

Jan. 18, 1944.

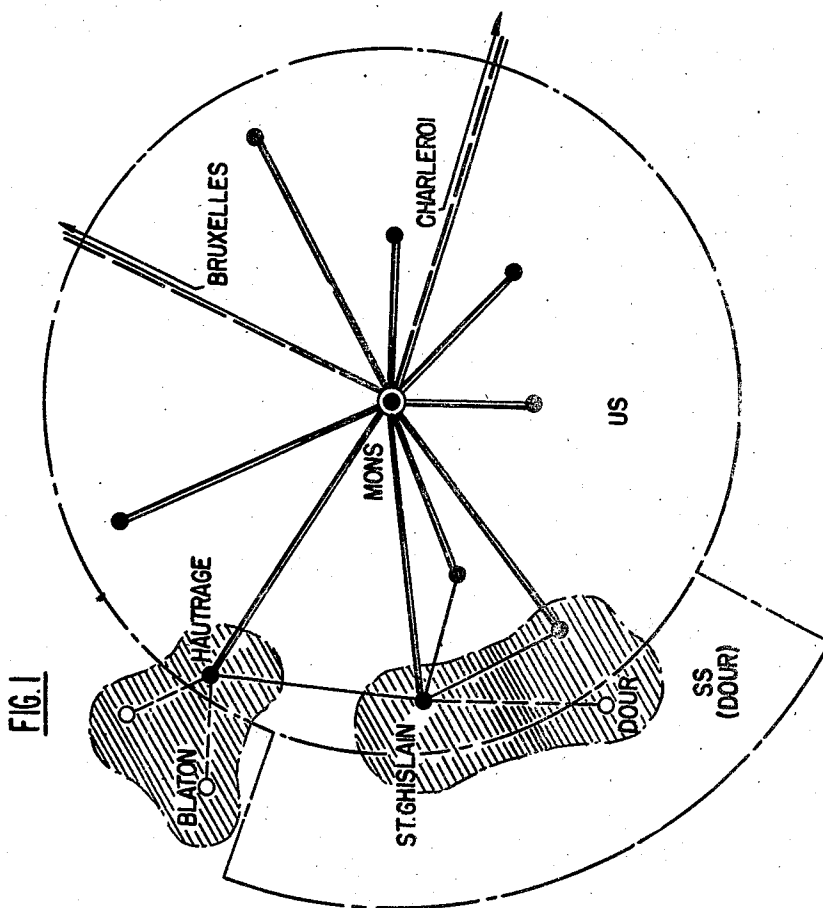
J. E. OSTLINE

2,339,709

TELEPHONE SYSTEM

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39 Sheets-Sheet 1



INVENTOR
JOHN ELLIS OSTLINE

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Chas. H. Condy
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Jan. 18, 1944.

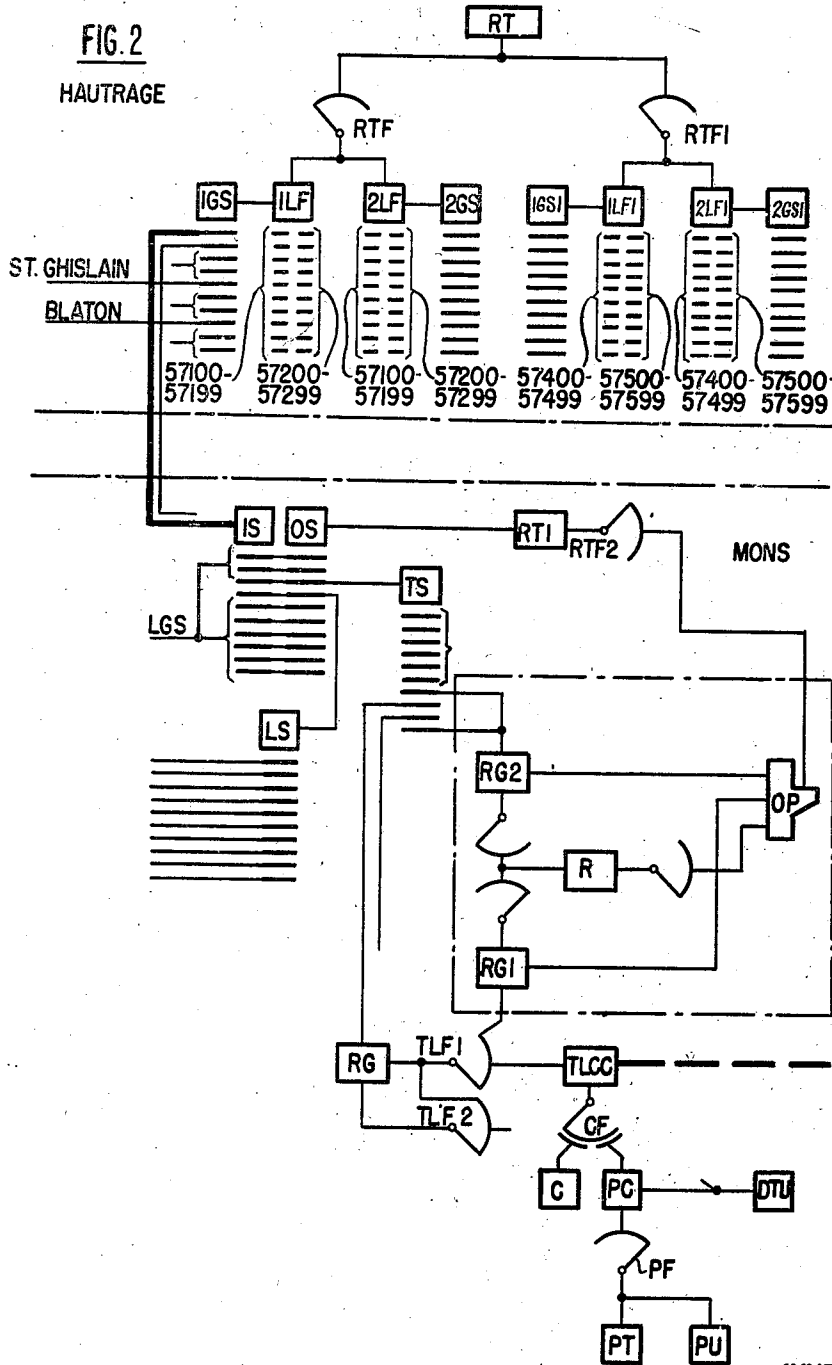
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TELEPHONE SYSTEM

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39 Sheets-Sheet 2



INVENTOR
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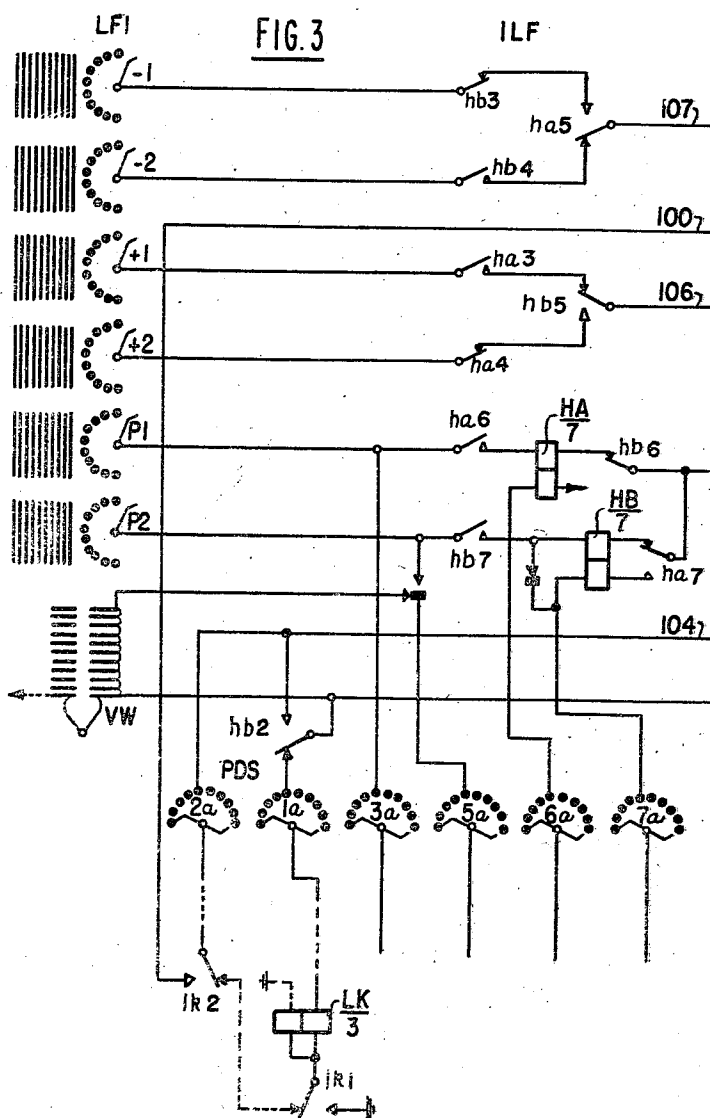
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FIG. 4

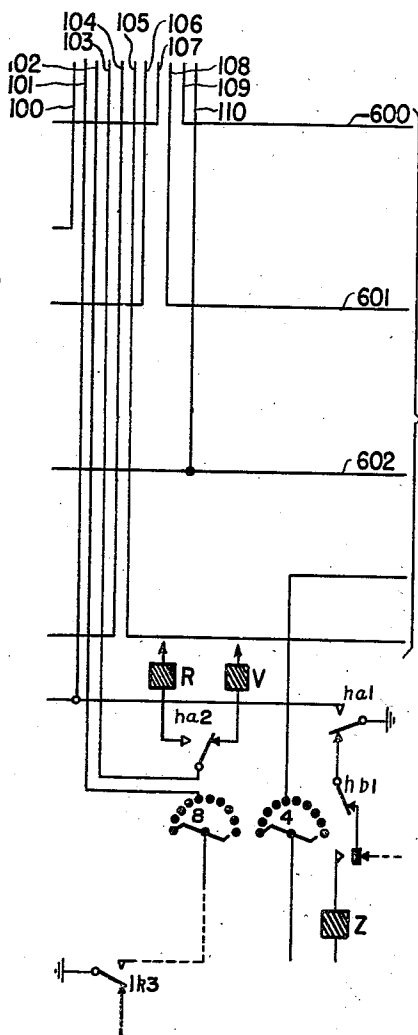
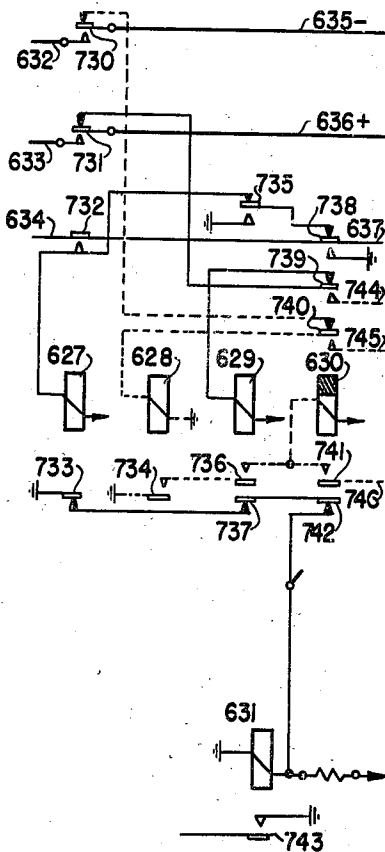


FIG. 30



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Jan. 18, 1944.

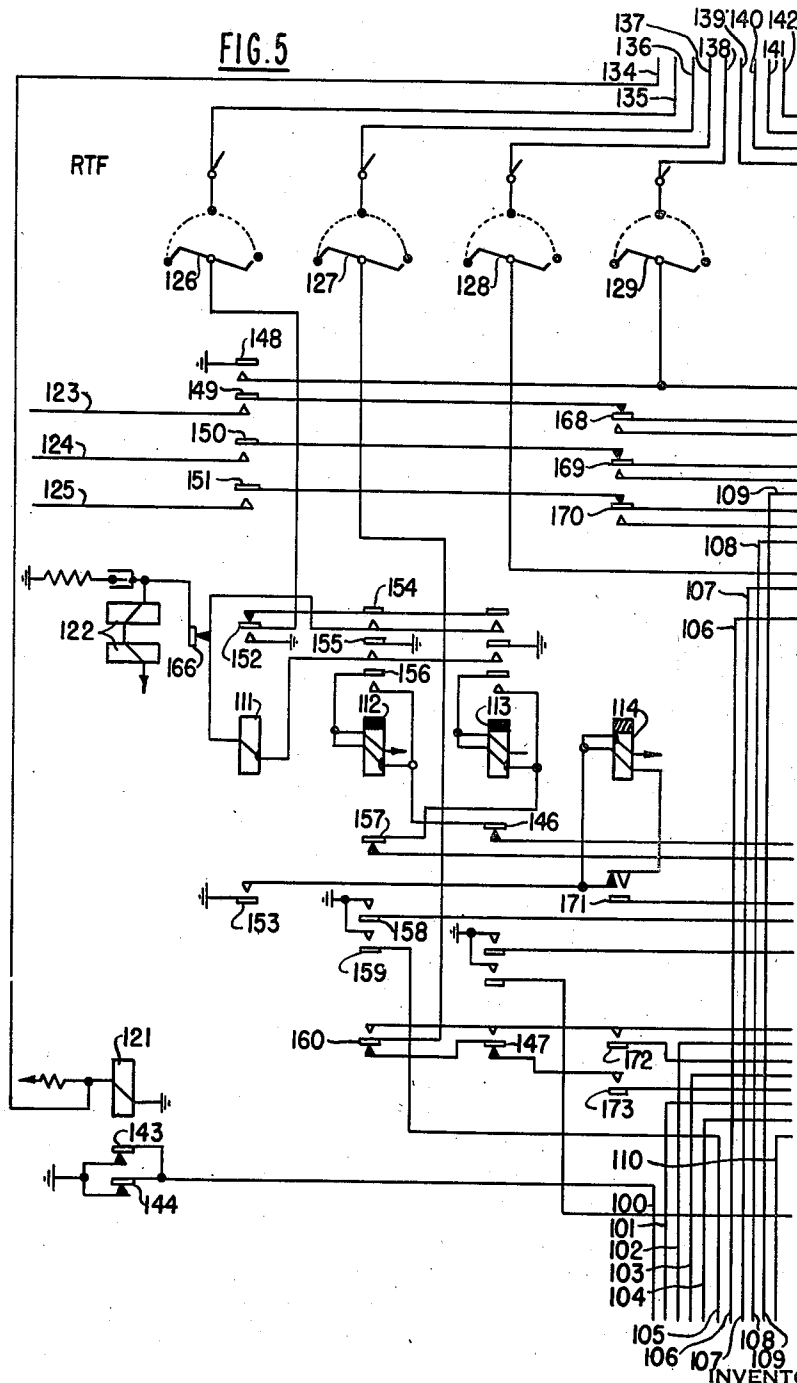
J. E. OSTLINE

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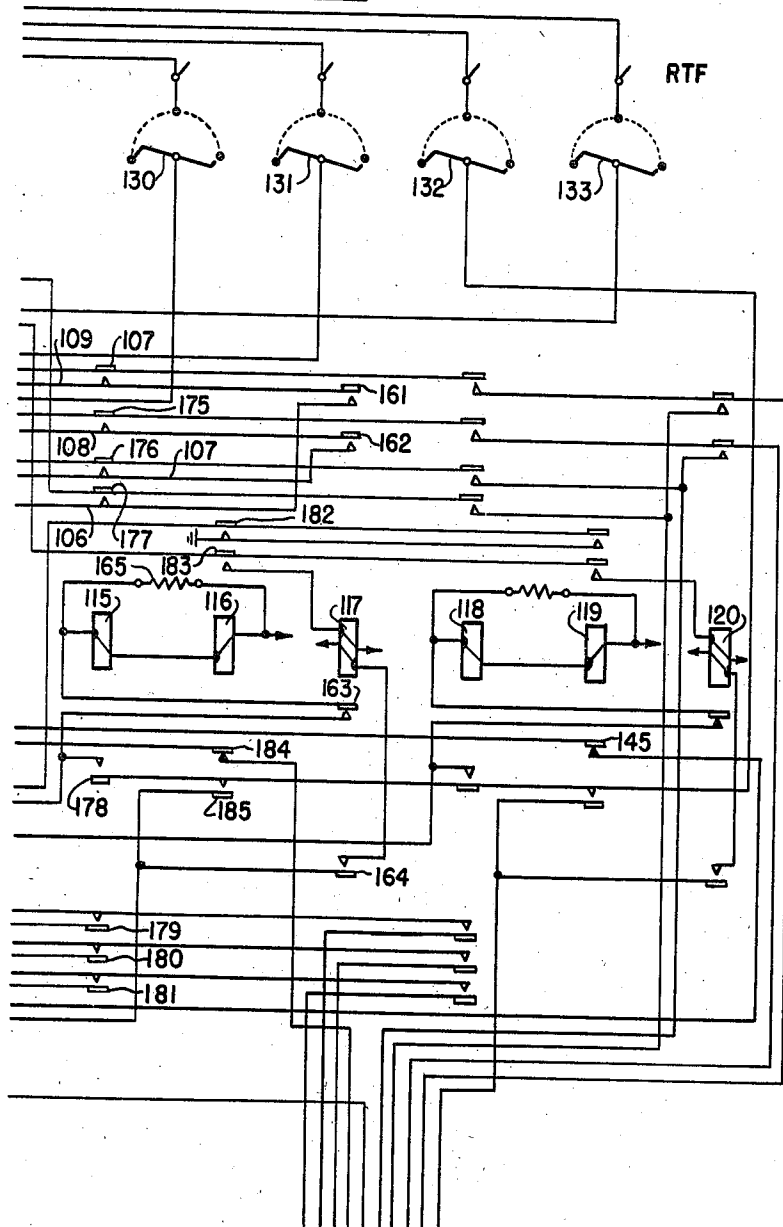
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FIG. 6



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Jan. 18, 1944.

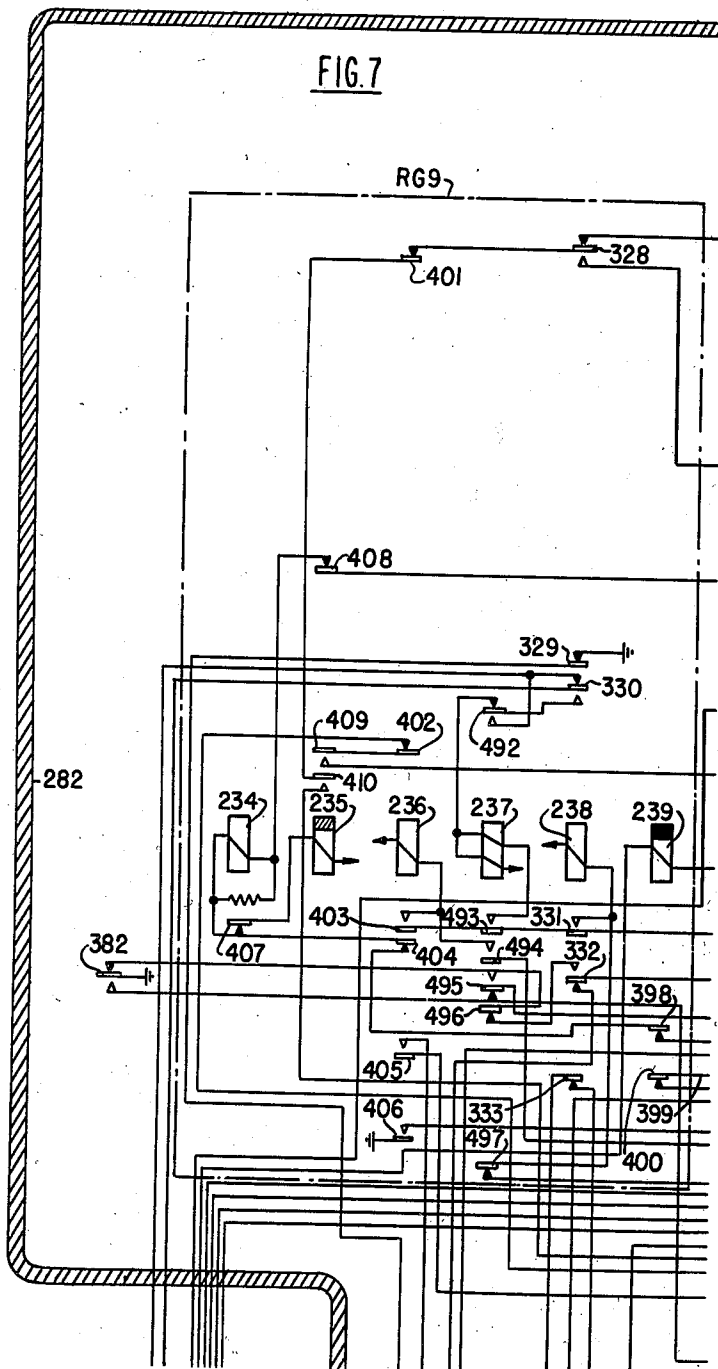
J. E. OSTLINE

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TELEPHONE SYSTEM

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INVENTOR
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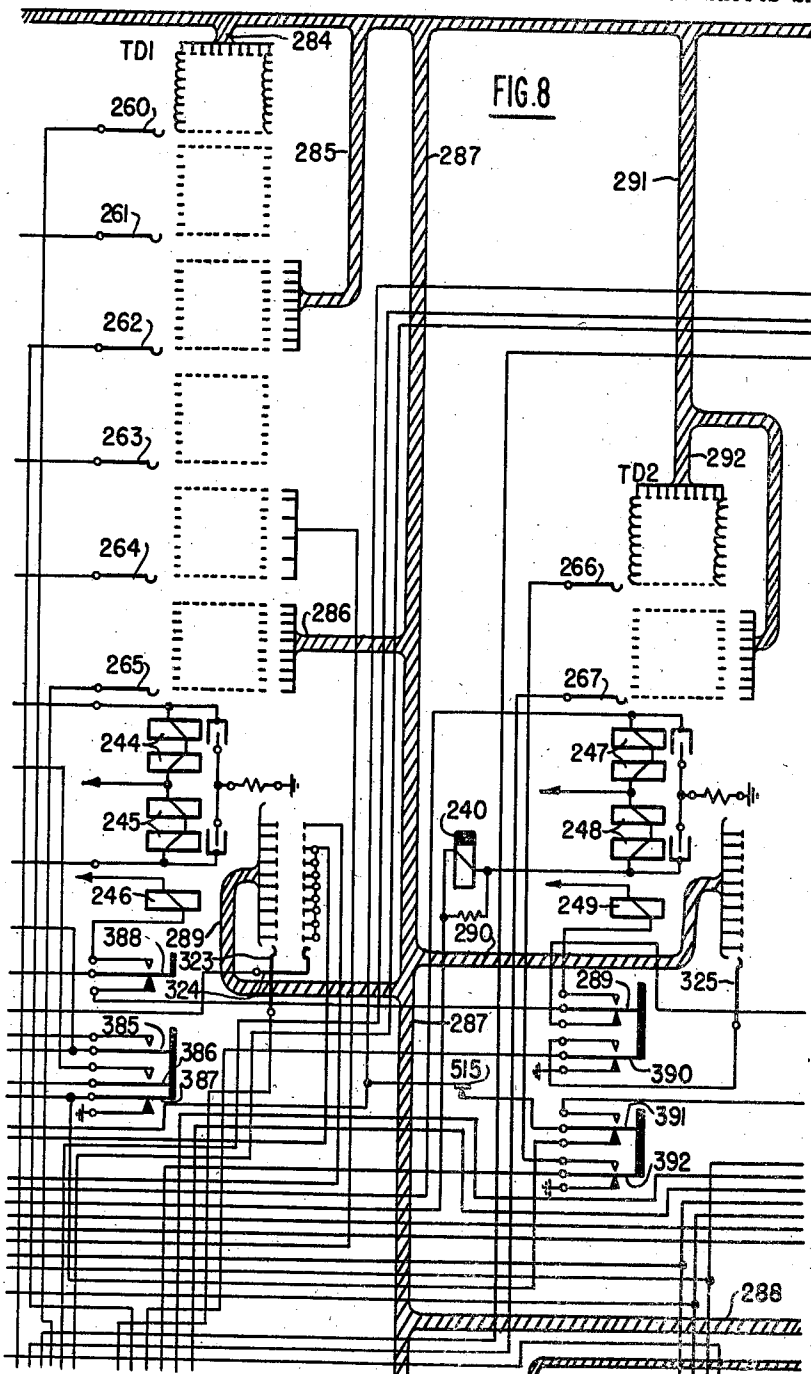
J. E. OSTLINE

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INVENTOR
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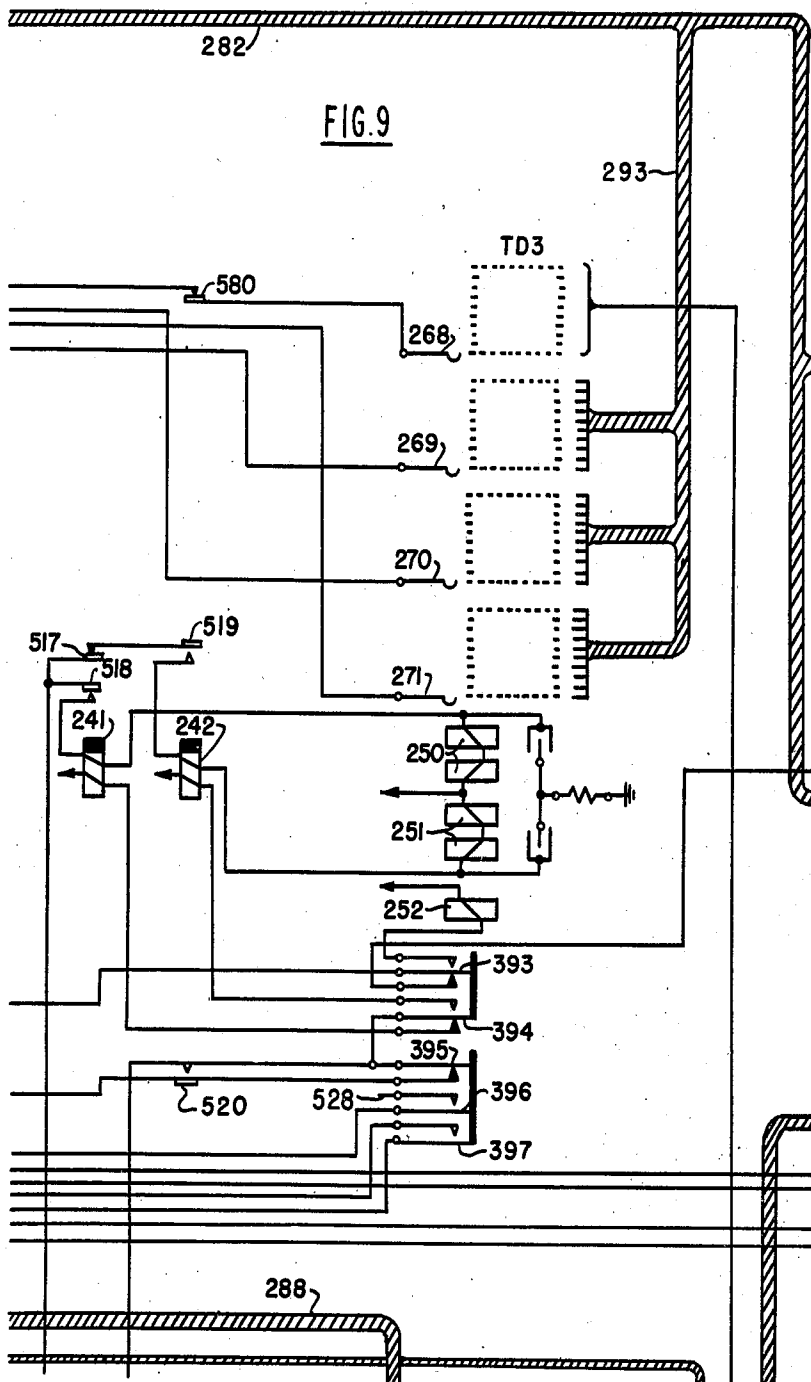
J. E. OSTLINE

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INVENTOR.
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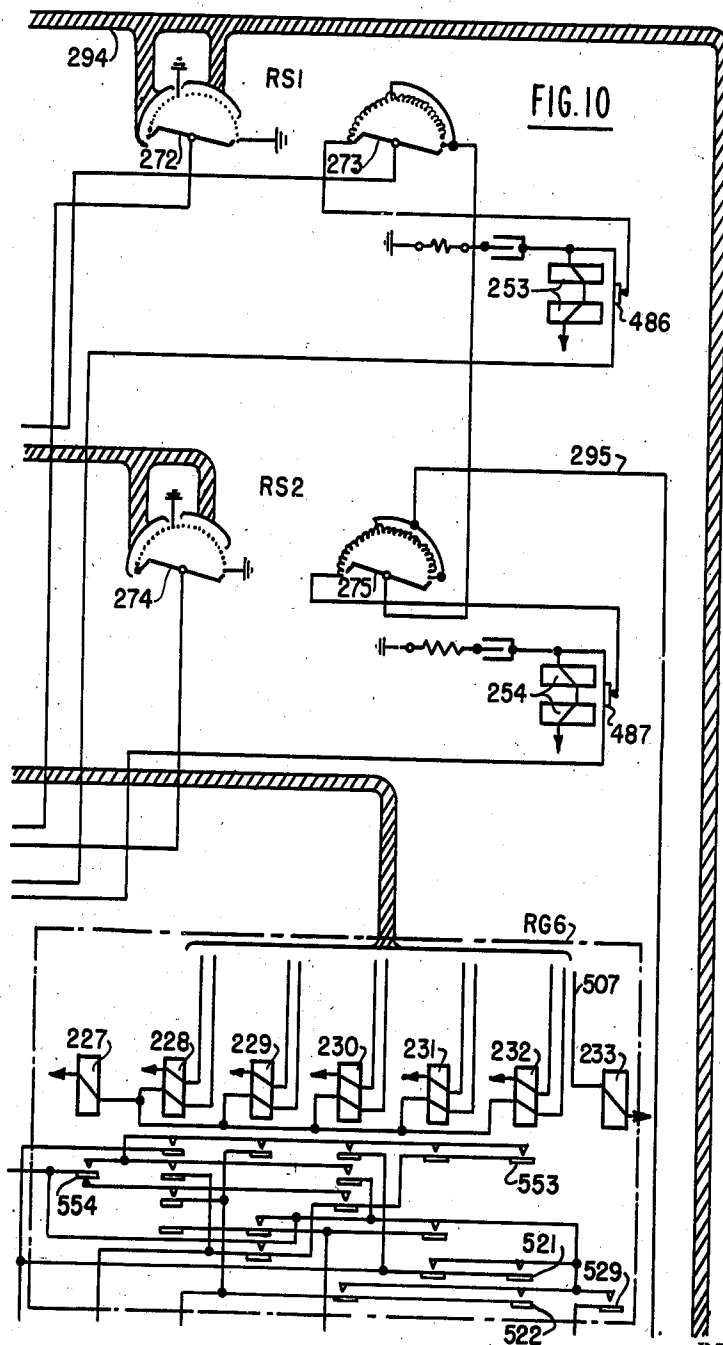
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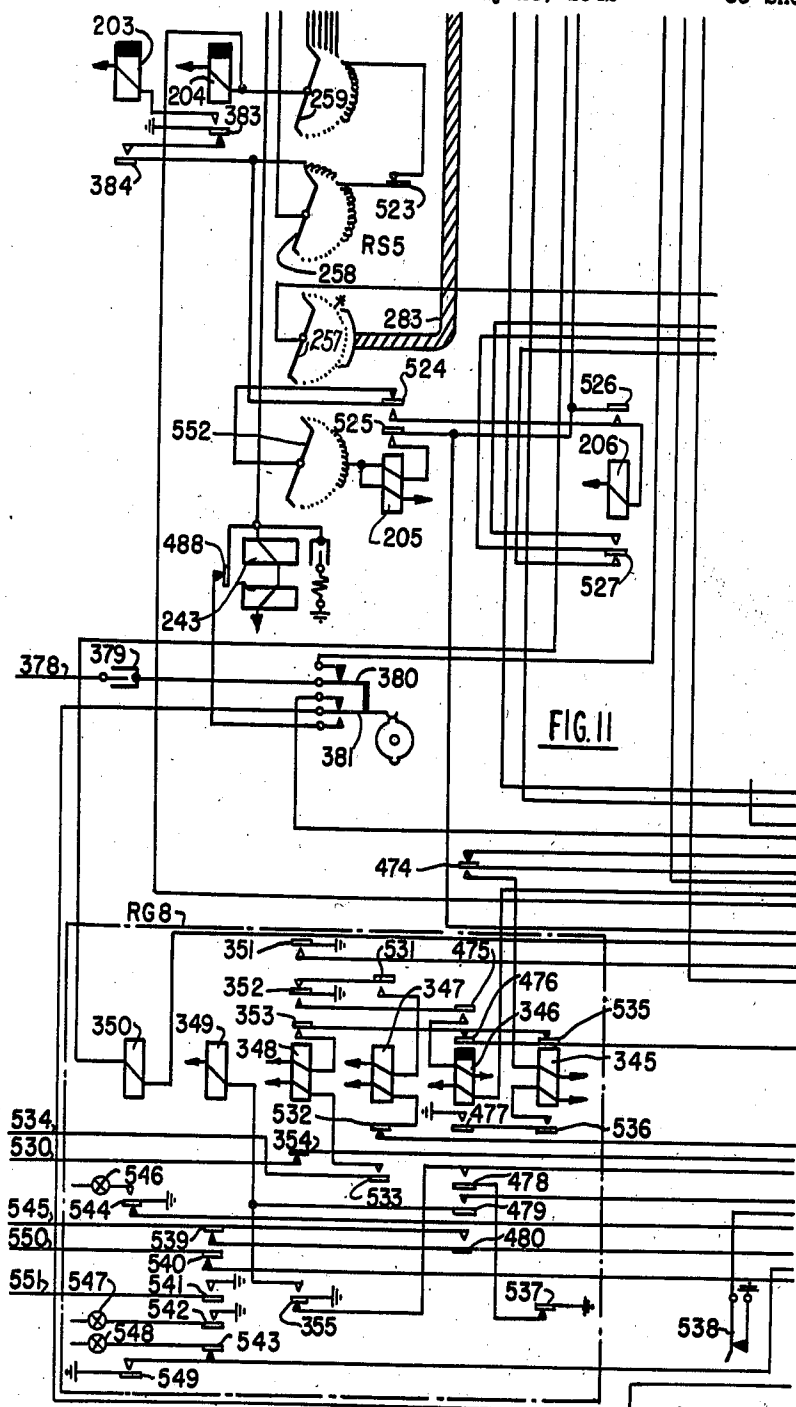


FIG. 11

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Jan. 18, 1944.

