

Oct. 14, 1941.

E. JAUCH

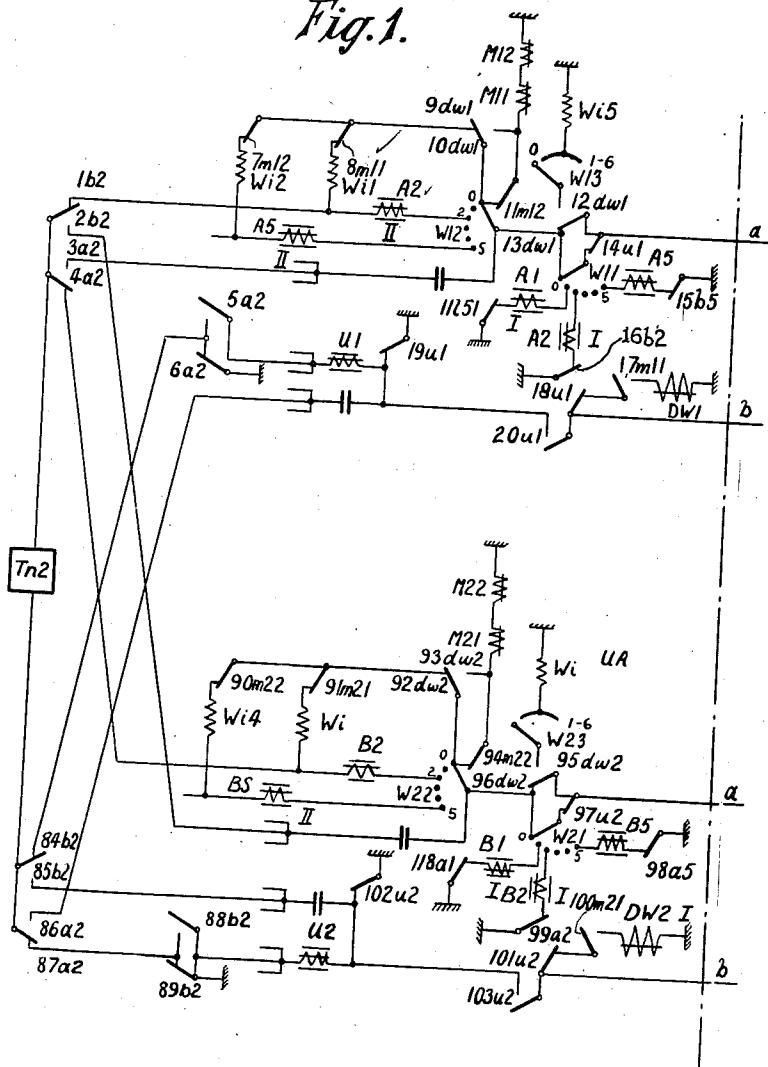
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TELEPHONE SYSTEM

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3 Sheets-Sheet 1

Fig. 1.



