

June 24, 1941.

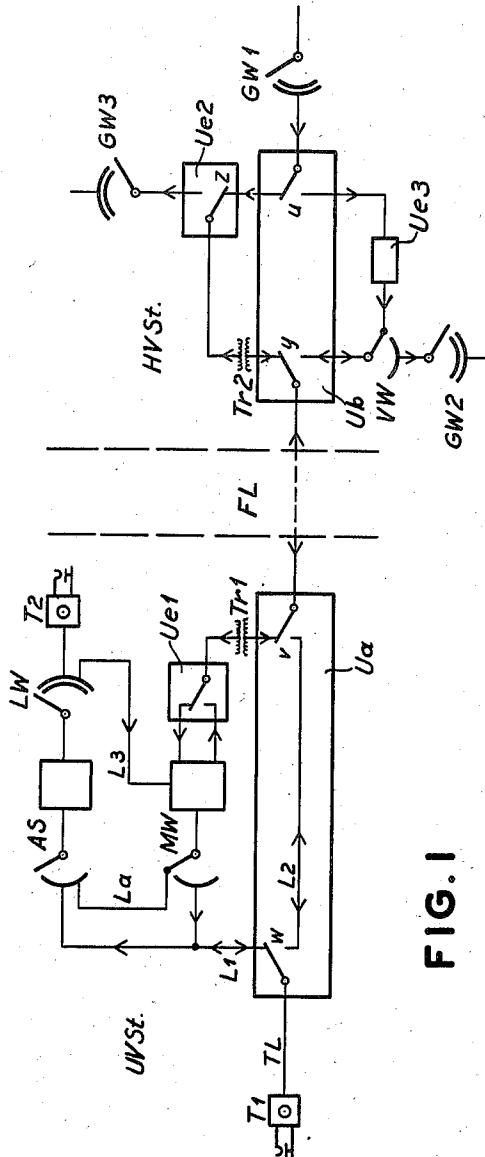
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AUTOMATIC TELEPHONE SYSTEM

Filed Dec. 21, 1938

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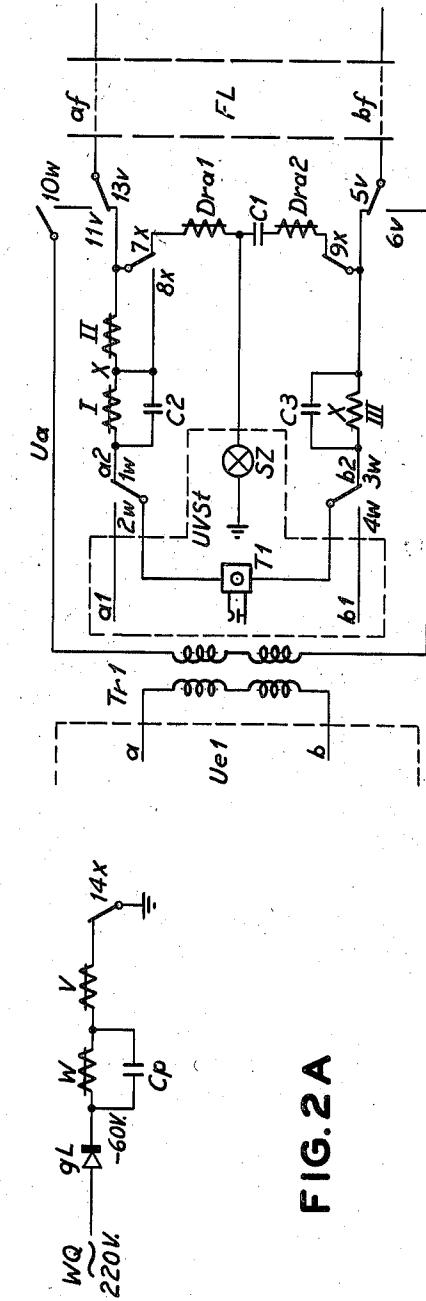