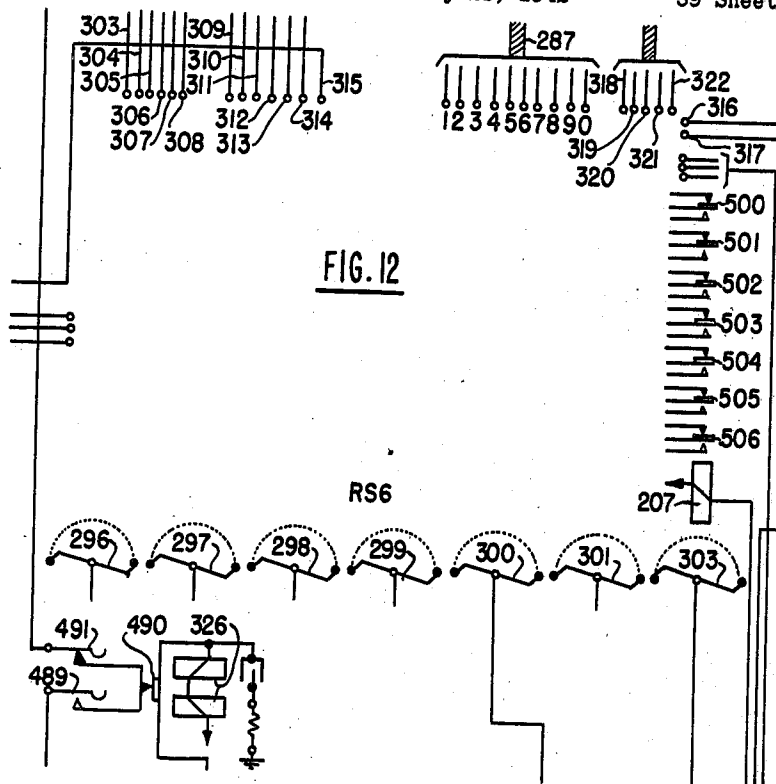
J. E. OSTLINE

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INVENTOR.
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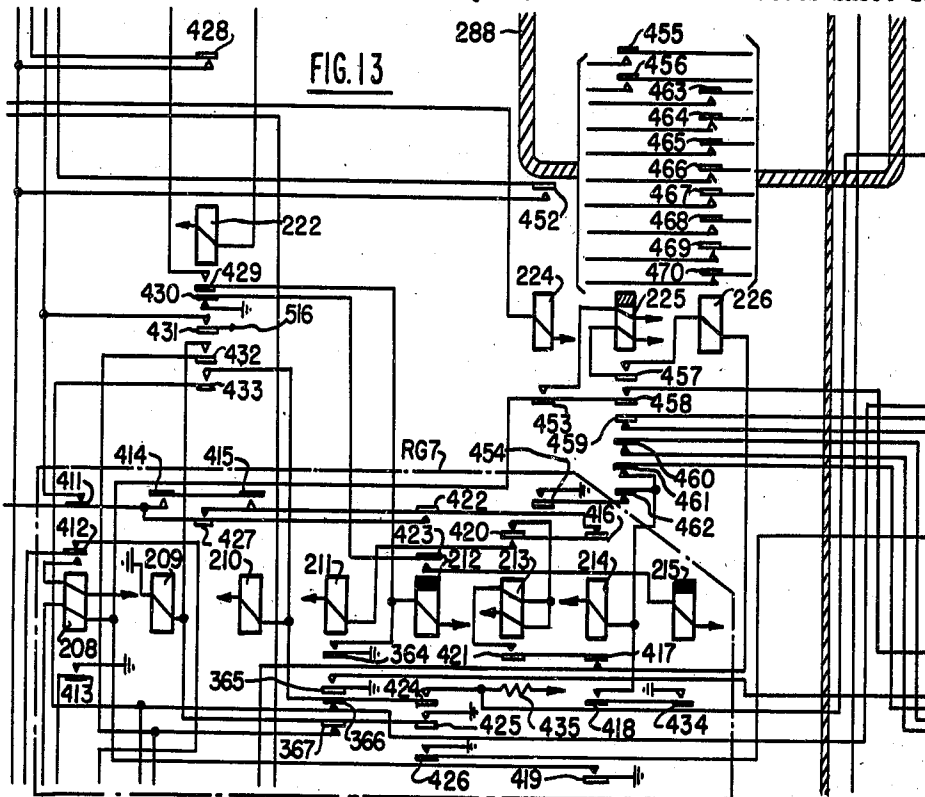
J. E. OSTLINE

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INVENTOR.

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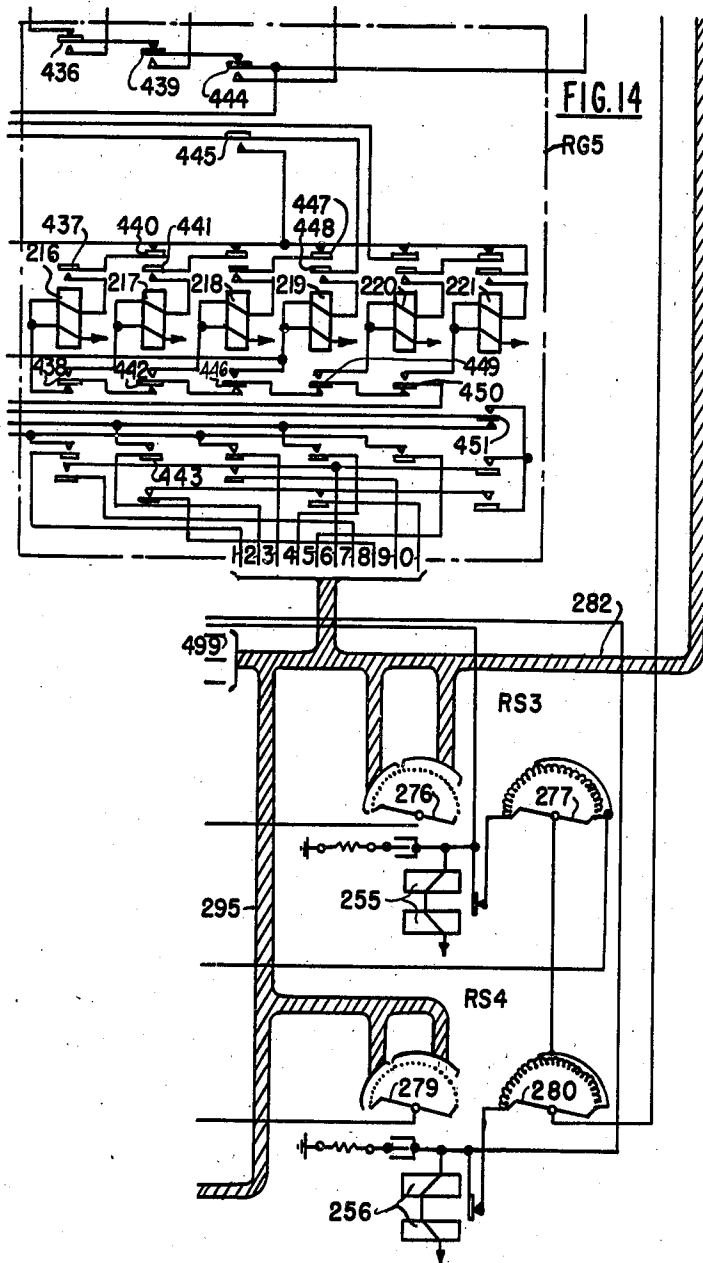
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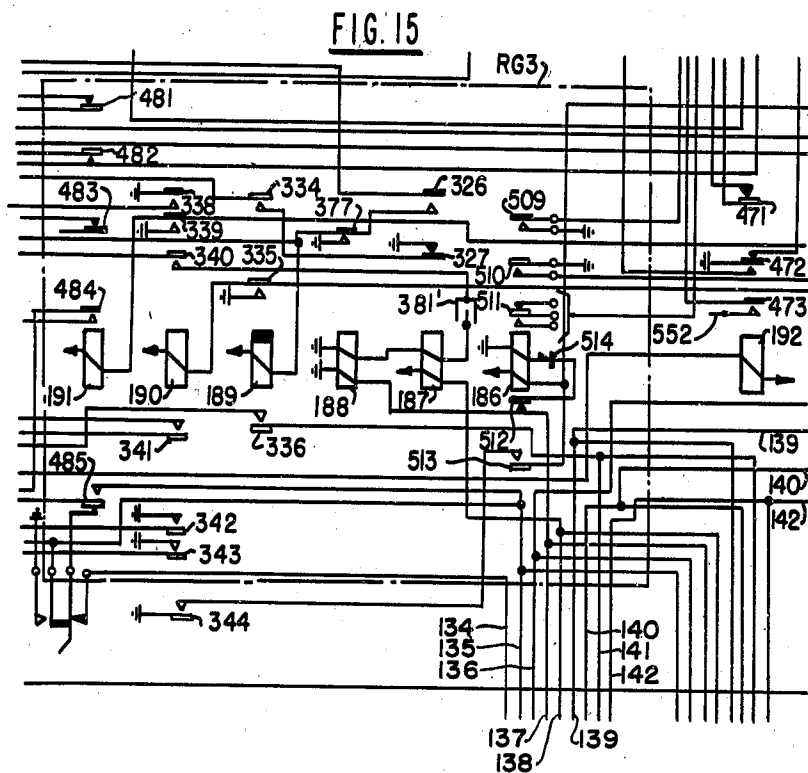
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INVENTOR.
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Jan. 18, 1944.

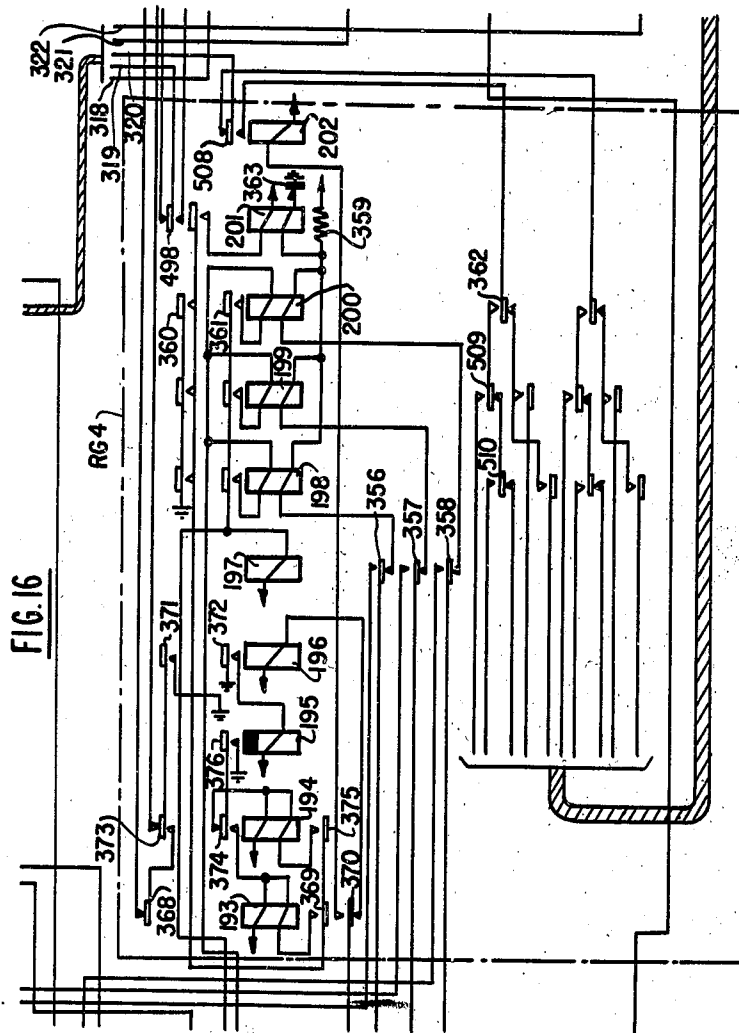
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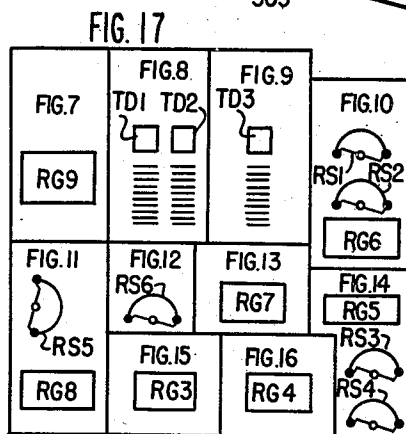
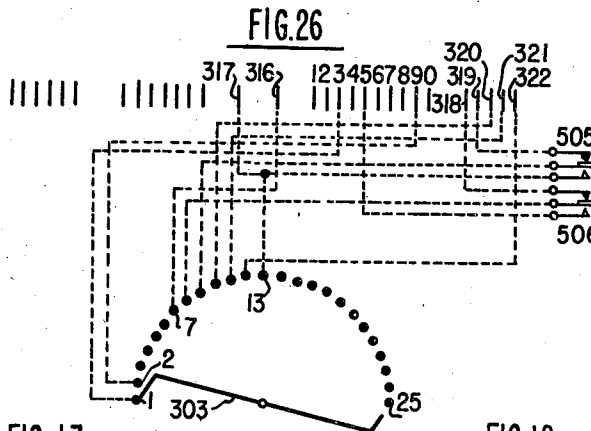
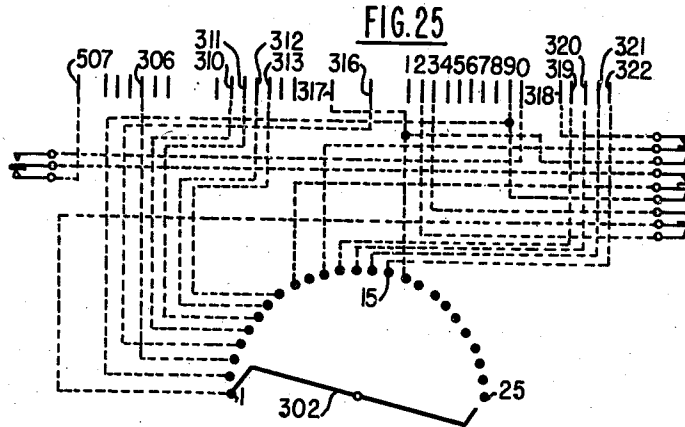


FIG. 18

	1	2	3	4
1	X	X		
2	X		X	
3	X			X
4		X	X	
5		X		X
6			X	X
7	X			
8		X		
9			X	
0				X

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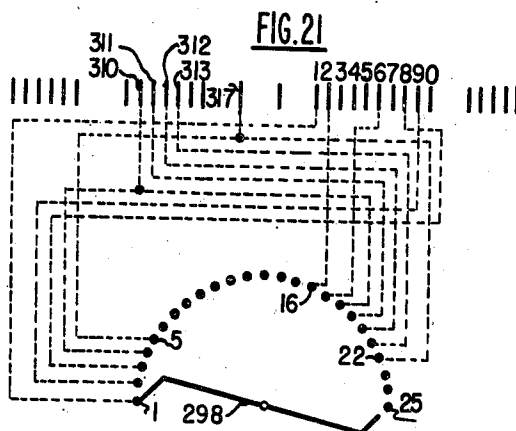
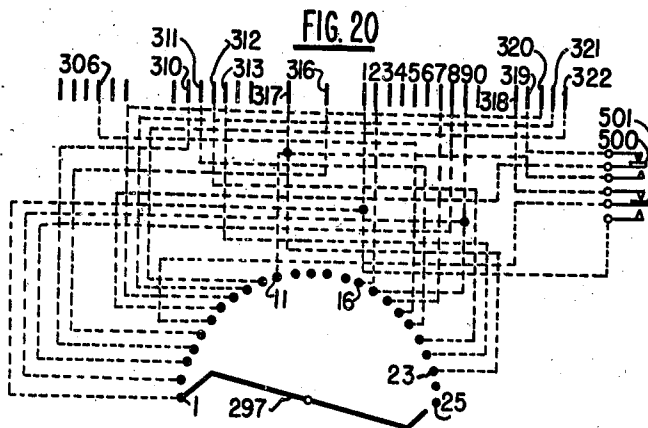
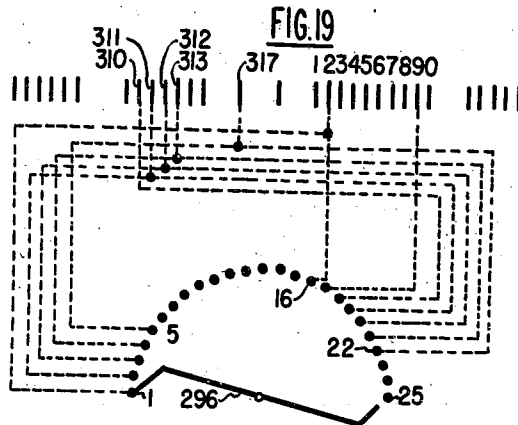
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INVENTOR.
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FIG. 22

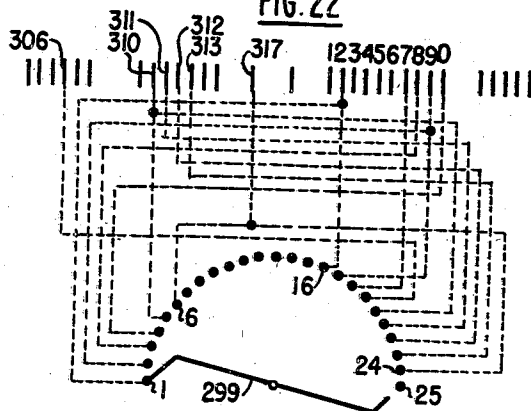


FIG. 23

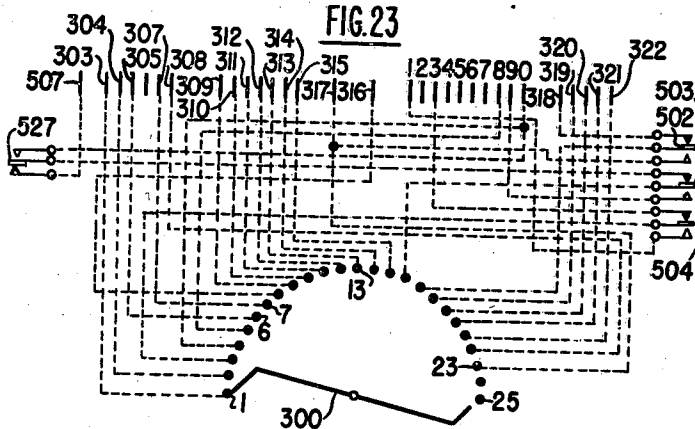
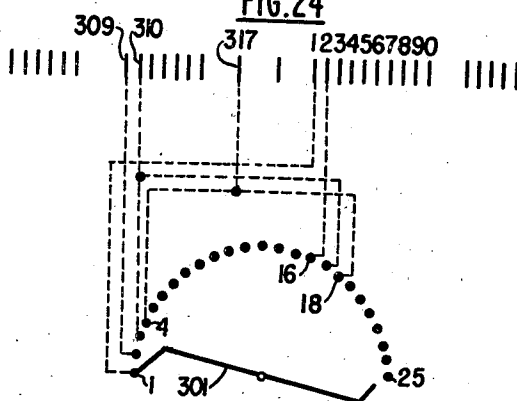


FIG. 24



INVENTOR.
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Jan. 18, 1944.

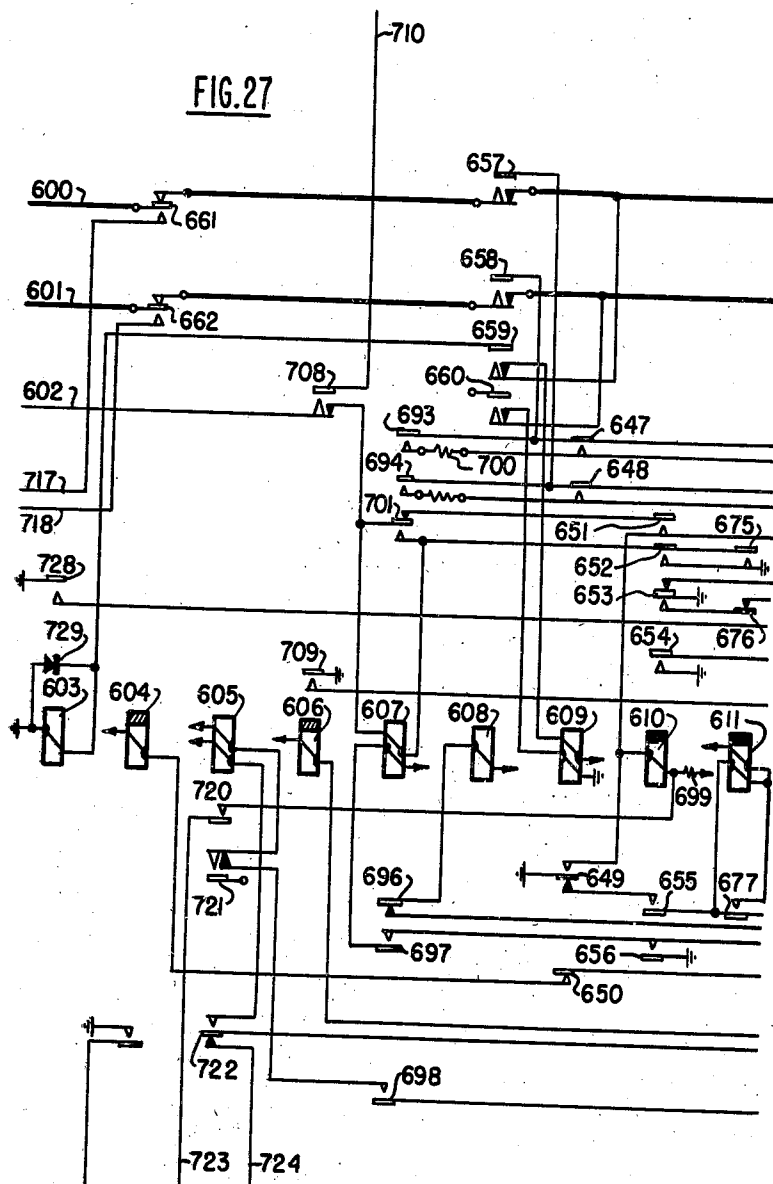
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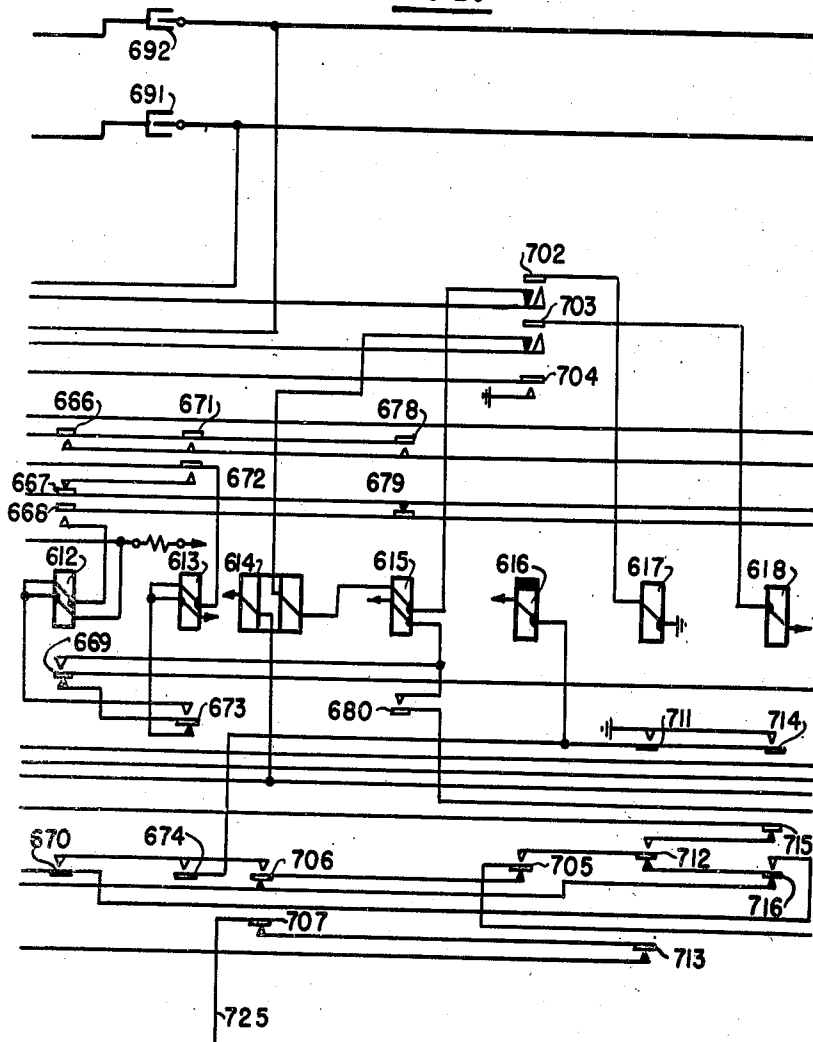
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FIG. 28



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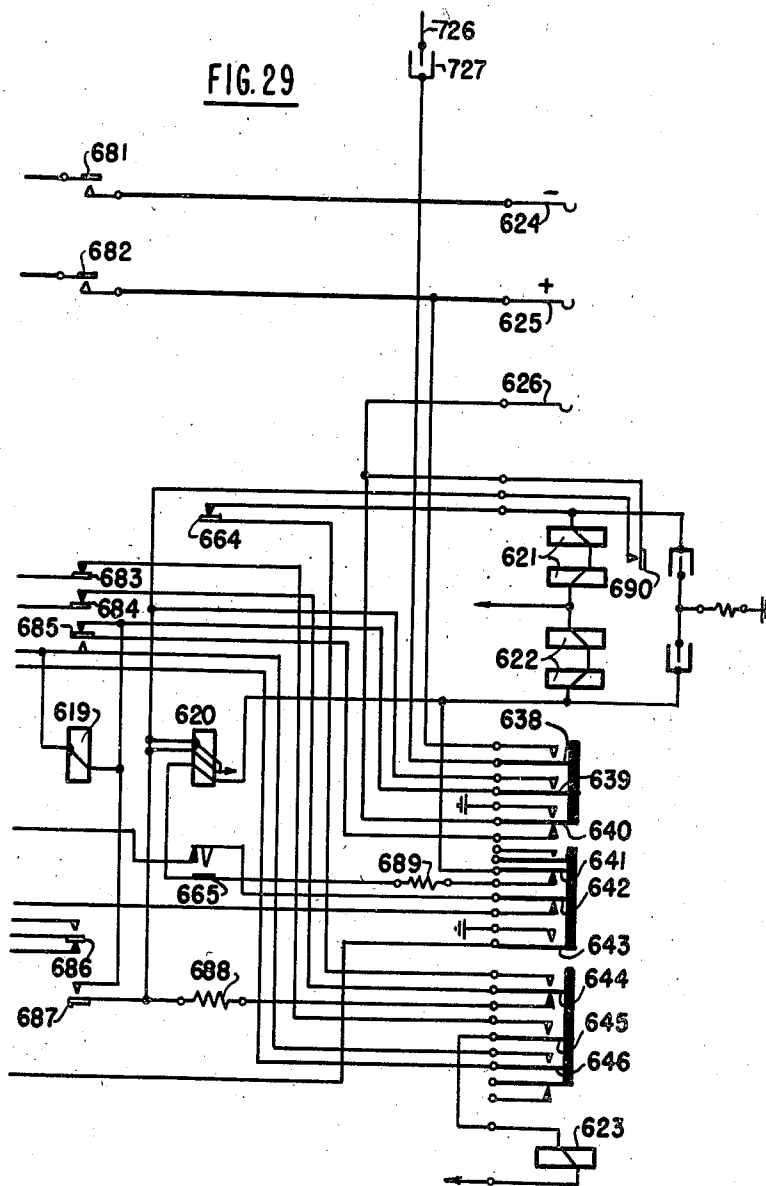
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INVENTOR.
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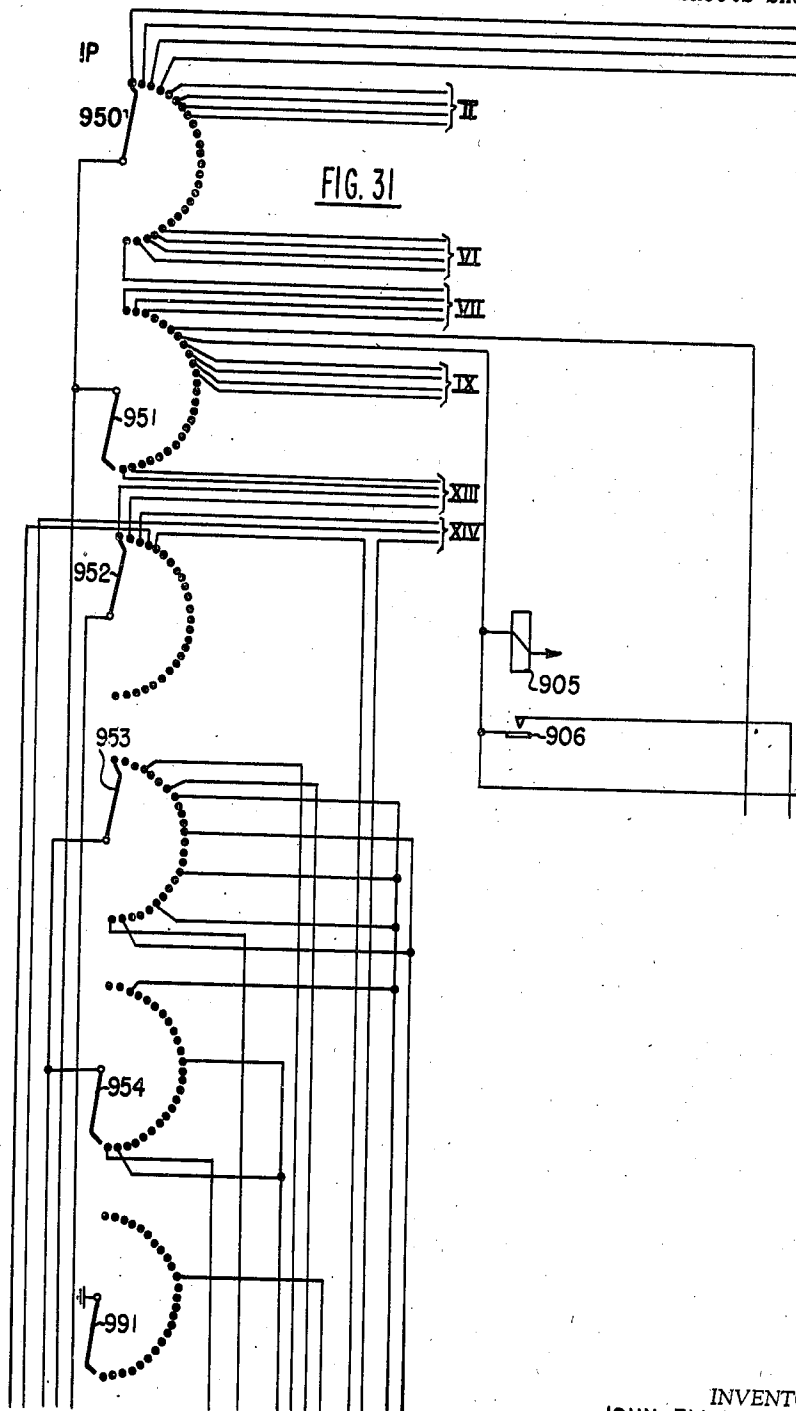
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TELEPHONE SYSTEM