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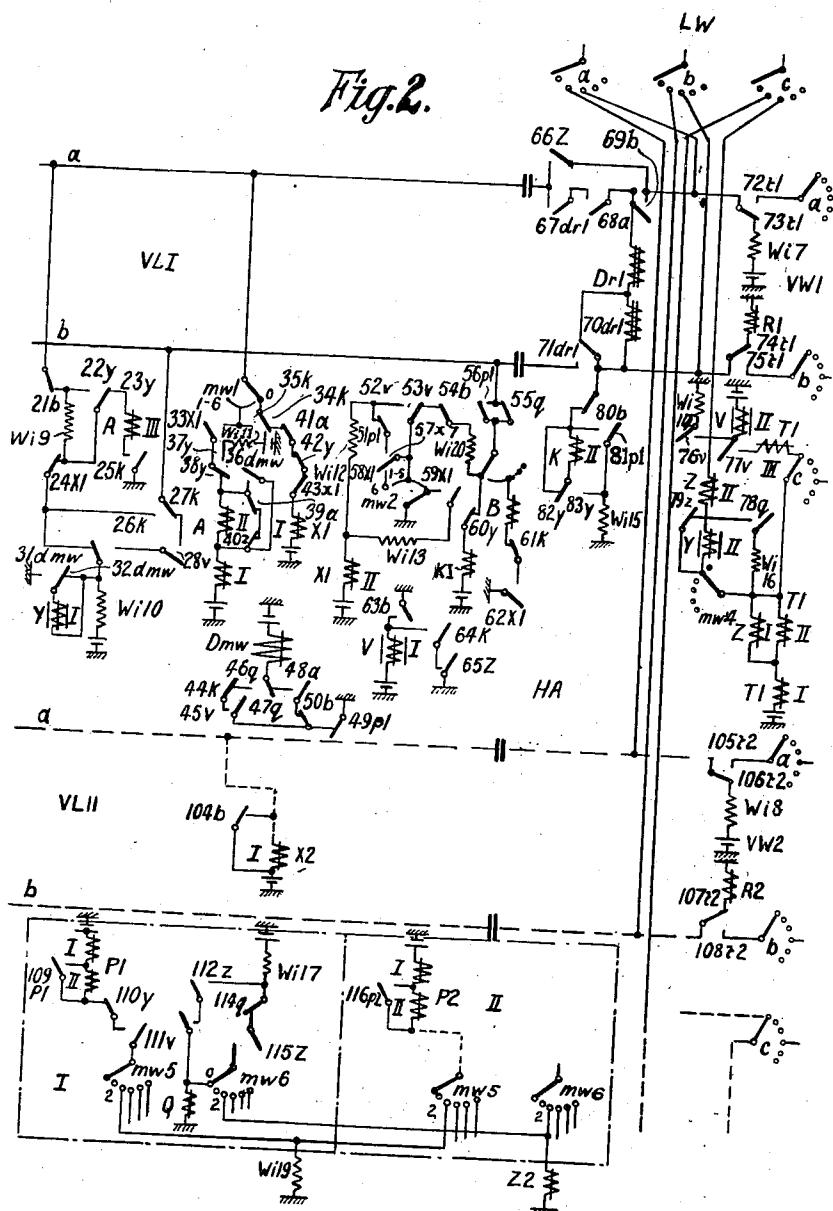
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3 Sheets-Sheet 2



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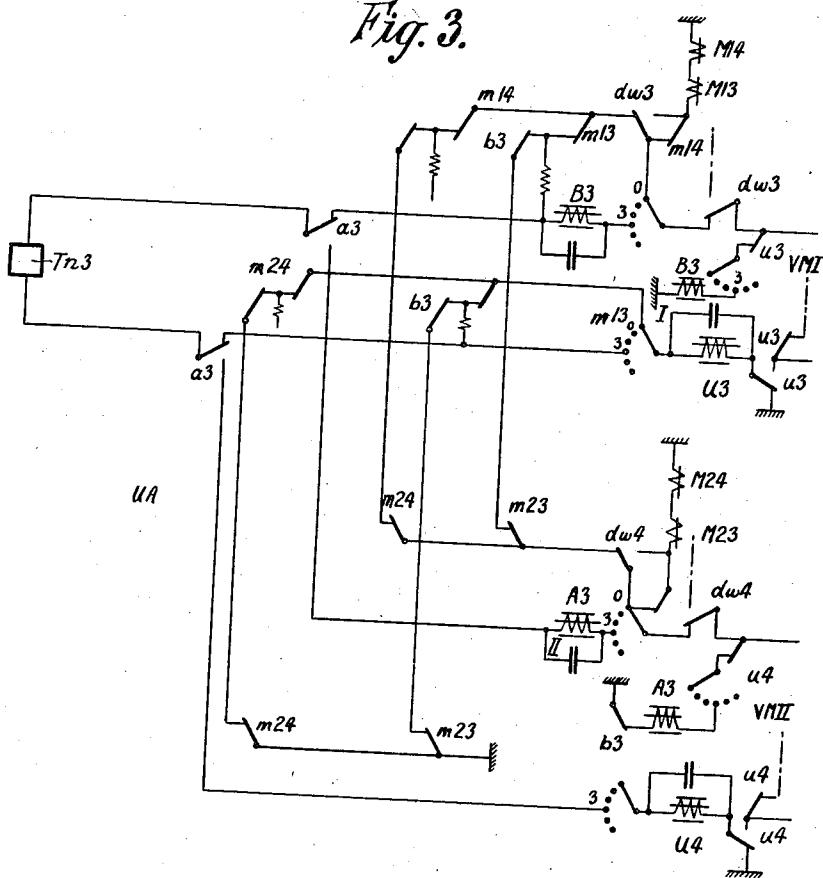
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Fig. 3.



