Jan. 23, 1934. A. H. OLSON ET AL 1,944,570

ARRANGEMENT RELATING TO AUTOMATIC TELEPHONE SYSTEMS

Filed Nov. 3, 1932 4 Sheets-Sheet 1

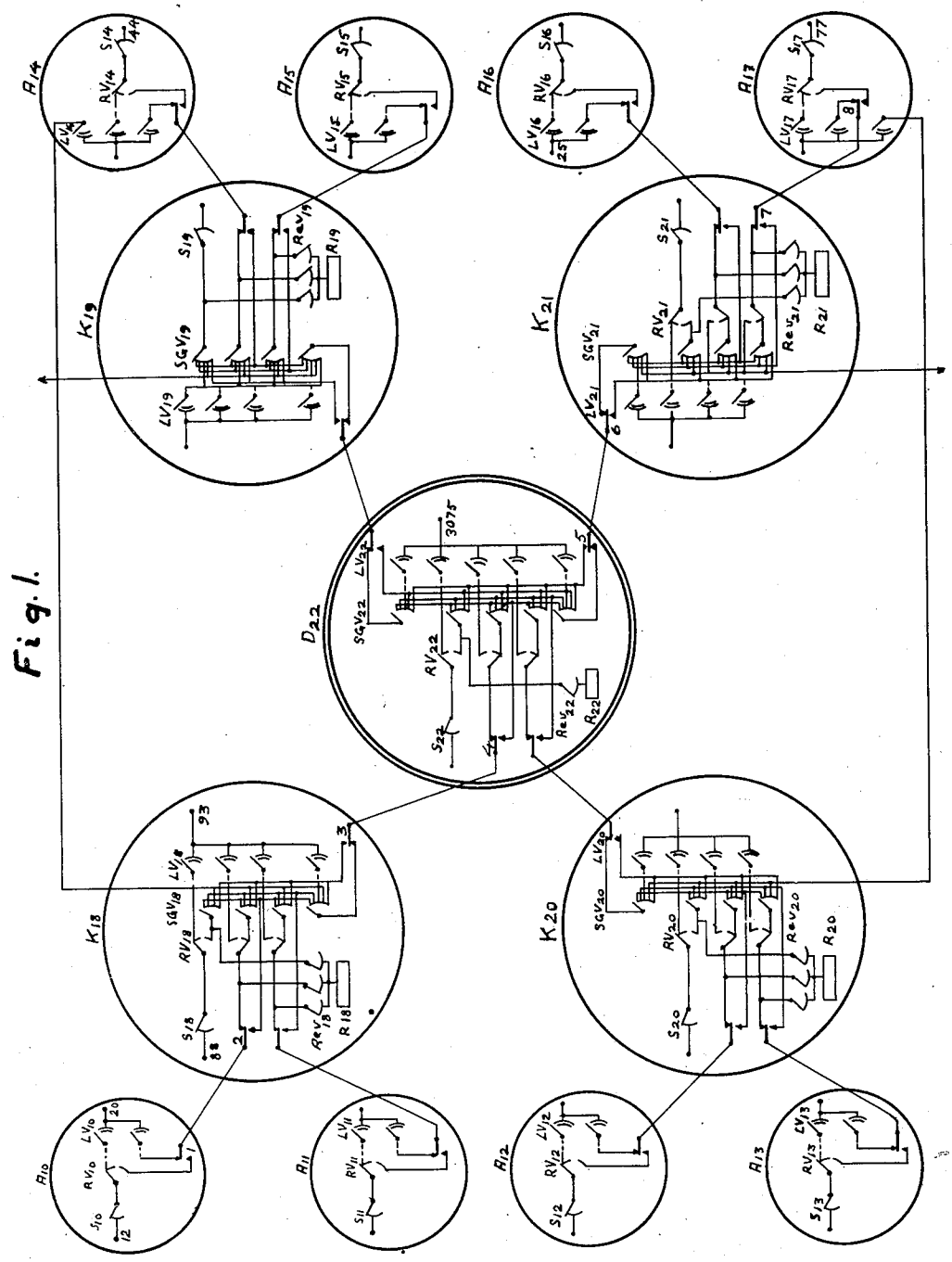


Fig. 1.