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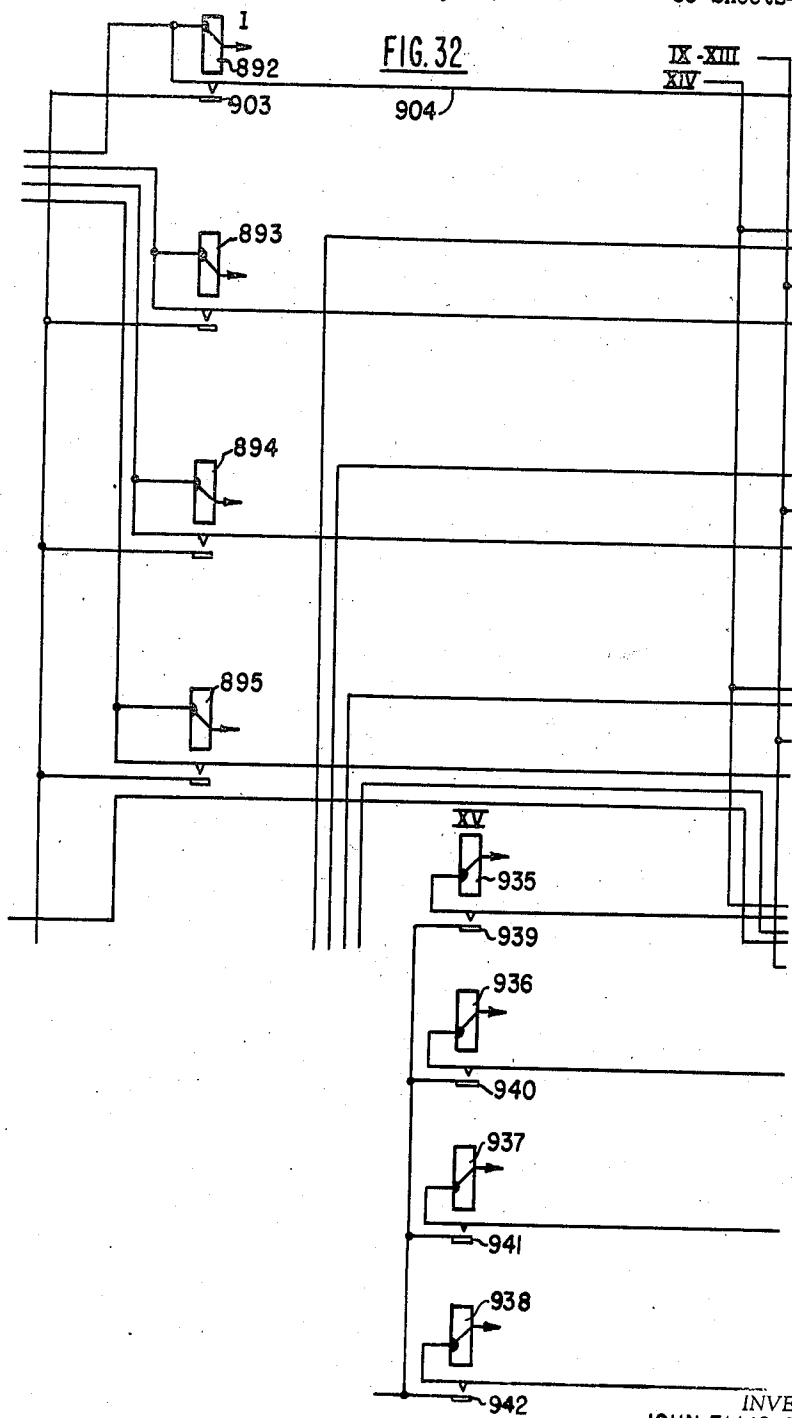
J. E. OSTLINE

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TELEPHONE SYSTEM

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39 Sheets-Sheet 24



INVENTOR.
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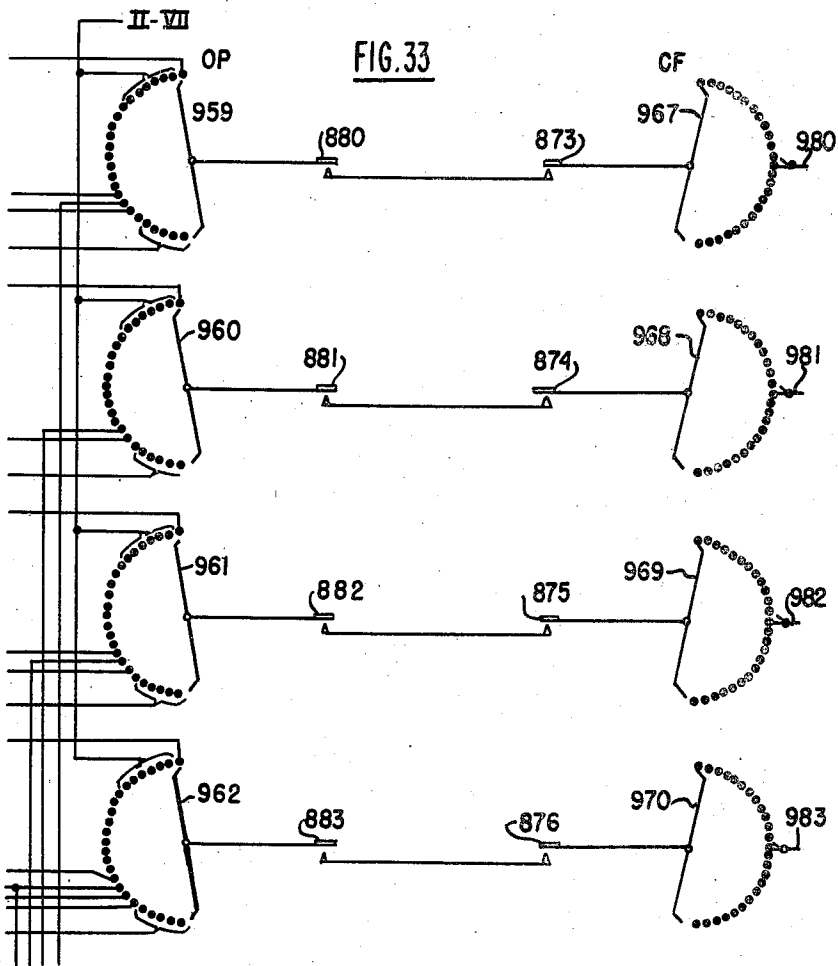
J. E. OSTLINE

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TELEPHONE SYSTEM

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INVENTOR.
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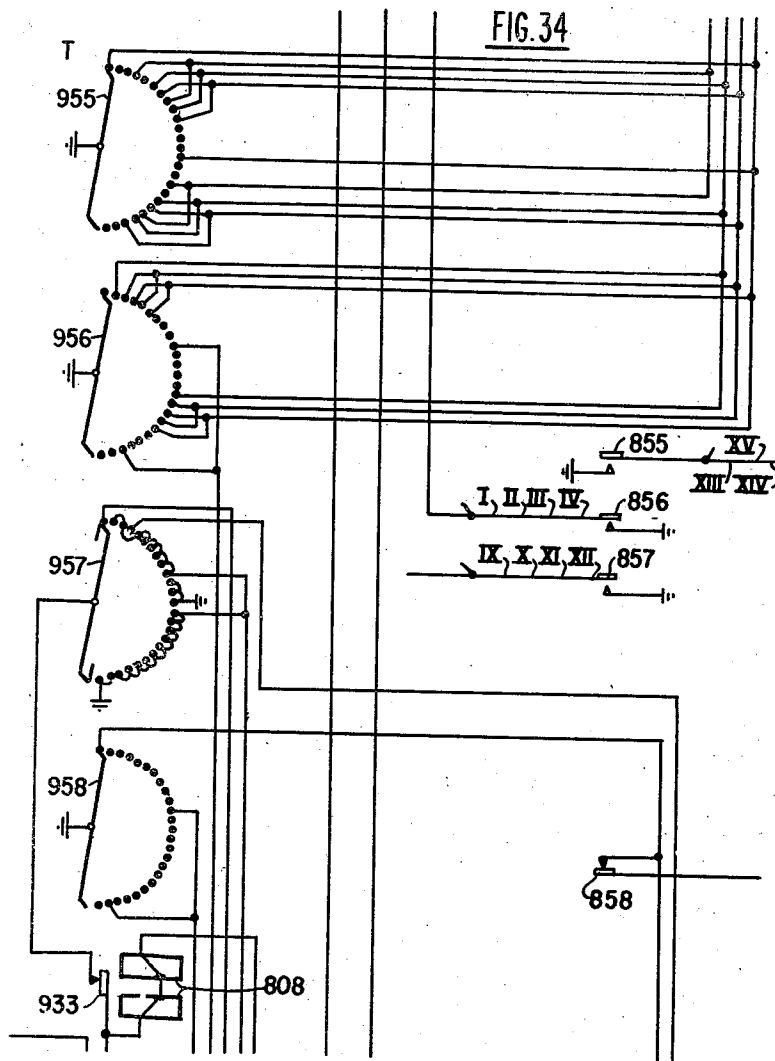
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TELEPHONE SYSTEM

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INVENTOR.
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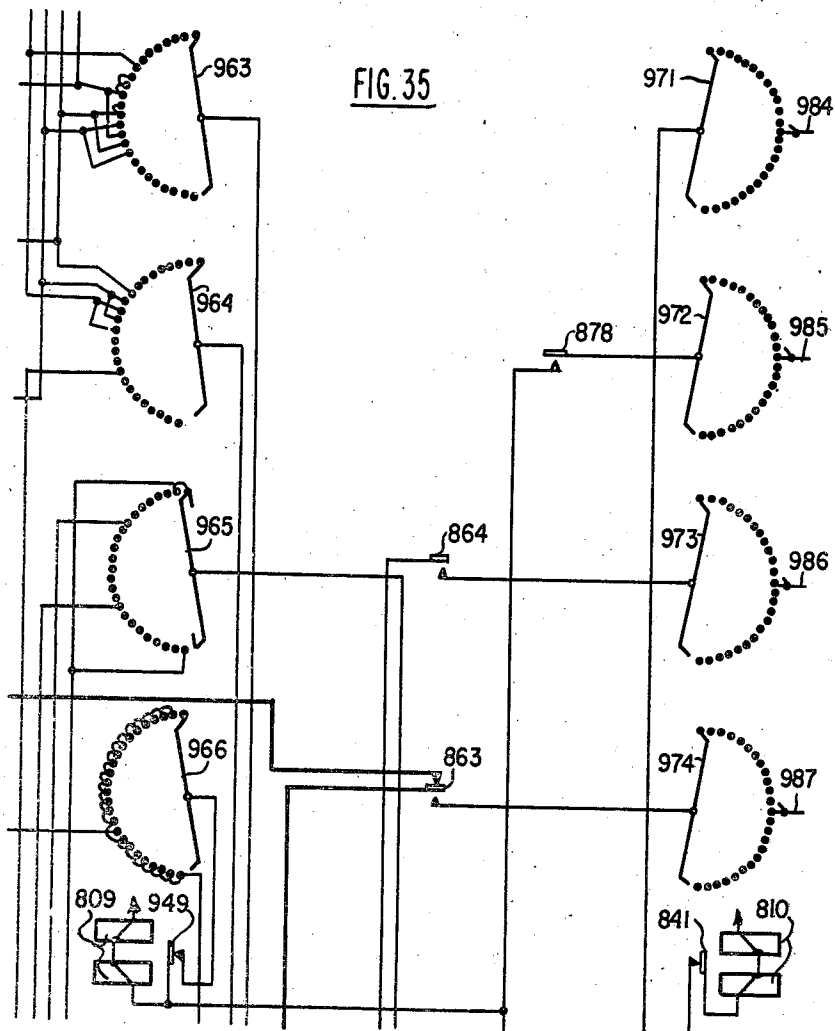
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TELEPHONE SYSTEM

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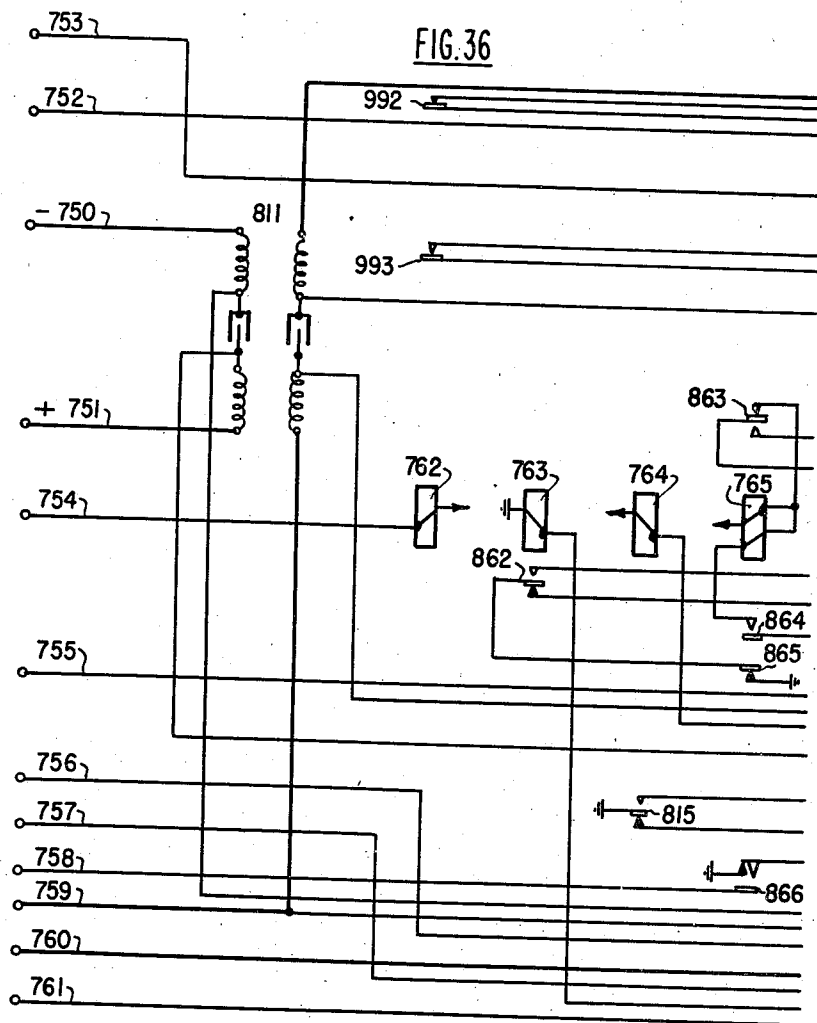
J. E. OSTLINE

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TELEPHONE SYSTEM

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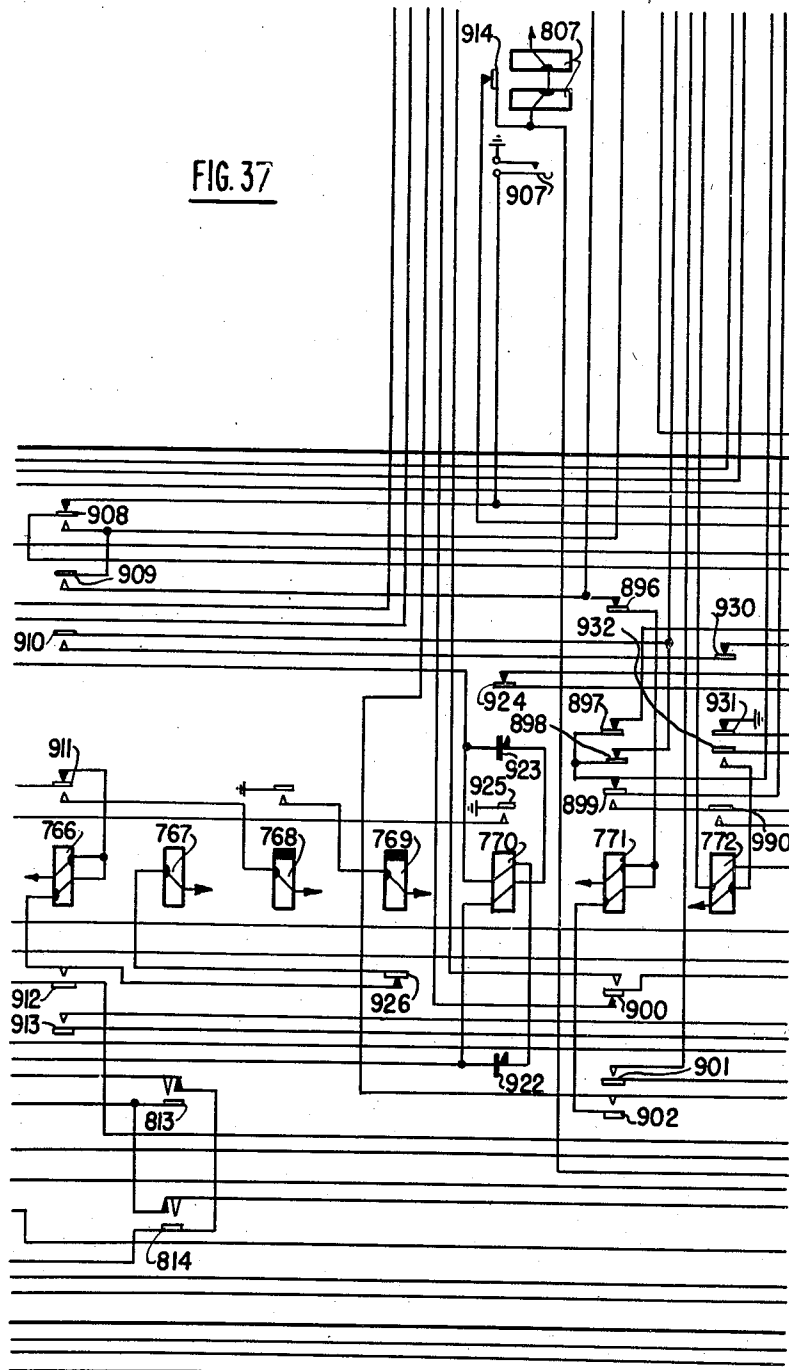
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FIG. 37



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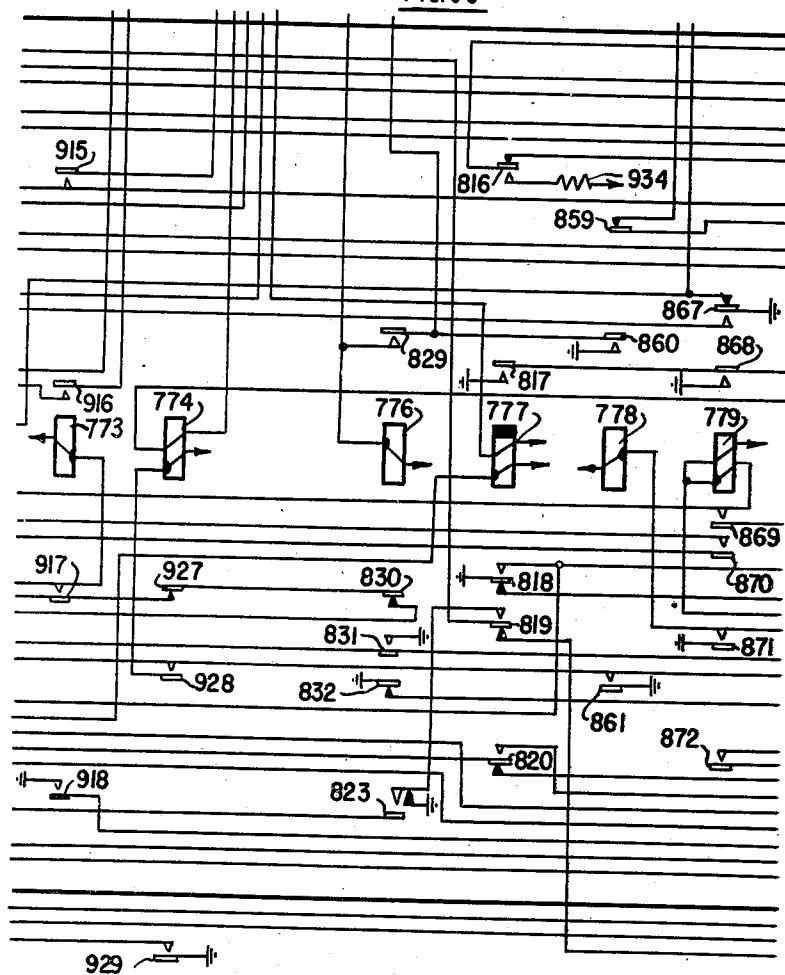
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FIG. 38



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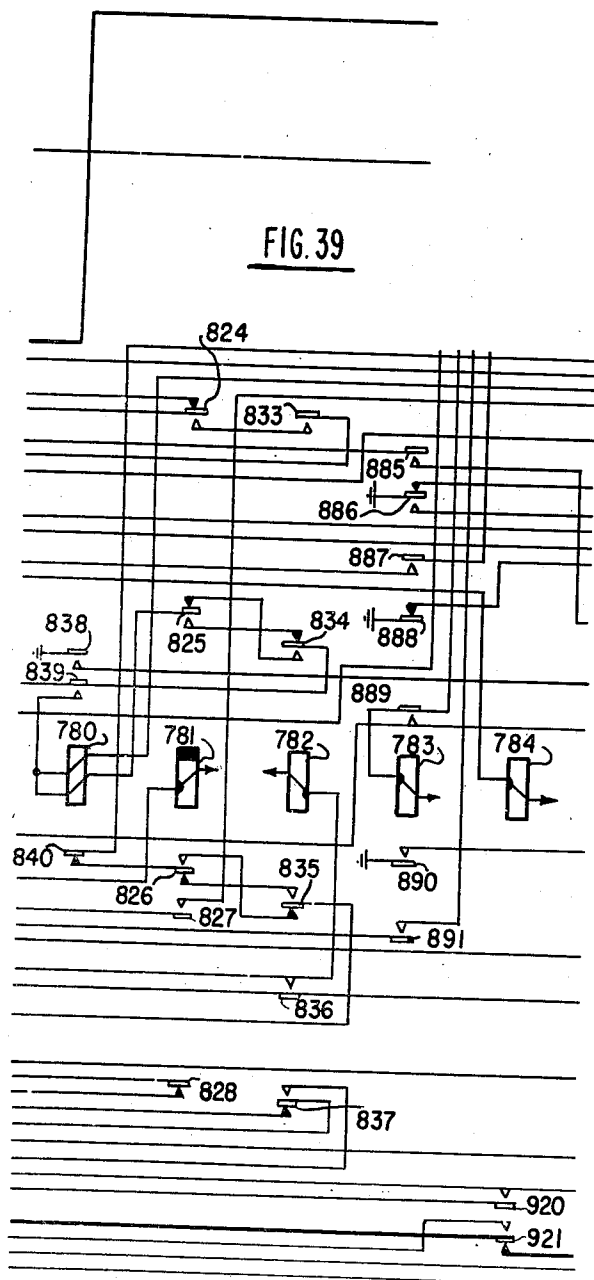
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TELEPHONE SYSTEM

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INVENTOR.
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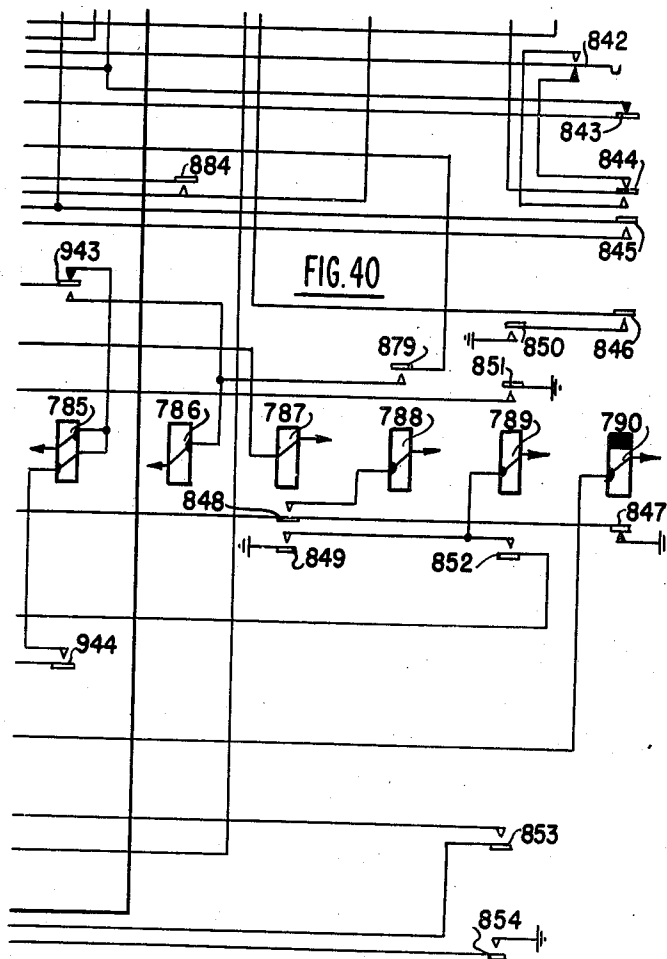
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TELEPHONE SYSTEM

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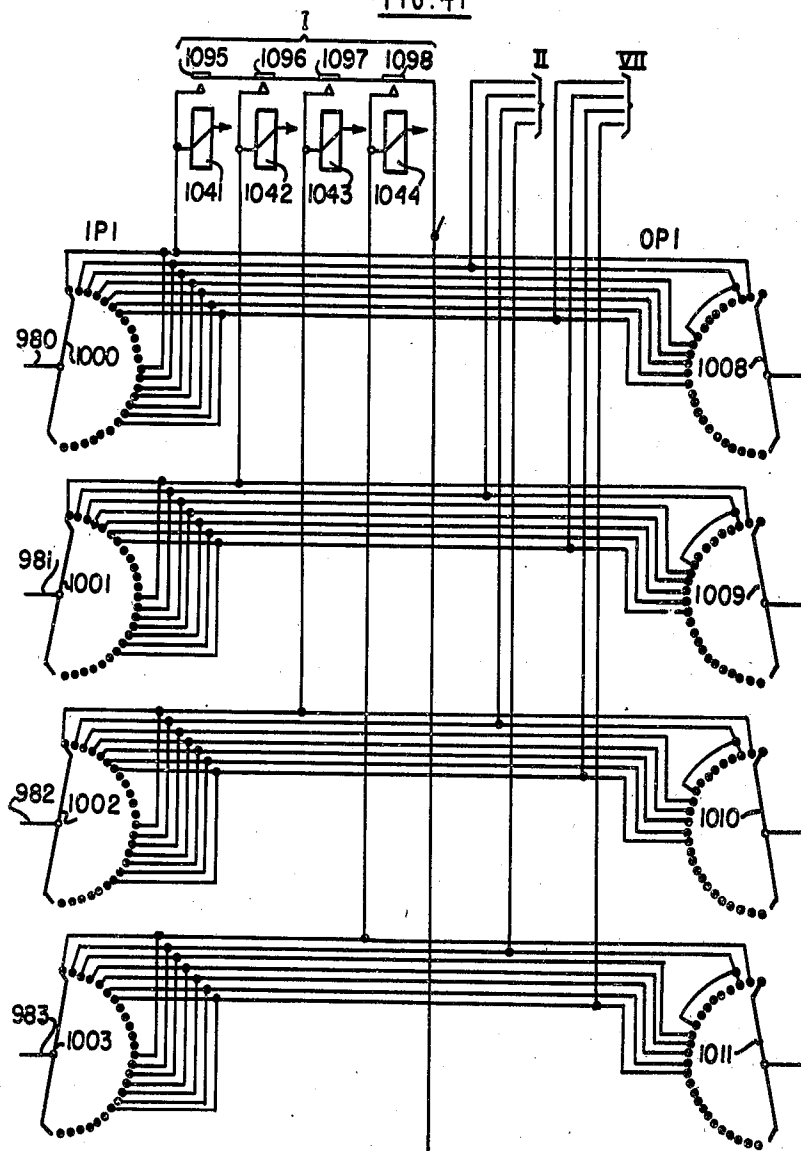
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FIG. 41



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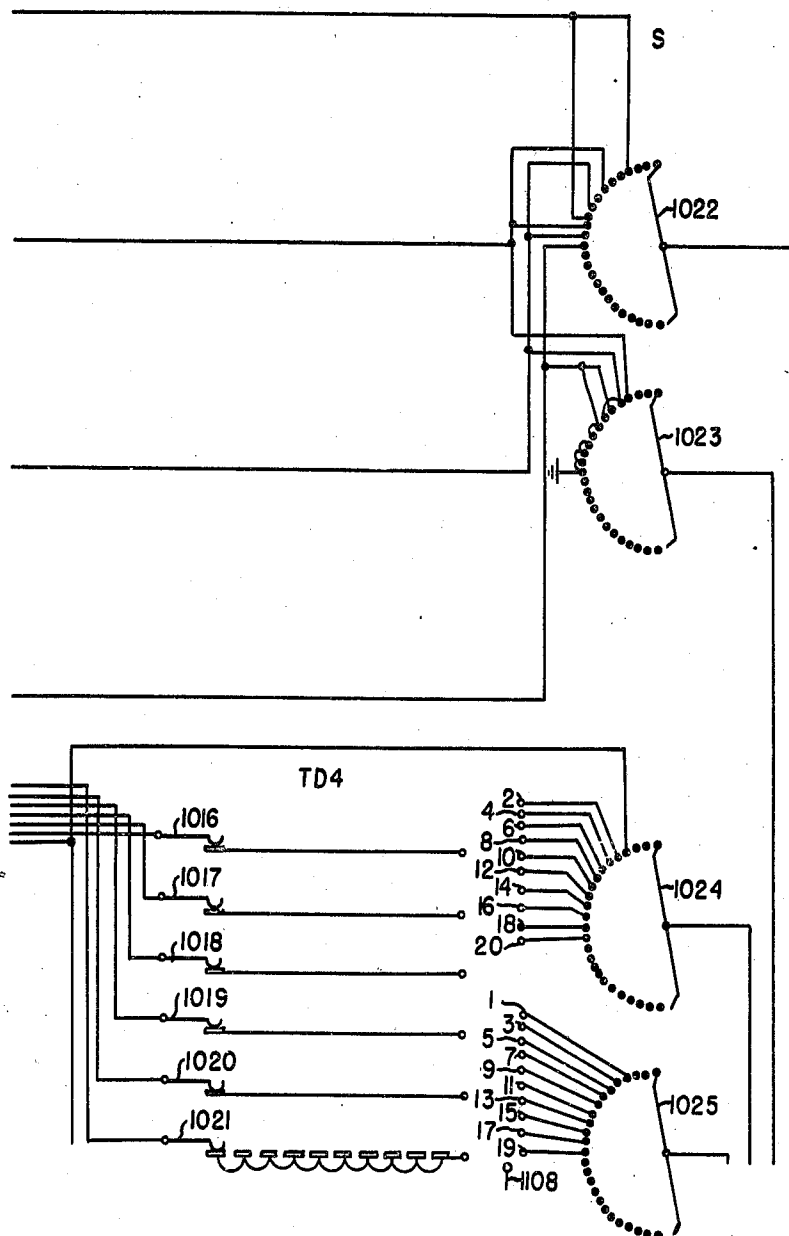
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FIG. 42



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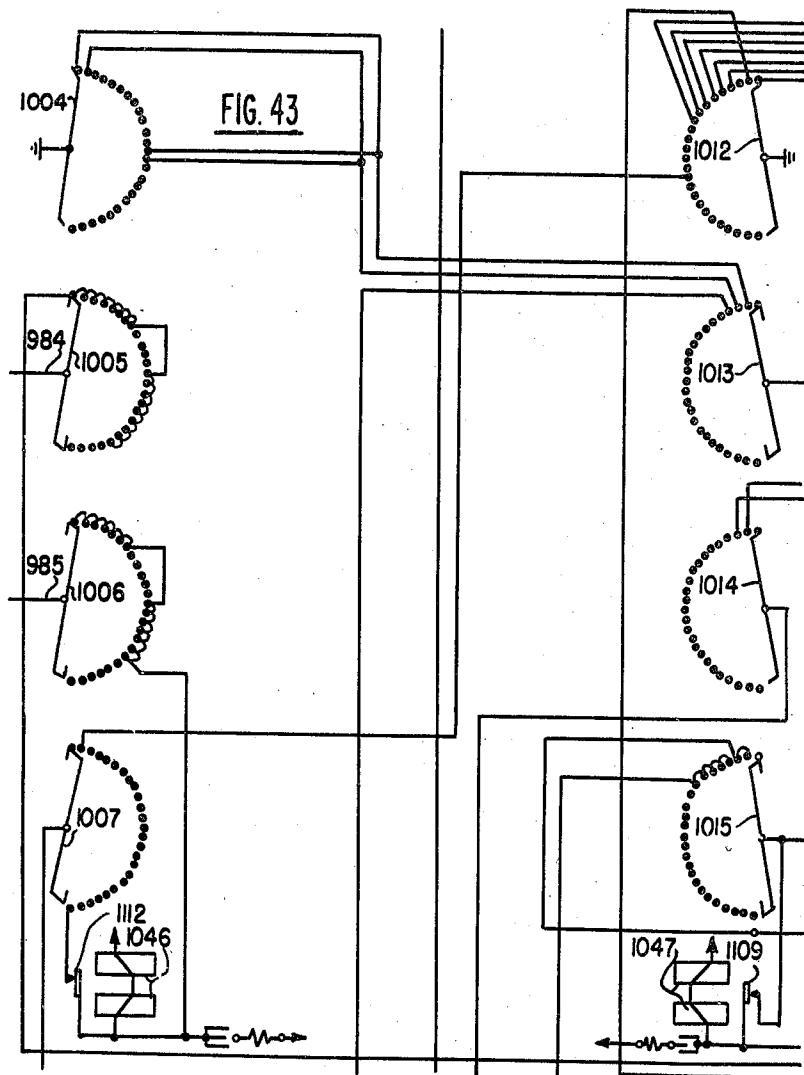
J. E. OSTLINE

