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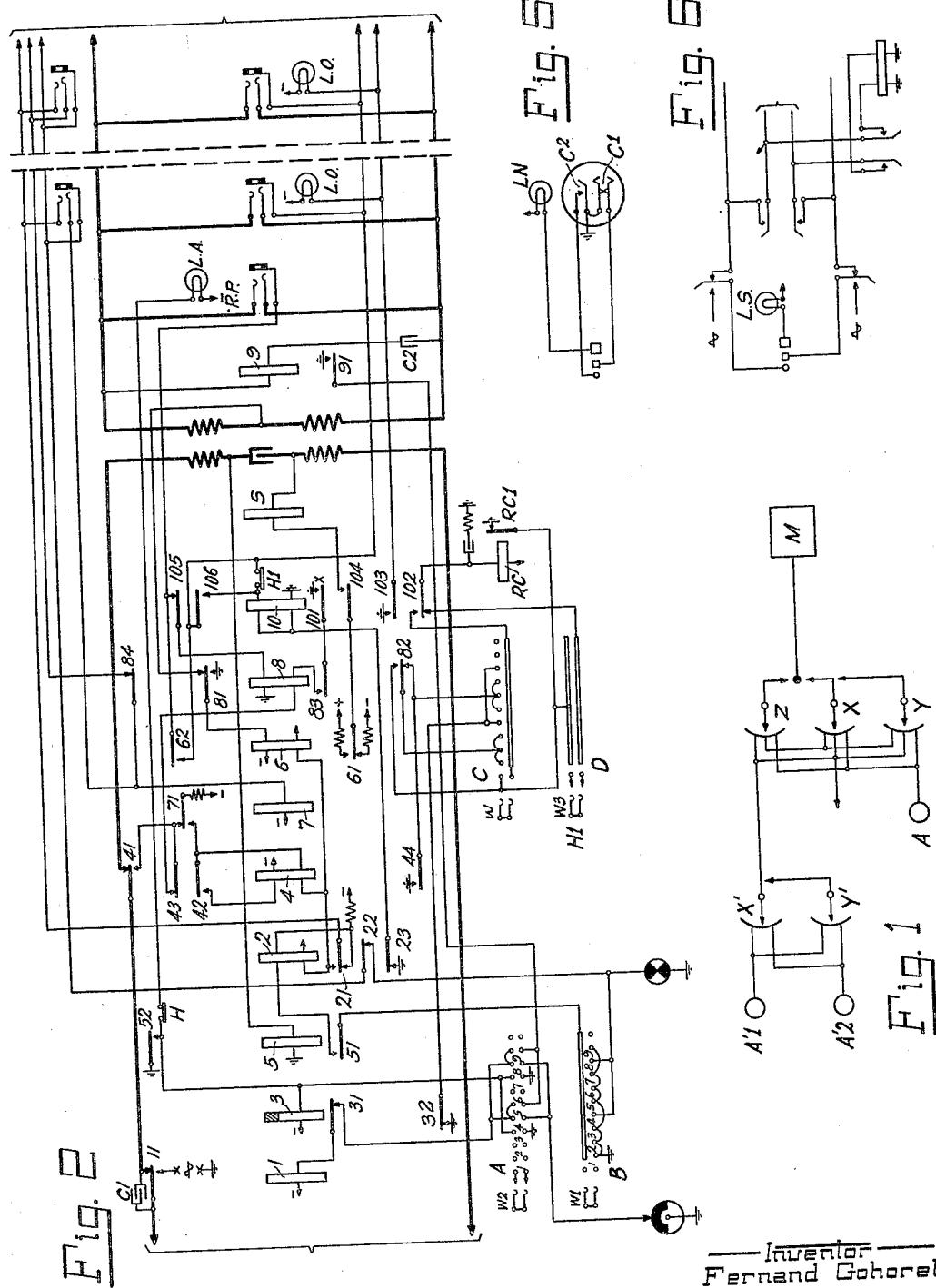
F. GOHOREL

1,907,062

SEMIAUTOMATIC TELEPHONE SYSTEM

Filed Sept. 11, 1931

3 Sheets-Sheet 1



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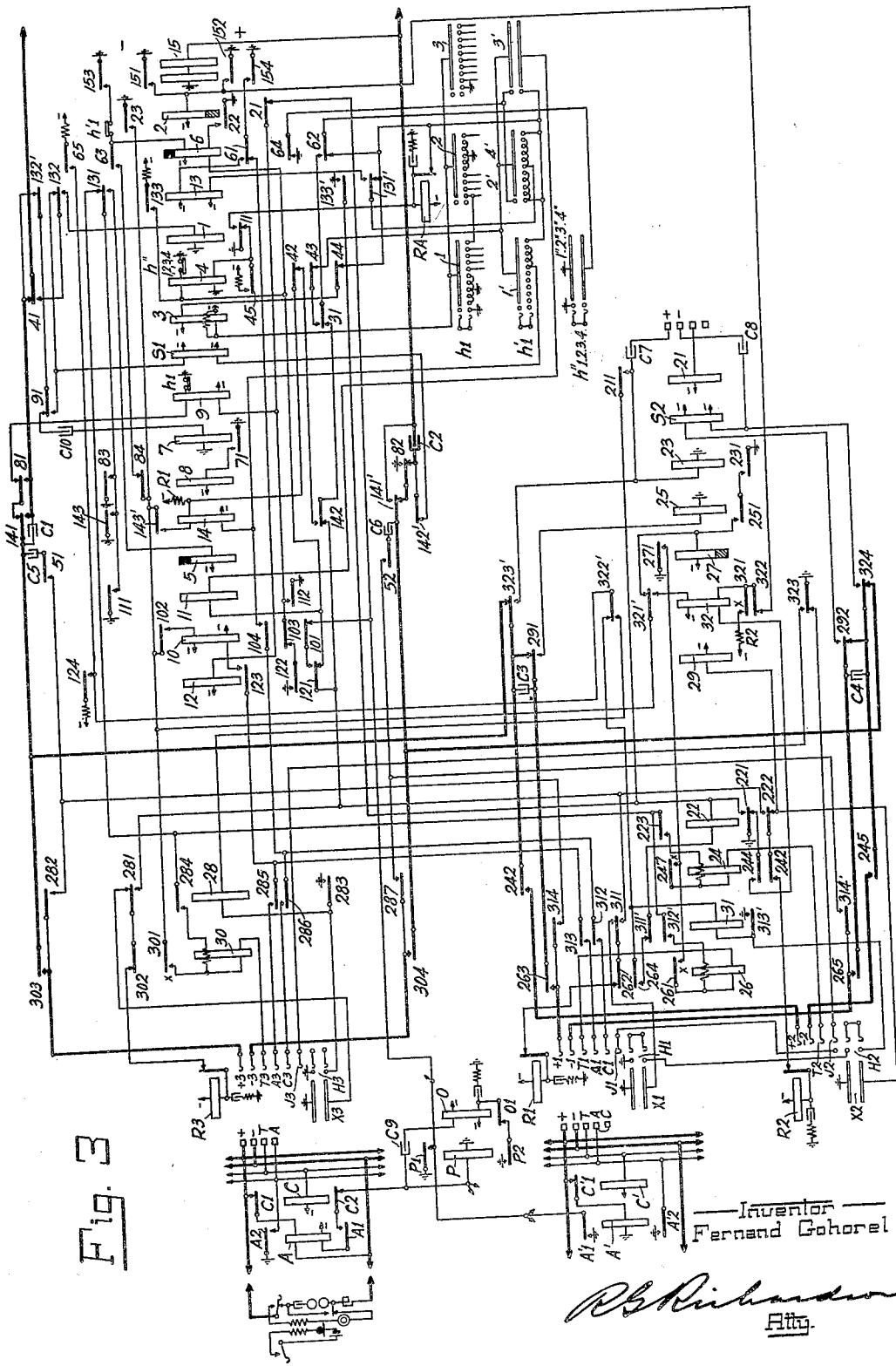
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## SEMITAUTOMATIC TELEPHONE SYSTEM

Filed Sept. 11, 1931

3 Sheets-Sheet 2



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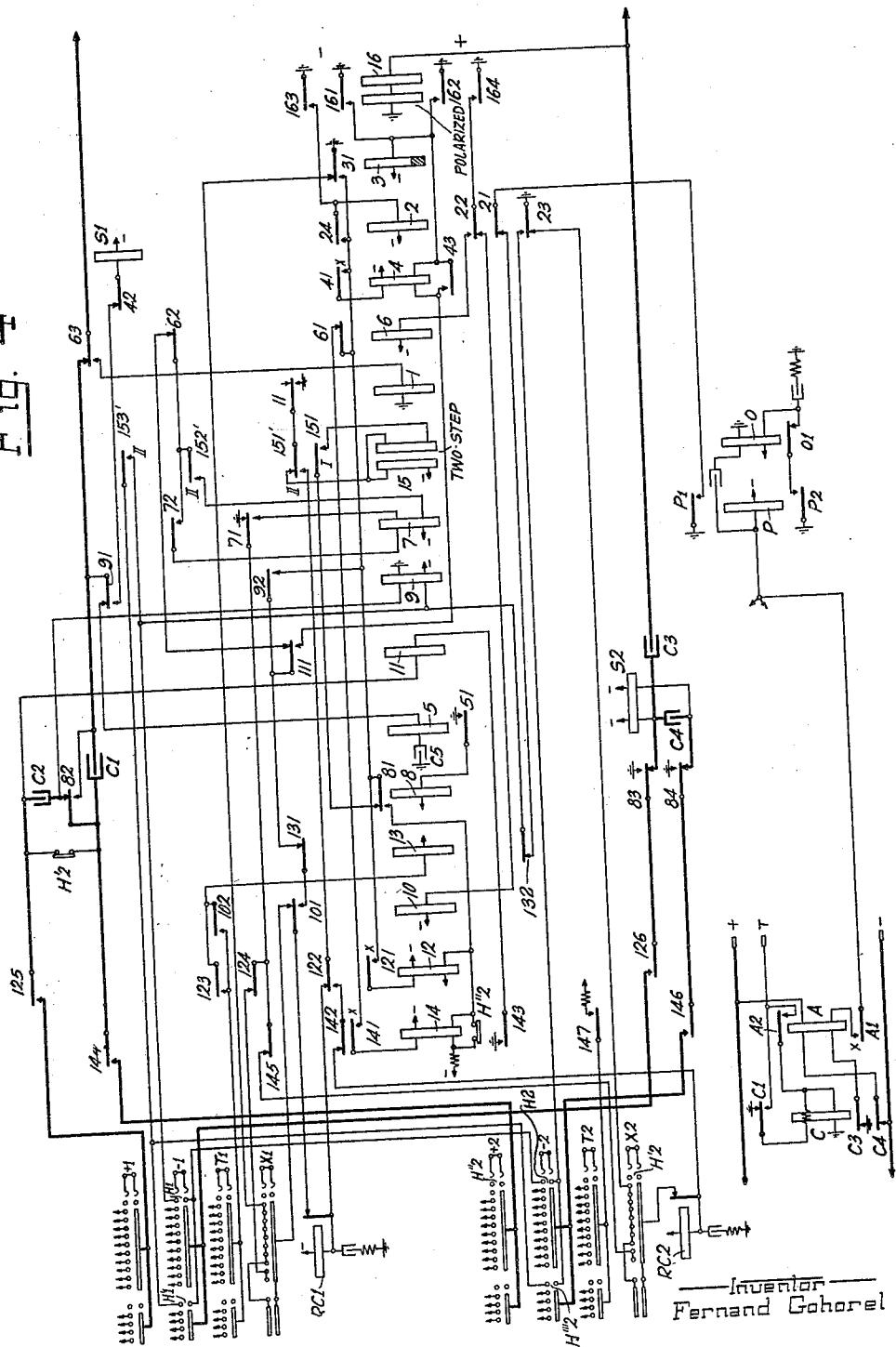
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SEMITAUTOMATIC TELEPHONE SYSTEM

Filed Sept. 11, 1931

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FIG. 4



Patented May 2, 1933

1,907,062

# UNITED STATES PATENT OFFICE

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## SEMITAUTOMATIC TELEPHONE SYSTEM

Application filed September 11, 1931, Serial No. 562,241, and in France September 19, 1930.