FIG. 2A

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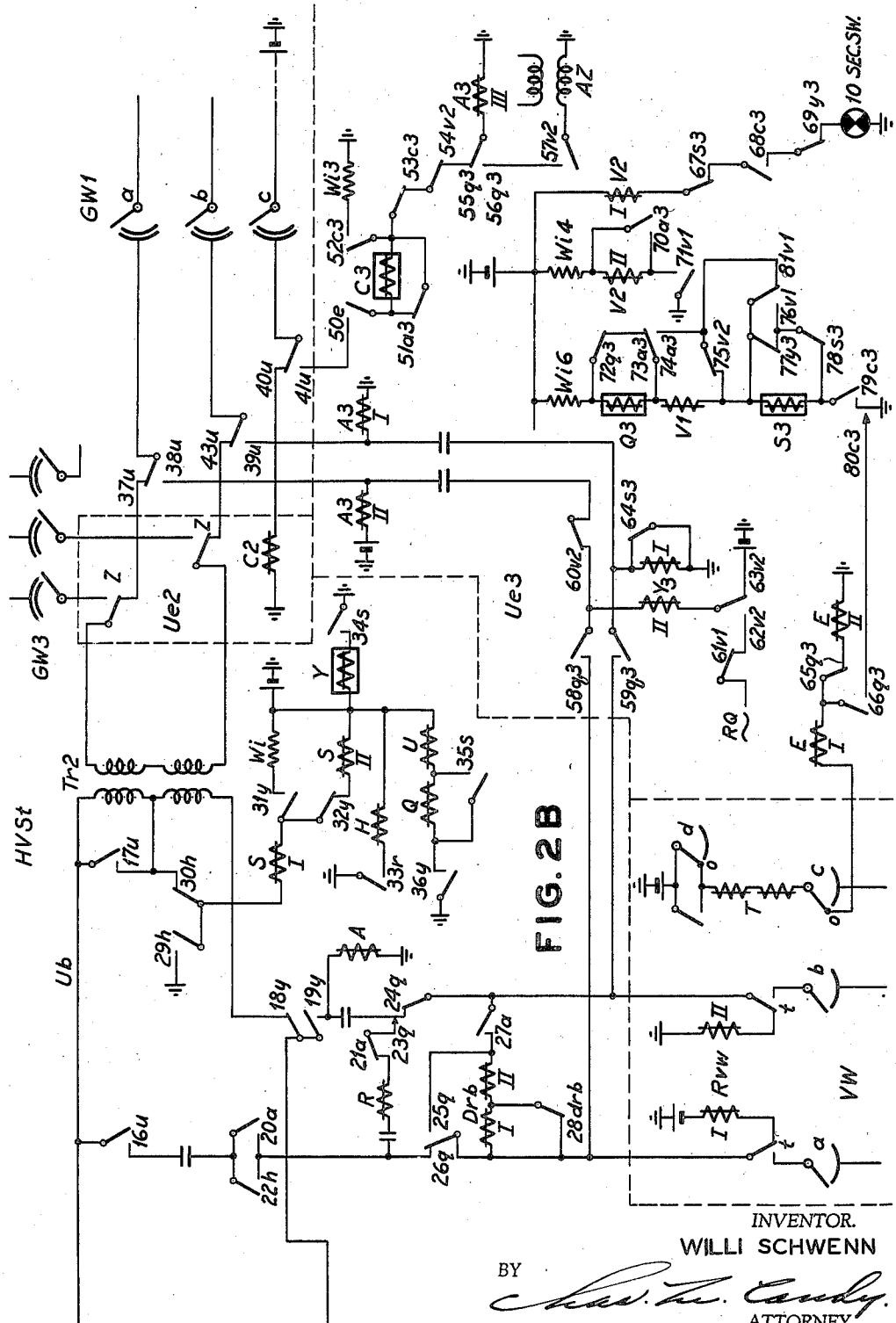
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2 Sheets-Sheet 2



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AUTOMATIC TELEPHONE SYSTEM

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12 Claims. (Cl. 179—23)

The invention relates to automatic telephone installations in which a local, for example, a sub-exchange is supplied with current from the lighting mains in which on failure of the power supply, receives current over a junction line from the main exchange.

