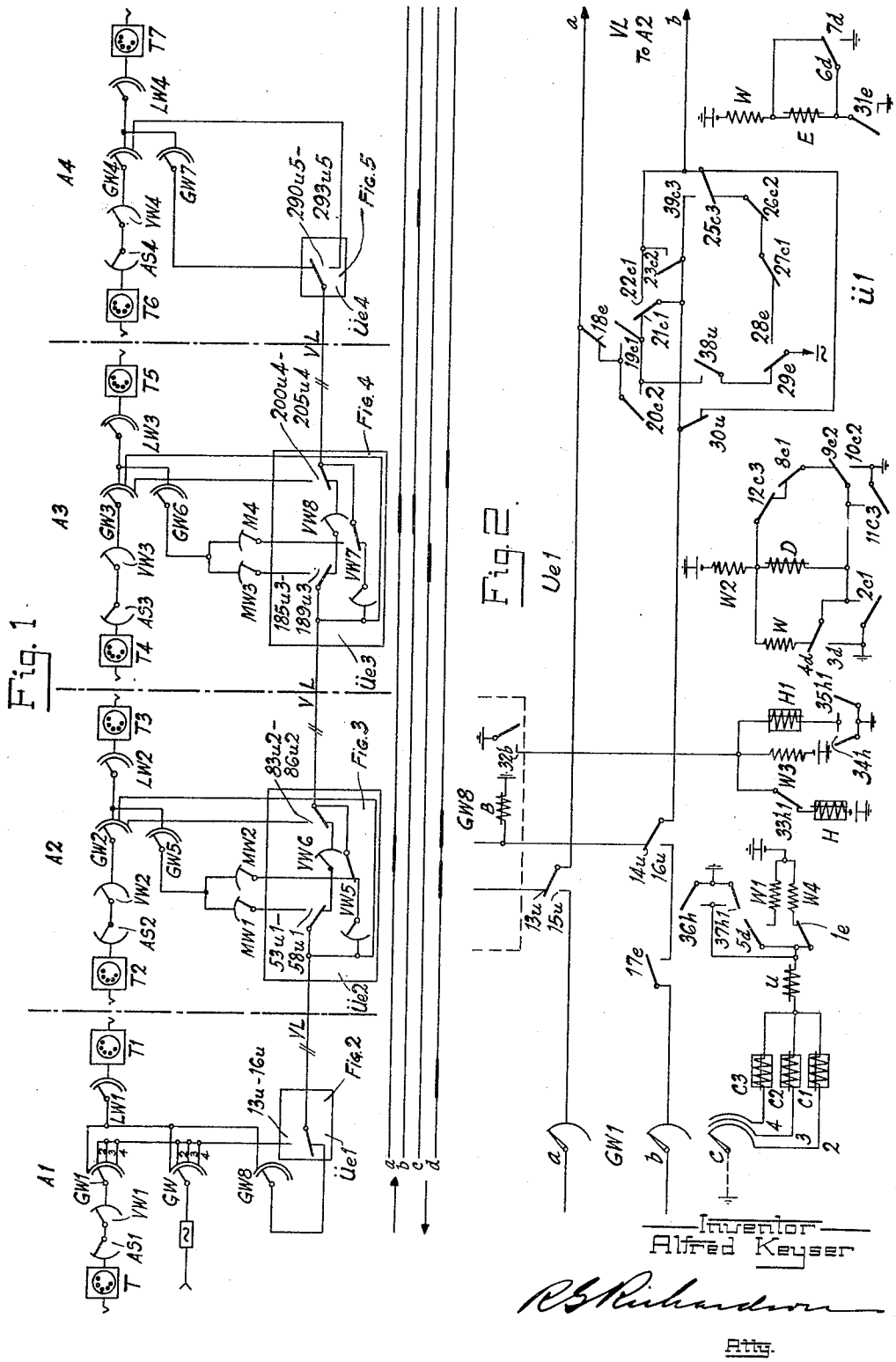
May 9, 1933. A. KEYSER 1,908,365

TELEPHONE SYSTEM

Filed June 22, 1932 5 Sheets-Sheet 1



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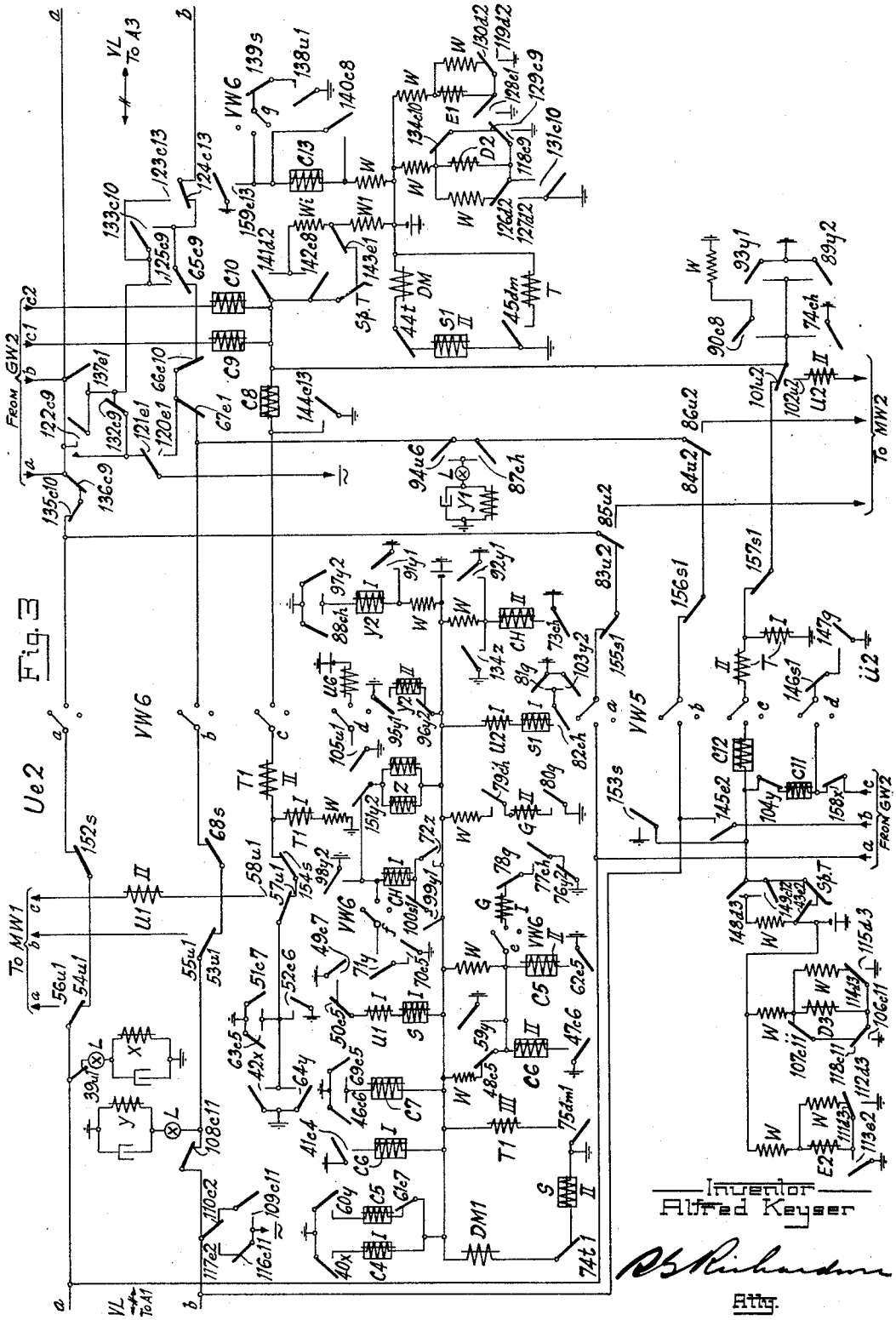
TELEPHONE SYSTEM

Filed June 22, 1932 5 Sheets-Sheet 2



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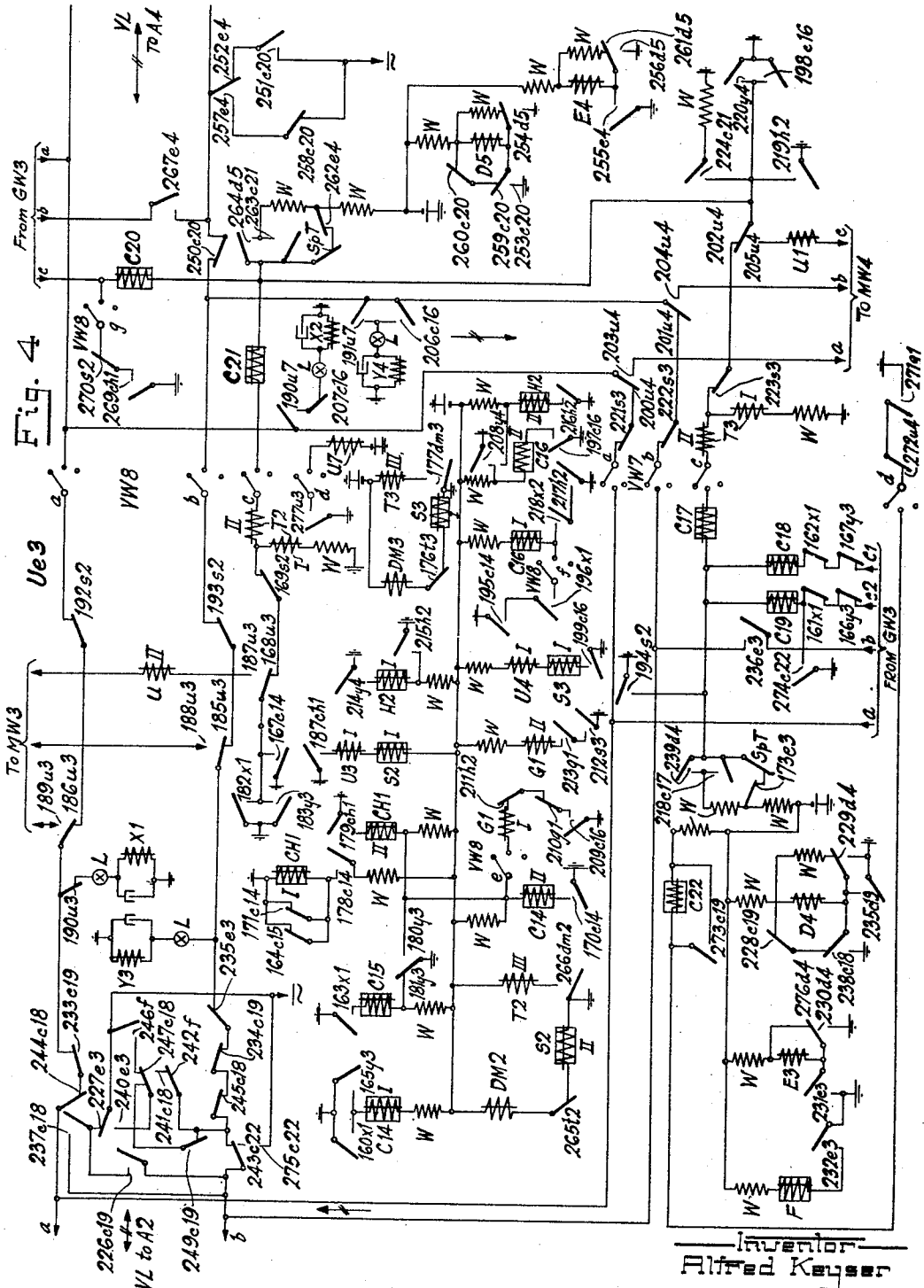
TELEPHONE SYSTEM

Filed June 22, 1932 5 Sheets-Sheet 3



Inventor
Alfred Keyser

R B Richardson

Atty.