The present invention relates to semi-automatic telephone systems in which communications between two subscribers are established at a distance, by manual operators.

5 The said invention is more particularly applicable to telephone networks called rural networks in which the subscribers are grouped in small capacity offices connected either among themselves or to central man-

ual offices of more importance.

In general, the great number of these offices and the small number of circuits which connect them render the necessary operations complicated for establishing communications 15 in these networks. This augments chances of wrong connections and the time required for putting these connections through.

20 The present invention has for its object to remedy these inconveniences by suitable means, rendering always simple the operations carried out by the operator for establishing these communications at a distance, and this no matter how many and how dis-

25 posed are these offices in question. The choice of connecting circuits to connect up whichever two subscribers attached to this office of the same group or attached to the same office is effected solely by the sending 30 of impulse trains corresponding to the subscribers' numbers.

A rural network can be considered as comprising a first office connected by a plurality of junctions to a more important office 35 served by the manual operator. Also, other offices connected each one by a junction to the first office these said offices being able in their turn to serve more distant offices to which they are connected by a junction 40 and so on.

In the following, by "tandem" office is meant an office which serves other offices more distant than itself from the central manual office, and by "central terminus" office 45 is meant one which is not connected to any office more distant than itself from the central manual office.

One of the features of the invention consists in the first arrangement of switches 50 more particularly applicable to the case of

an office "tandem" and which is such that for each junction at the preceding office (with regard to the manual operator's position) three switches are provided to connect the said junction (which is called the principal junction) to subscribers or to the junctions going towards the more distant office. The first of these switches (X) is used either for finding a calling line and connecting it to the corresponding main junction, or for 55 rotating it on to the called line through the action of impulses sent by the manual operator over the main junction, eventually to connect the calling subscriber or called subscriber, or for rotating it onto the main junction or to a second switch described here- 60 after.

The second of these switches (Y) is used for rotating onto a called line under the effect of impulses sent by the manual operator over the main junction and for connecting the subscriber thus called to the subscriber already connected to the first switch, eventually to permit establishment 65 of a local communication circuit between the two subscribers. When the first of the two switches is used for a connection between two subscribers of the same network the third of these switches (Z) is used for either finding a calling line or finding a called line 70 through the action of impulses sent by the manual operator over the main junction, eventually to connect a calling or called subscriber to the main junction. 75

The invention is also applicable to cases 80 where there are a plurality of groups of switches X and Y and a switch Z for each main junction. The groups of switches X and Y being used one after another in the case where there are several simultaneous 85 inward connections passing through the office in question, switch Z being used for connections with the preceding office when all the groups X and Y are engaged upon 90 inward connections. 95

Another feature of the invention consists in a second simple arrangement of switches in combination with offices having the first arrangement. This is more particularly applicable to terminus offices from whence it 100

will be noticed that in general a number of inward connections is very small which permits maintaining the junction occupied during the said inward connections without resulting in an appreciable reduction in efficiency of the junction.

To this end, the second arrangement is constituted by the association of two switches with the junction going to the preceding offices, the first switch  $X'$  analogous to the switch  $X$  described above, a second switch  $Y'$  analogous to switch  $Y$  described above.

Another feature of the invention resides in an arrangement of electric circuits permitting the starting off in the operation of switch  $Y$  described above only if the preliminary setting of switch  $X$  does not correspond to the digit which is to set switch  $Y$ .

The object of this arrangement is to set in operation the arrangement constituted by a group of switches  $X$  and  $Y$  which is destined to establish inward communications only in offices where they must be used.

Another feature of the invention consists in special means for keeping in abeyance calls initiated by subscribers while permitting the operator to put through other calls, the operator replying to the subscribers' calls only at her own wish.

One of the most important devices in the invention for attaining this object consists in the using of one of the two wires of the junction for the transmission of impulses and signals and the other wire for the control of different operations for effecting signaling, supervision, release, etc.; this control being obtained by a polarized relay branched on the last-mentioned wire and operated at a distance in one direction or the other by the action of the manual operator.

A feature of the invention consists also in the arrangement of a circuit for operating the called subscriber's bell which consists in the calling generator of the manual office, one wire of the junction, the bell of the called subscriber, and earth, at the attached office considered, the other wire of the junction being used for maintaining the switches used in the connection in operative condition.

The invention is also characterized by the circuit for testing the impulse circuit, and which includes the sending wire and a relay at the manual office, whose energization prevents the sending of impulses in such a manner as to avoid this sending and signal the operator of it as long as the switch which should be controlled by the impulse at the rural office is not free, or is not in a position to permit it to reply to these impulses.

The annexed drawings represent by way of example one method of putting the invention into operation.

Fig. 1 shows a schematic example of a simple network.

Fig. 2 shows a detailed scheme of the manual operator's position.

Fig. 3 shows a detailed scheme of the "tandem" office.

Fig. 4 shows a detailed scheme of a "terminus" office.

Fig. 5 shows a dialing cord.

Fig. 6 shows a part of a regular cord circuit.

In the following the description is devoted to the case where there is a "tandem" office attached to a manual office, and a "terminus" office attached to a "tandem" office. The invention is not, however, limited to the case of a single "tandem" office, but is applicable also to the case of a plurality of connected tandem offices.

In Fig. 3 switch R1 represents switch  $X$ .

In Fig. 3 switch R2 represents switch  $Y$ .

In Fig. 3 switch R3 represents switch  $Z$ .

In Fig. 4 switch RC1 represents switch  $X'$ .

In Fig. 4 switch RC2 represents switch  $Y'$ .

Each subscriber's line or junction from the office in question is equipped inside the office with a cut-off C and a calling relay A and is multiplied on the banks of the connectors. In addition, the office connected directly to the manual position (perhaps equipped for one or more junctions with the said position) has each of its circuits supplied at each end with an equipment as represented in Figs. 2 and 3.

In these main lines the operation is as follows:

#### *Manual office call by a rural subscriber*

(a) The case of an office directly connected to the manual position.

The subscriber operates his magneto and energizes its calling line relay A which causes the sending of a calling signal over one of the junctions (if they are free) to the manual position. The calling lamp associated with the junction in question lights.

The operator replies by inserting the plug of a cord in the jack RP corresponding to the said junction which causes by the sending of a suitable potential between one of the wires and earth and also through the medium of a polarized relay the setting in operation of a switch R1 (Z) (connector finder), or R3 (Z) if the local connector R1—R2 ( $X$ — $Y$ ) is occupied until it finds the calling line upon which it stops. At this time the calling signal is removed, and through this the call is automatically cut off at the manual position.

In addition, immediately upon plugging in the supervisory lamp flickers during the entire hunting period. It assumes a steady glow during the calling period. It is extinguished immediately upon the reply of the calling subscriber.

In the case where no circuit is free at the moment of the subscriber's call, his call remains in abeyance on relay A. This call is transmitted as soon as a circuit becomes available. During the entire period between the reception of the call on relay A and the taking of the line by the finder an occupation tone is sent to the subscriber notifying him that his call is registered.

10 (b) Case of connected terminus office.

The general operation is identical with that described above and only differs in the following points:

15 The subscriber operates his magneto and through the operation of his relay A (Fig. 4), for example, causes the sending of a calling signal over the junction from the office in question to the office to which it is attached. In this latter office, this signal causes the energization of a calling relay A of the junction concerned (Fig. 3). This call is then carried out in the same fashion as previously described. It is extended via the different connected offices until it arrives at the manual position.

20 The operations involved in the reply are of the same kind as previously described, and the operations succeed one another in the office concerned, until the taking of the calling subscriber. At this time the call is automatically cut off by the definitive suppression of the rural manual calling signal.

25 The communication over, the operator is notified by the lighting of the supervisory lamp, the lighting being caused by the hanging up of the calling subscriber. The operator withdraws her plug. All the switches return to normal.

40 Rural subscriber called by the manual office

45 The operator inserts the plug of a cord in the calling jack which causes the sending between one of the wires and earth of a potential such that the polarized relay of the rural office is energized in a sense opposite to that used for the reply to the call, as described above. By this means the switches of the office in question are set in condition for "reception of the dialling" the same as if the said office is in calling condition, in which case the rural manual calling signal is immediately suppressed and postponed pending the release of the circuit in question.

55 Through the medium of associated relays the putting in this position of the polarized relay permits also the using of the other position (initial Y used for the "finding of a call" as has been seen above) for the realization of another operating condition as described in the following and thus until the release of the circuit by the operator. The latter inserts in an associated dialling jack of the circuit in question the plug of her calling dial. A dialling lamp associated

with the said dial is immediately caused to flicker until the switches of the office concerned are in the dialling position, which causes by the sending from the rural office of a suitable signal the extinction of the said lamp.

70 The operator can then send her first impulse train.

To this end, she winds up the dial and through this operation the energization current of the polarized relay is reversed and also the position of the said relay used for establishing different impulsing circuits. The impulses are sent and registered on a switch X1 of control RA, Fig. 3. This causes the movement of switch R1 (X) or R3 (Z) if R1—R2 (X1) are occupied following upon the digit sent (characteristic of the office to be reached):

(a) To select a subscriber if he is attached to this office. In this case control switch RA moves automatically into the position for receiving the following digit.

(b) To select a junction corresponding to the chosen office which causes if the said office is not engaged the connection of the terminus office with the manual position via a tandem office. The switches of the tandem office are put out of circuit upon the reply of the called subscriber.

95 The operations then succeed one another at the terminus office (Fig. 4) in the same manner as described above for the tandem office. In both cases at the manual position as soon as the dial returns to its normal position the dialling lamp is again made to flicker until the switches of the "tandem" office or the "terminus" office are in position to receive the following impulse train.

100 This operation is repeated in an identical manner for the two following impulse trains corresponding to the tens and units digits. This arrangement allows of maximum reliability of operation.

110 In addition, and in spite of this signal, if the operator winds up her dial too soon, the system for sending impulses is immediately rendered inoperative. At the end of the last impulse train counted by switch RC associated with the equipment of the circuit (manual position, Fig. 2) the calling current is automatically cut off. If the subscriber is busy a signal sent immediately by the taken rural position prevents the cutting off of this call and the supervisory lamp of the cord in question is set flashing, thus notifying the operator. The subscriber being free, the supervisory lamp is lit with a steady glow during the entire period of the call. The unhooking by a called subscriber causes the suppression of the call and the extinction of the supervisory lamp.

115 120 125 130 In addition, upon the sending of the first digit corresponding to an engaged connected

office, the dialling lamp remains flashing, so notifying the operator.

Upon the hanging up, the subscriber's supervisory lamp lights and the operator withdraws her plug. By this operation and through the medium of polarized relays returning to their middle positions, the switches of the office in question return to normal.

#### 10 Local connections

These connections can be established between subscribers of the same network.

(a) Upon a call of a calling subscriber: 15 These operations having been carried out as indicated in the corresponding paragraph, the operator without removing her answering plug introduces her dialling plug into the corresponding jack. By this operation the switches of the office concerned are set in the dialling position, as in the same proceeding described above (call by a manual exchange). It suffices then to send the number of the called subscriber.