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TELEPHONE SYSTEM

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The present invention relates to telephone installations with main and sub-exchanges in which the sub-exchanges not provided with local battery feed are connected with the main exchange over a number of two-conductor junctions. The object of the invention is to connect a calling sub-exchange subscriber to the main exchange over one of the free junctions.

In systems where a sub-exchange is connected to the main exchange over two junctions it is known to connect the calling subscriber of such a sub-exchange by means of start relays associated with the subscribers for the individual junctions. Since in known arrangements the sub-exchange is provided with local battery feed these start relays are operated in a local circuit when a subscriber makes a call.

The present invention relates to a method of solving the problem of connecting sub-exchanges not provided with battery feed over a number of two-conductor junctions and of connecting a calling sub-exchange subscriber to a free junction line. This result is obtained in that, in the sub-exchange, switching arrangements are associated with each subscriber which, on a call from a subscriber, are so controlled from the main exchange over one of the junction lines, corresponding to the junction to be used for setting up the connection, that the calling subscriber has access only to the main exchange over this junction.

The invention is illustrated with respect to an embodiment shown in Figs. 1 and 2, Fig. 2 being a continuation of the system to the right of Fig. 1 in which a telephone installation including a sub-exchange UA without local battery feed is connected to a main exchange HA over two lines (VLI, VLII).

Fig. 3 is a modification of the arrangement shown in Fig. 1.

For connecting a sub-exchange subscriber to the junction extending to the main exchange a selector is provided at each junction in the sub-exchange which selector is set by impulses transmitted from the main exchange and each subscriber is also associated with a relay for each junction. For outgoing calls one junction (VLI) has prior facilities and for incoming calls the other junction line (VLII) has prior facilities.

In the main exchange, a switch mechanism (mw) is provided for each junction which switch means are positioned synchronously with the sub-exchange selector when impulses are transmitted for setting the sub-exchange selector. For outgoing and incoming connections it serves to indicate that the calling sub-exchange sub-

scriber's line is engaged and, moreover, for outgoing connections it switches in the calling subscriber's meter at the main exchange.

For testing the condition of the subscriber's line at the main exchange, testing arrangements are associated with each junction and are connected to the wipers of the previously mentioned switch in which both contacts corresponding to the individual sub-exchange subscribers in the contact banks of the switches for both lines are connected together. When indication is given that a subscriber's line is engaged at the switch of one junction line the testing apparatus at the switch of the other junction line is seized when the same subscriber has been selected.

In the embodiment the setting-up of the connections of the telephone system takes place in the manner following:

In the normal condition of the system a permanent current circuit is completed over each junction and prepares call circuits over each junction for all the subscribers of the sub-exchange UA. The permanent current circuit over the junction line VLI extends over: earth, battery, winding 1 of relay XI, contacts 43x1, 42y, 41a, 34k, wiper mw1 in zero position, a-conductor of the junction line VLI, contact 13dw1 or contact 14u1 and wiper w11 in zero position, wiper w12 in zero position, contact 11m12, relays M11, M12, earth. In this circuit relays M11 and M12 are energised so that its contacts are in the position shown. Therefore a multiplied call circuit for all subscribers of the sub-exchange UA is prepared over the junction VLI to the main exchange HA.

The permanent current circuit over the junction line VLII extends in a corresponding manner over the a-conductor of this junction so that, in the sub-exchange, the relays M21 and M22 of the junction line VLII are energised. These relays have their contacts in the positions shown so that over the junction VLII a multiply-connected call circuit is prepared for all subscribers of the sub-exchange UA. By means of the relays (e. g. A2, B2) associated with subscribers of each junction the two multiply-connected call circuits corresponding to the two junctions are made accessible to all subscribers of the sub-exchange UA. In the embodiment the arrangement is such that on a call from a subscriber when both junction lines are free, a call circuit is first completed over the junction line VLI in that the relay X2 of the junction line VLII for receiving the call impulse is short-circuited over contact 104b of the relay B of the junction line VLI so that it