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ARRANGEMENT RELATING TO AUTOMATIC TELEPHONE SYSTEMS

Filed Nov. 3, 1932 4 Sheets-Sheet 2

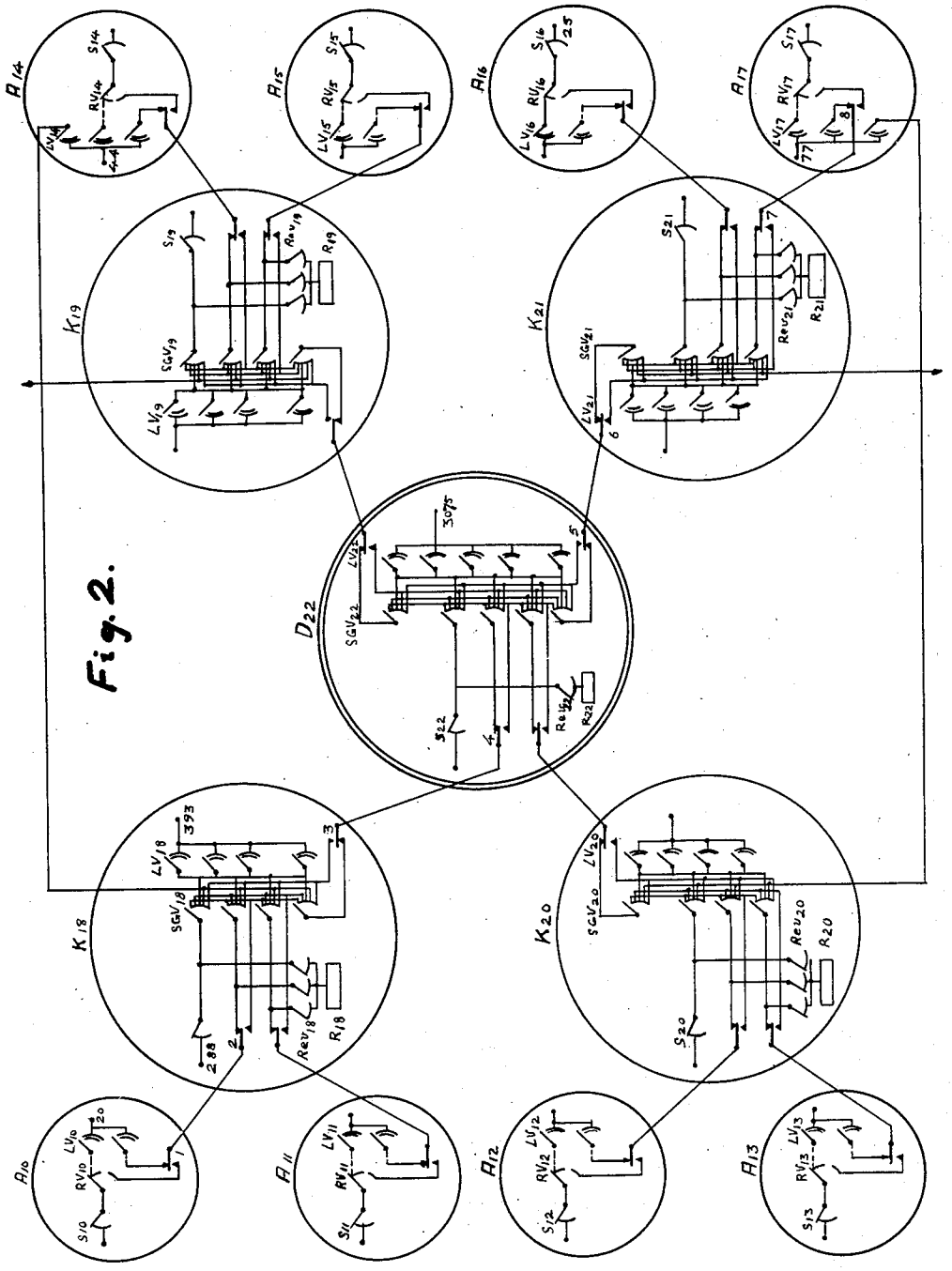


Fig. 2.

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ARRANGEMENT RELATING TO AUTOMATIC TELEPHONE SYSTEMS

Filed Nov. 3, 1932 4 Sheets-Sheet 3

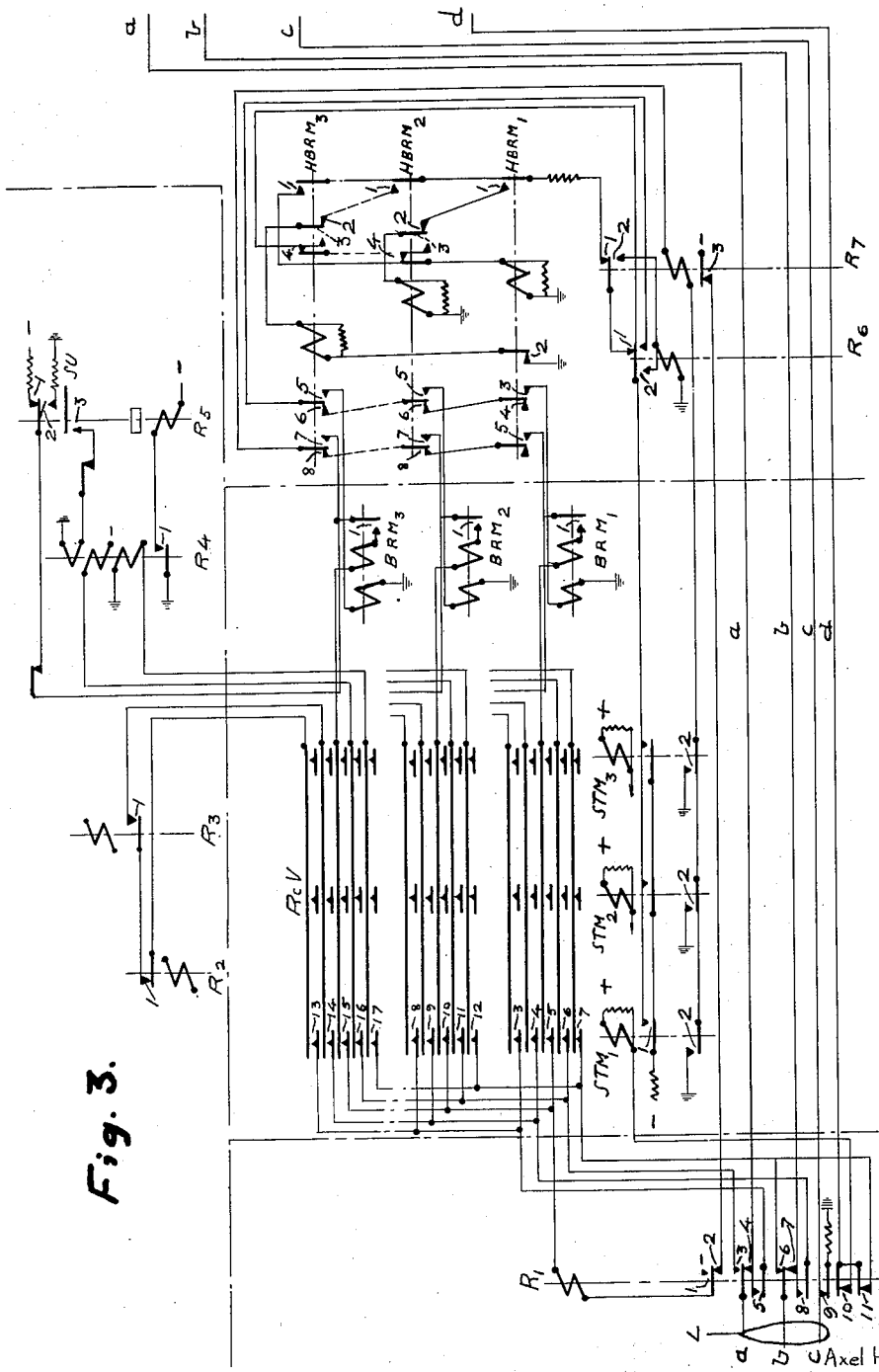


Fig. 3.