25 Sending of the first digit received solely on the control switch RA, Fig. 3, of the tandem office directly connected causes the rotation of switch R2 (Y), Fig. 3, either to select a junction or to select a subscriber of the said office. In the case where the digit received on the control switch RA (Fig. 3) corresponds to a circuit occupied by the connector R1 (X) which is associated with it, the connector R2 (Y) is not set in use and 30 the connection (impulse supervision) with the said circuit is established as at the beginning by switch R1 (X). The following impulses received at the terminus position causes the rotation of connector RC2 (Y')

35 from the said position, (Fig. 4), the supervision being the same as that described above for the dialling of a first subscriber. At the end of the third impulse train the call to the called subscriber is cut off (if he is free) until his unhooking which causes the extinction of the supervisory lamp. The operator can enter upon the conversation and can withdraw her plug immediately upon the establishment of the connection between the two subscribers. The connectors R1, R2 or R<sub>c1</sub>, R<sub>c2</sub> are maintained in busy condition in the office where they are used and maintained if there are any and through their medium the connectors R1 or R<sub>c1</sub> 45 from beyond. The switches not mentioned above are returned to normal.

Upon the hanging up of either of the subscribers the switches held in the connection are freed.

60 (b) Local connections can be established by successive dialling of two subscribers. The first subscriber is called as described in paragraph "Rural subscriber called by the manual exchange". This first subscriber having replied, it is sufficient without any

further operations to dial the number of the second subscriber, the operations at this time being identical to those described above.

#### Special operations

(1) Supervision and release of local connections by the operator.

She can, after unplugging and when any of the inlets to the local connector are free, enter into the conversation. In order to do this she plugs in on the calling side, winds up her dial, and does the following:

(a) In the case where the local connector X', Y' is that of a terminus office, she dials the special number for this office. The connector X or Z at the tandem office thus chooses the circuit going to the found group X', Y' and the connection is established between the operator and the two conversing subscribers.

(b) In the case where the local connector X-Y is that of a tandem office, she dials a number which is special for this operation. Switch Z of this office is then switched into a position which connects the circuit to the group X-Y and the conversation between the operator and the two subscribers takes place.

Under these circumstances the operator can free the local connection by pressing a special key, individual to the position and called the forced listening and releasing key. This operation reverses the energization current of the polarized relay of the office concerned. The latter by a group of relays which are associated with it at this moment causes the release of a relay which itself brings about the release of the connection.

#### (2) Verification of the nature of the busy connections met with

These are signalled by means of supervisory lamps. In general, listening to established communications is done directly through the medium of the ordinary listening key only when these connections are established by the local connector at a terminus office. In all other cases the operator has to use her forced listening key. This operation reverses the energization current of the polarized relay of the tandem office which by a group of relays which are associated with it at this moment completes the connection of the circuit with the occupied portion reached by the switches X or Z of this office.

The following is a detailed circuit description.

##### I. Call by a rural subscriber

In the following description T denotes an operated contact and R a normal contact.

First case: The subscriber is attached to a

tandem office, Fig. 3, the said subscriber operates his magneto and energizes relay A over the circuit: magneto, lower line, upper winding of relay A, RC1, upper line, normal contacts of switch hook to the other pole of the magneto. A holds up from battery through the lower winding of A, TA1, RC2, relay P, to earth.

The latter relay energizes and at TP1 sends an earth to relay 9 of one or the other of the idle circuits, the circuit being from R21, lower winding of relay 9, to battery. A busy relay opens this circuit at contact 21.

In addition, at TP2 relay O is operated in a vibrating circuit through the medium of its contact O1, the interruptions of the current in the lower winding of said relay produce in the upper winding an alternating current of musical frequency, which is superimposed upon the holding circuit of relay A through the upper winding of relay O, coupling condenser C9, RC2, TA1, lower winding of relay A. By induction between the two windings of relay A, this current is sent on to the calling subscriber. If the latter takes off his receiver he hears the signal of occupation notifying him that his call is registered but is in abeyance.

If a circuit is free and by the energization of relay 9 as seen above, the calling signal is sent to the manual position over the circuit: battery, upper winding of retard S1, T91, R132', R41, upper wire of the junction circuit connected to the manual position.

At the manual position, Fig. 2, the circuit continues by upper wire of the junction R11, R41, upper left-hand winding of the transformer, winding of relay 5, and earth which energizes relay 5 and lights the calling lamp associated with the junction over the circuit: earth, T52, H (normal position of the counting switch RC) and battery through the calling lamp LA. Relay 3 is energized over the circuit T52 and battery through the winding of said relay. The operator replies by inserting a plug of a cord in the answering jack.

Relay 8 operates by battery through the supervisory lamp LS, sleeve of the plug and the answering jack, R105, upper winding of relay 8, to earth.

Relay 6 operates over the circuit: battery, through its upper winding, T81, and earth.

Relay 10 operates from earth, R23, upper winding of 10, H1 (normal position of RC) T62 and battery, through supervisory lamp LS. This lamp lights in series with the upper winding of relay 10.

The energization of relay 10 causes:

(a) At T101 a holding up of relay 8 from earth, T101, T83, lower winding of relay 8, R43, R71, and battery, through the safety resistance.

(b) Upper winding of said relay is put out of circuit by the opening of contacts 105.

(c) At T106 contact H1 is short circuited.

(d) T102 the rotation circuit of the counting switch is completed over the circuit: battery, winding of motor magnet RC, T102, home contact of the bank C, wiper W, normal contact of the motor magnet RC1 and earth. The latter operates by self-interruption, and leaves its initial position and comes to position 1, where we get the following circuit: battery, winding of the motor magnet RC, T102, wiper W, contacts 1, 2, 3 of bank C in parallel, T82, RC1 and earth. The switch continues its hunting and stops in position 4.

(e) At T103 a circuit is closed for the lighting of the busy lamps LO corresponding to other positions.

(f) Finally at T104, battery (with positive earth return) is sent on the lower wire of the junction from positive through a safety resistance, T61, T104, winding of the retard S, lower left-hand winding of the transformer and lower line of the junction.

The calling lamp LA is extinguished by the opening of H (normal position of RC).

In addition upon the arrival at position 4 of the control switch we get the circuit: Interrupted earth, position 4 on the bank B, wiper W1, T51, upper winding of relay 2, and battery through the safety resistance.

The operation of relay 2 causes the periodic opening of contact 23 which periodically removes the short circuit from the lower winding of relay 10, during which time this relay maintains itself by its two windings in series, but the supervisory lamp LS flashes, advising the operator that hunting is set in operation at the rural position.

In Fig. 3, we have the circuit from battery on the lower wire of the junction, winding of polarized relay 15, to earth. This relay operates and closes its contacts 152 and 154. Relay 12 operates from battery, winding of relay 12, R61, T154, and earth. Relay 2 operates through T152. This slow-to-release relay will remain held up during the movement of relay 15 from one operated position to the other.

The operation of relay 2 causes:

(1) At T23 the connecting of earth to the main hold wire and the operation of relay 27 by battery, winding of said relay R321', T23, and earth.

(2) At 21 the opening of the circuit of relay 9 which holds itself energized from earth T122, R103, and lower winding of said relay.

Through the operation of relay 12 we get battery through the safety resistance T124, R322', winding of relay 31, H2, H, and earth.

Relay 31 operates and holds up at T313'. Switch R1 starts to hunt from a circuit:

earth, RP1, R101, T121, T311, R262, motor magnet R1, through its interrupter. It operates by self-interruption to advance its wipers over the bank contacts where are arranged different subscribers' lines. The wipers arrive on the line of the calling subscriber.

We then get the circuit: earth, TA2, bank contact A, and wiper A1, switch R1, T313, T123, lower winding of relay 10, battery.

The latter operates and opens at 101 the hunting circuit indicated above, causing thus the stopping of the finder switch R1 on the contacts corresponding to the calling subscriber.

Relay 10 holds up from battery, upper winding of said relay T102, T23, and earth.

The circuit of relay 9 is opened at contact 103 which removes by the opening of contact 91 battery from the upper wire of the junction.

This causes at the manual position, Fig. 2, the release of relay 5 which opens at 51 the intermittent circuit of relay 2. At R23 the short circuiting of the lower winding of relay 10 lights the supervisory lamp LS with a steady glow which notifies the operator of the finding of the calling subscriber, and of the cut-off of the call as indicated below.

The release of contact of relay 3 by the opening of 52 causes interrupted earth to extend from position 4 of bank A of the counting switch RC, wiper W2, R31, and battery through the winding of relay 1, which operates and releases intermittently.

During the period of energization of the said relay, at T11 we get alternating current with an earth return sent over the upper wire of the junction. During its normal period we get at R11 the upper wire of the junction connected to relay 5, Fig. 2.

A condenser C1 allows the operator to assure herself by the operation of a listening key of the cut-off of the call.

In addition, a circuit is closed from earth R32, position 4 of bank C, T102, wiper W, battery through the motor magnet RC, the latter energizes and remains operated until the opening of the said circuit.

At the rural position, Fig. 3:

During the period of sending of alternating current on the upper wire of the junction, a circuit is closed from the upper wire of junction R41, R132', R91, condenser C10, winding of alternating current relay 7, and earth.

Relay 8 operates from T71. The following circuit then closes: earth, T83, R131, T312', the windings of relay 26 in series, wiper T1 and bank contact T of the finder R1, and battery through the winding of relay C of the subscriber in question.

The two relays C and 26 operate in series. The latter holds up in series with relay C

over the circuit: battery, winding of relay C, T1, lower winding of relay 26, T261, T271, and earth.

The energization of relay C causes the release of associated relay A by the opening of C2 and the opening of C1 removes the connection between the upper line and relay A.

The calling circuit being thus completed, the circuit is closed from the upper wire of the junction, R41, T81, R141, R323', R291, T263, wiper and bank contact + of the finder R1, upper wire of the subscriber's line, switch hook, bell, condenser, lower wire of the subscriber's line, bank contact and wiper of the finder R1, T265, R292, R324, R141', T82, and earth.

The calling subscriber's bell is thus rung, notifying him of the reply of the operator.

During the time the calling current is removed the release of relay 7 causes relay 8 to return to normal which places a battery via the circuit, retard S1, R142', R82, etc. This is extended to the lower wire of the subscriber's line. The upper wire is connected to earth through the winding of relay 9 over the circuit, R141, R81, upper winding of relay 9, H1 (normal position of RA) and earth.

The above circuit is opened at the subscriber's station by the interposition of a condenser in series with the subscriber's bell, and will only be closed in series with the receiver and the secondary of the induction coil if the subscriber takes off his receiver. The operation reproduces itself periodically until the subscriber unhooks his receiver.

We then get by the operation of relay 9 as indicated above the following circuit: battery, upper winding of the retard S1, T91, R132', R41, upper wire of the junction to the manual position (Fig. 2) R11, R41, transformer and relay 5 to earth.

By the operation of relay 5 we get:

(a) The operation of relay 3 via T52, which by the opening of 32 deenergizes the motor magnet RC (operated during the entire preceding period). The wipers move to position 5. The circuit of relay 1 is opened at 31, and also at contact 4 bank A.

(b) Operation of relay 2 from earth, bank contact 5, of bank B, wiper W1, T51, upper winding of relay 2, and battery through the safety resistance.

The lower winding of relay 10 is again unshort circuited, the associated supervisory lamp LS of the cord going out.

The operator, notified of the answering of the subscriber, can listen in on the conversation by the operation of her listening key.

The conversation currents are transmitted over the two-line wires in series through

(at the rural office, Fig. 3) condensers C1 and C2.

The conversation finished, the subscriber replaces his receiver which causes the opening of the holding circuit of relay 9 (Fig. 3) and the removal of battery placed on the upper wire of the junction. This at the manual position through the release of relays 5 and 2 causes the lighting of supervisory lamp LS.

The operator is notified of the hanging up of the calling subscriber.

There is provided an arrangement for recalling the subscriber if necessary by the simple operation of a calling key.

The sending of alternating current from the cord in use causes the operation of relay 9 through the condenser C2, closes the circuit: earth, T91, bank contact 5 of bank A, wiper W2, R31 and battery through relay 1. The latter energized sends via T11, alternating current from earth to line as before. The operator repeats the operation of throwing the calling key until the subscriber by unhooking extinguishes the lamp LS.

