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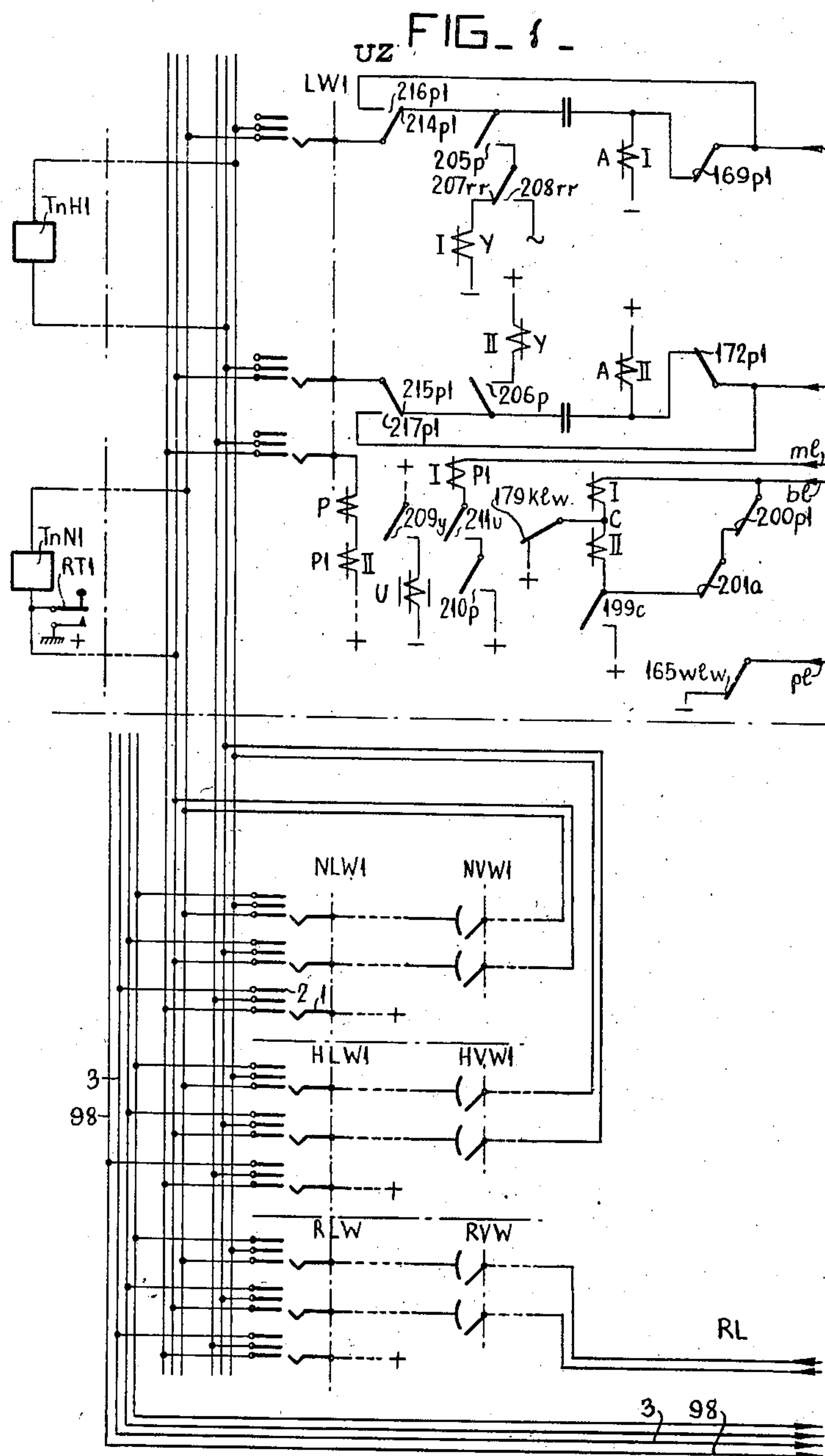
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2,267,178

TELEPHONE SYSTEM

Filed Aug. 25, 1939

5 Sheets-Sheet 1



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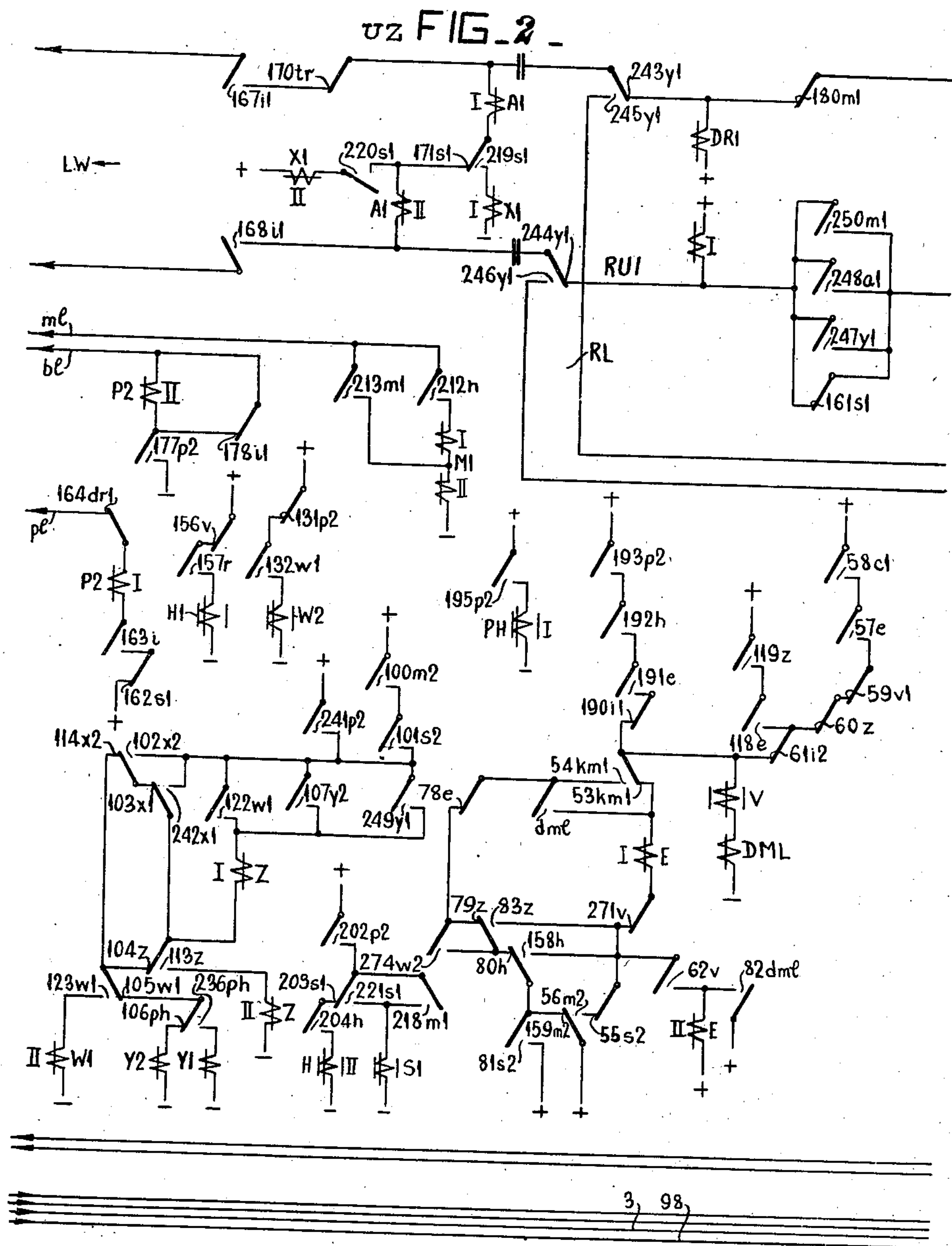
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TELEPHONE SYSTEM