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TELEPHONE SYSTEM

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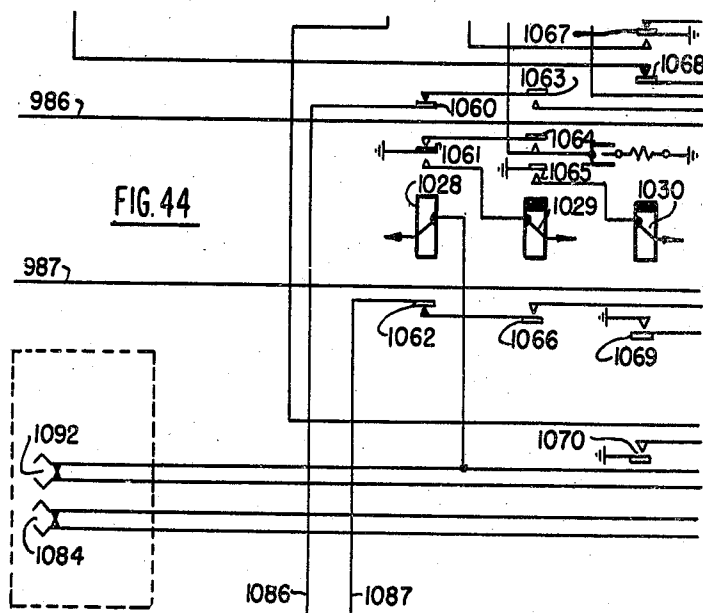
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TELEPHONE SYSTEM

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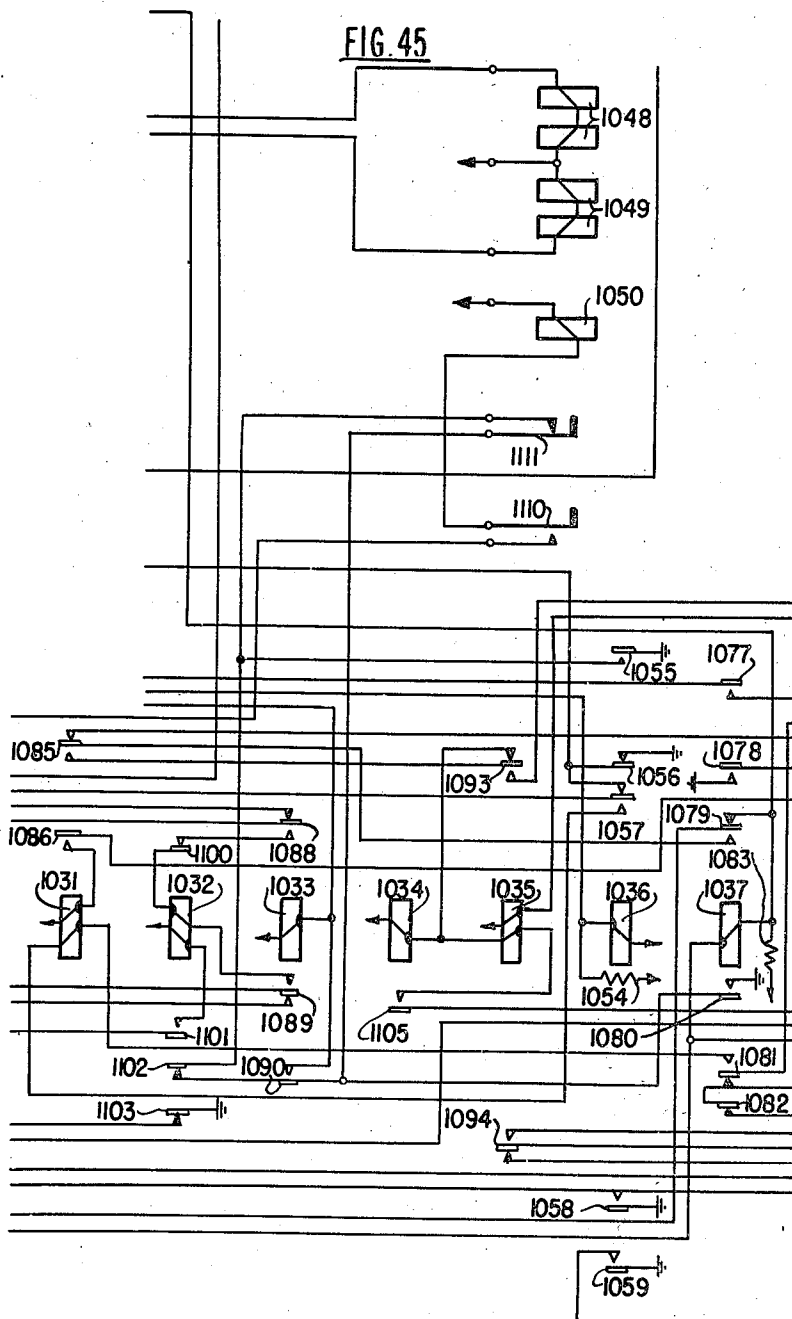
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TELEPHONE SYSTEM

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39 Sheets-Sheet 37



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Jan. 18, 1944.

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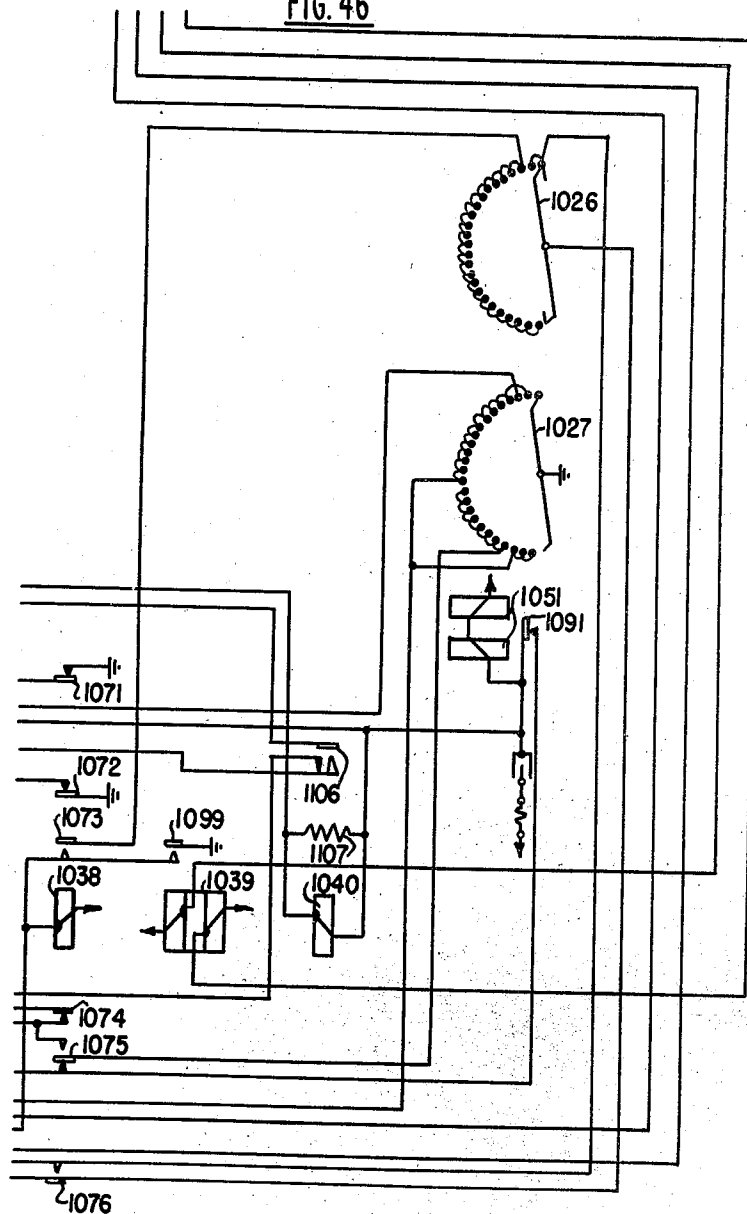
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FIG. 46



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Filed May 28, 1942

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FIG. 47

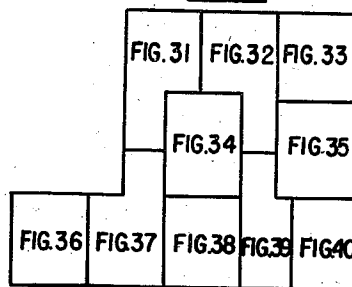
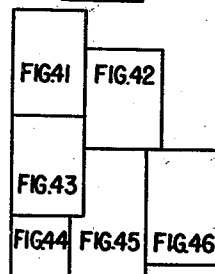


FIG. 48



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UNITED STATES PATENT OFFICE

2,339,709

TELEPHONE SYSTEM

John Ellis Ostline, Chicago, Ill., assignor to Automatic Electric Laboratories, Inc., a corporation of Delaware

Original application June 12, 1939, Serial No. 278,727. Divided and this application May 28, 1942, Serial No. 444,812. In Great Britain June 14, 1938

16 Claims. (Cl. 179—18)

The present invention concerns improvements in or relating to telephone systems, and while it is more particularly concerned with the linking of networks by automatic switching means which have previously been linked solely by manual switching means or with the extension of a network by linking up exchanges by automatic switching means which due to their geographic position with respect to a network have previously been linked up to such network by manual switching means (for instance, in Great Britain, the invention would be concerned with the setting up of trunk calls or toll calls respectively by automatic switching means), the invention also has applications within networks as will be referred to hereinafter. The present application is a division of my co-pending application Serial No. 278,727, filed June 12, 1939.

Generally speaking, a network as it exists at present consists of a number of exchanges suitably interconnected by cables or junction lines which are either now or it is intended will be equipped for automatic working and automatic interworking.

Associated with each network there are usually a number of other exchanges which are too far distant from the centre of the network to be conveniently dealt with in the same manner. For instance, it may be desirable to route such calls in a special manner and to depart from the unit fee rate for calls to and from such exchanges as may be adopted for exchanges within a certain distance of the centre of the network.

One object of this invention is to extend the area over which calls can be automatically set up by linking up exchanges within the network either by incorporating them in the same designation plan which is employed for every exchange in the network while providing special facilities for separately charging and routing such calls, or if it is not convenient to incorporate such exchanges in the same designation plan either because the exchanges are more conveniently situated for inclusion in a different network having its own designation plan or for any other reason, such as the fact that the inclusion of certain exchanges, would necessitate a modification of the designation plan proposed or in operation, then such exchanges and subscribers

connected thereto would be designated according to a different plan.

As examples of the latter, a designation plan of a network may be based upon five digits and the addition of a certain exchange or exchanges may involve a changeover to a six digit system. Similarly in an area where the designation plan is such that exchanges are represented by their initial letters it may be inconvenient to add certain other exchanges to the same designation plan because of conflict of name.

For the purpose of setting up calls between exchanges operating on different designation plans, it is convenient to allot to the designation of each subscriber or party on a designation plan, an additional distinctive digit or digits which may be prefixed to the number to be used by subscribers on the same designation plan to indicate that the call is between networks.

By "designation plan" is meant the plan according to which subscribers and other parties in an area are allotted their distinctive designation which may be all numbers or letters and numbers or all letters, and which calling parties in the area are to use alone in establishing a connection to such subscribers or other parties, and calling parties outside the area are to use if setting up the call automatically after initially sending a digit or digits characteristic of the area. It will be understood that designation plans in different areas may be compiled according to the same or different methods. For convenience, the word "zone" will be used in this specification to indicate the area covered by a network of exchanges having the same designation plan. A zone will be considered as formed of two parts, the "urban area" of a zone in which subscribers may call each other for the same unit fee, or in which such calls can be registered on the subscriber's individual meter, such area being usually the area within a certain distance of a suitably selected point in the zone, and the "suburban area" of a zone, for calls to and from which special charging arrangements have to be provided such as ticket printing equipment, which area falls outside the said distance and not within the area of another zone.

Another object of the invention is to set up calls from within an area covered by a network of exchanges, having the same designation plan

in a novel manner which permits of local calls and calls outside the area being controlled by equipment capable of being used for either purpose.

Another object of the invention is to control the setting up of a call outside from within an area covered by a network of exchanges having the same designation plan to other exchanges both within and without the area over routes having appropriate transmission characteristics having regard to the originating and destination exchanges.

According to one feature of the invention the stage of the connection which serves for the collection of information for automatically recording particulars of a call, for instance for charging purposes is also employed for controlling the further setting up of the connection. In the case of a call to outside the zone the whole of the distinctive digits of a called party are, after the appropriate switches have been operated to select an appropriate line outgoing from the zone, transferred to a register translator or converter to enable control of the connection to the wanted party in the distant zone to be effected in an appropriate manner; for instance, it may be desirable to effect the control to a distant exchange by means of voice frequency impulses or over a carrier channel or in any way different from or including the normal direct current impulsing method whichever may be considered desirable; or again the zones concerned may employ different kinds of automatic switching or they may operate on different numerical systems, and the appropriate control could be effected from the converter without involving any change in the telephone equipment in the rest of the zone. Or again, it may be desirable to have the converter, in addition to controlling the numerical positioning of the various switches used in establishing a connection, control the bringing into operation of repeaters or the selection of an appropriate quality of junction line, particularly when it is borne in mind that inter-zone calls may involve connections through one or more intermediate zones. Again, the converter in the case where there are a number of intermediate zones may add appropriate additional numerical controls to effect the establishment of the connection to the wanted zone before effecting the selection of the exchange required and of the wanted subscriber.

A further feature of the invention concerns an arrangement whereby the calling party's number after identification is transmitted over the connection to a point where it is stored preparatory to the operation of the recording equipment. By storing in this manner it is possible to have a check on the reception of the complete information before recording takes place or even to provide special checking means operative under control of the calling party's number as stored to make sure that no error has occurred in transmission.

According to a further feature of the invention equipment taken into use when the calling party's line is in a particular condition which, in response to varying kinds of control exerted thereon, routes the call to corresponding destinations and causes the calling party's identification to be transmitted over the connection set up at an appropriate stage on the setting up thereof.

Of the varying kinds of control which bring about this result may be mentioned calls for subscribers outside the zone of the calling party,

calls for subscribers inside the zone of the calling party but for which the charge is greater than a predetermined amount or over a particular junction line, calls to a manual operator's position, calls initiated due to faults, for instance on the calling line, or delays on the part of the calling party to complete his dialling. The latter type of control enables incorrect functioning on the part of the equipment or of the subscriber to be checked.

Another important feature of the invention is the employment of code signalling to enable particulars of a connection to be transmitted from one point to another in the shortest time; such particulars may include the called number, the calling number, the charging rate and possibly other information of a special character. The code preferably consists of a small but constant number of impulses for each digit dialled or each item of a piece of information in which the individual impulses are varied in combinations characteristic of the particular value or significance of the individual items. Conveniently the information, or part of it, may be collected at an originating exchange and transmitted to a central exchange in the same zone where the automatic recording takes place.

A further feature of the invention concerns the provision in association with an originating exchange in a zone of a register translator adapted to register the called party's number and to control, in accordance with the destination of the call, both the positioning of the switches over which the connection is to be set up and the determination of the nature of the various operations involved in calls to different kinds of destinations, such as kind of metering; quality of junction lines to be used, whether additional routing digits are to be inserted or not, whether the called party's number is to be transmitted in the usual way by means of series of impulses or in code, and whether the calling party's number is to be transmitted or not for identification or for record purposes.

As examples of the means which may be incorporated in a register translator according to the invention, in addition to means for controlling the positioning of switches over which the connection is to be set up, may be mentioned, firstly, means for determining the kind of metering to be employed in a connection, that is to say, whether the subscriber's meters are to be operated or the call is to be recorded on a ticket printing equipment or whether the charge is to be effected by an operator marking out a ticket as is usual in connection with trunk and toll calls; secondly, means for determining the quality of junction lines to be taken into use having regard to the destination of the call, for instance, local calls may be set up over poor quality junction lines, trunk lines to distant exchanges involving use of repeaters may also be set up over poor junction lines, while calls to less distant exchanges not involving the use of repeaters may be set up over good quality lines; thirdly, means for determining whether the connection may be set up by digits corresponding to the called party's number or by the addition of extra digits or by digits quite independent of the called party's number to route the call to a position or junction line determined by the initial registration; fourthly, means for determining whether the called party's number is to be transmitted in code, and also at what stage in the setting up of the connection it is to be transmitted; the transmis-

sion in code would take place in conditions where it was desirable to store the called party's number either for transmission to another zone or for operating ticket printing equipment or for operating a called indicator; fifthly, means for determining whether or not a signal is to be sent forward indicating that the calling subscriber required information, for instance, the subscriber may dial an extra digit, and the register translator in response thereto causes the signal to be given to an attendant and possibly a ticket to be printed with a special marking so that the subscriber may be advised on the termination of a call of its cost or any other particulars he may require; sixthly, means for determining if the register is arranged to record the calling party's number as will generally be the case whether the calling party's number is to be transmitted, for instance, for the purpose of operating a ticket printing equipment, to record full particulars of the call or, in the case of a permanent short on the line, to advise the attendant of the number of the faulty line or, for operating a call indicator equipment, to advise an operator of the number of the calling party.

It will be understood that the invention is applicable to a register translator embodying any one or any combination of the above mentioned determining means by which the nature of the various operations involved in calls to different kinds of destinations is controlled.

According to yet a further feature of the invention a register translator arranged to control the setting up of a connection is provided with a plurality of progressively operated switching devices, one of which is selected in accordance with the initial operation of the register translator to bring about successively the various steps required in the setting up of a connection in accordance with the particular kind of connection determined by such initial operation.

According to another feature of the invention a register translator arranged to control the setting up of a connection determines in accordance with the initial digit or digits to which the register translator first responds, whether the call is to a subscriber in a distant or the same zone as the calling party, and if in a distant zone exerts a control to enable a second register translator to control the setting up of the connection and particulars of the calling party's number to be transmitted to enable automatic recording to take place.

According to another feature of the invention the same register switching device of a register translator is adapted to effect different sequences of controlling operations for the setting up of connections according as to whether it is initially operated by a predetermined digit or digits or not. For instance, a register switching device may respond to the first digits dialled and if the call is for outside the zone of the calling party, then the switching device will release in response to the initially dialled digits, and respond to the next succeeding digits. In the case where the switching device does not release, the sequence of operations or the particular digit or digits registered on said switching device will correspond to the setting up of a particular local call dependent upon the values of such digit or digits. If the call is for outside the zone then the digit or digits to which the register device responds will control a different sequence of controlling operations so that the same setting of such register switching device may effect different se-

quences of controlling operations, according as to whether it is initially operated by a predetermined digit or digits or not.

Conveniently the progressively operated switching device consists of wipers of a switch and their associated bank contacts, or parts of certain rows of bank contacts. Different wipers, and possible different parts of rows of bank contacts, are selected according as to whether the call is a local call, is a call to a satellite exchange of one capacity, say less than 100 lines, or is to a satellite exchange of another capacity, say less than 1000 lines, or is to a central exchange in the same urban area, or is to an exchange in a suburban area, or is to a calling party outside the zone which requires high grade junction lines, or is to a zone outside which requires low grade junction lines and the use of repeaters, whether it is to an operator such as in the case of a trunk call where the operator requires to register particulars of a call on a ticket, or is set up automatically, in which case it is necessary to send from the register translator full particulars of the call, including the calling and called parties' number in full and the charging rate and whether the subscriber requires to be advised of the particulars of the call, whether the call is an international call, whether the call is for the time or is to a manual exchange, and also if a call can be set up over a special route which may be available instead of through a central exchange. Furthermore, a special setting up could be provided in the case of either a subscriber leaving his receiver off the hook for an indefinite time, or there being a short on his line in which case the information on the calling line can be transmitted to an operator's desk or printed on a ticket for the attention of the attendants' concerned.

According to a further feature of the invention, a calling determining device is adapted to be taken into use by calls originating in a certain exchange to register the destination of a call and to control the route over which the call to a distant exchange is set up, and in addition to determine which of alternative lines or cables between respective exchanges is to be taken into use so as to enable the transmission characteristics of connections to be adjusted in accordance with the final destination of the call.

The invention will be better understood by referring to the following description of one arrangement for carrying the invention into effect which is described by way of example only with respect to a particular numbering scheme proposed for Belgium, and it will be understood that the invention is equally applicable for use with different numbering schemes although considerable changes will be necessary in the constructional and circuit details. For instance, in application of an area such as London where the numbering scheme is based upon three initial letters followed by four numbers, it is possible to precede the three initial letters by, say, two or three digits (the digit "0" having already been used for other purposes) which do not correspond to the first letters of the name of an exchange in the London zone to indicate that a call is required to outside the London zone, for instance, to a toll exchange outside the London zone or to an exchange in a distant zone having either the same numbering scheme as the London area or a different one. The transmission of the preliminary digits would bring about a change in the register translator so that the same initial

letters, for instance, could bring about a different control from that which would be exerted if the preliminary digits were omitted.

In the drawings

Fig. 1 shows a network of exchanges forming a zone having the same designation plan and showing both urban and suburban areas. It also shows trunk lines leading from the central exchange of the zone towards other zones and also nearby exchanges of other zones.

Fig. 2 shows in diagrammatic form some of the units of equipment at the central exchange and at one other exchange for the purpose of illustrating the invention.

Figs. 3 and 4 show sufficient elements of a known finder switch circuit to illustrate modifications incorporated in view of the invention.

Figs. 5 and 6 illustrate the register translator finder circuits.

Figs. 7-16 illustrate the register translator for use at other than the central exchange. These figures should be arranged as shown in Fig. 17 to give the complete circuit.

Fig. 18 shows a table indicating the manner in which digits are transmitted in code.

Figs. 19-26 show the cross connections extending between the banks of the route control switch RS6 which forms part of the register translator, to various conductors shown adjacent the banks thereof in Fig. 12.

Figs. 27-29 show the circuits of the first group selector.

Fig. 30 shows a junction line circuit.

Figs. 31-40 show a toll line control circuit located at a central exchange which serves to store all the information transmitted from the register translator, and to time the duration of the call. These figures should be arranged as shown in Fig. 47 to give the complete circuit.

Figs. 41-46 show a register translator converter which receives the called party's number from the toll trunk line circuit and converts it into the required routing digits. These figures should be arranged as shown in Fig. 48 to give the complete circuit.

For the purpose of determining the charge for a particular telephone connection, the whole of Belgium has been divided up into zones, each zone being drawn as far as possible with an important town at the centre and being designated by the central two, for instance there is a Mons zone, a Brussels zone, a Charleroi zone, a Tournai zone and so on. Each zone is then divided up into an urban area which includes all exchanges within approximately 10 kilometers from the centre of the zone and into a suburban area which includes exchanges outside the 10 kilometer area but which properly belong to the zone.

For instance referring to Fig. 1 which shows the Mons zone, with the central exchange at Mons the exchange Hautrage is an example of an exchange in the urban area US, St. Ghislain is another, while Dour exchange is an example of an exchange in a suburban area SS. The limits of the zone are indicated by the heavy chain-dotted line.

The determination of the charge which is to be made for a call is effected in accordance with the straight-line distance between the exchanges and in this particular example, a call between any two exchanges within the urban area is considered to be unit rate call. The same applies to certain calls from exchange within the urban area to exchanges in the suburban area. Thus

for example, calls from St. Ghislain to Dour are to be considered as unit rate calls and for this reason the area which covers these exchanges is shown shaded in Fig. 1. Calls between other urban exchanges and Dour, however, are considered as multi-rate calls.

In general calls between exchanges of different zones will be multi-rate calls but here again since charges are based on straight-line distances between the exchanges, a certain amount of adjustment is necessary. Thus in Fig. 1 the exchange Blaton is in the Tournai zone but calls between this exchange and Hautrage are considered as unit rate calls as indicated by the shaded area which includes these exchanges.

It is to be noted that at present Blaton is a manual exchange and has direct junctions to Hautrage. When, however, conversion to automatic working takes place the direct junctions may be dispensed with and a call from Hautrage to Blaton may then be set up through the Mons central exchange, the Brussels central exchange, the Tournai central exchange and thence to Blaton. In addition the connection may include repeaters but the call will still be considered a unit rate one.

Similarly Dour is at present manual with a direct junction to St. Ghislain. When Dour is converted to automatic working this junction may be dispensed with and a direct junction between Dour and Mons central provided so that a connection between Dour and St. Ghislain will be set up over the Mons central exchange although the call will still be considered as a unit rate call.

The junction lines extending between the Mons central exchange and the various exchanges within the zone and the toll lines extending between the Mons central exchange and other central exchanges are of two grades which may be termed "good" and "poor." The grade of junction to be used on a particular call and whether repeaters are to be used is determined in accordance with the destination of the call. For instance on local calls "a poor" junction line is employed but on toll calls a "good" junction and a "good" toll line are employed. The "poor" and "good" grades of junctions are indicated in Fig. 1 by the light and heavy lines connecting the Mons central exchange to the other exchanges in the urban sector and by the light and heavy lines extending from the Mons central exchange to other central exchanges.

With regard to the numbering scheme, each subscriber is allocated a five-figure number which is for use on local calls only that is to say for calls within the same zone including urban and suburban exchanges. For calls outside the zone the calling subscriber will be instructed to dial three additional digits of which the first is always zero and the next two are distinctive of the particular zone which includes the desired exchange.

As an example, subscribers in the Mons exchange which has an ultimate capacity of 8000 lines have numbers which will begin with the digit 2 followed by one of the digits 1 to 6 and 9 to 0; Hautrage subscribers having an ultimate capacity of 600 lines have numbers which will begin with the digits 57 and Dour with an ultimate capacity of 1200 lines have numbers which will begin with the digit 6 followed by the digit 1 or 2. Finally, St. Ghislain with an ultimate capacity of 3000 will begin with the digit 3 followed by the digit 1, 2 or 3. It will be of advantage at this point to describe in general the setting up of the various possible connections between

the exchanges in the Mons zone. In the first place all connections from Hautrage, with the possible exception of direct calls to St. Ghislain, will eventually pass through the Mons central exchange although in the meantime provision may be made for direct calls to other nearby exchanges such as Blaton. Connections to other exchanges of the zone are trunked through Mons.

In connection with the arrangements for assessing the charge for or the metering of connections, it should be explained that three types are possible. On unit rate calls within the Mons urban area, the call is metered by the calling party's meter in the usual manner. On all other calls the metering will be effected either automatically by ticketing or printing equipment located at the Mons central exchange or for certain calls such as toll or inter-zone calls which the subscriber desires to have set up by an operator, or international calls by the operator making out a ticket.

It is also to be noted that on calls from an exchange which is still manual such as Dour the operator is provided with the necessary equipment to set up the various calls automatically, the type of metering employed being based on the considerations mentioned above.

It will thus be understood that it is essential to provide at each of the automatic exchanges arrangements whereby the routing of the connection, the type of metering which is to be employed, the grade of junction and toll lines which are to be used in setting up the connection and finally the rate at which the call is to be charged and determined. Further the arrangement should be able if necessary to store the calling and called parties numbers for subsequent transmission to the automatic ticketing equipment at Mons. The arrangement employed at each automatic exchange takes the form of a register translator.

Reference will now be made to Fig. 2 of the drawings which shows the trunking layout at the exchanges of Hautrage and Mons. It is to be understood however that only that part of the layout which is essential for an understanding of the invention has been shown. Both exchanges employ a finder switch system but the arrangement of the finder switches at Hautrage only has been shown since that at Mons is in all respect similar.

The subscribers lines are divided into groups of 200 and a group of register translators is usually provided for each group of 2000 lines, a calling line being adapted to be temporarily associated with a register translator of the appropriate group. It will however be understood that since the ultimate capacity of Hautrage is only 600 lines, a single group of register translators is sufficient to deal with all calls. The calling line is associated with a register translator over line finder switches 1LF, 2LF, 1LF1, 2LF1 and over a register translator finder switch RTF, RTF1, the line finders being permanently connected respectively to first group selectors 1GS, 2GS, 1GS1, 2GS1. Each line finder has two sets of wipers and thus has access to 200 lines and in the example of Figure 2, line finders have access to the lines numbered as shown. The register-translator finder RTF, and RTF1 are respectively common to line finders 1LF and 2LF and 1LF1 and 2LF1. It will of course be understood that in an exchange of larger capacity than Hautrage there will be other pairs of line finders having different subscribers numbers within the 2000 line group

terminating at their banks which will also have access to the same register-translators.

With regard to the recording of the calling party's number, the two thousand line group including the calling line is determined by a permanent connection in the register translator itself since as stated above each register translator serves a particular group of 2000 subscribers lines. At Hautrage the thousands digit is also determined by a permanent connection in the register translator while in an exchange of larger capacity the thousands digit and the two hundred line group including the calling line is determined by the finder switch over which the register translator is seized. The hundreds digit is determined by the set of wipers over which the calling line is reached by the line finder while the tens and units digits are stored in the register translator by causing switches to be operated in synchronism with the vertical and rotary magnets of the line finder.

Each first group selector at Hautrage has access over levels 1, 2, 4, 5, 7 and 8 to local final selectors; over level 3 to junction lines extending to Blaton; over level 6 to junction lines extending to St. Ghislain; over level 9 to "poor" grade junction lines to Mons and over level 0 to "good" grade junction lines to Mons.

The junction lines to Mons terminate on an incoming selector IS which has access over levels 1 to 6, 9 and 10 to local group selectors LGS. Over level 7 the selector IS has access to further selectors such as LS over which access is obtained to junction lines extending to exchanges within the urban area. Over level 8 the selector IS has access to special service selectors such as TS. Over levels 1 and 4 of the selector TS access is had to operator's positions such as OP over a relay group RG2, a register R also being connected up over a finder switch for the purpose of recording the calling party's number. It should be pointed out that while both these levels are shown for convenience as having access to the same operator's position they will in fact have access to different positions. Thus one level may have access to operators' positions at which toll calls are set up while the other level has access to operators' positions at which international calls are set up. Levels 5 to 10 inclusive of the selector TS are employed for setting up any other special services which may be required as such as the speaking clock calls while levels 2 and 3 are employed for setting up connections over the toll lines extending to or over the Brussels and Charleroi central exchanges. The equipment associated with both these levels is similar and has been shown in respect of level 3 only. Each contact on level 3 is connected to a relay group RG which in accordance with the type of call serves to set in operation according as to whether a "good" or "poor" grade junction is required one or other of the toll line finder switches TLF1 and TLF2 to hunt for a toll line control circuit such as TLCC associated with a junction of the appropriate grade. Similar equipment is associated with each toll line but that associated with a "good" grade toll line only has been shown. If a "poor" grade line is required and all are busy, a "good" grade line is seized but if all these are busy, the call is routed to an operator's position such as OP over the last contact in the banks of the toll line finder switches and the relay group RG1 to enable the operator to take what steps may be necessary.

The toll line control circuit TLCC is adapted to be connected over a hunting switch CF with a converter C for setting up the connection and with a printer control unit PC on the termination of the connection. A date and time unit DTU is accessible from the printer control unit. Finally at the end of conversation the printer units PT and PU are adapted to be associated with the printer control unit PC to cause the printing of particulars of the call, one on the toll ticket and the other for record purposes which can conveniently be typed on a single line.

With this general description reference will now be made to the detailed circuits of which Figs. 3-31 represent equipment located at Hautrage exchange while Figs. 31-46, 47 and 48 represent equipment located at Mons central exchange.

DETAILED DESCRIPTION

Line finder and register translator finder

Referring to the line finder switch arrangements shown in Figures 3 and 4 it will be understood that these circuits are only shown in sufficient detail to enable the invention to be understood. A full showing of these circuits is given in British specification No. 376,265 and the present circuits have been shown with detached contacts in order that the differences made in the circuits as shown in the above-mentioned specification may be easily appreciated.