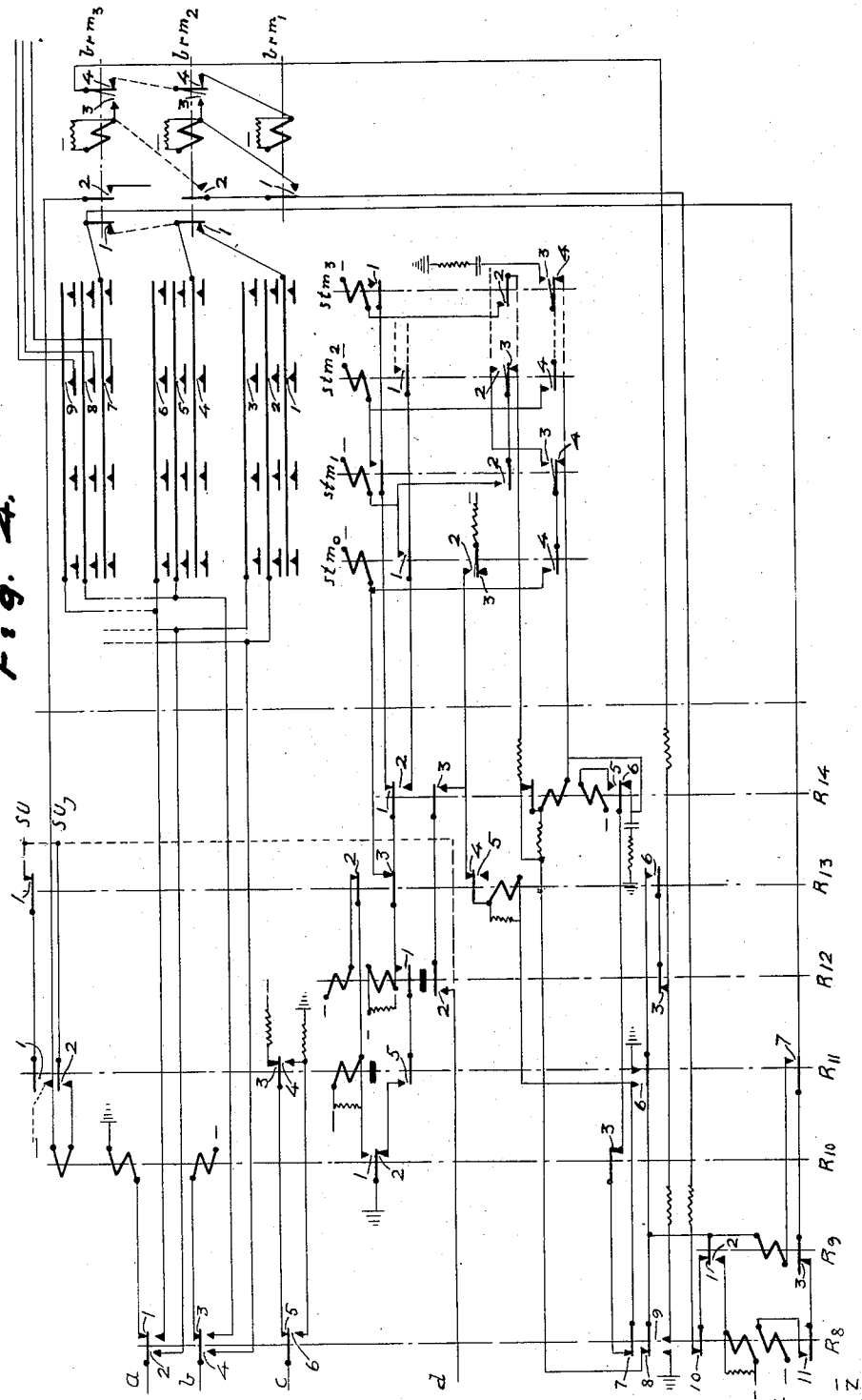
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ARRANGEMENT RELATING TO AUTOMATIC TELEPHONE SYSTEMS

Filed Nov. 3, 1932 4 Sheets-Sheet 4

Fig. 4.



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Patented Jan. 23, 1934

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UNITED STATES PATENT OFFICE

1,944,570

ARRANGEMENT RELATING TO AUTOMATIC TELEPHONE SYSTEMS

Axel Herman Olson and Sten Daniel Vigren,
Stockholm, Sweden

Application November 3, 1932, Serial No. 640,975,
and in Sweden November 20, 1931

10 Claims. (Cl. 179—18)

This invention relates to a certain new and useful arrangement for automatic telephone systems, and the following is a full, clear and exact description of the same, reference being made to the accompanying drawings, forming part of this specification.

Our invention has reference to an arrangement for automatic telephone systems, that makes possible an economic automatic switching between various telephone plants of different size and varying operating conditions.

Making rural telephone plants automatic has heretofore caused certain difficulties of economic and technical nature.

These difficulties have specially been observed in such systems, which contain several exchanges of different sizes, said systems being usually referred to as star shaped.

In such systems it is economically desirable to employ as few registers as possible and this is specially so in small rural exchanges that contain few subscribers. Furthermore, it is desirable, when registers are employed in intermediate exchanges only, that they be used as little as possible.

The present invention has for its object an arrangement for automatic telephone systems, to permit economical automatic service between telephone plants of different kinds and comprising exchanges of various sizes.

The invention is principally characterized by the fact, that registers and so called exchange group selectors, that is, switching devices for selecting idle trunk lines to other exchanges, are located principally at exchanges which are arranged for tandem working and by the fact that the registers are used only for calls between two or more exchanges.

Another characteristic of the invention is that the exchange group selectors can be directly operated by impulses from a register. The exchange group selectors can, however, also be so arranged, that they are operated by impulses from registers via direction selectors.

The necessary direction selectors are arranged for selection over two separate groups of lines, of which one is used for direct connection to necessary group and line selectors for internal traffic and the other for direct connection to exchange group selectors. The direction selectors are so arranged that the sequence in which its groups of lines shall be selected, can be changed by changing the connections of the direction selector.

The advantages of arrangement according to the invention are manifold:

In order to establish a connection between subscribers connected to the same exchange, only that number of digits need be dialled which corresponds to the size of that exchange, that is, the number of the subscriber. If a communication is desired between subscribers connected to different exchanges, that number of digits should be dialled, which depends partly upon the exchange of the desired subscriber and partly upon the size of said exchange.

Another advantage of the invention is that it permits so-called cross connections of star shaped plants, that is, direct connections from one exchange to another, should the exchanges belong to the same or to different districts. Existing plants can thus be used and the lines needed for a certain connection can be made shorter than is now the case in star shaped plants. The cross connections are of the greatest importance in cases where, for instance, a terminal exchange, a satellite to a larger exchange or so-called junction exchange, has a heavy traffic with other terminal or junction exchanges. In such cases it is economically desirable to establish direct lines or so-called cross connections. Heretofore, traffic between two nearby exchanges belonging to different districts, has been directed over the respective district exchanges. With cross connections, according to the present invention such roundabout ways are avoided.

This invention provides for a simple time-zone-metering. When a register has accumulated a number corresponding to a certain exchange, said exchange is definitely determined, whereby circuits for toll charges devices can be prepared for completion, when the communication is established.

The invention is further characterized by the fact that a call from one exchange to another is accumulated in a register which in any known way transfers and transmits the impulses corresponding to the desired number. When the series of impulses is transmitted, these operate either direction selectors and exchange group selectors or only exchange group selectors. In the former case only exchange group selectors are used for tandem working, while the direction selector must be operated for connection to a subscriber belonging to said exchange. In the latter case the exchange group selector is used both for through traffic to another exchange and for traffic to a subscriber belonging to the exchange.

The arrangement of direction selectors and exchange group selectors in series has advantage that group and line selectors of an exchange will be used not for tandem working to other exchanges, but only for internal connections between subscribers belonging to the same exchange. In axchanges having relatively heavy outgoing traffic this arrangement makes it possible to build the selecting equipment at a lower total cost than what would be possible with arrangements with exchange group selectors without direction finders.