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5 Sheets-Sheet 2



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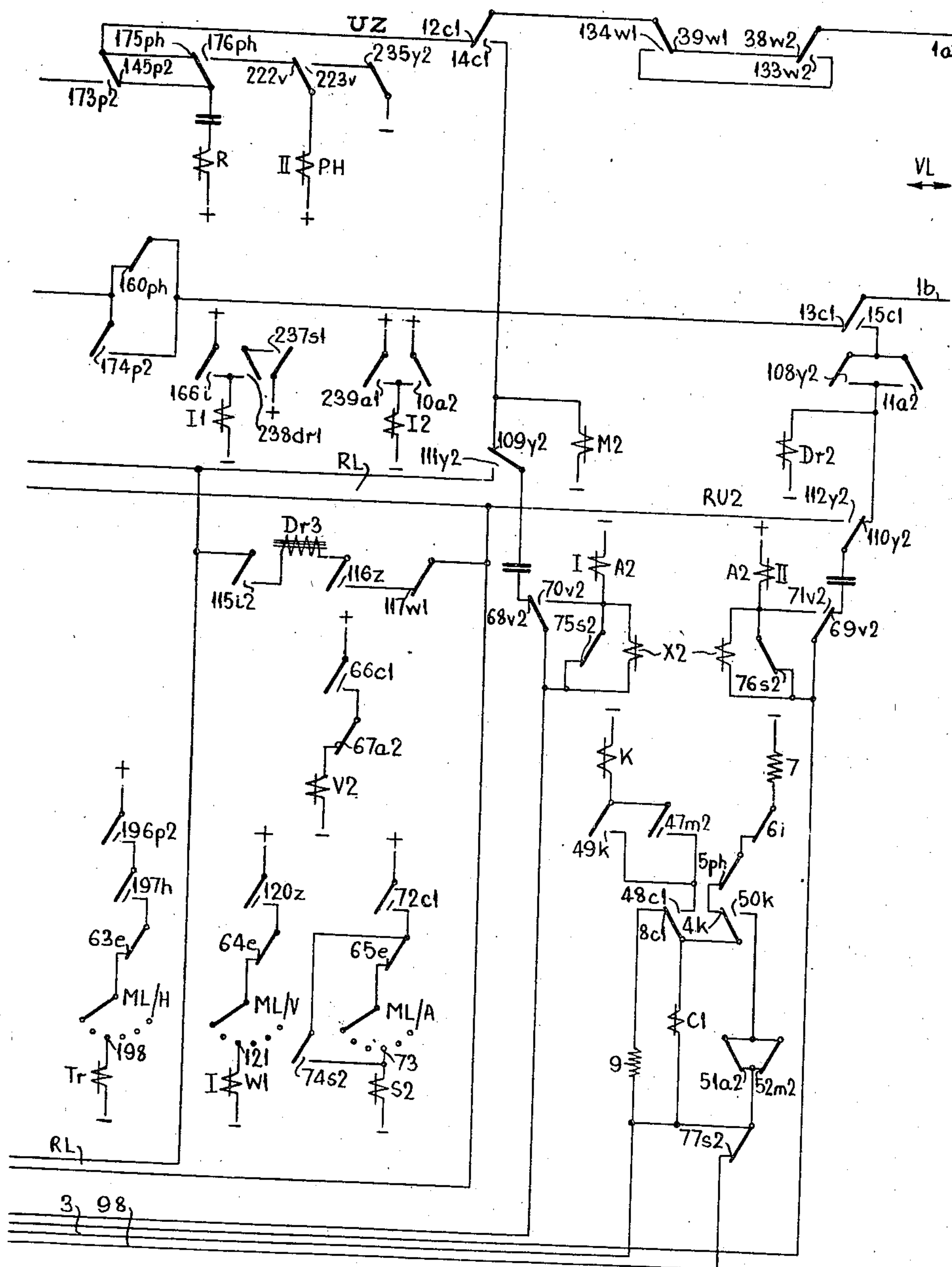
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TELEPHONE SYSTEM

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FIG. 3.



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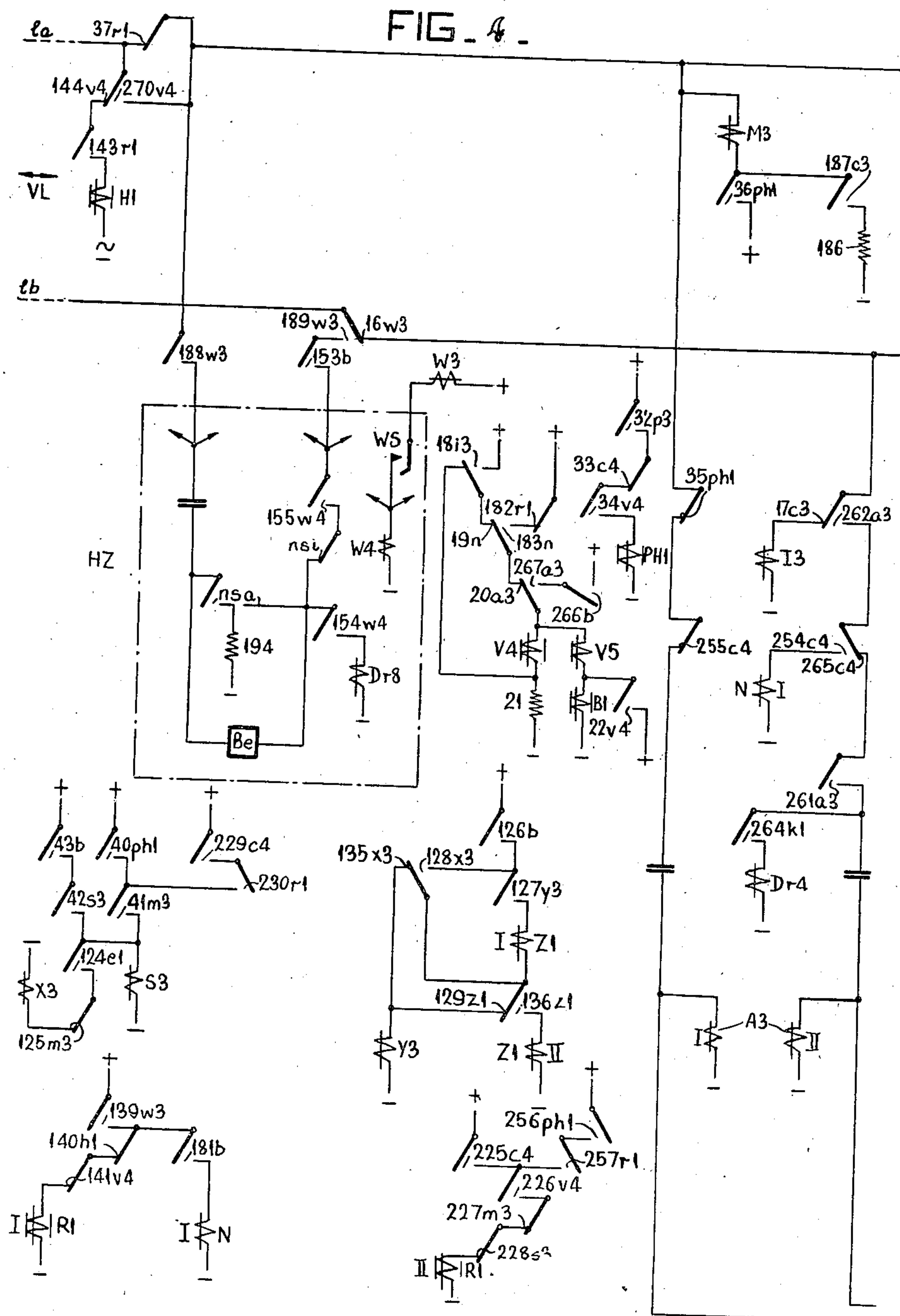
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TELEPHONE SYSTEM