With known arrangements of this kind the case is simple as under undisturbed condition of the installation the dialled impulses do not pass through an intermediate repeater, are pure direct current and are only sent in one direction, viz. from the sub-exchange to the main exchange over the connecting line.

The problem of drawing current from the main exchange on failure of the power supply is very much more difficult when dealing with installations in which both-way operation is effected and the dialling pulses are transmitted as inductive direct currents or alternating currents. In such installations on account of the necessity of good impulsing and speech transmission, contrary to the known arrangements, no current feeding source can be applied to the connecting line under normal circumstances. In order in such systems, to ensure the auxiliary feeding means to the sub-exchange from the main exchange there are, in accordance with the invention, at the ends of the connecting line supervisory means provided which on failure of the local current supply bring into operation switching means at the sub-exchange and these effect the connection of a source of current in the main exchange HVSt to the junction lines.

The invention will best be understood by reference to the specification and the accompanying drawings, in which Fig. 1 is a schematic diagram illustrating a sub-exchange UVSt, a main exchange HVSt, interconnecting trunk line FL, and the associated switching apparatus in each exchange. Figs 2A and 2B show the detail circuits of the schematic diagram which are necessary for a complete understanding of the invention. Fig. 2A shows the equipment in the sub-exchange at one end of the trunk line FL and Fig. 2B shows the equipment in the main exchange at the other end of the trunk line FL.

Fig. 1 is a schematic diagram of the arrangement by which the sub-exchange UVSt is connected through transformers Tr1, Tr2 in the two-way trunk line FL to the main exchange. The subscriber of the sub-exchange is fed with current from the local lighting mains through a rectifier. The internal connections of the sub-exchange are so arranged that the calling subscriber, T1 for example, on taking down his re-

ceiver causes a call finder AS to set itself on the calling line. By means of his calling dial the subscriber sends out impulses which position the line selector connected to the call finder on to the terminals of the desired subscriber, say, T2.

Connections which pass from the sub-exchange over the line FL to the main exchange can be effected in two ways. Either the subscriber, after a call finder has set itself on his line selects, by dialling a special digit, the line selector LW which is connected via repeater Ue1 to line L3. Further digits are then transmitted from the repeater Ue1 via the transformer Tr1, line FL to the transformer Tr2, repeater Ue2, group selector GW3 of the main exchange. The direct current pulses from the calling subscriber become inductive direct current pulses in the repeater Ue1. These impulses pass as such over the line FL and in repeater Ue2 at the main exchange are transformed again into pure direct current pulses. There is the further possibility of a subscriber of the sub-exchange UVSt to effect connections to the main exchange via the call finder and line selector if, after taking down his receiver, he presses a key and thereby causes the operation of a mixing selector MW at the sub-exchange which sets itself on his line. When the selector MW has found the calling line, the call finder AS is released and returns to its home position. The dialling pulses from the calling subscriber T1 pass over the line TL, resting contact w, line L1, mixing selector MW, repeater Ue1, transformer Tr1, resting contact v, line FL, resting contact y, transformer Tr2, contact z to the group selector GW3.

Connections from the main to the sub-exchange pass from the group selector GW1 over resting contact u of the change-over switching arrangement Ub, resting contact z of the repeater Ue2, transformer Tr2, resting contact y of the change-over switching arrangement Ub, line FL, resting contact v, transformer Tr1, repeater Ue1, mixing selector MW to the call finder AS. The call finder starts up and sets itself on the calling line La which is, similarly to a subscriber's line, connected to the contact bank of the call finder. The direct current pulses from the group selector GW1 of the main exchange are transformed into inductive direct current pulses in the repeater Ue2 and are transmitted over the line FL to the repeater Ue1 of the sub-exchange. In the repeater Ue1, the inductive pulses are transformed back into pure direct current pulses and pass as such to the line selector LW. The line selector is then