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TELEPHONE SYSTEM

Filed June 22, 1932 5 Sheets-Sheet 4

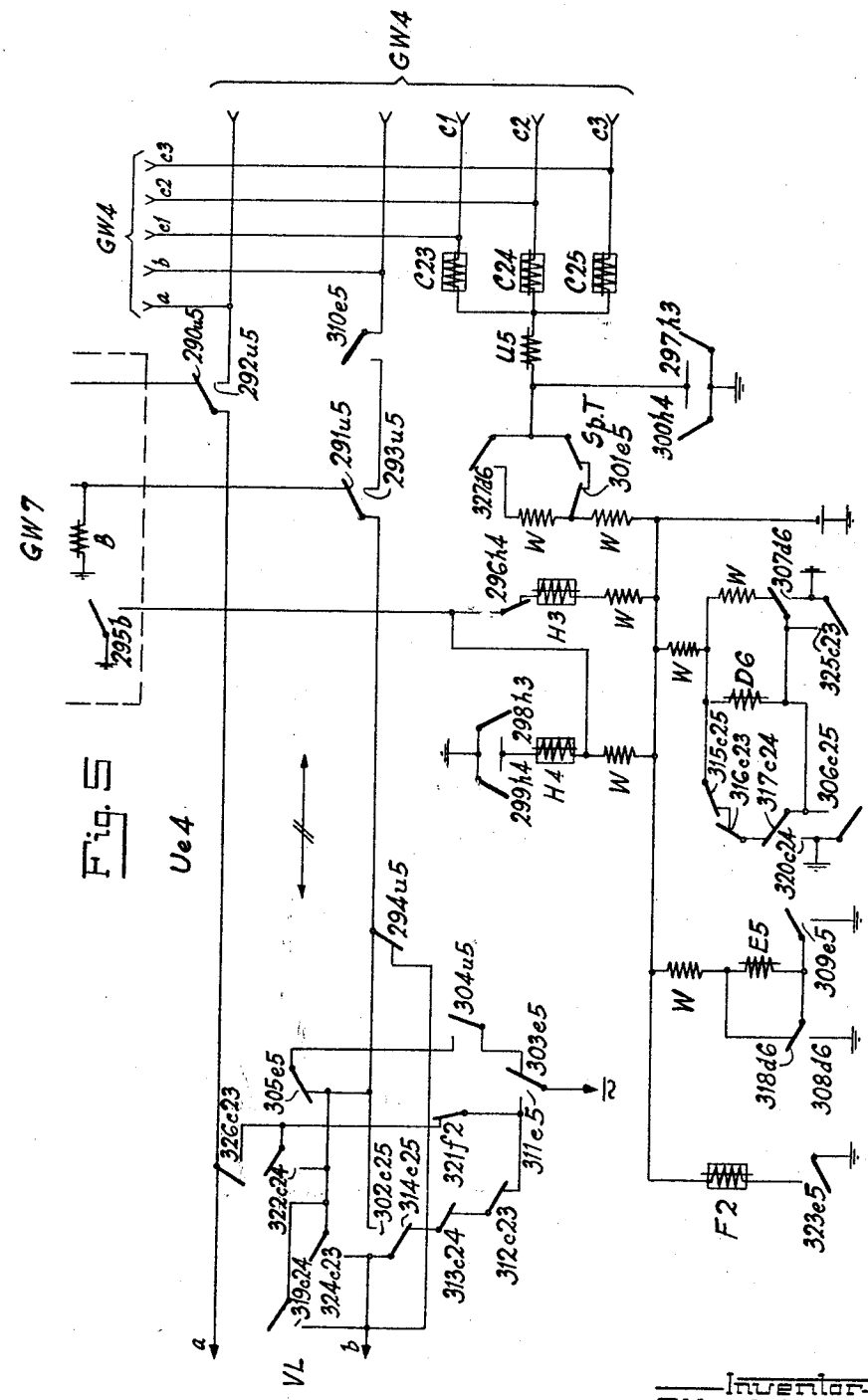

Fig. 5

Ue 4

Inventor
Alfred Keyser

Atty.

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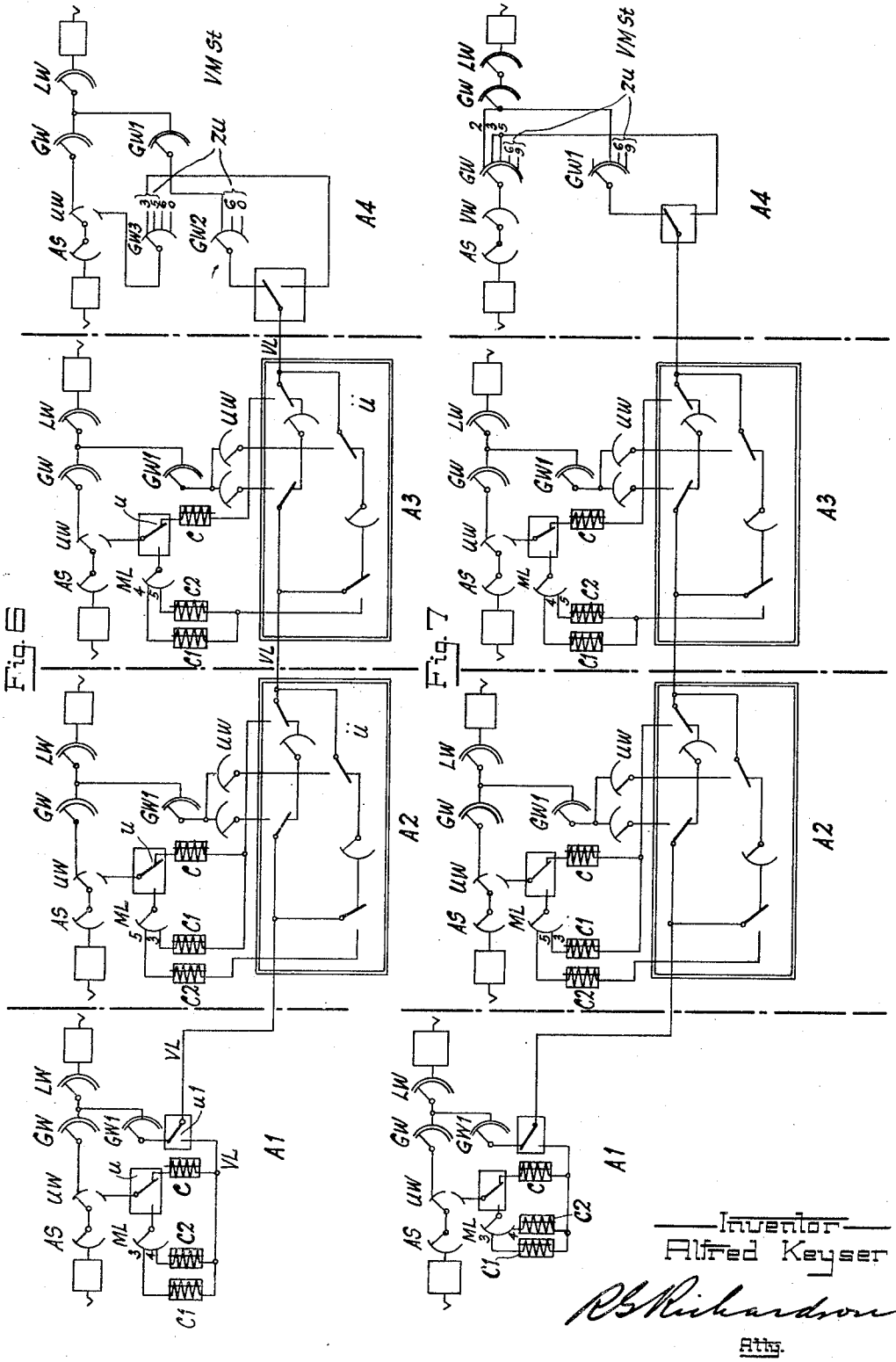

Inventor
Alfred Keyser
R B Richardson
Atty.

Patented May 9, 1933 1,908,365

UNITED STATES PATENT OFFICE

ALFRED KEYSER, OF BERLIN-TEGEL, GERMANY, ASSIGNOR TO SIEMENS & HALSKE, AKTIENGESELLSCHAFT, OF SIEMENSSTADT NEAR BERLIN, GERMANY

TELEPHONE SYSTEM

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The present invention relates in general to telephone systems, and more particularly to systems including a plurality of series-connected exchanges, and has for its object to select the required exchange in the simplest and most convenient manner by providing the exchanges with means for the transmission of a definite number of impulses over either one or the other or both speaking leads of the junction line, and to identify the required exchange according to the number of impulses transmitted and the lead utilized for the impulse transmission.

Figs. 1–7 show embodiments of the invention.

Fig. 1 shows the theoretical switch train when four exchanges A1—A4 are concerned. When setting up a connection in the traffic direction from exchange A1 to exchange A4 or in the reverse direction, as indicated in Fig. 1, it is necessary to transmit a definite number of impulses indicating the required exchange and to send them over one or both leads of the line VL which interconnects all the exchanges. According to Figs. 1–5, the definite number of impulses is automatically transmitted by seizing the junction line VL over a group selector in the individual exchanges A1—A4.

If, for example, a subscriber of the exchange A1 wishes to set up a connection with a subscriber of the exchange A2, the junction line VL is switched over to the group selector GW1 at contacts 13*u*—16*u* when the repeater U*e*1 (Fig. 2) is seized over the access 2 of the group selector GW1, and an impulse is transmitted over the *a* lead which causes the junction line VL in the repeater U*e*2 (Fig. 3) to be switched over at contacts 53*u*1—58*u*1 to the connecting devices in the exchange A2.

Should a subscriber of the exchange A1 wish to communicate with a subscriber of the exchange A3, two impulses are simultaneously transmitted over the *a* and *b* leads. This causes a changeover (at contacts 185*u*3—189*u*3 in Fig. 4) to the devices in exchange A3. The same type of changeover operation is carried out if a subscriber of exchange A2 wishes to speak to a subscriber of exchange A3.

The exchange A4 is denoted by the transmission of an impulse over the *b* lead when a subscriber of exchange A1, A2, or A3 requires a connection with a subscriber of exchange A4.

In opposite direction the following conditions are set up over the junction line VL. For a connection between a subscriber of the exchange A4 and a subscriber of exchange A3, an impulse is first transmitted over the *b* lead and then another impulse over the *a* lead. If a subscriber of the exchange A3 or A4 wishes a connection with a subscriber of exchange A2, two impulses in succession are sent out over the *b* lead. Should a subscriber of exchange A2, A3, or A4 wish to communicate with a subscriber of exchange A1, it will be necessary to transmit an impulse over the *b* lead for the purpose of denoting the exchange A1.

Fig. 2 shows the repeater U*e*1 of the exchange A1, Fig. 3 the repeater U*e*2 of exchange A2, Fig. 4 the repeater U*e*3 of A3, and Fig. 5 the repeater U*e*4 of exchange A4.

A description of the switching operations brought about in the repeaters of the exchanges A1—A4 by the individual identification impulses will be given below.

When, for example, a subscriber of exchange A1 wishes to communicate with a subscriber of exchange A2, the calling subscriber will have to set the group selector GW1 according to Fig. 2 to access 2 over which relay C1 is energized in series with relay U. The circuit extends over the *c* wiper of the group selector GW1, access 2, relay C1, relay U, contact 1*e*, resistance W4, battery, earth. Both relays C1 and U are energized. Relay U causes the junction line to be switched over from the group selector GW8 to group selector GW1 by opening its contacts 13*u* and 14*u* and by closing 15*u* and 16*u*. A current source of supply delivering superimposed direct current is applied to the *a* lead of the junction line VL over contacts 29*e*, 38*u*, 19*c*1, and 18*e*.

Relay C1, energized on the seizure over the group selector GW1, causes the follow-

ing circuit to be completed for relay D: earth, contact 2*c*1, relay D, resistance W2, battery, earth. The short circuit for relay D over contacts 9*c*2, 8*c*1, and 12*c*3 is removed at contact 8*c*1. A short circuit still remains for relay D, however, over contact 4*d* and resistance W. The resistance ratios between the resistance W and relay D, however, are so calculated that even when relay D is short-circuited over contact 4*d* and resistance W, this relay operates and remains energized over contact 3*d*. Relay D opens contact 6*d* and closes 7*d*, causing relay E to be energized over earth, contact 7*d*, relay E, resistance W, battery, earth. Relay E cuts off the superimposed direct current at contact 29*e*. The *b* lead of the junction line VL is then switched through over contact 22*c*1. The application of superimposed direct current to the *b* lead over contact 28*e* is prevented by the opening of contact 27*c*1.

This superimposed direct current influences the identification receiving relays X and Y provided in the individual repeaters of the exchanges A2 and A3. Preceding these relays a lamp has been connected up which makes it possible to cause the relays to be influenced only by superimposed direct current without these relays being connected direct to the junction line.

The switching operations brought about in the individual exchanges A2—A4 by the impulse transmitted over the *a* lead are described in connection with the repeaters U*e*2—U*e*4 in the exchanges A2—A4 shown in Figs. 3–5.

The setting of the connecting devices in the required exchanges is effected by means of impulse series transmitted in known manner over the junction line with the aid of the dial switch provided at the subscribers' stations.