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5 Sheets-Sheet 4



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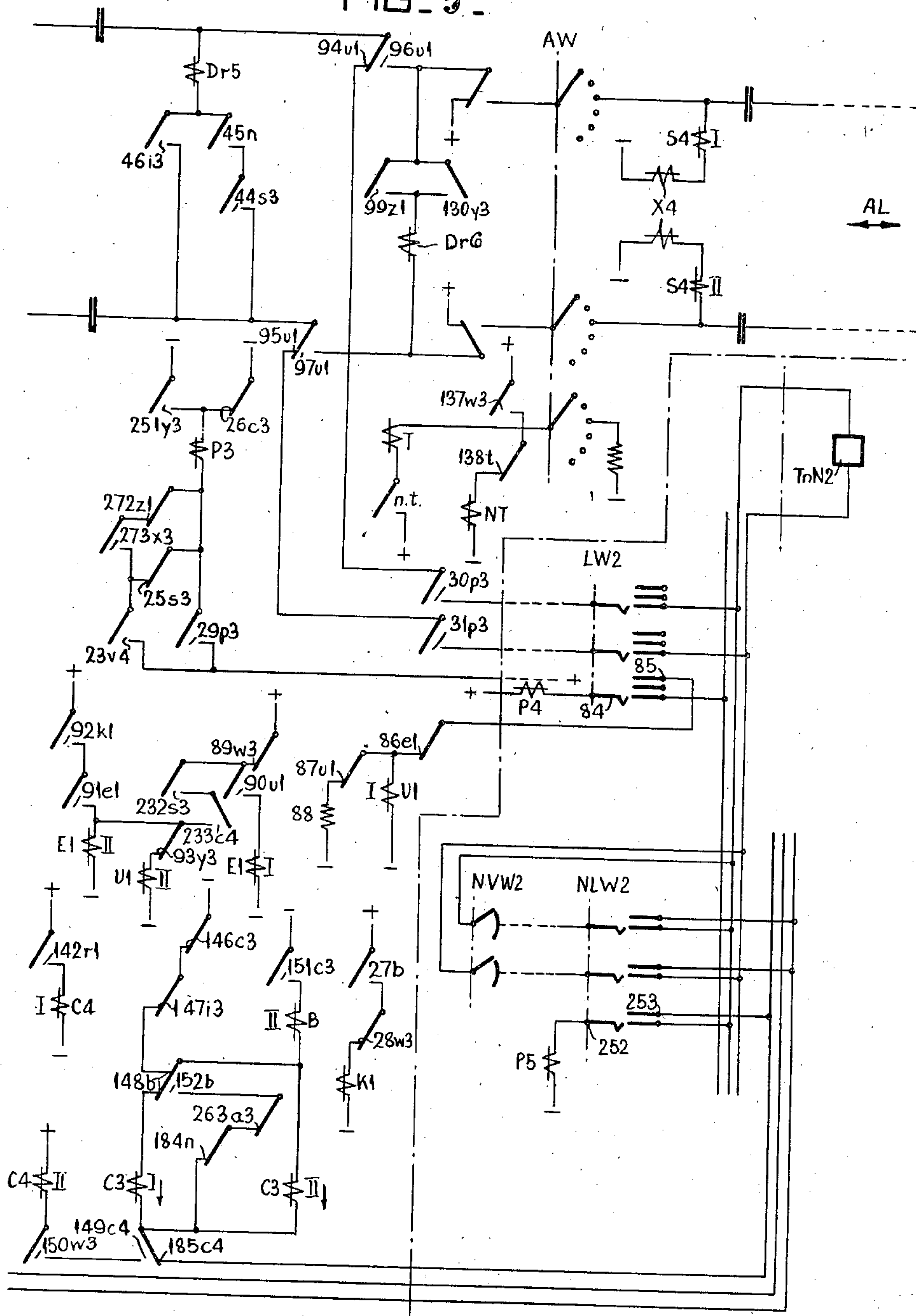
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TELEPHONE SYSTEM

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5 Sheets-Sheet 5

FIG. 5.



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TELEPHONE SYSTEM

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7 Claims. (Cl. 179—18)

In automatic telephone installations with a number of exchanges and in particular in private exchanges, it is often required to extend all high-valued connections with other telephone systems, i. e. exchange connections, over a particular exchange which is the main exchange. High-valued connections to and from subscribers of the other exchanges (sub-exchanges) must therefore be set up over connecting arrangements of at least two exchanges.

If subscribers with different traffic facilities are connected to these installations, e. g. private exchange stations and house telephone stations, and if moreover it is to be possible to set up revertive connections, then in setting up high-valued connections to and from subscribers of the sub-exchange considerable difficulties are experienced in testing the traffic facilities of the subscriber for the outgoing and incoming connections. During the setting up of a connection revertive switching is carried out in the calling subscriber's exchange, or in another exchange over which the high valued-connections extend, according to the traffic direction.

It has already been proposed in such telephone systems to determine the traffic facilities of the subscriber of a sub-exchange according to the traffic direction of the existing high-valued connection either in the sub-exchange or in the main exchange. The determination of the traffic facilities is performed for out-going connections by means of the discriminator in the sub-exchange and for incoming connections by means of a special selector connected in the main exchange in the talking connection and provided specially for this purpose. When a subscriber of the sub-exchange initiates a revertive connection and if the required subscriber is connected to the main exchange, then the impulse for carrying out the revertive connection in the main exchange is given by means of a numerical impulse receiver situated in the sub-exchange in the revertive path. Economically, this is only possible when between the main and sub-exchanges only one cross connecting line is present since, when there are several cross connecting lines, the transmission of the enquiry impulse over a cross connecting line connected in the exchange connection requires a considerable complication of the connecting path and arrangements of the sub-exchange.

The present invention has as its object the simplification of telephone systems with a number of exchanges and automatic operation whose subscribers have different traffic facilities and in

which high-valued connections are always extended over a main exchange, so that for testing the traffic facilities of the subscriber in the sub-exchange and for carrying out a revertive connection in the main exchange under the control of a subscriber of the sub-exchange the considerable complication due to different connecting apparatus, in particular, the provision of special wipers, is avoided. To obtain this result, discriminators are provided in an exchange at which, for high-valued connections junction lines to other systems, e. g. to a public exchange, are not completed for use, which discriminators control switch means, when a high-valued connection is set up, for determining the traffic facilities of a subscriber of the exchange and, when revertive connections are set up, control switch means in another exchange under the control of the marking operation by means of the revertively calling subscriber which bring about a revertive connection at the other exchange.

Since a single discriminator may control the testing of the traffic facilities and the control of the revertive connected station it is not necessary to provide the connecting apparatus of the exchange with extra wipers over and above those which are necessary for setting up and maintaining the connection. Testing operations and removal of disturbances can be rapidly performed since the switching operations in question are always controlled from one station by the discriminator.

The drawings show those connecting and control arrangements of a private telephone system, consisting of a main exchange HZ and an unsupervised sub-exchange UZ, which are necessary for the understanding of the invention.

By revertive enquiry connection is meant a connection set up by a subscriber who is already in an established connection and desires to hold the established connection and revert the call to another subscriber for the purpose of making an enquiry, after which the enquiry connection is released and the original connection reestablished to report the result of the enquiry.

In Figures 1, 2 and 3 arrangements for the sub-exchange UZ are shown and in Figures 4 and 5 arrangements for the main exchange HZ.

Before the individual connections are explained the general features of the installations will be indicated.

In the main exchange HZ the two-way exchange lines AL are terminated. The main and sub-exchanges are connected by a number of junctions (VL) over which the exchange traffic

of the private exchange subscriber with the sub-exchange the local traffic between subscribers connected to the various exchanges and also revertive conversations take place.

Each junction is associated in the sub-exchange with the discriminator which, when exchange and revertive connections are set up is positioned by means of the numerical impulses. It prevents exchange connections to and from local stations of the sub-exchange which are not permissible, and determines the revertive switching station to which the required subscriber is connected when setting up a revertive connection under the control of the exchange over which the enquiry connection must extend. If a subscriber of the sub-exchange sets up a local connection to the subscriber of the main exchange, the discriminator is positioned by means of numerical impulses but performs no switching operations. In local connections from the main to sub-exchanges the discriminator is not positioned by means of the numerical impulses.

In the embodiment shown in each of the two exchanges HZ and MZ pre-selectors and final selectors are used. In one exchange and also in both exchanges, one or more group selectors or finder switches can be used in place of pre-selectors and also primary and secondary line finders instead of simple pre-selectors. The selector equipment of the exchanges is not related to the subject of the invention.