set on the terminals of the called subscriber. Among the subscribers of the sub-exchange is one, T_1 according to the example given, privileged in so far as by failure of the power supply he is connected to the contacts w and v of the change-over switching arrangement so that line TL is immediately connected via line L_2 to the line FL and switched through to the main exchange. At the main exchange on the failure of the power supply at the sub-exchange, contacts y and u of the switching arrangement Ub reverse. Subscriber T_1 can set up outgoing calls which, at the main exchange, pass via the preselector VW and the group selector GW_2 . He can also receive calls from the main exchange which pass via group selector GW_1 , the reversed contact u of Ub , the repeater Ue_3 , the home contact of the preselector VW , the reversed contact of Ub , the line FL , reversed contact v of Ua , line L_2 , reversed contact w to the subscriber's line TL . If in the direction main to sub-exchange a call does not, as in Fig. 1 arrive over a group selector GW_1 , but comes via a line selector, then repeater Ue_3 in the main exchange can be dispensed with as calling current can be sent out from the line selector to the privileged subscriber.

In Figs. 2A and 2B the circuit details of the schematic are shown so far as these are necessary to an understanding of the invention.

The current feeding arrangements of the sub-exchange $UVSt$ are effected in known manner through a rectifier connected to the alternating supply WQ .

Current from the supply WQ through the rectifier is fed to the supervisory relays W and V over the circuit: 60 volts, windings of relays W and V , contact $14x$, earth. So long as current is delivered from WQ , both relays W and V are energized. Parallel to the relay W is a condenser C_p of large capacity so that relay W requires a greater operating time than relay V . The purpose of this arrangement is explained later. When relays W and V are energized, the subscriber's station T_1 is connected to the wires a_1/b_1 which correspond to the line L_1 of Fig. 1 via contacts $2w$ and $4w$. The junction line FL is connected to the transformer Tr_1 at the sub-exchange, the upper wire af via contacts $11v$ and $10w$ and the lower wire bf via contact $6v$. Repeater Ue_1 is reached by the transformer Tr_1 . The setting up of connections under normal conditions is not pertinent to the invention and will therefore not be described.

If the current supply at the sub-exchange fails, the supervisory relays W and V of the change-over switching arrangement Ua release. Station T_1 is now switched directly on to the line FL . As a result of this operation at the sub-exchange the current feeding source at the main exchange is connected to the line FL . After the switching over the following circuit is formed for the relay S of the change-over group Ub at the main exchange: earth, indicator SZ at station T_1 , choke coil Dra_1 , contact $7x$, $13v$ of change-over group Ua , wire af of line FL , upper half winding of transformer Tr_2 , contact $30h$, winding I of relay S , contact $32y$, winding II of relay S , battery, earth.

Relay S of the change-over group Ub operates in this circuit and closes the following circuit for relay Y : earth, contact $34s$, winding of the slow-acting relay Y , battery, earth.

Relay Y closes the following circuit for relay U : earth, contacts $36y$, $35s$, winding of relay U ,

battery, earth. Relay Y at contact $18y$ interrupts the connecting of line FL to transformer Tr_2 while simultaneously at contact $19y$ the feeding bridge relay A is connected to the lower wire of the line FL . Relay S is connected to the upper wire line FL via contact $17u$ and, after relay Y has operated, the high resistance winding of relay S is disconnected by the opening of contact $32y$. Relay S locks up over: earth, battery, W_1 of low resistance, contact $34y$, winding I of relay S , contact $30h$, $17u$, wire af of the line FL , contacts $13v$, $7x$, choke coil Dra_1 , indicator SZ , earth. At contact $16u$ the circuit for connecting line FL to the preselector VW is prepared. Relay U prepares further by closure of its contacts $41u$, the busy circuit for incoming calls.

When the subscriber T_1 of the sub-exchange takes down his receiver to effect a connection the following circuit is closed: earth, winding of relay A in the main exchange, contact $19y$, wire bf , contact $5v$, winding III of the relay X in the sub-exchange, contact $3w$, closed subscriber's loop T_1 , contact $1w$, windings I and II of relay X , contact $13v$, wire af , contacts $17u$, $30h$, winding I of relay S , contact $34y$, resistance W_1 , battery, earth.