In every case the operator, having received the finishing signal, releases the circuit by withdrawing the plug from the jack in question.

This operation causes the release of relays 10, 8, and 6. The counting switch RC returns to its initial position over the circuit: earth, interrupter RC1, bank D, wiper W3, R102, motor magnet of the said switch to battery.

At 103, the busy lamps corresponding to the circuits are extinguished.

At 104 positive battery is removed from the lower wire of the junction.

By the return to its middle position of relay 15 (Fig. 3), we get:

(a) Opening of contact 154. This releases relay 12 which at 124 deenergizes relay 31.

Opening of contact 152. This releases relay 2 which at 23 opens the circuit of relay 27 which by opening its contact 271 deenergizes relays 26 and C.

The following circuit is then closed: battery through the motor magnet of R1 via its interrupter, R262, R311, and earth through bank X1. The switch hunts until it reaches its home position. Everything is then normal.

Second case: The subscriber is attached to a terminal office (Fig. 4).

As indicated previously, the sending of calling current by the subscriber is received on relay A (upper winding) which holds up in series with relay P through winding of P, TA1, lower winding of A, RC3, and earth. An occupation tone is sent over the calling subscriber's line as in the previous system.

By the operation of P a circuit is closed

from earth, TP1, R21, R132, lower winding of relay 9 to battery.

By the operation of relay 9 a circuit is closed through the retard S1, R42, T91, R63, and upper wire of the junction connection to the tandem office (Fig. 3) RO'1, winding of calling relay A', to earth.

The operation of the said relay causes at TA'1 the operation of relay 9.

The calling signal is then re-transmitted to the manual position, and is treated in the same fashion as described in the previous paragraph. The operation is identical up to the time of setting R1 in operation.

The finder arriving on the position corresponding to the calling junction is stopped by the opening of contacts 101, due to the energization of relay 10 in the following circuit: earth, TA'2, bank contact A, wiper A1, of the finder R1, T313, T123, lower winding of relay 10, and battery. The energization circuit of relay 9 is opened at 103, which causes the removal of battery from the upper wire of the junction.

The following circuit is also closed: earth, TA'2, contact C, wiper C1 of the finder, T312, T104, lower winding of relay 14, to battery. This relay energizes and holds up from battery resistance R1, upper winding of said relay T143', T23, and earth.

The circuit is closed from earth, T143, R131, T312', both windings in series of relay 26, wiper T, bank contact T1, winding of relay C', to battery. These two relays energize in series and hold up by lower winding of relay 26, T261, T271, and earth.

The operation of relay C' opens at C'1 the circuit of the calling relay A'.

Battery comes from the terminus position via the upper wire of the junction, and is sent to the manual position over the circuit: upper wire of the junction, bank contact and wiper +1, of the finder R1, T263, R291, R323', T141, R41, and upper wire of the junction going to the manual position.

The removal of the battery during the period between the operation of relay 10 and the deenergization of relay 9 and the holding up of relays 14 and 26 does not produce the cut-off of the call, the momentary release of relay 5 not having produced the deenergization of the slow-to-release relay 3, (Fig. 2).

The energization of relay 5 is now controlled from the terminus position.

In addition at the tandem office (Fig. 3) through the energization of relay 14 a positive battery extends over the lower wire of the junction and is sent to the terminus office.

The circuit extends from positive battery on the lower wire to T141', R324, R292, T265, wiper and bank contact -1 of the finder R1, lower wire of the junction to the terminus office (Fig. 4), winding of the

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polarized relay 16, to earth. This relay closes its contacts 162 and 164.

(a) Relay 3 is operated by 162 and closes its contact 31.

5 (b) A circuit is closed from earth, T164, R22, and battery through the winding of relay 10.

The finder is set in operation over the circuit: earth, T31, T92, R131, T101, interrupter spring and through the winding of the motor magnet of the finder RC1, to battery.

10 The arrival of the finder on the bank contact associated with the calling subscriber closes a circuit from earth, the two windings in parallel of relay C, TA2, bank contact and wipers of bank T1, T102, and battery through the winding of relay 13.

15 The operation of relay 13 opens the circuit at 131, of the motor magnet, at 132 it opens a circuit of relay 9, which releases and removes at T91 the battery from the upper wire of the junction.

In addition, relay C energizes and holds 20 up in series with relay 13 from earth, windings of relay C in series, TC1, bank contact and wiper, etc.

At C3 and C4 the energization and holding circuits of the calling relay A are opened.

25 30 The removal of battery from the upper wire of the junction causes as described above the cut-off of the calling current. Alternating calling current is impressed on the upper wire of the circuit from the manual position as previously described, extends via R63, R91, alternating current relay 5, and earth through condenser C5 which causes the energization of relay 8 at T51.

35 By the operation of the latter a circuit is closed from earth, T31, T81, lower winding of relay 12, to battery.

40 Relay 12 holds up from battery, upper winding of said relay T121, T31, to earth.

The calling current is then sent to the 45 subscriber's bell over the circuit: upper wire of the junction, T82, H'2 (normal position of switch RC2), T125, bank and wiper +1 and contact associated with the subscriber in question, upper wire, bell, condenser, lower wire, bank contact, wiper and bank -1, T126, T83, and earth.

45 During the other period of the ringing, and if the subscriber unhooks, a circuit is closed from battery, left-hand winding of retard S2, R83, T126, the previously described circuit via the receiver and secondary of the induction coil of the unhooked subscriber's station, T125, H'2, R82, upper winding of relay 9, earth.

50 60 Supervisory battery is sent from the upper line wire of the junction from battery, retard S1, R42, T91, upper wire of the junction, etc. . . . The call is terminated and the supervisory lamp extinguished, as described above.

The conversation currents pass through the two wires connected directly to the tandem office and through the condensers C1 and C3 at the terminus office.

Upon the subscribers hanging up, relay 9 70 releases and removes the supervisory battery. Lamp LA lights at the manual position.

The removal of the plug causes by the removal of positive battery from the lower wire of the junction the return to its middle 75 position of the polarized relays.

(a) Polarized relay 15 at the tandem office (Fig. 3) causes the release as described already.

(b) Polarized relay 16 at the terminus office, Fig. 4, releases, which causes at 164 the release of relay 10, and at 162 the release of relay 3, which by opening contact 31 releases relay 12. Switch RC1 returns to normal over the circuit: earth, R31, bank and wiper x1, R101, interrupter of the rotary magnet RC1, winding of the magnet, to battery, and during rotation also over another circuit from earth, R71, R124, bank x1, etc. All the pieces of apparatus return 90 thus to their initial positions.

## II. Subscriber called by the operator

The operator puts a plug of the cord into the calling jack and so closes a circuit from battery, supervisory lamp LS, sleeve of the plug and the jack considered, H1, (if the counting switch is at zero), upper winding of relay 10, R23, to earth. This causes:

(a) At T106 the short circuiting of H1. 100  
(b) At T103 the lighting of the busy lamps L.O on the other positions.

(c) At T102 a circuit is closed from earth, interrupter spring of RC1, home contact of bank C, wiper W, T102, motor magnet, to battery. The latter operates by self interruption to move the wipers to position 1.

(d) At T104 a circuit is closed from negative battery and extended to the lower wire of the junction through the safety resistance, R61, T104, retard S, lower left-hand winding of the transformer, etc.

The operator next inserts her dialling plug in the corresponding jack and a circuit 115 is closed from:

(a) Earth, through the contact C1 of the dial, ring of the plug, dialling jack and battery through the winding of relay 7, which operates.

(b) Interrupted earth via R22, sleeve of the dialling plug, dialling lamp LN, to battery, and the lamp flashes.

The operator can only dial during this signal.

The sending on the lower wire of the junction of a negative potential causes at the tandem office, Fig. 3, the operation of polarized relay 15 to its negative position, which, therefore, closes contacts 151 and 120 125 which, therefore, closes contacts 151 and

153, operating at T151, relay 2. It is to be noted that if a subscriber at this time is calling at this office the signal will be removed from the upper wire of the junction by the release of relay 9, releasing from the opening of contact 21. Relay 6 is operated over the circuit: battery, through the winding of said relay, h'1, (normal position of RA) T153 to earth. Relay 27 operates through contact T23. Relay 6 holds up over the circuit: battery, upper winding, T63, R84, T23, to earth.

The operation of relay 6 sends a circuit from battery through the safety resistance, T65, R322', winding of relay 31, to earth, via contacts H1 and H2 in series. The said circuit is only closed if the two switches R1 and R2 are in normal position.

The operation of relay 31 short circuits at 313' the contacts H1 and H2. A circuit is closed from battery through the motor magnet R1, R262, T311, R121, upper winding of relay 4 and earth, through h'' (normal position of switch RA). It may be seen that relay 4 only energizes if the different pieces of apparatus in this circuit are in suitable positions.

The operation of the said relay causes the sending of the dialling signal over the circuit: battery, upper winding of retard S1, R132, T41, upper wire of the junction to the manual position, (Fig. 2), R11, R41, relay 5, and earth.

Relay 2 operates over the circuit: earth, wiper Wi, position 1 of bank B, T51, upper winding of relay 2, and battery through the safety resistance.

The opening of contact 22 extinguishes lamp L.N.

The operator can now send the first digit. To this end, the dial is wound up so closing the circuit: earth, TC2, (contact of the dial operated until its return to zero) tip of the plug, T21, lower windings of relays 2, 4, 6, 45 to battery (through T71 for relay 4). This causes:

(a) The holding up of relay 2.

(b) The operation of relay 4 which holds up via T42, upper winding, to battery. At T44 a circuit is closed from earth, T44, R82, wiper W, position 1 of bank C, T102, motor magnet RC, and battery. The latter energizes and remains in the operated position.

(c) Relay 6 operates and negative battery is removed from the lower wire of the junction being replaced by positive battery. At the rural position, (Fig. 3) relay 15 changes over to the positive position, contacts 151, 153, opening. Contacts 152, 154 close. Relay 2 remains held up via T152 (during the movement to the middle position 152, and 151 open the said relay not releasing, being slow to release). At T154 relay 13 energizes over the upper winding,

T61, T154, to earth. At R132 battery is removed from the upper wire and the latter is connected at T132 to the impulsive relay 1.

At the manual position, Fig. 2, upon the release of the dial, contact C1 of the said dial is opened a number of times corresponding to the digit set up. This causes the release of relay 7 a similar number of times causing the sending over the upper wire of a corresponding number of battery impulses over the circuit: battery, safety resistance, R71, T41, R11, upper wire of the junction, to the rural position (Fig. 3), T41, T132, winding of relay 1, to earth.

The latter energizes a number of times corresponding to the digit set up on the dial, causing at T11 the advance of control switch RA.

In addition, as soon as the latter leaves its normal position, contact h'' is opened. Relay 4 remains held up via T45 and its lower winding, which is itself short circuited at R11 between each impulse, which causes the maintaining in the operative position of the relay during impulse train.

As soon as the ten-point switch RA leaves its normal position, the following circuit is closed: earth, bank 1'', T62, R31, R142, T311, R262, interrupter spring of the motor magnet of switch R1, to battery.

The said switch is set in automatic rotation until it arrives on the contacts corresponding to the position of control switch RA. At this moment, the stepping circuit 100 is as follows: earth, R323, J2 (in its normal position) J1, bank contact and control wire corresponding to the position of RA, bank 1, lower winding of relay 3, battery.

The operation of relay 3 causes at R31 105 the opening of the rotation circuit of R1, which is thus stopped on a position corresponding to the digit sent, that is, a junction connected to another office or the line of a subscriber of the present office.

#### *(1) Call to a subscriber connected to the first office*

The digit sent is in this case ten corresponding to ten impulses. Switch RA is moved into the last position of banks 1, 1', 1''.