1. Setting up of an exchange connection by the subscriber TnN1 of the sub-exchange

The calling subscriber TnN1 is connected by means of the selector NVW1 associated with his line and a further selector NLW1 with a free junction to the main exchange HZ. In the seizing circuit: +, test relay, not shown, in the first selector NLW1, wiper 1, contact 2, conductor 3, relay C1, contacts 4k, 5ph, 6i, resistance 7, —, relay C1 operates with a delay in view of the short circuit by contact 8cl and resistance 9 so that before the operation of its contact the talking conductors are switched through in the final selector NLW1 and the feeding bridge relay A2 of the seized access means to the junction line operated in the microphone feeding circuit. At contact 10a2 relay I2 is connected. Contact 11a2 in the access means to the conductor 1b to the junction VL is closed so that after the operation of relay C1 and opening of contacts 12cl, 13cl as well as the closing of contacts 14cl, 15cl minus is connected to both conductors 1a and 1b of the junction VL. At contact 58cl the circuit for the rotary magnet DML of the junction VL is prepared in the discriminator associated with the sub-exchange UZ.

Over the conductor 1b the seizing impulse is transmitted to the main exchange: —, relay Dr2, contacts 11a2, 15cl, conductor 1b, contacts 16w3, 17c3, relay I3, +. The relay I3 by opening contact 147i3 guards the junction VL against seizing over the selector of the main exchange. It connects the relay V4; +, contacts 18i3, 19n, 20a3, relay V4, resistance 21, —. At contact 22v4 relay B (winding I) is connected. At contact 27b the circuit extending over contact 28w3 for the relay K1 is closed. The contact 148b in series with the contact 147i3 is opened in the seizing circuit. Simultaneously relay P3 is also operated: +, in the final selector LW2 associated with the junction, contacts not shown in this selector, contacts 23v4, 25s3, relay P3, contact 26c3, —. At contact 29p3, the relay P3 locks up

independently of contact 23v4 and 25s3 in a circuit which is dependent on the contacts in the final selector LW2 not shown. At contact 30p3 and 31p3 the talking conductors to the final selector LW2 over which the numerical impulses are also transmitted are switched through.

The impulse receiver of the final selector LW2 not shown which bridged the talking conductors operates in the circuit over contacts 30p3, 94u1, choke Dr5, contacts 46i3, 95u1, 31p3 and carries out the known switching operations which make possible the setting of the final selector by means of numerical impulses. The relay Ph1 is connected: +, contacts 32p3, 33c4, 34v4, relay PH1, —. At contact 35ph1 one conductor of the access means to a junction line VL from the final selector of the main exchange HZ is opened and at contact 36ph1 a circuit is closed over the conductor 1a over the junction VL: +, contact 36ph1, relay M3, contact 37r1 or 270v4, conductor 1a, contacts 38w2, 39w1, 14cl, relay M2, —. Both relays M3 in the main exchange and M2 in the sub-exchange operate.

In the main exchange relay S3 is connected: +, contacts 40ph1, 41m3, relay S3, —. At contact 42s3 it locks up dependent on contact 43b. The closing of contact 44s3 in series with the choke Dr5 is without significance since contact 45n is opened.

In the sub-exchange UZ relay M2 has completed at contact 47m2 the energising circuit for relay K prepared at contact 48cl and extending over relay C1 and the test relay of the final selector NLW1. Relay K locks up at contact 49k, opens the original energising circuit for relay C1 at contact 4k and by closing contact 50k prepares the short circuit of the relay C1 which comes into effect on the release of the connection when contacts 51a2 and 52m2 are closed continuously. For the time being contacts 51a2 and 52m2 are opened.

Relay M2 also connects relay E: —, rotary magnet DML, control relay V, principal contact of the discriminator 53km1, winding I of relay E, contact 271v, 55s2, 56m2, +. Only relay E operates. It closes contact 57e in the energising circuit for rotary magnet DML still open at contact 61i2.

The calling subscriber TnN1 transmits the marking digit, for example "0," for impulse trains corresponding to the exchange connection (10 impulses). These impulses are effective on the relay A2 which by means of contact 10a2 controls the impulse repeating relay I2 and by means of the contact 11a2 transmits the impulses to the impulsing relay I3 in the main exchange HZ. The relay I3 by means of its contact 46i3 transmits the impulses to the impulsing relay, not shown, in the final selector LW2 which is thus stepped up to the fourth bank. The further switching operations in the main exchange are explained later.

In the sub-exchange relay I2 on each release closes the circuit for rotary magnet DML: +, contacts 58cl, 57e, 59v1, 60z, 61i2, control relay V, rotary magnet DML, —. The control relay V is energised and maintains its armatures operated during the impulse train. At contact 271v it opens the energising circuit over the winding I of relay E and at contact 62v closes a holding circuit over winding II of this relay. On the first rotary step of the discriminator the off-normal contact 53km1 is opened and the off-normal contact 54km1 closed. The relay E has opened contacts 63e, 64e, 65e and therefore dur-

ing the positioning of the selector over the wipers ML/H, ML/V and ML/A switching operations cannot be performed. On the first release of relay A2 relay V2 is connected: +, contacts 66c1, 67a2, relay V2, —. The contacts 68v2, 69v2 are opened and contacts 70v2, 71v2 closed.

At the end of the impulse transmission and when contacts 61i2 and 67a2 are maintained open relays V, V2 and E restore. Over the discriminators set corresponding to the marking digit for exchange connections, the traffic facilities of the calling subscriber are now determined. For this purpose over the wiper ML/A relay S2 is connected: +, contacts 72c1, 65e, wiper ML/A, contact 73, relay S2, —. Relay S2 locks up at contact 74s2 independently of contact 65e, wiper ML/A and contact 73, until the release of the connection, and at contacts 75s2 and 76s2 it opens the short circuit for windings I and II of the difference relay X2 in series with relay A2 and further opens the contact 77s2 in the seizing conductor 93 which can only be reached over the final selector HLW1, with which only the group of subscribers (local stations) which are not authorized for exchange connections are associated. The effect of contact 77s2 is explained later.

The energising of relay S2 results in the immediate setting of the discriminator to its normal position. The circuit for the magnet DML and the control relay V is completed: —, magnet DML, relay V, off-normal contact 34km1, contacts 78e, 79z, 80h, 81s2, +. The discriminator steps on by one step. Over the contact 82dm1 relay E (winding II) is energised and at contact 78e opens the circuit for the driving magnet DML and the control relay V. The rotary magnet restores more quickly than the control relay and disconnects the winding II of relay E. This interaction between the magnet DML and the relay E continues until the discriminator has reached the normal position. In this position the off-normal contact 54km1 is opened and the energising circuits for DML and V can no longer be closed. Also on the release of relay V further closing of the circuit for magnet DML is not possible over the off-normal contact 53km1 since the contacts 83z, 55s2 and 153h in series with contact 27iv are opened.

In the main exchange after the setting of the final selector by means of the impulse train corresponding to the marking digit for exchange connection over a contact of the final selector, e. g. over bank contact or as shown over a bank contact of the selecting group on to which the final selector automatically rotates, the relay U1 is energised: +, test relay P4, wiper 84 and contact 85 of the final selector LW2, contact 86e1, winding I of relay U1, —. Parallel to winding I the resistance 88 is connected over the contact 87u1. The relay U1 operates and is slow-to-energise. It closes a circuit over winding I of relay E1: +, contacts 89w3, 90u1, relay E1, winding I, —. At contact 91e1 a holding circuit is set up over winding II of relays E1 and U1: +, contacts 92k1, 91e1, winding II of relay E1, — and contact 93y3, winding II of relay U1, —. At contacts 94u1 and 95u1 the conductors extending to the final selector LW2 are disconnected from the junction VL. The latter is connected over contacts 96u1 and 97u1 with the conductors which extend to the exchange selector AW. As the exchange selector instead of distributors finder switches can also be used.

On the opening of contacts 94u1, 95u1 the re-

lays in the final selector LW2 bridging the talking conductors restore and bring about the release of the final selector. By means of the control arrangements + is thus disconnected from the holding relay P3 so that the contacts 30p3 and 31p3 are opened.

In bridge between the conductors extending to the exchange selector AW the choke Dr5 is now connected over contact 46i3. The exchange selector AW selects a free outgoing exchange line AL. The bridge relay S4 is energised in the circuit extending over the choke Dr5 and brings about the known switching operations necessary for the further setting up of the exchange connection. The difference relay X4 is not energised.

By means of the contact 46i3 the impulses transmitted for the calling subscriber and serving to set the selector in the public exchange are repeated to the impulse repeating relay S4 which transmits these impulses to the impulse receiving apparatus in the selectors of the public exchange.

