

Oct. 25, 1927.

A. B. PREUSS

1,646,387

AUTOMATIC TELEPHONE SYSTEM

Filed Aug. 21, 1925

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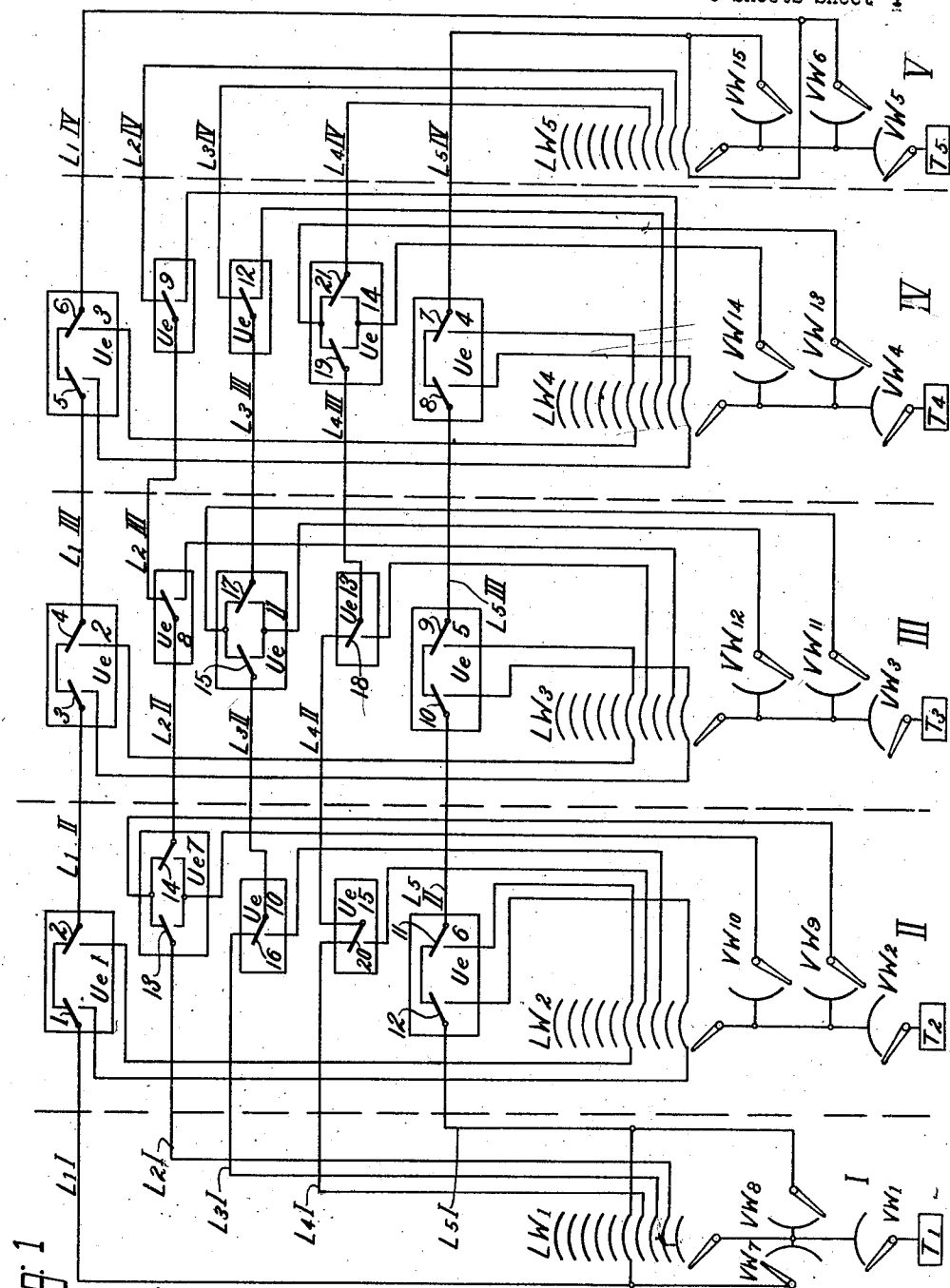