cannot be operated by the call and only the relay X_1 can be energised. This circuit, when for example the subscriber T_{n2} is the calling subscriber, extends over: earth, battery, winding I of relay X_1 , contacts $43x_1$, $42y$, $41a$, $34k$, wiper mw_1 in zero position, a -conductor of the junction line VLI , contact $13dw_1$ or contact $14u_1$ and wiper w_1 in zero position, wiper w_1 in zero position contacts $9dw_1$, $8m_1$, resistance W_1 , contact $1b_2$, subscriber T_{n2} , contacts $84b_2$, and $6a_2$ or $81a_2$ and $89b_2$, earth. The relay X_1 by closing contact $59x_1$ locks its winding II over the resistance W_1 , in a circuit which after the switch is stepped on extends over wiper mw_2 , contacts $57x_1$, $51p_1$, (or, later, $52v$) and the resistance W_1 . Contact $43x_1$ operates when relay X_1 is energised and breaks the permanent current circuit extending over the a -conductor of the junction line VLI so that, in the sub-exchange UA , the relays M_{11} and M_{12} are disconnected. These two relays allow their operated contacts $1m_{12}$, $8m_{11}$ and $11m_{12}$ to open, interrupting the multiply-connected call circuit in the sub-exchange and the permanent current circuit while the rotary magnet Dw_1 of the selector in the sub-exchange UA is connected to the b -conductor of the junction VLI by the closing of contact $17m_{11}$ and thus the following circuit is completed: earth, battery, winding I of relay K , contact $60y$, wiper mw_3 in zero position, contact $55q$, b -conductor of the junction line VLI , contacts $18u_1$, $17m_{11}$, rotary magnet Dw_1 , earth. In this circuit relay K and rotary magnet Dw_1 are energised. Winding I of relay A is connected to the a -conductor of the junction line VLI by the closing of contact $35k$ so that, after the selector in the sub-exchange is stepped-on by the rotary magnet Dw_1 energising, over the contact $12dw_1$ which is operated by the rotary magnet Dw_1 , the following circuit is completed: earth, battery, winding I of relay A , contacts $40z$, $39a$, $38y$, $33x_1$, $35k$, wiper mw_1 in zero position, a -conductor of the junction line VLI , contact $12dw_1$, wiper w_1 on the segment $1-6$, resistance W_1 , earth. In this circuit relay A is energised so that contact $48a$ closes and causes the rotary magnet Dm_w of the switch in the main exchange to energise over: earth, battery, rotary magnet Dm_w , contacts $47q$, $48a$, $50b$, $49p_1$, earth. The switch mechanism in the main exchange is advanced by one step. Relay Y is energised over its winding I by the closing of contact $31dm_w$ so that as contact $60y$ is opened the winding I of relay K is disconnected. The circuit extending over the b -conductor of the junction VLI for the rotary magnet Dw_1 is interrupted after the stepping-on of the switch at the main exchange at wiper mw_3 , so that the circuit completed for the winding I of relay A over the a -conductor of the junction VLI is disconnected by the opening of contact $12dw_1$. Relay A is thus disconnected and breaks the circuit of the rotary magnet Dm_w at contact $48a$ so since contact $31dm_w$ is opened the relay Y restores.

During the period during which relay Y is energised relay K is not energised, the test circuit for determining the calling subscriber is prepared in that battery potential is connected to the a -conductor over the resistance W_{11} and contact $37y$ and earth potential is connected to the b -conductor over the contact $61k$ and the test relay B . By means of the battery potential on the a -conductor in the sub-exchange relay A_1 , connected over wiper w_1 of the subscriber T_{n1} (not shown), is energised in order to determine whether this subscriber is the calling subscriber. If the subscriber

(not shown,) is already connected to the junction line VLI then, since his relay B_1 is energised, an energisation of relay A_1 is prevented so that the subscriber's conversation over the other junction line is not disturbed.

Since, in the present case, the subscriber T_{n2} makes a call, after the switch is first stepped-on there is still no test circuit completed and after the energisation of relay Y and the closing of contact $60y$, the winding I of relay K , is energised again over: earth, battery, winding I of relay K , contact $60y$, resistance W_{12} , contacts $54b$, $53v$, wiper mw_2 on segment $1-5$, earth. The relay K over its contact $26k$ connects battery to the b -conductor. The interaction described above is repeated so that in the sub-exchange the selector is advanced by a further step and by sending back an impulse over the a -conductor of the junction VLI the relay A in the main exchange is also advanced by a further step. After the second step relay A_2 is energised as long as relay Y is energised over: earth, battery, resistance W_{11} , contacts $37y$, $33x_1$, wiper mw_1 on segment $1-6$, a -conductor of the junction line VLI , contact $18u_1$, wiper w_1 on contact 2, winding I of relay A_2 , contact $16b_2$, earth. The relay A_2 disconnects the calling subscriber T_{n2} from the junction VLI . Moreover, the calling subscriber is connected over contact $3a_2$ with a branch, used for all subscribers, multiplied to the a -conductor at which branch a condenser is connected for bridging over the A -relay, while at contact $86a_2$ a corresponding connection is effective for bridging over the relay U_1 at the b -conductor. In this special arrangement two condensers only are used for bridging over the relays at each conductor for all the subscribers.