Switch R1 being in a corresponding position, relay 3 is energized. The train of impulses finished, relay 4 releases, owing to a prolonged short circuit of its lower winding at R11. The following circuit is closed: earth, bank 1'', T62, T31, R43, last position of the bank 1', interrupter spring of the motor magnet RA, to battery. The latter is set in automatic rotation and comes to the normal position of banks 2, 2', 2''.

During this time relay 3 remains held up in parallel with the motor magnet RA over 130

the circuit R44, upper winding of relay 3, to battery.

In addition, at the manual position (Fig. 2) the dial returns to its normal position, the relays 2, 4, and 6 releasing.

At the release of relay 2, the dialling lamp LN is again caused to flicker at R22.

At the release of relay 4 and by the opening of 44 the counting switch RC1 (by the deenergization of its motor magnet previously energized) moves into position 2.

At the release of relay 6 positive is removed from the lower wire of the junction and replaced at R61 by negative.

15 At the tandem office (Fig. 3) polarized relay 15 returns to the negative position and relay 2 is held up via T151. Upon the opening of 154, relay 13 releases.

The ten-point switch having come to the initial positions of banks 2, 2', 2'' as seen above, relay 4 energizes immediately upon the closing of  $h''$  in the circuit already described. Dialling battery is again sent over the upper wire over the circuit: battery, 25 upper winding of retard S1, R132, T41, etc. . . . The operations are repeated at the manual position as described above.

The dial is wound up. Positive is projected on the lower wire. The polarized 30 relay passes to the positive position. Relay 13 operates. Impulses are transmitted to relay 1 over the lower wire of the junction. Relay 4 remains operated via T45. Switch RA leaves its normal position, and stops on 35 the position corresponding to the tens digit.

In addition, the following circuit is closed: earth, bank 2'' of the switch RA, T62, R31, R142, T311, R262, switch R1. The latter rotates automatically and stops 40 by the opening of contact R31 (by the operation of relay 3) when it has arrived in position corresponding to the position of RA.

At the manual position (Fig. 2), the dial returns to normal, which causes:

45 (a) The movement of counting switch RC from position 2 to position 3.

(b) The disconnection of the upper wire of the junction from the impulsing circuit and its connection to relay 5.

50 (c) Flickering of the dialling lamp LN.

(d) Finally, the replacing of positive battery on the lower wire by negative battery.

At the rural position (Fig. 3), polarized 55 relay 15 moves to its negative position. Relay 13 releases. Relay 4 has remained normal from the time of the last impulse. If switch R1 is in the position corresponding to that of RA (representing the position of 60 the tens digit chosen), the following circuit is closed: earth, bank 2'' of switch RA, T62, T31, R43, bank 2', interrupter of rotary magnet RA. The latter comes to the normal position of banks 3, 3', 3'', closing  $h''$ , which 65 causes the release of relay 4, and the sending

of dialling battery on the upper wire of the junction.

In the case where the equipment is only provided for fifty subscribers (example chosen in Fig. 3) five tens only are used, and if by error switch RA is positioned on a position corresponding to an unused ten the system is locked up. The locking circuit is closed on the unused positions 5-9. On these positions the stopping of the rotation of switch R1 is caused by operation of relay 3 (opening of R31), which finds an earth on bank 2 of switch RA.

The concluding of the impulse train causes the release of relay 4. A circuit is closed from earth, bank 2'', T62, T31, R43, bank 2' on positions 5, 6, 7, 8, or 9, T131', and lower winding of relay 13. The latter remains held up and by the opening of contact R132, dialling battery is prevented from being reset over the upper wire of the junction. The dialling lamp associated with the dial flickering warning the operator of the locked up condition of the circuit.

In case the switch comes to rest on positions 1, 2, 3, or 4, relays 4 and 13, being released and the stopping relay 3 energized, the setting in automatic rotation of switch RA is assured by the following circuits:

(a) Positions 1, 2, 3, 4 . . . . T31, R43, bank and contacts in question of bank 2', motor magnet RA, which operates by self-interruption.

(b) Positions 5, 6, 7, 8, 9 . . . . T31, 100 R43, bank contact in question, bank 2', R131', and motor magnet RA set in self-interrupted operation. If the switch is stopped at the tenth position corresponding to digit 0 the rotation is resumed directly.

In supposing the chosen digit suitable, as we have seen above, the projecting of dialling potential on the upper wire permits by the extinction of the dialling lamp the sending of the third digit corresponding to units. 110 The operations are identical to those already described, the following being a summary:

The dial is operated, positive battery is projected over the lower wire, relay 13 operates at the rural position (Fig. 3) through 115 the movement of the polarized relay to its positive position.

Impulses are sent over the upper wire.

Switch RA rotates in accordance with 120 the digit chosen, and switch R1 consequently rotates on to the line in question.

Relay 3 operates, relay 4 releases. A circuit is closed from earth, bank 3'' of switch RA, T62, T31, R43, bank 3', winding of relay 11, R121, T311, R262, and battery through the motor magnet R1. The latter does not energize in series with relay 11, but relay 11 energizes and closes at T112 a circuit and holds up for relay 9 over earth,

T112, lower winding of relay 9, to battery. Relay 9 energizes.

The dial returns to normal position, causing the release of relay 13. By the movement of the polarized relay from the positive to the negative position, a circuit is closed via S1, T91, R132', R41, upper wire of the manual position, where the operations succeed one another in the following manner:

Upon the return to normal of the dial the counting switch RC leaves position 3 and moves to position 4. By the removal of wiper W2 from position 3 of bank A, the circuit of the slow-to-release relay 3 is opened, battery being placed at this moment on the upper wire of the junction. The said relay remains held up at T52 by the operation of relay 5.

(a) Case where subscriber is free.

At the tandem office (Fig. 3) a circuit is closed from earth, T111, R131, T312', lower and upper windings of relay 26 in series, wiper and bank contact T1 of switch R1, winding of relay C of subscriber in question, to battery. These two relays energize in series and hold up over the circuit: T271, T261, lower winding of relay 26, winding of C, to battery.

The operation of relay 26 causes at 262 the opening of the energizing circuit of relay 11. Relay 11 releases and opens the circuit of relay 9, which also releases, and battery is removed from the upper wire.

(b) Case where the subscriber is engaged. (He is engaged through the medium of another connector).

In this case relay 26 (two windings in series) does not energize, being shunted by the lower winding of an identical relay of the finder connector held up by the subscriber. By this means relay 11 is maintained held up, 9 is also held up, and battery is maintained on the lower wire.

At the manual office (Fig. 2), the switches are in the position indicated above. A circuit is closed from interrupted earth, position 4 of bank B, wiper W1, T51, upper winding of relay 2, and battery through the safety resistance.

Relay 2 operating intermittently, at its contact 23 causes the unshort-circuiting of the lower winding of relay 10. The supervisory lamp LS is thus caused to flash.

The operator advised of the busy condition of the subscriber, withdraws the plug. The switches always return to the normal position as we shall see.

If the communication is urgent, the operator can enter into conversation with the busy subscriber in the following manner:

The listening key of the cord used is depressed, then by the operation of the "busy subscriber's listening key" (individual to the operator's position) an earth is sent in paral-

lel on the two conversation wires, the two right-hand lines in parallel of the transformer, R81, upper winding of relay 6, to battery. The operation of relay 6 causes the changing over of battery on the lower wire of the junction to positive from negative as long as the forced listening key is depressed.

At the rural position (Fig. 3), the movement of the polarized relay 15 to the positive position operates relay 13. Relay 5 operates over the circuit: earth, T111, T131, winding of relay 5, to battery.

The conversation circuit is established from upper wire of the junction, condenser C1, condenser C5, T51, T314, wiper and bank contact +1 of switch R1, upper wire of the subscriber's line, and lower wire of the junction, condenser C2, R82, R141', condenser C6, T52, T314', wiper, and bank contact -1 of switch R1, lower wire of the subscriber's line.

The operator can warn him of the urgency of the communication. He releases the prior communication by hanging up, to be automatically recalled by the circuit in question.

In all cases, the subscriber being or becoming free, battery is removed from the upper wire as described above. The call is cut off automatically at the manual position, Fig. 2. We get as already described, the release of relay 5 which at 51 opens the circuit of the interrupted earth, so releasing relay 2 (supervisory lamp LS gives a fixed glow). Relay 3 releases by the opening of contact 52.

Relay 1 operates intermittently via R31 in accordance with the interruptions for controlling calling current.

RC energizes via R32.

Periodic alternating current is projected on the upper wire of the junction. At the rural position (Fig. 3), alternating current relay 7 operates and relay 8 operates via contact T71. The call is extended to the subscriber by the upper wire of the junction, R41, T81, R141, R323', R291, T263, wiper and positive bank contact, upper conductor of the subscriber's line, bell, condenser, lower conductor of the subscriber's line, bank contact and negative wiper T265, R292, R324, R141', T82, to earth.

In addition, at R84 the holding circuit of the upper winding of relay 6 is opened, the lower winding of this relay having been opened at 262, it releases. We get:

(a) Automatic rotation of RA over the circuit: earth, bank 3'', R62, interrupter spring, rotary magnet RA and battery, via the home contact. In position 4 we get: earth, R64, home contact of bank 4', motor magnet of RA, to battery. Said switch moves to position 1, bank 4, and a circuit is closed from earth, bank 4'', R62, motor mag-

net RA, to battery. The latter moves to the home position of bank 1, closing  $h_1$ ,  $h'_1$ ,  $h''_1$ . Relay 6 energizes from earth, T153,  $h'_1$ , upper winding of said relay, to battery.

(b) By the momentary opening of contact T65 relay 31 deenergizes, and by the opening of 313' its locking circuit to T65 is opened permanently (H1 of R1 being opened). When the called subscriber replies, relay 9 operates ( $h_1$  being closed) and following the same operation as previously described in chapter "Reply to a Call", battery is sent via the upper wire of the junction.

At the manual position (Fig. 2), we get energization of 5, energization of 2, extinction of supervisory lamp LS, and at contact 32 the opening of the circuit of RC and its passing from position 4 to position 5.

The operator, being notified, can enter into the conversation with the subscriber as already described.

*25 (2) Call to a subscriber attached to the terminus office*

Let us return to the stage of the operation corresponding to the finish of the sending of the first digit supposing the latter corresponds to a junction (in the example chosen position 6, 7, 8, and 9 of bank 1, Fig. 3), the switch R1 remains in this case locked up in this position until the time of a call or until the calling plug is withdrawn.

The following circuits are closed: earth, bank 1'', T62, T31, R43, position 6, 7, 8, or 9 of bank 1' as chosen, lower winding of relay 14, to battery.

40 Relay 14 energizes and holds up from battery in series with resistance R1 via its upper winding T143', T23, to earth. A circuit is also closed from earth, T143, R131, T312', the two windings in series of relay 26, wiper and bank contact T1 of switch R1, winding of cut-off relay C' of the junction being considered, to battery.

Relay 26 energizes in series with relay C', and holds up from earth, T271, T261, 50 lower winding of relay 26, wiper and bank contact T1, C' to battery.

At this time negative battery existing on the lower wire of the junction is extended to the terminus office over the circuit: T141', 55 R324, R292, T265, wiper and negative bank contact of switch R1, R1, lower wire of the junction and polarized relay 16 to the terminus office (Fig. 4). Relay 16 energizes to its negative position, closing its contacts 161 and 163. A circuit is closed at T161, to energize relay 3 which closes its contact T31.

At T163, relay 2 energizes and holds up over the circuit T24, T31, to earth. It closes 65 the following circuit: earth, T23, H2, (nor-

mal position of switch RC2) H1 (normal position of RC1), lower winding of relay 9, to battery. The latter operates and closes the following circuit: battery, retard S1, R42, T91, R63, upper wire of the junction to the tandem position, Fig. 3, bank contact and positive wiper of switch R1, T263, R291, R323, T141, R41, and upper wire of the junction to the manual position. This causes the extinction of the dialling lamp LN.