The *c* lead in the group selector GW1 is cut off in known manner at the end of the conversation so that the circuit which, after relays D and E have been energized, extends over the *c* wiper of the group selector GW1, access 2 to the junction line VL, relay C1, relay U, contact 5*d*, resistance W*i*, battery, earth, is also cut off. Relays C1 and U, therefore, release. Relay U causes the junction line VL to be switched over to the group selector GW8 at contacts 13*u*—14*u* while superimposed direct current is applied to the *b* lead over earth and contacts 28*e*1, 27*c*1, 26*c*2, 25*c*3 when relay C1 releases. This superimposed direct current is applied until relay E has restored its contacts to normal. This, however, only occurs when relay D has been short circuited due to the closing of contact 8*c*1 In consequence of this short circuit, relay D releases with slow action, with the result that it only restores its contacts to normal after a definite period and short circuits relay E by opening contact 7*d* and closing contact 6*d*. This causes relay E also to release with slow action, resulting in its contacts being returned to their original positions only after an extended period. The rapid energization but slow release of relays D and E has the effect that the identification impulses are applied a short time only, whereas the impulse transmitted over the *b* lead at the end of the connection lasts longer. This latter impulse causes the release of the repeaters utilized in the corresponding exchanges.

If a subscriber of exchange A1 wishes to speak to a subscriber of exchange A3, two impulses, that is to say one impulse transmitted over the *a* lead and another over the *b* lead, are simultaneously sent out in the manner indicated in Fig. 1. The transmission of an impulse over each of the *a* and *b* leads is effected by the seizure of the junction line over access 3 of the group selector GW1. Relays C2 and U are energized when the junction line is seized over access 3. Relay U, in the manner described above, switches over the junction line VL to group selector GW1, while relay C2 applies superimposed direct current to the *a* lead over contacts 29*e*, 38*u*, 20*c*2, and 18*e*, and to the *b* lead over contacts 29*e*, 38*u*, 21*c*1, and 23*c*2. This superimposed direct current is cut off from the *a* and *b* leads when relay D is energized due to the closing of contact 10*c*2, remains energized over contact 3*d*, and consequently brings about an energization of relay E over contact 7*d*. Relay E is maintained energized over contact 31*e* and cuts off the superimposed direct current by opening contact 29*e*. Contact 28*e* is, therefore, closed. The opening of contact 26*c*2, however, prevents the current source of supply from being connected to the leads of the junction line.

The switching operations carried out in the individual exchanges in consequence of these identification impulses are described in conjunction with the description of the individual repeaters in the exchanges A2—A4.

When, at the end of the connection between the subscriber of exchange A1 and the subscriber at exchange A3, the *c* lead of the group selector GW1 in exchange A1 is cut off, relays C2 and U release. Relay U completes the switching back to normal, while the impulse for the release is transmitted over the *b* lead in the following manner: superimposed direct current is applied to the *b* lead of the junction line VL over contacts 28*e*, 27*c*1, 26*c*2, and 25*c*3 when relay C2 releases. Relay C2 short circuits relay D over contacts 9*c*2, 8*c*1, and 12*c*3. Relay D releases after a definite period, cuts off its locking circuit over contact 3*d*, and short circuits relay E at contact 6*d*. This relay also releases after a short interval, opens its locking circuit at contact

31*e*, and, by opening contact 28*e*, cuts off the superimposed direct current.

If a subscriber of exchange A1 wants a connection with a subscriber of exchange A4, the identification impulse, in this case a single impulse, is transmitted over the *b* lead by the seizure of the junction line VL over access 4 from the group selector GW1. Relays C3 and U are energized in such a case. Relay U, as described above, causes the switching-over while relay C3 applies superimposed direct current to the *b* lead over contacts 29*e*, 38*u*, 21*c*1, and 39*c*3. Relay D is energized over contact 11*c*3, remains energized over contact 3*d*, and causes relay E to be operated by closing contact 7*d*. Relay E cuts off the superimposed direct current at contact 29*e*.

The release impulse at the end of the connection is transmitted over the *b* lead by relay C3 in this case. The *c* lead of the group selector GW1 is cut off at the end of the call which causes relays C3 and U to release. Relay U controls the switching-over, while relay C3, when releasing, applies the superimposed direct current to the *b* lead over contacts 28*e*, 27*c*1, 26*c*2, and 25*c*3. Relay C3 short circuits relay D at contact 12*c*3. Relay D releases after a definite period and short circuits relay E at contacts 6*d*. Relay E also releases with slow action due to the short circuit, and opens contact 28*e* which cuts off the superimposed direct current applied to the *b* lead.

Should a subscriber of exchange A2, A3, or A4 wish to set up a connection with a subscriber of exchange A1, an impulse is transmitted over the *b* lead in accordance with the seizure of the junction line VL in the individual exchanges A2—A4 (see description of Figs. 3–5). This impulse over the *b* lead causes the following switching operations to be carried out in exchange A1: the impulse over the *b* lead according to Fig. 2 extends over contacts 30*u* and 14*u*, relay B of the selector GW8, earth. Relay B is energized by this impulse over the *b* lead, but this causes no switching operations in the group selector GW8. Relay B closes contact 32*b* which causes relay H to operate over earth, contacts 32*b* and 33*h*1, relay H, battery, earth. Relay H closes contact 36*h* and thereby guards the junction line against seizure from the group selector GW1. Relay H also closes contact 34*h*, causing relay H1 to be energized over earth, contact 34*h*, relay H1, resistance W3, battery, earth, relay B having released at the end of the received impulse. Relay H1 remains energized over contact 35*h*1 independent of contact 34*h* and takes over the guarding for relay H at contact 37*h*1 since relay H has been deenergized due to the opening of contact 33*h*1.

The additional impulses transmitted from the calling station set the group selector GW8 and the final selector LW1 in Fig. 1 in known manner. When an impulse of longer duration is sent out from the calling station at the end of the call and is transmitted over the *b* lead, relay B in the group selector GW8 is energized an extended period. Relay B closes contact 32*b* which short circuits relay H1 so that it releases. The opening of contact 37*h*1 removes the guarding of the junction line. The release impulse transmitted over the *b* lead lasts until relay H1 has restored its contacts to normal. Relay H is prevented from being energized over contacts 32*b*, and 33*h*1 due to the release impulse being already ended, and consequently relay B has opened contact 32*b* before relay H, which is energized with slow action, actuates its contacts.

When setting up a connection between a subscriber of exchange A3 or exchange A4 with a subscriber of exchange A2, two impulses are transmitted over the *b* lead on the seizure of the junction line VL in exchange A3 or A4 (see description applicable to Figs. 4 and 5). These impulses cause the repeater U*e*1 to guard the junction line against seizure in exchange A1.

When a connection is set up between a subscriber of exchange A4 and a subscriber of exchange A3, an impulse is sent out over the *a* lead as well as the *b* lead. The impulse transmitted over the *a* lead causes no switching operations in exchange A1, but the impulse sent out over the *b* lead sets up the guarding of the junction line although it is again removed in the manner described below (see description applicable to Fig. 4) when, after the identification impulse, a release impulse is transmitted over the *b* lead.

The switching operations brought about in the exchange A2 by the individual indentification impulses will be described below. Fig. 3 shows only the devices particularly framed-in in Fig. 1 which are provided in exchange A2 and which will be called the repeater U*e*2. This repeater U*e*2 may be seized over the junction line from exchange A1 for the setting up of a connection with subscribers of exchange A2, A3, or A4. The same repeater may also be seized by subscribers of exchange A2 from the group selector GW2 (see Fig. 3, top right-hand corner and bottom center) for the setting up of a connection with subscribers of exchange A1, A3, or A4. In addition, the repeater U*e*2 according to Fig. 3 may also be seized from exchange A3 over the junction line for the setting up of a connection between subscribers of exchange A3 or A4 and subscribers of exchange A2 or A1.

The switching operations which take place on the seizure of the repeater U*e*2 over the junction line VL from exchange A1 will first be explained. This seizure occurs when a subscriber of exchange A1 wishes to set up a

connection with a subscriber of exchange A2, A3, or A4.

For a connection between a subscriber of exchange A2 and a subscriber of exchange A1, the group selector GW1 in exchange A1 must be set to a definite access which causes an impulse to be transmitted over the *a* lead. The manner in which this transmission takes place has already been described. The impulse (superimposed direct current) transmitted over the *a* lead actuates relay X in exchange A2 over the *a* lead, contact 39*u*1, signal lamp L, relay X, earth. The signal lamp L preceding the identification impulse receiving relays X and Y in Figs. 3 and 4 is of such a type that only superimposed direct current can influence relays X and Y over it. Relay X is energized and throws over its contact 42*x*, which causes winding I of relay T1 to be short circuited so that the junction line VL cannot be seized from the group selector GW2 over the accesses *c*1 and *c*2. Relay C8 then operates and maintains the circuit extending over earth, contacts 42*x*, 57*u*1, 154*s*, winding II of relay T1, *c* wiper of the preselector VW6, relay C8, Key S*p*T, contact 143*e*1, resistance W1, battery, earth, independent of key S*p*T and contact 143*e*1 due to the closing of contact 142*c*8. The opening of contact 158*x* prevents the junction line VL from being seized over the access *c* of the group selector GW2. Relay C8 takes over this guarding at contact 90*c*8 at the end of the impulse and after relay X has released.

Relay X causes relay C4 to be energized over earth, contact 40*x*, relay C4, battery, earth. Relay C4 actuates its contact 41*c*4 with the result that relay C6 operates over earth, contact 41*c*4, winding I of relay C6, battery, earth. Relay C6 sets up its own locking circuit over contact 47*c*6 which then extends over earth, contact 47*c*6, winding II of relay C6, contact 48*c*5, resistance W, battery, earth. Due to the fact that the impulse over the *a* lead of the junction line is of very short duration, relay X consequently remains energized a short period only. Relay C6, however, operates before relay X releases and maintains the guarding at contact 52*c*6. Relay C6 closes its contact 46*c*6 which in turn causes relay C7 to be energized over earth, contact 46*c*6, relay C7, battery, earth. Relay C7 then takes over the guarding at contact 51*c*7. By means of relay C7 a circuit for relays U1 and S is closed as follows: earth, contacts 49*c*7 and 50*c*5, winding I of relay U1, winding I of relay S, battery, earth. Contact 153*s* short circuits relay T over earth, windings I and II of relay T, *c* wiper of the preselector VW5, relay C12, contact 153*s*, earth. Relay T, therefore, releases and battery is applied to the rotary magnet DM over earth, battery, rotary magnet DM, contact 44*t*, winding II of relay S1, earth. The above-mentioned circuit for the rotary magnet DM is cut off at contact 44*t* when relay T is operated over its winding III by the closing of contact 145*dm*. The release of magnet DM causes the preselector VW5 to be advanced one step. A circuit for the rotary magnet DM can only be completed if relay T is short circuited due to the succeeding line being busy, as otherwise relay T remains energized and prevents a circuit for the rotary magnet from being completed by retaining contact 44*t* open. Relay U1, by opening contacts 53*u*1 and 54*u*1 and closing contacts 55*u*1 and 56*u*1, causes the secondary lineswitch MW1 to be seized which gives an access to the group selector GW5 (see Fig. 1). The opening of contact 57*u*1 and closing 58*u*1 switches through the *c* lead to the secondary lineswitch MW1 to which a second winding of relay U1 is connnected and which maintains relay U1 energized. Relay C8 releases due to the change-over of the *c* lead and causes relay C13 to operate over earth, contacts 138*u*1, 139*s*, *g* wiper of the preselector VW6, relay C13, resistance W, battery, earth. Relay C13 applies superimposed direct current to the *b* lead over contacts 121*e*1, 132*c*9, 123*c*13 until relay C8 is energized over earth, contact 144*c*13, relay C8, key S*p*T, contact 143*e*1, resistance W1, battery, earth. Relay C8 short circuits relay C13 by actuating its contact 140*c*8, thus causing said relay to release after a certain period and consequently restore its contacts to normal. The opening of contact 123*c*13 then cuts off the superimposed direct current. This long impulse transmitted over the *b* lead, the duration of which is determined by the slow action of relay C8, causes the release of the devices in the other exchanges A3 and A4 reached over the junction line VL and actuated by the identification impulse transmitted over the *a* lead.