Fig. 1

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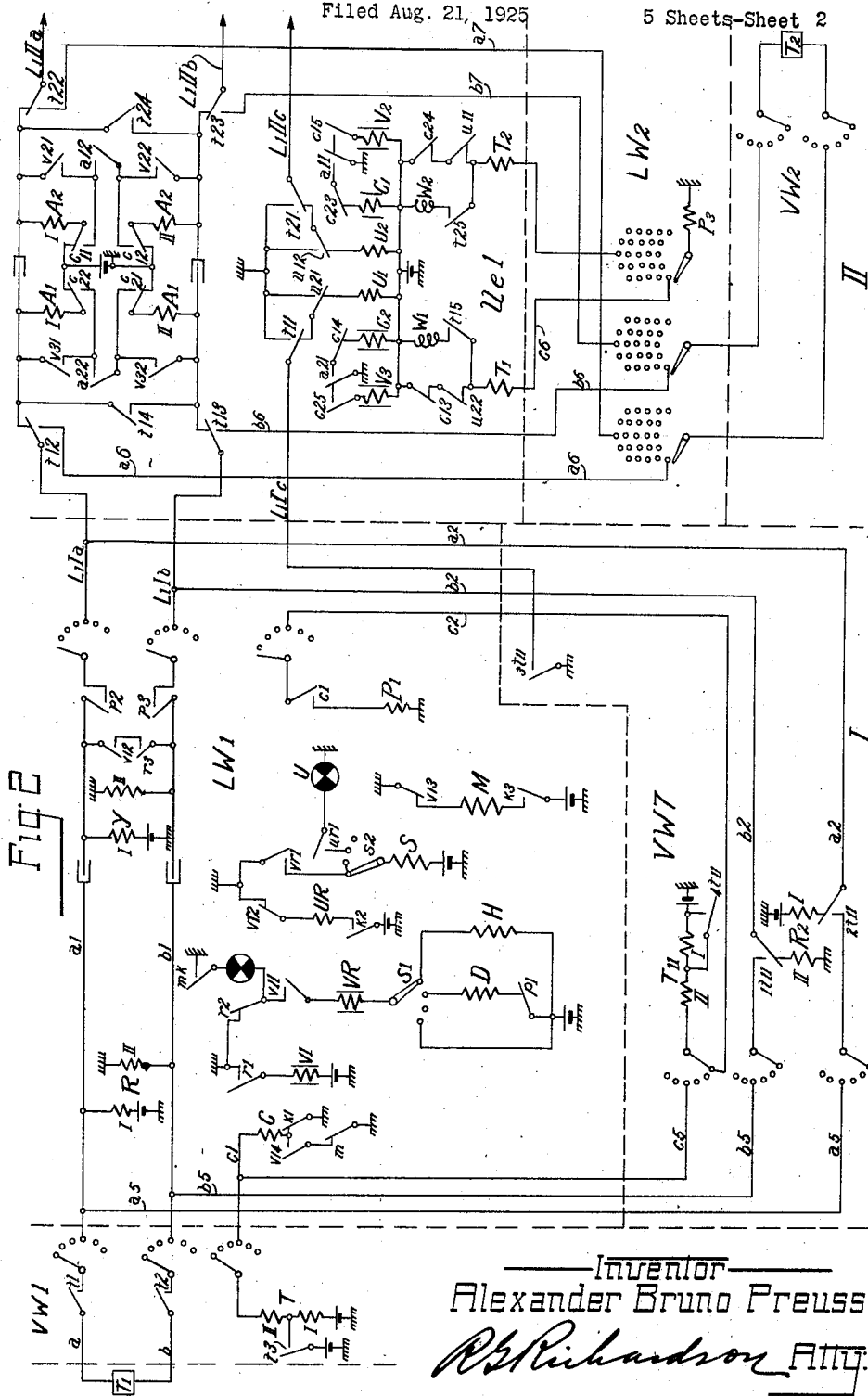
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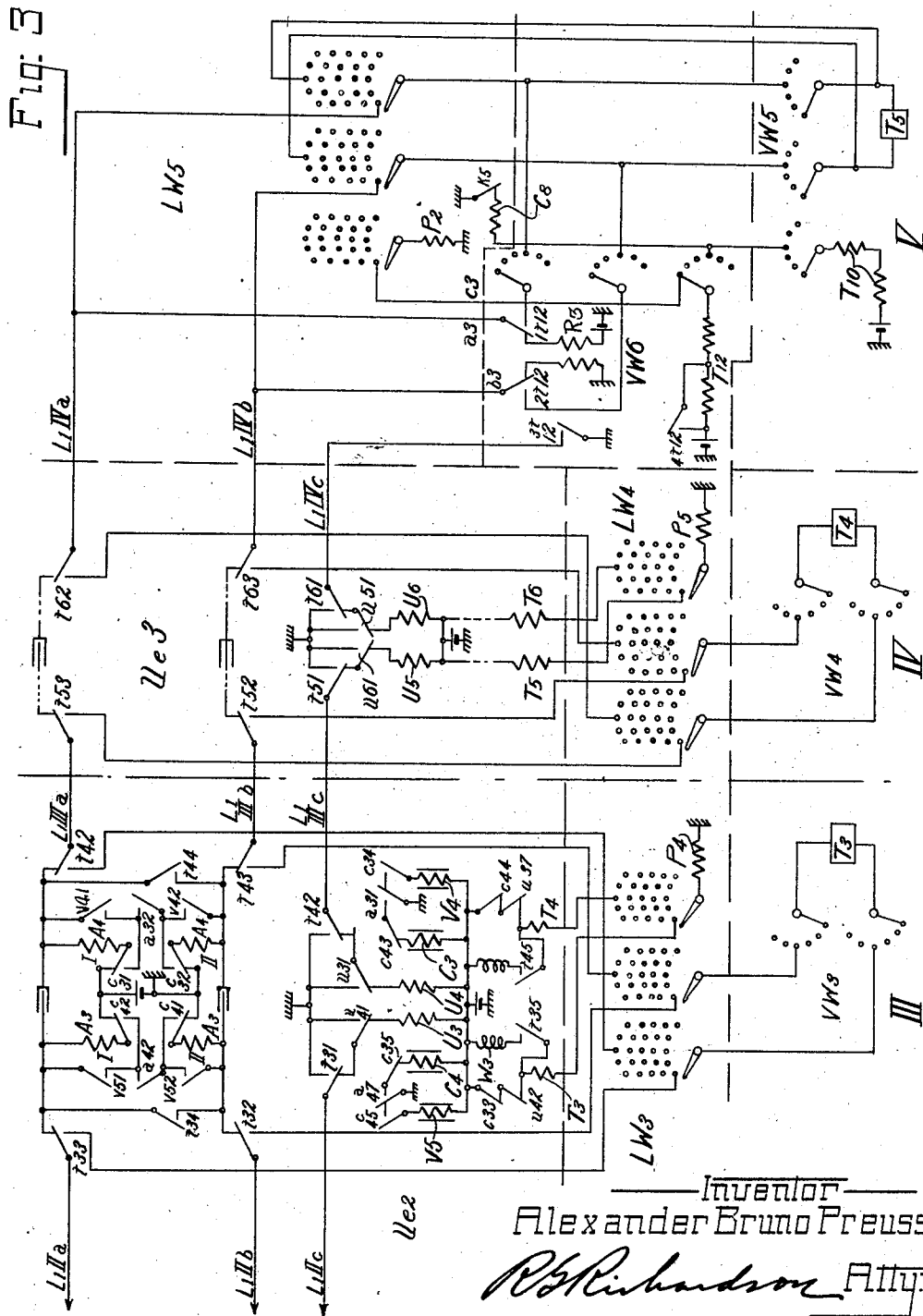
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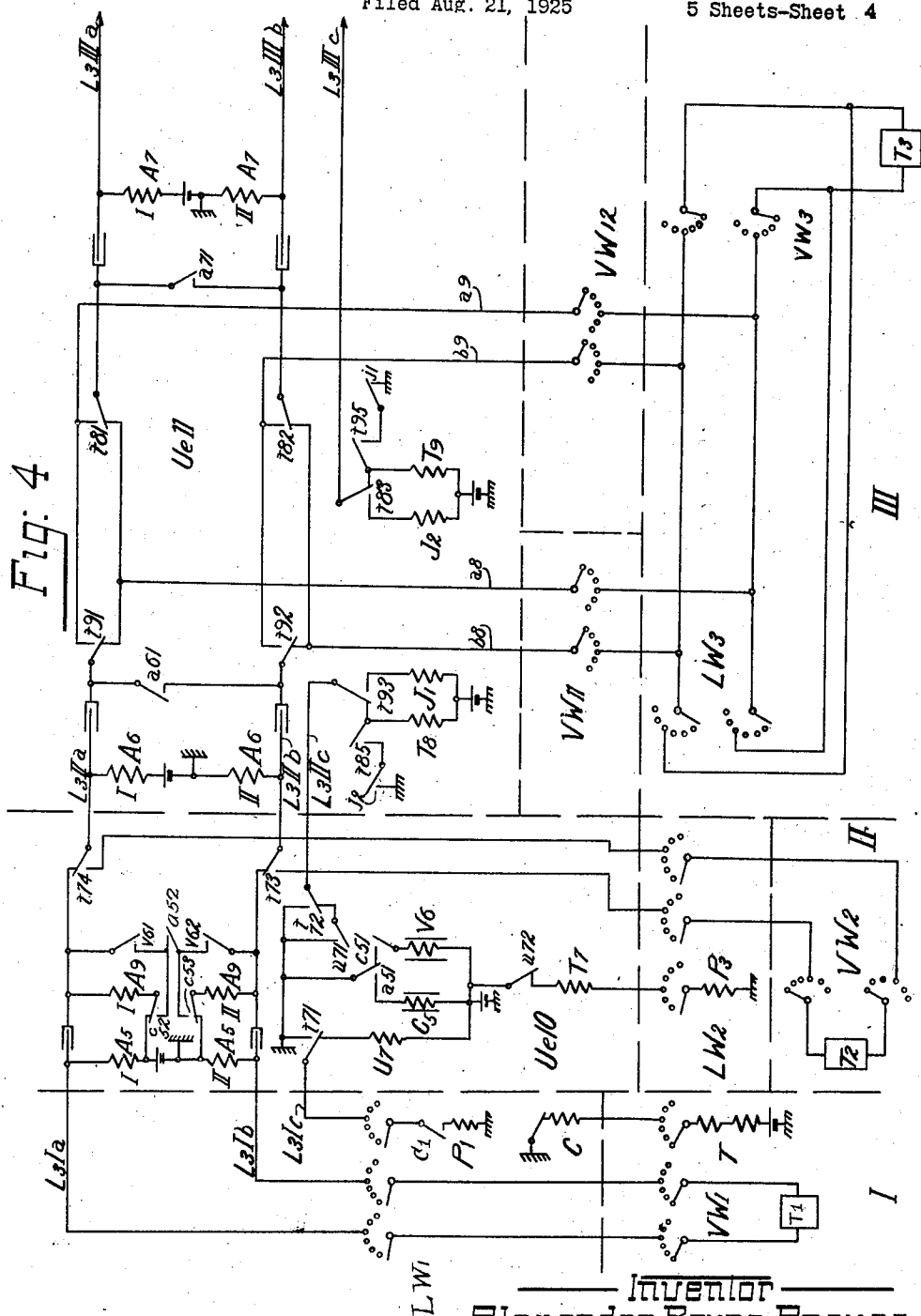
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AUTOMATIC TELEPHONE SYSTEM

