-relay passing over the *a*-lead, at contact 40*h*10. Thereupon this relay again deenergizes. Through the closing of contact 23*l*10 the operating circuit of switching magnet W10 passing over the *b*-lead of the connecting line is again closed so that the selector in the subsidiary station makes one switching step (into the normal position). By relay K10 energizing in the operating circuit of switching magnet W10 the switching magnet of the switching device in the main exchange is now operated over contact 52*k*10, so that this switching device also makes one step, likewise into the normal position. Thus both are now standing again in position 0. On reaching this position the condition existing when the system is at rest is again set up (L-relay energized).

The number of steps of the selector in the subsidiary exchange are known to be larger than the number of steps of the switching device in the main exchange. Since, however, in order actually to connect up the meter of the calling subscriber through the switching device in the main exchange, the switching device and the selector in the subsidiary exchange must be synchronous, the arrangement is such, as described above, that the motion is synchronous until the 11th contact, i. e. until the first contact without any subscriber's

connection, whereupon the selector in the subsidiary exchange travels over the remaining contacts and then accomplishes the last switching step together with the switching device. This release motion is achieved in that up until the 11th contact the relays K10, Y10 and the magnet D10 produce impulses for advancing both switching devices, whereupon the magnet D10 is disconnected from the impulse producing circuit and by a switching over process (H10) impulses are only produced through relays K10 and Y10 for the magnet W10. In position 17 this then causes a reversal of the change-over device so that for the last switching step the circuit first operative comes into operation again, together with the switching magnet D10.

Incoming traffic

The subscribers attached to the subsidiary station can obviously also be called from the main station. The last digit of their call numbers corresponds, for example, to the number of steps which the selector DB10 in the subsidiary exchange must be taken in order to be set on their connections. If they were previously subscribers having individual lines to the main exchange they can retain their original call numbers unaltered. Only the *c*-lead from the final selector has to be disconnected from their previous connections and led to a contact of wiper *d* I 10. The *a*- and *b*-leads of all subscribers' lines incoming from the final selector are connected together in parallel. Thus both subscribers attached to the same level of a final selector and also those attached to different levels of the same final selector or in particular to different final selectors are incorporated in the subsidiary exchange while maintaining their call numbers.

If a final selector (not shown) is set in any manner on the line leading to the subsidiary exchange for the purpose of calling subscriber A5, testing is carried out, in the known way, over the lead *c*5 thus seized, as to whether the line leading to the apartment house exchange is free. If this is not the case, wiper *d* III 10 has left its position 0, so that the lead *c*5 incoming from the final selector is open and the calling subscriber receives an engaged signal in the known way.

If on the contrary the line leading to the subsidiary exchange is free relay A*n*10 is energized over the lead *c*5 (lead *c*5, resistance W*i*9, contact 36*i*10, relay A*n*10, wiper *d* III 10 in position 0, resistance W*i*7, battery, earth). Relay A*n*10 lies in a circuit dependent upon wiper *d* III 10, via contact 37*an*10. Through the opening of contact 39*an*10 the circuit existing the relays L10, L11 and L12 in the normal condition of the system is broken, so that these relays deenergize. Seizing from the subsidiary exchange is not possible since relay P10 which is otherwise used for testing is disconnected and the selector is brought to rest through setting the switching device in the main exchange under the control of the seized testing lead. By the closing of contact 23*l*10 after the release of relay L10 the operating circuit for the switching magnet passing over the *b*-lead is closed in series with relay K10. Both switching devices now move synchronously as was described above for the case of the call of a subscriber of the subsidiary exchange. The advancement now, however, takes place until the wiper *d* I 10 comes to rest on the calling lead *c*5. When this occurs relay *c*10 energizes over the circuit: lead *c*5, wiper *d* I 10, contact 32 *an*10, relay C10, battery, earth. By the opening of contact 24*c*10 the operating circuit of magnet W10 and also the control circuit for the magnet D10 are broken. The speaking leads are switched through to the final selector by the closing of contacts 25*c*10 and 26*c*10. The ringing current is transmitted to the desired subscriber from the final selector in any of the known ways, and passes over the *a*-lead of the connecting line of the subscriber's station in the subsidiary exchange and the earth in the subsidiary station connected over contact 20*u*10. If the ringing current were connected over the *b*-line, then obviously the *a*- and *b*-leads must be interchanged.