After these operations, taking place over the subscriber's loop the following circuit is completed: earth, battery, resistance W_{11} , contacts $37y$, $33x_1$, wiper mw_1 on segment $1-6$, a -conductor of the junction line VLI , contact $13dw_1$, wiper w_1 , on the contact 2, winding II of relay A_2 , contact $1b_2$, subscriber T_{n2} , contact $84b_2$, $5a_2$, relay U_1 , contact $19u_1$, earth. In this circuit relay A_2 remains energised while relay U_1 is energised so that, with disconnection of earth at contact $19u_1$ and of the rotary magnet Dw_1 at contact $18u_1$, the b -conductor of the junction line VLI between the calling subscriber T_{n2} and the main exchange HA is switched through over the contact $28u_1$. Over the calling subscriber's loop the relay B , connected to the b -conductor of the junction line VLI , is now energised in series with relays U_1 and A_2 since contact $61k$ is closed. By the opening of contact $50b$ a further energisation of the rotary magnet Dm_w is prevented. Relay Y now restores and in place of the resistance W_{11} connects the relay A to the a -conductor so that now this relay is energised in series with the relays A_2 , U_1 and B .

Meanwhile, by the closing of contact $69b$, the relay R_1 is energised over the choke D_1 for the purpose of starting-up the pre-selector VW_1 . Further, contact $63b$ closes, connecting the winding I of relay V so that, contact $111v$ closing, the following circuit is completed (1): earth, battery, windings I and II of relay P_1 , contacts $110y$, $111v$, wiper mw_5 on contact 2, resistance W_{12} , earth. At contact $109p_1$ the high resistance winding II of relay P_1 is short-circuited so that at the main exchange the calling subscriber's line is indicated as being locked. Should the subscriber T_{n2} now be called over the junction line VLI according to the positioning of the wiper mw_5 (II), in the

manner explained later, the relay P_2 is not energised. As a result earth potential (compare VLI: earth, W_{15} , $81p_1$) is not connected over a p_2 -contact to the b -conductor of the junction line VLII to the series final selector, as can be seen in the case of the junction VLI, whereby a relay operated up till the reply of the required subscriber over the b -conductor of the final selector is restored and on transmission of an engaged signal from the final selector the test conductor c of the junction line of the sub-exchange is disconnected so that this junction line is released. A further connection to the subscriber already engaged is thus prevented. It can be seen that in the main exchange HA the line of the calling sub-exchange subscriber Tn_2 is marked as being engaged by means of the relay P_1 so that connections over the other line cannot be put through to him.

If, in the meanwhile, the pre-selector VWI started up by the call impulse, has found a free selector, then, in known manner the relay T_1 is energised whereby the calling subscriber is switched through over the wipers of the pre-selector VWI to the numerical impulse receiver. When the subscriber Tn_2 operates his dial switch the relays A and B are restored intermittently by interruption of the subscriber's loop so that by the corresponding interruption of the contact $69b$ a transfer of impulses for setting the subsequent numerical impulse receiver occurs. When the required subscriber has been reached after transmission of the necessary impulse trains, there follows transmission of ringing current. When he replies, the ringing current is disconnected in the known manner and a metering impulse is transmitted over the test conductor by which the winding I of relay Z is operated. By the closing of the contact 115_2 the meter Z_2 corresponding to the calling subscriber Tn_2 and connected to contact 2 over the wiper mw_6 of the switch in the main exchange, is operated.