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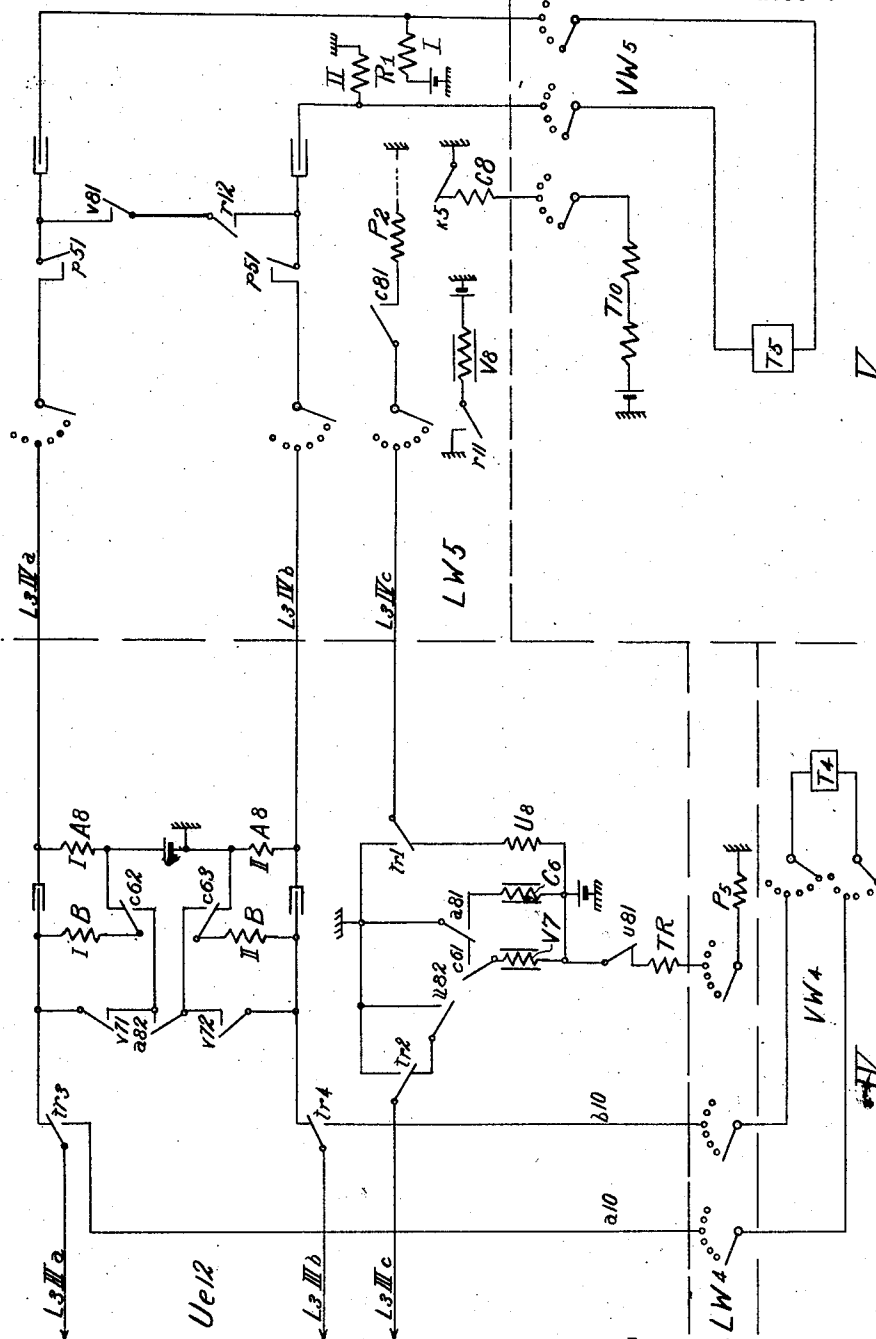
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AUTOMATIC TELEPHONE SYSTEM

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Fig. 5



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AUTOMATIC TELEPHONE SYSTEM.

Application filed August 21, 1925, Serial No. 51,616, and in Germany September 27, 1924.

The present invention relates to automatic telephone systems, especially to those in which calls are set up over several exchanges connected in series.

In the known arrangements of this kind the setting up of connections over several exchanges connected in series is effected either by means of so called through going traffic, that is, each exchange calls the succeeding exchange and is then switched through to the next exchange or the setting up is effected by running a trunk-line through all the exchanges and by providing a special jack in each of the exchanges located in series for each connection from one exchange to the next.

Now the object of the present invention is to enable calls between the individual exchanges located in series to be set up in an entirely automatic manner in both directions, and to render the plant as economical as possible by simultaneously using each trunk line for different calls. According to the invention, this is achieved by running the trunk lines, which are subdivided into groups, over all the exchanges located in series, and by rendering each of the exchanges accessible from all the other exchanges only over a particular trunk line or group of trunk lines. At the individual exchanges, these trunk lines are provided with switching-over devices, which disconnect a section of the trunk line when this section is taken into use, and render the idle section available for the traffic between other exchanges.

By way of example, the figures show diagrammatically a circuit arrangement for five automatic exchanges located in series. The Fig. 1 shows a fundamental circuit for the whole arrangement, while the Figs. 2 and 3 show the circuit of a trunk line, over which the two end exchanges can be reached, and the Figs. 4 and 5 show the circuit of a trunk line, over which a connection can be set up with a particular intermediate exchange.

The method of operating the whole arrangement will now be described in detail with reference to the diagrammatic circuit (Fig. 1). The exchanges I and V can be reached by all the exchanges over the line

L1. If, for example, a subscriber T1 wishes to make a call to any particular subscriber of the exchange V, a final selector LW1 is taken into use over his preselector VW1 and the final selector is raised to the fifth level, from which there is a group of outgoing trunk lines to the exchange V. Only the lines L1 and L5 of this group are shown. As soon as the final selector LW1 has found an idle trunk line, for example L1, the final selector LW5 at the exchange V is taken into use over the line L1I, the contacts 1 and 2 of the repeater Ue1, and the line L1II of the exchange II, the contacts 3 and 4 of the repeater Ue2, and the line L1III of the exchange III, contacts 5 and 6 of the repeater Ue3, and the line L1IV of the exchange IV, and over the preselector VW6 to the final selector LW5. In the manner to be hereafter more fully described, the contacts of the final selectors LW2, LW3 and LW4, to which the trunk line L1 is accessible are marked engaged, so that the trunk line L1 can no longer be taken into use.

If a subscriber of the exchange V be wanted by the subscriber T2 of the exchange II, the preselector VW2 hunts for an idle final selector such as LW2, which is set onto the fifth level and takes into use an idle trunk line to the exchange V, for example, the line L1II. From the line L1II, this connection follows the same route as that described for the subscriber T1. The opening of the contact 2 prevents this trunk line being taken into use from the exchange I, while another connection can be set up from the exchange II, to the exchange I over the section L1I of the trunk line L1 and over the preselector VW7 over contact 1 in its working position.

If the line L1 be taken into use by a subscriber T3 of the exchange III over the preselector VW3 and the final selector LW3, the line L1 is disconnected at the contact 4, so that a connection can be set up from the exchange II or III to the exchange I over the line sections L1II or L1III and L1I over contacts 1 or 3, in its working position, respectively, in addition to the connection extending over the sections L1III, and L1IV to the exchange V. In a similar manner it is possible for calls to be made simultane-

ously between the exchange IV and the exchanges V and I.

The same kind and number of calls can be set up over the line L5, which likewise serves to set up connections to the end exchanges I and V. For example, a connection can extend from the subscriber T5 of the exchange V over the preselector VW5, the final selector LW5 in the first level, the line L5IV, contacts 7 and 8 of the repeater Ue4, line L5III, contacts 9 and 10 of the repeater Ue5, line L5II, contacts 11 and 12 of the repeater Ue6, line L5I, and over the preselector VW8 to the final selector LW1 of the exchange I. The other connections from the separate intermediate exchanges II to IV to the two end exchanges I and V or from the exchange I to the exchange V extend in the same manner as that previously described above for the line L1, so there is no need to describe them in detail.