The operator is now able to send the second digit. In the case where the junction is not free, relay 26 not being able to operate in parallel with the lower winding of a similar test relay, the circuits indicated above remain open at contacts 263 and 265.

The operator notified of this condition by the flickering of the dialling lamp LN can enter by force into the conversation as described above (busy condition of a subscriber to the tandem office) earth being extended to the circuit of relay 5 at T143.

In reconsidering the case of a free junction, the operator sends the tens digit, the terminus office being in the example chosen equipped for twenty subscribers, the said digit being 0 or 1 (ten impulses or one impulse). A special arrangement at the terminus office permits without the interposition of auxiliary rotary switches finds subscribers in accordance with normal numerical order.

Upon the winding up of the dial, positive instead of negative is projected on the lower wire of the junction, and at the tandem office (Fig. 3), this causes relay 15 to move to its positive position. Relay 13 energizes and opens at contact 132 the circuit of the upper winding to earth of relay 7 via the upper wire before the transmission of the impulses. It may be noted at this point that the upper dialling wire is directly connected to the terminus office without any shunt.

At the terminus office (Fig. 4), the polarized relay 16 passes from its negative to its positive position, opening at contact 161 the circuit of relay 3, immediately reclosed at contact T162. This relay being slow to release remains operated during this change-over of position.

At T164 a circuit is closed from earth, T164, T22, winding of relay 6, to battery. The latter energizes and opens at R63 the circuit of the supervisory battery and connects the upper wire of the junction to relay 1 at contact T63 which is above to receive the impulse of the tens digit sent from the manual position.

(a) The digit sent is 1.

Relay 1 energizes in response to the impulse and closes at contact 11 the following circuit: earth, T11, R151', left-hand winding of relay 15, to battery. The latter energizes on its left-hand winding alone and closes contact T151.

At the opening of contact 11, a circuit is closed from battery, left-hand winding of relay 15 in series with right-hand winding of same relay, T151, R81, T31, to earth. The 5 energization of the right-hand winding of the said relay causes the closing of contacts 151', 152', and 153'.

The impulse train being terminated, the polarized relay 16 returns to its negative 10 position, causing the deenergization of relay 6. A circuit is closed from earth, T31, T92, (RC1 being in its initial position) R111, R62, T152', lower winding of relay 7, to battery. The latter holds up over 15 the circuit T152', T72, T31, to earth.

Dialling battery is projected on the upper wire at R63.

(b) The digit sent is 0 (ten impulses).

As before, the first impulse causes the 20 energization of relay 15 via its two windings.

The following nine impulses are sent to the switch RC1 over the circuit: earth, T11, T151', R122, motor magnet RC1, to battery. When the switch arrives at position 9, a circuit is closed from earth, R71, R124, contacts 25 9 and 10 of bank  $\alpha_1$ , R101, motor magnet RC1 which is in self-interrupted operation, to battery. The latter moves over the two marked positions by automatic rotation and 30 comes to rest in a position corresponding to the digit 10, closing H'1.

The impulse train being terminated, relay 6 releases through the movement of polarized relay 16 to its negative position.

35 A circuit is closed from earth, T23, H2, H'1, T153', lower winding of relay 9, to battery. Relay 9 operates. At T91 dialling battery is extended to the upper wire of the junction.

40 It may be seen from the preceding that the said battery can only be sent if the switch in question is in the home position, corresponding to the tens digit chosen (closing of H1 or H'1).

45 The operator then sends the units digit. This causes the movement of switch RC1 to the corresponding position over the circuit: earth, T11, T151', R122, motor magnet RC1, to battery.

50 If the switch is rotated to one of the two subscribers corresponding to the numbers 19 and 10 in moving over the contacts corresponding to  $\alpha_1$ , the automatic rotation circuit previously described is opened at R71, 55 relay 7 being energized. In addition, the switch having arrived in this position, the following circuit is closed: battery, winding of RC1, interrupter spring, R101, bank contact 9 or 0 of bank  $\alpha_1$ , R124, T71, upper winding of relay 7, to earth via T31. Relay 7 is thus maintained operated and will remain held up if the circuit of its lower winding is opened. The third impulse train having terminated, a negative battery exists 60 on the lower wire of the junction and no

battery exists on the upper wire. The call is cut off at the manual position.

(a) At the tandem office (Fig. 3), the energization of relays 7 and 8 causes the release of relay 6, as for a call to a tandem 70 office subscriber. This insures (1) the automatic rotation of switch RA, through the medium of banks 1'', 2'', 3'', 4'', and R62 and the normal positions 2', 3', 4', R64. The latter then returns to the home position of 75 banks 1, 1', 1'', closing the contacts h1, h'1, h''1. Relay 6 energizes via contact h'1. (2) During the opening of contact T65, relay 31 has remained released as we have previously seen.

80 In addition, relay 14 being always energized, the closure of contacts 81 and 82 is without effect, their circuits being opened at R141 and R141'.

The calling current goes direct to the terminus position by the upper wire. A circuit is closed (Fig. 4), from R63, R91, alternating current relay 5, to earth, via condenser C5. Relay 8 operates via T51. At R81 the energizing circuit of relay 15 is 85 opened. It releases and opens contact T152', so opening the energizing circuit of the lower winding of relay 7 which falls back, excepting when the switch RC1 is in positions 19 and 10. In this case relay 7 remains held 90 up by its upper winding as described above.

95 At T81, relay 12 is energized over the circuit: T31, T81, lower winding of relay 12, to battery. Relay 12 holds up over the circuit: battery via its upper winding, T121, 100 T31, to earth (the latter opens in the present case at R124, the holding circuit of relay 7). At this moment, the call is extended to the subscriber over the circuit, upper wire of the junctions, R63, T82, H'2, (normal position RC2), T125, bank +1 and positive bank contact of the chosen subscriber, upper wire of the subscriber's line, bell, condenser, lower wire of the subscriber's line, negative bank contact, bank -1, T126, T83, to earth. 110

The chosen subscriber's calling relay A energizes through its upper winding, it being inserted in the line. By the closing of contact TA2, relay C energizes in series with relay 13 and opens at C4 the circuit of the 115 calling relay A, relay C then remaining energized via TC1.

The following operations are then identical with those described above in Chapter I "Call by a rural subscriber".

120 III. Local communications—the description continuing from the time of the reply of the subscriber

The operations being the same as described in Section I, the apparatus is in the 125 following positions: Fig. 2, plug of a cord is inserted in an answering jack.

Supervisory lamp LS is extinguished (the calling subscriber having answered the recall signal). Relays 3, 5, 2, 8, 10 are energized,

switch RC is in position 5, positive battery is on the upper wire of the junction. The operator having taken the requirements of the subscriber inserts the dialling plug in 5 the corresponding jack and this causes the energization of relay 7. The holding circuit of relay 8 is opened at R71. The latter opens at T81 the energizing circuit of relay 6 which falls back and so extends negative 10 battery to the lower wire of the junction.

At the tandem office (Fig. 3), polarized relay 15 moves to its negative position. Relay 2 remains energized via T151. The circuit of relay 12 is opened at T154 and it 15 opens at T124 the circuit of relay 31, which falls back.

At T153 relay 6, which is slow to operate, is energized by its upper winding, via h'1. It holds up over the circuit: T63, R84, 20 T23, to earth.

At the manual position (Fig. 2), dialling lamp LN being extinguished the operator winds up her dial and a circuit is closed by the closing of the dial contact C2 to energize relay 4 in series with T71. The said 25 relay holds up at T42. Relay 6 also holds up and at T61 sends positive battery to the lower wire of the junction.

This causes at the tandem office, Fig. 3, 30 the energization of relay 13 at T154 (the polarized relay moving to its positive position).

The following circuit is closed: battery, via the safety resistance, T65, R322', T264, 35 R311', winding of relay 22, T133' to earth.

Relay 22 energizes and holds up via contact T221. Relay 4 energizes via T133.

(1) Case where the calling subscriber is in the tandem office.

40 The first impulse train received by relay 1 (Fig. 3) causes the rotation of switch RA into the position determined by the digit chosen.

At the closing of bank 1'', a circuit is 45 closed from earth, bank 1'', T62, R31, R142, T222, R242, battery via motor magnet R2, which operates by self interruption.

Switch R2, leaving its normal position, closes the following circuit: earth, x2, battery via the winding of relay 29, which energizes. The latter opens circuits of supervision of S1, and also of relay 9 of the calling subscriber at R291 and R292. The subscriber's line being reconnected at T291 and 55 T292, on to a similar arrangement constituted by battery through the upper winding of retard S2, T292, lower wire of the subscriber's substation, upper wire T291, relay 25, to earth. The latter energizes. The calling subscriber remaining in the main circuit via condensers C3 and C4.

The dialling operations follow next by using this time switch R2, by a medium of relay 22 in the same manner as described in 60 Section II (dialling a subscriber), the lat-

ter being connected to a tandem office or a terminus office.

(2) Case where the calling subscriber is connected to a terminus office.

The beginning of the operations is the 70 same as those described above. Relay 6 (Fig. 4) energizes and holds up.

In the case considered, relay 14 being energized remains held up via T143' and T23, to earth. 75

The inversion of battery on the upper wire has been received at the terminus office, Fig. 4, on relay 16, and this causes the energization of relay 2 which holds up at T24. Relay 10 deenergizes. 80

The conditions at this office are then as follows:

Switch RC1 is held by the calling subscriber, relay C of the said subscriber's line is energized, relays 12, 9, 2, 3, are energized, 85 relay 16 is in the negative position. All the other relays are normal.

Upon the winding up of the dial preceding the first digit train, relay 15 (Fig. 3) moves to its positive position. Relays 13, 90 4, and 22 energizes as already described.

Upon the energization of relay 4, the circuit of the upper wire of the junction is opened at R41 and is connected to relay I at T41. It will be noticed that the first impulse train will only be received on relay I at the tandem office. 95

Three distinct cases then present themselves:

(a) The called subscriber is connected to 100 the tandem office.

(b) The called subscriber is connected to a terminus office different from that of the calling subscriber.

(c) The called subscriber is connected to 105 the same terminus office as the calling subscriber.

In the two first cases *a* and *b* the local connection may be established through the medium of switches R1 and R2 of the 110 tandem office.

In the third case (*c*) only switches RC1 and RC2 of the terminus office in question will be used.

(a) The subscriber is connected to the 115 tandem office.

A number received on switch RA has caused the movement of this switch on to the stopping wire corresponding to the arrangement of the subscribers in the office, but, contrary to the operation previously described, switch R2 has not been set in rotation through the closing of bank 1'', the circuit previously described being obtained at R142 (14 being energized). 120

At the end of the impulses, relay 4 deenergizes and a circuit is closed from: earth, bank 1'', T62, R31, T142, R42, resistance R1, to battery, which causes relay 14 to be short circuited. This relay releases. The 130

rotation circuit of R2 is closed at R142. The latter starts off in rotation and is stopped at the desired position by the energization of relay 3 in the following circuit: earth, 5 R323, J2, via the bank of switch R2, control wire considered etc. . . .

Switch R2 leaving its normal position cuts off the control earth of wiper J1 at J2 and at  $\alpha_2$  energizes relay 29.

10 The apparatus at the terminus office is then held up from the tandem office in operated position over the circuit: battery, upper winding of retard S2, T292, T262, etc. . . .

15 Polarized relay 16 of the terminus position (Fig. 4) is at its negative position.

In addition, the supervisory battery (as long as the calling subscriber remains on the line) is extended by the upper wire of the junction to relay 25 of the tandem office (Fig. 3) over the circuit: T263, T291, winding of relay 25, to earth (the subscriber remains in circuit via the condensers C3 and C4).

25 The operations follow at the tandem office as already described in Chapter III.

(b) The called subscriber is connected to a terminus office, different from that of the calling subscriber.

30 The number received on switch RA, Fig. 3, has caused the movement of this switch until the stopping wire corresponding to the junction to be used is reached.