At the end of the connection the release of the connecting arrangements in the private exchange system (HZ, UZ) is performed in the usual manner when the subscriber TnN1 hangs up his receiver and causes the feeding bridge to restore.

II. The subscriber TnH1 initiates an exchange connection

In addition to the subscribers (such as TnN1) authorized for exchange connections subscribers are included in the sub-exchange UZ who may only set up connections with subscribers of the private system. The subscriber TnH1 represents such a local station.

It is assumed that the private stations and the local stations do not use the same numerical impulse receiver but that for each subscriber group a selector group (NLW for private stations, HLW for local stations) is provided. It is understood that both groups of subscribers have access to the same numerical impulse receivers and dependent on the equipment of the subscribers circuit in the exchange the traffic facilities of the calling subscriber to the access means of the junction are marked.

When the subscriber TnH1 makes a call the preselector HVW1 seizes a free final selector HLW1 which is positioned by means of numerical impulse trains corresponding to the marking digits for connections over main exchange HZ and thereupon seizes a free junction VL.

The seizing circuit does not extend over the seizing conductor 3 connected only to the final selectors NLW and RLW, but over the special seizing conductor 93 and the contact 77s2 in this conductor. The switching operations described in section I are carried out. On the selection of the marking digit for exchange connections the relay S2 is energised over the wiper ML/A and opens the contact 77s2 in the seizing circuit. The relay C1 and the test relay in the final selector HLW1 in series with it restore. The connection of the junction of the subscriber TnH1 with the trunk is discontinued. The final selector is released. The discriminator in the sub-exchange UZ has thus prevented the setting up of an exchange connection by means of a subscriber TnH1 who is not authorised to do so.

By the opening of contacts 14c1, 15c1, the circuit over the relays I3 and M3 is opened. These relays do not remain energised since on the clos-

ing of contacts 12c1, 13c1 the necessary negative potential is not connected to the conductors 1a and 1b in the sub-exchange. The relays 13 and M3 restore the arrangement in the main exchange to its normal condition.

III. Setting up of a revertive connection by the subscriber TnN1 connected in the outgoing trunk

Each junction VL is provided in sub-exchange with two revertive switching points RU1 and RU2. The first (RU1) serves for connecting the revertive line RL on initiation of an enquiry during an incoming exchange connection, and the second (RU2) for connecting the enquiry line on initiation of an enquiry during an outgoing exchange connection. As revertive switching relay groups, relays Y1 and Z are used for incoming exchange connections which are controlled by relay X1 and on outgoing exchange connections the relays Y2, Z which are controlled by the relay X2.

Since the subscriber TnN1 is in an outgoing exchange connection the circuits of relays Y2 and Z are prepared at the contacts 100m2, 101s2 and 106ph.

For initiating a revertive connection the subscriber TnN1 momentarily presses the enquiry key RT1 at his apparatus. Thus the subscribers loop is earthed. The differential relay X2, transmitting the revertive impulse, which is in series with relay A2 operates and completes the energising circuit for relay Y2: +, contacts 100m2, 101s2, 102x2, 103x1, 104z, 105w1, 106ph, relay Y2, —. Contact 107y2 is closed. Relay Z can however not operate since its winding I is short-circuited over the contacts 102x2 and 103x1. Contact 11a2 is short-circuited over contact 108y2. Thus the impulses serving to determine the traffic direction of the revertive connection (sub-exchange or main exchange) are prevented from operating arrangements in main exchange. By the opening of contacts 109y2, 110y2 and the closing of contacts 111y2 and 112y2 the talking conductors from the final selector NLW1 are switched over at the revertive switching station RU2 to the revertive path RL.

The subscriber releases his revertive enquiry key RT1. The relay X2 restores. The contact 102x2 is opened. The short circuit for winding I of relay Z is removed. Relay Z operates and opens contact 104z and closes contact 113z. Both windings I and II of the relay Z are now connected in series. Parallel to winding II of relay Z the relay Y2 is connected over contacts 106ph, 105w1, 114x2, 103x1.

Choke Dr3 is connected over contacts 115i2, 116z, 117w1 in shunt across the talking conductors of the revertive enquiry line RL. The pre-selector RVW on this line in the local network hunts for a free final selector RLW.

A contact 119z a further circuit is prepared for the rotary magnet DML of the discriminator and at contact 83z relay E is connected: —, magnet DML, relay V, contact 53km1, winding I of relay E, contacts 271v, 83z, 80h, 81s2, +. Magnet DML and relay V do not operate. At contact 118e the circuit for rotary magnet DML is further prepared.

The first numerical impulse train transmitted by the enquiring subscriber serves to mark the exchange to which the required subscriber is to be connected. The impulses of this train are transmitted by means of the contact 115i2 of the impulsing relay in the impulse receiver of the

revertive enquiry path. Those impulse trains which serve to determine only the traffic direction are suppressed in the final selector RLW the position of which is not adjusted thereby.

If the revertive enquiry path extends over a group selector to which, for example, cross connections to other sub-exchanges which can be reached directly are connected, then by means of these numerical impulse trains the first group selector is positioned and corresponding to the number of effective impulses over a free final selector RLW, a cross connection outgoing to another sub-exchange or on selection of the marking digit of the main exchange a free contact is seized.

By means of the impulses of the first impulse train sent out from the subscriber for the purpose of setting up a revertive enquiry connection the discriminator is also positioned since on each release of the relay I2 the circuit of the magnet DML is completed: +, contacts 119z, 118e, 61i2, relay V, rotary magnet DML, —.

During the positioning of the discriminator the contact 271v is open, but relay E remains energised in the circuit: +, contacts 81s2, 80h, 83z, 62v, relay E, winding II, —. Thus the relay is prevented from energising over the wipers of the discriminator during the positioning operation at the end of the first impulse train since relays A2 and I2 remain energised and relays V and E restore.

The discriminator differentiates between different impulse trains received and thus determines whether the revertive connection is to be set up over the revertive enquiry switch (RU2) in the sub-exchange or over a revertive enquiry switch in the main exchange.

If the required subscriber is connected to the sub-exchange of the revertively calling subscriber or any sub-exchange which can be reached directly over the revertive enquiry line and a group selector, then after a corresponding impulse train comes into effect a wiper ML/V controlling the setting up of the revertive enquiry connection is set on a free contact. A switching operation is not initiated in this case.

If, on the other hand, impulse trains corresponding to the marking digits of the main exchange are effective, the revertive enquiry switching in the sub-exchange is discontinued, and revertive enquiry switching operations are carried out in the main exchange. For this purpose, the relay W1 is used with the relay W2 controlled by this relay.

Relay W1 is energised: +, contacts 120z, 64e, wiper ML/V, contact 121, winding I of relay W1, —, and closes the contact 122w1 in the circuit of the revertive enquiry switch relay group parallel to contact 107y2 and thus ensures that relay Z is maintained energised. At contact 105w1 it disconnects relay Y2 and locks up over contact 123w1 and winding II in a holding circuit: +, contacts 100m2, 101s2, 122w1, relay Z, winding I, contacts 103x1, 114x2, 123w1, relay W1 winding II, —.

Relay Y2 restores. At contacts 111y2, 112y2 it disconnects revertive enquiry line RL and at contacts 109y2 and 110y2 connects the revertively calling subscriber TnN1 with the junction VL again. By the opening of contact 108y2 the short circuit for the impulse contact 11a2 is removed.

At contact 117w1 the direct current bridge between the talking conductors of the revertive enquiry line RL is opened. The connecting apparatus of the enquiry path is released.

Thus the switching operation resulting when a connection is set up at the revertive enquiry position RU2 in the sub-exchange is released.

For carrying out the revertive enquiry connection in the main exchange the circuit existing over the conductor 1a of the junction VL is momentarily broken. This interruption takes place at contact 39w1. At contact 134w1 the further closing of this circuit and hence switching through of the conductor 1a is prepared.

On the opening of contact 39w1 the relay M3 restores in the main exchange and connects relay X3 controlling the revertive enquiry switch relay group Y3, Z1: +, contacts 43b, 42s3, 124e1, 125m3, relay X3, —. Relay X3 closes energising circuits for relays P3 and Y3: —, contact 26c3, relay P3, contacts 272z1, 273x3, 23v4, +, in final selector LW2 and +, contacts 126b, 128x3, 129z1, relay Y3, —.