Even in cases, where the exchange group selectors are used for internal as well as for outgoing and through traffic, the register devices will be occupied only for communications via two or more exchanges. The selectors and the registers are therefore arranged in such a way, that communications are obtained over one or more exchanges, no matter where situated, by dialling the number of the desired subscriber, or a direction number. A tone is received from the register corresponding to the last exchange number and the number of the desired subscriber. The connection of the registers for receiving and transmitting dial impulses is such, that the register is controlled by group selectors or so-called exchange group selectors. The latter are of such a construction, that they are used only by establishing communications via one or several exchanges. Should the communication be extended only over one exchange, the exchange group selectors will be used only once. Should the communication be extended via two or several exchanges, the exchange group selectors will be used twice. By dialling a so-called direction number, the exchange group selectors are connected to a register and eventually over register selectors in such a way that the exchange group selectors will again be restored to normal position, and then operated by the first series of impulses transmitted from the registers after the transmission of the dial tone. The connection to registers and register selectors is cut off after the transmission of all impulses from the corresponding register.

Other characteristics of the invention will appear from the following description in conjunction with the accompanying drawings, of which Fig. 1–4 show different arrangements according to the invention. Although the automatic system is disclosed as applied to cross-bar switches, which can be used as line finders, direction selectors, line selectors, exchange group selectors, register selectors, registers, etc., it can be used also in combination with other types of switches. When a terminal exchange with step-by-step selectors is connected to a system according to this invention, no changes are necessary in such a terminal exchange.

One of the principal advantages of the system according to this invention is that trunks or junction lines, selectors and registers are not made busy before they are really needed for establishing a connection. The dial impulses operate the selectors directly as long as such a proceeding is desirable and suitable to a uniform numbering scheme. Registers are introduced only when really needed, that is, when a call passes over two or more exchanges. The first cost will be reduced to a minimum.

Fig. 1 shows the arrangement, according to which the transmission of impulses from registers is directed via direction selectors to exchange group selectors, etc., while Fig. 2 shows exchange group selectors directly connected to register connecting devices or register preselectors and by which arrangement direction selectors will be less used, than according to the arrangement shown in Fig. 1. Figs. 3 and 4 show special forms of arrangements according to Fig. 2. In Fig. 1 K_{18}, K_{19}, K_{21} and D_{22} are provided with direction selectors in addition to the exchange group selectors, only exchange K_{19} being provided with the latter. This figure is intended to show the flexibility of the system, satisfying different individual traffic requirements of each exchange.

In Fig. 2 there are no direction selectors of K_{18}, K_{20}, K_{21}, D_{22}.

The exchange group selectors are in both cases so arranged that they can be operated directly by impulses transmitted from a register or by the impulses of a subscriber's dial.

According to Fig. 2 a substantial reduction of the number of direction selectors of the whole system is obtained and is specially suitable for the mechanization of existing rural telephone plants.

The exchange group selectors can be connected directly to direction selectors as per Fig. 1, or to a register via register selector as per Fig. 2.

Fig. 1 contains a number of circles of which A_{10}, A_{11}, . . . A_{17} represent terminal exchanges. K_{13}, K_{19}, . . . K_{21} intermediate or junction exchanges, and D_{22} a district or debiting exchange. The exchanges are provided with finders, direction selectors, line selectors, register selectors, registers and exchange group selectors, which are marked S, RV, LV, ReV and SGV respectively. The junction exchanges K_{18}, K_{20} and K_{21} are provided with direction selectors and exchange group selectors for through traffic, while the junction exchange K_{19} is provided with only exchange group selectors for both through traffic and traffic to subscribers connected to the said junction exchange.

If the subscriber 12 of the terminal exchange A_{10} calls another subscriber 20 of the same exchange, the subscriber 12 obtains a connection to the line selector LV_{10} over a finder or preselector S_{10}, a direction selector RV_{10} and eventually also over a group selector. The desired connection is obtained by dialling the number 20 of the desired subscriber. If the same subscriber 12 desires a connection to a subscriber 93 of the junction exchange K_{18}, he will obtain in the above described way a connection to a line selector LV_{10}. Having received a dial tone he dials a special digit, for instance 0. The direction selector RV_{10} will be operated so that the connection to the group and line selectors of the terminal exchange A_{10} will be cut off and the connection established over the contact 1 to an outgoing trunk line. When the call arrives to the junction exchange K_{18} over the contact 2, the subscriber 12 will automatically obtain connection over a register selector ReV_{18} to a register R_{18}. If the said register is disengaged, the subscriber will receive a dial tone, after which he then may dial the numbers of both the junction exchange and of the desired subscriber, in this case 18—93.

The register R_{18} is so connected, that its transmitting device, after the dialling of the figures, first will transmit a series of impulses which will switch the direction selector RV_{18} from the connection to the exchange group selector SGV_{18} to the group and line selectors LV_{18}. The other impulses transmitted from the register are sent in any known way.

Should the subscriber 12 desire to call the subscriber 3075 of the district exchange D_{22}, the switching, in order to obtain connection to the register R_{18}, will be similar to that described above. Upon receiving the dial tone, the subscriber 12 shall dial the numbers corresponding to the district exchange and to the desired subscriber, in this case 22—3075. In this case the register R_{18} will be connected in such a way, that its transmitting device, when the digits have been dialled, firstly transmits a series of impulses, which operates the exchange group selector SGV_{18} in order to find a disengaged trunkline to the district exchange D_{22}, whereby the contact 3 is closed. The next series of impulses operates the direction selector RV_{22} in order to connect it to the group and line selector LV_{22} of the district exchange. The following impulses transmitted from the register will complete the connection in any known way.

If the subscriber 12 desires to call the subscriber 77 of the terminal exchange A_{17}, the connection to the register R_{18} will be similar to that described above. After receiving the dial tone, the subscriber 12 dials the numbers corresponding to the terminal exchange A_{17}, and to the desired subscriber, in this case 17—77. The register R_{18} is connected in such a way, that its transmitting device, after dialling, firstly will transmit a series of impulses, to operate the exchange group selector SGV_{18} to find a disengaged trunk line leading to the district exchange D_{22}, whereupon the contact 3 is closed. The next series of impulses operates the exchange group selector SGV_{22} to find a disengaged trunk to the junction exchange K_{21}, whereupon the contact 6 is closed. The following series of impulses operates the exchange group selector SGV_{21}, to find a disengaged trunk line to the terminal exchange A_{17}, whereupon the contact 7 is closed. Other transmitted series of impulses will complete the connection to the subscriber 77 in any known way.

If a subscriber 25 of the terminal exchange A_{16} should desire to call the subscriber 77 of the terminal exchange A_{17}, the dialling of the subscriber 25 will be similar to that which will take place, when the subscriber 12 obtains connection to the subscriber 77, although the connection will be established over a less number of exchanges.