Relay S is the last to be energized during the release, as will be described hereinafter, and disconnects the junction line VL from the preselector VW6 by opening contacts 152*s* and 68*s*, and at the same time removes the guarding potential by opening contact 154*s*, with the result that the junction line between exchanges A2 and A3 is released. A further connection may, therefore, be set up in both directions between exchanges A2 and A3 over the junction line VL, and, due to the preselector VW5 having been set to an idle line leading to exchange A1, a connection to this exchange also may be completed. Relay Y1 serves as an identifying receiving device for connections from the exchange A3 completed over the junction line VL, and is now connected to the *b* lead over contact 94*u*6. Relay U6 is energized over earth, contact 105*u*1, *d* wiper of the switch VW6, relay U6, battery, earth.

The setting of the group selector GW5 and the final selector LW2 in exchange A2

(see Fig. 1) is effected in any known manner of no interest in the present case.

At the end of the conversation a long impulse is transmitted from the connecting devices in exchange A1 over the *b* lead of the junction line VL and this impulse actuates relay Y, which causes winding II of relay C6 to be short circuited at contact 59*y*, so that said relay C6 releases. The release of relay C6 cuts off the circuit for relay C7 at contact 46*c*6. Relay C7 also restores and at contact 49*c*7 breaks the circuit for relays U1 and S. Relay S, being a slow-acting relay, is the last to remain energized, and, by opening its contact 153*s*, removes the guarding of the junction line VL from exchange A1, and at the same time connects the junction line from exchange A1 to the preselector VW6 by closing its contacts 152*s*, 68*s*, and 154*s*, with the result that a connection may be set up over this device also.

If a subscriber of exchange A1 wants a subscriber of exchange A3, an impulse is transmitted simultaneously over the *a* and *b* leads due to the seizure of the junction line VL over a definite access from the group selector GW1 in the manner described above (see description for Figs. 1 and 2). This impulse causes relays X and Y, connected to the junction line VL over the neon lamps L, to be energized. Relays X and Y, by closing contacts 42*x* or 64*y*, guard the junction line to exchange A3 against seizure by the group selector GW2, and at the same time energize relay C8, while the junction line to exchange A1 is guarded against seizure by the group selector GW2, due to the opening of contact 158*x* or 104*y*. Relay C8 takes over the guarding at contact 90*c*8. Relay X energizes relay C4 over contact 40*x*, causing relay C6 to respond over winding I and contact 41*c*4. A locking circuit for relay C6 extends over earth, contact 47*c*6, winding II of relay C6, resistance W, battery, earth, due to relay C5 being energized over earth, contact 60*y*, winding I of relay C5, contact 61*c*7, battery, and earth by the closing of contact 60*y* of relay Y. Thus the locking circuit for relay C6 is prevented from being completed over contact 48*c*5 and resistance W. Relay C5 remains energized over earth, contact 62*c*5, winding II of relay C5, battery, earth. Relay C7 is energized over earth, contact 69*c*5, relay C7, battery, earth. Relays C5 and Y close their contacts 70*c*5 and 71*y*. A circuit for relay Z is now completed over earth, contacts 70*c*5, 71*y*, *f* wiper of the preselector VW6, contact 151*y*2, relay Z, battery, earth. Before relay Z actuates its contacts, the circuit over the *b* lead is cut off and relay Y opens contact 71*y*. This again cuts off the circuit for relay Z. The junction line to exchange A3 is guarded against further seizures over the accesses *c*1 and *c*2 of the group selector GW2 by relays C5, C6, and C7 (contacts 63*c*5, 52*c*6, and 51*c*7) after the release of relays X and Y according to the sequence. The junction line to exchange A1, after relays X and Y have released and consequently contacts 158*x* and 104*y* have been closed, is, therefore, guarded by means of contact 90*c*8. No further operations take place in the present case on the seizure of the repeater U*e*2 in exchange A2. The operations caused in the other exchanges due to the two impulses simultaneously transmitted over the *a* and *b* leads will be explained in the description of the repeaters provided in the individual exchanges.

The switching means of the repeater U*e*2 in Fig. 3 are restored to normal at the end of the conversation by means of a long impulse transmitted over the *b* lead. This long impulse causes relay Y to be energized, which, at contact 59*y*, short circuits both relays C5 and C6, with the result that these two relays release after a definite period. Relay C5 opens the circuit for relay C7 at contact 69*c*5, which removes the guardings at contact 51*c*7.

On the other hand, should the subscriber of exchange A1 wish to communicate with a subscriber of exchange A4, it will be necessary to transmit an impulse over the *b* lead which, in the manner described above, is carried into effect by a corresponding seizure of the junction line VL by means of the group selector GW1 in exchange A1. This impulse over the *b* lead energizes relay Y. Relay Y, as mentioned above, guards the junction line at contacts 64*y* and 104*y* and also energizes relay C8, which, by means of contact 90*c*8, takes over the guarding for contact 104*y*. A circuit for relay C5 is completed over contact 60*y*. Relay C5 remains energized after the release of relay Y over earth, contact 62*c*5, winding II of relay C5, resistance W, battery, earth. Relay C5 energizes relay C7 over contact 69*c*5. After the release of relay Y, the junction line to exchanges A3 and A1 is further guarded over contacts 63*c*5 and 51*c*7 by relays C5 and C7.

The switching operations caused in the individual exchanges by this impulse over the *b* lead are mentioned in the description of the individual repeaters in the exchanges.

The release of the switching device after a call is also effected by means of a long impulse transmitted over the *b* lead which causes relay Y to be energized an extended period, and the short-circuit relay C5 at contact 59*y*, causing it to release. Relay C5, by means of contact 69*c*5, opens the circuit for relay C7, which, in the capacity of the switching means last actuated, removes the guarding of the junction line against being seized by a subscriber of exchange A2.

When, for example, a subscriber of exchange A3 or A4 wishes to set up a connection with a subscriber of exchange A2, he has

to transmit two successive impulses over the *b* lead corresponding to the seizure of the repeater in exchange A3 or A4. The manner in which this is carried into effect in the individual repeaters in exchange A3 or A4 will be explained in the description of the repeaters U*e*3 and U*e*4 (Figs. 4 and 5) in the exchanges A3 and A4.

The first impulse over the *b* lead, according to Fig. 3, energizes relay Y over the *b* lead of the junction line VL, contacts 124*c*13, 65*c*9, 66*c*10, 67*e*1, *b* wiper of the preselector VW6, contacts 68*s*, 53*u*1, lamp L, relay Y, earth. Relay Y, in the manner already described, guards the line and over contact 60*y* energizes relay C5, which, by closing contact 62*c*5 after the release of relay Y, closes its own locking circuit over earth, contact 62*c*5, winding II of relay C5, resistance W, battery, earth. Relay C5 energizes relay C7 over earth, contact 69*c*5, relay C7, battery, earth. An energization of relay Z is prevented by the first impulses over the *b* lead. Relays C5, C7, and C8 take over the guarding at contacts 51*c*7, 63*c*5, and 90*c*8 in the manner described above. Relay C5 prepares a circuit for relay Z at contact 70*c*5. The second impulse over the *b* lead reenergizes relay Y, causing a circuit for relay Z to be closed over earth, contacts 70*c*5, 71*y*, wiper *f* of preselector VW6, contact 151*y*2, relay Z, battery, earth. Relay Z closes contact 72*z*, with the result that relay CH is energized in parallel with relay Z. Relay CH remains energized over earth, contact 73*ch*, winding II of relay CH, resistance W, battery, earth, after the end of the second impulse and after relay Z has released. Relay CH closes contact 74*ch* so that the junction line to exchanges A3 and A1 cannot be seized due to the short circuit of winding I of relay T and windings I and II of relay T1. Relay T1 of the preselector VW6, which is short circuited, now releases. This applies battery to the rotary magnet DM1 of the preselector VW6 over earth, winding II of relay S, contact 74*t*1, rotary magnet DM1, battery, earth. The rotary magnet DM1, when energized, actuates contact 75*dm*1, thereby completing a circuit over winding III of relay T1. Relay T1 opens the circuit for the rotary magnet DM1 so that it releases, which causes the switch wiper of the preselector VW6 to advance one step. If the succeeding line, to which the preselector VW6 is set, is idle, relay T1 of the preselector VW6 is permanently energized and prevents the rotary magnet DM1 from operating by opening contact 74*t*1. Relay C8 also is short circuited by means of contact 74*ch*, and consequently releases.

Before the preselector VW6 is advanced, relay CH completes a circuit for relay G extending over earth, contacts 76*y*2, 77*ch*, 78*g*, winding I of relay G, *e* wiper of the preselector VW, resistance W, battery, earth. Relay C5 is short circuited due to this circuit. It, therefore, releases and opens the circuit for relay C7, with the result that the preselector VW6 may be seized from the exchange A1 over the junction line.

Relay G sets up a locking circuit for itself extending over earth, contact 80*g*, winding II of relay G, contact 79*ch*, battery, earth.

Relay Y2 responds over earth, contact 88*ch*, winding I of relay Y2, resistance W, battery earth, and remains energized over contact 97*y*2. This relay maintains the circuit for relays U2 and S1 independent of contact 81*g* by means of its contact 103*y*2. Relay Y2 takes over the guarding at contact 89*y*2 in a manner similar to that of contact 74*ch*. By means of contact 87*ch*, relay CH connects up relay Y1 to the *b* lead, and this relay Y1, in a connection set up from exchange A1 to A2, receives the impulses over the *b* lead for the identification of the exchanges, and also receives the release impulse over the *b* lead after a connection from either exchange A3 or A4 to exchange A2 has been set up.

Relay C11 is energized over earth, contacts 147*g*, 146*s*1, relay C11, contact 104*y*, key S*p*T, contact 43*c*2, battery, earth, before relay S1 is energized, and applies superimposed direct current over contacts 109*c*11, 110*c*2, to the *b* lead of the line leading to exchange A1 for the purpose of releasing the devices in the exchange A1 which have been set in operation by the identification impulse. Relay D3 is connected to battery over earth, contact 106*c*11, relay D3, resistance W, battery, earth. This relay remains energized over contact 115*d*3 and energizes relay E2 over earth, contact 112*d*3, relay E2, resistance W, battery, earth. Relay E2 cuts off the release current over the *b* lead at contact 110*e*2. This release current now flows over contacts 116*c*11, 117*e*2, due to the fact that relay S1 in the meantime has opened the circuit for relay C11 at contact 146*s*1. Relay C11 releases and short circuits relay D3 at contacts 107*c*11 and 118*c*11. Relay D3 releases and short circuits relay E2 at contact 111*d*3. This cuts off the release impulse over the *b* lead at contact 117*e*2. Relays S1 and U are energized over earth, contacts 81*g*, 82*ch*, winding I of relay S1, winding I of relay U2, battery, earth. Relay U2 opens contact 83*u*2 and 84*u*2 and closes 85*u*2 and 86*u*2. This switches the junction line from exchange A3 to exchange A2 over to a line leading to a secondary lineswitch MW2 and over this to a group selector GW5 (see Fig. 1). This switching-over operation cuts off the *c* lead to the preselector VW5, so that winding I of relay T is no longer short circuited and the junction line to exchange A1 may be seized over the group selector GW2 (access *c*). A locking winding II for relay U2 is also connected up due to the switching over of the *c* lead. Relay S1, in the circuit for relay U2, disconnects the junc-

tion line from the preselector VW5 at contacts 155*s*1, 156*s*1, and 157*s*1 since relay S1 is the last relay to be restored to normal, as will be described in connection with the release operation.

The setting of the secondary lineswitch and group selector GW5 in exchange A2 (see Fig. 1) is carried into effect in a manner of no interest in the present case.

At the end of the conversation, a long impulse which energizes relay Y1 an extended period of time is again transmitted over the *b* lead. Relay Y1 short circuits relay Y2 at contact 91*y*1, causing relay Y2 to release. Relay Y1 also short circuits winding II of relay CH at contact 92*y*1, with the result that relay CH is also deenergized. Relay CH opens the circuit for relay G as well as relay U2 and relay S1 at contacts 79*ch* and 82*ch*. The guarding of the line leading to exchange A3 is only removed when relay CH, which is slow to release, has restored its contacts to normal and discontinued the guarding by opening contact 74*ch*.

Should a subscriber of exchange A3 or A4 require a connection with a subscriber of exchange A1, relay Y in the repeater of exchange A2 (see Fig. 3) will be energized by the one impulse over the *b* lead which denotes exchange A1, and, by closing contact 64*y* (causing relay C8 to be energized) and opening contact 104*y*, guards the junction line immediately upon the seizure. By closing contact 60*y*, it causes relays C5 and C7 to be energized in the manner described above. Relay C8 also energizes over contact 64*y* and the line is further guarded at contacts 63*c*5, 51*c*7, and 90*c*8 after the identification impulse has ended. The switching operations occurring in exchange A1 on the transmission of an impulse over the *b* lead have already been described. The connection between the subscriber of exchange A3 or A4, therefore, extends according to Fig. 3, over the preselector VW6 to the repeater U*e*1 in exchange A1 shown in Fig. 2.