In explaining the detailed operation of the circuits it will be assumed that a subscriber having the number 57109 wishes to make a call and it will further be assumed that the line finder LF is selected for extending the calling party's line to the register translator RT. When the primary distributor switch PDS finds the idle finder switch, relay LK operates over: earth, both windings of relay LK in series, wiper and bank contacts 1a, armature hb2, vertical bank and vertical wiper VW to battery. Relay LK operates and locks over its right-hand winding at armature 1k1 while at armature 1k2 the following circuit is completed: earth, armature 143 or 144 of relay 121 (Figure 5) conductor 100 (Figure 5 and Figure 4) armature 1k2, wiper and bank contact 2a of the switch PDS, conductor 104 (Figs. 4, 5 and 6), armatures 145, 146, windings of relay 112 in series to battery. Relay 112 operates in this circuit and at armature 156 places a short-circuit around its lower winding; at armature 155 connects earth to one terminal of relay 111; at armature 154 completes a testing circuit for the register translator finder RTF; at armature 157 opens a point in the circuit of relay 113 and at armature 159 places earth potential on conductor 105. In addition at armature 158, relay 112 completes the following circuit for energizing relays 115 and 116; earth at armature 158, armature 163, windings of relays 115 and 116 in parallel with resistance 165 to battery.

The register translator finder RTF is not pre-selective in its action and if the wipers of the finder are resting on a contact leading to a busy register translator, earth will be fed back over conductor 135, bank contact and wiper 126 armature 152 in its resting position, armature 154, interrupter contacts 153 of the magnet 122, winding of the magnet 122 to battery. In addition this earth is extended to one terminal of relay 111 the other terminal being earthed as pointed out above

so that this relay is short-circuited and does not operate. The magnet 122 energizes in the above circuit and causes the switch wipers 128-133 inclusive to be stepped until an idle register translator is found. An idle register translator has not potential connected to the test contact so that the following circuit is now effective: earth, armature 155, winding of relay 111, interrupter contacts 156 and magnet 122 to battery. Relay 111 only operates in this circuit and at armature 152 and its resting contact opens the energizing circuit for the magnet 122 and at its operating contact feeds guarding earth to the register translator, and at armature 153 closes an obvious circuit for relay 114. Relay 114, however, is slow-to-operate in order to enable the thousands digit of the calling subscriber (if necessary) and the two-hundred line group which includes the calling subscriber to be registered before the relay operates. In addition relay 111 at armature 148 extends earth over: wiper 129 and bank contact, conductor 138, (Figure 5 and Figure 15) winding of relay 187 to battery. Relay 187 operates and at armature 326a closes the following energizing circuit for relay 183: earth at armature 329 of relay 238 (Fig. 7), armature 326a, winding of relay 189 to battery. Relay 189 operates and at armature 335 closes an obvious circuit for relay 190. Relay 190 operates and at armature 339 closes an obvious circuit for relay 191. In addition relay 189 at armature 336 extends earth from armature 355 and resting contact (Fig. 11) to conductor 141 (Fig. 5) and thence over bank contact and wiper 132 (Fig. 6) armature 185, conductor 110 (Fig. 5) to render the line finder LF busy in the banks of the secondary finder switches (not shown) and to maintain the calling party's cut-off relay energized this guarding earth having previously been extended over armatures 158 (Fig. 5), 178 and 185 (Fig. 6).

Determination of calling party's number

As pointed out above each register translator finder is permanently associated with two line finder switches both having access to the same group of subscribers lines. Thus referring again to Figure 2 the finder LF and 2LF both have access to subscribers lines numbered 57100 to 57299 inclusive. Similarly line finders 1LF and 2LF have access to lines numbered 57400 to 57599 inclusive. If the exchange with which the register translator is associated had a greater capacity than Hautrage there would be other pairs of line finders associated with a single register translator finder and these line finders would have access to lines numbered differently to those accessible by the line finders 1LF, 2LF, 1LF and 2LF. It will thus be seen that when a register translator is seized over a particular register translator finder the 200 group of lines which include the calling subscriber is immediately determined and arrangements are provided in each register translator finder whereby a particular potential is extended over one of a group of conductors or over a combination of the conductors from the finder to the register translator in order to register in the latter the 200 line group. Referring now to Figure 5 the group of conductors comprise conductors 123, 124, and 125 which are connected to the register translator over operated contacts 149, 150, and 151, of relay 111, unoperated contacts 168, 169 and 170 of relay 114 to wipers 133, 131 and 130 and their bank contacts, conductors 142, 140 and 139, resting contacts of ar-

mature 358, 357 and 356, and relays 200, 199 and 198 (Fig. 16) resistance 359 to battery. The potential applied to these conductors is indicated in the following table.

Line group 1100-1299	Positive potential connected to conductor 123.
Line group 1300-1499	Positive potential connected to conductor 124.
Line group 1500-1699	Positive potential connected to conductor 125.
Line group 1700-1899	Positive potential connected to conductors 123 and 124.
Line group 1900-2099	Positive potential connected to conductors 123 and 125.
Line group 2100-2299	Booster battery connected to conductor 123.
Line group 2300-2499	Booster battery connected to conductor 124.
Line group 2500-2699	Booster battery connected to conductor 125.
Line group 2700-2899	Booster battery connected to conductors 123 and 124.
Line group 2900-3099	Booster battery connected to conductors 123 and 125.

It will be noted from the above table that the markings extended over the three conductors are such as to deal with 2000 subscribers lines. This is of course unnecessary in the Hautrage exchange where the ultimate capacity is 600 lines but it is necessary in larger exchanges for instance Mons where the ultimate capacity is 8000 lines. Since a group of register translators is provided for each 2000 subscribers lines, four such groups will be provided at Mons and all the markings will be employed. In Hautrage however the first three markings shown in the table will be employed. Further since the ten thousands and thousands digits of the calling number of a Hautrage subscriber are always 5 and 7 respectively, these can be registered by a permanent connection in the register translator as will be explained later.

From the above it will be seen that since it has been assumed that the calling subscriber has the number 57109 i. e., in the first 200 line group, positive potential will be permanently connected to conductor 123 in the register translator finder RTF. This potential is extended over armatures 149, 168, wiper 133 and bank contact, conductor 142 (Fig. 5 and Fig. 15), armature 358 (Fig. 16), winding of relay 200 to battery, over resistance 359. Relay 200 locks over its "x" contacts 361 from battery over the winding of relay 197 to earth at armature 335 (Fig. 15). Relay 197 operates in series with relay 200 and at armatures 358, 357 and 356 disconnects the conductors 123, 124 and 125 respectively (Fig. 5) from relays 200, 199 and 198. It should be pointed out that relay 201 cannot operate in the circuit of relays 200, 199 and 198 owing to the rectifier 363 in series with its lower winding. If, however, the register translator is in a larger exchange then when booster battery potential connected to one or a combination of the conductors 123, 124 or

125, i. e., the number of the calling line is in the 2nd thousands group, relay 201 will operate in series with relays 198, 199 or 200 since in this case the potential is such as to cause current to flow in the direction in which the metal rectifier 363 is conductive. It will, therefore, be understood that the discrimination effected by the operation of relays 198, 199 and 200 and relay 201 determines the 200 line group which includes the calling subscriber and also determines the thousands number of the calling party.

Returning now to Fig. 5 the operation of relay 114 is delayed for a sufficient period to enable the above described discrimination to be effected. Relay 114 in operating locks over both windings in series with armature 171 to earth at armature 182; at contacts 168, 169 and 170 it disconnects wipers 133, 131 and 130 from conductors 123, 124 and 125 and connects them respectively to the upper winding of relay 117 over armature 183; to conductor 109 over armature 174 and to conductor 108 over contact 175. The operation of contacts 169 and 170 serve to prepare the group selector IGS associated with the line finder ILF. One circuit for preparing the group selector extends over: earth, winding of relay 209 (Fig. 13), armatures 367, 357, conductor 140 (Figs. 15 and 5), bank contact and wiper 131, armatures 169, 174, conductor 109 to the negative conductor leading from the line finder ILF and thence to battery over one winding of the impulsing relay in the group selector. The other circuit extends over: battery, winding of relay 210 (Fig. 13), armatures 366, 356, conductor 139 (Figs. 15 and 5), bank contact and wiper 130, armatures 170, 175, conductor 108 to the positive conductor leading from the line finder and thence to earth over the other windings of the impulse responding relay. Consequently relays 209, 210 and the impulse responding relay energize following the energization of relay 114. In addition at contact 172, relay 114 connects together conductors 102 and 103 over contacts 179 and 180 respectively thereby connecting the contacts of the stepping relay which effects the step-by-step operation of the magnets to the circuit for the vertical magnet of the line finder LFI. It will also be noted that a circuit extends from contact 172 over operated armature 160, wiper 127 and bank contact, conductor 136 (Fig. 5 and Fig. 15), armature 370 and resting contacts, winding of relay 196 to battery. Relay 196 is thus operated and released in synchronism with the operation and release of the vertical and rotary magnets of the line finder so that the number of steps taken by the line finder in the vertical and rotary direction is repeated at contacts of relay 196 in order to register the tens and units digit of the calling subscriber's number. Since the tens and units digit are 0 and 9 respectively, the wipers of the line finder will be raised to the tenth level and hence 10 impulses will be repeated at armature 371 of relay 196. These impulses are repeated over earth, armature 371, armature 372 and resting contacts, winding of magnet 255 to battery. The wipers of the switch RS3 are thus stepped on to the tenth contact. It will also be noted that relay 196 at armature 372 closes a circuit for relay 195 which being slow-to-release remains energized for the whole of the impulse train. Relay 195 in turn closes a circuit at armature 376 for relay 194 to cause this relay to operate over its first step and close armature 375. Since, however, the lower winding of relay 194 is short circuited by the earth connections at armatures

376 and 360 this relay does not operate fully until the release of relay 195 at the end of the train of impulses. Then when relay 195 releases, relay 194 operates fully and at armature 373 prepares a circuit over which the units digit will be repeated to the magnet 256 of the switch RS4. The units digit, in this case the number 9, is thus stored on the switch RS4 during the rotary movement of the line finder. It will also be noted that when relay 195 operates on the reception of the units digit a circuit is closed from earth, armatures 376, 374, upper winding of relay 193 to battery. Relay 193 is arranged similarly to relay 194 so that at this stage it closes armature 369 only. At the end of the impulse train, however, relay 193 operates fully and at contact 368 opens the circuit to the magnet 256. In addition relay 193 at armature 370 prepares a circuit for relay 202.

When the line finder LFI has found the calling line, the primary distributing switch PDS (Figs. 3 and 4) is released and relay LK releases. Earth is thus removed from conductor 104 and relay 112 (Fig. 5) releases.

As pointed out above the line finders have access to 200 subscribers lines and the determination as to which group of 100 lines includes the calling subscriber is effected by the operation of the switch relays HA and HB (Figs. 3 and 4). In the present instances the hundreds digit of the subscriber's number is 1 and hence relay HA will be operated. Under these circumstances, earth at contact *ha1* (Fig. 4) is connected over conductor 101 (Figs. 4, 5 and 6), armatures 181, 173, 147, 160, wiper 127, conductor 136 (Fig. 5 and Fig. 15), armature 370 and its operated contact, winding of relay 202 to battery.

The calling party's number is now completely recorded as regards the thousands, hundreds, tens and units digits by the selective operation of relays 193 and 202 inclusive and by the setting of the two switches RS3 and RS4.

Extension of impulsing circuit to register translator

Further when relay HA operates in the line finder 1LF, the subscriber's loop circuit is extended into the register translator as follows: earth, lower winding of relay 188, conductor 137 (Figs. 15 and 5), bank contact and wiper 128, armature 176, conductor 107 (Figs. 5 and 4), contacts *ha5*, *hb3*, wiper —1 subscriber's loop, wiper +1, contacts *ha3*, *hb5*, conductor 106 (Figs. 4 and 5), armature 177, wiper 129, conductor 138, lower winding of relay 187 to battery. Relay 188 operates over this loop circuit and at armature 377 provides an alternative earth for relay 189. In addition dial tone is now transmitted from the dial tone source 378 (Fig. 11) condenser 379, cam contacts 380 in their resting position, armatures 333, 340, condenser 381', winding of relays 187 and 188 to earth and thence over the loop circuit as traced above by induction into the second windings of the relays. The calling party now dials the required number.

Double access to register translator finder

Returning to the register translator finder shown in Figs. 5 and 6 it is to be noted that the conductors 100-110 inclusive, relays 112, 115, 116 and 117 are duplicated and the register translator finder can be seized over either group of conductors. The reason for this arrangement will be appreciated by referring to the trunking diagram shown in Fig. 2. It will be remembered

that a register translator finder is permanently connected to two finder switches such as 1LF and 2LF. Now the register translator and the register translator finder are only employed for a short period while the line finder and associated group selector are of course employed for the whole of the call. By arranging that the register translator finder can be seized by the two line finders over different groups of conductors it is possible for the register translator to be used by one line finder while a call is in progress over the other line finder. It is to be noted that when the register translator finder is seized over the alternative group of conductors by earth extended over the conductor corresponding to conductor 104 of the first group, this earth extending over armature 184 of relay 116, armature 157 of relay 112 both windings of relay 113 in series to battery. The operation of the register translator finder is then precisely as described above, the relays 113, 118, 119, 120 performing the functions of relays 112, 115, 116, 117.

The electrical interlocking of relays 112 and 113 at armatures 157 and 146 ensures that only one of these relays can be operated at a time depending upon the group of conductors over which the register translator finder has been taken into use.

When digit transmission from the register translator is ended earth is extended over conductor 142, bank contact and wiper 133, armatures 168, 183, upper winding of relay 117 to battery. Relay 117 locks at armature 164 over conductor 110 and at armatures 161 and 162 completes the speaking circuit through to the first group selector independent of the register translator over conductors 106, 107, 108, and 109. In addition at armature 163 relay 117 opens the circuit of relays 115 and 116 which release slowly and at their various armatures disconnect the register translator to cause the release thereof. In addition at armature 182 relay 116 opens the locking circuit of relay 114 which releases. With the exception of relay 117 therefore the register translator finder is now in its original condition and can be seized by the finder switch 2LF. It will be appreciated that relay 117 will remain operated until the connection is released to maintain the through speaking connection between the finder switch and the group selector. When the connection is released however earth will be removed from conductor 110 and relay 117 will release and open the speaking connection.

Before considering the detailed operation of the circuits of the register translator, a general description will be given of the principles underlying its operation.

GENERAL DESCRIPTION OF REGISTER TRANSLATOR

These circuits are shown in Figs. 7 to 16 which should be arranged as indicated in Fig. 17. In Fig. 17 the components of the circuits are indicated briefly in order that a clear picture is obtained of the essential elements. The circuits comprise three two-directional switches TD1, TD2 (Fig. 8), TD3 (Fig. 9), rotary switches RS1, RS2 (Fig. 10), RS3, RS4, (Fig. 14), RS5 (Fig. 11) and RS6 (Fig. 12) together with various relay groups which are indicated by the references RG3 (Fig. 15), RG4 (Fig. 16), RG5 (Fig. 14), RG6 (Fig. 10), RG7 (Fig. 13), RG8 (Fig. 11) and RG 9 (Fig. 7). The called party's number is recorded on the switches TD1, TD2, RS1, RS2 and RS5, the latter also acting as a distributor switch for routing the incoming digits to the ap-

propriate switches. Switch TD3 is a combining switch for determining the kind of junction and the rate at which the call is to be charged. The calling party's number as has already been described is recorded on the relay group RG4 and the switches RS3 and RS4. In addition the switch RS6 serves to control the transmission of routing digits and any additional information which is desirable in view of the destination of the call. For this purpose according to the destination of the call as determined by the registration of the called party's number a particular wiper of the switch RS6 is selected and the contacts over which this wiper moves are cross-connected to the various groups of conductors shown adjacent the banks in such a manner as to control the transmission of the necessary digits for setting up the particular call. Impulse transmission from the register translator is effected by the relay group RG7, the number of impulses which are to be transmitted in each train being controlled by markings extended either directly or indirectly over the various switch banks to a group of ten control conductors indicated generally by the cable 282 with its various branches. These conductors extend from the relay group RG5 and are multipled to the various switch banks in the register translator as indicated by the cabled conductor and are connected directly to certain contacts in the banks of the switch RS6. In certain circumstances coded impulses are transmitted by the register translator in which case the relay group RG5 is adapted to act in conjunction with the relay group RG6 due to the operation of relays 224, 225 and 226. Finally a relay group RG8 is provided for the purpose of giving alarms and supervisory signals in certain circumstances to be discussed later.

Following the registration of the calling party's number dial tone is transmitted from the register translator and the next operation to be performed is the registration of the called party's number. It will first be assumed that the call is for a local subscriber at Hautrage and in this case the called number comprises five digits, the first being other than zero.

The first incoming digit is registered by the vertical movement of the switch TD1, the second by the rotary movement of the switch TD1. The third and fourth are registered by the vertical and rotary movement respectively of the switch TD2 while the fifth is registered on the rotary switch RS1. The selection of the wiper of the switch RS6 is effected by the position taken up by the switch TD1 and for this purpose the contacts associated with wipers 261 and 263 are connected to the wipers of the switch RS6, the wipers 261 being employed in accordance with the kind of call which the contacts represent on five-digit calls while wiper 263 is employed on multi-rate calls. On all calls the first digit re-transmitted by the register translator is effective in the first group selector such as IGS (Fig. 2) to register the type of metering which is to be employed that is to say this digit indicates whether the call is to be metered by the calling subscriber's meter or by an operator or by an automatic ticketing arrangement. This digit is determined by a cross-connection extending from a contact associated with the selected wiper of the switch RS6 to the appropriate one of the control conductors 1-10.

In general the number of contacts of the banks of the switch RS6 which are employed for cross-

connection purposes is less than half the number of available contacts and hence it is arranged that such banks of the switch RS6 are capable of carrying two sets of cross-connections. The determination as to whether the cross-connections for the first or second half of the banks of the switch RS6 is to be used is determined by wiper 264 of switch TD1. This wiper is earthed and certain of the contacts in the bank are connected to the magnet of the switch RS6 over a cam contact which is opened on the 16th contact so that when the wiper 264 is set on to such a contact the switch RS6 is automatically rotated to its 16th position in order that the cross-connections over the second part of its bank may be used. However, in the case of a multi-rate call where the determination of the charge for the call is to be effected automatically the whole of one of the banks of the switch RS6 is employed for giving the necessary cross-connections.

Returning again to the consideration of a local call, impulse transmission from the register translator commences when the second digit has been stored. As explained above the first digit is employed to indicate the type of metering while the remaining digits transmitted form the called party's number and are retransmitted without translation. For this purpose the vertical wiper 323 and wiper 260 of the switch TD1, vertical wiper 325 and wiper 266 of the switch TD2 and wiper 272 of the switch RS1 are connected up in turn by means of cross-connection extending from the contacts of the selected bank of the switch RS6. Thus for instance each contact in the vertical banks associated with wipers 323, 325 of the switches TD1 and TD2 respectively is connected to the appropriate one of the control conductors 1 to 10 while in the bank associated with wipers 260 and 266 of the same switches the contacts in each vertical column are connected together and thence to the appropriate one of the control conductors 1 to 10. Similarly contacts 1 to 10 of the banks associated with wiper 272 of switch RS1, wiper 274 of switch RS2 and contacts 8 to 17 associated with wiper 257 of switch RS5 are connected to conductors 1 to 10. At the termination of the transmission of the last impulse series a cross-connection occurs to conductor 317 which disconnects the impulsing means and serves to release the register translator and register translator finder RTF.

Consideration will now be given to the registration of called numbers the first digit of which is 0 whereby indicating that the call is for a special service. In connection with the term "special service," it is to be understood that this term includes calls to an operator, calls for services such as the speaking clock and also toll or inter-zone calls. In setting up toll or inter-zone calls it is necessary for the calling party to dial 8 digits while for the other services, three are sufficient. In all cases, however, the switch TD1 which will be raised to the 10th level is released that is to say the first digit in all cases is absorbed but a circuit operation which will be pointed out in detail hereafter takes place an effect of which is that wiper 263 instead of wiper 261 is employed for determining which wiper of the switch RS6 is to be employed. The 2nd and 3rd digits are then registered by the vertical and rotary movement respectively of the switch TD1 the 4th and 5th by the vertical and rotary movement respectively of the switch TD2, the 6th by the operation of the switch RS1, the 7th by the operation of the switch RS2 and the 8th by the

operation of the switch RS5. In addition the switch TD3 is set automatically in dependence upon the position of the wipers of the switch TD1 as regards the vertical movement and as regards its rotary movement in accordance with the position of the wipers of the switch TD2. The switch TD3 may thus be said to take up a position which is the resultant of the first four digits registered in the register translator. The purpose of the switch TD3 is to enable one or more routing digits to be transmitted from the register translator and also one or more digits which are indicative of the "tariff" or rate at which the call is to be charged.

The control of digit transmission from the register translator is again effected by the route control switch RS6 as it steps from contact to contact and as in the case of a local call the first digit retransmitted by the register translator is effective in indicating the manner in which the charge for the call is to be recorded. Following this a series of digits is transmitted which is effective in setting the switches in the Mons central exchange in order that the call is routed towards the desired terminating exchange. Next follows what may be termed a class digit the purpose of which will be explained in detail later. When these routing digits and the class digit have been transmitted the called party's number and the calling party's number is transmitted to equipment located at the outgoing toll line in the main exchange in the form of coded impulses. The change in transmission from the decimal basis to a code basis is effected by a cross-connection extending from the appropriate contact in the selected bank of the switch RS6 to the conductor 316. This causes the operation of the relays 224, 225, 226, to enable co-operation to take place between the relay groups RG5 and RG6. Finally after these coded impulses have been transmitted the "tariff" digit is transmitted in accordance with the position of wiper 271 of the switch TD3. After the transmission of the "tariff" digit the next contact of the route control switch is cross-connected to conductor 317 to cause the release of the register-translator and register-translator finder RTF.

DETAILED DESCRIPTION OF REGISTER TRANSLATOR

Local call

Reception of dialled digits

A detailed description will now be given of the operation of the register translator and for this purpose it will be assumed that the calling subscriber wishes to set up a connection to a subscriber in his own exchange, that is to say, in the Hautrage exchange. It will be remembered that the description of the register translator has been given in detail as far as registration of the calling party's number and the transmission of dial tone back to the calling subscriber over the windings of relays 187 and 188 (Fig. 15), the lower windings of these relays being energized over the calling subscriber's loop. As pointed out above all subscribers connected to the Hautrage exchange will have for the first two digits in their call number the digits 5 and 7. Consequently the first two digits dialled by the calling subscriber will be 5 and 7.

When the first break occurs in the calling subscribers line circuit relays 187 and 188 will release and at armature 327 a circuit is closed as follows: earth, armatures 327, 334, winding of relay 204 to battery. A branch of this circuit

also extends over wiper 259 of the switch RS5 in position 1, winding of the vertical magnet 244 of the two-directional switch TD1 to battery. Relay 204 at contact 333 closes an obvious circuit for relay 203, both these relays being slow-to-release so that they are maintained operated during the reception of the impulse train. The first digit dialled by the calling party is thus registered by the vertical movement of the switch TD1. At the end of the first impulse train relay 204 releases after a short-period and at contact 333 opens the circuit of relay 203. During the release period of the relay 203, however, a circuit is closed over earth, armatures 383, 384, contact 1 and wiper 258 of the switch RS5, armature 330, winding of magnet 243 of the switch RS5 to battery. The magnet of the switch RS5 is, therefore, energized for the duration of the release period of relay 203 after the wipers of the switch RS5 are stepped on to their second position whereby the impulsing circuit is extended over relay 239 to the rotary magnet 245 of the switch TD1. Relay 239 is a slow-to-release relay and is maintained operated for the duration of the impulse train. The third, fourth and fifth digits will be registered by the operation of the vertical magnet 247 and the rotary magnet 248 of the switch TD2 and the magnet 253 of the switch RS1 respectively the relay 240 remaining operated during the reception of the fourth digit. It will of course be understood that the switch RS5 is advanced one step as each digit is received so that at the termination of the fifth digit the wipers of the switch will be in their sixth position.

Impulse transmission from register-translator on decimal basis

Digit transmission from the register translator takes place as soon as the second digit has been registered and is controlled by the release of relay 239 at the end of the second digit. On the release of relay 239 a circuit is completed from earth at armature 338 of relay 10 (Fig. 15) rotary off-normal springs 385 of the switch TD1 in their operated position, armatures 398, 404, 407, winding of relay 235 to battery. Relay 235 operates armature 409 and this completes the following circuit: impulsing conductor 399 extending from an impulsing machine, armature 400, rotary off-normal springs 386 of the switch TD1 in their operated position, armatures 409, 402, 411 (Fig. 13), 414, 415, 416, 420, lower winding of relay 213 to battery. On the reception of the first impulse from the impulsing machine relay 213 operates over its first step and closes armature 421 and energizes fully at the end of the impulse. On energizing fully relay 213 at armature 420 opens its original energizing circuit at its resting contact and at its operated contact transfers the impulsing conductor to the winding of relay 211. The succeeding impulses, therefore, cause the synchronous operation of relay 211 which at armature 366 and 367 repeats the impulses to the first group selector by opening the circuit extending from relays 209 and 210 to the impulse responding relay in the group selector. Further at armature 364 relay 211 closes an obvious circuit for relay 212. Relay 212 is a slow-to-release relay and is thus maintained operated during the period that relay 211 is being impulsed. At armature 423 relay 212 closes a circuit from earth at armature 430 of relay 222, armature 423, winding of relay 215 to battery. At armature 424 and 425 the relay

212 replaces the battery and earth connections normally supplied by relays 210 and 209 by battery over a resistance 435 and a direct earth to improve the impulsing circuit to the group selector. Relays 209 and 210 release during impulse transmission but a shunt circuit is provided across armatures 414 and 415 which shunt circuit extends over armature 422 of relay 212. The impulses transmitted by relay 211 to the group selector are repeated at armature 365 to the group of counting relays RG5.

It will be understood that for impulse transmission to take place from the register translator both conductors must be alive from stage to stage otherwise one or both of relay 209 and 210 will not be operated.

Operation of counting relay group RG5 on decimal basis

The counting relays RG5 comprise the relays 216 to 221 inclusive arranged to count any number of impulses up to ten. The relays are operated sequentially until six impulses have been counted when relay 221 is held operated and relays 216 to 219 inclusive are re-operated to count the remaining four impulses. Impulse transmission from the register translator is stopped by a marking extended over one of the ten control conductors 1-10 and over armatures of the counting relays to operate relay 214. Thus for example assume the digit 2 is the first digit to be transmitted from the register translator. In this case an earth is extended in a manner to be described later, over conductor 2 of the control conductors. Then when relay 211 operates on the first impulse it closes a circuit over: earth, armatures 365, 450, 449, 446, 442, 438 of relays 220, 219, 218, 217 and 216 respectively, lower winding of 216 to battery. Relay 216 operates over its first step and closes its "X" armature 437. At the end of the impulse, relay 216 operates fully over both windings in series and armatures 437 and 440 to earth at armature 426 of relay 212 and at armature 438 and its resting contact opens its original energizing circuit and at its operating contact prepares the energizing circuit for relay 217. The second impulse causes the operation of relay 217 in a similar manner first to close its "X" armature 441 and then to operate fully and this relay at armature 440 opens the locking circuit of relay 216 which releases. On the operation of relay 217 a circuit is closed from earth on conductor 2, armatures 443, 451 and 461, winding of relay 214 to battery. Relay 214 operates and locks over armature 418 to earth at armature 434 and at armature 416 disconnects the impulsing conductor from relay 211 whereby further impulse transmission is prevented. In addition relay 214 at armature 417 opens the clocking circuit for relay 213 which releases, and at armature 419 causes a circuit operation which removes earth from conductor 2 and causes it to be extended over another conductor to control the transmission of the next digit. Relay 213 releases when its circuit is opened at armature 417 and at armature 420 opens a further point in the impulsing circuit to relay 211. Relay 212 releases a short period after the disconnection of the impulsing conductor from relay 211 and at armature 426 opens the locking circuit for the counting relays which then release; at armature 424 and 425 restores the non-shunted condition of relays 210 and 209 across conductors 139 and 140 respectively and at armature 423 opens the circuit of relay 215. Relay 215 releases and at arma-

ture 434 opens the locking circuit of relay 214 which releases and reconnects the impulsing conductor to relay 213 to start the transmission of the next digit.

Route control switch RS6

Consideration will now be given to the arrangements for determining the particular digits which are to be transmitted by the register translator. As stated above this is determined by cross-connections extending between the contacts of the route control switch RS6 and the various conductors and contact groups adjacent the banks. Typical examples are shown of the cross-connections in Figs. 19-26 and in this connection it should be pointed out that in general each wiper of the switch may be used for controlling the setting up of two types of connection. Thus for example wiper 296, Fig. 12, cross-connected as shown in Fig. 19, controls the setting up of local calls, i. e., calls to Hautrage subscribers and also calls to Mons subscribers. An exception to this occurs on eight-digit calls where it is necessary to employ the whole of one bank.

With regard to the transmission of routing digits by the register translator, this is controlled in two ways. In the first place the digits which are the same for a particular kind of call whatever the destination exchange are determined by a direct connection between the appropriate bank contact of the switch and one of the conductors 1 to 10, while for those which are variable for different exchanges of the same kind of call the connection is taken indirectly to one of the conductors 1 to 10 over wipers of the various switches TD1, TD2, TD3 and so on. Thus for instance calls to exchanges within the Mons urban area are all extended over the Mons exchange and the junctions to these exchanges are reached over the same switch at Mons, i. e., the switch LS, Fig. 2. In the present case the switch LS will be reached by the transmission of digits 9 and 7 and hence for the transmission of these two digits, direct connections are made to the appropriate conductors of conductors 1 to 10. The various junction lines are however reached over different levels of the switch LS and hence the next digit will be variable and the indirect connection will be employed.

For an understanding of the case under consideration reference will be made to Fig. 19, which shows the cross-connections made from wiper 296 of the switch RS6. It should be pointed out that the selection of the appropriate wiper of the switch RS6 is effected by the position taken up by wipers 261 and 263 of the switch TD1, according to the type of connection required. Connections are taken from contacts in the banks associated with these wipers to the appropriate wipers of the route control switch RS6 which are thus connected up in dependence upon the first two digits recorded in the register translator.

As pointed out above the first digit transmitted determines the type of metering which is to be employed and in this case since the metering will be effected by the calling party's meter in the usual way, the digit 2 will be transmitted. Since this will always be the case on a local call the first contact associated with wiper 296 will be connected directly to conductor 2 of the conductors 1-10. Since the call is local no routing digits are transmitted and further since Hautrage has less than 1000 lines, three digits only need be retransmitted. Hence the 2nd, 3rd,

and 4th contacts are cross-connected to the wipers of the switches TD2 and RS1 the position of which represent the 3rd, 4th and 5th digits dialled, i. e., wipers 325, 266, and 272.

In detail, when wiper 296 of switch RS6 is on the first contact, earth at armature 472 of relay 192 (Fig. 15) is extended over armature 412 and its resting contact, armatures 471, 410 (Fig. 7), 401, 328, wiper 261 on contact (5, 7), wiper 296 of switch RS6 on contact 1, cross-connection to conductor 2, cable 287 and 282, and thence as described above in connection with the operation of the counting relay group RG5 (Fig. 14). When relay 214 is operated at the end of the transmission of digit 2, it completes the following circuit: earth at contact 419, lower winding of relay 238, winding of magnet 326 of switch RS6 to battery. The magnet 326 is maintained energized until the release of relay 214 when its circuit is opened and it de-energizes to step the wipers of the switch on to contact 2. Relay 208 operates over the energizing circuit of the switch magnet and at contact 411 disconnects the impulsing conductor from relay 213 and 211 until the switch has stepped.

Contact 2 associated with wiper 296 of switch RS6 is cross-connected to one of the group of conductors 309 to 315 which are connected to the various wipers of the switches whose positions represent the digits dialled by the calling party. In the present case contact 2 is connected to conductor 311 and thence to vertical wiper 325 of switch TD2 over vertical off normal springs 399. Assume the number of the required subscriber is 57, 146. Then wiper 325 is in engagement with contact 1 of the vertical bank and thence to conductor 1 of the conductors 1-10 of the cable 290. Hence the digit 1 will be transmitted from the register translator to the group selector IGS (Fig. 2). The group selector then hunts over the first level for an idle final selector (not shown). Wiper 296 of the switch RS6 is now rotated on to the 3rd contact which is cross-connected to conductor 312 connected to wiper 266 of the switch TD2. As a result of this cross-connection conductor 4 will be earthed and the digit 4 (the tens digit) will be transmitted to the final selector (not shown). Lastly contact 4 associated with wiper 296 of the switch RS6 is cross-connected to conductor 313 connected to wiper 272 of the switch RS1 and consequently the final digit transmitted is 6. Digit transmission is now completed and wiper 296 of switch RS6 is stepped to contact 5 which is cross-connected to conductor 317. A circuit is now closed from the earthed wiper 296 of switch RS6, conductor 317, armature 474 and resting contact (Fig. 11), armature 358 to conductor 142 leading to the register translator finder.