Only the exchange II can be reached over the line L2, while only connections to the intermediate exchanges III or IV can be set up over the lines L3 or L4, respectively, if, for example, the subscriber T1 of the exchange I wishes to make a call to a subscriber of the exchange II, a trunk line L2 is taken into use over the preselector VW1 and the final selector LW1 in the second level, this line L2 going over the contact 13 of the repeater Ue7 to the preselector VW9 of the exchange II. The contact 14 is operated when the repeater Ue7 is taken into use, hence a call incoming from one of the succeeding exchanges III to V over the line section L2II is taken to the preselector VW10. A full description will be given hereafter of the manner in which a call is switched from one of the succeeding exchanges, and how the line L2 is prevented from being taken into use.

If a subscriber of an exchange I, II, IV, or V wishes to set up a call to a subscriber of the exchange III, for example, the subscriber T2 belonging to the exchange II, the line L3II is taken into use over the preselector VW2 and over the final selector LW2 set on the third level. This line extends over contact 16 of repeater Ue10 in its working position, over the contact 15 of the repeater Ue11 and to the preselector VW11 at the exchange III. The disconnection of the line L3 at the contact 16 prevents the line being taken into use by a final selector of the exchange I, while the line section L3III is switched over at contact 17 to the preselector VW12 of the exchange III when the trunk line L3II is taken into use. Hence a connection set up from the exchange IV or V to the exchange III extends over the line sections L3III or L3III and L3IV respectively, through the repeater Ue12 to the preselector VW12.

The exchange IV can only be reached over

a group of trunk lines represented by the line L4. For example, if the subscriber T2 of the exchange II wishes to set up a call to the subscriber of the exchange IV, the connection extends over the preselector VW2, the final selector LW2, the line L4II, which is connected to the fourth level, over contact 20 of repeater Ue15 in its working position, over the contact 18 of the repeater Ue13, the line L4III, contact 19 of the repeater Ue14, and over the preselector VW13 to the final selector LW4, to which the wanted subscriber of the exchange IV is connected. At the contact 20, the trunk line L4 is divided, so that it cannot be taken into use by the exchange I over the line L4I and the repeater Ue15. The contact 21 is operated when the repeater Ue14 is taken into use, hence the exchange IV can still be reached by the exchange V over the line L4IV, the contact 21, and over the preselector VW14.

It remains to be mentioned that the exchanges are shown provided only with final selectors, so that for the local traffic each exchange can have only 60 subscribers' lines. This, however, is only shown in the example for the sake of simplicity. It is obvious that the groups of trunk lines, of which the trunk lines L1 to L5 are shown, could also be connected to the bank contacts of the group selectors in the different exchanges, so that these could contain as many subscribers' lines as desired.

The Figs. 2 to 5 show in detail the circuits of two trunk lines, each in a separate group of trunk lines. Thus the Figs. 2 and 3 show the circuit of the trunk line L1, while the Figs. 4 and 5 show the circuit of the trunk line L3.

The method of operating the circuit arrangement for trunk lines to the end exchanges I and V will now be described in detail with reference to the Figures 2 and 3. For this purpose it will be assumed that the subscriber T1 wishes to set up a call to a subscriber of the exchange V. When the receiver is lifted down at the instrument of the subscriber T1, the preselector VW1 is started in known manner over the leads *a* and *b*, and the preselector selects an idle final selector such as LW1. As soon as this is found, the relay T is operated over its windings I and II and over the test wiper of the preselector in series with the relay C of the final selector LW1. This circuit contains the off-normal contact *k*1 of the final selector, which is closed only when the final selector is in its normal position. The relay T opens the rotary magnet circuit of the preselector VW1 in the known manner; at its contacts *k*1 and *k*2, it connects the subscriber's leads *a* and *b* through to the leads *a*1 and *b*1 of the final selector LW1; and at its contact *k*3, it short circuits its high resistance winding I, thereby putting the engaged condition on the

final selector taken into use in known manner. At the same time, the relay R is operated over its windings I and II and the subscriber's loop *a*, *b*. At the contact *r1* a circuit is closed for the slow acting relay V1, which at its contact *v11* prepares the circuit for the lifting magnet H through the winding of the relay VR and the wiper *s1* of the side switch. The first train of impulses transmitted by the subscriber T1 comprises 5 current impulses. The relay R falls back a number of times corresponding to the number of impulses transmitted, and each time closes, at its back contact *r2*, the circuit for the lifting magnet H, which has been prepared at the contacts *v11*. The relay VR is energized in this circuit and remains in its operated position throughout the train of impulses, because it is a slow acting relay. At its contact *vr1* relay VR energizes the motor magnet S of the side switch in series with the wiper *s2* of the side switch while at the contact *vr2* the circuit of the relay UR is opened, a normally open point in this circuit being closed over the off-normal contact *k2* at the first lifting movement. The lifting magnet H raises the wipers of the final selector LW1 to the fifth level, in response to the selected number 5, whereupon, at the end of the train of impulses, the relay VR falls back and opens at its contact *vr1* the circuit of the side switch magnet S, so that the side switch is moved on into position 2.

The calling subscriber now transmits one current impulse for the purpose of initiating the non-numerical selection of a trunk line connected to the fifth level. The relay R again falls back and energizes the rotary magnet D over the contact *r2* and over the contacts *v11* and *p1*, the winding of the relay VR and over the side switch arm *s1* in position 2. The wipers LW1 are set onto the first contact on the fifth level. The multiple contacts *mk* close upon the first rotary step on level 5 (and also on levels 2 to 4, inclusive). The wipers continue in their rotary motion if the line connected to this contact be engaged, this being effected by the further energization of the rotary magnet D over the multiple contact *mk* and the interrupter until a free trunk line, for example L1I, has been found. Thereupon the relay P1 is energized in the following circuit: earth, winding of P1, contact *c1*, test wiper of relay LW1, lead *c2*, home position contact of the test wiper of VW7, windings II and I of T11, battery, earth. At its contact *p1*, the relay P1, opens the rotary magnet circuit, whereupon the switch is stopped, and at its contacts *p2* and *p3* it switches through the leads *a1* and *b1* over condensers to the leads L1Ia and L1Ib of the trunk line L1 taken into use. The relay VR, having operated again, falls back, the magnet S is

deenergized and the switch wipers are allowed to move into position 3. The relay Ur is also energized over the contact *vr2* and the off-normal contact *k2*. The relay UR, at its contact *ur1*, connects the interrupter U to the contact 3 of the side switch, thereby momentarily energizing the magnet S, which moves the side switch into position 4.

The relay T11 of the preselector VW7, which was energized when the trunk line L1I was taken into use, at its contacts 1tII and 2t11, disconnects the windings I and II of the relay R2 from the leads *a2* and *b2* going to the preselector VW7, and at its contact 3t11, applies earth to the third lead L1Ic of the trunk line L1I. The relay U1 of the repeater Ue1 of the exchange II is thereby energized over the contacts *t11* and *u21*. The relay U1, at its contact *u11*, opens the test circuit of line *a7*, *b7* connected to the contacts of the final selector LW2, hence the trunk line L1 cannot be taken into use by the exchange II. At the contacts *v12* and *r3* in the final selector LW1, a circuit is closed for the relay A1 of the repeater Ue1 over the following route: earth, contact *c21*, winding II of A1, contact *t13*, lead L1Ib, wiper of LW1, contacts *p3*, *r3*, *v12*, *p2*, lead L1Ia, contact *t12*, winding I of A1, contact *c22*, battery, earth. The relay A1, at its contact *a11*, closes a circuit over the back contact *c23* for the winding of the relay C1, which, at its contacts *c11* and *c12*, disconnects the windings I and II of the relay A2 from battery and earth, and connects these windings in series with the contact *a12* across the outgoing leads L1IIa and L1IIb. A circuit is thus prepared for the transmission of current impulses to the repeater Ue2 at the exchange III. The relay U1, at its contact *u12* and over the contact *t21*, applies earth to the lead L1IIc going to the exchange III, and energizes the relay U3 at the repeater Ue2 over the contacts *t31* and *u41*. The relay U3 then energizes the relay U5 at the repeater Ue3 in the exchange IV over the contact *u31* and the contact *t42* and over the lead L1IIc and the contacts *t51* and *u61*.