When the called subscriber replies the ringing current is disconnected by the completion of the loop in the final selector, and by the energizing of relay U10 over the speaking leads contact 21*u*10 is closed so that now lead *b* of the connecting line is also switched through to the main exchange. The desired subscriber is now connected to the calling subscriber.

After the termination of the conversation lead *c*5 is cut off from the final selector in any desired way, so that relays C10 and A*n*10, which had established a locking circuit over contact 35*c*10, release. In the subsidiary exchange relay U10 is deenergized so that the operating circuit for magnet W10 in the subsidiary exchange and for relay K10 in the main exchange is again completed over the *b*-lead of the connecting line. By relay K10, the magnet D10 of the selector in the main exchange is switched on through contact 52*k*10. Thus the reciprocal play between the two switching devices, already described, causes the advancement into the normal position in the manner described in the case of the release for an outgoing connection.

Special circuits

If the selector in the subsidiary exchange is displaced from position 0 by hand, and the two switching devices thus become out of step, relays L10, L11, L12 deenergize since the normal circuit is broken at wiper *a* of the selector. The magnet W10 is connected in an operating circuit through the closing of contact 23*l*10, the circuit being completed as in the case of a call over relay K10 in the main exchange and the lead *b* of the connecting line running between the main exchange and the subsidiary exchange. The magnet D10 in the main exchange is switched on by relay K10, so that both switching devices are advanced under the control of the impulse circuit in the main exchange. Since in this case both switching devices are not synchronous the possibility of a subscriber who hangs up during the advancement into the normal position, causing the connecting line leading to the main exchange to be seized must be prevented, for otherwise the meter of another subscriber would be operated in the main exchange. This is prevented in that through the displacement of the selector in the subsidiary exchange by hand, in contrast to the procedure in a normal call, relay K10 is energized in the main exchange, so that the testing relay P10 in the main exchange is not connected over contact 44*x*10, i. e. this relay cannot test and thus the advancement of the switching device into the normal position cannot be interrupted. For the rest the release motion occurs in the same way as after the normal establishment of a call, i. e. advancement in step until the eleventh contact of the switch in the main exchange is reached, then the selector of the subsidiary exchange is controlled alone until position 17, and then the last step to the zero

position is accomplished by both switching devices in common. The two switches are thus again in corresponding positions.

The same switching operations take place when the switching device of the main exchange is displaced from the zero position by hand.

In this case the wiper *d* IV cuts off the *a*-lead of the connecting line so that relay X10 cannot be energized. Seizing during the release motion is thus prevented. By the interruption of the circuit existing in the normal condition relays L10, L11 and L12 again deenergize, whereupon the magnet W10 in the subsidiary exchange is again connected in an operating circuit over contact 23 *l* 10, and is influenced by the reciprocal play of relays K10 and Y10, partly together with the switching magnet D10 in the main exchange, and partly independently, as mentioned above, until the zero position is reached. They can then operate synchronously again when the next call is set up.

Each seizing of the devices in the main exchange can be indicated by a seizure lamp L. If desired, each seizing direction can be indicated specifically, if the contacts 55*c*10 for the outgoing seizing and 56*an*10 for the incoming seizing are wired separately.

In Fig. 2 a system with a main and subsidiary exchange is illustrated as an embodiment of the invention. This in addition to the outgoing and incoming calls enables connections to be set up between subscribers of the same subsidiary exchange. For this purpose, in addition to selector DB30 which serves for setting up outgoing and incoming calls (exchange calls) and thus works as a double purpose selector, a second selector LW30 is provided in the subsidiary exchange which serves to set up interval connections within the subsidiary exchange. This auxiliary selector is connected over an auxiliary line (*a*2 *b*2) between the subsidiary exchange and main exchange to the connecting line leading to the main exchange which is seized by calling subscribers.

In order to differentiate between the different call directions i. e. outgoing exchange calls and internal calls, an additional switching device is provided (magnet D*i*30, wipers *di* I 30—*di* IV 30) in the main exchange which is switched round according to the characterizing number dialled so that either a call is set up over the connecting devices of the main exchange, or the auxiliary selector LW30 in the subsidiary exchange can be set on the desired subscriber's connection. In the present embodiment the characterizing is arranged so that by dialling the digit 1 an outgoing exchange call is characterized, while by dialling the subscriber's number directly, i. e., any digit except 1, an internal call and thereupon the subscriber desired in the internal call, is characterized.

The characterizing digit for the outgoing exchange call is not taken up by the connecting devices in the main exchange, but only by the characterizing switching device and the auxiliary selector LW3 provided in the subsidiary exchange.