In order to establish a connection between the subscribers 12 and 44 of the terminal exchange A_{10} and of the terminal exchange A_{14}, respectively, the numbers of both the terminal exchange and of the desired subscriber must be dialled, in this case 14—44, whereupon a connection to the register R_{18} is obtained and dial tone is received. The register R_{18} is connected in such a way, that its transmission device, after dialling of the numbers, first transmits a series of impulses which operates the exchange group selector SGV_{18} to find a disengaged and direct trunk line to the terminal exchange A_{14}. Other impulses transmitted by the register transmission device will complete the connection in any known way.

If a subscriber of a junction or of a district exchange, for instance the subscriber 88 of the junction exchange K_{18} desires to call the subscriber 93 of the same exchange, the calling subscriber 88 firstly obtains connection to the line selector LV_{18} over a finder or preselector S_{18} and eventually also over a group selector. After receiving the dial tone, the number of the desired subscriber is dialled, whereupon the connection will be established.

Should the same subscriber 88 desire to call another subscriber belonging to any other exchange, the subscriber 88, having obtained connection to a disengaged line selector LV_{18} and having received the dial tone, must dial a special digit, for instance 0. The direction selector RV_{18} will be operated in such a way, that connections will be obtained both to the exchange group selector SGV_{18} and to the register R_{18} over the register selector ReV_{18}.

Having received a dial tone the subscriber 88 will dial the numbers of both the exchange and the subscriber and these will be accumulated in the register. The switching arrangements are in other respects similar to those described above.

Fig. 2 also shows a number of exchanges marked by circles. A_{10}, A_{11}, . . . A_{17} are terminal exchanges, K_{18}, K_{19}, . . . K_{21} junction exchanges and D_{22} a district or debiting exchange. The terminal exchanges are provided with finders S, direction selectors RV and line selectors LV and the junction and the district exchanges with finders S, line selectors LV, exchange group selectors SGV, register selectors ReV and registers R. If necessary all exchanges can, of course, be provided with preselectors and group selectors.

Calls between two subscribers belonging to the same exchange, for instance to the terminal exchange A_{10}, will be established in the same way as described in conjunction with the arrangements, shown in Fig. 1.

However, in case of calls between two subscribers belonging to different exchanges of the same district or junction exchange, the connection will be different.

If in the arrangement according to Fig. 2 the subscriber 10 at the terminal exchange A_{10} desires a communication with a subscriber 393 of the junction exchange K_{18}, he obtains in the above described way connection to the line selector LV_{10}. After receiving the dial tone, he dials a special digit for instance 0. The direction selector RV_{10} will be operated in such a manner that the connection to a group and line selector of the terminal exchange is cut off, and connection to an outgoing trunk line over the contact 1 is obtained. When the call arrives at the junction exchange K_{18} over the contact 2, the subscriber 10 is automatically connected over a register selector ReV_{18} to a register R_{18}. If the register is disengaged, dial tone is sent out. The subscriber 10 then dials the numbers of both the junction exchange and the desired subscriber, in this case 18393. The register R_{18} is so connected that its transmitting device, after the dialling of the digits, transmits a series of impulses, which operates the exchange group selector SGV_{18}, connecting it to group or line selectors LV_{18}. Other series of impulses complete the connection in the known way.

Should the subscriber 10 of terminal exchange A_{10} desire to call the subscriber 3075 of the district exchange D_{22}, the connection to the register R_{18} will be similar to that described above. After receiving the dial tone, the subscriber 10 dials the numbers of both the district exchange and the desired subscriber, in this case 22—3075. The register R_{18} is so connected that its transmitting device, after receiving the dialled numbers, first transmits a series of impulses which operates the exchange group selector SGV_{18} to find a disengaged trunk line to the district exchange D_{22}, whereupon the contact 3 is closed. The next series of impulses operates the exchange group selector SGV_{22} for connection to the group or line selector LV_{22} of the district exchange. Other series of im-

pulses, transmitted from the register, will complete the connection.

If the subscriber 10 of the terminal exchange A_{10} desires to call the subscriber 77 of the terminal exchange A_{17} the connection to the register R_{18} will be similar to what has been described above. After receiving the dial tone the subscriber 10 dials the numbers of both the terminal exchange and of the desired subscriber, in this case 17—77. The register R_{18} is so connected that its transmitting device, after receiving the dialled numbers, first transmits a series of impulses to operate the exchange group selector SGV_{18} to find a disengaged trunk line to the district exchange D_{22}, whereupon the contact 3 is closed. The next series of impulses operates the exchange group selector SGV_{22} to find a disengaged trunk line to the junction exchange K_{21}, whereupon the contact 5 is closed.

The following series of impulses operates the exchange group selector SGV_{21} to find a disengaged trunk line to the terminal exchange A_{17}, whereupon the contact 7 is closed. Other series of impulses transmitted from the register complete the connection to the subscriber 77.

If the subscriber 25 of the terminal exchange A_{16} desires to call the subscriber 77 of the terminal exchange A_{17}, the connections will be similar to those which will take place when the subscriber 10 establishes a connection to the subscriber 77, although the connection will pass through a lesser number of exchanges.

In order to obtain a connection between the subscriber 10 and the subscriber 44 of the terminal exchange A_{14}, the numbers of the terminal exchange A_{14} and that of the desired subscriber must be dialled, in this case 14—44 after connection has been made to the register and the dial tone has been obtained. The register R_{18} is so connected that its transmitting device, after receiving the dialled numerals, first transmits a series of impulses to operate the exchange group selector SGV_{18} to find a disengaged trunk line going directly to the terminal exchange A_{14}. Other transmitted series of impulses complete the connection in any known way.

If a subscriber of a junction or district exchange, for instance the subscriber 288 of the junction exchange K_{18} desires communication with subscriber 393 of the same exchange, the calling subscriber 288 obtains connection to exchange group selector SGV_{18} over a finder or preselector S_{18}. Having received a dial tone he dials the number of the desired subscriber, whereupon the connection is obtained in any known way.

Should the same subscriber 288 desire to call another subscriber belonging to any other exchange, the subscriber 288, after having established connection to the exchange group selector SGV_{18}, dials a special digit, for instance 0. In this way connection is obtained to a register R_{18} over a register selector ReV_{18}. Having received a dial tone, the subscriber 288 dials the numbers of the exchange and of the subscriber. These numbers are accumulated in the register. The switching arrangements are in other respects similar to those described above.

Figs. 3 and 4 show diagrammatically an exchange group selector circuit according to the system shown in Fig. 2.

The constuction and the connection of the registers and register selectors will be alike and independent of the origin and destination of the calls as will be clear from the following. The construction of the exchange group selectors will also be independent of these factors, but its connections must be varied somewhat. In order to demonstrate the different connections of the exchange group selectors the following three cases will be assumed:

a. Calls extended over only one exchange group selector.

b. Calls extended over two or more exchange group selectors.

c. Calls extended over a direction selector and one or several exchange group selectors.

a. Calls extended over only one exchange group selector

When for instance the subscriber 288 belonging to junction exchange K_{18} desires to call the subscriber 393 belonging to the same exchange, the first subscriber lifts his receiver from the hook whereupon he obtains connection to the exchange group selector SGV over a finder or preselector and the line L (see Fig. 4) over contacts 4 and 7 of relay R_1 in the register selector ReV (see Fig. 3).