When the calling subscriber hangs up at the end of a conversation the relays A and B and, a short while later, relays A_2 and U_1 are restored by the interruption of the subscriber's loop. By the opening of contact $69b$ the numerical receiver is released as well as the pre-selector VWI which, over its wiper c , after it has restored to normal, short-circuits the winding II of relay V which after the disconnection of winding I has hitherto remained energised over contact $76v$. The holding circuit of winding II of relay X_1 is interrupted by the opening of contact $52v$ so that, during the following return movement, of the selector in the sub-exchange, a testing by a calling subscriber is prevented by means of the relay B (contact $62x_1$ open). After the release of relay V and on the opening of contact $111v$ relay P_1 is also disconnected. By the closing of contact $53v$ winding I of relay K is further energised so that now the stepping-on of the sub-exchange selector which is of not further interest, and of the switch in the main exchange to their normal positions, takes place. When the sub-exchange selector has taken its final step, as long as the rotary magnet Dw_1 is still energised, relays M_{11} and M_{12} are energised over contact $10dw_1$ over the a -conductor of the junction line VLI and resistance W_{10} and over the winding I of relay X_1 so that when contact $11m_{12}$ closes after the disconnection of rotary magnet Dw_1 the permanent current circuit (already indicated) for 75

the multiple connection of the call circuits is closed.

As described above the relay B in the main exchange is energised during the existence of a connection over the junction line VLI so that at the junction line by the opening of contact $104b$ the short circuit for winding I of relay X_2 is removed. As a result a further call for setting-up an outgoing connection from the junction line VLII can be undertaken in one of the ways described above in connection with the junction line VLI. The switching arrangements of the junction line VLII, not shown in the drawings, operate in the same manner as those explained for the junction line VLI. The connected subscriber's line is locked by means of the relay P_2 over the wiper mw_5 (11).

If instead of an outgoing connection an incoming connection is set up then the final selector LW is first set by means of the characteristic digit of the sub-exchange UA. The final selector LW then tests which line is free in known manner, it then tests, therefore, the next junction line VLII since this is the first line connected in its contact bank. If this line is engaged it steps on to the junction line VLI. When this is free the relays Z, Y and T_1 are energised over the c -wiper of the final selector LW. Over the b -conductor the relay K (winding II) is energised, from the series final selector LW. The other switching operations (energising of relays Q, V, X_1) are performed after the rotary magnet Dw_1 has been connected to the b -conductor by the interruption of the permanent current circuit over the a -conductor (42y) by the relay K operated by the impulses transmitted over the b -conductor; this switch (44k) in the main exchange and the selector (27k) in the sub-exchange are stepped-on in synchronism. In the main exchange when these have been set, the relay P_1 tests to determine if the required subscriber marked by the positioning of the wiper mw_5 in the main exchange is free. Should this be the case, relay P_1 operates and after disconnecting the winding II of relay K (Y restores after the impulse transmission) over the contact $81p_1$, earth is connected to the b -conductor of the final selector so that a call is initiated. The required subscriber is connected by the operation of the corresponding A-relay over the wiper w_{11} after the selector in the sub-exchange has been set in position. At contact $56p_1$ relay B is connected to the b -conductor.

When the required subscriber replies the relays A, U_1 , B operate over the subscriber's loop in series with the already energised A-relay of the required subscriber. The disconnection of ringing current in the final selector is brought about by the opening of contact $80b$. Further operations are not of interest.

It should be noted that all switching operations described for the junction VLI in the setting-up of outgoing or incoming connections are performed in the manner when using the junction VLII.

While in Figs. 1 and 2 each subscriber is associated with a relay for each junction line, which according to the junction line to be used, disconnects him from the other junction line, in Fig. 3 each subscriber has two associated relays of which one relay in the normal position connects him with one junction line and in the operated position with the other junction line while the second relay disconnects the subscriber from the call circuit over the second junction

line. Further circuits correspond to those of Figs. 1 and 2. The main exchange HA can when setting up a connection over the first junction line be arranged in the same manner in this case.

In the normal position of the system the subscribers are connected to the multiplied call circuits of the two junction lines since the relays M13, M14, M23 and M24 are energised in the permanent current circuit and their contacts take up the positions shown.

If the upper junction line VMI is free a subscriber Tn3 can transmit a call impulse to the exchange over the call circuit, multiplied for all subscribers in common, and over the upper conductor of the junction VMI in the manner shown in Figs 1 and 2. The selector of this junction, after the disconnection of the permanent current circuit for relays M13 and M14, is set by the exchange on the calling subscriber. Relay B3, energised on the setting of the selector over its winding I, is maintained energised over the calling subscriber's loop in the speaking circuit. By the opening of the rest contact b3, the calling subscriber is disconnected from the call circuit over the lower junction.