35 As previously, the switch R2 is not set in rotation until the conclusion of the impulse train.

Relay 4 releases and short circuits the upper winding of relay 14, which releases.

40 Switch R2 is set in operation, and the circuit of the calling subscriber is moved to the local connection device at T291, and T292 by the operation of relay 29.

The stopping on the junction considered is brought about by the operation of relay 3.

45 A circuit is then closed from earth, bank, 1'', T62, T31, R43, bank 1', bank contact corresponding to a junction, winding of relay 14, to battery. The latter energizes and when the dial returns to normal (15, in the negative position, 13 released) causes the energization of relay 24 (if the junction considered is free) over the circuit: earth, T143, R131, T223, the two windings in series

50 of relay 24, wiper T2, bank contact T, relay C' of the chosen junction to battery. These two relays energize in series and hold up at T241 to the earth at T271.

The main circuit is from that time directly connected to the junction of the calling subscriber's terminus office, over the circuit: upper wire R41, T141, R323', T242, wiper and bank contact +2, etc., lower wires T141', R324, T245, wiper and bank contact -2, etc. . . .

55 The operations follow next at the ter-

minus office as previously described in Section II, the only difference being at the manual position, Fig. 2, where the positions of the counting switch RC1 are successively 5, 6, 7, 8, and 9, respectively, identical to the positions 1, 2, 3, 4, and 5.

In the case of the two examples already mentioned, and at the end of the operations, the call being cut off, alternating current relay 7 operates at the tandem office, Fig. 3, and also relay 8. At contact 84, the holding circuit of relay 6 is opened, which causes the return to zero of switch RA, the latter closing its contacts  $h1$ ,  $h'1$ ,  $h''1$ . Relay 6 reenergizes at  $h'1$ . By the opening of T65, relay 22 releases and does not reenergize upon the reclosing of contact T65, its circuit being opened at T221 and T133'. If the called subscriber replies the operator is notified (as previously described) by the extinction of supervisory lamp LS. The two subscribers calling and called converse through the medium of condensers C3 and C4.

The operator can release the operation of the circuit not utilized by the local connection. To this end, she withdraws the plugs (dialling plug), the potential of occupation (negative) is removed from the lower wire of the main circuit, and this causes the release of polarized relay 15 at the tandem office (Fig. 3).

A circuit is then closed from earth, R221, T224, lower winding of relay 32, R322, winding of relay 2, to battery (this circuit prepared at the time of the call of the second subscriber only causes the energization of relay 32 upon the opening of the short circuit at T151). The latter energizes and holds up at T321 to battery via resistance R2. At T324 battery is sent on the lower wire either of the subscribers if he is connected to a tandem office or of a junction if he is connected to a terminus office. In this case this battery replaces that which is about to be removed from the manual position and maintains through the medium of polarized relay 16, Fig. 4, the terminus office apparatus in the operated position, the momentary removal of the said battery not having caused the release owing to slow release relay 3.

In both cases, there will be a battery on the upper wire as long as the called subscriber remains on the line. This battery at T323' is sent via relay 23 to earth. Relay 23 energizes. The holding circuit is then closed from earth, T231, T251, relay 27, battery, the said relay (slow to release) having just had its energizing circuit opened at R321'.

In addition, at T322' the switch-taking circuit is transferred to relay 28.

At 323 the control earth is removed from J2 and is transferred to J3.

Polarized relay 15 releases (returns to its middle position) and the restoration to normal of the apparatus associated with the principal circuit, is brought about and this 5 includes relays 1-15 of switch RA.

The principal or tandem office circuit can then deal with either rural-manual or manual-rural calls through the medium of switch R3 in the same fashion as previously described in Chapters I and II with the use 10 of switch R1. Relay 31 being replaced in the description by relay 28 as long as relay 32 remains energized.

When the conversation between the two 15 local subscribers is finished, they hang up and this causes the release of the apparatus used for the establishment of the said connection.

Upon the hanging up of either one of the 20 two subscribers, supervisory battery is removed from the upper wire of the junction either directly or through the medium of relay 9, Fig. 4. If the subscriber in question is connected to a terminus office, this 25 causes at the "tandem" office the release of corresponding relays 23 or 25, or both. These at 231 or 251 open the energizing circuit of 27 which releases some time afterwards (the latter being made slow to release 30 in order to avoid a momentary opening of the circuit indicated above which would cause the release).

By the opening of T271, the circuit of 35 relays 24 and 26 is opened, these release and open the lines respectively at 263, 265, and 242, 245, which causes the removal of battery (through retard S2) from the lower wires. This causes in the present case the 40 release of the terminus office used through the deenergization of polarized relay 16 (Fig. 4).

At tandem office the release of relay 26 causes also the resetting to normal of switch R1 over the circuit: earth,  $\alpha_1$ , R311, R262, 45 motor magnet R1, to battery.

The release of relay 24 causes the resetting to zero of switch R2 over the circuit: earth,  $\alpha_2$ , R222, R242, motor magnet R2, to battery. Upon the opening of  $\alpha_2$  relay 29 50 releases.

Finally, at 244, the energizing circuit of the lower winding of relay 32 is opened. If the main circuit is occupied at this time (using the switch R3) relay 32 remains energized over the circuit: battery, upper winding, T321', T23, to earth, maintaining thus the switched condition of the connection on R3. The circuit having become released, the 55 said relay releases and reprepares the switching on to switch R1 at R323', R322', R321', R323, R324.

(c) The called subscriber is connected to the same terminus office as the calling subscriber.

65 Let us consider the functioning of the ar-

rangement as explained at the beginning of the cases (a) or (b).

The first digit in this case received on switch RA of the tandem office, Fig. 3, has caused the rotation of switch R1 on to the control wire corresponding to the position occupied by switch RA. A circuit is closed from earth, R323, J2 on its normal position, J1, control wire considered, bank 1 of switch RA, and battery through the lower 70 winding of relay 3 which energizes. The latter opens at R31 the short circuit to relay 14, which in this case remains held up. Owing to this fact, switch R2 will not be put in operation, its rotation circuit remaining 75 open at R142.

At the end of the first impulse train, relay 4 releases and will not be reenergized during the two other trains, its circuit being 80 opened at  $\alpha_1$ . At R41 the main circuit is again directly connected to the calling terminus office which is about to receive the two following impulse trains, during the course of which in the tandem office, relay 13 (through the medium of relay 15) will 85 open at T132' the circuit of relay 7 to earth.

At the terminus position, Fig. 4, we have the following: relay 9 being held operated 90 through the answering of the calling subscriber and also the sending of dialling battery to the manual position immediately upon the completion of the previously described circuit to the tandem office.

The operator winds up the dial, polarizes 95 relay 16 moves to its positive position. Relay 6 energizes and connects at T63 relay 1 to the upper wire of the junction.

The impulses sent are received on the said 100 relay which as previously described correspond to the digits 1 or 0 (one or ten impulses). This causes the energization of relay 15 and the maintaining in its initial position of switch RC2, or its return to the beginning of the second ten over the circuit: 105 battery T11, T151', (after the first impulse) T122, R142, motor magnet RC2 to battery, T11, T151', (after the first impulse) T122, R142, motor magnet RC to battery. The latter thus moves automatically to the normal position of the second ten over the circuit: earth, T71, R145, positions 9 and 0 of the first ten, bank  $\alpha_2$ , and battery via the motor magnet which is in self-interrupted 115 operation.

The impulse train having finished, relay 120 16 returns to its negative position, relay 6 releases, dialling battery is sent over the upper wire, relay 9 being held up, in the first case (beginning of first ten) by the hanging up of the calling subscriber as previously, in the second case (beginning of the second ten) over the circuit: earth, T23, H2, H'2, T2, T153', lower winding of 125 relay 9 to battery; the upper winding of the 130

said relay being disconnected from the upper wire of the calling subscriber at H'2 as soon as switch RC2 leaves its normal position in the first ten.

- 5 In addition and in both cases, 7 energizes over a circuit: earth, T31, T92, R111, R62, R152', lower winding of relay 7 to battery. Relay 7 holds up over the same winding T152', T72, and earth at T31. This from 10 that time by the opening of R71 permits switch RC2 to rotate to positions 9 and 0 of the first ten, without being automatically taken back to the home position of the following ten.

- 15 The units digit is then sent in the usual manner, which causes the rotation in the chosen ten of switch RC2 on to the called subscriber.

- 20 The call is sent in the usual manner, which causes the energization of relays 5 and 6 (the call is not sent to the calling subscriber—his circuit being opened at H'2 and R82). The energization of relay 8 causes also at T81 the energization of relay 14 through its lower winding unshort-circuited by the opening of H'2. It holds up via T141, R61, T31, to earth.

- 25 The call is at this time extended towards the called subscriber as already described by the closing of T144 and T146. Upon taking off the receiver by the latter, relay 9 energizes over the circuit: earth, upper winding of 9, R82, T144, substation T146, R84, to battery through left-hand winding of retard S2. Supervisory battery is sent on the upper wire of the junction. The calling finished, the operator is notified of the reply of the subscriber and can release by withdrawing the plug.

- 30 40 The two subscribers are in communication via the condensers C2 and C4.

- Upon energization of relay 14, relay 11 is put in circuit at T143 on to the calling subscriber instead of relay 9 which is transferred to the called subscriber. The two subscribers being unhooked, these two relays are energized.

- When the operator releases, relay 16 comes to its middle position, and a circuit is closed 50 from T31, T92, T111, lower winding of relay 4, to battery through the winding of relay 3.

- 55 Relay 4 energizes and holds up through its upper winding at T41. At T43 the lower winding is next short circuited, finally by the opening of 42 battery is removed from the upper wire of the junction.

- Upon either subscriber hanging up, the switches are returned to normal, T92 or T111 opens. Relay 3 releases slowly, the holding circuits of relays 2, 4, 12 and 14 are opened 60 at T31, switch RC1 returns to its home position via R31 and R71 as already described, and switch RC2 via R23 and R71.

- 65 If during the time when a local connec-

tion is established as above, the junction is taken for the establishing of a manual communication through the medium of switches R1, R2, or R3 of the tandem office, the following takes place:

The operator after sending the first digit receives the busy signal through the flickering of the dialling lamp (battery being removed from the upper wire of the junction at the terminus office at R42). The 75 operator by the operation of her listening key enters into the conversation directly with the subscribers in the local connection and asks them to release. It is possible, in cases of extreme urgency, to force the release of a local connector by the operation of her forced listening key which causes as previously described the movement from the negative to the positive position of polarized relay 16.

80 Relay 6 energizes, and at 61 opens the holding circuit of relay 14. Relay 9 deenergizes. Upon the withdrawal of the plug, the switches return to normal as described above.

85 The various preceding descriptions relating to the putting into communication of two local subscribers following upon the call of a calling subscriber can equally well be applied to the case where both subscribers 90 are dialled.

95 The first stage is described in Section II (call of a subscriber) then without further operations being included, the dialing of the second subscriber takes place as described above in Section III.

100 In addition, at the tandem office, Fig. 3, an arrangement for listening and for releasing the local connection is provided.

105 The operator dials on the principal circuit corresponding to the local engaged connector a digit which causes as described already the movement of switch R3 on to the listening circuit. Relay 21 energizes in the same manner as cut-off relays C and C'. 110 Listening in, and the conversation is then dependent upon condensers C7 and C8.

115 The operator can advise the subscribers to hang up and can, in cases of extreme urgency, release from the office by the operation of her forced listening key the subscribers in the connection.

To this end, the following takes place: Relay 15 moves to its positive position. Relay 13 energizes. Relay 23 is short circuited over the circuit T211, T133', to earth. The latter releases, causing the deenergization of relay 27, which causes the switches used in the local connection to return to normal. The operator can after plugging use 125 switches R1 and R2 to establish other connections.