In the normal condition of the system all the selectors both in the subsidiary exchange and also the switching devices in the main exchange and in addition all the relays, are uninfluenced.

Outgoing calls

When a subscriber takes up his receiver and momentarily depresses the key, for example B2 in the case of subscriber A2, earth is connected to lead *a*1 of the connecting line leading to the main exchange. In the main exchange relay X30 energizes over the circuit: earth, battery, resistance W*i*19, wiper *d* II 30, winding I of relay X30, contacts 345*x*30, 348*an*30, 350*c*30, lead *a*1, winding I of relay U31, wiper *a*1 of selector DB30 in position 0, key B2, earth. Relay X30 locks up over its winding II on closing its contact 373*x*30. Contact 345*x*30 disconnects battery from the lead *a*1 of the connecting line. Contact 337*x*30, however, connects battery to the *b*1 lead. The following circuit is then set up: earth, magnet W31, contact 309*u*31, B1 lead of the connecting line, contacts 335*c*30, 337*x*30, 339*e*30, 342*y*30, relay K30, battery, earth. In this circuit the magnet W31 energizes in the subsidiary exchange and relay K30 in the main exchange, so that the selector DB30 in the subsidiary exchange advances one step. Similarly the switching device influenced by the magnet D30 in the main exchange is advanced one step, after this magnet has been energized over contact 316*k*30. On the energizing of this magnet contact 318*d*30 is closed and thus relay Y30 is switched on over resistance W*i*24. This relay opens its contacts 342*y*30, among others, so that the operating circuit of magnet W31 and relay K30 is broken, so that these are both deenergized. By the opening of contact 316*k*30 magnet D30 is also deenergized which again results in the opening of contact 318*d*30 and hence the deenergizing of relay Y30. Contact 342*y*30 is again closed and thereby the operating circuit for magnet W31 and for relay K30 is set up afresh, so that selector DB30 in the subsidiary exchange and the switching device in the main exchange which is influenced by relay K30, advance a further step.

Since the calling subscriber A2 is connected to the second contact of selector DB30, on reaching this contact after relay Y30 has operated as before after the completion of the second switching step, the following circuit is set up: earth, battery, relay P30, contacts 347*y*30, 346*x*30, 348*an*30, 350*c*30, lead *a*1 of the connecting line, winding I of relay U31, wiper *a*1 of selector DB30 in position 2, subscriber A2, wiper *b*1 of the same selector in position 2, winding II of relay U31, contacts 307*u*31, 306*w*32 (1—17) (mechanically operated by LW 30, earth. It should be noticed that the connection of the testing relay P30 to lead *a*1 by relay Y30 takes place after each step of the switching device in the main exchange. By the closing of contact 319*p*30 relay Y30 is held energized so that by the opening of contact 342*y*30 further transmission of impulses for advancing the switching device is prevented. Earth is connected to lead *b*1 over contact 340*y*30 and the choke D*r*31, so that after opening contact 307*u*31 and closing contact 308*u*31 the following locking circuit is set up for relay U31, energized in the above testing circuit: earth, choke coil D*r*31, contacts 341*k*30, 340*y*30, wiper *d* IV 30 in position 1—11, contact 335*c*30, lead *b*1 of the connecting line, contact 308*u*31, winding II of relay U31, wiper *b*1 of selector D*b*30 in position 2, subscriber A2, wiper *a*1 of selector DB30 in position 2, winding I of relay U31, lead *a*1 of the connecting line, contacts 350*c*30, 348*an*30, 345*x*30, 347*y*30, relay P30, battery, earth. At contact 354*p*30 a loop is closed for the connecting devices of the main exchange so that just as in the case of a subscriber having an individual line, a preselecting device, for example a call finder, is set in operation. After the setting of such a preselecting device, if the calling subscriber is connected

to a free connecting device he received a signal from the exchange.