Release of register translator

When the register translator is disconnected from the register translator finder as previously described above relays 209 and 210 (Fig. 13) release together with relays 187 and 188 (Fig. 15). The release of the latter two relays opens the circuit for relay 189 and during the release period of this relay a circuit is closed from earth at armature 327 over armature 334, winding of relay 204 (Fig. 11) to battery. Relay 204 causes the operation of relay 203 and when relay 189 releases and the above traced circuit is opened a pulse is transmitted during the release time of relay 203 to magnet 243 of the switch RS5. Switch RS5 is thus stepped on to contact 7. Re-

lay 189 in releasing opens the circuit of relay 190 which releases and opens the circuit of relay 191. Relay 191 in releasing at armature 483 closes a circuit as follows: earth, armature 403, winding of relay 359, armature 332, operated vertical off-normal springs 388 of the switch TD1 in their operated position, release magnet 246 to battery. The release magnet 246 is thus energized and the switch TD1 restored to normal. Rotary off-normal contacts 385 are thus opened and relay 235 de-energizes, thereby disconnecting earth from wiper 261 of the switch TD1. Further the restoration of the vertical off-normal contacts 388 extends the earth connection previously traced, to the release magnet 249 of the switch TD2 over operated vertical off-normal springs 389. The switch TD2 is thus restored to normal and the earth connection is again extended over vertical off-normal springs 389 of the switch TD2 in their resting position, vertical off-normal springs 393 of the switch TD3 in their resting position, wiper 273, bank contact and multiplying associated with this wiper, interrupter springs 486, magnet 253 of the switch RS1 to battery. Switch RS1 is thus rotated to the 11th contact whereupon the above energizing circuit is further extended over wiper 275 and conductor 295 in turn to magnets 254, 255, 256, and 243 to step switches RS2, RS3 and RS4 to their 11th or 25th contacts and to restore switch RS5 to normal. On the restoration of switch RS5, the circuit is further extended over off-normal springs 381 and their resting position, armature 481 of relay 191, off normal contacts 489 of the switch RS6, interrupter contacts 490, winding of magnet 326 to battery. The switch RS6 is thus returned to normal in which position the off-normal springs 489 are opened and the above-traced circuit is interrupted. The register translator has now been completely released and can be used for a further call.

Calls to Mons

It will be understood that the operation of the register translator will be the same on all calls up to the reception of the impulses transmitted by the calling party hence in describing the various calls which may be set up it will be assumed that the register translator has been seized and that the calling party's number has been registered therein.

Reception of dialled digits

A call to Mons is a local or unit rate call and hence it is only necessary for the calling party to dial five digits. Referring to Fig. 19, however, it will be seen that the cross-connection for setting up a call to Mons extends from the 16th contact of wiper 296 of the route control switch RS6 and it is, therefore, necessary to step the route control switch to its 16th contact before digit transmission from the register translator takes place.

Referring to the numbering scheme for Mons subscribers given above it will be seen that the first digit which will be dialled by the calling party will be the digit 2 and this will be followed by the digits 1-6, 9 or 0. The reception of the digit 2 will cause the switch TD1 to be positioned on the second level and the second digit which for example will be assumed to be 5, will cause the switch TD1 to be positioned on the 5th contact of the second level. Contacts 1-6 and 9-0 in level 2 of the bank associated with wiper 264 are multiplied together and connected over cam contacts 491, interrupter springs 490, winding of magnet 326 of switch RS6 to battery. Conse-

quently when relay 239 restores at the termination of the rotary movement of the switch the following circuit is completed: earth, contact 338 (Fig. 15), rotary off-normal springs 385 of the switch TD1 in their operated position, armatures 398, 404, contact of armature 407, winding of relay 234, armature 408, wiper 264, contact (2; 5), cam springs 491, interrupter contact 490, winding of magnet 326 to battery. The magnet 326 operates in the above self-interrupting circuit and steps the wipers of the switch RS6 to the 16th contact when the cam springs 491 are opened and the energizing circuit for the magnet is interrupted. It will be noted that a parallel circuit also extends over armature 407 of relay 234 (Fig. 7) winding of relay 235 to battery. This relay, however, has a high resistance compared with that of relay 234 and hence does not energize in this circuit. The impulsing circuit to relays 213 and 211 from the impulsing conductor 399 is thus held open at contact 490 of relay 235 until the switch RS6 has been set on to the 16th contact. When the energizing circuit for magnet 326 is opened however relay 235 then energizes to complete the impulsing circuit to enable digit transmission to commence.

Impulse transmission from register translator

Since a call to Mons is a unit rate call the first digit retransmitted by the register translator will be the digit 2 as described in connection with the local call at Hautrage. The second digit transmitted will set the first group selector IGS to the level at which a poor grade junction line to Mons is accessible and in the case shown in the layout of Fig. 2 this second digit will be 9. Contacts 16 and 17 will thus be cross-connected to conductors 2 and 9 respectively of the control conductors. The call is thus routed as far as incoming selector IS at the Mons exchange. Since Mons has a capacity of 3600 lines it will be appreciated that four digits must now be transmitted from the register translator in order to set the incoming selector IS, the local selector LS, and the appropriate final selector (not shown). Thus contacts 18, 19, 20 and 21 will be cross-connected to conductors 310, 311, 312 and 313 in order that the second, third, fourth and fifth digits dialled by the calling party are retransmitted without translation to the Mons exchange. Finally contact 22 will be connected to conductor 317 in order to enable the register translator to be released as described above.

CALLS THE FIRST DIGIT OF WHICH IS 0

Operation on all calls

When the first digit dialled by the calling party is the digit 0 the switch TD1 will be raised to the 10th level whereupon a circuit is closed during the energized period of relay 204 from earth at armature 382 of relay 204 and its operated contact (Fig. 7) armature 495, vertical wiper 324, tenth vertical bank contact, armature 497, winding of relay 238 to battery. Relay 238 operates and locks over armature 331 to earth at armature 338 (Fig. 15). Relay 238 in operating at contact 330 opens the circuit to magnet 243 of switch RS5 in order to prevent this switch stepping its wipers from the first to the second contact. Further at armature 332 relay 238 closes the following circuit for the release magnet 246 of the switch TD1: earth at armature 382 and its resting contact (Fig. 7), armatures 496 and 332, vertical off-normal springs 388 and

their operated contacts, winding of release magnet 246 to battery. The switch TD1 is thereby restored to normal. In addition relay 238 at armature 330 closes a circuit during the release period of relay 203 as follows: earth at armature 383, armature 384, contact 1 and wiper 253 of switch RS5, armatures 330, 492, lower winding of relay 237 to battery. Relay 237 operates and locks over both windings in series with armature 493 and at armature 492 and its operated contact prepares a circuit for the magnet 243 of the switch RS5.

The above operations take place whenever the first digit dialled by the calling party is the digit 0, but the subsequent operations of the register translator depend upon the second digit.

Operation on individual calls

As pointed out above there are two general types of call numbers commencing with the digit "0." First there are the three digit call numbers for setting up a connection to an operator and for obtaining other services and second there are the eight digit call numbers for setting up calls to exchanges in other zones. Consideration will now be given to the first type.

Three digit calls

Three digit calls may again be subdivided into those for which the second digit is "0" and those for which the second digit is other than "0." In the first subdivision are included calls to an operator (call number 001 for a toll operator and 004 for an international operator) and calls for certain services (call numbers 005-008 inclusive). In the second are included for instance calls for the speaking clock (call numbers 091 and 092).

Second digit "0"

When the second digit is "0" the switch TD1 is again raised to the 10th level and is then rotated over this level in accordance with the third digit. As before relay 235 operates on the first rotary step of the switch. Consideration will first be given to the case where the third digit is either 1 or 4, i. e., a call for a toll or international operator. Contacts 1 and 4 in the 10th level of the contact bank associated with wiper 263 are connected together and to wiper 297 (Fig. 20) of the switch RS6. The setting up of these two connections is controlled over contacts 1 to 11 associated with wiper 297 and hence no circuit is closed over wiper 264 for the magnet 326 of the switch RS6 to advance the switch wipers to contact 16. Earth potential is now extended to wiper 297 over the following circuit: earth, armature 472 (Fig. 15), armature 412, 471, 410, 401, 328 and its operated contact, wiper 263 of the switch TD1 on contact 1 or 4 to wiper 297 of the switch RS6. The impulsing conductor 399 is also extended on the release of relay 239 to the relay group RG7 to enable digit transmission from the register translator to commence.

With regard to the digits which are to be retransmitted, in this case the call will be metered by an operator in the usual way. Consequently the first digit retransmitted from the register translator will be the digit "1" and for this purpose, referring to Fig. 20, contact 1 associated with wiper 297 of the switch RS6 is cross-connected to conductor 1 of the control conductors. The second digit transmitted will serve to position the first group selector on to a "poor" grade junction line extending to the Mons exchange at which the operators are located, and for this purpose the second contact associated with wiper 297

is connected to conductor 9 in the similar way as for a call to Mons described above.

The third digit transmitted by the register translator serves to set the incoming selector IS (Fig. 2) at the Mons exchange to a level over which it has access to the special service selectors TS. According to the trunking diagram shown in Fig. 2 this digit will be "8," and hence contact 3 associated with wiper 297 is cross-connected to conductor 8 of the control conductors. The level to which selector TS is to be raised is determined by the third digit dialled by the calling party, that is to say, the second digit registered by the register translator and hence contact 4 associated with wiper 297 is cross-connected to conductor 310 which is directly connected to wiper 260. Thus, for instance, if the third digit dialled by the calling party is "1" the contact on which wiper 260 rests will be connected to conductor 1 of the control conductors and hence the fourth digit transmitted by the register translator will be the digit "1." If however, the third digit dialled by the calling party is the digit "4" then that digit will be transmitted by the register translator. In the first case, the switch TS will be raised to the first level and in the second case to the fourth level, over both of which levels access is had to operators' positions.

The 5th contact associated with wiper 297 of the switch RS6 is cross-connected to conductor 316 and the earth extended to this conductor causes the operation of relay 224. Relay 224 at armature 454 closes a circuit over: earth, armatures 454, 462, winding of relay 214 to battery. Relay 214 at contact 419 closes an energizing circuit for magnet 326 as described above. Further earth at contact 419 is also extended over armature 453 of relay 224 to the upper winding of relay 225. Relay 225 is slow-to-energize and first closes a locking circuit over its "X" armature 457 in series with the winding of relay 226 from earth at contact 339 (Fig. 15). When relay 225 operates fully it opens at armature 462 the circuit for relay 214 which releases and at armature 419 opens the energizing circuit of magnet 326 whereby the wipers of switch RS6 are stepped on to the next, i. e., the 6th contacts. Relay 226 operates in the above locking circuit and relays 225 and 226 by their operation causes the counting relays RG5 to co-operate with the counting relays RG6 to enable the remaining digits transmitted by the register translator to be in coded form.

The remaining digits to be transmitted by the register translator comprise the calling party's number and a description will now be given of this transmission from the point of view of the route control switch RS6, a description of the arrangements for transmitting impulses in code being postponed until later.

It will be noted on referring to Fig. 20 that contacts 6 and 7 associated with wiper 297 of the switch RS6 are extended over armatures 501 and 500 of relay 207 in the resting position to conductors 318 and 319 while contacts 8, 9 and 10 are connected directly to conductors 320, 321 and 322 respectively. With regard to conductors 318 and 319 these are permanently connected, the first with conductor 5 of conductors 1-10 and the second with conductor 7 of conductors 1-10 over armature 498 of relay 201 and its resting contact and conductor 499 to conductor 7 of the control conductors. This as explained previously is always the same since the ultimate capacity of Hautrage exchange is only 600 lines and hence

the 10,000 to 1,000 numbers of all the subscribers lines are the same. With wiper 297 of the switch RS6 on contact 6 therefore earth is extended from conductor 318 to conductor 5 of the control conductors and thence through cable 282, cable 287, cable 288, armature 465 of relay 226, winding of relay 232 of the relay group RG6 to battery. Relay 232 operates and causes the digit 5 to be transmitted in coded form. Similarly when wiper 297 steps on to contact 7 earth is extended over a similar circuit, contact 467 of relay 226, windings of relays 229 and 227 in series to battery. These relays operate to cause the transmission of the digit 7 in coded form. Conductor 320 is connected over the operated armature 508 of relay 202 to operated armature 362 of relay 200, armatures 509, 510 in their rest position to conductor 1 of the control conductors in accordance with the hundreds digit of the calling party's number (57109) and thence over cable 295, cable 282 to the winding of the appropriate relays of the group RG6 as described above. Conductors 321 and 322 are connected to wipers 276 and 279 respectively of switches RS3 and RS4 and thence over cable 282 as described above to the appropriate relays of the group RG6. It will thus be understood that as wiper 297 of the switch RS6 steps from the 6th to the 10th contact the calling party's number will be transmitted in code over the junction line to the Mons central exchange. At the termination of digit transmission wiper 297 will be stepped on to the 11th contact which is cross-connected to conductor 317 to cause the release of the register translator as described above.

The above description deals with calls of which the number is 001 and 004. As pointed out previously however arrangements are provided for dealing with other services and calls if any for these services also have the digits "00" for the first two digits. Since however the metering of these calls is effected by an operator it has been found simpler to deal with these calls over a different wiper of the switch RS6. The third digit of these calls may be any of the digits 5 to 8 and consequently a connection is made from contacts 5 to 8 of the 10th level of the bank associated with wiper 263 of the switch TD1 to wiper 298 (Fig. 21) of the switch RS6. Further the first part of the bank is employed for the calls and hence no connection is made from the contact on which wiper 264 of the switch TD1 is standing, to magnet 326.

Referring now to Fig. 21 which shows the cross-connections for a call of this type, it will be noted that contact 1 is cross-connected to conductor 1 of the control conductors so that the first digit transmitted will be the digit "1" indicating that metering is to be effected by an operator. The next two contacts are cross-connected to conductors 9 and 8 respectively of the control conductors in order to secure the necessary routing of the connection as far as the switch TS at the Mons exchange. Contact 4 is cross-connected to conductor 310 which is directly connected to wiper 260 of the switch TD1 in order that the third digit dialled by the calling party is retransmitted without translation to raise the switch TS to the appropriate level. Finally contact 5 is cross-connected to conductor 317 to cause the release of the register translator.

Second digit 9

If the second digit dialled by the calling party is 9 this indicates that the call is for a speaking

clock. The third digit will be either 1 or 2 according as to whether the subscriber wishes to have the time spoken to him in French or Flemish. The switch TD1 will thus be raised to the 9th level and rotated on to contacts 1 or 2 in this level. Both these contacts are connected together in the bank associated with wiper 263 and this multiple connection is extended to wiper 299 of the switch RS6. Referring to Fig. 22 it will be noted that the cross-connections for extending a connection to the speaking clock are arranged over the first half of the bank contacts and hence no circuit will be closed over wiper 264 for magnet 326. It should be explained that in this case the call will be metered by the calling party's meter and hence contact 1 associated with wiper 299 of the switch RS6 will be connected to conductor 2 of the control conductors. The speaking clock is actually located in the Mons central exchange and hence the second digit which controls the operation of the first group selector will again be digit 9. Further referring to Fig. 2 the speaking clock is reached over the 10th level of the selector TS and hence contacts 3 and 4 associated with wiper 299 of the switch RS6 will be cross-connected to control conductors 8 and 0 respectively. A further discriminatory digit must now be transmitted depending on the third digit in order to connect up the speaking clock which will give the time in the desired language and hence conductor 5 is cross-connected to conductor 310 which is in turn connected with wiper 260. This digit is effective on a switch (not shown) in the Mons exchange in order to select the appropriate speaking clock. Finally the 6th contact associated with wiper 299 is cross-connected to conductor 317 to cause the release of the register-translator.

EIGHT DIGIT CALLS

Straight forward connection

If the second digit is 1-8 it indicates that the call is for an exchange in another zone. In this case when the second digit has been registered by the vertical movement of the switch TD1 and relay 204 has released, a circuit is closed as follows: earth at armature 382 and its resting contact (Fig. 7), operated contact and armature 495 of relay 237, vertical wiper 324, the bank contact to which this wiper has been raised, armature 494 of relay 237, winding of relay 236 to battery. Relay 236 operates and locks at armature 403 in parallel with relays 237 and 238. Relay 236 at armature 404 opens the circuit of relay 235 in order to prevent the register translator from commencing digit transmission. The fourth and fifth digits dialled by the calling party are registered by the vertical and rotary movements of the switch TD2 and the sixth by the operation of the switch RS1 as previously described. At the termination of the reception of the sixth digit, the wipers of the switch RS5 are stepped on to the 6th contacts and the seventh series of impulses are thus repeated to magnet 254 of the switch RS2. The wipers of the switch RS5 are now stepped on to the 7th contacts and the eighth digit dialled is repeated at contacts 327 of relay 187 (Fig. 15) to the magnet 243 of the switch RS5 as follows: earth, armatures 327, 334, wiper 259 of switch RS5 on contact 7, armature 523 of relay 205, contact 7 and wiper 258, armatures 330, 492 in their operated positions winding of magnet 243 to battery. The eighth and last digit is thus registered on the switch RS5.

As pointed out above in a call for an exchange of another zone the switch TD3 is automatically set as regards its vertical movement in accordance with the resultant of the first two digits recorded in the register translator and as regards its rotary movement in accordance with the third and fourth digits registered in the register translator. Relay 236 prepares the circuit for operating the switch TD3 which circuit is completed as follows on the registration of the fourth digit: earth at armature 406 of relay 236, armature 515 of relay 240, rotary off-normal springs 391 and their operated contacts, rotary off-normal springs 395 of the switch TD3 and their resting contacts, vertical off-normal springs 394 and their resting contacts, winding of relay 241 to battery. Relay 222 (Fig. 13) is also operated in parallel with relay 241. Relay 222 at armature 431 connects the impulsing conductor 516 extending from an impulsing machine to relay 213, the circuit extending as follows: impulsing conductor 516, armature 431, contact and armature 411, armature 427 and its operated contact, armatures 416, 420, winding of relay 213 to battery. Relay 213 operates as previously described and at armature 420 and its operated contact extends the impulsing conductor to relay 211. Relay 211 operates and completes an impulsing circuit extending from earth at armature 364, armature 429 of relay 222, armature 518 and its operated contact, winding of relay 241, winding of vertical magnet 250 of the switch TD3 to battery. Relay 211 and the magnet 250 are thus operated in synchronism. It will be noted that relay 222 at armatures 432 and 433 completes a shunt circuit across armatures 367 and 366 of relay 211 to prevent any impulses being transmitted to the first group selector. Further relay 222 at armature 428 extends earth to wiper 300 of the switch RS6 over which wiper the setting up of the connection is controlled. This circuit extends as follows: earth at armature 472 of relay 192 (Fig. 15), armatures 412, 471, 428, 405 to wiper 300.

The determination as to the number of steps to be taken by the switch TD3 is effected over wiper 262 of the switch TD1. Referring to Fig. 23 it will be noted that contact 1 associated with wiper 300 of the switch RS6 is cross-connected to conductor 303 which is directly connected with wiper 262.

Contacts associated with wiper 262 are connected to appropriate ones of the 10 conductors 1-10 and according, therefore, to the conductor which is connected to the particular contact on which wiper 262 is resting so the switch TD3 will make this number of vertical steps, the control being exerted over cable 285 and cable 282 through the counting relays RG5 in a precisely similar manner to that described in connection with the digit transmission on a decimal basis from the register translator. Thus relay 214 (Fig. 13) will operate when the switch TD3 has made the required number of steps and at armature 419 will close the circuit of magnet 326 to step wiper 300 on to the second contact. The original circuit of relay 241 is interrupted when the switch TD3 is moved off-normal, but this relay is maintained operated until the end of the vertical movement by the impulses transmitted over its upper winding to the vertical magnet 250. When the switch TD3 moves off-normal, however, the original energizing circuit for relay 241 is extended to the lower winding of relay 241 over vertical off-normal springs 394 in their op-

erated position. Relay 242 operates and at contact 519 prepares the impulsing circuit for the rotary magnet 251. When relay 241 releases at the end of the vertical movement this impulsing circuit is completed over armature 517 of relay 241 and the switch TD3 is rotated over the level upon which it has been set. The rotary movement of the switch TD3 is determined by the position of the wiper 267 of the switch TD2. The contacts associated with this wiper are connected to the appropriate ones of the conductors 1-10 and the rotary movement of the switch TD3 is controlled in a similar manner to that of the vertical movement, contact 2 associated with wiper 300 of the switch RS6 being cross-connected to conductor 304 and thence to wiper 287. Relay 242 at armature 520 serves to maintain the circuit of relay 222 during the rotary movement, the original circuit being opened at rotary off-normal springs 395. At the termination of the rotary movement of the switch TD3, the wipers of switch RS6 are stepped on to the 3rd contact and relay 222 releases.

The release of relay 222 causes at armature 421 the disconnection of the impulsing conductor 516 from relay 211. A further impulsing conductor 528 is, however, connected for the purpose of digit transmission from the register translator over rotary off-normal springs 396 of the switch TD3 in their operated position (Fig. 9) to armature 411 of relay 202. It is to be noted that the circuit over which earth is extended to wiper 300 is opened at armature 428 on the release of relay 222. The circuit is however maintained over rotary off-normal springs 397 which close on the first rotary step of the switch TD3 to shunt armature 428. Impulse transmission now commences from the register translator and the first digit is controlled by wiper 300 of the switch RS6 in position 3. Referring again to Fig. 23 it will be seen that contact 3 is cross-connected over armature 504 and its resting contact to conductor 3 of the control conductors since the determination of the charge for the call will be effected automatically. Following the transmission of this digit the next four digits transmitted, control the routing of the connection to and through the Mons central exchange. Thus contact 4 is cross-connected to conductor 0 of the 10 control conductors to step the first group selector IGS to the 10th level where it selects an idle junction line of "good" grade to the Mons central exchange. As previously pointed out the next digit will be the digit 8 in order to step the incoming selector IS of the Mons exchange to the 8th level. The incoming selector hunts over this level to find an idle special services selector TS. Calls to other zones are routed over levels 2 and 3 of this selector according as to whether the call is to proceed over the Brussels central exchange or over the Charleroi central exchange. Consequently the next digit will be variable so that contact 6 associated with wiper 300 will be cross-connected to conductor 305 which is directly connected to wiper 269 of the switch TD3. The position taken up by this wiper serves to control over the control conductors the transmission either of the digit 2 or the digit 3 in accordance with the destination of the call whereby the special services selector TS to the Mons exchange is raised to the second or third level whereupon it hunts for an idle relay group RG. The next digit to be retransmitted determines whether a "good" or "poor" grade junction line extending from the Mons central exchange shall be taken into use.

As pointed out previously this depends on the destination exchange and also as to whether repeaters are to be used in the connection. Assuming that a "good" grade junction is to be employed as determined by wiper 270, the transmission of the next digit will cause the toll line circuit finder TLF1 to start hunting for an idle toll line control circuit TLCC. The routing of the call through Mons exchange is now completed and the remaining digits are transmitted to Mons in code. Consequently contact 8 associated with wiper 300 is cross-connected to conductor 316 to cause circuit operations to take place as described previously which result in the transmission of coded impulses. The next seven contacts, i. e., contacts 9 to 15 associated with wiper 300 are cross-connected respectively to conductors 309 to 315 inclusive which are directly connected with the vertical and rotary wipers 323 and 260 of the switch TD1, the vertical and rotary wipers 325 and 266 of the switch TD2 and the wipers 272, 274 and 257 of the switches RS1, RS2 and RS5 on which the second to the 8th digits dialled by the calling party are stored. Of these digits the first two indicate the zone and the second two the destination exchange in that zone while the remaining impulses indicate the number of the called subscriber. The transmission of these digits only takes place in response to a signal from the toll line control circuit TLCC. The digit control when wiper 300 is on contact 16 is only employed in certain circumstances which will be described later and on a normal call no digit is transmitted. Contact 16 is, therefore, cross-connected over armature 503 of relay 207 and its resting contact, armature 527 of relay 206 and its resting contact to conductor 507 (Fig. 10). Earth extended over wiper 300 therefore causes the energization of relay 233 which at armature 529 closes a circuit which causes wiper 300 to be stepped on to contact 17 without any digit being transmitted. This circuit will be traced in detail later. The remaining digits to be transmitted from the register translator represent the calling party's number and the rate at which the call is to be charged. The transmission of the digits representing the calling party's number takes place as described previously except that the cross-connection between contact 17 and conductor 318 which controls the transmission of the 10,000 digit of the called subscriber's number is extended over contact 502 and its resting contact, the purpose of which cross-connection will be explained later. Finally when the calling party's number has been transmitted wiper 300 is stepped onto contact 22 which is connected to conductor 308 which is directly connected to wiper 271 of the switch TD3. This is for the purpose of transmitting a digit which is indicative of the rate of which the call is to be charged and it will be appreciated from what has been stated above that this digit will be dependent upon the zone to which the connection is to be extended and the destination exchange in that zone. Finally contact 23 is cross-connected to conductor 317 to cause the release of the register translator as previously described.

An alternative method of operation on calls of which the first digit is "0" is to allow the first group selector to be set on to an idle "good" grade junction line to Mons while the digit "0" is being absorbed in the register translator. The digit indicating the type of metering which is to be employed is transmitted to the first group se-

lector subsequently. This method of operation considerably reduces the holding time of the junction. The necessary alterations to effect this modification are slight and will be readily apparent to those skilled in the art.

Facilities are provided whereby on multi-rate calls the calling party can be informed if he so desires of the total cost of the call. For this purpose he is instructed to dial an additional digit after dialling the call number. A full description of this feature will be found in my co-pending application Serial No. 278,723, filed June 12, 1939.

Variation when calls are set up from manual operator

As has been previously pointed out when an operator at a manual exchange, e. g., Blaton, takes a register translator at Hautrage exchange into use for the purpose of setting up multi-rate or inter-zone calls or a connection to toll or international operator, the call is metered by the manual operator and for this purpose arrangements must be provided for altering the cross-connections extending from the contacts associated with the appropriate wipers of the switch RS6.

It should be pointed out that when the register translator is seized from a manual operator's position, booster battery is extended from the register translator finder switch over conductor 137 to cause the operation of relay 186, the rectifier 514 being so arranged that it is not operated when the usual battery potential is applied over this conductor. Relay 186 in operating locks over its "X" armature 513 to earth at armature 344 of relay 190; at armature 512 it opens its original energizing circuit; at armature 510 it closes an energizing circuit for relay 197 to prevent any operation of relays 198 and 202 and the switches RS3 and RS4 which normally record the calling party's number and at armature 509 closes a circuit for relay 207. Relay 207 operates and at armatures 500 to 506 alters the cross-connection extending from certain of the contacts associated with wipers 297, 300, 302 and 303.

Consideration will now be given to the effect of the operation of relay 207 as regards the cross-connections extending from contacts associated with wipers 297 and 300, that for wipers 302 and 303 being considered later. Referring first to wiper 297 it will be remembered that contact 6 is cross-connected over armature 501 of relay 207 and its resting contact to conductor 318 to cause the transmission of the 10,000 digit of the calling party's number in code. Similarly contact 7 is cross-connected over armature 500 and its resting contact to conductor 319 to cause the transmission of the 1,000 digit of the calling party's number. When the connection is being set up by manual operator, however, the calling party's number will not be transmitted but in place of this a special digit is transmitted to give an indication to the toll or international operator that the connection is being set up under the control of an operator at a manual exchange. This digit is the digit 1 and hence a cross-connection is made from contact 6 over armature 501 in its operated position to conductor 1 of the control conductors. No further transmission is now necessary from the register translator and consequently contact 7 is cross-connected over armature 500 and its operated contact to conductor 317 to cause the release of the register translator.

With regard to wiper 300 it will be remembered that contact 3 is normally cross-connected over

armature 504 and its resting contact to conductor 3 of the control conductors to cause the transmission of the digit which gives an indication in the first group selector of the type of metering which is to be employed. Since the call is metered by the manual operator when a connection is being set up from a manual exchange, the operation of relay 207 causes the cross-connection from contact 3 to be extended over armature 504 and its operated contact to conductor 1 whereby the digit 1 is transmitted from the register-translator. Further contact 16 which is normally cross-connected to armature 527 would now be cross-connected over armature 503 and its operated contact to conductor 9 of the control conductors, to cause the transmission of the digit 9 thereby giving an indication that the connection is being set up by a manual operator. Further contact 17 which is normally cross-connected over armature 502 and its resting contact to conductor 318 to cause the transmission of the 10,000 digit of the calling party's number is now cross-connected over armature 502 and its operated contact to conductor 317 to cause the release of the register-translator.

It is possible to arrange that the "special" digit is employed only in the case where the subscriber requires the cost of the call to be communicated to him. It will be understood that if the call originates from a manual exchange, the call is metered in the usual way by the originating operator and hence no rate digit will be transmitted. This involves a loss of time since the route control switch RS6 has still to step over this contact. Now there will normally be five rate digits with a possibility of a sixth when Blaton is converted to automatic working and by referring to Fig. 18 it will be seen that six digits can be transmitted without employing the fourth impulse of the cycle. Hence by employing the digit "0" for instance as a manual indication it can be transmitted as an alternative to the rate digit with a consequent saving of time.

Coded impulse transmission from register-translator

It will be remembered that the impulsing circuit extended from the register-translator to the first group selector consists of battery and earth potential extended over the windings of relays 210 and 209 to earth and battery respectively in the first group selector, battery potential being extended over the positive conductor. When impulse transmission takes place, the battery and earth potentials are replaced in the register translator by battery over resistance 435 and direct earth, impulsing being controlled by contacts 366 and 367.

When coded impulses are to be transmitted, each digit is represented by the cyclic operation of four of the counting relays of the group RG5. Normally the sequential operation of these four relays would involve the transmission of four impulses to the first group selector but owing to the operation of relays 225 and 226 the effect now is to cause certain of these impulses to be suppressed as regards their transmission over the positive conductor, those transmitted over the negative conductor being in all cases unaffected. The code adopted is indicated in Fig. 18 where the numerals in the vertical column on the left hand side represent the digit and the numerals in the top row represent the impulses of the cycle. Thus if the digit 5 is to be transmitted,

the 1st and 3rd impulses of the cycle will be suppressed, the 2nd and 4th being transmitted and so on for other digits.

The manner in which this coded transmission takes place will now be considered. On the operation of relays 225 and 226, the counting relays of the group RG5 will be removed from the control of conductors 1-10, at armature 460 and 461. In addition conductors 1-10 of the cable 288 will be extended over armatures 455 and 456 of relay 225 and armatures 463-470 inclusive of relay 226 to the windings of relays 227 to 232 inclusive.

Assume the digit "5" is to be transmitted. Then earth is extended over conductor 5 as previously described to cause the energization of relay 232. Relay 232 then closes the following circuit: battery, resistance 435 (Fig. 13), armature 521 of relay 232, armature 436 of relay 216, armatures 439, 444 to the contact associated with armature 366. Thus when armature 366 is opened when relay 211 responds to the first impulse, no impulse is transmitted over the positive conductor due to the shunt circuit traced above. Relay 216 responds to the first impulse however and on the termination thereof opens the shunt circuit at contact 436. The next impulse is therefore transmitted over the positive conductor and at the end of this impulse relay 217 operates fully and again closes the shunt circuit across the contact of armature 366. This shunt circuit extends as traced above except that it passes over armature 522 of relay 232 and armature 439 in its operated position instead of over armature 521 of relay 232 and armatures 436 and 439. The fourth impulse is transmitted over the positive conductor and at the termination of this impulse relay 219 operates fully and locks over its own armature 448, and armature 445 of relay 218. Relay 219 at armature 447 opens the circuit of relay 218 which releases and at armature 445 opens the circuit of relay 219 which also releases. On the release of relay 219 the four relays 216, 217, 218 and 219 are now all de-energized and the transmission of the next digit can take place. It will of course be understood that the transmission of digits other than the digit "5" will take place in a manner similar to that described above although the detailed circuits will differ in order that the correct impulses as indicated in Fig. 18 may be suppressed. For instance for the digit "0" relay 232 will be energized over its lower winding in series with relay 227. The shunting circuit for the first and third impulse is the same as described in connection with the transmission of digit 5 and the shunting circuit for the second impulse extends over armatures 554 and 553 to armature 436 so that the first, second and third impulses are suppressed.

The switch RS6 is stepped at the termination of each digit transmission over a branch of the energizing circuit for relay 219 over armature 458 of relay 225, lower winding of relay 208, winding of magnet 326 to battery.

With regard to the method of transmitting the coded impulses, it will be understood that this may be varied in a number of ways. For instance the impulses may be transmitted over the positive or the negative conductor and this method of operation enables a more satisfactory check to be made at the point where the impulses are received as will be explained more fully in connection with the operation of the toll line control circuit.

Other calls

A brief description will now be given of the cross-connections employed for setting up other calls from Hautrage exchange.