Relay X at the sub-exchange operates in this circuit and relay A at the main exchange. Relay X by means of its contacts $7x$ and $9x$ disconnects both choke coils Dra_1 and Dra_2 and at the same time the circuit of the indicator SZ and the earth potential. Further, relay X at its contact $8x$ short-circuits its own winding II so that it operates as a slow-to-release relay during the loop interruptions resulting from dialling.

In the change-over group Ub at the main exchange, relay A by means of its contact $27a$ closes the following loop to the calling relay R_{vw} of the preselector VW : earth, battery, winding I of relay R_{vw} , contact t of the test relay of the selector, contact $28drb$, winding II of relay Drb , contact $27a$, contact t , winding II of relay R_{vw} , earth. The calling relay operates in this circuit and effects in known manner the start of the preselector VW . As soon as the preselector has left its home position, relay E , previously energized by direct current, of the repeater Ue_3 , releases. This has the result that Ue_3 can no longer be seized via group selector GW_1 in the incoming direction. Relay A further, at its contact $20a$, switches through the wire af to the pre-selector VW . The opening of contact $21a$ disconnects the calling relay R from the talking wires. When the preselector VW has found a free group selector, the test relay T operates.

Subscriber T_1 receives in known manner dialling tone from the group selector seized by the preselector VW over the following circuit: a wire from the group selector, a wiper of the preselector VW , contacts t , $26q$, $20a$, talking condenser, contact $16u$, wire af , contact $13v$, $8x$, condenser C_2 , contact $1w$, subscriber station T_1 , contact $3w$, condenser C_3 , contact $5v$, wire bf , contact $19y$, talking condenser, contact $24q$, contacts t , b wiper of preselector, b wire of group selector.

If the subscriber now dials to set the group and line selectors, his loop circuit is alternately opened and closed. Thereby relays A and S of the change-over group Ub are impulsively released. Relay A at its contact $27a$ interrupts the impulse loop to the group selector. At the first release of relay S a short-circuit for relay Q is opened at contact $35s$. Relay Q operates in series with relay U . Relay Q bridges, at its contact $25g$ the relay Drb serving as bridging choke

for the duration of the impulse groups. The talking wires to subscriber T¹ are cut off by opening of contacts 24q and 26q during the dialling period. At the end of this, relays A and S operate continuously again. Resulting from this relay Q releases. The talking wires to the calling subscriber are again switched through. Further, relay Drb again operates and at its contact 28drb interrupts the short-circuit on its highly inductive winding I. Further processes for effecting the connection are not part of the invention and are therefore not described. At the end of the conversation when subscriber T¹ hangs up the receiver, relay X in the sub and relay A in the main exchange release which brings about the release of the preselector and the selector seized by it. Relay S at the main exchange is held energized over the earth potential and the indicator SZ at subscriber station T¹ in the following circuit: earth, indicator SZ, choke coil Dra₁, contact 1x, 13v, wire af, contacts 11u, 30h, winding I of relay S, contact 31y, resistance Wi, battery, earth. Relay S maintains relays Y and U energized. In this way the feeding battery in the main exchange remains connected to the line FL. If subscriber T¹ of the sub-exchange is, after failure of the power supply, desired for a connection from the main exchange via the group selector GW₁, relay A₃ in the calling repeater Ue₃ operates via: earth, battery, wiper c of group selector GW₁, contacts 41u, 50e, 51a₃, 53c₃, 54v₂, 55q₃, winding III of relay A₃, earth. Relay A₃ operates and breaks at its contact 51a₃ the short-circuit of the busy relay C₃. C₃ operates in series with A₃ and breaks at the contact 53c₃ the original busy circuit. The circuit for winding III of relay A₃ is thereby broken. Relay A₃ locks up over both its windings connected to the talking wires and the loop to the group selector: earth, winding I of relay A₃, contact 39u, wiper b of the group selector GW₁, loop at group selector, wiper a of GW₁, contact 38u, winding II of relay A₃, battery, earth. The occupancy circuit is held via: earth, resistance W₁₃, contact 52c₃, winding of relay C₃ contacts 50e, 41u, wiper c of GW₁, battery, earth. Relay C₃ feeds the following circuit for the relay Q₃: earth contacts 79c₃, 78s₃, 77y₃, 75v₂, 74a₃, winding of slow relay Q₃, resistance W₁₆, battery, earth. Relay Q₃ at its contact 65q₃ disconnects the high resistance winding II of relay E from the direct current supply which flows via wiper c of the preselector in its home position. Relay E is held energized via the low resistance winding I in the following circuit: earth, contacts 79c₃, 80c₃, 66q₃, winding I of relay E, wiper c of the preselector VW in the home position, test relay T of the preselector, wiper d of VW in the home position, battery, earth. Further, relay Q₃ switches through at its contacts 58q₃ and 59q₃, the talking wires from the group selector line wipers to the change-over group Ub.