Since it is an outgoing call which is being set up in the present case, the subscriber must dial the characteristic digit 1. It should be added that relay J30 was energized over contacts 324x30 and 326p30 and also over wiper *di* III 30 in position 0, so that contact 354p30 which was closed by the testing relay P30 which operates as the impulse relay during the numerical selection, is shunted by contact 355j30. The selection of the characterizing digit 1 is accordingly not transmitted to the connecting devices of the main exchange. On the first impulse i. e. on the first deenergizng of relay P30 the magnet Di30 of the characterizing switching device is operated in the main exchange over contacts 324x30, 327p30, and 328j30, and relay V30 is operated in parallel with the magnet; moreover, by the transitory closing of contact 375p30, battery is connected over contact 374i30 to the *b*2 lead of the auxiliary connecting line and hence magnet W32 of the auxiliary selector LW30 is operated. By means of relay V30, energized during the impulse emission, the choke coil Dr30 is short circuited by the closing of contact 352v30, and by the opening of contacts 351v30 and 353v30 the condensers in the speaking leads are disconnected so as to ensure a more clear impulse emission. After the one impulse has been given relay V30 deenergizes on account of the prolonged opening of contact 327p30, so that relay J30, which after one step has been made, can hold up over wiper *di*III 30 in position 1 and over contact 325v30, is deenergized. The short circuit of impulse contact 354p30 is accordingly removed by the opening of contact 355i30 so that the next impulse trains can be transmitted to the connecting devices of the main exchange. The magnet W32 in the subsidiary exchange, which previously displaced the auxiliary selector LW30 one step, can no longer be effected since the corresponding circuit is broken at contact 374j30.

When the desired subscriber is reached, after testing on the contact in the normal way, ringing current is transmitted and the speaking connection is established on the desired subscriber replying. When the conversation has finished a metering impulse is transmitted on the *c*-lead in any desired manner which does not concern us here. This is extended to the meter SM2 in the main exchange corresponding to the calling subscriber of the subsidiary exchange. The connecting of the corresponding meter takes place on the setting of selector DB30 in the subsidiary exchange by the switching device in the main exchange controlling this selector.

By the switching on of winding II of relay Y30 in the *c*-lead, which relay assists in sending out the control impulses, the existing connection is prevented from being released during this metering even when the calling subscriber replaces his receiver and thereby releases relay P30 which lies in the circuit of the speaking current. When the metering is completed and the calling subscriber replaces his receiver relays P30 and U31 deenergize. Since a locking circuit no longer exists for relay Y30 in the *c*-lead it is disconnected by the opening of contact 319p30 so that it deenergizes. At contacts 342y30 and 309u31 the operating circuit through magnet W31 and relay K30 in series is now closed again, so that now, in the same way as for the setting of selector DB30 on the calling subscriber, this is again controlled synchronously by the switching device in the main exchange. If the selector DB30 thus moves on to a subscriber's line in which the subscriber has just taken up the receiver, seizing can at once take place again, since both the selector in the subsidiary exchange and the switching device in the main exchange are both in the same switching position, so that the meter in the main exchange corresponding to the calling subscriber is also connected up when the switches are brought to rest. If such a call does not occur, and selector DB30 and the controlling switching device in the main exchange accordingly reach position 11, relay E30 energizes in the main exchange over: earth, battery, relay E30, wiper *d* III 30 in position 11, contact 324x30, earth. Relay E30 establishes a locking circuit for itself over its contact 363e30. The operating circuit passing over the *b*1 lead is broken by contact 339e30, and also battery is connected to lead *b*2 of the auxiliary connecting line, so that now magnet W32 of selector LW30 which stands in position 1 is influenced in series with relay K30 of the main exchange. The impulse circuit previously operating magnet D30 is correspondingly opened at contact 312e30 and is switched over to magnet Di30 of the characterizing selector by the closing of contact 313e30. The auxiliary selector LW30 is accordingly switched on one step, and through the energizing of relay K30 in the same circuit magnet Di30 is operated over contact 316k30, and likewise advances the characterizing selector one step. Relay Y30 is operated by the closing of contact 317di30, and by opening contact 342y30 breaks the operating circuit for the magnet W32 and relay K30. Contact 316k30 is accordingly opened, so that by the disconnection of magnet Di30 and the associated opening of contact 317di30, relay Y30 is deenergized and the operating circuit for magnet W32 and relay K30 is again closed. This alternating play is repeated until the characterizing switching device has reached position 11. When this occurs relay H30 is operated over wiper *di* I 30 and contact 367y30, and hence contact 314h30 is opened which now breaks the impulse circuit for magnet Di30 and connects relay Y30 directly in this impulse circuit. Relay X30 deenergizes on the opening of contact 372h30. The auxiliary selector LW30 is moved on further by means of impulses from the main exchange, but there the characterizing switching device does not move with it. The switching device LW30 continues to be advanced until it reaches position 17. In this position earth is connected to the lead *a*2 over wiper *a*2 of the switching device LW30. Thus relay U32 is energized in the following circuit: earth, wiper *a*2 of the switching device LW30 in position 17, winding I of relay U32, lead *a*2 of the connecting line, contact 344h30, resistance Wi19, battery, earth. By the opening of contact 302u32 the switching magnet W32 is disconnected and also the circuit of relay K30 is broken. The current is cut off from relay Y30 by the opening of contact 316k30 so that this relay opens contact 367y30 and deenergizes relay H30. Contact 344h30 is opened and the energizing circuit of relay U32 described above is broken down. Contact 302u32 again closes the operating circuit for magnet W32 and relay K30, so that selector LW30 in the subsidiary exchange advances one step and likewise the magnet Di30 energized over contact 316k30 advances the characterizing switching device in the main exchange by one step. Accordingly both switching devices accomplish the last step into the