Relay P3 at contact 29p3 locks up and at contacts 30p3, 31p3 switches through the conductors of the final selector LW2 and at contact 32p3 connects relay PH1.

The relay Y3 closes the contact 127y3. The relay Z1 however cannot operate since its winding I is short circuited at contact 128x3. At contact 93y3, the holding circuit extending over winding II of relay U1 is opened. Since relay U1 restores, the exchange line is disconnected at contacts 96u1, 97u1 and connects the final selector LW2, by closing contacts 94u1, 95u1, to the junction VL. The exchange connection is thus maintained since the choke Dr6 is connected over contact 130y3 between the talking conductors extending to the exchange selector AW.

When, in the subexchange, the slow-to-operate relay W2 connected by relay W1 has energised, contact 38w2 is opened and contact 133w2 closed and the conductor 1a of the junction is again switched through. The relay M3 in the main exchange again operates and disconnects relay X3. The contact 128x3 is opened and the contact 135x3 closed. The relay Z1 operates: +, contacts 126b, 127y3, relay Z1 winding I, contact 129z1, relay Y3, —. Contact 129z1 is opened and at contact 136z1 the winding II is connected. Relay Y3 is connected over contact 135x3 in parallel with winding II of relay Z1 and remains energised for a further period. The contact 99z1 in parallel with contact 130y3 in the holding bridge for the exchange line is closed.

The impulses transmitted from the calling subscriber for setting the final selector LW2 are repeated from the relay A2 by means of contact 11a2 to relay I3 and thence by means of contact 46i3 to the impulse receiving arrangements of the final selector LW2.

The relay W2 in the sub-exchange energises and causes the discriminator to be stepped-on to its normal position. At contact 274w2 the homing circuit is closed: +, contacts 81s2, 80h, 274w2, 78e, 54km1, relay V, rotary magnet DML, —. Over contact 33dm1 winding II of relay E is connected and opens the circuit for magnet DML at contact 78e. Magnet DML and relay E are alternately energised until the discriminator has reached the home position in which contact 54km1 is opened and contact 53km1 closed.

For setting up the exchange connection again when the revertive enquiry connection is finished further temporary interruption of the circuit over the conductor 1a of the junction is necessary. The revertively enquiring subscriber momentarily operates his enquiry key RT1. The relay X2 is energised and by opening contact

114x2 disconnects relay W1 (contact 104z is opened). Relay W1 opens contact 134w1 and closes contact 39w1. In the main exchange HZ relay M3 restores and over contact 125m3 causes relay X3 to energise. By the opening of contact 135x3 relay Y3 is disconnected and at contact 128x3 winding I of relay Z1 is short-circuited. Over the contact 128x3 the relay Z1 (winding II) is still maintained energised when on the release of relay Y3 the contact 127y3 is opened. The contact 130y3 in the holding bridge of the exchange line is opened. At contact 93y3 the circuit over the winding II of relay U1 is closed. The relay U1 disconnects the final selector LW2 and connects the junction VL to the conductors extending to the exchange selector AW again.

In addition to the switching operations already described relay X2 in the sub-exchange brings about the disconnection of winding I of relay Z at contact 122w1 and the completion of a holding circuit over the winding II of relay Z at contact 102x2.

On the release of relay W1 the slow relay W2 is disconnected at contact 132w1. When this restores after some time, and its contact 133w2 is opened and contact 38w2 closed, the conductor 1a is again switched through and the relay M3 in the main exchange operates.

The relay X3 is disconnected. At contact 128x3 the holding circuit of the winding II of relay Z1 is opened. After the release of relay Z1 the revertive enquiry switch relay group of the main exchange is again in the normal position. The holding bridge over Dr6 which maintains the exchange connection over the revertive enquiry is disconnected as now contact 99z1 is opened. The discontinuing of the revertive enquiry switch operation and the further setting up of the exchange connection of the main exchange therefore occurs independently of the termination of the switch operations by the subscriber TnN1.

When the subscriber TnN1 in order to set up the exchange connection again releases the enquiry key RT1 the relay X2 restores. At contact 102x2 the holding circuit over the winding II of relay Z is interrupted. When the relay Z has restored the revertive enquiry switch relay group of the sub-exchange consisting of the relays Y2, Z, W1, W2 is restored.

IV. Setting up an exchange connection to subscribers of the sub-exchange UZ

The operator receiving the call over the exchange line AL when a subscriber of the sub-exchange UZ is required actuates the selector key WS (Fig. 4) associated with the free junction to this sub-exchange. The relay W3 associated with the junction VL and the relay W4 common to all junctions are energised. The relay W3 disconnects conductor 1b at contact 16w3 and by closing contacts 188w3 and 189w3 connects the branch to the impulse sender at the junction line VL. The relay NT is also energised: +, 137w3, 133t, relay NT, —, and in known manner brings about the positioning of the exchange selector AW on the calling exchange line AL. The relay R1 is energised: +, contacts 139w3, 140h1, 141v4, relay R1, winding I, —. At contact 142r1 relay C4 (winding I) is connected. By the opening of contact 185c4 the junction is guarded against seizing over selector NLW2. Over the winding II of relay C4 a holding circuit is set up extending over winding I of relay C3: —, contacts 146c3, 147i3, 148b, winding I of relay C3,

contact 149c4, 150w3, winding II of relay C4, +. In view of the closing of contact 151c3 and opening of contact 146c3 relay B operates over its winding II. It opens contact 148b and closes contact 152b. At contact 181b the relay N is energised and at contact 183n prepares a circuit for relay V4.

At contact 37r1 the conductor 1a is interrupted and at contact 143r1 a circuit is set up over the conductor 1a to the sub-exchange UZ: A. C. source, relay H1, contacts 143r1, 144v4, conductor 1a, contacts 38w2, 39w1, 12c1, 145p2, and 175ph, condenser, relay R, +. In this circuit however relay R operates and connects relay H: +, contacts 156v, 157r, relay H, winding I, —. At contact 158h the circuit of relay E is closed: +, contacts 159m2, 158h, 271v, winding I of relay E, contact 53km1, relay V, rotary magnet DML, —. V and DL are not energised in this circuit. At contacts 191e and 192h the setting circuit for the discriminator is prepared. At contact 212h the reply circuit is prepared which is closed on the reply of a selected subscriber of a sub-exchange.

In the main exchange relay B closes a circuit over the conductor 1b of the junction: —, choke Dr8, contacts 154w4, nsi, 155w4, 153b, 189w3, conductor 1b, contacts 13c1, 160ph, 161s1, relay I, +. Relay I by opening contact 6i guards the junction VL against seizing over a selector of the sub-exchange and connects the test relay P2 which determines whether the selector LW1 is ready to operate: +, contacts 162s1, 163i, relay P2, winding I, contact 164dr1, conductor p1, rotary off-normal contact 165wlv of the final selector LW1, —. Simultaneously at contact 166i relay II is connected and at contact 178i1 removes the short circuit for winding II of relay P2 and at contacts 167i1 and 168i1 switches through the talking conductors to the final selector LW1. The relay A (final selector LW1) and relay A1 (junction line VL) operate: —, winding I of relay A, contacts 169p1, 167i1, 170tr, winding I of relay A1, contact 171s1, winding II of relay A1, contacts 168i1, 172p1, winding II of relay A, +. Relay A1 at contact 239a1 connects the relay I2 which transmits impulses for setting up a revertive enquiry connection, while relay A prepares the final selector LW1 to receive impulses. Contact 201a is opened.

Relay P2 has opened contact 145p2 and at contact 173p2 switched through the conductor 1a. Thus a circuit to be described later is completed over the conductor 1a of the junction. The contact 174p2 parallel to contact 160ph in the conductor 1b is closed. At contact 195p2 relay PH (winding I) is connected and opens contact 160ph in the conductor 1b. At contact 175ph relay R is finally disconnected from the conductor 1a over contact 176ph connects its own winding II to the conductor 1a. The relay P2 also completes the seizing circuit over the relay C of the final selector LW1: —, contact 177p2, winding II of relay P2, conductor b1, winding I of relay C, off-normal contact 179klw of final selector, +. Relay P2 remains energised over this circuit until the termination of the connection. Relay C prepares at contact 199c a holding circuit over its winding I and II which becomes effective after the opening of contact 179klw on the first vertical step of the final selector.