If the calling subscriber now dials, a repetition of the impulses and transmission of ringing current to subscriber T¹ is prevented in the following manner: By the loop interruptions in the group selector GW₁ resulting from dialling, relay A₃ of the repeater Ue₃ releases impulsively. On the first release of relay A₃ the short circuit of relay V₁ is broken by the opening of the contact 74a₃. Relay V₁ operates in series with relay Q₃, it opens its contact 61v₁ and thereby prevents the application of ringing current generator RQ. Further, it closes the following circuit for relay

V₂: earth, contact 71v₁, winding II of relay V₂, resistance W₁₄, battery, earth. During impulse transmission relay V₂ is impulsively short-circuited at contact 70a₃ and locks up during the series of impulses. At the conclusion of the impulses relay A₃ operates and remains operated. Relay V₂ releases due to the continued closing of contact 70a₃, and completes the short circuit around relay V₁ via contacts 74a₃ and 75v₂; relay V₁ releases. Relay V₂ becomes energized via its winding I and the 10 second switch over the following circuit: earth, 10 second switch, contacts 69y₃, 68c₃, 67s₃, winding I of relay V₂, battery, earth. Calling current is now sent to the call receiving relay R of the change-over group Ub over the following circuit: calling current generator RQ in repeater Ue₃, contacts 61v₁, 62v₂, winding II of relay Y₃, contacts 58q₃, 26q, 64s₃, earth. Relay Y₃ as a result of the short-circuiting of its winding I at contact 64s₃ is not operated by the calling current. On the contrary call responding relay R operates in the change-over group Ub. Via contact 33r, relay H is energized. Relay H at contact 22h switches the upper talking wire through to the subscriber T¹. After this wire has been switched through ringing current flows parallel to the ringing responding relay R to the subscriber T¹ over the following circuit: ringing generator RQ in repeater Ue₃, contacts 61v₁, 62v₂, winding II of relay Y₃, contacts 58q₃, 26q, 22h, condenser 16v, wire af, contacts 13v, winding II of relay X, condenser C₂, contact 1w, subscriber T¹'s bell, contacts 3w, condenser C₃, contact 5v, wire bf, contact 19y, condenser, contacts 24q, 59q₃, 64s₃, earth. Relay H in the change-over group Ub cuts off the relay S from the upper wire of the line FL at contact 30h during the calling period. Relay S during this time is held energized in the following circuit: earth, contact 29h, winding I of relay S, contact 31y, resistance Wi, battery, earth. During the non-ringing intervals relays A and S of Ub are energized. Relay A at its contact 27a closes the direct current loop for relay Y₃ of the repeater Ue₃. Relay Y₃ operates and at its contact 69y₃ interrupts the circuit for the call connecting relay V₂. In this way the transmission of ringing current is stopped. By the energization of relay Y₃, the short-circuit for relay S₃ is broken at contact 77y₃. Relay S₃ operates in series with relay Q₃. The connection is now established. The release of the connection can be effected by the called subscriber T¹ by back release, or by the calling subscriber. If the called subscriber T¹ hangs up, relay A in the change-over group Ub releases. Release of relay A results in the release of relay Y₃ in the repeater Ue₃ whereby the release of the selectors is effected.

If the calling subscriber hangs up, the loop in the group selector GW₁ is broken and relay A₃ in the repeater Ue₃ releases. Relay C₃ is short circuited at contact 51a₃. Relay C releases and by opening its contacts 79c₃ and 80c₃, opens the holding circuit of the relays Q₃ and S₃. Relay Q₃ is slow to release and breaks the circuit to the selector GW₁ at the contact 58q₃ whereby the release of the selectors is effected.