When the relay C1 operates at the repeater Ue1, the contact *c13* opens the test circuit of the branch of the trunk line L1, which goes to the final selector LW2. The trunk line is thus also marked engaged to other calls in the direction of the end exchange I.

The relay A3 of the repeater Ue2 is energized in series with the windings I and II of the relay A2, which are bridged across the leads L1IIa and L1IIb by means of the contact *a12*. This circuit extends from earth at the contact *c41* at the repeater Ue2 through the winding II of A3, contact *t32*, lead L1IIb, contact *t23*, winding II of the relay A2, contacts *c12*, *a12*, *c11*, winding I of A2, contact *t22*, lead L1IIa, contact *t33*,

winding I of A3, and over the contact *c42* to battery and earth. At contact *a31*, the slow acting relay C3 is energized over the back contact *c43* and the relay, at its contact *c33*, interrupts the test circuit of the branch of the line L1, which is connected to the first level of the final selector LW3. When the relay U3 operates, its contact *u31* interrupts the test circuit for the branch of the line L1 going to the exchange V via the final selector LW3. The relay C3, at its contacts *c31* and *c32*, disconnects the windings I and II of the relay A4 from battery and earth and connects them across the leads L1III*a* and L1III*b* in series with the contact *a32*; at its contact *c34*, the relay prepares a circuit for the relay V4; and at its contact *c35*, it disconnects the winding of the relay C4 from the contact *a41* in order to prevent the operation of the relay C4.

In a similar manner the preparation of the repeater Ue3 for the repetition of the current impulses over the branch of the line L1 as well as the marking engaged of this trunk which is accessible to the final selector LW4 is effected. For the sake of simplicity, the circuit of the repeater Ue3 is not shown in full, because all its details correspond to those of the repeater Ue1 and Ue2. The leads L1IV*a* and L1IV*b*, which are connected to the leads of the preselector VW6, are bridged at the repeater Ue3 by a relay corresponding to the relay A4. Hence, the relay R3 at the preselector VW6 in the exchange V is energized and causes the preselector to be set in motion and take into use an idle final selector in the exchange V such as LW5. When the test wiper of VW 6 leaves its normal position, it opens the test circuit of the outgoing line branch L1IV marking this engaged to the outgoing traffic.

As soon as the calling subscriber transmits the next train of impulses, which, in the present example, corresponds to the tens digit of the wanted subscriber's number, the relay R at the final selector LW1 falls back a number of times, corresponding to the number of impulses transmitted, and at each impulse opens, at its contact *r3*, the circuit of the windings I and II of the relay A1. Relay A1 releases at each impulse and, at its contact *a11*, closes a circuit for the relay V2 over the contact *a15*, and opens its contact *a12*. The slow acting relay V2 operates and remains attracted for the duration of the train of impulses. In order to improve the repetition of the current impulses, the windings of the relay A2 are short circuited over the contacts *v21* and *v22* during the impulse period. At each impulse, the relay A1, at its contact *a12*, opens the circuit of the relay A3, which energizes the relay A4 over the contact *a31* and the contact *c43*. The windings of the relay A4 are short circuited over the contacts *v41* and *v42* during the im-

pulse period. At its contact *a32* the relay A3 opens the circuit of a repeating relay, corresponding to the relay A3, and located at the repeater Ue3. This circuit extends over the contacts *t42* and *t43*, *t53* and *t52*. This relay repeats the current impulse over a contact corresponding to the contact *a32* of the repeater Ue2 and belonging to the repeater Ue3, and transmits the impulses over the contacts *t62* and *t63* to a relay of LW5 in the exchange V corresponding to the relay R of the final selector LW1. This relay transfers the current impulses to the lifting magnet of the final selector LW5. The circuit arrangement of the final selector LW5 is similar to that of the final selector LW1 and is therefore not shown in detail in the Figure 3. After the transmission of the last impulse in the tens train of impulses, the relay A1 remains attracted for a longer time, hence the current through the winding of the relay V2 is interrupted long enough for the relay V2 to release its armature. At the contacts *v21* and *v22* the short circuit is removed from the windings of the relay A2, so that the relay again operates.

While the calling subscriber is transmitting the last train of impulses, the relay V2 is energized in the same manner as that described above for the tens train of impulses, and thus the windings of the relay A2 are again short circuited. At the final selector LW5, a relay which corresponds to the relay VR of the final selector LW1 is energized during the tens train of impulses and is released at the end of this train, so that the side switch is moved into position 2, thereby preparing the rotary magnet circuit. During the units train of impulses the rotary magnet is operated and positions the wipers of LW5 onto the contacts of the wanted subscriber's line.

Thereupon the testing and calling of the wanted subscriber is effected in known manner. After the wanted subscriber has answered, a relay of the final selector LW5 corresponding to the relay Y of the final selector LW1 is operated and feeds current to the subscriber's microphone.

At the end of the conversation, both subscribers hang up their receivers, whereupon the relay R of the final selector LW1 falls back. The circuit of the relay V1 is interrupted at the contact *r1*. Relay V1 releases and at its contact *v13* closes the circuit of the release magnet M, which has been prepared at the off-normal contact *k3*. By means of the magnet M the final selector LW1 is returned to its normal position in known manner. At a contact *m* of the release magnet M the marking engaged circuit of the final selector is opened, hence the relays T and C fall back. The relay T returns the preselector VW1 to its normal position in known manner, while the

relay C, at its contact *c1*, interrupts the circuits of the test relay P1 and the relay T11 of the preselector VW7. The lead L1Ic is disconnected from earth at the contact 3t11, and the relay U1 of the repeater Ue1 falls back and opens the circuit of the relay U3 of the repeater Ue2 at the contact u12. At its contact u11 it closes the test circuit of the line L1 for the final selector LW2, over which the line L1 can therefore now be taken into use. When the relay R released, the opening of the contact r3 caused the relay A1 to fall back. At its contact a11, it opens the circuit of the relay C1 and at the contact a12 it opens the circuit of the windings of the relay A2. After a short interval, the relay C1, at its contact c15, opens the circuit of the relay V2; at the contact c13, it removes the engaged condition from the test circuit of the final selector LW2; and it again connects the windings I and II of the relay A2 to battery and earth at the contacts c11 and c12. The switching means at the repeaters Ue2 and Ue3 and the final selector LW5 are returned to normal in the same manner as the repeater Ue1 and the final selector LW1, so this need not be further described.

If a subscriber of the exchange V, for example the subscriber T5, wishes to be connected to the exchange I, the call is set up in the same manner as that described for a call in the opposite direction. After the preselector VW5 (Fig. 3) has found an idle final selector such as LW5, the relays T10 and C8 are operated over the off-normal contact t5 and over the test wiper of VW5. The subscriber T5 in this case dials the digit 1 to raise the wiper of final selector LW5 to the proper level, and then dials an additional digit 1 to start the rotary trunk hunting movement. The final selector LW5 is thereby positioned on an idle trunk line for example L1. The test relay P2 is operated over the test wiper of VW6 in its normal position and over the windings of the relay T12. The latter, at its contacts 1t12 and 2t12, disconnects the windings of the relay R3 from the leads a3 and b3, thereby preventing the starting of the preselector VW6 and the taking into use of a final selector. At the contact 3t12 the relay U6 is energized over the lead L1IVc and over the contacts t61 and u51; the relay U4 of the repeater Ue2 is then energized over the contact u61 of the relay U6 and over the contact t51, the relay U4 being connected to the lead L1IIIc over the contacts u31 and t42. The relay U2 at the repeater Ue1 is energized over the contacts u41, t31, the lead L1IIc, and over the contacts t21 and u12. At the contacts of the relay U6 and of a relay at Ue3 corresponding to the relay C4 of the repeater Ue2, the