The switching means in Fig. 3 are restored to normal by the operation of relay Y responsive to a long impulse over the *b* lead in the manner described above.

The impulse receiving relays X and Y also are influenced during a connection between a subscriber of exchange A4 and a subscriber of exchange A3. As mentioned in the description of Fig. 1, when such a connection is set up an impulse is first transmitted over the *b* lead and then another impulse over the *a* lead, according to the seizure of the junction line in exchange A4. The impulse transmitted over the *b* lead energizes relay Y, which momentarily guards the junction line and causes relays C5, C7, and C8 to operate so that they take over the guarding of the line. The impulse transmitted over the *a* lead energizes relay X, which in turn causes relays C4 and C6 to respond. None of the devices in exchange A2 are switched over. If the junction line, however, is switched over to the devices in exchange A3 (see Fig. 4) in an operation to be described at a later stage, a long release impulse is transmitted over the *b* lead of the junction line to exchange A2, and this impulse restores the relays in Fig. 3 to normal in the manner described above.

When the repeater in Fig. 3 is seized from exchange A3 or A4 while a connection exists over the junction line from exchange A1 to exchange A2, the junction line from exchange A1 is switched over to the secondary lineswitch MW1 over which the group selector GW5 is accessible (Fig. 1), said switching-over operation being carried out over contacts 55*u*1, 56*u*1, and 58*u*1. In such a case, the impulse receiving relays X and Y cannot be actuated by any impulses. An auxiliary impulse receiving device, however, is connected to the *b* lead over contact 94*u*6 by means of relays U1 and U6, relay Y1 constituting the said auxiliary impulse receiving device.

If, therefore, a connection from a subscriber of exchange A3 or A4 to a subscriber of exchange A2 is required while the line between the exchanges A1 and A2 is busy, the identification impulses, in this case two impulses transmitted successively over the *b* lead, influence relay Y1. The first impulse causes this relay to operate. Contact 93*y*1 completes the guarding in the same manner as it was performed by means of contact 74*ch*. Relay Y2 is energized over earth, contact 95*y*1, winding II of relay Y2, contact 96*y*2, battery, earth. Relay Y2 breaks the energizing circuit at contact 96*y*2, but still remains energized over earth, contact 97*y*2, winding I of relay Y2, resistance W, battery, earth. By closing its contact 98*y*2, it prepares a circuit for relay CH, due to the fact that the first impulse is ended after contact 98*y*2 has been closed so that a circuit for relay CH cannot be completed by the actuation of contact 99*y*1. If the second impulse energizes relay Y1, the circuit for relay CH is completed over earth, contact 98*y*2, winding I of relay CH, contacts 100*s*1, 99*y*1, battery, earth. When its short circuit is removed at contact 92*y*1, at the end of the second impulse, relay CH closes a locking circuit for its winding II over earth, contact 73*ch*, winding II of relay CH, resistance W, battery, earth. Relay CH causes the same switching operations to be performed as those described in relation to a connection being set up from a subscriber of exchange A3 or A4 to a subscriber of exchange A2 when the junction line from exchange A1 to A2 is idle and relay Y operated as an impulse receiving relay.

The release at the end of the conversation is also in this case caused by a long impulse

transmitted over the *b* lead. The release impulse actuates relay Y1, which, in the manner described above, restores the switching means of the repeater U*e*2 to normal.

When a subscriber of exchange A3 or A4 wishes to set up a connection with a subscriber of exchange A1 while the junction line from exchange A1 to exchange A2 is busy, the impulse transmitted over the *b* lead, which at the same time denotes the exchange A1, causes relay Y1 to operate. Relay Y1 guards the junction line and energizes relay Y2 over earth, contact 95*y*1, winding II of relay Y2, contact 96*y*2, battery, earth. Relay Y2 remains energized over earth, contact 97*y*2, winding I of relay Y2, resistance W, battery, earth. The energizing circuit for relay Y2 is cut off at contact 96*y*2. This relay Y2 operates its contact 89*y*2 and thus takes over the guarding of the junction line from exchange A2 to exchange A3 as well as to exchange A1. The circuit extending over earth, windings I and II of relay T, *c* wiper of the preselector VW5, relay C12, contact 149*c*12, resistance W, battery, earth, is, therefore, shorted. Relay T consequently releases, and, in the manner previously described, advances the preselector VW5 to the succeeding idle line. Relay C12, therefore, releases and opens contact 149*c*12. The circuit for relay C11, however, is still maintained over the key S*p*T and contact 43*e*2.

In the case of a subscriber of exchange A2 wanting a subscriber of exchange A1, it is necessary that the subscriber of exchange A2 set the group selector GW2 to the access *c* (Fig. 3, lower central portion of drawings). This definite seizure energizes relay C11 over the *c* wiper of the group selector GW2 in the following circuit: earth applied to the group selector GW2, *c* lead, contact 158*x*, relay C11, contact 104*y*, key S*p*T, contact 43*e*2, battery, earth. Relay C11 is operated and applies superimposed direct current to the *b* lead over contacts 109*c*11 and 110*e*2. Relay X and the other impulse receiving relays located in the other exchanges and connected to the *b* lead cannot be energized due to the opening of contact 108*c*11. Relay D3 is connected to battery over earth, contact 106*c*11, relay D3, resistance W, battery, earth. Relay D3 opens contact 111*d*3 and closes contact 112*d*3, thus causing relay E2 to operate over earth, contact 112*d*3, relay E2, resistance W, battery, earth. Relay E2 closes its contact 113*e*2 and is maintained energized independent of contact 112*d*3. It also cuts off the superimposed direct current at contact 110*e*2, and switches through the *b* lead from the group selector GW2 at contact 145*e*2.

The impulse transmitted over the *b* lead energizes, in the manner described, the relay B in the group selector GW8 in exchange A1, and thereby sets up the guarding of the junction line against further seizures over the group selector GW1 in exchange A1.

The release of the connecting devices, more particularly the transmission of a long release impulse over the *b* lead, is effected in the following manner: when the subscriber of exchange A2 replaces his receiver, the group selector GW2 is restored to normal in the usual way. The circuit extending over the *c* lead is cut off, resulting in the release of relay C11. This relay closes its contact 116*c*11 and thereby causes superimposed direct current to be applied to the *b* lead over contacts 116*c*11 and 117*e*2, and maintains it applied until relay E2 restores. Relay E2 is short circuited when relay D3 is short circuited by the opening of contact 106*c*11 and closing the contacts 118*c*11 and 107*c*11, and releases to close its contact 111*d*3. Relay E2 releases with slow action due to said short circuit and restores its contacts to normal, thereby cutting off the superimposed direct current applied over contact 117*e*2.

A subscriber of exchange A2 calling another subscriber of exchange A3 has to set the group selector GW2 to the access over which relay C9 is energized over the *c* lead, that is to say, the group selector must be set to the access *c*1. The circuit for relay C9 extends over earth applied to the group selector GW2, *c*1 lead, relay C9, key S*p*T, contact 143*e*1, resistance W1, battery, earth. The circuit extending over earth, resistance W, windings I and II of relay T1, *c* wiper of the preselector VW6, relay C8, key S*p*T, contact 143*e*1, resistance W1, battery, earth. The circuit extending over earth, resistance W, windings I and II of relay T1, *c* wiper of the preselector VW6, relay C8, key S*p*T, contact 143*e*1, resistance W1, battery, earth, is consequently short circuited. Relay T1 releases, and, in the manner previously indicated, advances the preselector VW6 to an idle junction line leading to exchange A3. Relay C9 applies superimposed direct current to the *a* lead over contacts 121*e*1 and 122*c*9, and to the *b* lead over contacts 121*e*1, 122*c*9, and 125*c*9. The opening of contacts 136*c*9 and 65*c*9 prevents the backward directed impulse receiving relays connected to the *a* and *b* leads from being influenced by the superimposed direct current. A circuit for relay D2 is completed over earth, contact 188*c*9, relay D2, resistance W, battery, earth. Relay D2 opens its contact 126*d*2 and closes 127*d*2, which causes it to remain energized independent of contact 118*c*9. It also closes contact 119*d*2, which energizes relay E1 over earth, contact 119*d*2, relay E1, resistance W, battery, earth. Relay E1 remains energized over contact 128*e*1 independent of contact 119*d*2. This relay cuts off the superimposed direct current by opening contact 121*e*1. The opening of contact 143*e*1 does not cause relay C9 to release due to a locking circuit having been estab-

lished over contact 141*d*2. Contact 120*e*1 is now closed, but the current source of supply mentioned is not connected up to the *b* lead due to the opening of contacts 67*e*1 and 65*c*9. The *b* lead from the group selector GW2 is now switched through over contacts 137*e*1, 125*c*9, and 124*c*13.

The switching operations in the repeater Ue3, according to Fig. 4, caused by the impulses transmitted simultaneously over the *a* and *b* leads, will be described in a later paragraph.

The group selector GW2 is released in known manner and the circuit over the *c*1 lead cut off, so that relay C9 releases when the connection with the subscriber of exchange A3 is ended and the subscriber of exchange A2 replaces his receiver. Relay C9 now applies superimposed direct current to the *b* lead of the junction line leading to exchange A3 over contacts 120*e*1, 66*c*10, 65*c*9, 124*c*13, and this superimposed current is applied until relay D2 is short circuited by the opening of contact 118*c*9 and closing of 129*c*9, short-circuiting relay E1 by opening contact 119*d*2 and closing contact 130*d*2 and allowing the latter relay to release. In releasing, relay E1 cuts off the current from the junction line at contact 120*e*1. This impulse causes the release of devices shown in Fig. 4 in the manner indicated in this figure and explained in connection therewith.

If a subscriber of exchange A2 wishes to speak to another subscriber of exchange A4, he sets the group selector GW2 to the access over which relay C10 is energized over the *c*2 lead. The preselector VW6 is set to an idle junction line leading to exchange A3 by means of the circuit completed over the *c*2 lead, relay C10, key S*p*T, contact 143*e*1, resistance W1, battery, earth. This setting operation is carried out in exactly the same manner as that occurring when access *c*1 is seized.

Relay C10 applies superimposed direct current to the *b* lead over contacts 121*e*1, 132*c*9, 133*c*10, and 124*c*13. This superimposed direct current is prevented from being applied backwards due to the opening of contacts 135*c*10 and 66*c*10. Relay C10 closes a circuit for relay D2 over earth, contact 131*c*10, relay D2, resistance W, battery, earth, removes the short circuit for relay D2 at contact 134*c*10, and consequently causes relay D2 to be energized. Relay D2 remains energized over contact 127*d*2 independent of contact 131*c*10. It energizes relay E1 over earth, contact 119*d*2, relay E1, resistance W, battery, earth. Relay E1 is placed in a locking circuit over contact 128*e*1 independent of relay D2, and, by opening contact 121*e*1, disconnects the current source of supply from the *b* lead. In this case, therefore, an impulse which depends upon the operation of relay C10 is transmitted over the *b* lead of the junction line leading to exchange A3. The opening of contact 143*e*1 does not release relay C10 due to a locking circuit having been completed for this relay over contact 141*d*2.

The switching operations caused in the repeaters Ue3 (Fig. 4) and Ue4 (Fig. 5) by the impulse transmitted over the *b* lead will be described later.

The circuit over the *c*2 lead is cut off at the end of the connection. Relay C10 releases and, with the object of restoring the switching means in the repeaters Ue3 and Ue4 to normal, applies superimposed direct current to the *b* lead over contacts 120*e*1, 66*c*10, 65*c*9, and 124*c*13. The release current over the *b* lead is only cut off at contact 120*e*1 after relay D2 has been short-circuited over contacts 129*c*9 and 134*c*10, and has in turn short-circuited relay E1 over contact 130*d*2. A long impulse consequently is transmitted over the *b* lead for the purpose of causing the release. It should be noted that the junction line to exchange A3 is guarded for the duration of the call over access *c*1 or *c*2 as long as relays C9 and C10 remain energized.