The talking circuit to the called subscriber is broken at contacts 58q₃, 59q₃ after relay Q₃ has released.

If now the called subscriber T¹ hangs up, relay A of Ub releases. Relay S is, however, held

energized until the power network at the sub-exchange is again effective.

If the power supply at the sub-exchange is restored during a conversation originating with subscriber T^1 , the energization of the supervisory relays W and V during a connection over the line FL and the relay X in the feeding bridge of the main exchange, is prevented. The latter relay at its contact $14x$ breaks the circuit for both relays. At the end of the conversation the relay X releases. Relays W and V can now operate. In order to prevent permanent energization of both feeding bridge relays A and S in the change-over group Ub via the repeating winding of the transformer T^1 of the sub-exchange, the two supervisory relays W and V have differing operating times. Relay V operates first opening its contacts $5v$ and $13v$ and closing $6v$ and $11v$. Somewhat later contact $10w$ closes. The loop to the main exchange is thereby interrupted for a period of time so that relay S and the relays in the change-over group Ub which are dependent on this can definitely release. If relay W is operated, the line FL is switched through to the transformer T^1 of the sub-exchange. In the main exchange after release of relay S, relays Y and U release which results in again connecting the line FL to the transformer T^2 .

What is claimed is:

1. In an automatic telephone system, a sub-exchange having a local source of operating current, a main exchange, a trunk line interconnecting said exchanges, a sub-exchange subscriber's station, switching equipment in said sub-exchange controllable from said station for extending connections via said trunk line to said main exchange and controllable from said main exchange via said trunk line for extending connections to said station, means operated responsive to the failure of said local operating current for disconnecting said switching equipment and for connecting said station to said trunk line, and means in said main exchange operated responsive to said connection for feeding operating current over said trunk line to permit connections to be established between said station and said main exchange in either direction over said trunk line.

2. In an automatic telephone system, a main exchange, a sub-exchange, a trunk line interconnecting said exchanges, a source of operating current for each of said exchanges, a sub-exchange subscriber's station, switching apparatus controllable from said station for extending connections to other local stations or via said trunk line to said main exchange, and change-over means operated responsive to the failure of sub-exchange operating current for disconnecting said apparatus and for connecting said station to said main exchange operating current via said trunk to thereby permit said station to extend direct connections to said main exchange via said trunk line.

3. In an automatic telephone system, a main exchange, a sub-exchange, a trunk line interconnecting said exchanges, a source of operating current for each of said exchanges, a sub-exchange subscriber's station, switching apparatus controllable from said station for extending connections to other local stations or via said trunk line to said main exchange, change-over means operated responsive to the failure of sub-exchange operating current for disconnecting said apparatus and for connecting said station to said main exchange operating current via said trunk to thereby permit said station to extend direct

connections to said main exchange via said trunk line, and means in said sub-exchange operated responsive to the establishment of a direct connection for preventing the reoperation of said change-over means to reconnect said switching apparatus.

4. In an automatic telephone system, a main exchange, a trunk line interconnecting said exchanges, a source of operating current for each of said exchanges, a sub-exchange subscriber's station, switching apparatus controllable from said station for extending connections to other local stations or via said trunk line to said main exchange, change-over means operated responsive to the failure of sub-exchange operating current for disconnecting said apparatus and for connecting said station to said main exchange operating current via said trunk to thereby permit said station to extend direct connections to said main exchange via said trunk line, and means in said sub-exchange operated responsive to the establishment of a direct connection for preventing the reoperation of said change-over means to reconnect said switching apparatus in the event that the sub-exchange operating current is reestablished.

5. In a telephone system, a sub-exchange, a main exchange, a trunk line interconnecting said exchanges, a local source of operating current for said sub-exchange, a subscriber's station, switching means in said sub-exchange operated responsive to failure of said operating current for connecting said station to said trunk line, a source of operating current for said main exchange, and supervisory means in said main exchange operated responsive to said connection for connecting said main exchange operating current to said station via said trunk line.