normal position together. In the position 0 of wiper *di* I 30 relay E30 remains energized over contacts 354*h*30 and 365*c*30 until, since relay Y30 is energized over contact 317*di*30 through the last switching step, relay H30 is again energized over: earth, wiper *di* I 30 in position 0, contacts 365*e*30, 368*x*30, 367*y*30, relay H30, battery, earth. By the opening of contact 364*h*30 the locking circuit for relay E30 is broken and this relay therefore deenergizes. Relay H30 holds up, after the opening of contact 365*e*30 over contact 377*h*30. After contact 317*di*30 has opened relay Y30 again deenergizes. By the closing of contact 339*e*30 relay K30 is furthermore again connected to the B1 lead of the connecting line and also preparation is made for switching in the magnet D30 of the switching device in the main exchange in the impulse circuit already described, over contact 312*e*30. Thereupon only magnet W31 is operated in series with relay K30. The latter causes relay Y30 to energize over contact 316*k*30, so that this opens the energizing circuit of magnet W31 by opening contact 342*y*30. By the alternate play of these relays the switching magnet is influenced until the selector DB30 reaches position 11. In this position the following circuit is set up: earth, wiper *a*1 of selector DB30 in position 11, winding I of relay U31, lead *a*1 of the connecting line, contacts 350*c*30, 348*an*30, 345*x*30, 344*h*30, resistance Wi19, battery, earth. Relay U31 energizes and by opening contact 309*u*31 disconnects the magnet W31. Relays K30 and Y30 then also release so that now relay H30 is deenergized by the opening of contact 367*y*30. Through the closing of contact 314*h*30 the switching magnet D30 in the main exchange is connected up while the energizing circuit just described for relay U31 is broken down at contact 344*h*30. The operating circuit for magnet W31 and relay K30 is accordingly closed again at contact 309*u*31. The selector DB30 is thus advanced one step and moved into the normal position. At the same time magnet D30 is also influenced by the closing of contact 316*h*30 so that the switching device in the main exchange similarly makes one switching step which takes it into the normal position. Since the wiper *d* IV 30 of this switching device has now left contact segments 1–11 further advancement of the switching devices is not possible. All the devices both in the subsidiary and also in the main exchange are now again in the normal position.

Incoming traffic

If a subscriber of the subsidiary exchange, for example A2 is called from the main exchange a final selector, which is not shown, is set by the corresponding numerical selection. If the connecting line leading to the subsidiary exchange is already seized the wiper *d* I 30 is not in the normal position, so that the final selector cannot test over the *c*-lead (*c*2) corresponding to the desired subscriber. The wiper *d* I 30 remains away from the normal position as long as any of the switching devices of the connecting line either in the main exchange or in the subsidiary exchange are displaced from the normal position. Seizing the connecting line over a final selector is only possible when all these switching devices have reached the normal position. In the present case the final selector tests over the lead *c*2 corresponding to the subscriber A2. The circuit passes over resistance Wi20, contact 358*c*30, relay A*n*30, wiper *d* I 30 in position 0, contact 360*an*30, resistance Wi22, battery, earth. Relay A*n*30 energizes in this circuit and locks up independently of wiper *d* I 30 over contact 359*an*30. At contact 348*an*30 battery is disconnected from the *a*1 lead of the connecting line, so that no seizure of the connecting line can take place from the subsidiary exchange. At contact 336*an*30 battery is connected to lead *b*1 of the connecting line through relay K30. The following circuit is thus set up: earth, magnet W31, contact 309*u*31, lead b1 of the connecting line, contacts 335*c*30, 336*an*30, 339*a*30, 342*y*30, relay K30, battery, earth. By the alternate play between magnet W31 and the magnet D30 in the main exchange operated by relays K30 or Y30 (as described in the case of outgoing traffic), the selector DB30 in the subsdiary exchange is now advanced synchronously with the switching device in the main exchange operated by magnet D30. This advancement is continued until the wiper *dI* 30 has reached the lead *c*2 seized by the final selector. At this moment the selector DB30 has also reached the second contact, to which subscriber A2 is connected. When this occurs relay C30 tests over contact 361*an*30 and by opening contact 335*c*30 prevents both the switching devices mentioned from being further advanced. At contacts 334*c*30 and 349*c*30 the speaking leads of the connecting line are switched over on the speaking leads of the final selectors. Relay A*n*30 now holds up over contact 357*c*30. Ringing current can now be sent from the final selector, which is not shown, to the desired subscriber A2 of the subsidiary exchange in the known way. When the desired subscriber replies the ringing current is disconnected in the final selector in any manner with which we are not now concerned. Relay U31 is operated over the subscriber's loop by the feeding current connected in the final selector, so that the *b*1 lead of the connecting line is switched through at contact 308*u*31, and magnet W31 is disconnected at contact 309*u*31. The subscriber A2 is now connected to the final selector of the main exchange just as a normal subscriber having an individual line.