R_{10} (Fig. 4) is operated (plus, operating winding of R_{10}, $1R_8$, conductor *a*, $4R_1$, the loop of the subscriber, $7R_1$, conductor *b*, $3R_8$, lower winding of R_{10}, minus). The operation of R_{10} breaks the contacts 2, $3R_{10}$ and closes $1R_{10}$ in such a manner that R_{11} and R_{12} are operated in parallel. The circuit of R_{11} passes from plus over $1R_{10}$, R_{11} to minus, and that of R_{12} from plus over $1R_{10}$, $2R_{13}$, R_{12} to minus. The operation of R_{11} opens the contact $3R_{11}$ and closes 1, 2, 4, 5, 6 and $7R_{11}$. The closing of $4R_{11}$ causes the operation of cut off relay of the calling subscriber and busies the corresponding finder and preselector. The closing of 1, $2R_{11}$ makes possible the transmission of dial tone from the buzzer devices SU (SU, $1R_{13}$, $1R_{11}$, the buzzer winding of R_{10}, $2R_{11}$, SU_j. The buzzer tone is transformed over the operating winding of R_{10} and the wires *a* and *b* to the subscriber.

The subscriber after receiving dial tone will dial a special direction digit, for instance 0, if he desires to call a subscriber connected to another exchange. In order to explain the operations that occur, when the subscriber, after receiving dial tone, dials the digit 0 (one impulse), the switching operations at the begining and at the end of the impulse will be described.

1st impulse starts.—R_{10} is demagnetized on account of the opening of the impulse contact of the subscriber's dial. STM_0 (Fig. 9) is energized (plus, $2R_{10}$, $5R_{11}$, $1R_{12}$, $3R_{13}$, STM_0, minus), whereby 1, 2, $4STM_0$ are closed and $3STM_0$ is opened. The closing of $2STM_0$ magnetizes R_{13} (plus, $6R_{11}$, R_{13}, $4R_{13}$, $2STM_0$, minus), which receives holding current (plus, $6R_{11}$, R_{13}, $5R_{13}$, minus). When R_{13} is energized 1, 2, 3, $4R_{13}$ are opened and 5, $6R_{13}$ are closed. The buzzer SU is disconnected.

1st impulse ceases.—R_{10} is magnetized, when the impulse contact of the subscriber's dial is closed, STM_0 receives holding current in series with R_{14}, which is magnetized (plus, $6R_{11}$, $8R_8$, $4R_{14}$, R_{14}, $4STM_1$, $4STM_0$, STM_0, minus).

At the end of the first impulse R_{10}, R_{11}, R_{12}, R_{13}, R_{14} and STM_0 are magnetized, R_{12} on account of its delayed action. As the impulse series now is ended, R_{12} will be de-energized when the time of delayed action is over. $2R_{12}$ is closed, whereby the bar magnet STM_1 is magnetized (plus, STM_1, $1OR_1$, *d*-wire, $2R_{12}$, $3R_{14}$, $2STM_0$, minus) and 1, $2STM_1$ are closed.

The hunting for a disengaged trunk from the

register selector to a register, is started, $HBRM_1$ is magnetized (plus, $HBRM_1$, $4HBRM_2$, $4HBRM_3$, $1STM_1$, minus), whereby 3, $5HBRM_1$ are closed and $2HBRM_1$ is opened. The closing of $5HBRM_1$ causes the testing relay R_7 to be magnetized, if the first trunk from the register selector R_aV to a register is disengaged (plus, $2STM_1$, R_7, $8HBRM_3$, $8HBRM_2$, $5HBRM_1$, contact corresponding to $1R_5$, minus). 1, $3R_7$ are opened and $2R_7$ is closed whereby R_6 is magnetized (plus, R_6, $2R_7$, $1STM_0$, minus), whereby $1R_6$ is opened and $2R_6$ is closed. R_6 thus receives holding current (plus, R_6, $2R_6$, $1STM_1$, minus), and the hunting for a disengaged outgoing trunk ceases. BRM_1 is magnetized (plus, BRM_1, $3HBRM_1$, $6HBRM_3$, $2R_6$, $1STM_1$, minus), and 3, 4, 5, 6, $7STM_1$ are closed. The closing of $7STM_1$ magnetizes a relay corresponding to R_4 (plus, R_4, $7STM_1$, $11R_1$, d-wire, $2R_{12}$, $3R_{14}$, $2STM_0$, minus). A contact corresponding to $1R_4$ is closed, so that a relay corresponding to R_5 is magnetized and closes two contacts corresponding to 2, $3R_5$. R_7 is demagnetized and closes $3R_7$, so that R_1 is magnetized. Its circuit will then be as follows (plus, contact corresponding to $2R_5$, $1BRM_1$, holding winding of BRM_1, $5STM_1$, R_1, $2R_1$, $3R_7$ and minus). 1, 3, 5, 6, 8, 9R are closed and 2, 4, 7, 10, $11R_1$ are opened, whereby R_1 receives holding current (plus, contact corresponding to $2R_5$, $1BRM_1$, holding winding of BRM_1, $5STM_1$, R_1, $1R_1$, minus). The calling line L is connected to the register R. The opening of 4, $7R_1$ demagnetizes R_{10} of the exchange group selector, whereby all its corresponding relays are demagnetized. The closing of 3, $6R_1$ causes that the wires a and b of the calling line L to obtain feeding current over 6, $7STM_1$ from a relay corresponding to R_4. The opening of $11R_1$ demagnetizes $HBRM_1$. When a subscriber thus, after dialing the digit 0, has obtained connection to a disengaged register over a register selector, BRM_1, R_1 and two relays corresponding to R_4 and R_5 are the only relays, that remain magnetized.

Should the first line outgoing from the register selector R_eV be engaged, R_7 cannot be magnetized. $1R_7$ remains closed in this case, whereby $HBRM_2$ is magnetized and opens the circuit of $HBRM_1$. Should also the second outgoing line be engaged, $HBRM_3$ is then magnetized, etc. Should all outgoing lines be occupied, $HBRM_3$ connects $HBRM_1$, whereupon the hunting starts again.

From the foregoing it will be clear that, when a line L is connected to a disengaged register, one BRM relay and two relays corresponding to R_4 and R_5 are the only ones that remain energized. The closing of $9R_1$ busies the previously used exchange group selector SGV, because plus is connected to its c-wire.