6. In a telephone system, a sub-exchange, a main exchange, a trunk line interconnecting said exchanges, a local source of operating current for said sub-exchange, a subscriber's station, switching means in said sub-exchange operated responsive to failure of said operating current for connecting said station to said trunk line, a source of operating current for said main exchange, supervisory means in said main exchange operated responsive to said connection for connecting said main exchange operating current to said station via said trunk line, said switching means in the sub-exchange controlled responsive to the reestablishment of the local sub-exchange operating current for disconnecting said station from said trunk line and for restoring the supervisory means in said main exchange to normal.

7. In a telephone system, a first exchange, a second exchange, a transformer, a trunk line interconnecting said exchanges and terminating in said transformer at said second exchange, a local source of operating current for said first exchange, a subscriber's station, switching means in said first exchange operated responsive to the failure of said operating current for connecting said station to said trunk line and for placing a potential on one conductor of said trunk line, a local source of operating current for said second exchange, supervisory means connected to the mid-point of said transformer operated over the said one conductor of said trunk line for connecting said second exchange operating current to said station via said trunk line.

8. In a telephone system, a branch exchange, a main exchange, a transformer at said main exchange, a trunk line interconnecting said exchanges and terminating at one end in said

transformer, a local source of operating current for said branch exchange, a subscriber's station, switching means in said branch exchange operated responsive to the failure of said operating current for connecting said station to said trunk line, supervisory means connected to the mid-point of said transformer operated responsive to the connection of said station to said trunk line, control means, auxiliary means operated responsive to the operation of said supervisory means for connecting said supervisory means to said trunk line independently of said transformer and for connecting said control means to said trunk line, and means operated responsive to the initiation of a call from said station for operating said control means to thereby permit the extension of a connection over said trunk line to a subscriber in said main office.

9. A system as claimed in claim 8 including a finder switch, the control means starting said 20 finder switch to find an idle line extending to main exchange switching apparatus and repeating dialled impulses received from the said station to thereby control said switching apparatus to extend the connection to a main exchange 25 subscriber.

10. In a telephone system, a main and a sub-exchange, a trunk line between said exchanges, subscribers' lines terminating in said exchanges, automatic switching equipment in said exchanges, a local source of operating current for said sub-exchange, means for extending talking connections from subscribers in one exchange to subscribers in the other exchange through said 30 switching equipment and over said trunk line, and means in said sub-exchange operated responsive to the failure of the operating current thereat for connecting a particular one of the sub-exchange subscribers to said trunk line independently of the switching equipment in the sub-exchange whereby talking connections between said particular subscriber and subscribers in the 35 main exchange are established through the main

exchange switching equipment and over the trunk line.

11. In a telephone system, a main and a sub-exchange, a trunk line between said exchanges, 5 subscribers' lines terminating in said exchanges, automatic switching equipment in said exchanges, a local source of operating current for said sub-exchange, means for extending talking connections from subscribers in one exchange to subscribers in the other exchange through said switching equipment and over said trunk line, means in said sub-exchange operated responsive to the failure of the operating current thereat for connecting a particular one of the sub-exchange subscribers to said trunk line independently of the switching equipment in the sub-exchange whereby talking connections between said particular subscriber and subscribers in the main exchange are established through the main exchange switching equipment and over the trunk line, and means in the sub-exchange controlled over the trunk line during the time that said particular subscriber is using his telephone for preventing the means operated responsive to the failure of the sub-exchange operating current from disconnecting said subscriber from said trunk line in the event that the sub-exchange operating current is reestablished.

12. In a telephone system, a main and a sub-exchange, automatic switching equipment including a repeater in said exchanges, a trunk line between said exchanges terminating in the repeater at each of said exchanges, a subscriber's line terminating in said main exchange, a subscriber's line terminating in said sub-exchange, a local source of operating current for said sub-exchange, means for extending connections between said subscribers through said switching equipment and repeaters and over said trunk line, and means responsive to the failure of the 40 said operating current for extending connections between said subscribers independently of said repeaters.

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