When the conversation has finished the *c*2 lead is disconnected in the final selector, relay C30 being thus deenergized. Contacts 334*c*30 and 349*c*30 open and break the circuit for the feeding current, so that relay U31 deenergizes. One effect of this is that the operating circuit for magnet W31 and relay K30 is closed through the closing of contact 309*u*31. Through the alternate play of the corresponding relays the selector DB30 in the subsidiary exchange is advanced synchronously with the switching device in the main exchange. Thus, in the same way as was explained in the case of outgoing traffic, the selector in the subsidiary station is first advanced synchronously with the switching device in the main exchange until position 11 is reached. Then it is moved on as far as position 17 alone by means of impulses from the main station, whereupon it completes the final step into the normal position together with the switching device of the main exchange. During the release motion of the switching devices seizing cannot take place again until the two switching devices have returned to the normal position, since, in the case of an incoming call, relay X30 which takes up the initiation of a call is otherwise not energized.

Internal calls

Seizing of the connecting line leading to the

main exchange by the calling subscriber attached to the subsidiary exchange takes place in the same way as has already been described in the case of outgoing traffic. While in the case of outgoing traffic (exchange calls) the subscriber had to dial the characterizing digit 1, in the case of internal calls he must now dial the number which the desired subscriber has for internal calls, immediately. Since the digit 1 is employed for outgoing traffic, the internal numbers of the subscribers are limited to the numbers 2 to 10. Thus in this case nine subscribers can be attached to the subsidiary exchange.

As described above, relays J30 and V30 are energized during the dialling, while relay P30 is intermittently deenergized by the impulses, so that if for example the calling subscriber A2 desires a connection to subscriber A3 and accordingly dials the digit 3, magnet W32 received three impulses over the lead *b*2 and contacts 374*j*30 and 375*p*30 (impulse contact). The auxiliary selector LW30 is thus set on the third contact. The characterizing switching device is advanced synchronously by its magnet D*i*30 to the third contact. After the dialling relay V30 is deenergized and relay Z30 is influenced over: earth, battery, relay Z30, contact 366*v*30, wiper *di* I 30 in position 3, earth. Since the impulse contact 354*p*30 in the main exchange loop is shunted during the dialling by contact 355*j*30, the connecting devices of the main exchange are not set. By the opening of contact 356*z*30 the pre-selecting device in the main exchange is now no longer seized. Since relay J30 remains energized over: earth, contacts 329*y*30, 322*i*30, 321*p*31, wiper *di* III 30, relay J30, battery, earth, relay R30 is operated over: earth, battery, relay R30, contacts 369*i*30, 370*z*30, 3 second switch. Subscriber A3 is called by ringing current transmitted from the main exchange: ringing current source, contacts 330*r*30, 332*z*30, 333*p*30, lead a^2 of the connecting line, winding I of relay U32, wiper a^2 of the auxiliary selector LW30 in position 3, subscriber A3, wiper b^2 of the auxiliary selector LW30 in position 3, winding II of relay U32, contact 303*u*32, earth. Since relay R30 is influenced over a 3 second switch, ringing current is transmitted to the desired subscriber every 3 seconds. The calling subscriber receives part of this ringing current as a "free" signal over contact 310*r*30.