Calls to Mons satellite exchanges having a capacity of less than a thousand lines

A call to an exchange within the urban area of the Mons zone is considered as a unit rate call and five digits only will be dialled by the calling party the first two digits indicating the required exchange. It will be understood that for each exchange within the urban area the first two digits will be different, but the cross-connections extending from the banks of the switch RS6 are so arranged that all calls to exchanges within the Mons urban area and having a capacity of less than 1000 lines can be set up under the control of wiper 297 and contacts 16 to 23 (Fig. 20). Hence the contacts to which wiper 261 of the switch TD1 may be set on a call to any such exchanges are multiplied together and connected to wiper 297 of the switch RS6. Since the cross-connections for setting up calls of this nature are taken from contacts 16-23 associated with wiper 297, the corresponding contacts in the bank associated with wiper 264 are multiplied together and connected to magnet 326 of the switch RS6. Thus when the first two digits dialled indicate that the call is for an exchange in the Mons urban area having a capacity of less than 1000 lines, the wipers of the switch RS6 are automatically rotated to the 16th contact. Referring now to Fig. 20 since the call is to be metered by the calling party's meter contact 16 will be cross-connected to conductor 2 of the control conductors. Further all calls to these exchanges are routed over the switch LS at the Mons exchange and hence the first two routing digits are always the same, namely, 9 and 7. Consequently contacts 17 and 18 associated with wiper 297 are cross-connected to conductors 9 and 7 respectively of the control conductors. The next routing digit will be effective in raising the wipers of the switch LS to the appropriate level and is hence variable depending upon the destination exchange. Contact 19, therefore, is cross-connected to conductor 306 which is in turn connected to wiper 265 of the switch TD1. The contact in the bank associated with this latter wiper is connected to one of the control conductors of the cable 286 to cause the transmission of the appropriate routing digit to the Mons exchange. It will be understood that the contacts on which wiper 265 may be set on calls of this nature are connected to different ones of the control conductors of cable 286 in order to secure the transmission of the appropriate routing digit as determined by the position to which wiper 265 has been set. The call has now been routed as far as the incoming selector at the desired exchange and the remaining digits serve to set the group selector and final selector at this exchange. For this purpose contacts 20, 21 and 22 associated with wiper 297 of the switch RS6 are cross-connected respectively on conductors 311, 312 and 313 which are in turn connected with the various wipers on which the third, fourth and fifth digits are stored. These digits represent the called party's number in the exchange. Contact 23 is then connected to conductor 317 to cause the release of the register translator.

Calls to Mons satellite exchanges having a capacity of greater than one thousand lines

It will be understood that if the capacity of the desired exchange is greater than a thousand lines an additional digit must be transmitted from the register translator which digit will be effective on an additional group selector at the desired exchange. A different wiper of the switch RS6, therefore has to be employed and it is arranged that when the first two digits dialled by the calling party indicate that the call is to an exchange within the urban area and having a capacity greater than a thousand lines the appropriate contacts in the bank associated with wiper 261 are connected to wiper 299 of the switch RS6. Further contacts 16-24 associated with this wiper are employed so that a connection is also extended over wiper 264 to the magnet 326 of the switch RS6 to cause this switch automatically to step to the 16th contact. The cross-connections employed for setting up a call of this nature are similar to those described for a call to an exchange of less than a thousand lines and the additional digit is obtained by connecting contacts 20, 21, 22 and 23 to conductors 310, 311, 312 and 313 in order that the last four digits dialled by the calling party are retransmitted in untranslated form to set the switches in the desired exchange. It will be understood that with an exchange having a capacity greater than 1000 lines, of the first two digits the second will be variable since it also takes part in the selection of the desired subscriber. In this case therefore more than one contact in the bank associated with wiper 265 will be connected to the same one of the control conductors so that the same routing digit is transmitted although the second digit is different.

Calls over direct junctions to nearby exchanges

A direct junction line extends between Hautrage and St. Ghislain and it is thus unnecessary for the call to be routed through the Mons exchange. On a call to St. Ghislain wiper 298 of the switch RS6 is connected up over wiper 261 of the switch TD1 and the switch RS6 is also rotated to the 16th contact. This call is again a unit rate call so that referring to Fig. 21 contact 16 associated with wiper 298 is cross-connected to conductor 2 of the control conductors. A single routing digit is necessary for a call to St. Ghislain since junctions thereto are accessible over the 6th level of the first group selectors 1GS at Hautrage. Consequently the contact 17 is cross-connected to the conductor 6 of the control conductors. The capacity of St. Ghislain is greater than a thousand lines and hence four digits must be transmitted to set the switches in that exchange consequently contacts 18, 19, 20 and 21 are cross-connected to conductors 310, 311, 312, and 313 in order that the 2nd, 3rd, 4th and 5th digits dialled by the calling party are retransmitted to St. Ghislain without translation. This completes the setting up of the call and contact 22 is cross-connected to conductor 317 to cause the release of the register translator.

Calls to suburban exchange

As explained previously there is at present a direct junction between St. Ghislain and Dour and calls from Hautrage to Dour are extended through St. Ghislain. Now Dour is in a suburban area within the Mons zone and hence a call

thereto from Hautrage is a multi-rate call. At the moment, therefore, the call is metered by the operator dealing with incoming calls at Dour. The cross-connections for setting up a call to Dour extend from contacts 1-4 associated with wiper 301 of the switch RS6 and referring to Fig. 24 it will be seen that contact 1 is cross-connected to conductor 1 of the control conductors while contact 2 is cross-connected to conductor 309 to cause the transmission of the first digit dialled in order to route the call to St. Ghislain. This is satisfactory as long as it is arranged that the junction lines to St. Ghislain are connected on a level corresponding to the first digit of the Dour numbers. Contact 3 is cross-connected to conductor 310 in order to secure the transmission of the second digit dialled by the calling party. This digit is repeated through St. Ghislain to Dour to extend the connection to an operator's position at Dour. The remainder of the call is thus set up manually and consequently conductor 4 is cross-connected to conductor 317 to cause the release of the register translator.

When Dour is converted to automatic working, the junction between it and St. Ghislain will probably be removed and a direct junction will be provided between Dour and Mons so that calls from Hautrage to Dour will be set up entirely automatically and will be routed through Mons. Further since the call is a multi-rate call ticket-printing apparatus will be taken into use at Mons for the purpose of recording the total charge. The trunking layout shown in Fig. 2 does not provide the necessary switches for routing the call to Dour when the latter is automatic, but it is obviously not a difficult matter to arrange for this. The switch LS has no spare contacts but a group selector could be inserted between the switches IS and LS, the group selector having access to switches such as LS, some of which would have connected thereto junction lines extending to exchanges in the urban area while one or more would have access to junction lines extending to exchanges in the suburban area. This segregation would be desirable owing to the fact that ticket-printing equipment has to be associated with junction lines extending to suburban exchanges. Alternatively the switch IS may have direct access to junction lines leading to Dour.

With regard to the operation of the register translator it will be understood that although a call to Dour is a multi-rate call, it differs from multi-rate calls to exchanges in other zones in that a five figure number will be dialled instead of an eight figure number. Since, however, once the dialled digits have been registered in the register translator, the further operation is controlled by the route control switch RS6, the circuits of the register translator will not have to be altered but the modifications will occur in the cross-connections extending from the contacts associated with wiper 301 of the switch RS6.

Rate determination will be limited to the choice between two rates while with regard to the controlling circuits and ticket-printing equipment it will be appreciated that in general they will be similar to those employed on a call to an exchange in another zone. The requisite information will be transmitted to the Mons exchange in coded form since this results in a saving of time and a converter will be employed for converting the coded digits into decimal routing digits. No non-decimal impulse trains will be required however since repeaters will not be employed and "poor"

grade junction lines may be used. The routing digits may be transmitted in the form of alternating current impulses or if direct current impulsing is to be employed, regeneration may be made use of. At the end of conversation the various items will be transferred to the printer-controller as for other calls with the exception that the star indication may not be employed.

An example of the cross-connections which would serve for setting up a call to Dour when the latter is automatic is shown in Fig. 25. It should, however, be understood that this particular example is somewhat tentative and may involve alteration when the route which the call follows in the Mons exchange has been finally decided. Wiper 302 in Fig. 25 represents an alternative to wiper 391 of switch RS6 and can be substituted therefore when the change takes place.

Referring now to Fig. 25 it will be noted that contact 1 associated with wiper 302 is cross-connected to conductor 3 of the control conductors to cause the transmission of the digit 3 to indicate that the call is to be metered by ticket-printing equipment. Contact 2 is connected to conductor 9 of the control conductors whereby the first group selector 1GS (Fig. 2) is raised to the ninth level to select a "poor" grade junction line to Mons. Contact 3 is cross-connected to conductor 396 which in turn is connected to wiper 265. The contact on which wiper 265 is resting is connected to the appropriate control conductor to cause the transmission of the appropriate routing digit to Mons. This is the only routing digit transmitted to Mons and hence in this particular example the junction lines to Dour are directly accessible over the switch IS. Contact 4 is cross-connected to conductor 316 to enable the remaining digits to be transmitted in code. The remaining contacts are cross-connected in a manner similar to that for a toll call to another zone as shown in Fig. 23 the rate digit being transmitted between the called and calling party's number.

Calls to nearby exchanges in other zones

At present Blaton is a manual exchange and has a direct junction to Hautrage. It is, therefore, only necessary to transmit a single routing digit in order to set the first group selector 1GS on to level 3 where it has direct access to junction lines leading thereto.

Referring now to Fig. 24 a call to Blaton is controlled by cross-connections extending from contacts 16, 17 and 18 associated with wiper 301 and it will be seen that since this call is regarded as a unit-rate call contact 16 is connected to conductor 2 of the control conductors while contact 17 is connected to conductor 310 which is in turn connected to wiper 260 of the switch TD1. This cross-connection is made in preference to cross-connection to conductor 3 of the control conductors in view of the fact that there may be other manual exchanges having direct junctions to Hautrage which are differentiated by the second digit dialled by the calling party. Finally contact 18 is cross-connected to conductor 317 in order to cause the release of the register translator.

It will be understood that when Blaton is converted to automatic working, the direct junction between it and Hautrage will probably be removed. A call between these two exchanges will then be set up in a similar manner to that described for a call to another zone, that is to say the calling party at Hautrage will dial an eight

digit number commencing with the digit "0." With regard to the metering of the call this may be effected by the usual operation of the calling party's meter or it may be ticket printed. In the first case the contact on which wiper 268 of the switch TD3 is set is connected to the winding of relay 186. Consequently on the release of relay 242 at the end of rotary movement of the switch TD3, earth is extended from armature 406 (Fig. 7), armature 580 of relay 242 (Fig. 9), wiper 268 and bank contact to relay 186. Relay 186 operates to cause the same alterations to be made in the cross-connecting field of the switch RS6 such that the first digit transmitted will be the digit 2 indicating that metering is to be effected by the operation of the calling party's meter. If however, the call is to be ticket-printed, this connection will not be provided and the register-translator will operate in the manner described above for a call to another zone.

Supervisory and alarm arrangements

The supervisory and alarm arrangements are controlled by the relay group RG8 (Fig. 11) and a description will now be given of the operation of this group under different conditions. It will be understood that failure on the part of the calling party to dial any digits or to complete the dialling of the required number or the existence of a permanent short on a subscriber's line results in retaining the register-translator for a longer period than is necessary for the normal setting up of a connection and arrangements are provided such that under these conditions the register-translator is released.

Calling party fails to dial or permanent earth on subscriber's line

It is to be noted that during the normal setting up of a connection relay 346 is operated until the calling party has dialled the first two digits on a 5 digit call or the first 5 digits on an 8 digit call. The circuit for relay 346 extends over: battery, lower winding of relay 346, armature 482 of relay 191 to earth at rotary off normal springs 387 of the switch TD1 with an alternative circuit over rotary off-normal springs 391 of the switch TD2 in their resting position, armature 515 to earth at armature 406 of relay 236 is operated signifying that the call is an 8-digit one.

The operation of relay 10 when the register-translator is taken into use prepares at armature 341 a circuit to the conductor 530 (Fig. 11). Periodically earth impulses are applied to conductor 530 so that in due course a circuit is completed for relay 347 as follows: earth on conductor 530, armature 354 of relay 348, armatures 341, 532, lower winding of relay 347 to battery. Relay 347 operates and locks over its "X" armature 531 to earth at armature 352. At armature 532, relay 347 opens its original energizing circuit and at armature 533 prepares a circuit for relay 348 which extends to conductor 534 to which earth pulses are applied at a time interval which exceeds the greatest time normally taken before relay 346 releases after corresponding pulses have been applied to conductor 530. Relay 348 operates in response to a pulse over the conductor 534 and locks over its "X" armature 353, armatures 476 if relay 346 is not operated or armature 535 if relay 345 is not operated, armature 484 to earth at key 538 in the closed position. At armature 351 relay 348 provides an alternative holding circuit for relay 189; at armature 352 at its resting contact it opens the hold-

ing circuit of relay 347 which releases; and at its operated contact closes a holding circuit for relay 346 over armature 475 if relay 346 has not previously released; at armature 355 and its resting contact it removes earth from conductor 141 extending to the calling party's line circuit but this conductor is still earthed from armature 537 and armature 478 of relay 346; at its operated contact armature 355 closes a circuit for relay 349 and for relay 192 over armature 479. This circuit cannot be completed if relay 346 has released. Relay 349 operates and at armature 539 opens a point in the circuit of the start conductor 545; at armature 540 it opens the start conductor 550 to the time impulse generator; at armature 541 it earths alarm conductor 551; at armature 542 closes a circuit for lighting the lamp 547 and at armature 543 it opens the circuit of the busy lamp 548.

Relay 192 in operating at armature 472 connects earth to wiper 303 of the switch RS6 and at armature 473 connects the impulsing conductor 552 to the winding of relay 213 to set in operation the digit transmission from the register translator.

Referring now to Fig. 26 which shows the cross-connections extending between contacts associated with wiper 303 of the switch RS6, it will be noted that contact 1 is cross-connected to conductor 3 of the 10 control conductors. It is in this case immaterial to which of the conductors 1, 2 or 3 the cross-connection is made as, of course, there is no question of metering but a series of impulses must be sent before the group selector can be positioned as will be explained later. Contact 2 is cross-connected to conductor 9 in order to position the first group selector to cause it to select a junction line to Mons. Contacts 3 to 6 are also cross-connected to appropriate ones of the 10 control conductors to route the connection to a special ticket-printing apparatus which is reserved for this particular purpose. This special ticket-printing apparatus is not shown in Fig. 2 and hence the cross-connection from contacts 3-6, which will extend to the appropriate control conductors, have not been inserted. Following the transmission of the routing digits, the calling-party's number will be transmitted in code to the ticket-printing apparatus in a similar manner to that previously described so that the ticket printed will bear the calling party's number and serves as a permanent record of the fault. After the transmission of the calling party's number, the wiper 303 is stepped on to contact 13 which is cross-connected to conductor 317. The usual circuit extending to the register-translator finder for rendering the finder available for another connection has however been opened at the resting contact of armature 474 (Fig. 11) and consequently the earth applied to wiper 303 is extended over the operated contact of armature 474 to the upper winding of relay 345. This relay operates and locks to earth at armature 477 over armature 536. At armature 537 earth is removed from conductor 141 to cause the release of the line relay so that in known manner the cut-off relay due to its being slow-to-release is locked over the subscriber's loop independently of the exchange apparatus so that the 1st group selector, the register translator finder and the register translator become free for use on other calls and the subscriber's line can only become effective when the faulty condition is removed.

Further at armature 535, relay 345 opens the

locking circuit of relay 348 which releases and at armature 351 opens the alternative locking circuit to relay 189 which releases to cause the release of the register translator as previously described.

Arrangements which are not shown may also be provided whereby if dialling has not been completed and a period of 30 seconds elapses after the reception of the last impulse dialled, the register translator is automatically connected to Mons over a special circuit having access to a special printer unit. The calling party's number is thereupon printed in a manner similar to that described previously. This method of operation is useful in that it enables a record to be made of subscribers where dialling is unsatisfactory. It is also useful in that it will be effective where a short on a line is of an intermittent nature provided of course that the period between any two successive short circuits is greater than 30 seconds.

Faulty register-translator

In the case where the calling party has dialled sufficient digits to ensure the release of relay 346 but the register-translator is still in use after a predetermined period due for instance to failure to complete digit transmission, arrangements are provided for disconnecting the calling party's line from the register-translator while the circuits of the latter remain in the position to which they have been set so that the register-translator is maintained busy and the attention of an attendant may be called thereto.

Relays 347 and 348 operate in response to the earth pulses over conductors 530 and 534 as previously described and on operating relay 348 at armature 355 removes earth from conductor 141 to enable the line relay to release and if the subscriber's line is still looped the cut-off relay locks as before and the calling party can in due course initiate a fresh call independent of the faulty register-translator. Since relay 346 is not operated, the circuit over conductor 142 will be maintained at armature 474 and hence the register-translator finder RTF will remain in the position to which it has been set.

In addition relay 348 at armature 351 closes an alternative locking circuit for relay 189, the original circuit of which is opened when relays 187 and 188 release on the disconnection of the calling party's line from the register-translator. The circuits of the register-translator are thus held in the position to which they have been set.

Finally relay 348 at armature 355 and its operated contact closes an obvious circuit for relay 349. Relay 349 in operating at armature 542 closes a circuit for lighting the lamp 547 to give a visual alarm and at armature 541 extends earth over conductor 551 to cause an audible alarm to be given.

The circuits remain in this condition until the fault has been remedied and key 538 opened. The opening of key 538 opens the locking circuit of relay 348 which releases and at armature 355 and its operated contact opens the circuit of relay 349. Further at armature 351 the holding circuit of relay 189 is opened and this relay releases to initiate the release of the register-translator as previously described.

Delaying transmission pending reception of complete impulse series

Suppose that the calling party delays dialling one of the digits then it is obviously necessary

to delay impulse transmission from the register-translator. For instance on a 5 digit call to a local subscriber, impulse transmission from the register-translator commences after the registering of the second digit by the connection of impulsing conductor 399, at armature 400. If now the calling party has not completed dialling the third digit before the first digit is transmitted, then the following holding circuit is completed for relay 208 which is operated at the end of each digit transmission: earth at vertical off-normal contacts 390 of switch TD2 in their resting position, conductor 311, cross-connection to contact 2 associated with wiper 296 of the switch RS6 (Fig. 19), wiper 296, contact on which wiper 261 of the switch TD1 is set, wiper 261, armatures 328, 401, 410, 471, 412 in its operated position, upper winding of relay 208 to battery. Relay 208 in its operated condition disconnects the impulsing conductor 399 from the winding of relay 213 hence delays impulse transmission. Relay 208 is released when its holding circuit is opened on the operation of vertical off-normal springs 390 on the first vertical step of the switch TD2.

Similarly on a call to Mons for example a similar holding circuit is closed for relay 208 with wiper 296 (Fig. 19) on contact 19.

Further similar holding circuits are closed if the calling party delays dialling the fourth or fifth digits, the earth in these cases extending from rotary off-normal springs 392 of the switch TD2 or from contacts 11 or 25 associated with wiper 272 of the switch RS1 respectively with wiper 296 on the appropriate contacts.

It will be understood that while a description has been given in connection with local calls and calls to Mons only, this control over the impulse transmission from the register-translator is effective on all five digit calls.

With regard to three digit calls, impulse transmission does not commence until all the digits have been dialled so that the above considerations do not, therefore, apply.

With regard to 8 digit calls it will be remembered that impulse transmission does not commence until the switch TD3 has been set, i. e., until after five digits have been dialled. It will therefore be seen by referring to Fig. 23 that impulse transmission may take place to the extent of all the routing digits and the called party's number up to the fifth digit. If now the calling party delays in dialling the 6th digit, relay 208 is held over the following circuit: earth at contact 11 or 25 associated with wiper 272 of the switch RS1, conductor 313 cross-connected to contact 13 associated with wiper 300 (Fig. 23) of the switch RS6, wiper 300, armatures 405, rotary off-normal springs 397 of the switch TD3, armatures 471, 412, upper winding of relay 208 to battery. If the delay occurs in dialling the 7th or 8th digit the earth will be derived from contacts 11 or 25 associated with wiper 274 of the switch RS2 or contact 7 associated with wiper 257 of the switch RS5 with of course wiper 300 of switch RS6 on the appropriate contacts 14 or 15, respectively.

Detailed description of first group selector

Reference will now be made to Figs. 27, 28, and 29 which show the circuits of the first group selector 1GS and to Fig. 30 which shows a junction line circuit accessible to the wipers of the first group selector.

When the line finder 1LF switches through on to the calling line, earth as previously explained

is extended from the register-translator over the negative conductor 109, to conductor 600 (Fig. 27), armature 661 and its resting contact, make-before-break contacts of armatures 657 and 659, upper winding of relay 699 to battery. Similarly battery is extended over the positive conductor 108 to conductor 601, armature 662 and its resting contact, make-before-break contacts of armatures 658 and 660, lower winding of relay 609 to earth. Relay 609 therefore operates and at armature 649 closes a circuit for relay 610. In addition at armature 647 and 648 relay 609 prepares the impulsing circuit to the outgoing conductors. Relay 610 in operating at armature 652 extends earth over the upper winding of relay 607 to test conductor 602 and conductor 110 (Fig. 4). The switch is now in a condition to receive impulses from the register-translator.

The first digit transmitted from the register-translator is effective in giving an indication as to the type of metering which is to be employed for the call and does not effect any setting operation of the switch wipers. This digit may be 1, 2 or 3 and on the first impulse, relay 609 releases and closes a circuit over: earth, armature 649 and its resting contact, armature 655 and its operated contact, rotary off-normal springs 642, make-before-break contacts of armature 665, armatures 669, 673, lower winding of relay 613 to battery. Relay 613 is a two-step relay and at this time closes its "X" armature 672 only. At the termination of the impulse, relay 613 operates fully over: earth, armatures 654 (Fig. 27) 667, 672 to battery over both windings of relay 613 in series. Relay 613 at armature 673 extends the impulse repeating circuit to the lower winding of relay 612. It is also to be noted that relay 611 is energized over both windings in a parallel branch of the impulse repeating circuit and being slow-to-release is maintained operated for the whole of the impulse train.

Assume that the first digit comprises three impulses. Then the second impulse will cause the energization of relay 612 over operated armature 673. Relay 612 is also a two-step relay and operates in a similar manner to relay 613. It locks over its "X" contacts 668 to earth over armatures 679 and 654 and on operating fully at armature 667 opens the locking circuit of relay 613 which thereupon releases. Finally the third impulse causes the energization of relay 615 over operated armature 669. Relay 615 is a two-step relay and at the end of the impulse locks over its "X" armature 680, armatures 686, 656, to earth and operates fully. At armature 679 relay 615 opens the locking circuit of relay 612 which releases. Relay 611 also releases at the end of the impulse series and at armature 676 the following circuit is closed for relay 620; earth, armatures 653, 676 (Fig. 27), armatures 678, 684, or armature 671 or 666 according to the number of impulses, vertical off-normal springs 644, resistance 688, centre winding of relay 620 to battery. Relay 620 operates and at armature 665 prepares an impulsing circuit to the vertical magnet 622. The second impulse series transmitted from the register translator is repeated at armature 649 of relay 609 over the following circuit: earth, armature 649 (Fig. 27) and its resting contact, armature 655, rotary off-normal springs 642, operated contacts and armature 665, resistance 689, rotary off-normal springs 641 in parallel with the low resistance lower winding of relay 620, winding of magnet 622 to battery. On the first vertical step of the switch the original

energizing circuit of relay 620 is opened at vertical off-normal springs 644 but the relay is maintained operated by the impulses over the lower winding. At the end of the impulse series, relay 620 releases and at armature 664 the following circuit is closed for the rotary magnet 621: earth, armatures 653, 676 (Fig. 27), armatures 678, 684, vertical off-normal springs 644 in their operated position, armature 664, winding of rotary magnet 621 to battery. The rotary magnet energizes and steps the wipers on to the first line in the selected level. Further on energizing the rotary magnet closes contacts 690 thereby completing the following circuit: earth, armature 654 (Fig. 27), winding of relay 619, armature 685, 11th step springs 648, self-interrupting contacts 690 of magnet 621, upper winding of relay 620 to battery. If the line on which the wipers are standing is engaged, earth is fed back over wiper 626 so that relay 619 is short-circuited but relay 620 operates and at armature 664 opens the circuit of the rotary magnet. The rotary magnet thereupon releases and opens contacts 690 whereupon relay 620 releases and again closes the circuit for the rotary magnet. This interaction continues until an idle line is found to which no battery potential is applied. Relay 619 now operates in series with the upper winding of relay 620 and locks over armature 687 in series with the centre and upper windings of relay 620 and at armature 684 opens the energizing circuit of the rotary magnet to prevent any further operation thereof. Further at armature 686 relay 619 opens at its resting contact, the locking circuit of relay 615 if this relay has been operated. Relay 615, having enabled the impulsing circuit to the vertical magnet to be prepared, releases. At its operated contact, armature 676 of relay 619 closes the following circuit for relay 608; earth at armature 656 (Fig. 27), armatures 686, 696, winding of relay 608 to battery. In addition relay 619 at armatures 681 and 682 closes points in the circuit of the outgoing conductors. Relay 608 in operating over the above circuit at armatures 657, 658, 659 and 660 disconnects the conductors 600 and 601 incoming from the register-translator from relay 609 which releases and connects them to the outgoing conductors over a circuit which by-passes the condensers 691 and 692, thereby providing a direct current impulsing circuit from the register-translator to the succeeding apparatus. Impulse transmission from the register-translator continues and at the termination thereof, earth is disconnected from conductor 602 whereupon relay 607 which was short-circuited by this earth and the earth extended from armature 652, operates over the following circuit: earth, armature 652, upper winding of relay 607, armatures 695, 651, winding of relay 610 to battery over resistance 699. Relay 607 operates and locks over its "X" armature 697 to earth at armature 656; at armature 696 relay 607 opens the circuit of relay 608 which releases; at armature 693 and 694 it closes a loop including resistances 700 and 701 for holding subsequent switches and at armature 695 short-circuits its upper winding to make it slow-to-release. Relay 608 on releasing reconnects the incoming conductors to relay 609 which energizes and at armatures 647 and 648 shunts armatures 693 and 694, together with resistances 700 and 701. This holding circuit extends as follows: negative conductor, wiper 624, armatures 681, 648, make-before-break contacts associated with armature 703, right-hand winding of shunt-field relay 614, up-

per winding of relay 615, make-before-break contacts associated with armature 702, armatures 647, 632 to the positive wiper 625. The left-hand winding of relay 614 was energized on the operation of relay 610 but the relay does not operate at this stage and neither does relay 615.

The effect of the operation of relays 612, 613 and 615 in response to the first digit received from the first group selector will now be discussed and it will first be assumed that the connection is to be metered by the calling party's meter in the usual manner, i. e., the first digit is "2" and relay 612 is operated. When the called party replies the battery and earth connections are reversed to cause the operation of relay 614. Relay 614 at armature 706 closes the following circuit for relay 606; earth at rotary off-normal springs 643 and their operated contacts (Fig. 29), armatures 705, 706, 670, winding of relay 606 to battery. Relay 606 operates and at armature 708 disconnects the earth from armature 652 which is applied to conductor 602 and connects booster battery thereto over conductor 710. The calling party's meter is thus operated. Further relay 606 at armature 709 short-circuits relay 612 which releases and at armature 670 opens the circuit of relay 606 which also releases. Further operation of the calling party's meter is thus prevented.

When the calling party replaces his receiver at the end of conversation, relay 609 releases followed shortly after by relay 610. Relay 610 at armature 654 opens the circuit for relays 619 and 620 which release and at armature 653 and its resting contact the following circuit is closed for the release magnet 623: earth, armatures 653, 623, vertical off-normal springs 645, winding of release magnet 623 to battery. The switch wipers are thus returned to normal. Further at armature 656 the locking circuits of the various relays are opened and the switch is thus restored to normal.

When the first digit transmitted by the register-translator is "1" indicating that the connection is extended to an operator who as previously stated will control the metering, relay 613 is operated. On the reply of the operator, reversal of the battery and earth connections takes place as before and relay 614 operates. At armature 706 however, owing to the operation of relay 613, relay 616 instead of relay 606 is operated, the circuit being as follows: earth at operated rotary off-normal contacts 643, armatures 705, 706, 674, winding of relay 616 to battery. Relay 616 at armatures 702 and 703 disconnects the outgoing conductors from the windings of relays 614 and 615 and connects them to earth over the winding of relay 617 and to battery over the winding of relay 618, both the relays operating. At armature 705 relay 616 opens its own energizing circuit but being slow-to-release it is maintained operated until its alternative circuit is closed at armature 711 or 714; at armature 704 relay 616 provides an alternative earth for relay 610 so that the release of the switch and hence of the connection set up by the calling party is completely under the control of the operator.

Thus when the calling party replaces his receiver, relay 609 releases but the only effect of this release is to remove at armatures 647 and 648 the short-circuit around armatures 693 and 694 and the high resistances 700 and 701. The current flowing in the loop circuit is thus reduced sufficient to cause the release of the line relay at the operator's position to indicate that

the calling party has hung up but insufficient to cause the release of relays 617 and 618. These relays are only released when the operator takes down the connection, for instance by removing the plug from the jack or by the restoration of a key. The operator is thus in a position to re-
 5 rering the calling party if necessary and to do this the negative conductor is opened at the operator's position. Relay 618 then releases and the following circuit is closed; earth at operated rotary off-normal springs 643, armatures 705, 712,
 10 715, 650, winding of relay 604 to battery. Relay 604 operates and at armatures 661 and 662 connects conductors 717 and 718 to conductors 600 and 601 over which conductors ringing current is transmitted to the calling party.

It is also possible as will be appreciated from the description of the register-translator that certain calls (e. g., for the speaking clock and certain other services) may be metered on the
 20 calling party's meter. This may be effected either before or after the calling party has hung up by opening the positive conductor whereupon relay 617 releases and a circuit is closed as follows: earth at operated rotary off-normal springs 643, armatures 705, 712, 716, winding of relay
 25 606. Relay 606 operates and causes the operation of the calling party's meter as previously described.

If no reversal of battery and earth over the outgoing speaking conductors occurs within a predetermined time, i. e., the called party does not reply, the connection is automatically released. On the operation of relay 607, when transmission from the register-translator has been completed, conductor 725 is connected up. This conductor is periodically earthed and serves to energize relay 605 over; conductor 725, armatures 707, 713, 698, make-before-break contacts associated with armature 721, upper winding of relay 605 to battery. Relay 605 operates and locks over its lower winding, armatures 722,
 40 706, 705 to earth at rotary off-normal springs 643; at armature 721 it opens its original energizing circuit and at armature 720 connects conductor 723 to the junction point of resistance 699 and the winding of relay 610. Conductor 723 is also earthed periodically, the time between an earth pulse over conductor 725 and one over conductor 723 being considerably greater than that necessary for the connection to be set up and the called party to reply. Consequently when an earth pulse is transmitted over conductor 723, relay 610 is short-circuited and releases to cause the release of the group selector and of the connection.

On a call for an exchange to a different zone, if no junction lines to the required zone are available the connection is automatically routed to an operator at the Mons exchange who then sets up the connection and controls the release thereof. In this case relay 613 in the group selector must be operated and to do this a pulse of alternating current is transmitted over the negative conductor to the group selector when the operator replies. It will be understood that this alternating current signal will be received before the register-translator has finished impulse transmission, so that relay 608 is still operated. Relay 603 responds to the alternating current due to the parallel-connected rectifier 729 and at armature 728 closes an obvious circuit for relay 613. Further operation is then similar to that described above.

If the group selector is unable to find an idle outlet in the selected level, the wipers are rotated

to the 11th step whereupon 11th step springs are operated. At springs 640 and their resting contacts the testing circuit over relay 619 is opened and at their operated contacts earth is applied to wiper 626 to operate an overflow meter; at
 5 contact 639 a circuit is closed for relays 619 and 629 in series so that these relays operate to prevent further energization of magnet 621 and finally at contact 638, busy tone is transmitted over conductor 726, condenser 727 to the positive conductor and thence to the calling party. The latter now replaces his receiver and relays 609 and 610 release and the release of the switch takes place as previously described.

Referring to the junction line circuit shown in Fig. 30 it will be seen that when earth is extended over wiper 626 of the 1st group selector on the operation of armature 685 (Fig. 29), relay 627 is operated and at armatures 730 and 731, the wipers of the group selector are extended over conductors 632 and 633, armatures 730 and 731, to the junction line conductors 635 and 636. Relay 627 in addition locks independent of armatures 738 and 735 over contact 732 to earth on wiper 626 of the group selector, this earth providing busy test to other group selectors. Finally at armature 733 the shunting earth is removed from relay 631 which thereupon operates and an armature 743 closes a signal circuit to indicate the
 30 busy condition of the junction line.

The junction line circuit is arranged so that it can be used for both-way working. Thus when the junction line is seized at the Mons exchange, conductors 636 and 635 are looped and relays 628 and 629 operate. At armatures 734 and 736 these relays complete a circuit for relay 630. In addition relay 629 at armature 735 earths conductor 634 to busy the junction line in the banks of the 1st group selectors and at armature 737 removes the shunting earth from relay 631 to enable this relay to operate. Relay 630 in operating at armatures 739 and 740 extends the junction line conductors 635 and 636 to conductors 744 and 745 extending to the incoming group selector which is permanently associated with the junction line; at armature 738 extends a further guarding earth to conductor 634; at armature 741 locks to earth in the incoming group selector over conductor 745 and at armature 742 opens a further point in the shunting circuit to relay 631. Relays 628 and 629 release when their circuits are opened at armatures 739 and 740, but their functions are now taken over by relay 630.

When the called party hangs up his receiver at the end of conversation the switch train at Hautrage is released followed by the release of relay 630. If now the equipment at Mons has not yet released, relays 628 and 629 operate again to maintain the junction line busy. When the Mons equipment has released, relays 628 and 629 release and the junction line is available for other calls.