In the circuit set up after the energisation of relay P2 by the closing of contact 173p2 over the conductor 1a: +, relay Dr1, contacts 180m1, 173p2, 12c1, 39w1, 38w2, conductor 1a, contacts 144v4, 143r1, relay H1, —, relays Dr1 and H1 operate.

The relay H1 at contact 140h1 opens the circuit for relay R1 (winding I) which restores. Relay V4 operates: +, contacts 182r1, 183n, 20a3, relay V4, resistance 21, —. At contact 22v4 a holding circuit is completed for relay B over its winding I. The relay V5 is short-circuited and does not operate. After the closing of the contact 37r1 in the conductor 1a the relay M3 to which minus is connected over resistance 186 and contact 187c3 is energised.

The operator of the main exchange now transmits impulses for positioning the selector LW1 on the required subscriber's line. During the operation the talking apparatus Be is short-circuited at contact nsa. At the same time the resistance 194 is connected parallel to the choke Dr8. The impulse contact nsi on the operation of the dial switch interrupts the circuit of the impulsing relay I of the sub-exchange which repeats the impulses by means of contact 166i to the relay II. By means of the contacts 167i1 and 168i1 the impulses are transmitted to the impulsing relay A of the final selector LW1. At contact 190i1 on each release of relay II the rotary magnet DML is connected: +, contacts 193p2, 192h, 191e, 190i1, relay V, rotary magnet DML, —.

The first impulse train transmitted from the operator by which the first selector is positioned on a line group determines whether the required subscriber is authorised for exchange connections (private station) or not (public station). In order to evaluate these impulse trains and thus to mark the traffic facilities the discriminator is used again.

If by means of the positioning of the discriminator it is determined that a group of private subscribers has been selected, then at the end of the impulse trains when the relay E, energised during the setting operations of the discriminator, over its winding II and contacts 62v, 158h, 159m2, restores, a switch operation is not initiated over the discriminator.

If however by means of the first impulse train the wipers of the final selector LW1 are set on a contact group in which subscribers not having facilities for exchange connections are included i. e. public stations, then the wiper ML/H of the discriminator rests on contact 198. The cut-off relay Tr operates: +, contacts 196p2, 197h, 63e, wiper ML/H, contact 198, relay Tr, —. At contact 170tr the circuit over the relays A1 and A is interrupted, and both relays restore. The seizing relay C in the final selector LW1 is short-circuited at contact 201a. The contact 199c is opened and thus the holding circuit over the winding II of relay P2 is interrupted. The contacts 173p2 and 174p2 are opened. The winding I of relay PH is disconnected at contact 195p2 but relay PH remains energised in the circuit which extends over its winding II, the contacts 222v, 176ph, 145p2, conductor 1a and relay M3, and by keeping the contact 5ph open guards the junction VL against seizing over a selector of the sub-exchange. The relays I and Dr1 restore.

In the main exchange relay Dr8 restores and connects the signal (a lamp) by which the operator is informed that the required connection cannot be set up since the subscriber selected is not permitted facilities for exchange connections and therefore she connects herself once more with the calling exchange subscriber.

In the sub-exchange the release of relay P2 results in the release of relay H since its holding

circuit is open at contact 202p2. At contact 80h the circuit for releasing the discriminator is completed. The relay V energised during the release movement of the discriminator holds relay PH energised: +, winding II of relay PH, contacts 223v, 235y2, -. When the discriminator reaches its zero position relay V restores and thereupon relay PH which is now no longer connected over conductor 1a, since, in the meantime, in the main exchange negative has been disconnected from relay M3, which restores. This takes place in that when the selector key WS is set back to normal the relay W3 restores and, at contact 139w3, interrupts the circuit over the winding I of relay N. Relay N restores since the holding circuit over its winding II and conductor 1b is open in the sub-exchange at contacts 160ph and 174p2. At contact 184n, the winding II of relay C3 and at contact 19n the relay V4 are short-circuited and the relays C3 and V4 restore. Relay C3 disconnects negative from relay M3 at 187c3, and at contact 22v4 the relay B is disconnected.

On the determination of the exchange traffic facilities of the subscriber reached over the selected line group in the final selector, the relay Tr is not energised. By means of the second impulse train the wipers of the final selector LW1 are set on the contact of the required subscriber's line. The positioning of the discriminator by means of this impulse train does not occur since contact 191e is opened.

The discriminator remains in the position which it took up on the first impulse train since the relay H maintains its homing circuit open at contact 80h.

When the final selector LW1 has been set and the selected line is free only the test relay P of the two series relays P and P1 operates and brings about the known switching operations. Contacts 205p and 206p are closed. At definite time intervals, for example, every 10 seconds, a call relay not shown is energized which opens contacts 207rr and over contact 208rr connects a ringing current source. If the subscriber TnN1 replies in a call pause relay Y operates and disconnects the call relay. At contact 209y the relay U is connected and closes the reply circuit: +, contacts 210p, 211u, winding I of relay P1, conductor m1, contact 212h, windings I and II of relay M1, -. The relay P1 of the final selector opens contacts 169p1, 172p1, 214p, 215p1, and closes 216p1 and 217p1. The talking conductors in the final selector are metallically switched through. The subscriber TnN1 receives feeding current over the bridge across the junction line (relay A1). Relays A and Y restore. Relay C is not short-circuited since the contact 200p1 is opened. Relay U restores and at contact 211u interrupts the circuit transmitting the reply signal to the apparatus on the junction. The winding I of relay P1 is thus disconnected. This relay further holds over its winding II in locking circuit.

The relay M1 energised on the coming into effect of reply signal short-circuits its winding I at contact 213m1 and therefore restores slowly on the resulting interruption of the circuit (at contact 211u). At contact 218m1 the relay S1 is connected and by means of contact 180m1 reply signal is transmitted to the main exchange by momentary opening of the circuit over the conductor 1a.

The relay S1 locks up at contact 221s1 and at contact 203s1 opens the holding circuit for relay H which at contact 80h closes the previously described homing circuit for the discriminator. The

bridge relay A1 is operated. By the opening of contact 171s1 the direct connection of the two windings I and II is discontinued. At contact 219s1 the winding I of relay X1 connected with minus is connected to the winding I of relay A1 and at contact 220s1 the winding II of relay X1 connected with plus is connected to the winding II of relay A1. The relay X1 does not operate in the microphone feeding circuit since it is a difference relay.

In the main exchange the relay M3 is operated by the momentary interruption of the current over the conductor. It connects relay R1: +, contacts 225c4, 226v4, 227m3, 228s3, winding II of relay R1, -. This circuit is interrupted by the further energisation of relay M3. During the release period of relay R1 relay S3 is energized: +, contacts 229c4, 230r1, 41m3, relay S3, -. Relay S3 locks up in a circuit extending over its contact 42s3.

Relay U1 operates since the operator has already set back the selector switch WS to its normal position and the relay W3 has restored: +, contacts 89w3, 232s3, 233c4, 93y3, winding II of relay U1, -. Relay U1 connects the junction VL at contacts 96u1 and 97u1 with conductors extending to the positioned exchange selector AW and at contact 94u1 and 95u1 disconnects the access means to the final selector LW2. Parallel to the winding II of relay U1 is the winding II of relay E1 which also operates.

After the switching through of the junction VL to the exchange selector AW the bridge relay S4 in the exchange line AL operates and brings about the known switch operation on the exchange line whereby the maintenance of the exchange connection is made dependent on the subscriber of the sub-exchange UZ.

V. Setting up a revertive enquiry by the subscriber TnN1 called in an exchange connection

In an exchange connection to the subscriber of the sub-exchange the relay PH in this sub-exchange is energised and disconnects relay Y2, which operates in outgoing exchange connections on the revertive enquiry switching operations, at contact 106ph and for this purpose at contact 236ph connects the relay Y1 controlling the revertive enquiry switch station RU1 on incoming exchange connections. In order that during the impulse transmission over the junction necessary for a revertive enquiry connection to a subscriber of the main exchange the relay I1 will not be controlled by means of the relay I, connected in the impulse circuit over the conductor 1b, impulse contact 166i in its circuit is short-circuited by means of contacts 237s1 and 238dr1. The relay I2 connected at contact 239a1 repeats the numerical impulses which the subscriber transmits for setting up the revertive enquiry path to the numerical impulse receiver of the sub-exchange and to the circuit of the rotary magnet of the discriminator.