If the desired subscriber replies within a pause in the ringing i. e. at a moment when relay R30 is deenergized the following circuit is set up: earth, contact 303*u*32, winding II of relay U32, wiper *b*2 of the auxiliary selector LW30 in position 3, subscriber A3, wiper *a*2 of the auxiliary selector LW30 in position 3, winding I of relay U32, lead a^2 of the connecting line, contacts 333*p*30, 332*z*30, 331*r*30, winding I of relay P31, battery, earth. In this circuit relays P31 and U32 energize. Since contact 303*u*32 is opened on the energizing of relay U32, the earth necessary for holding relays U32 and P31 energized is connected through contact 311*p*31 and winding II of relay P31, after the lead *b*2 of the connecting line has been switched through. Meanwhile relay J30 is deenergized by the opening of contact 321*p*31 and relay R30 is deenergized by the opening of contact 369*i*30, so that further transmission of ringing current is prevented. The feeding current for both subscribers is supplied from the main exchange. For subscriber A2 the circuit runs from the battery connected to lead *a*1 and relay P30, to the earth connected through the choke coil Dr31 to lead *b*1, while for subscriber A3 current is fed from the battery connected through winding I of relay P31 to lead *a*2 of the connecting line, to the earth connected through winding II of relay P31 to lead *b*2.

Metering of internal calls takes place by the meter SM2 of the calling subscriber A2, connected through the switching device of the main exchange (wiper *d* II 30), being influenced over contacts 362*z*30, 323*j*30, 320*y*30, and earth.

On the termination of the conversation, when the calling subscriber replaces his receiver relays P30 and U31 deenergize. Contact 319*p*30 opens and relay Y30 is thus deenergized, while by the opening of contact 333*p*30 relay P31 is deenergized. By the closing of contact 342*y*30 battery is connected to the *b*1 lead of the connecting line over relay K30, so that the magnet W31 of selector DB30 in the subsidiary exchange is energized. By the alternate play which has already been described above, the selector of the subsidiary exchange is advanced synchronously with the switching devices of the main exchange so that both switching devices are stepped round as far as position 11. In position 11 relay E30 again energizes and causes the auxiliary selector LW30 in the subsidiary exchange to be advanced in the manner already described, under the influence of the corresponding magnet E32. The characterizing switching device D*i*30 is switched on together with this selector. When these two switching devices reach the normal position by the switching operations described above, the selector DB30 of the subsidiary exchange is moved on automatically under the control of relays K30 and Y30 in the main exchange until it reaches position 17. It then completes the final switching step into the normal position together with the switching device in the main exchange.

This short description of the release motion should suffice, since a detailed description has already been given of the release in the case of an outgoing call.

If the called subscriber of an internal call does not reply, relay P30 releases when the calling subscriber replaces his receiver, while relay J30 is only released after the release of relay Y30. Accordingly the earth is disconnected from the metering circuit by contact 320*y*30 before contact 323*j*30 closes so that in this case metering does not take place.

Special circuits

If selector DB30 in the subsidiary exchange is displaced from the normal position by hand, earth is connected over contact 301*w*31 to lead *a*2 over wiper *a*2 of the auxiliary selector LW30, so that relay X30 is energized in the main exchange and locks up over contact 373*x*30. Battery is connected to the *b*1 lead over contact 337*x*30 and thus the magnet W31 in the subsidiary exchange is influenced in series with relay K30 in the main exchange. The selector DB30 is now held until magnet D30 in the main exchange has been switched on through the closing of contact 316*k*30 whereupon both switching devices are advanced synchronously as in the case of a subscriber's call, until they reach position 11. In this position relay E30 energizes, as in the case above, and causes the auxiliary selector LW30 in the subsidiary exchange and the characterizing selector (rotary magnet D*i*) to advance synchronously to position 11, whereupon the auxiliary selector continues to advance alone into position 17 in precisely the same way as in the case of the re-

lease of an outgoing call, the last step into the normal position being executed together with the characterizing switching device. After this selector DB30 is advanced into position 17 and then finally into the normal position the last step being made together with the switching device of the main exchange. If the magnet W32 of the auxiliary selector is displaced from the normal position by hand contact 305*w*32 (1—17) connects earth over wiper *a*1 of the selector DB30 to the *a*1 lead of the connecting line, so that relay X30 is again influenced. In a manner corresponding to that above, selector DB30 and the switching device in the main exchange which is operated by magnet D30, are again advanced, whereupon after reaching position 11, the magnet W32 of auxiliary selector LW30 is influenced synchronously with the characterizing switching device D*i*30. The release motion thus takes the same course as is described above. If both selectors in the subsidiary exchange are displaced from the normal position simultaneously, then since contacts 0 and 1 are connected together in the auxiliary selector, earth is connected to the *a*2 lead of the connecting line over contact 301*w*31, so that again relay X30 is operated and the release motion described above takes place.