If the upper junction VMI is engaged by a call of the subscriber Tn3 the relays M13 and M14 are restored, and the call impulse of the subscriber operates, over the upper conductor of the lower junction line VMII, on the associated call arrangements in the main exchange as is shown in Figs. 1 and 2. The selector at this junction is set into operation; when it is positioned on contact 3 relay A3 is energised over its winding I; it connects the calling subscriber Tn3 over operated contact a3 to the lower junction line VMII. Over the subscriber's loop this relay A3 (winding II) is maintained energised. The subscriber Tn3 is now disconnected from the call circuit over the upper junction line VMI at a further station.

It can be seen from the above description that on the energising of relay A3 the subscriber is connected to the lower junction while the call circuit extending over the upper junction is disconnected and that on energising of the relay B3 the calling subscriber remains connected to the upper junction while the call circuit extending over the lower junction is disconnected. In this way the switching technique of the construction of the sub-exchange UA is different in Fig. 3 from the sub-exchange UA of Fig. 1. The selector positioning and testing by the main exchange follows in the manner described with reference to Figs. 1 and 2.

I claim:

1. In a telephone system having main and sub-exchanges with trunk lines connecting the two, subscriber's lines in the sub-exchange normally connected to two of said trunk lines; all battery feed for said lines and connections therefrom supplied from the main exchange over said trunk lines, and switching arrangements in said sub-exchange operated responsive to a call from a subscriber's line in the sub-exchange to set up a connection over one of said trunk lines, said arrangements controlled by means in the main exchange to determine the trunk line over which the connection will be extended.

2. In a telephone system a main and a sub-exchange, trunk lines connecting said exchanges, a plurality of subscribers' lines in the sub-exchange, each line normally connected to the main

exchange over a plurality of said trunk lines, one of the connected trunk lines being first choice for calls to said lines from the main exchange and the other being first choice for calls to the main exchange, and means in the main exchange for determining which trunk will be used for either type of call.

3. In a trunking system, a main and a sub-exchange, a plurality of subscribers' lines in the sub-exchange, a plurality of trunk lines connecting said exchanges, each subscriber's line connected to a plurality of said trunk lines, a normally closed circuit including one of said trunk lines and a plurality of said subscribers' lines, means for controlling said circuit when a call is initiated from one of said subscriber's lines, all battery feed for the sub-exchange supplied solely over said trunk lines, and means in the main exchange for determining the trunk line to be used in extending the call to the main exchange.

4. In a telephone system, a main and a sub-exchange, subscribers' lines in the sub-exchange, a pair of trunk lines connecting said exchanges and supplying all battery feed thereto, a circuit for each trunk line normally including all of the subscribers' lines in the sub-exchange, means responsive to the initiation of a call at one of said lines for controlling said common circuits to extend connections to the main exchange over said trunk line, and means in the main exchange for determining the trunk line used.

5. A telephone system such as claimed in claim 4 wherein there is a circuit for each trunk line to each subscriber's line and controlled thereto to start the operation of said switches.

6. A telephone system as claimed in claim 4 wherein one of said trunk lines is always used as first choice for calls to said main exchange and the other as first choice for calls from said main exchange.

7. In a telephone system, a main and a sub-exchange, a plurality of trunk lines connecting said exchanges, subscribers' lines in the sub-exchange, each subscriber's line normally connected to all of said trunk lines, means responsive to the initiation of a call from one of said subscriber's lines for extending a connection to the main exchange over an idle one of said trunk lines and disconnecting said subscriber's line from the other trunk lines, and means in the main exchange operated when a call is originated in said main exchange for extending a connection to one of said subscriber's lines in the sub-exchange over one of said trunk lines and disconnecting it from the other trunk lines.

8. A telephone system such as claimed in claim 7 wherein all battery feed connections to the sub-exchange are supplied over said trunk lines from the main exchange.

9. In a telephone system, a main and a sub-exchange, a pair of trunk lines connecting said exchanges, subscribers' lines in the sub-exchange, a normally closed circuit for each trunk line including relays in the branch exchange normally energized, a plurality of branches for each circuit extending to all the subscribers' lines, said circuits all controlled by said relays, means controlled by the initiation of a call over one of the subscriber's lines for controlling its branch circuit to complete a connection to the main exchange over one of the trunk lines, and to operate certain of said relays to disconnect the seized trunk line from other subscribers' lines.

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