After initiating the revertive enquiry connection the subscriber TnN1 operates the enquiry key RT1 for a short time. The relay X1 operates and connects relay Y1: +, contacts 241p2, 242x1, 104z, 105w1, 236ph, relay Y1, -. The relay Y1 by opening contacts 243y1, 244y1 disconnects the junction VL from the connecting path to the enquiring subscriber and connects the latter over contacts 245y1 and 246y1 at the enquiry line RL. At contact 247y1 the impulse contact 248a1 is bridged over and thus the first numerical impulse train by which it is determined whether the re-

vertive enquiry connection is to be transmitted over the selector of the main exchange or over the selector of the sub-exchange is prevented from reaching the main exchange. The contact 249y1 in the circuit of the winding I of relay Z is closed. Relay Z cannot operate since its winding I is short-circuited at contact 242x1.

When the calling subscriber releases his enquiry key relay X1 restores, contact 242x1 is opened and contact 103x1 is closed. Relay Z operates and with its contact 113z locks up over its winding II. Relay Y1 also remains energised since it is connected parallel to winding II of relay Z in series with its winding I: —, relay Y1, contacts 236ph, 105w1, 114x2, 103x1, winding I of relay Z. At contact 116z the choke Dr3 is connected in shunt between the talking conductors in the revertive enquiry line RL. The revertive enquiry preselector RVW operates and seizes the free final selector RLW to be used for revertive connections.

The discriminator positioned by the first impulse train sent out from the calling subscriber determines the traffic direction of the revertive enquiry connection (to the sub-exchange or to the main exchange). If the main exchange is marked relay W1 is energised again and disconnects relay Y1 at contact 105w1. Contact 247y1 is opened and thus the short circuit for the impulse contact 248a1 is removed. At contacts 243y1 and 244y1 the talking line is switched through to the main exchange and by the opening of contacts 245y1, 246y1 the revertive enquiry line RL is disconnected.

The relays W1 and W2 operating one after the other, as described previously, transmit the marking signal consisting of a momentary interruption of the circuit over the conductor 1a for determining the revertive enquiry switching operation in the main exchange.

This marking signal is received by relay M3 which brings about the disconnection of relay U1 and hence the connection of the final selector LW2 to be used for the revertive enquiry connection. The energising circuit of relay P3 is closed by a relay Y3 at the contact 251y3 which is in parallel with contact 26c3.

The discontinuing of the enquiry connection and setting up of the exchange connection again takes place in the usual manner on the momentary pressing of the impulse key. The impulse for discontinuing the revertive enquiry connection is transmitted to the main exchange by the successive restoration of relays W1 and W2 momentarily interrupting the conductor 1a. All these operations are explained in detail in section III so that further explanation at this point is not necessary.

VI. Connection between subscriber TnN2, main exchange, and subscriber TnN1, subexchange

On the setting of the final selector NLW2 on a free outgoing junction VL to the sub-exchange, relays P5 and C3 in the test circuit operate: +, test relay P5, wiper 252, contacts 253, 185c4, parallel windings I and II of relay C3, contacts 148b, 147i3, 146c3, —. The two windings I and II of relay C3 are connected in opposite senses so that relay C3 operates slowly and actually only when, in the final selector NLW2, the talking conductors are metallically switched through and the bridge relay A3 of the seized access means to the junction is energised in the microphone feeding circuit. At contacts 261a3 and 262c3 the access

means to the conductor 1b of the junction is switched through and at contact 187c3 negative potential is connected to the relay M3. By the closing of contact 151c3 relay B (winding II) is connected and operates since contact 146c3 is open. At contact 148b winding I of relay C3 is disconnected and at contact 152b the release of the junction is prepared at the termination of the conversation. The winding II of relay C3 is now not short-circuited since contact 263a3 is open. At contact 27b the relay K1 is connected and at contact 264k1 the choke Dr4 connected to minus is extended to the conductor 1b.

A circuit is now set up over the conductor 1b of the junction and relay I in the sub-exchange: —, choke Dr4, contacts 264k1, 261a3, 265c4, 262c4, 16w3, conductor 1b, contacts 13c1, 160ph, 161s1, relay I, +. Relay I at contact 166i connects relay II and closes the circuit extending over the test line p1 for the relay P2 which operates and closes contacts 173p2 and 174p2. Relays Dr1 (UZ) and M3 (HZ) now operate: +, relay Dr1, contacts 180m1, 173p2, 12c1, 39w1, 38w2, conductor 1a, contacts 37r1 relay M3, contact 187c3, resistance 186, —. In the sub-exchange at contact 195p2 the winding I of relay PH is connected.

In the main exchange the connection of relay B results in the connection of relay V4: +, contacts 266b, 267a3, relay V4, resistance 21, —.

The impulses transmitted from the subscriber TnN2 for setting the final selector LW1 on the junction of the required subscriber are repeated from relay A3 by means of contact 261a3 to the impulse accepting relay I. The transmission of the impulses to the final selector takes place in the manner described. A positioning of the discriminator by means of the impulses for setting up the incoming local connection does not occur since relay H which is only energised when the alternating current impulse initiating an exchange connection is effective is in its normal position.

I claim:

1. In an automatic telephone system having a plurality of exchanges, trunk lines connecting a pair of said exchanges, subscribers' lines in one of said exchanges some having facilities for inter-exchange calls and others having facilities for only local calls, a discriminating switch for each trunk line operated on all calls between said exchanges over said trunk lines, means associated with said trunk lines for completing revertive inquiry calls in either exchange on calls over the trunk line in either direction, and means controlled by said discriminating switch for preventing exchange calls to subscribers not entitled thereto and also for controlling all revertive calls.

2. In a telephone system a pair of exchanges a trunk line connecting the two, subscribers' lines in one exchange entitled to high valued calls and others only to low valued calls, a discriminator switch associated with said trunk in said one exchange and operated during the extension of calls over said trunk line, means associated with the trunk line for extending high valued calls and revertive inquiry calls in either exchange, means operated in one position of the switch for permitting or preventing high valued calls dependent on the line calling, means operative in another position of the switch for controlling inquiry calls in one exchange, and means operative in another position of the switch for

permitting or preventing calls of high value dependent on the line called.

3. In a telephone system, a trunk line extending between two exchanges, means for extending calls in either direction over said trunk line, a discriminator switch in one of said exchanges, said switch operated in calls over said trunk line, certain of the lines in said one exchange having facilities for high valued calls and others for only local calls, means controlled in one position of the discriminator switch for preventing calls to the other exchange from lines not having the proper facilities for such calls, and means controlled in another position of the switch for preventing calls from the other exchange to lines having facilities for only local connections.

4. In a telephone system, a trunk line extending between two exchanges, means for extending connections over said trunk line in either direction, said trunk line terminating at each end in automatic switches for extending such connections, other branches associated with said trunk line in each exchange for connection therewith to complete inquiry calls, a discriminator switch associated with said trunk line in one exchange and operated in calls in both directions thereover to control the extension of inquiry calls over said branches.

5. A telephone system as claimed in claim 4 in which there are certain subscribers in one

exchange having means for effecting inquiry calls by means of said branches and other subscribers not having such means.

6. In a telephone system, an inter-exchange trunk line, means for extending connections in either direction thereover, branches at each end of said trunk for seizing the same, other branches for each end thereof containing switches for extending connections therefrom, other branches for extending revertive inquiry connections from the trunk line, and a discriminator switch associated with said trunk line and operated by impulses transmitted to the trunk in connections thereover in either direction to control the extension of connections over said branches.

7. In a telephone system, a two way trunk line extending between two exchanges, subscribers' lines in one exchange divided into two classes, branches associated with said trunk lines and available to subscribers of only one class for connection with said trunk lines for making revertive inquiry calls when connections are extended over said trunk line, a discriminator switch associated with said trunk line in said one exchange, said switch operated in calls over the trunk line in accordance with the destination of such calls to render said branches available for revertive calls.

HERMANN ERNST v. KÖNIG.