If the switching device in the main exchange which is operated by magnet D30 is displaced from the normal position by hand, battery is connected to lead *b*1 over wiper *d* IV 30, and hence the selector DB30 in the subsidiary exchange and the switching device in the main exchange are advanced by the known interaction. All other operations take place as above. In contrast to the movements described above, the connecting line cannot be seized during this return motion, because relay X30, which prepares a circuit for the testing relay P30, is not energized. If the characterizing switching device which is operated by magnet D*i*30 is displaced by hand from the normal position, relay E30 energizes over wiper *di* IV 30, and through contact 338*e*30 completes a circuit for magnet W32 in the subsidiary exchange and relay K30 in the main exchange, so that now the characterizing switching device in the main exchange and the auxiliary selector LW30 in the subsidiary exchange are advanced synchronously by the interaction as above. If, for example, at this moment seizing takes place on the part of the final selector in the main exchange, relays A*n*30 and C30 can be energized but the selector DB30 in the subsidiary exchange can only be set when the characterizing selector D*i*30 is in the normal position, so that relay Z30 releases and by closing contact 339*c*30 connects battery to the *b*1 lead of the connecting line. Each seizure is indicated by the lighting up of the seizing lamp L. Seizing can also be recorded. If seizing in the incoming and outgoing directions is to be recorded separately the contacts 372*h*30 and 371*an*30 can be led separately to a recording device.

Having described the invention, what is considered to be new and is desired to be protected by Letters Patent will be set forth in the following claims:

What is claimed is:

1. In a telephone system, a main and a subsidiary exchange connected together, selector switches in said exchanges operated together to establish telephone connections between said exchanges, means for operating the switches in both exchanges in case any of them are not operating together so as to restore them to their normal position, and means for preventing the establishment of a telephone connection while said switches are being restored.

2. In a telephone system, a main and a subsidiary exchange connected together, selector switches in both of said exchanges operated in synchronism to establish telephone connections from the subsidiary exchange, means responsive to a condition in which said switches are not operated in synchronism for operating them to their normal positions, and means for preventing the establishment of telephone connections from said subsidiary exchange during the time said switches are operating to their normal positions.

3. In an automatic telephone system, a main and a subsidiary exchange connected together, selector switches at both of said exchanges, the selector at the main exchange controlling the subsidiary exchange selectors and operating in synchronism therewith to establish an outgoing call from the subsidiary exchange, means operable in case said switches become out of step for operating them to their normal positions, and relay means operated when the selectors become out of step for preventing the establishment of an outgoing call from the subsidiary exchange over said selectors during the time said selectors are being restored to their normal positions.

4. In an automatic telephone system, a main and a subsidiary exchange connected together, selector switches at both of said exchanges, the main exchange selectors controlling the subsidiary selectors and operating in step therewith to establish an outgoing call from the subsidiary exchange, a testing relay in said main exchange for testing for the presence of a call from said subsidiary exchange, means operated in case said selector switches become out of step for operating them back to their normal positions, and means for rendering said testing relay inoperative during the restoring operation of said selector switch to prevent the establishment of an outgoing call from the subsidiary exchange.

5. In an automatic telephone system, as claimed in claim 4, means for breaking a partially prepared telephone connection in case it takes place during the restoring operation of said selector switches, the breaking of the connection preventing the testing of calling lines by said testing relay during said restoring operation.

6. In an automatic telephone system, a main and a subsidiary exchange connected together, selector switches at both of said exchanges, the main exchange switches controlling the subsidiary exchange switches and operating them in step therewith to establish outgoing calls from the subsidiary exchange, means in case said main exchange selectors are displaced from their normal position and therefore out of step with the subsidiary selectors for operating all of said selector switches to their normal positions again, means in the normal operating condition of said selector switches for testing for the presence of an outgoing call from the subsidiary exchange and for preparing for the establishment of the call, and means for breaking said call and preventing the testing for the presence of the same at a time when said selector switches are displaced out of step and are being restored to their normal positions.

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