The repeater Ue3 for exchange A3 (see Fig. 1) is shown in Fig. 4. This repeater Ue3 is seized when a connection is to be set up to a subscriber of exchange A3. In such a case an impulse (by means of superimposed direct current) is simultaneously applied to the *a* and *b* leads of the junction line in accordance with the seizure of said junction line in exchange A1 or exchange A2 in the manner described. This causes relays X1 and Y3 to be energized for the duration of the impulse over the *a* and *b* leads. These relays close contacts 182*x*1 and 183*y*3, causing winding I of relay T2 to be short-circuited and relay C21 to operate, which prevents the seizure of the junction line VL from exchange A3 to A4. Relays X1 and Y3 also cause relay C14 to be energized over earth, contacts 160*x*1 and 165*y*3, winding I of relay C14, resistance W, battery, earth. Relay C14 locks up over its contact 170*c*14. Relay C16, however, cannot be operated due to the fact that the identification impulse over the junction line is ended and relay X1 has caused contact 196*x*1 to be opened before the slow-acting relay C16 responds. Relays X1 and Y3 also open contact 161*x*1, 162*x*1, 166*y*3, and 167*y*3, so that the junction line from the group selector GW3 in exchange A3 and leading to exchange A2 cannot be seized. This guarding is taken over by relay C21 (contact 224*c*21). At the end of the impulse over the *a* and *b* leads and after the release of relays X1 and Y3, relay C14 short circuits winding I of relay T2 over contacts 167*c*14, 168*u*3, and 169*s*2, and thus prevents the junction line VL to exchange A4 from being seized. The opening of contact

171*c*14 removes one short circuit from winding I of relay CH1.

Relay X1 at the same time causes relay C15 to be operated over earth, contact 163*c*1, relay C15, resistance W, battery, earth, due to the short circuit for relay C15 having been removed at contact 181*y*3. Relay C15 in turn removes the second short circuit from winding I of relay CH1 at contact 164*c*15, thus causing relay CH1 to respond over earth, winding I of relay CH1, contact 178*c*14, resistance W, battery, earth. Relay CH1 remains energized over earth, contact 179*ch*1, winding II of relay CH1, resistance W, battery, earth, at the end of the impulse over the *b* lead and after relay Y3 has removed the short circuit for relay CH1 at contact 180*y*3. Relay C20 is energized over earth, contacts 269*ch*1, 270*s*2, *g* wiper of the preselector VW8, relay C20, key S*p*T, contact 262*e*4, resistance W, battery, earth, and brings about the release of the switching means in exchange A4, which were operated by the identification impulse transmitted over the *b* lead, by sending out a release impulse over the *b* lead. Relay C20 for this purpose applies superimposed direct current to the *b* lead over contacts 251*c*20, 252*e*4. Relay C20 also energizes relay D5 over earth, contact 253*c*20, relay D5, resistance, battery, earth. Relay D5 energizes relay E4 at contact 256*d*5. Relay E4 cuts off the release current at contact 252*e*4. Due to the fact that relay C20 in the meantime has been deenergized by the opening of contact 270*s*2 (relay S2 is energized by means of relay CH1 at contact 187*ch*1), superimposed direct current is applied to the *b* lead over contacts 258*c*20 and 257*e*4 until relay D5 releases due to a short circuit over contacts 259*c*20 and 260*c*20, short-circuiting relay E at contact 261*d*5. Relay E releases after a definite period and cuts off the release current by opening its contact 257*e*4. Relay CH1 closes contact 187*ch*1 and thereby energizes relays U3 and S2 over earth, contact 184*ch*1, winding I of relay U3, winding I of relay S2, battery, earth. Due to the opening of contacts 168*u*3, 185*u*3, and 186*u*3 and the closing of 187*u*3, 188*u*3, and 189*u*3, the junction line from exchange A2 is switched over to the secondary lineswitch MW3 over which the group selector GW6 is accessible. Relay U3 removes the short circuit for winding I of relay T2 at contact 168*u*3, which removes the guarding of the junction line against further seizures over access *c* of the group selector GW3, and also opens contact 190*u*3 which disconnects the receiving device X1 from the *a* lead of the junction line. Relay U3 at the same time closes contact 277*e*3, which energizes relay U7 and causes relays X2 and Y4 to be connected to the *a* and *b* leads of the junction line over contacts 190*u*3 and 191*u*7. Relays X2 and Y4 serve as receiving devices for the identification impulses when the junction line from exchange A4 is seized.

The closing of contact 194*s*2 short circuits windings II and I of relay T3, causing relay T3 to release and apply current to the rotary magnet DM3 of the preselector VW7 over earth, winding I of relay S3, contact 176*t*3, rotary magnet DM3, battery, earth. The rotary magnet DM3 closes contact 177*dm*3 and sets up a circuit for relay T3 over winding III as follows: earth, contact 177*dm*3, winding III of relay T3, battery, earth. Relay T3 opens contact 176*t*3 which breaks the circuit for the rotary magnet DM3 and causes the wipers of the preselector VW7 to be set to the succeeding idle junction line leading to exchange A2. Contact 177*dm*3 is now reopened and the circuit over winding III of relay T3 is cut off. A fresh circuit for windings I and II of relay T3 can be completed over the succeeding idle junction line, with the result that the rotary magnet DM3 can no longer be actuated over contact 176*t*3.

Relay S2 in the circuit for relay U3 disconnects the junction line from exchange A2 from preselector VW8 at contacts 192*s*2, 193*s*2, and 169*s*2, and removes the guarding of said junction line at contact 169*s*2 so that the incoming line may be seized.

The setting of the connecting devices in exchange A3 is effected in a manner of no interest in the present case.

At the end of the conversation, and when calling subscriber cuts off the connection, a long impulse is transmitted over the *b* lead in exchange A1 or exchange A2. This impulse retains relay Y3 (Fig. 4) energized an extended period of time, and this relay short circuits winding II of relay CH1 and winding II of relay C14 over contact 180*y*3. Relays CH1 and C14 release and restore their contacts to normal. Relay CH1 opens the circuit for relays U3 and S2 at contact 187*ch*1. Relay U3 releases first, whereas relay S2 remains energized a short period longer, due to its slow action, and at contacts 169*s*2 and 194*s*2 prevents the seizure of the junction line from exchange A2 or the group selector GW2 in exchange A3 until all of the switching means have been restored to normal.

If the subscriber of exchange A1 or A2 requires a connection with a subscriber of exchange A4, relay Y3 is energized by the identification impulse for exchange A4 (an impulse over the *b* lead). Relay Y3 closes its contact 183*y*3, whereupon relay C21 is energized and the junction line is guarded against seizures from the group selector GW3 for connections to exchange A4. Relay Y3, by opening contacts 166*y*3 and 167*y*3, guards the line to exchange A2 from the group selector GW3 over the accesses *c*1 and *c*2. Relay C21 (by means of contact 224*c*21) takes over the guarding of the junction line after

the release of relay Y3. This relay Y3 also operates its contact 165*y*3 and thus energizes relay C14, which, by closing contact 170*c*14, completes a locking circuit for itself over earth, contact 170*c*14, winding II of relay C14, resistance W, battery, earth, as soon as relay Y3 releases at the end of the impulse over the *b* lead and opens contact 180*y*3, so that the short circuit for winding II of relay C14 is removed. Relay C14 guards the junction line between exchanges A3 and A4 against seizure from the group selector GW3 over the *c* lead by closing its contact 167*c*14, whereupon relay C21 remains energized and the junction line from exchange A3 to exchange A*a* is guarded against further seizures over access *c*1 or access *c*2 by the closing of contact 224*c*21. The switching operations brought about in exchange A4 by the impulse over the *b* lead are enumerated in the description relating to Fig. 5. At the end of the conversation between a subscriber of exchange A1 or A2 and a subscriber of exchange A4, a long release impulse is again transmitted over the *b* lead which maintains relay Y3 energized an extended period of time. Relay Y3, by closing its contact 180*y*3, causes winding II of relay C14 to be short circuited. Relay C14 releases after a definite interval and, by restoring its contacts to normal, removes the guarding of the line.

Should a subscriber of exchange A4 wish to set up a connection with a subscriber of exchange A3, an impulse is first transmitted over the *b* lead and then another impulse over the *a* lead as indicated in Fig. 1. The impulse transmitted over the *b* lead actuates relay Y3 and causes the same switching operations to be carried out as were described in the case of a connection between a subscriber of exchange A1 or exchange A2 and a subscriber of exchange A4. The impulse also causes the guarding of the junction line to be set up in the same manner. Due to the fact that a circuit is prepared for relay C16 by the closing of contact 195*c*14, the succeeding impulse over the *a* lead closes a circuit for relay C16 by the closing of contact 196*x*1 as follows: earth, contacts 195*c*14 and 196*x*1, *f* wiper of the switch VW8, winding I of relay C16, resistance W, battery, earth. Relay C16 remains energized over winding II in the following circuit: earth, contact 197*c*16, winding II of relay C16, resistance W, battery, earth. By closing contact 198*c*16, it short circuits relay T2 so that the preselector VW8 is set to the succeeding idle junction line in the manner described above. Relay C14 is short circuited over earth, contacts 209*c*16, 210*g*1, and 211*h*2, winding I of relay G, wiper *e* of the switch VW8, resistance W, earth. It, therefore, releases and removes the guarding of the junction line at contact 167*c*14. Relay G1 is energized in the above-described circuit and causes relay C22 to operate in the following circuit: earth, contacts 271*g*1 and 272*u*4, *d* wiper of the preselector VW7, relay C22, resistance W, battery, earth. Relay C22 applies superimposed direct current to the *b* lead for the purpose of releasing the preceding switching means which were operated by the identification impulse. Relay C19 is operated over earth, contact 274*c*22, relay C19, key S*pt*, contact 173*e*3, resistance W, battery, earth, and takes over the connecting up of the release current over contacts 227*e*3 and 226*c*19. Relay D4 responds over contact 235*c*19, remains energized over contact 229*d*4, and operates relay E3 over contact 230*d*4. Relay E3 is maintained energized over contact 231*e*3 and breaks the release current at contact 227*e*3. Due to the release of relay C22 by the opening of contact 272*u*4, and the release of relay C19 by the opening of contact 274*c*22, the release current is applied over contacts 240*e*3, 247*c*18, and 249*c*19, until relay D4 is short-circuited over contacts 228*c*19 and 238*c*18, and in turn short-circuits relay E3 at contact 276*d*4. Relay E3 releases and cuts off the release current by opening its contact 240*e*3.

Relay C16 also completes a circuit for relays U4 and S3, which extends over earth, contact 199*c*16, winding I of relay S3, winding I of relay U4, battery, earth. Relay U4 opens contacts 200*u*4, 201*u*4, and 202*u*4, and closes contacts 203*u*4, 204*u*4, and 205*u*4. This switches over the junction line from exchange A4 to the devices in exchange A3, that is to say, over the secondary lineswitch MW4 to the group selector GW6. Relay C16 connects relay Y4 to the *b* lead of the junction line over contact 206*c*16. Relay X2 cannot be connected up due to the opening of contact 207*c*16.

The setting of the switches in exchange A3 has no bearing on the present invention, and, consequently, will not be described.

At the end of the conversation, the repeater shown in Fig. 5 applies superimposed direct current for an extended period of time to the *b* lead, with the result that relay Y4 is energized. This relay short circuits relay C16 over contact 208*y*4, so that the latter relay releases. Relay C16, when releasing, cuts off the circuit for relays U4 and S3 at contact 199*c*16, and these relays consequently release and restore their contacts to normal.

If a subscriber of exchange A4 wishes to communicate with a subscriber of exchange A1, A2, or A3, and the junction line between exchanges A2 and A3 is busy transmitting a call from a subscriber of exchange A1 or exchange A2 to a subscriber of exchange A3, said junction line is switched over at contacts 185*u*3, 186*u*3, 188*u*3, and 189*u*3 to the group selector GW6 in exchange A3 over the secondary lineswitch MW3. Relays U3 and U7, however, connect the auxiliary impulse receiving devices X2 and Y4 to the *a*

and *b* leads over contacts 190*u*7 and 191*u*7, so that the identification impulse may influence these devices.