For the sake of simplicity let us assume that BRM_3 is magnetized instead of BRM_1. The line L thus obtains its feeding current from the relay R_4 over the contacts 16, $17STM_1$. The closing of $1R_4$ magnetizes R_5 (plus, $1R_4$, R_5, minus), whereby $3R_5$ is closed and buzzer tone is transformed to R_4 and the line L. Having received a second dial tone the subscriber dials the numbers of the exchange and of the subscriber, which are accumulated in the register to be retransmitted later. Before the transmission device of the register transmits the impulses necessary for the setting of the different selectors, $1R_3$ is closed. This happens after the subscriber has dialled one or several digits and causes R_2 to be connected to the wires a and b attached to the exchange group selector SGV over 13, $14STM_1$ and 5, $8R_1$. When the series of impulses from the register are transmitted, $1R_2$ is closed and opened in the same way as the impulse contact of the dial of the calling subscriber. In order to understand the switching arrangements of the exchange group selector those conditions can for instance be studied, which take place when the impulse transmitting device of the register transmits the first series of impulses. This series corresponds for instance to the digit 2 (3 impulses). In order to understand the switching it will be convenient to study the conditions at the beginning and the end of each impulse.

The first impulse starts.—R_{10} is demagnetized on account of the opening of the impulse contact $1R_2$. STM_0 is magnetized (plus, $2R_{10}$, $5R_{11}$, $1R_{12}$, $3R_{13}$, STM_0, minus), whereby 1, 2, $4STM_0$ are closed and $3STM_0$ is opened. The closing of $2STM_0$ magnetizes R_{13} (plus, $6R_{11}$, R_{13}, $4R_{13}$, $2STM_0$, minus), which receives holding current (plus, $6R_{11}$, R_{13}, $5R_{13}$, minus). By the magnetizing of R_{13}, 1, 2, 3, $4R_{13}$ are opened and 5, $6R^{13}$ closed. The buzzer SU is disconnected.

The first impulse ceases.—R_{10} is magnetized by the closing of $1R_2$. STM_0 receives holding current in series with R_{14} which is magnetized (plus, $6R_{11}$, $3R_8$, $4R_{14}$, R_{14}, $4STM_1$, $4STM_0$, STM_0, minus). When the first impulse ceases, R_{10}, R_{11}, R_{12}, R_{13}, R_{14} and STM_0 are magnetized, R_{12} on account of its delayed action.

The second impulse starts.—R_{10} is demagnetized on account of the opening of the impulse contact $1R_2$. STM_1 is magnetized (plus, $2R_{10}$, $5R_{11}$, $1R_{12}$, $2R_{14}$, $1STM_0$, STM_1, minus), whereby 1, 2, $3STM_1$ are closed and $4STM_1$ is opened. The opening of $4STM_1$, however, does not demagnetize R_{14}, because this relay has holding current (plus, $6R_{11}$, $7R_8$, $3R_{10}$, $5R_{14}$, minus). STM_0 is, however, demagnetized upon the opening of $4STM_1$.

The second impulse ceases.—R_{10} is magnetized upon the closing of $1R_2$, whereby $1R_{10}$ is closed and 2, $3R_{10}$ are opened. The opening of $3R_{10}$ demagnetizes R_{14}, whereby 1, 4, $6R_{14}$ are closed and 2, 3, $5R_{14}$ are opened. STM_1 gets holding current over (plus, $6R_{11}$, $8R_8$, $3STM_2$, $2STM_1$, STM_1, minus).

After the end of the second impulse R_{10}, R_{11}, R_{12}, R_{13} and STM_1 are magnetized, R_{12} on account of its delayed action.

The third impulse starts.—R_{10} is demagnetized on account of the opening of the impulse contact $1R_2$. STM_2 is magnetized (plus, $2R_{10}$, $5R_{11}$, $1R_{12}$, $1R_{14}$, $1STM_2$, minus), whereby 1, 2, $4STM_2$ are closed and $3STM_2$ is opened. The opening of $3STM_1$ demagnetizes STM_1.

The third impulse ceases.—R_{10} is magnetized upon the closing of $1R_2$. STM_2 receives holding current in series with R_{14}, which is magnetized (plus, $6R_{11}$, $8R_8$, $4R_{14}$, R_{14}, $4STM_3$, $4STM_2$ minus). When the third impulse ceases, R_{10}, R_{11}, R_{12}, R_{13}, R_{14} and STM_2 are thus magnetized, R_{12} on account of its delayed action.

When the series of impulses have been sent out, R_{12} is demagnetized after the time of the delayed action, whereby $1R_{12}$ is opened and 2, $3R_{12}$ are closed. The closing of $3R_{12}$ magnetizes BRM and 1, 2, $3STM_2$ are closed. If the first outgoing line is disengaged, R_9 is magnetized, before BRM_2 gets time to operate. The circuit of R_9 will be (plus, $6R_{11}$, R_9, $7R_{11}$, $1BRM_3$, $1BRM_2$, $1STM_2$, the outgoing c-wire not shown, minus). The magnetizing of R_9 opens 1, $3R_9$ and closes $2R_9$. By opening of $1R_9$, BRM_2 is prevented from

magnetizing. The closing of $2R_9$ causes R_8 to be magnetized (plus, $6R_{11}$, $2R_9$, R_8, minus), whereby 1, 3, 5, 7, 8, $10R_8$ are opened and 2, 4, 6, 9, $11R_8$ are closed. The closing of 2, $4R_8$ causes the incoming *a* and *b* wires to be connected to the corresponding outgoing ones over 3, $2STM_2$. The closing of $6R_8$ connects ground to the incoming *c*-wire, whereby the group selector is busied. The opening of 7, $8R_8$ demagnetizes R_{14}. The closing of $9R_8$ causes holding of R_8 (plus, $9R_8$, $2R_9$, R_8, minus). The opening of 1, $3R_8$ demagnetizes R_{10}, whereby R_{11} is demagnetized and opens 6, $7R_{11}$, whereby also R_{13} and R_9 are also demagnetized. R_9 gets holding current from the succeeding selector's *c*-wire, which in the meantime has been connected to ground (plus, *c*-wire, $1STM_2$, $1BRM_2$, $1BRM_3$, $3R_9$, $11R_8$, R_8, minus). When the connection has been established, R_8 and BRM_1 are the only relays of exchange group selector SGV that are magnetized.

After the exchange group selector has been operated by the first series of impulses transmitted from the register, the other series of impulses are transmitted, which will operate the succeeding selector. As soon as the last two series of impulses have operated a line selector, the circuit of R_1 is automatically opened and R_1 is demagnetized, whereby the register selector ReV and also the register are disconnected and the wires *a* and *b* of the line L are connected to the wires *a* and *b* leading to the exchange group selector SGV.

As will be noticed from the above description, an impulse can be transmitted also from the register to connect those from the exchange group selector SGV, which correspond to the STM_0 magnet.

b. Calls extended over two or more exchange group selectors

When, for instance, the subscriber 288 belonging to the junction exchange K_{18} calls the subscriber 3075 of the district exchange D_{22}, the switching will in general be similar to what has been described under *a*.