What is claimed is:

1. In a telephone system, two offices, calling lines and called lines in one office, a 130

- trunk line connecting said offices and terminating at said one office in switching mechanism having access to said lines, and means responsive to one operation at the other office for operating said switching mechanism to find a calling line and means responsive to a different operation at the other office for operating said switching mechanism to find a called line.
2. In a telephone system, two offices, a trunk line connecting said offices and terminating at one office in an automatic switch, lines at said one office accessible to said switch, a signal at the other office, means responsive to the initiation of a call on one of said lines for operating said signal over the trunk line, and means controlled over the trunk line from said other office for operating said switch to connect with the calling line.
3. In a telephone system, a main office and a branch office, a trunk line connecting said offices and terminating in a manual switchboard at the main office and in an automatic switch at the branch office, lines accessible to said switch, a signal at said switchboard, means responsive to the initiation of a call on one of said lines for operating said signal over the trunk line, and means responsive to the establishment of a connection with said trunk at the switchboard for operating said switch to connect with the calling line.
4. In a telephone system, two offices, a trunk line connecting said offices and terminating at one office in a plurality of switches, lines at said one office accessible to said switches, a signal at the other office, means responsive to the initiation of a call on one of said lines for operating said signal over the trunk line, means responsive to the establishment of a connection with the trunk line for operating one of said switches to connect with the calling line, and means controlled from the other office over said trunk line for operating another of said switches to connect with another of said lines as a called line.
5. In a telephone system, three offices, a trunk line connecting the first and second office and terminating at the second office in an automatic switch, a second trunk line connecting the second and third offices and terminating at the third office in a second automatic switch, lines in the third office accessible to said switch, a signal at the first office, means responsive to the initiating of a call on one of said lines for operating said signal over said two trunk lines, means responsive to an operation at the first office for operating said first switch to connect with the second trunk line, and means responsive to the establishment of the connection with the second trunk line for operat-

ing said second switch to connect with the calling line.

6. In a telephone system, two offices, lines terminating in one office, a two-way trunk line connecting said offices and terminating at said one office in a switch having access to said lines, a signal at the other office, means responsive to the establishment of a calling connection over said trunk line by one of said lines for operating said signal, means for connecting with said trunk line at said other office for extending a connection to one of said lines, and means for disabling said signal responsive to the establishment of said last connection with the trunk line.

7. In a telephone system, two offices, a trunk line connecting said offices and terminating in an automatic switch at one office, a dialling circuit at the other office and means for connecting it to the trunk line to directly control said switch, a supervisory signal associated with said circuit, means for operating said signal responsive to the connection of said circuit with the trunk line, means for extinguishing said signal in case said switch is in normal position, and means for maintaining said signal operated in case said switch is in an off-normal position.

8. In a telephone system, two offices, a trunk line connecting said offices and terminating at one office in a switching device comprising two selective switches, a third switch associated with said selective switches, calling and called lines at said one office, means controlled over the trunk line from said other office for operating the first selective switch to connect with a calling line, means controlled over the trunk line from said other office for directly operating said third switch to designate a called line, and means responsive to the operation of said third switch for operating the second selective switch to establish a connection with the called line designated by said third switch.

9. In a telephone system, two offices, a two-conductor trunk line connecting said offices and terminating at one office in a switching device comprising a selective switch and a register switch, means at the other exchange for transmitting impulses over one conductor of the trunk line to directly operate said register, means for operating said switch to a particular position in accordance with the setting of said register, and means operated over the other conductor of said trunk line for maintaining said switch in said particular operated position.

10. In a telephone system, a two-conductor trunk line connecting two offices, a line terminating in one office, means responsive to the condition of said line for transmitting a plurality of separate and distinct sig-

nals over one conductor of the trunk line, and means at the other office for transmitting a plurality of separate and distinct signals over the other conductor of the 5 trunk line.

11. In a telephone system, a trunk line terminating in a switching device comprising three automatic switches, calling and called lines accessible to said switches, 10 means controlled over the trunk line for operating the first and second of said switches to establish a talking connection between a calling and called line, and means controlled over the trunk line for operating the 15 third of said switches to establish a connection with a calling line while said first connection is maintained.

12. In a telephone system, a trunk line terminating in a switching device comprising 20 three automatic switches, calling and called lines accessible to said switches, means for operating the first of said switches to connect with a calling line, means for operating the second of said 25 switches to connect with a called line, means for establishing a talking connection between the lines connected with by said two switches, and means for operating the third of said switches to connect with another 30 calling line while maintaining said first connection.

13. In a telephone system, a trunk line terminating in a switching device comprising three automatic switches, a calling line 35 and a called line, means controlled over the trunk line for operating the first of said switches to connect with the calling line, means controlled over the trunk line for directly operating the second of said 40 switches for locating said called line, means for operating the third switch to connect with said called line, and means for establishing a talking connection between said 45 lines via said first and third switches and for releasing said second switch.

14. In a telephone system, a trunk line terminating in a switching device comprising three automatic switches, calling and called lines, means controlled over the trunk 50 line for operating the first of said switches to connect with a calling line, means controlled over the trunk line for operating the second of said switches to connect with a called line, means for establishing a talking 55 connection between the lines connected with by said two switches, and means controlled over the trunk line for operating the third of said switches to connect with said talking connection.

60 15. In a telephone system, a trunk line terminating in a switching device comprising three automatic switches, calling and called lines, means for operating the first of said switches to connect with a calling line, 65 means for operating the second of said

switches to connect with a called line, means for establishing a talking connection between the lines connected with by said two switches, means controlled over said lines for maintaining said talking connection independent of control over the trunk line, 70 means for operating the third of said switches to connect with said talking connection, and means rendered effective responsive to said last connection and controlled over the trunk line for forcibly releasing said talking connection.

16. In a telephone system, a trunk line extending from an operator's position to a switching device comprising three automatic switches, lines accessible to said switches, a signal at the position, means responsive to the initiation of a call on one of said lines for operating said signal over the trunk line, an operator's link circuit 80 at the position and means for connecting it to the trunk line, means responsive to the connection of the link to the trunk line for operating the first of said switches to connect with the calling line, means for restoring the signal to normal responsive to the establishment of the connection with the calling line, means at the position for operating the second of said switches to connect with another of said lines, means for 85 establishing a talking connection between the lines connected with by said two switches, means for freeing the trunk line from said connection without releasing the connection responsive to the disconnection of 90 said link circuit from the trunk line, means responsive to the initiation of a call on another of said lines for reoperating said signal over the trunk line, and means responsive to the reconnection of said link circuit to the trunk line for operating the third of said switches to connect with said other calling line.

17. In a telephone system, a trunk line extending from an operator's position to an 110 automatic switch, a calling line accessible to said switch, a link circuit at the position adapted to be connected to the trunk line, a signal associated with said link, means responsive to the connection of the link circuit to the trunk line for operating said 115 switch to hunt for the calling line, means for operating said signal in one manner during the hunting operation of said switch, and means for operating said signal in a different manner responsive to said switch finding the calling line.

18. In a telephone system, a two-conductor trunk line, two link circuits adapted to the trunk line, means responsive to the connection of the first link to the trunk line for connecting a source of current of one polarity to one of said trunk conductors, means including the other link for transmitting impulses over the other of said trunk 125 130

- conductors, and means controlled from said other link for disconnecting said current source of one polarity and for connecting a current source of the opposite polarity to 5 said one trunk conductor during the transmission of impulses.
19. In a telephone system, two offices, a trunk line connecting said offices and terminating at one office in an automatic switch, 10 lines at said one office accessible to said switch, a signal at the other office, means responsive to the initiation of a call on one of said lines for operating said signal over the trunk line, means controlled over the 15 trunk line from said other office for operating said switch to connect with the calling line, and means responsive to the establishment of the connection with the calling line for signalling the line.
20. In a telephone system, two offices, a trunk line connecting said offices and terminating at one office in an automatic switch, lines at said one office accessible to said switch, a signal and a source of signalling 25 current at the other office, means responsive to the initiation of a call on one of said lines for operating said signal over the trunk line, means controlled over the trunk line from said other office for operating said 30 switch to connect with the calling line, and means responsive to the establishment of the connection with the calling line for intermittently transmitting signalling current from said source over the trunk line and the 35 calling line.
21. In a telephone system, two offices, a trunk line connecting said offices and terminating at one office in an automatic switch, lines at said one office accessible to said 40 switch, a signal and a source of signalling current at the other office, means responsive to the initiation of a call on one of said lines for operating said signal over the trunk line, means controlled over the trunk line from said other office for operating said 45 switch to connect with the calling line, means responsive to the establishment of the connection with the calling line for connecting said current source to the line via said trunk 50 line, and means controlled over the calling line for disconnecting said current source therefrom.
22. A telephone system as claimed in claim 21 in which a supervisory signal is 55 operated while signalling current is applied to the line and disabled when the signalling current is disconnected from the line.
23. In a telephone system, three offices, a trunk line connecting the first and second 60 offices and terminating at the second office in an automatic switch, a second trunk line connecting the second and third offices and terminating at the third office in a second 65 automatic switch, lines in the third office accessible to said second switch, a signal at the first office, means responsive to the initiation of a call on one of said lines for operating said signal over the trunk line, means responsive to an operation at the first office for operating one of said switches to connect with and signal the calling line, and means responsive to an operation by the party on the calling line for disabling said signalling means and for rendering the other of said switches di-
- the first office, means responsive to the initiation of a call on one of said lines for operating said signal over said two trunk lines, means responsive to an operation at the first office for operating said first switch to connect with the second trunk line, means responsive to the establishment of the connection with the second trunk line for operating said second switch to connect with the calling line, a source of signalling current at the first office, and means responsive to the establishment of the connection with the calling line for connecting said current source to the calling line via said trunk lines.
24. A telephone system as claimed in claim 23 in which the disconnection of the source of signalling current from the calling line is controlled over that line.
25. In a telephone system, three offices, a trunk line connecting the first and second offices and terminating at the second office in a switching device comprising two automatic switches, a second trunk line connecting the second and third offices and terminating at the third office in a second switching device comprising two automatic switches, lines at the second and third offices accessible to the respective switches, a signal at the first office, means responsive to the initiation of a call on one of the lines at the third office for operating said signal over the two trunk lines, means responsive to an operation at the first office for operating one of the switches at the second office to connect with the second trunk line, means responsive to the establishment of the connection with the second trunk line for operating one of the switches at the third office to connect with the calling line, means at the first office for transmitting series of impulses over the first trunk line indicative of called lines in either the second or third offices, and means whereby the other switch at the second office is set responsive to series of impulses indicating a called line at that office and whereby the other switch at the third office is set responsive to series of impulses indicating a called line at that office.
26. In a telephone system, two offices, a trunk line connecting the offices and terminating at the second office in a switching device comprising two automatic switches, lines at the second office accessible to said switches, a signal at the first office, means responsive to the initiation of a call on one of said lines for operating said signal over the trunk line, means responsive to an operation at the first office for operating one of said switches to connect with and signal the calling line, and means responsive to an operation by the party on the calling line for disabling said signalling means and for rendering the other of said switches di-

rectively controllable over the trunk line from the first office.

27. In a telephone system, a trunk line terminating in an automatic switch, a relay having a normal position and two operated positions in the switch, means for operating the relay to one position responsive to the trunk line being taken into use, means controlled by the relay in said one position for placing the switch in holding condition, means controlled over the trunk line for operating the relay to the other position, and means controlled by the relay in said other position for placing the switch in operating condition.

28. In a telephone system, a trunk line terminating on an automatic switch, a relay having a normal position and two operated positions in the switch, an impulse relay and a holding relay in the switch, means for operating said first relay to one position responsive to the trunk line being taken into use, means controlled by said first relay in said one position for operating said holding relay, means for operating said first relay to the other position over the trunk line, and means controlled by said first relay in said other position for maintaining said holding relay operated and for connecting said impulse relay to the trunk line.

In witness whereof, I hereunto subscribe my name this 29th day of July, A. D. 1931.

FERNAND GOHOREL.

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