When a subscriber of exchange A4 in such a case desires a connection with a subscriber of exchange A3, the identification impulses (one impulse transmitted over the *b* lead and then another impulse over the *a* lead) influence relays Y4 and X2. The first impulse over the *b* lead energizes relay Y4, which guards the junction line by means of contact 220*y*4 and over contact 214*y*4 completes a circuit for relay H2 as follows: earth, contact 214*y*4, winding I of relay H2, resistance W, battery, earth. Contact 220*y*4 short-circuits relay T2, and, in consequence thereof, causes the preselector VW7 to seize an idle line. Relay H2 short circuits its winding I at contact 215*h*2, but still remains energized over earth, contact 216*h*2, winding II, resistance W, battery, earth, and prepares a circuit for relay C16 at contact 217*h*2. The succeeding impulse, transmitted over the *a* lead at the end of the first one which passed over the *b* lead, causes relay X2 to operate and complete the circuit for relay C16 by closing its contact 218*x*2, so that relay C16 is energized over earth, contact 217*h*2, contact 218*x*2, winding I, resistance W, battery, earth. Relay H2 takes over the guarding of the junction line at contact 219*h*2, and thus prevents the seizure of the junction line over the group selector GW3. Relay C16, by means of relay S3 (contacts 221*s*3 to 223*s*3), disconnects the junction line from the preselector VW7 and switches it over by means of relay U4 (at contacts 200*u*4 to 205*u*4). Relay C16 takes over the guarding of the junction line at contact 198*c*16. Also in this case the release at the end of the conversation is brought about by a long impulse transmitted over the *b* lead, so that relay Y4, by closing its contact 208*y*4, short-circuits winding II of relay C16 and causes it to release. Relay C16 then opens the circuit for relays U4 and S3. Relay S3 in turn cuts off the circuit for relay G1, and all the switching means are thus restored to normal.

Responsive to the seizure of the junction line in exchange A4, when a subscriber of exchange A4 wishes to set up a connection with a subscriber of exchange A2, two impulses are transmitted over the *b* lead. If, therefore, the junction line between exchanges A*a* and A3 is busy and has been switched over (by relay U3) to the connecting devices in exchange A3, the auxiliary impulse receiving devces relays X2 and Y4 are connected to the *a* and *b* leads. The first impulse over the *b* lead causes relay Y4 to operate. Relay Y4 energizes relay H2 over contact 214*y*4, which, by means of contact 219*h*2, takes over the guarding of the junction line at the end of the first impulse.

The succeeding impulse over the *b* lead re-energizes relay Y4. The impulse, however, is of short duration so that, due to the closing of contact 208*y*4, a release of relay C16 or relay H2, owing to the short circuit of winding II of these relays, does not occur.

The switching operations caused in the exchange A2 by the two impulses over the *b* lead have already been described. The release also in this case is brought about by a long impulse transmitted over the *b* lead, which energizes relay Y4 for an extended period of time. Relay Y4 short-circuits windings II of relays C16 and H2 at contact 208*y*4, with the result that all the switching means are restored to normal in the manner indicated above. If the junction line between exchanges A2 and A3 should be busy when a subscriber of exchange A4 desires a connection to a subscriber of exchange A1, the identification impulse (an impulse over the *b* lead) operates relay Y4 in exchange A3 which guards the line and sets the preselector VW7 to an idle line in the manner described above. The switching operations taking place in exchange A1 or exchange A2 in consequence of the impulse over the *b* lead have previously been described.

The release also in this case is brought about by means of a long impulse over the *b* lead.

Outgoing connections from exchange A3 are to be described below.

When a subscriber of exchange A3 wants a connection with exchange A1, the group selector GW3 in exchange A3 (see Fig. 1) must be set to the access *c*2 (Fig. 4). This energizes relay C19 over the *c*2 lead, contacts 166*y*3 and 161*x*1, relay C19, key S*p*T, contact 173*e*3, resistance W, battery, earth. The circuit for relay C19 short circuits relay T3 and the preselector VW7 is set to an idle line in the manner described above. Relay C19 closes contact 226*c*19, and thereby applies superimposed direct current to the *b* lead over contacts 227*e*3 and 226*c*19. It also energizes relay D4 over earth, contact 235*c*19, relay D4, resistance W, battery, earth, the short circuit for relay D4 having been removed at contact 228*c*19. Relay D4 remains energized over contact 229*d*4 independent of relay C19 and energizes relay E3 over earth, contact 230*d*4, relay E3, resistance W, battery, earth. Relay E3 is maintained energized over contact 231*e*3 and completes a circuit for relay F over contact 232*e*3 as follows: earth, contact 232*e*3, relay F, battery, earth. Relay E3, by opening its contact 227*e*3, cuts off the superimposed direct current. Relays C19 and E3 disconnect the *a* and *b* leads from the preselector VW8 at contact 233*c*19 and contact 234*c*19 or 235*e*3, whereas, due to the closing of contact 236*e*3, the *b* lead from the group selector GW3 is connected to the junction line. The switching operations brought about in exchanges A2 and A1 by the impulse

over the *b* lead have previously been described.

Should a subscriber of exchange A3 want a subscriber of exchange A2, the group selector GW3 in exchange A3 is set to the access *c*1, over which relay C18 is then energized. The circuit for relay C18 extends over the *c*1 lead from the group selector GW3, contacts 167*y*3 and 162*x*1, relay C18, key S*p*T, contact 173*e*3, resistance W, battery, earth. This short-circuits relay T3 and sets the preselector VW7 to an idle line. Relay C18 applies superimposed direct current to the *b* lead over contacts 227*e*3 and 237*c*18. In addition, relay D4 is energized over earth, contact 238*c*18, relay D4, resistance W, battery, earth, and maintains the circuit for relay C18 over contact 239*d*4 independent of the key S*p*T and contact 173*e*3. Relay D4 itself remains energized over contact 229*d*4. This latter relay also closes contact 230*d*4, thus causing relay E3 to operate over earth, contact 230*d*4, relay E3, resistance W, battery, earth. Relay E3 remains energized over contact 231*e*3, and sets up a circuit for relay F over contact 232*e*3. Relay E3 cuts off the superimposed direct current to the *b* lead at contact 227*e*3. Prior to relay F being energized due to its slow action, however, the superimposed direct current is re-applied to the *b* lead over contacts 240*e*3, 241*c*18, 242*f*, and 243*c*22, and is cut off as soon as relay F operates over contact 232*e*3 and opens its contact 242*f*. Two impulses in succession, therefore, are in this case transmitted over the *b* lead in dependence of the seizure over the *c*1 access. The opening of contacts 244*c*18, 245*c*18, and 235*e*3 causes the junction line to be disconnected from the preselector VW8 before an impulse is transmitted over the *b* lead. The switching operations of the devices in exchanges A1 and A2 caused by the two successive impulses have been described above.

When the calling subscriber of exchange A3 replaces his receiver, the *c*1 lead of the group selector GW3 is cut off in known manner and the circuit for relay C18 is opened. Relay C18 releases so that the superimposed direct current is applied to the *b* lead over contacts 240*e*3, 247*c*18, 249*c*19, and 243*c*22, until relay D4 is short circuited by the closing of contact 238*c*18 and, by closing its contact 276*d*4, short circuits relay E3. This relay opens the circuit for relay F at contact 232*e*3 and cuts off the superimposed direct current at contact 240*e*3. The long release impulse which actuates the devices in exchange A2 then restores them to normal.

If a subscriber of exchange A3 desires a connection with a subscriber of exchange A4, the first-mentioned subscriber sets the group selector GW3 to the access over which relay C20 is operated. This access is shown in the right hand top corner of Fig. 4. Relay C20 thus is energized and cuts off the *b* lead at contact 250*c*20. Superimposed direct current is applied to the *b* lead over contacts 251*c*20 and 252*e*4. Relay C20 energizes relay D5 over earth, contact 253*c*20, relay D5, resistance W, battery, earth. Relay D5 remains energized over earth, contact 254*d*5, relay D5, resistance W, battery, earth, and also energizes relay E4 over earth, contact 356*d*5, relay E4, resistance W, battery, earth. Relay E4 is maintained energized over contact 255*e*4 independent of contact 256*d*5 and cuts off the superimposed direct current at contact 252*e*4. This source of supply will not be re-applied over contact 257*e*4 due to relay C20 having opened contact 258*c*20. The preselector VW8 is advanced in consequence of the seizure over relay C20 and the junction line is guarded. The switching operations brought about in exchange A4 by the impulse transmitted over the *b* lead will be explained in connection with the description of the arrangement shown in Fig. 5.

At the end of the conversation between the subscriber of exchange A3 and the subscriber of exchange A4, the circuit for relay C20 is cut off, causing the superimposed direct current to be applied to the *b* lead over contacts 258*c*20 and 257*e*4. This current is applied until relay D5 is short circuited by the opening of contact 253*c*20 and the closing of contacts 259*c*20 and 260*c*20. Relay D5 then closes its contact 261*d*5 and causes relay E4 to restore its contacts to normal, with the result that the superimposed direct current is cut off at contact 257*e*4. This long impulse over the *b* lead causes the release of the repeater U*e*4 according to Fig. 5 as will be described in conjunction with the arrangement shown in Fig. 5.

When a subscriber of exchange A1 wishes to speak to a subscriber of exchange A2, only one impulse is sent over the *a* lead. This impulse causes relay X1 in exchange A3 to be energized, which relay in turn energizes relay C14 over contact 160*x*1. Relay C14, after completing the guarding of the junction line, remains energized over earth, contact 170*c*14, winding II, resistance W, until short-circuited by contact 180*y*3 when relay Y3 operates responsive to a long impulse over the *b* lead. Relay C14 consequently releases. The release impulse in this case, however, is transmitted immediately after the switching over to the connecting devices in exchange A2 (see description applicable to Fig. 3).

An impulse is transmitted over the *b* lead in accordance with the seizure in the individual exchanges A1—A3 when a subscriber of exchange A1, A2, or A3 wishes to set up a connection with a subscriber of exchange A4. The manner in which this is carried out has been described in detail in the description of the arrangement shown in Figs. 2, 3, and 4. In Fig. 5, the identification impulse over the *b* lead causes relay B in the

group selector GW7 to be operated over the *b* lead, contacts 294*u*5 and 291*u*5, relay B, earth. Relay B is energized and closes its contact 295*b*. No further switching operations are brought about in the group selector in consequence of the energization of relay B. Due to the closing of contact 295*b*, relay H3 is connected to battery over earth, contacts 295*b*, 296*h*4, relay H3, resistance W, battery, earth. Relay H3 is energized and by closing contact 297*h*3 guards the junction line against seizure from the group selector GW4. Relay H3 energizes relay H4 over contact 298*h*3, which then remains energized over contact 299*h*4 and, at contact 296*h*4, opens the circuit for relay H3. Relay H4 takes over the guarding of the junction line at contact 300*h*4. The impulse transmitted over the *b* lead ends, and relay B releases, before the circuit for relay H4 has been completed.

The setting of the group selector GW7 in exchange A4 is effected in known manner.

At the end of the connection a long release impulse is again transmitted over the *b* lead. It causes relay B in the group selector GW7 to remain energized for an extended period of time, contact 295*b* being closed in the meantime so that relay H4 is short circuited and releases after a time, thus restoring its contacts to normal so that the guarding of the junction line is removed. Relay B, however, remains energized only until relay H4 has restored its contacts to normal, and contact 295*b*, after the circuit for relay H3 has been set up over earth, contacts 295*b*, 296*h*4, relay H3, resistance W, battery, earth, does not remain closed due to the release impulse over the *b* lead for such a long period that the slow-acting relay H3 is caused to function.

When a subscriber of exchange A4 wants a connection with a subscriber of exchange A1, an impulse has to be sent over the *b* lead in the manner shown in Fig. 1. This is effected by the group selector GW4 seizing the junction line VL over the access *c*3 over which relay C25 is energized in series with relay U5. The circuit then extends over the *c* lead, relay C25, relay U5, key S*p*T, contact 301*e*5, resistance W, battery, earth. Relay C25 applies superimposed direct current to the *b* lead over contacts 303*e*5, 304*u*5, 305*e*5, and 302*c*25. Relay C25 energizes relay D6 over contact 306*c*25 in the following circuit: earth, contact 306*c*25, relay D6, resistance W, battery, earth. Relay D6 remains energized over contact 307*d*6 and, in addition, sets up a circuit for relay E5 over earth, contact 308*d*6, relay E5, resistance W, battery, earth. Relay E5 remains energized over contact 309*e*5 independent of contact 308*d*6 and, by opening contact 303*e*5, cuts off the superimposed direct current from the *b* lead. It also switches through said *b* lead at contact 310*e*5. The opening of contact 301*e*5 cuts off the above-mentioned circuit for relay C25, but the latter relay remains energized over contact 327*d*6.

The switching operations brought about in the individual exchanges due to the impulse over the *b* lead have already been described. When the conversation between the subscriber of exchange A4 and the subscriber of exchange A1 is ended, the *c*3 lead from the group selector GW4 is cut off and relays C25 and U5 consequently release. Relay U5 brings about the switching over of the junction line to the group selector GW7 at contacts 290*u*5 and 291*u*5, while superimposed direct current is applied to the *b* lead over the contacts 311*e*5, 312*c*23, 313*c*24, and 314*c*25 due to the release of relay C25. The release of relay C25 also causes relay D6 to be short circuited over contacts 315*c*25, 316*c*23, and 317*c*24, with the result that relay D6 releases after a definite period, its release being retarded by the short circuit. Relay D6 short circuits relay E5 at contact 318*d*6, so that relay E5 also releases after an extended period of time and restores its contacts to normal. The superimposed direct current applied to the *b* lead is cut off by the opening of contact 311*e*5, and the release impulse over the *b* lead is thus ended.