When the first impulse transmitted from the engaged register, has caused connection to a line leading to the district exchange D_{22}, the contact 3 is operated when that line is tested and formed, disengaged, whereupon connection is obtained to an exchange group selector of district exchange D_{22}. Said exchange group selector can not be connected to a register. Buzzer arrangement is not needed either. Accordingly the arrangements of Fig. 4 for transforming buzzer tone and the *d*-wire are unnecessary at exchange group selectors which are used by a call from a preceding exchange group selector. The switching is otherwise similar to that described above.

c. Calls extended over a direction selector and one or several exchange group selectors

When, for instance, the subscriber 10, belonging to the terminal exchange A_{10}, calls the subscriber 393 of the junction exchange K_{18}, the switching will be as follows: When the subscriber 10 lifts his telephone and is connected over finder S_{10} and a preselector and direction selector RV_{10} to the line selector LV_{10}, dial tone is transmitted. The subscriber dials the digit 0, whereby the direction selector RV_{10} is connected to a trunk leading to the junction exchange when this line is tested and found disengaged, contact 1 is operated establishing a connection to an exchange group selector. In this case a second dial tone will be transmitted direct from a register and not from the selected exchange group selector, that is, connection to a register over a register selector will be obtained automatically as soon as connection to an exchange group selector has been obtained. The minus pole is connected to the contact $1R_{11}$ and the contact $1R_{13}$ is connected to the *d*-wire. As the dial tone buzzer of the exchange group selector does not function, it is disconnected. The switching is otherwise similar to that described above under *a*.

It will be clear that the invention can be modified in several ways without departing from the main idea. Thus, for instance, in the terminal exchanges shown, direction selectors RV may be replaced by group selectors of the same construction as the exchange group selectors SGV.

It will also be clear that connections can be extended over any number of exchanges in series with registers provided only in even number exchanges, counted from the terminal exchange.

Having thus described our invention, what we claim is:

1. In an automatic telephone system, a plurality of full automatic terminal exchanges, and a plurality of full automatic intermediate exchanges, direction selectors in said terminal exchanges, impulse accumulating and transmitting registers at said intermediate exchanges only, subscribers' lines terminating at said exchanges, impulse transmitting dials associated with each one of said lines, and means controlled from said terminal exchanges for actuating said registers to establish connections between a plurality of exchanges.

2. In an automatic telephone exchange system according to claim 1, characterized by exchange group selectors in said intermediate exchanges, means responsive to the dialling of the number of a called subscriber belonging to the same exchange as the calling subscriber for establishing a connection with this line, means responsive to the dialling of a direction digit by a line for operating said direction selector to connect with a register, and means responsive to the dialling of a number of the called subscriber belonging to a different exchange than the calling subscriber for operating said register to establish a connection to said called subscriber at said different exchange.

3. In an automatic telephone exchange system, a plurality of full automatic terminal exchanges, a plurality of full automatic intermediate exchanges, subscribers' lines terminating in said exchanges, impulse transmitting dials associated with each one of said lines, impulse registers and exchange group selectors in said intermediate exchanges, means controlled by the dialling of a calling subscriber for operating said registers, means controlled by said registers for operating said exchange group selectors, and means controlled by the dial of a calling subscriber for operating said exchange group selectors.

4. In an automatic telephone system, a plurality of full automatic terminal exchanges, a plurality of full automatic intermediate exchanges, subscribers' lines terminating at said exchanges, impulse transmitting dials associated with each one of said lines, impulse registers and exchange group selectors at said intermediate exchanges, means controlled by said dials for operating said registers, means controlled by said dials for operating said exchange group selectors, and means responsive to the operation of said

exchange group selector for connecting a calling line with said registers.

5. In an automatic telephone exchange system, a plurality of full automatic telephone exchanges, a plurality of full automatic intermediate exchanges, subscribers' lines terminating in said exchanges, impulse transmitting dials associated with each one of said subscribers' lines, impulse registers and exchange group selectors at said intermediate exchanges, means controlled by said dials for operating exchange group selectors, means controlled by said registers for operating exchange group selectors, and means responsive to the dialling of a certain digit by a subscriber belonging to an intermediate exchange for connecting with the calling subscriber's line said registers.

6. In a telephone exchange system, a plurality of full automatic terminal exchanges, a plurality of full automatic intermediate exchanges, subscribers' lines terminating at said exchanges, impulse transmitting dials associated with each one of said lines, exchange group selectors at said intermediate exchanges, means for establishing a connection over said group selectors between a calling and a called subscriber belonging to an intermediate exchange, and means for establishing a connection through said group selectors between a calling subscriber belonging to an intermediate exchange and a called subscriber belonging to a different exchange.

7. In a telephone exchange system, a plurality of full automatic terminal and intermediate exchanges, a plurality of lines terminating at said exchanges, impulse transmitting dials connected with each one of said lines, exchange group selectors at said intermediate exchanges, means controlled by the dial of a calling subscriber belonging to an exchange for once operating a group selector to establish a connection with a called subscriber belonging to the same exchange, and means responsive to the operation of the dial of a calling subscriber belonging to one exchange for twice operating said group selector to establish connection with a called subscriber belonging to a different exchange.

8. In a telephone exchange system, a plurality of full automatic terminal exchanges, a plurality of full automatic intermediate exchanges, a plurality of subscribers' lines terminating at said exchanges, impulse transmitting dials associated with each one of said lines, exchange group selectors and impulse registers at said intermediate exchanges, means responsive to the dialling of a direction digit by a subscriber belonging to any exchange to operate a group selector to connect the calling line with a register, means operative thereupon for restoring to normal the operated group selector, means controlled by said register for actuating said last mentioned group selector, and means for disconnecting said register from the last mentioned group selector.

9. In an automatic telephone system, a plurality of full automatic terminal exchanges, a plurality of full automatic intermediate exchanges, a plurality of subscribers' lines terminating at said exchanges, an impulse transmitting dial associated with each line, exchange group selectors and impulse registers at said intermediate exchanges, means for connecting a calling line at one exchange with a distant intermediate exchange, means operative thereupon for actuating said exchange group selectors to connect the calling line at said registers, and means responsive to the dialling of a direction digit by another calling subscriber for actuating said exchange group selectors for connecting the last mentioned calling line with said registers.

10. In an automatic telephone system, a plurality of terminal exchanges, a plurality of intermediate exchanges, subscribers' lines terminating at said exchanges, a calling dial associated with each line, selector switches at each exchange, impulse accumulating and transmitting registers at said intermediate exchanges only, means responsive to the dialling of the number of a called line belonging to the same exchange as the calling line for operating selectors to interconnect said lines without the intervention of said registers, and means operative upon the dialling of the number of the called line belonging to a different exchange for first connecting the calling line with a register and then actuating said register to operate selectors for extending the connection to the called line, the dialling number of the last mentioned called line consisting of a number designating the register, a number designating the called office and a number designating the called line proper.

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