trunk line L1 is prevented from being taken into use by the exchange IV. Similarly, the line L1 is marked engaged to the exchanges II and III at the contacts u42 and c44 of the repeater Ue2 and at the contacts u22 and c24 of the repeater Ue1 respectively. When the leads L1IIIIa and L1IIIIb are taken into use, the relay A4 of the repeater Ue2 is energized over the repeater Ue3, and causes the relay C4 to operate. Thus the relays A3 and A2 are connected up over the contact a42 and the contacts c41 and c42. The relay A2, at its contact a21, closes a circuit for the relay C2, whereupon the windings I and II of the relay A1 are bridged across the leads L1IIa and L1IIb over the contacts c21, a22, and c22. The leads L1IIa and L1IIb are connected to the leads a2 and b2 of the preselector VW7. The relay R2 is energized over its windings I and II, and starts the preselector VW7 to hunt an idle final preselector in the known manner. When the preselector leaves its normal position, its test wiper interrupts the testing circuit of the line L1, which is connected to a test contact of LW1 over the lead c2. An idle final selector, for example LW1, having been found, the relay T11 of the preselector is operated over the lead c5, and the winding of the relay C is connected to earth over the off-normal contact t1; while the leads a2 and b2 are connected over the contacts 1t11 and 2t11 to the leads a5 and b5 going to the final selector LW1.

The number impulses are repeated in the same manner as that above described for a call in the opposite direction, so only a short description need be given here.

Each train of impulses, repeated by the repeaters Ue3 and Ue2, is transmitted by the contact a22 of the relay A2 over the contacts v31 and v32 of the relay v3 and over the leads a2, b2, a5, and b5, to the relay R at the final selector LW1. The final selector LW1 is set onto the wanted subscriber's line in known manner by means of the tens and units trains of impulses and then the testing and calling is effected. When the wanted subscriber answers, the relay Y is operated over its windings I and II and over the loop of the wanted subscriber, thereupon in known manner disconnecting the ringing current. At the end of the conversation the connection is released in the manner above described, so it need not be further referred to here.

It will now be assumed that a subscriber of the exchange II, for example the subscriber T2 wishes to set up a call to a subscriber of the exchange I. Upon lifting down the receiver at the calling subscriber's instrument, the preselector VW2 is started in known manner and hunts for an idle final selector.

LW2 for example. The first train of impulses, which in the present case comprises one impulse, causes the final selector LW2 to be raised to the first level, while an additional impulse starts the non-numerical trunk section. As soon as an idle trunk line, such as L1 has been found, the relay P3 is operated over the lead c6 the relay T1 and over the contacts w22 and c13. In this circuit the relay T1 is also energized and at its contacts t12 and t13 connects the leads a6 and b6 over the leads L1Ia and L1Ib to the leads a2 b2. The preselector VW7 is then started and at its test wiper opens the test lead of the line L1, so that this is marked engaged to outgoing traffic from the exchange I, and an idle final selector is taken into use. In order to prevent the trunk line L1 being taken into use for a call from the exchanges III, IV, or V to the exchange I, the relay A1 is energized over the contact t14; (earth, C21, winding II of A1, t14, winding I of A1, c22, battery, earth). At its contact a11 the relay A1 connects up the relay C1. The latter at its contact c13 opens the test circuit for the relays P3 and T1, but this circuit has been closed in the meantime over the contact t15 and the resistance W1, thus locking the relays. The relays A2 and A3 are energized in series with one another over the contacts c11 and c12. The relays C3 is operated over the contact a31 of the relay A3, and opens at its contact c33 the test circuit of the branch of the line L1 going to the exchange I. Similarly, the line L1 is marked engaged at the test contact of the final selector LW4 at the exchange IV, this being effected by switching means at the repeater Ue3. At the same time, a bridge is placed across the leads L1IVa and L1IVb at the repeater Ue3, corresponding to the bridge including the contact a32 and the windings I and II of the relay A4 at the repeater Ue2. The relay R3 of the preselector VW6 is thus energized and the preselector VW6 is rotated off its normal position. When the test wiper leaves its normal position, it interrupts the test lead of the line L1, so that the line is marked engaged to outgoing traffic from the exchange V. The positioning of the final selector LW1 and the establishment of the connection takes place in known manner.

If the subscriber T2 wishes to set up a call to a subscriber of the exchange V, he removes his receiver and dials the number of the substation with which connection is desired, which consists of the digit 5, a digit 1 to start the hunting movement and the tens and units digits. In response to the removal of the receiver, the preselector VW2 selects an idle final selector. Assuming that the final selector LW2 is selected, its wipers are raised to the fifth level and an idle trunk line such as L1 is found. The relay P3 is then operated in series with the relay T2

over the contacts w11 and c24, and connects the line of the subscriber T2 with the leads a7 and b7. The relay T2 over its contact t21, the line L1IIc and over the contacts t31 and w41, energizes the relay U3 at the repeater Ue2. As above described, at its contact w31, the relay U3 takes into use the repeater Ue3, the preselector VW6 and a final selector LW5 at the exchange V. At the contacts t22 and t23, the leads a7 and b7 are connected to the trunk line leads L1IIa and L1IIb, hence the relay A3 is energized at the repeater Ue2 and it repeats the current impulses to the repeater Ue3, which repeats the impulses to the final selector LW5 at the exchange V. The final selector is thus positioned onto the wanted subscriber's line as previously described. The separate line sections are marked engaged in the same manner as for the above described connections.

A connection between a subscriber of the exchange III or IV and a subscriber of the exchange I or V is set up in the same manner as that described for the exchange II. It is therefore not necessary to give a description thereof.

The method of operating calls over a trunk line going to one of the intermediate exchanges will now be described with reference to the Figs. 4 and 5. For this purpose it will be assumed that a subscriber T1 of the exchange I wishes to set up a call to a subscriber T3 of the exchange III. When the receiver is taken down at the instrument of subscriber T1, the wipers of the preselector VW1 are rotated over its bank contacts in search for an idle final selector. Assuming that the final selector LW1 is the one selected, the relay T is operated in series with the relay C, when the line to this switch is reached by the wipers of the preselector. By means of the first two trains of impulses, consisting in this case of the digit 3 and an additional digit 1 to initiate the trunk hunting movement, the final selector is positioned on an idle trunk line in the third level, for example, trunk line L3. The relay P1 is energized over the contact c1 and the lead L3Ic in series with the relay U7 of the repeater Ue10 at the exchange II over the contact t71. The relay U7, over its contact w71, the contact t72, the lead L3IIc and the contact t93, energizes the relay T8 of the repeater Ue11 at the exchange III. The relay T8 at its contacts t81 and t82 switches the line section L3III incoming from the opposite direction over to the preselector VW12. At the same time, at the contact t83 the line L3IIIC is disconnected from the relay T9 and is connected to relay J2. The relay A5 is operated when the repeater Ue10 is taken into use. This relay, at its contact a51, connects up the relay C5, which at its contacts c51 prepares the circuit of the relay V6. At the

contacts *c52* and *c53*, the windings I and II of the relay A9 are connected over the contact *a52* across the leads L3II*a* and L3II*b*. Thus, the relay A6 of the repeater Ue11 operates in series with the relay A9. The relay U7, at its contact *u72*, interrupts the test circuit of the final selector LW2, hence the line L3 cannot be taken into use by a subscriber of the exchange II. When the subscriber T1 transmits trains of impulses, the relay A5 falls back at each impulse. Hence, at the first impulse a circuit is closed for the relay V6 over the contacts *a51* and *c51*. The relay *v6* at its contacts *v61* and *v62*, short circuits the windings of the relay A9, thereby increasing the current flowing over the lines L3II*a* and L3II*b* to the relay A6 so as to improve the transmission. It remains to be mentioned that when the relay A6 operates, its contact *a61* bridges the leads *a8* and *b8* going over the contacts *t91* and *t92* to the pre-selector VW11. The preselector VW11 is thereby started in known manner, and takes into use an idle final selector such as LW3. At each impulse, the opening of the contact *a52* causes the relay A6 to fall back, thereby opening the loop, which has been closed over the leads *a8* and *b8* and over the contacts *t91* and *t92*, and thus current impulses are repeated for positioning the final selector LW3. The positioning of the final selector and the establishment of the connection are effected in known manner, hence the subscriber T1 can communicate with the subscriber T3.