Should a subscriber of exchange A4 require a connection with a subscriber of exchange A2, he sets the group selector GW4 to access *c*2. This causes relay C24 to be energized in series with relay U5. Relay U5 brings about the switching over of the junction line from the group selector GW7 to the group selector GW4 at contacts 292*u*5—293*u*5, while relay C24 applies superimposed direct current to the *b* lead over contacts 303*e*5, 304*u*5, 305*e*5, and 319*c*24. Relay C24 energizes relay D6 over earth, contact 320*c*24, relay D6, resistance W, battery, earth. Relay D6 remains energized over contact 307*d*6, and energizes relay E5 over contact 308*d*6. Relay E5, by opening contact 303*e*5, cuts off the superimposed direct current. If contact 311*e*5 is now closed, superimposed direct current will be re-applied to the *b* lead over contacts 311*e*5, 321*f*2, 322*c*24, 319*c*24 until, by means of relay E5, the relay F2 is energized over earth and contact 323*e*5 and cuts off the superimposed direct current by opening its contact 321*f*2. In this case, therefore, two impulses in succession are transmitted over the *b* lead on the seizure of the junction line over access *c*2 by the group selector GW4.

The *c*2 lead is cut off at the end of the call and relays C24 and U5, therefore, release. Relay U5 brings about the switching over of the junction line to the group selector GW7, whereas relay C24 applies the superimposed direct current to the *b* lead over contacts 311*e*5, 312*c*23, 313*c*24, and 314*c*25. This superimposed direct current is intended to bring about the release and is applied until

relay D6 restores, after being short-circuited by the opening of contact 320*c*24 and closing of contact 317*c*24. Relay D6, by closing its contact 318*d*6, short circuits relay E5 which restores its contacts to normal after a definite period, and thus cuts off the superimposed direct current applied to the *b* lead by opening its contact 311*e*5.

When a subscriber of exchange A4 wants a connection with a subscriber of exchange A3, he sets the group selector GW4 in exchange A4 to access *c*1, which causes relay C23 to be energized in series with relay U5. Relay U5, in the manner described above, brings about the switching over of the junction line to the group selector GW4. Relay C23 applies superimposed direct current to the *b* lead over contacts 303*e*5, 304*u*5, 305*e*5, and 324*c*23. By closing its contact 325*c*23 it energizes relay D6, which remains energized over contact 307*d*6 and energizes relay E5 by closing contact 308*d*6. Relay E5 cuts off the superimposed direct current applied to the *b* lead by actuating contact 303*e*5. The closing of contact 311*e*5 causes superimposed direct current to be applied to the *a* lead over contacts 311*e*5, 321*f*2, and 326*c*23 which, however, is cut off when relay E5 energizes relay F2 over contact 323*e*5 and breaks the connection at contact 321*f*2. In this case, therefore, an impulse is first transmitted over the *b* lead and then one over the *a* lead.

When the connection between the subscribers of exchanges A4 and A3 is ended, the access of the group selector GW4 is cut off. Relays C23 and U5 are deenergized so that relay U5, in the manner described above, switches over the junction line to the group selector GW7, and relay C23 applies superimposed direct current to the *b* lead over contacts 311*e*5, 312*c*23, 313*c*24, and 314*c*25 for the purpose of releasing the repeater U*c*3 in exchange A3. Relay D6 releases and at contact 318*d*6 short circuits relay E5. Relay E5 releases after a definite period and, by opening its contact 311*e*5, cuts off the superimposed direct current applied to the *b* lead.

It will be mentioned in this connection that when a subscriber of exchange A1 sets up a connection with a subscriber of exchange A*a*, the identification impulse transmitted over the *a* lead causes no switching operations to be carried out in the repeater U*e*4 shown in Fig. 5. In a connection extending from exchange A2 to exchange A3, however, an impulse is transmitted over the *b* lead as well as over the *a* lead. The impulse transmitted over the *b* lead brings about exactly the same switching operations (guarding by means of relays H3 and H4) as those brought about in a connection extending from exchanges A1—A3 to exchange A4. After the repeater U*e*3 has been switched over to the connecting devices in exchange *a*3, however, a release impulse is transmitted over the *b* lead as previously described, and this impulse causes the switching means in the repeater U*e*4 (Fig. 5) to be restored to normal.

As will be seen from Fig. 1 and also further described in conjunction with Figs. 2–5, the identification impulses are transmitted in dependence upon the seizure of the junction line VL, which interconnects all the exchanges, over a group selector of the individual exchanges A1—A4.

Fig. 6 shows a theoretical embodiment according to which the first impulse seizes the junction line VL, but the impulses are transmitted by means of a special device actuated by a second impulse series.

In Fig. 6 the calling subscriber has access over a call finder AS to a change-over switch UW in exchange A1, over which the group selector GW is accessible. When the group selector GW is set to a definite contact row, for example O, the switch UW is switched over in known manner to a junction line VL which interconnects all the exchanges A1—A4. The junction line is then guarded against seizure from any other station and from transmission of the identification impulse of exchange A4 (an impulse over the *b* lead). For the purpose of selecting the required exchange A2 or A3 between exchanges A1 and A4, the stepping switch ML is now set to a definite contact (3 or 4) over which an identifying relay C1 or C2 is energized, being simultaneously switched over at contact *u*. The identifying relays C—C2 correspond, for example, to relays C1, C2, and C3 shown in Fig. 2. If an identifying relay is not energized over the stepping switch ML by the second impulse, the group selector GW2 is set by this impulse series to a contact row over which the group selector GW1 or another group of exchanges may be reached in the manner indicated in Fig. 6.

Connections from exchange A2 or A3 are set up in the same manner as that described in the case of a connection from exchange A1.

When a connection from exchange A4 is set up, the first identification digit causes the group selector GW in exchange A4 to be set over switches AS and UW. In the case of a connection to another exchange, for example A2, the group selector GW3 is seized by the first identification digit (switch UW causing a change-over from the group selector GW to the group selector GW3) over which the required junction line VL is seized, and identification impulses are transmitted over the corresponding access to the junction line in the manner indicated in Figs. 1–5.

The arrangement shown in Fig. 6 is used when a plurality of groups of exchanges A1—A4 are concerned and individual exchanges, for example exchanges A2 and A3, operate as subexchanges and others, for example A4 as

main exchanges, and connections between the individual groups are possible.

Fig. 7 shows an arrangement in which the switch UW in the individual exchanges A1—A3 is not switched over to a junction line VL, but said line is seized over the call finder AS and the change-over switch UW as soon as a calling subscriber lifts his receiver. The first impulse series transmitted by the subscriber causes the group selector GW1 in exchange A4 to be set and simultaneously also the stepping switch ML in the calling exchange (A1—A3). If this first identification digit corresponds to exchanges A1—A3, the stepping switch ML in the calling exchange (A1—A3) energizes one of the C relays, which then automatically transmits the identification impulse over the junction line as shown in the embodiment according to Figs. 1–5. If this first digit does not correspond to the identification digit of any of the exchanges A1—A3, the group selector GW1 in exchange A4 is either set to the group selector GW, or to another junction line interconnecting a plurality of exchanges, and the identification of the required exchange is completed at the same time.

In the case of outgoing connections, the required exchange is identified in exchange A4 by seizing junction lines over definite accesses over the group selector GW in the same manner as that indicated in Figs. 1–5.

What is claimed is:

1. In a telephone system, a plurality of exchanges connected in series by a trunk line, a repeater in each exchange for transmitting coded impulses over the trunk line indicative of each of the other exchanges, an identifying device in each exchange selectively operated by impulses received over said trunk line, and a switching device in each exchange controlled by the associated identifying device to connect the exchange to the trunk line when the code identifying such exchange is received.

2. In a telephone system, a plurality of exchanges connected in series by a trunk line, a repeater in each exchange accessible over a plurality of different routes, the number of routes being one less than the number of exchanges, and means in each repeater responsive to its seizure over one of the routes over which it is accessible for transmitting a predetermined code of impulses over one or both conductors of said trunk line, the code and the conductor or conductors over which code is transmitted being determined by the particular route over which the repeater is seized.

3. In a telephone system, a plurality of exchanges, a trunk line extending in series through all of said exchanges, a repeater at each exchange accessible over a plurality of different routes, means responsive to the seizure of a repeater in one exchange and dependent upon the route over which it was seized for transmitting a predetermined number of impulses over one or both conductors of said trunk line, and identifying devices in each exchange selectively operated by said impulses to connect the desired exchange to the trunk line as indicated by the number of impulses received and the conductor over which they were received.

4. In a telephone system, a plurality of exchanges, a trunk line extending in series through all of said exchanges, a repeater in each exchange accessible over a plurality of different routes, means responsive to the seizure of one of said repeaters and dependent upon the route over which it was seized for transmitting a predetermined number of impulses over one or both conductors of said trunk line, identifying devices in each exchange selectively operated by said impulses to connect the desired exchange to the trunk line, and means responsive to the release of said repeater for transmitting an impulse over one conductor of said trunk to disconnect the called exchange from said trunk line.

5. In a telephone system, a plurality of exchanges located in serial relation, a group of trunks connecting each pair of adjacent exchanges, one trunk of each group being normally connected together to form a connection extending through all of said exchanges in series, a repeater in each exchange accessible over a plurality of different routes, means responsive to the seizure of one of said repeaters and dependent on the route over which it is seized for transmitting coded impulses over one or both conductors of the serially connected trunk line, identifying devices in each exchange selectively operated by said impulses to connect the desired exchange to the trunk line, and means in the called exchange for connecting another trunk of the group extending to the adjacent exchange in the direction from which the call is being received to that portion of the serially connected trunk line extending through the exchanges in the other direction.

6. In a telephone system, three exchanges, a trunk line connecting said three exchanges in series, a repeater in the first exchange accessible over two routes to extend calls to the second and third exchanges, respectively, means responsive to the seizure of said repeater over one of said routes for transmitting coded impulses over said trunk line indicative of the second exchange, identifying devices in the second exchange selectively responsive to said impulses to connect the trunk line to said second exchange, an auxiliary trunk between the first and second exchanges, and means responsive to the connection of the first trunk to the second exchange for connecting said auxiliary trunk to that portion of the first trunk extending between the second and third exchanges.

7. In a telephone system, three exchanges, a trunk line connecting said three exchanges in

series, a repeater in each exchange accessible over two different routes to extend connections to the other two exchanges, respectively, means in each repeater for transmitting coded impulses over one or both conductors of the trunk line, means at each exchange selectively responsive to said impulses to connect the trunk line to the associated exchange upon receipt of the proper code of impulses, auxiliary trunks between the first and second exchange and between the second and third exchange, and means in each exchange responsive to the connection of the trunk line to that exchange for preparing a second through connection between said exchanges by means of said auxiliary trunks.

8. In a telephone system, a plurality of exchanges, a trunk line connecting said exchanges in series, a repeater in each exchange for transmitting coded impulses over said trunk line, each repeater being accessible over a plurality of different routes, the route over which a repeater is seized determining the code which it transmits, and an identifying device in each exchange selectively responsive to said impulses to connect its exchange with the trunk line, the identifying devices of the intermediate exchanges each being responsive to two different codes, one for each traffic direction.

9. In a telephone system, a plurality of exchanges, a trunk line connecting said exchanges in series, a repeater in each exchange for transmitting coded impulses over the trunk line, an identifying device in each exchange selectively responsive to said impulses to connect the called exchange as indicated by the received code to said trunk line, and an auxiliary identifying device in the called exchange connected to the unused portion of the trunk line to prepare said exchange for receiving calls from the opposite traffic direction.

10. In a telephone system, three exchanges, a trunk line connecting said exchanges in series, a repeater in the first exchange for transmitting coded impulses over said trunk line, an identifying device in the second exchange operated in case the proper code is received to connect said second exchange to said trunk line, an auxiliary identifying device in said second exchange, and means responsive to said connection for connecting said auxiliary identifying device to that portion of said trunk line extending to the third exchange to permit a call to be established from said third to said second exchange.

In witness whereof, I hereunto subscribe my name this 23rd day of May, 1932.

ALFRED KEYSER.