If, for example, the final selector LW4 of the exchange IV be positioned onto the same trunk line L3 by a subscriber T4, this call can be set up independently of the connection already set up over the other section of the line L3. When the line L3 is taken into use, the relay P5 of the final selector LW4 is energized in series with the relay TR over the contact *u81*. The relay TR applies earth to the test contact of the final selector LW5 over the contact *tr1* and the lead L3IV*c*, thereby the line L3 is marked engaged to the exchange V. At the contact *tr2*, earth is applied to the lead L3III*c*, hence the relay J2 at the repeater Ue11 is operated over the contact *t83*. The relay J2, at its contact *j2*, closes a locking circuit for the winding of the relay T8 over the contact *t85*. The purpose for which this is done will be explained hereafter. The contacts *tr3* and *tr4* are switched over upon the operation of the relay TR of the repeater Ue12 in the exchange IV. The leads *a10* and *b10* of the final selector LW4 are thereby connected to the leads L3III*a* and L3III*b* of the trunk line. The relay A7 at the repeater Ue11 then operates, and at its contact *a71*, repeats the current impulses over the leads *a9* and *b9* and the preselector VW12 to a final selector such as LW3.

After the conversation between the subscriber T1 of the exchange I and the subscriber T3 of the exchange III is ended, the marking engaged circuit, extending over the lead L3I*c*, is interrupted, and the relay U7 falls back. The latter, at its contact *u71*, opens the energizing circuit of the relay T8. Relay T8 however, does not release, because it is located in the holding circuit over the contacts *j2* and *t85*. Hence, the speaking or positioning circuit is maintained over the leads *a9* and *b9* between the exchanges IV and III until the relay J2 releases over this connection at the end of the conversation. Thereupon the opening of the contact *j2* also causes the release of the relay T8.

The method will now be described for setting up a connection between the subscriber T5, of the exchange V, and a subscriber of the exchange III. The pre-selector VW5 hunts for an idle final selector. Assuming final selector LW5 is the one selected, the relay T10 is then operated over the test wiper of VW5 in series with the relay C8 over the off-normal contact *z5*. The subscriber's leads are connected by way of the contacts of the relay T10 (not shown) to the speaking leads of the final selector, whereupon the relay R1 is energized over its windings I and II. At its contact *r11*, relay R1 closes a circuit for the relay V8. The trains of impulses transmitted by the subscriber T5 cause the final selector LW5 to be raised to the desired level, which in this case is the third level, and then hunt for an idle trunk line. Assuming that the trunk line selected is trunk line L3, the relay P2 is energized over the contact *c81*, the lead L3IV*c*, the contact *tr1* and through the winding of the relay U8. At the contacts *p51* and *p52*, a bridge comprising the contacts *r12* and *v81*, is connected across the leads L3IV*a* and L3IV*b*. The relay A8 is thereby operated and energizes the relay C6 over its contact *a81*. The opening of the contact *u81* prevents the line L3 being taken into use by the exchange IV, while at the contact *u82* earth is applied to the lead L3III*c* over the contact *tr2*. Hence, at the repeater Ue11, the relay T9 is energized over the back contact *t83*. At its contacts *t91* and *t92*, the relay T9 switches the section of the line L3, incoming from the opposite direction, to the leads *a9* and *b9* of the preselector VW12. At the contact *a82* the windings I and II of the relay B, by way of contacts *c62* and *c63*, are connected in bridge across the outgoing line L3III. The relay A7 at the repeater Ue11 is then energized. The closure of the contact *a71* causes the preselector VW11 to be started over the contacts *t81* and *t82* and over the leads *a8* and *b8*, and takes into use an idle final selector as LW3. The relay A8 falls back at each impulse of the last two trains of impulses. Over the contact *a81*

and the contact *c*61, the relay V7 is energized at the first impulse of each train and remains energized for the duration of each train of impulses. The closing of the contacts *v*71 and *v*72 short circuits the windings I and II of the relay B, increasing the current flowing over the leads L3III*a* and L3III*b*, thereby improving the transmission of the trains of impulses and ensuring the reliable operation of the relay A7. The relay A8 falls back at each impulse and at its contact *a*82 it opens the circuit of the relay A7. The latter, at its contact *a*71, opens the bridge, which has been closed over the leads *a*8 and *b*8, thereby repeating the current impulses to the motor magnets of the final selector LW3.

If, in the meantime, the same trunk line L3 to the exchange III has been taken into use by a subscriber T2 of the exchange II over his preselector VW2 and the final selector LW2, the relays P3 and T7 are energized. The relay T7 applies earth to the lead L3I*c* over its contact T71, so that the trunk line taken into use appears to be marked engaged at the final selector LW1. At the contacts *t*73 and *t*74, the leads *a*11 and *b*11 are switched through to the trunk leads L3II*a* and L3II*b*, while the relay J1 of the repeater U*e*11 is energized over the contact *t*72, the lead L3II*c* and over the front contact *t*93. At the contact *j*1 a holding circuit for the winding of the relay T9 is closed over the contact *t*95.

After the conversation between the subscriber T5 and the subscriber T3 is completed, the energizing circuit for the relay T9 is opened at the contact *u*82 after the relay U8 has fallen back. But the relay T9 does not release, because its winding is included in the holding circuit over the contacts *j*1 and *t*95. Not until the end of the conversation between the subscriber T2 and a subscriber of the exchange III, does the relay T9 fall back owing to the release of the relay J1 opening the contact *j*1.

It should also be mentioned that in the third level of the final selectors shown in the Figs. 4 and 5, no call outgoing from the exchange III can be set up. Therefore the third level of the preselector VW 3 shown in the Fig. 4 only serves for local traffic within the exchange III.

The circuit arrangement of the trunk lines L2, L4, and L5 and of the repeating devices associated therewith correspond to those shown in the Figs. 2 to 5, hence there is no need to show or describe these circuits.

What is claimed is:

1. In a telephone system, two exchanges, an intermediate exchange, a two-way trunk line connecting the first and second exchanges via said intermediate exchange, automatic switches in the first and second exchanges for completing through connections

over said trunk line in either direction, and automatic switches in said intermediate exchange cooperating with certain switches in the first or second exchange to complete connections over said trunk line from the intermediate exchange to either the first or second exchange or to both the first and second exchanges at the same time.

2. In a telephone system, two exchanges, an intermediate exchange, a two-way trunk line connecting the first and second exchanges via said intermediate exchange, automatic switches in the first and second exchanges for completing through connections over said trunk line in either direction, automatic switches in the intermediate exchange having access to said trunk line over two different paths corresponding to said first and second exchanges, respectively, and means effective when the trunk line is seized by a switch in the intermediate exchange for extending the connection to the first or second exchange depending on the path over which the trunk line is taken for use.

3. In a telephone system, two exchanges, an intermediate exchange, a two-way trunk line connecting the first and second exchanges via said intermediate exchange, automatic switches in the first and second exchanges for completing through connections over said trunk line in either direction, automatic switches in the intermediate exchange having access to said trunk line over two different paths corresponding to said first and second exchanges, respectively, means effective when the trunk line is seized by a switch in the intermediate exchange for extending the connection to the first or second exchange depending on the path over which the trunk line is taken for use, and means for making the particular path used busy to other switches while the other path is left free for use in completing connections over the trunk line to the corresponding exchange.

4. In a telephone system, two exchanges, an intermediate exchange, a two-way trunk line connecting the first and second exchanges via said intermediate exchange, automatic switches in the first and second exchanges for completing through connections over said trunk line in either direction, automatic switches in the intermediate exchange having access to said trunk line over two different paths corresponding to said first and second exchanges, respectively, means effective when the trunk line is seized by a switch in the intermediate exchange for extending the connection to the first or second exchange depending on the path over which the trunk line is taken for use, means for making the particular path used busy to other switches while the other path is left free for use in completing connections over the trunk line to the corresponding ex-

change, and means effective when the trunk line is first seized at the intermediate exchange for separating the sections extending to the first and second exchanges, respectively, so that the section not used in the first connection can be used for the second connection without interference.

5. In a telephone system, two end exchanges and a plurality of intermediate exchanges, a trunk line connecting said end exchanges and said intermediate exchanges in series, means for automatically establishing a talking connection from any intermediate exchange to either end exchange over said trunk line, and means for establishing a second talking connection from the same intermediate exchange to the other of said end exchanges over said trunk line while the first connection is intact.

6. In a telephone system, two end exchanges and a plurality of intermediate exchanges, a trunk line connecting said end exchanges and said intermediate exchanges in series, means for automatically establishing a talking connection from any intermediate exchange to either end exchange over said trunk line, and means for establishing a second talking connection from said calling intermediate exchange or any other intermediate exchange not included between a calling intermediate exchange and a called end exchange to said other end exchange over said trunk line while the first connection is intact.

7. In a telephone system, two end exchanges and a plurality of intermediate exchanges, a trunk line connecting said end exchanges and said intermediate exchanges in series, means for automatically establishing a talking connection from any intermediate exchange to either end exchange over said trunk line, and means controlled over the two talking conductors of said trunk line in series for guarding said trunk against being taken into use by any other exchange for extending a talking connection to said called end exchange.

8. In a telephone system, two end exchanges and a plurality of intermediate exchanges, a trunk line connecting said end exchanges and said intermediate exchanges in series, means for automatically establishing a talking connection from any intermediate exchange to either end exchange over said trunk line, means controlled over the two talking conductors of said trunk line in series for guarding said trunk against being taken into use by any other exchange for extending a talking connection to said called end exchange, and means for guarding said trunk against being taken into use by any exchange included between said calling intermediate exchange and said called end exchange.

9. In a telephone system, two end ex-

changes, a plurality of intermediate exchanges, a two-way trunk line connecting said first and second end exchanges and said intermediate exchanges in series, automatic switches in said first and second end exchanges for completing through connections over said trunk line in either direction, and automatic switches in the intermediate exchanges cooperating with certain switches in the first or second end exchanges for completing connections from any intermediate exchange to either the first or second end exchange or to both said first and second exchanges simultaneously.

10. In a telephone system, two end exchanges, a plurality of intermediate exchanges, a two-way trunk line connecting said first and second end exchanges and said intermediate exchanges in series, automatic switches in said first and second end exchanges for completing through connections over said trunk line in either direction, automatic switches in each of the intermediate exchanges having access to said trunk line over two different paths corresponding to said first and second end exchanges, respectively, and means effective when the trunk line is seized by a switch in a calling intermediate exchange for extending the connection to the first or second end exchange depending on the path over which the trunk line is taken for use.

11. In a telephone system, two end exchanges, a plurality of intermediate exchanges, a two-way trunk line connecting said first and second end exchanges and said intermediate exchanges in series, automatic switches in said first and second end exchanges for completing through connections over said trunk line in either direction, automatic switches in each of the intermediate exchanges having access to said trunk line over two different paths corresponding to said first and second end exchanges, respectively, means effective when the trunk line is seized by a switch in a calling intermediate exchange for extending the connection to the first or second end exchange depending on the path over which the trunk line is taken for use, and means for making the particular path used busy to the other switches in said calling intermediate exchange while the other path is left free for use in completing connections over the trunk line to the corresponding end exchange.

12. In a telephone system, two end exchanges, a plurality of intermediate exchanges, a two-way trunk line connecting said two end exchanges and said intermediate exchanges in series, automatic switches in said end exchanges for completing through connections over said trunk line in either direction, automatic switches in each intermediate exchange having access to said trunk line over two separate paths individual

to each intermediate exchange, means effective when the trunk line is seized by a switch in any intermediate exchange for extending a talking connection to either one of the two end exchanges depending on the path over which the trunk line is taken for use, means for preventing the seizure of said trunk by the automatic switches of the other intermediate exchanges included between a calling intermediate exchange and a called end exchange over either path, means for preventing the seizure of said trunk by the automatic switches of the other intermediate exchanges not included between said calling intermediate exchange and said called end exchange over the path corresponding to said called end exchange, while leaving said trunk free to be seized by the automatic switches of the other intermediate exchanges not included between said intermediate exchange and said called end exchange over the path corresponding to the non-called end exchange.

13. In a telephone system, a trunk line connecting a first and a second terminal exchange, a plurality of intermediate exchanges adapted to extend connections over said trunk line to either of said terminal exchanges, means at said intermediate exchanges operative upon one of said intermediate exchanges extending a call to either terminal exchange for disabling all of the remaining intermediate exchanges from extending calls in the same direction and also disabling the intermediate exchanges located between the calling intermediate exchange and the called terminal exchange from extending calls to the other terminal exchange, while permitting the other intermediate exchanges not included between the calling intermediate exchange and the called terminal exchange to extend connections to the non-called terminal exchange.

14. In a telephone system, a first and second trunk line normally connected to a first automatic switch and normally disconnected from a second automatic switch, and means for disconnecting either of said trunk lines from the first said automatic switch and connecting it to the second automatic switch when the first of said automatic switches is taken for use over the other of said trunk lines.

15. In a telephone system, an automatic exchange, a trunk line extending through said exchange having access to said trunk over either of two paths depending on the digit dialled, and means for extending a call in either direction over said trunk line from said exchange depending on which path said trunk line is seized over.

16. In a telephone system, an automatic exchange, a trunk line extending through

said exchange, automatic switches in said exchange having access to said trunk over either of two paths depending on the digit dialled, means for extending a call in either direction over said trunk line from said exchange depending on which path said trunk line is seized over, and means for making the particular path busy to other switches in said exchange while the other path is left free for use in completing calls over said trunk line in the other direction.

17. In a telephone system, an automatic exchange, a trunk line extending through said exchange, automatic switches in said exchange having access to said trunk over either of two paths depending on the digit dialled, means for extending a call in either direction over said trunk line from said exchange depending on which path said trunk line is seized over, means for making the particular path busy to other switches in said exchange while the other path is left free for use in completing calls over said trunk line in the other direction, and means effective when the trunk line is first seized for separating the trunk into two sections so that the section not used in the first connection can be used for completing calls in the other direction without interference.

18. In a telephone system, a first and a second trunk line normally connected to a first automatic switch and normally disconnected from a second automatic switch, and means for disconnecting the second trunk line from the first automatic switch and for connecting it to the second automatic switch when a connection is established over the first trunk line to the first automatic switch.

19. In a telephone system, a first and a second trunk line normally connected to a first automatic switch and normally disconnected from a second automatic switch, and means for disconnecting the second trunk line from the first automatic switch and for connecting it to the second automatic switch when a connection is established over the first trunk line to the first automatic switch, and means for maintaining the second trunk line connected to the second automatic switch after the termination of the connection over the first trunk line when a connection is established over the second trunk line to the second automatic switch.

20. In a telephone system, two end exchanges, an intermediate exchange, a trunk line comprising talking conductors and a release conductor connecting said end exchanges and said intermediate exchange in series, means for automatically establishing a connection from said intermediate exchange to either end exchange over said trunk line, means for automatically establishing a connection from one of said end exchanges to the other over said trunk line,

means operable when said second connection is established and controlled over the two talking conductors of said trunk line in series for preventing the taking into use of said trunk line at said intermediate exchange for establishing a connection to the calling end exchange, and means controlled over the

release conductor of said trunk line for preventing the taking into use of said trunk line at said intermediate exchange for establishing a connection to the called end exchange. 10

In witness whereof, I hereunto subscribe my name this 20th day of July, A. D. 1925.

ALEXANDER BRUNO PREUSS.