Reference will now be made to the circuits which are provided at the Mons exchange. It will be understood however that a number of the switches provided at Mons are of standard construction and arrangement and a description thereof apart from the general description already given with respect to Fig. 2 is unnecessary for an understanding of the invention. A detailed description will therefore be given only of the toll line control circuit TLCC and the register-translator or converter C with the associated finder switch CF. The printer-controller PC, the date and time unit DTU and the printer units PT

and PU are described in detail in my co-pending applications, Serial No. 278,728, filed June 12, 1939, and Serial No. 278,729, filed June 12, 1939.

Detailed description of toll line control circuit

The toll line control circuit TLCC is taken into use by a toll line finder switch such as TLF¹ (Fig. 2) and is arranged to store the called party's number, the calling party's number, the rate at which the call is to be charged and a digit indicating certain special features if any of call. This information is transmitted to the toll line control circuit from the register-translator as previously described. In addition the toll line control circuit sets in operation the switch CF to hunt for an idle converter C to which the digits representing the called party's number are repeated; it supervises the setting up of the connection; it times the call and stores this information and finally at the end of the call it again sets the switch CF in operation to hunt for an idle printer-controller PC to which it transmits all the stored information, whereupon the connection is released.

When a connection is extended to the toll line control circuit earth potential is extended over conductor 750 (Fig. 36), upper primary winding of transfer 811, make-before-break contacts associated with armature 813, winding of relay 764 to battery. Relay 764 in operating at armature 815 closes an obvious circuit for relay 777. Relay 777 in operating at armature 819 extends earth from make-before-break contacts associated with armature 823 to conductor 752 to guard the toll line control circuit and at armature 818 closes an obvious circuit for relay 781. Relay 781 in operating at armature 826 closes a self-interrupting circuit for the magnet 810 of the converter finder switch CF (Fig. 35). This circuit extends as follows: Earth, armature 832 (Fig. 38), armatures 835, 826, 840, self-interrupting contacts 841, windings of magnet 810 to battery. A busy converter is indicated by an earth on the appropriate contact associated with wiper 971 which is extended over armature 844 in its resting position, cam springs 842 in their resting position to the upper winding of relay 780, the other terminal of this winding being connected to earth over the following circuit: Earth at armature 817 (Fig. 38), armatures 834, 825 in its operated position both windings of relay 780 in series. Relay 780 is thus short-circuited and does not operate so that the wipers of the switch CF are rotated until they reach an idle converter. When this occurs relay 780 operates from earth at armature 817 as traced above over wiper 971 and conductor 984 to battery in the converter. Relay 780 in operating at armature 840 opens the energizing circuit to the magnet 810; at armature 839 closes a locking circuit for itself independent of relays 781 and 782 and at armature 838 closes an obvious circuit for relay 787. Relay 787 in operating at armature 848 closes a circuit for relay 788 to earth at armature 847 and at armature 849 closes a circuit for relay 789. Relay 788 in operating at armature 879 closes a circuit from earth at armature 886 (Fig. 39) for relay 786 which operates. The operation of relays 786 and 788 causes wiper 959 to 962 of the switch OP to be connected to wipers 967 to 970 of the switch CF over the pairs of contacts 880, 873; 881, 874; 882, 875; and 883, 876. Further relay 787 at armatures 863 and 864 connects wipers 973 and 974 of the switch CF to the toll line conductors 759 and 760. Relay 789 in operat-

ing at armature 852 extends earth at armature 849 over the winding of relay 778 to battery (Fig. 38) and at armature 853 connects relay 763 (Fig. 36) to the positive conductor 751 over make-before-break contacts of armature 814 and the lower primary winding of transformer 811. Relay 763 operates on its connection to conductor 751 and at armature 862 extends earth from armature 865, windings of relay 779 to battery. Further its connection to this conductor serves as an indication in the register-translator that the toll line control circuit is ready to receive impulses therefrom. Relay 779 operates and locks over armature 869 to earth at armature 851 (Fig. 40). Relay 779 in operating at armature 871 closes an alternative circuit for relay 778 independent of relay 787 and 789.

It should be pointed out that the cam springs 842 of the switch CF remain in the position shown when the switch wipers are resting on any of contacts 1-20 and are operated only when the wipers are in positions 21 to 25.

Digit transmission from the register-translator now commences and in this connection it will be appreciated from the description of the operation of the register-translator on a call for another zone that the digits which are to be received by the toll line control circuit TLCC comprise the called party's number (seven digits), the special digit, if any, the calling party's number (five digits) and finally a digit which indicates the rate at which the call is to be charged. Further all these digits are transmitted in code.

With regard to the code in which the digits are transmitted each digit is transmitted by a series of four impulses, each impulse being transmitted over the negative conductor while only certain combinations of the impulses are transmitted over the positive conductor. Briefly the effect of for example the first digit in the toll line control circuit is that the impulses over the negative conductor serve to step the switch IP from contact 1 to contact 4 while the impulses transmitted over the positive conductor serve to operate appropriate ones of the counting relays of group I comprising relays 892 to 895 which are connected up over contacts 1 to 4 associated with wiper 950 of Switch IP. A similar group of counting relays is provided for each digit and since a maximum of 14 digits have to be stored, that number of relay groups will have to be provided. These relay groups are accessible over wipers 950, 951, and 952 of the switch IP, wipers 950 and 951 being spaced apart by 180°. In addition the impulses transmitted to the counting relays are also transmitted over the wipers of the switches OP and CF to the converter, the switch OP making one step on the reception of each digit. The relay or combinations of relays which operate to indicate the different digits will be apparent from Fig. 18 if the numbers 1, 2, 3 or 4 appearing in the upper horizontal row are replaced by the relay references 892, 893, 894 and 895 respectively. The same applies to the relays in the other counting groups. It should also be pointed out that the counting relays employed in the various circuits are of a special small type having a locking contact only. They are indicated in the drawings by the diagonal line in the bottom left-hand corner of the relay.

A detailed description will now be given of the reception of the first digit which by way of example will be assumed to be the digit 1. Referring to Fig. 18 it will be seen that the first two impulses only are transmitted over the positive con-

ductor. The first impulse therefore interrupts both the positive and negative conductors 751 and 750 and both relays 764 and 763 will de-energize. Relay 764 at armature 815 and its resting contact closes the following circuit: earth, armature 815 and its resting contact, armature 820 and its operated contact, armature 837, winding of magnet 807 of switch IP to battery. Magnet 807 energizes but since it operates on the reverse-drive principle the wipers are not stepped at this time. It will be noted that at armature 815 and its operated contact the circuit for relay 777 is opened but this relay is sufficiently slow-release to enable it to remain operated for the duration of the impulse series. Relay 763 at armature 862 closes the following circuit: earth armature 865, armature 862 in its resting position, armature 870, armature 900 in its resting position, wiper 950 of switch IP on contact 1, winding of relay 892 to battery. Relay 892 operates and locks at armature 903 to earth at armature 856 (Fig. 34) of relay 778 (Fig. 38). In addition the impulse is also transmitted over conductor 904, contact 1 and wiper 959 of the switch OP, armatures 820, 873, wiper 967 of the switch CF to the converter.

At the end of the first impulse relays 763 and 764 re-operate and earth is thus removed from wiper 950 and from the winding of magnet 807. The switch IP is thus stepped on to contact 2. On the second impulse relays 763 and 764 again release and earth is again extended to wiper 950 in position 2 to the winding of relay 893. Relay 893 operates and locks. The impulse is also transmitted over contact 1 and wiper 960 of switch OP, armatures 881 and 874, wiper 968 of the switch CF to the converter. At the end of the second impulse relays 763 and 764 re-operate and earth is again removed from wiper 950 and from the winding of magnet 807. The switch IP is thus stepped on to contact 3. On the third impulse relay 764 only releases so that no earth potential is applied to wiper 950 and no impulse is repeated to the converter. The wipers of the switch IP are however stepped to position 4. In this position the following circuit is completed: earth, armature 861 (Fig. 38), wiper 953 of switch IP on contact 4, armatures 898, 897, winding of magnet 809 of the switch OP to battery. A branch of this circuit also extends over contact 878 of relay 788, wiper 972 of the switch CF to the converter.

Magnet 809 is energized in the above circuit but since the switch is arranged to operate on the reverse drive principle the wipers are not stepped at this time. On the fourth impulse no impulse is transmitted over wiper 950 of the switch IP or to the converter but relay 764 releases to step the wipers of the switch IP to position 5. With wiper 953 on contact 5 the above traced circuit for magnet 809 is opened so that the magnet de-energizes and the wipers of the switch OP are stepped on to contact 2. Further the circuit over wiper 972 of the switch CF is also interrupted. The first digit has now been stored.

The second digit is stored on group II of the counting relays. These relays are not shown but are connected to contacts 5 to 8 associated with wiper 950 as shown by the bracketed conductors II. Further on the 4th impulse of the second digit the wipers of the switch OP are stepped from position 2 to position 3 by earth connected to wiper 953 on contact 8, armature 897 and then as previously traced. The third

digit is stored on group III of the counting relays connected to contacts 9 to 12 associated with wiper 950 while the wipers of the switch OP are stepped from position 3 to position 4 by earth connected to wiper 953 on contact 12, armature 899 and thence over armature 897 as previously traced. The fourth, fifth, sixth and seventh digits are recorded in a similar manner, the impulse repeating circuit for the seventh digit extending over contact 25 associated with wiper 950 and contacts 1-3 associated with wiper 951.

Now the first seven digits as pointed out above comprise the called party's number and hence are the only digits which have to be recorded in the converter, the function of the converter being to transmit over the selected toll line the necessary digits for completing the connection. For this reason only contacts 1-7 associated with wipers 959 to 962 of the switch OP are connected to the impulse-repeating circuit extending over wipers 950 and 951 of the switch IP. These connections are indicated generally by the conductors marked II-VII and by the bracketed contacts 2-7 associated with wipers 959 to 962.

The next digit to be received is the special digit. On a normal toll call set up by a subscriber, as pointed out in the description of the register-translator, no "special" digit is transmitted and hence no impulses are transmitted over the positive conductor so that the wipers of the switch IP are stepped over four contacts without any impulses being repeated over the wipers of the switch. If the call although being for an exchange in another zone is to be considered as a unit rate call, e. g., a call from Hautrage to Blaton when the latter is automatic, or if the call is set up by an operator at a manual exchange, e. g., a call from Hautrage to Blaton when the latter is manual, the special digit "9" is transmitted the effect of which is to prevent a ticket being printed. Thus when this digit is received, which consists of a positive pulse on the third impulse only of the series an earth is connected to wiper 951 in position 6 to cause the operation of relay 776. Relay 776 operates and locks over armature 829 to earth at armature 860; at armature 832 removes earth from the contact associated with armature 840 in order to prevent the finder switch CF, on the release of the converter, from hunting for an idle printer-controller; at armature 831 close a circuit for relay 782 which as described later causes the restoration of the switch IP as no further digits will be transmitted from the register-translator; and at armature 830 prevents the timing of the call.

It will of course be understood that if it is decided to issue a ticket on a call from Hautrage to Blaton even though the call is a unit rate one, the "special" digit will not be transmitted in this case.

There is also a further possibility for the special digit which occurs when the calling party requires some additional information such as the total cost of the call. In this case the special digit is "0" and earth is then extended over wiper 951 in position 7 to cause the operation of relay 905 which locks over contact 906 to earth at armature 860. The effect of this operation will be described later.

The next five digits to be received comprise the calling party's number and these are stored on counting relay groups IX to XIII (not shown) in a similar manner to that described for the previous digits. The calling party's number will not however be repeated to the converter.

Finally the 14th digit to be received is a digit indicating the rate at which the call is to be charged and this digit is stored on counting relay group XIV (not shown).

It will be appreciated that the switch IP must be capable of responding to 56 impulses during the reception of the 14 digits. The switch however has only 50 contacts and to enlarge its capacity, wipers 959 and 951 are disconnected at the termination of the 50th impulse and wiper 952 is connected up instead. When wiper 954 is positioned on contact 25 to receive the 50th impulse, the following circuit is closed: earth at armature 861, wiper 954 on contact 25, armature 896, upper winding of relay 771 to battery. Relay 771 is a two-step relay and closes its "X" armature 902 only at this time. After the 50th impulse has been received however and the switch IP has been moved a further step, the earth applied to the upper winding of relay 771 is removed and the relay operates fully over the following circuit: earth at armature 861, armature 902, both windings of relay 771 in series to battery. At armature 900 relay 771 prepares the circuit for extending earth over wiper 952 instead of wipers 959 and 951 for the reception of the 51st to 56th impulses.

When the 56th impulse has been received the following circuit is then closed: earth at armature 861, wiper 953 of the switch IP in position 7, armature 901 of relay 771, winding of relay 782 to battery. Relay 782 operates and locks over armature 836 to earth at armature 861; at armature 833 it closes the following self-interrupting circuit for the magnet 807 of the switch IP: earth at off-normal springs 907 (Fig. 37), armatures 908, 833, 824, interrupter contacts 914, windings of magnet 807 to battery. The wipers of the switch IP are rotated into the position shown when springs 907 open to interrupt the energizing circuit for the magnet. Further at armature 837 relay 782 disconnects magnet 807 from the resting contact associated with armature 815 and connects it to armature 918.

While the circuits shown are designed to operate with the above described form of coded impulsing, it is to be understood that other forms may be employed. For instance impulses may be transmitted over the positive or negative conductor, those transmitted over the positive conductor serving to operate a storage relay and step the switch IP while those transmitted over the negative conductor step the switch IP only and no storage relay is operated. This arrangement has the advantage that a more positive check may be effected since if an impulse over either conductor is ineffective, relay 782 will not operate while in the case described in detail above, relay 782 operates if all the impulses transmitted over the negative conductor are effective irrespective of the impulses transmitted over the positive conductor. Failure of relay 782 to operate may then prevent the closure of the speaking circuit so that the connection is not completed.

The converter completes its operation, and then battery is removed from wiper 971 to cause the release of relay 789 followed by the release of relays 787, 788, and 786 while relay 789 is maintained over its locking armature 852 to earth at armature 871. The speaking circuit is now completed through the toll line control circuit over transformer 811, the lower secondary winding of which is connected directly to the out-going conductor 759 of the toll line while the upper secondary winding is connected to outgoing con-

ductor 760 over armature 863 of relay 787 and its resting contact, resting contact and armature 921 of relay 784 to conductor 769.

It is possible that the converter may complete its operation before all the transmitted information has been stored in the toll line control circuit. In this case the called party may reply before the calling party's line has been extended to the toll line control circuit. To avoid this it may be necessary to delay the transmission of the final digit from the converter until a predetermined number, for instance twelve digits have been stored in the toll line control circuit. Such an arrangement has not been shown in the drawings but the method of operation will be clearly understood by those skilled in the art.

The circuit remains in this condition until a momentary alternating current signal is returned from the distant exchange indicating that the connection has been completed to the desired subscriber. This signal causes the momentary operation of relay 770, half waves of one polarity passing from the lower terminal of the upper secondary winding of transformer 811 through the upper winding of relay 770, metal rectifier 922 in the conducting direction to the upper terminal of the lower secondary winding while half-waves of the other polarity pass from the upper terminal of the lower secondary winding, lower winding of relay 770, metal rectifier 923 in the conducting direction to the lower terminal of the upper secondary winding. The two windings of relay 770 are so arranged that both half waves act in the same sense to cause the operation of the relay. Relay 770 at armature 925 operates relay 765 to close its "X" armature 864 and at the end of the signal this relay operates fully over: earth, armatures 818, 864, both windings of relay 765 in series to battery. In the case where the call is being set up by an operator it will be remembered that relay 776 is operated. Hence the operation of relay 765 at armature 856 causes booster battery from conductor 758 to be extended over armature 823 of relay 776, armature 819 to private conductor 752 which without releasing the switches back to Hautrage serves to give an indication at the operator's position that the setting up of the connection has been completed.

When the called party replies a further momentary alternating current signal is transmitted back to the toll line control circuit again to cause the operation of relay 770 as described above. Relay 770 at armature 925 closes a circuit for two-step relay 766 over armatures 863 and 911. Relay 766 energizes to operate its "X" armature 912 and close a circuit for relay 767 over armature 926 to earth at armature 818. Relay 767 in operating provides supervision at armatures 813 and 814 by reversing the battery feed to the calling party. On the termination of the signal, relay 766 energizes fully and at armature 913 relay 766 initiates the timing of the call.

If the call is not set up by an operator the call is timed by 5 second pulses transmitted over conductor 755 to cause the stepping of the switches IP, T and OP. The switch IP it will be remembered has been returned to its normal position while switch OP is in its eighth position. Switch T is also in its normal position.

The first eaarth pulse transmitted over conductor 755 passes over armatures 830, 927, 913, winding of relay 773 to battery. Relay 773 operates and at armature 918 closes the following circuit for magnet 807 of the switch IP: earth at armature 918, armature 837, winding of magnet

807 to battery. The magnet energizes and at the end of the pulse releases to step the wipers of the switch IP on to contact 2. The switch IP is therefore caused to take one step every 5 seconds for the duration of the conversation. On the reception of the fourth pulse when wiper 953 is on contact 4, the following circuit is closed: earth at armature 861, wiper 953 on contact 4, armatures 910, 930, contact 1 and wiper 957 of the switch T, interrupter contacts 933, windings of magnet 808 upper low resistance winding of relay 777 to battery. The magnet energizes and at its interrupter contacts opens the above-traced circuit whereupon the magnet releases to step the wipers on to contact 2. In addition when wiper 953 is moved on to contact 5 at the end of the fourth pulse a further point is opened in the energizing circuit for magnet 808. With wiper 957 on contact 2 however a further circuit is closed for magnet 808 as follows: earth at armature 931 (Fig. 37), bank multiplying and wiper 957, interrupter contacts 933, windings of magnet 808 upper winding of relay 777 to battery. The wipers of the switch T are now stepped on to contact 4 where the energizing circuit for the magnet is opened. The switch T now remains in this position until three minutes have elapsed and wiper 991 is on contact 11 when earth is extended over the upper winding of relay 772, contact 4 and wiper 957, interrupter contacts 933 windings of magnet 808 upper winding of relay 777 to battery. Relay 772 is a high resistance relay and operates over this circuit although the magnet does not. Relay 772 locks over its lower winding and armature 932 to earth at armature 867 and at armature 930 and 931 opens points in the first two energizing circuits traced above for magnet 808. Further stepping of the switch T is now under the control of the switch IP and it is arranged that the switch T makes one step every minute which elapses. Thus on each reception of the 12th pulse with wiper 953 of the switch IP on contact 12 or 24, the following circuit is closed: earth at armature 861 (Fig. 38), wiper 953 of the switch IP on contact 12 or 24, armatures 899, 990, 916, windings of magnet 808 to battery. The wipers of switch T are thus stepped on to the next contact at the termination of the 12th pulse. The reason for stepping switch T on to contact 4 at the end of 20 seconds is that although charges for calls are based on a minimum call of 3 minutes the subscriber is allowed a grace period of 20 seconds before timing is effective.

The number of 10 minute intervals which elapse during a conversation are recorded on the switch OP which it will be remembered is in position 8. For this purpose when the switch T has made 10 steps and is on contact 11, the next 5 second pulse causes earth to be extended over wiper 950 of the switch T on contact 11, armature 915, windings of magnet 809 to battery. At the end of the pulse the wipers of switch OP are stepped on to contact 9.

It will be appreciated that in order for the positions of the wipers of the switch T to be the same for successive semi-rotations it is essential to arrange that at the end of the first 10 minute period the wipers of the switch T are brought on to contact 14; at the end of the second 10 minute period the wipers are brought on to contact 1 and so on. Thus at the end of the 10th minute wiper 957 is stepped on to contact 11 which is multiplied to contacts 12 and 13 and connected to earth. An obvious self-interrupt-

ing circuit is thus completed for magnet 808 and the wipers are stepped to contact 14.

It will also be understood that it is necessary to give the wipers of the switch IP an additional step when they reach the 25th contact and hence this contact associated with wiper 953 is connected to the contact associated with armature 908 while the 25th contact associated with wiper 954 is connected to the contact associated with armature 909. Hence at the termination of the 24th pulse a circuit is completed as follows: earth at armature 861, wiper 953 on contact 25, armatures 908, 933, 824, interrupter contacts 914, windings of magnet 807 to battery. Wipers 950, 952 and 953 are thus stepped off the 25th contact and wipers 951, 954, and 991 are stepped on to contact 1 in order to receive the next pulse. Similarly at the termination of the 48th pulse with wiper 954 on contact 25 a similar circuit is closed which extends in addition over armature 909 so that wipers 951, 954, and 991 are stepped off contact 25 and wipers 950, 952, and 953 are stepped on to contact 1.

Normally the timing operation is stopped only on the termination of conversation, but if a call lasts for 99 minutes, timing is terminated and a signal may be given. This feature is of importance since when the equipment is retained in operation for this length of time it would indicate a possible fault having developed for instance a permanent earth on the calling party's line or on the junction line extending from Hautrage to Mons. Thus at the end of the 99th minute wiper 956 of the switch T will be on contact 10 and wiper 964 of switch OP will be on contact 17. The following circuit is now closed: earth, wiper 956 on contact 10, upper winding of relay 774, contact 17 and wiper 964, armature 816 to battery over resistance 934. Relay 774 operates and locks over its lower winding and armature 928 to earth at armature 861; at armature 927 opens the circuit between conductor 755 and relay 773 and at armature 929 earth's conductor 761 to give an alarm.

Timing is stopped by the termination of conversation, when the calling party replaces his receiver, and relays 763 and 764 release. Relay 764 at armature 815 opens the circuit for relay 777. Relay 777 in releasing slowly at armature 819 and its operating contact removes earth from conductor 752 but this earth is replaced at its resting contact from armature 854 (Fig. 40) and finally at armature 818 relay 777 opens the circuit of relays 781, 765 and 766. During the release period of relay 781 however a circuit is closed from earth at armature 818 of relay 777, armature 827, wiper 963 and bank contact as determined by the number of 10 minute intervals, winding of one of the relays 935 to 938 to battery. A parallel branch of this circuit extends over armatures 843 and 816 to wiper 964 and bank contact to a winding of another of the same relays. The operation of a combination of relays 935 to 938 in accordance with the digit to be stored will be apparent from Fig. 18 if the references 1, 2, 3 or 4 in the upper horizontal row are replaced by the references 939, 937, 936 and 935 respectively. Thus if the call lasts for less than 10 minutes, the switch OP will not have been stepped and thus will remain on contact 8. On the release of relay 777 therefore relay 935 is operated over wiper 963 but no relay is operated over wiper 964 in accordance with the table. Relay 935 locks over armature 939 to earth at armature 855 (Fig. 34). This earth

is also extended over the contact associated with armature 939 to contact 18 associated with wiper 962. If the number to be stored is such that another one or two of the relays 935, 936, 937 and 938 are operated, the locking earth will be extended to appropriate contacts associated with wipers 959 to 962 in a similar manner.

The battery connection to magnet 808 of the switch T is taken over the upper winding of relay 777 to ensure that if the calling party hangs up during the reception of a pulse, the circuit for operating the relays 935 to 938 is not closed until the end of the pulse due to the continued energization of relay 777.

The circuit for extending earth to wipers 963 and 964 is opened at armature 827 when relay 781 finally releases. In addition relay 781 at armature 828 closes the following circuit for relay 790; earth at armature 815, armatures 820, 828, 872, winding of relay 790 to battery, at armature 824 closes a self-interrupting circuit for magnet 807 to earth at off-normal springs 997 to return the switch IP to contact 1 and finally at armature 826 relay 781 closes a self-interrupting circuit for magnet 810 of the switch CF. Relay 790 at armature 845 completes an energizing circuit for magnet 809 of the switch OP over wiper 966 to earth at armature 888. The switch OP is thus stepped to position 17 unless it is already at this position. A circuit is now closed for relay 783 as follows: earth, armatures 850, 846 (Fig. 40), wiper 965 on contact 17 winding of relay 783 to battery. Relay 783 operates and locks over armature 889 to earth at armature 851.

It should be explained that the switch CF has access over contacts 1 to 20 to the converters and over contacts 21 to 25 to printer-controllers. In order to connect the toll line control circuit with an idle printer-controller the switch CF has thus to be rotated automatically to contact 21 from whence it is stepped until it finds an idle printer-controller. The circuit for automatically rotating the wipers of the switch CF to position 21 extends as follows: earth at armature 832 (Fig. 38), armatures 835, 826, 840, interrupter contacts 841, windings of magnet 810 to battery. When the wipers of the switch reach the 21st contact, cam springs 842 are operated and the following test circuit is completed: earth at armature 868 (Fig. 38), armature 834 and its operated contact, armature 825 and its resting contact, both windings of relay 780 in series, cam springs 842 in their operated position, contact and armature 844, wiper 971. A busy printer-controller is indicated by earth which is extended over wiper 971 to shunt relay 780 while an idle printer-controller is indicated by battery which operates relay 780. Relay 780 in operating locks over its upper winding and armature 839; at armature 840, relay 780 opens the energizing circuit for the magnet 810 and at armature 838 closes as before a circuit for relay 787 which operates followed by relay 788 which is operated from earth at armature 890 (Fig. 39).

The position at the present time is, therefore, as follows. The toll line control circuit is associated over the switch CF with a printer-controller. Further the toll line control circuit has the called party's number stored on relay groups I to VII, the calling party's number stored on relay groups IX-XIII, the rate at which the call is to be charged stored on relay group XIV and the duration of the call in minutes stored on the switch T and relay group XV. The next operation

is to transfer this stored information to the printer-controller.

The transfer commences on the operation of relay 783 as described above when impulsing conductor 753 delivering earth pulses at the rate of 15 per second is connected over armature 885 of relay 783, armature 943, upper winding of relay 785 to battery. Relay 785 operates its "X" armature 944 at the commencement of the first pulse and at the termination thereof operates fully over both windings in series to earth at armature 861. At armature 943, relay 785 transfers the impulsing conductor to the winding of relay 786. Relay 786 at armature 884 repeats the pulses from earth at armature 886 (Fig. 39) to magnet 809 of the switch OP and also over wiper 972 of the switch CF to the printer-controller. On the reception of the second pulse relay 786 operates to energize magnet 809 and at armatures 880 to 883 connects wipers 959 to 962 to wipers 967 to 970 over armatures 873 to 876 of relay 788. It will be noted that contacts 17 associated with wipers 959, 961 and 962 of the switch OP are connected to counting relay group XIV (not shown) on which the "rate" digit is stored. The charging rates are so devised that the rate digit may be any one of five digits and hence three relays only of the group XIV are employed. Earth is thus extended from armature 855 (Fig. 34) of relay 778 (Fig. 38) over the locking contacts of the operated counting relays, contacts 17 in the banks of wipers 959, 961 or 962, armatures 880, 882, or 883, armatures 873, 875 or 876, wipers 967, 969 or 970 of the switch CF to the printer-controller. At the termination of the second pulse, relay 786 releases and the wipers of the switch OP are stepped on to the 18th contacts. Contacts 18 of wipers 959 to 962 are connected to the contacts associated with the locking armatures of the relays in group XV on which the number of 10-minute periods are stored. This information is transmitted to the printer-controller in a similar manner as that described for the "rate" digit. With the switch OP on contacts 19, connections are completed from wipers 955 and 956 of the switch T in order to transfer the minute periods to the printer-controller. Contact 20 associated with wiper 962 is connected to the locking circuit of relay 905 so that a circuit is now completed to the printer-controller if the calling party requires the cost of the connection. Contacts 21-25 of the switch OP are connected to counting relay groups IX to XIII to transfer the calling party's number to the printer-controller. The wipers of the switch OP are now stepped on to contact 1 and continue to step on to contact 8 under the control of relay 786 during which time the called party's number which is stored on counting relay groups I to VII is transferred to the printer-controller.

It will be understood that the information need not be transferred in the order stated. For instance the star indication may be transferred last of all.

All the necessary information has now been stored in the printer-controller which operates to control the printing or recording of the information as described in my previously-mentioned pending applications and the toll line control circuit may be released. When wiper 965 of switch OP reaches contact 8 a circuit is completed from earth at armature 850 (Fig. 40), armature 846, wiper 965 on contact 8, armature 891 to the junction of the windings of relay 779. The lower winding of this relay is thus shunted and since

the upper winding cannot maintain the relay alone, it releases. Relay 779 at armature 869 opens its own locking circuit; at armature 868 opens the locking circuit for relay 780 which releases; at armature 867 and its operated contact opens the circuit for relay 772 which releases; at armature 871 opens the circuit of relay 778 which releases and one point in the locking circuit for relay 789 and at armature 872 opens the circuit of relay 790 which releases slowly.

Relay 780 in releasing at armature 838 opens the circuit for relay 787 which releases; at armature 839 opens a further point in its own locking circuit and at armature 840 closes a point in the homing circuit for magnet 810 of the switch CF. Relay 787 causes the release of relays 788 and 789 and relay 789 at armature 851 causes the release of relay 783; and at armature 854 removes earth from conductor 752 to free the toll line control circuit for other calls.

Relay 783 in releasing at armature 885 disconnects the impulse conductor 753 from the winding of relay 786; at armature 886 disconnects the earth from armature 884 of the impulse repeating relay 786; and at armature 888 initiates the restoration of the switch OP.

Relay 772 in releasing at armature 931 closes the following circuit for magnet 808 of the switch T: earth at armature 931, bank multiping and contact associated with wiper 957, interrupter contacts 933, winding of magnet 808, upper winding of relay 777, to battery. The switch T is thus restored to its normal position. Earth is then extended on the release of relay 778 over wiper 953 on contact 1, armature 858, contact 17 associated with wiper 966, interrupter contacts 949, winding of magnet 809, to battery, and as the other contacts are earthed over contact 1 associated with wiper 958 and armature 859, the wipers of the switch OP are thus restored to their normal position.

Relays 778 in releasing at armatures 855, 856, 857 (Fig. 34) and 860 removes the holding earth from all the counting relay groups and the operated relays thus release. Further at armature 861 it removes a general holding earth to enable the release of relays 782 and 785.

Relay 799 in releasing at armatures 844 and 845 restores the original test circuit of the switch CF to enable it to hunt for a converter when the toll line control circuit is seized on a subsequent call.

It will be noted that the switch CF is still on contacts leading to the printer-controller. When the toll line control circuit is taken into use on another call, the following self-interrupting circuit is closed on the operation of relay 781; earth at armature 832 (Fig. 38), armatures 835, armatures 826 and its operated contact, armature 840, interrupter contact 841, windings of magnet 810 to battery. The wipers are thus stepped to contact 1 during which time no test circuit is operative to stop the switch since the cam springs 842 are in their operated position. In position 1 however these springs are returned to normal and a test circuit is then closed over wiper 971 as described previously.

Provision is also made in the above circuit for an alteration in certain of the rates if a call is set up between the hours of 19 and 7 o'clock. The rate digits 1 and 2 represent charging rates of 5 and 3 francs respectively and it is arranged that during the call the rate in both cases is reduced to 1 fr. 80 centimes. This is effected by an earth which is extended from the date

and time unit in a manner to be explained later, to conductor 754 to cause the operation of relay 762. It should be explained that digits 1 and 2 cause the operation of the first and second and the first and third relays respectively of the appropriate relay group. It will be noted however that contacts 4 and 5 associated with wiper 952 of the switch IP (Fig. 31) are connected to the windings of the storage relays over armatures 993 and 992 respectively. Consequently with relay 762 operated, the first only of the counting relays is operated in response to the reception of rate digit 1 or 2. Now the operation of the first relay of the group represents the digit 7 which is equivalent to a rate of 1 fr. 80 centimes. A conversion of the rate has thus taken place.

Detailed description of register translator or converter

This circuit which as previously explained is seized from the toll line control circuit over switch CF serves to control the transmission of the required routing digits over the toll line to control the setting up of the connection in the distance exchange. It will be remembered that on the reception of the called party's number in the toll line control circuit, this number was stored in that circuit and also repeated over the wipers of the switch CF to the converter. This number is also stored in the converter. As previously explained this number comprises two digits representing the zone of the called party and also five digits representing his local exchange and number. The two zone digits are translated to cause the transmission of a maximum of five digits on a non-decimal basis while the five local digits are transmitted without translation. On the converted basis each digit is converted into an impulse train having a maximum of 20 impulses per train and these impulses are effective on switches located at the distant exchange and having 20 positions. The setting of these switches is not effective as regards the routing of the call but determines other factors such as whether repeaters are to be inserted or not and whether a "good" or "poor" grade junction is to be employed for further extending the connection. Finally the called party's local number is transmitted in its original numerical value. All impulses transmitted over the toll line are in the form of alternating current impulses.

A detailed description will now be given of the operation of the converter. It will be remembered that when the converter is seized by the toll line control circuit TLCC, earth is extended over wiper 971 of the switch CF, and this is further extended over conductor 984 and wiper 1005 of the switch IP1 on contact 1 in parallel over resistance 1054 to battery and over the winding of relay 1036 to battery, the resistance-battery serving to prevent double seizure of the circuit. Relay 1036 operates and at armature 1058 closes the following circuit for relay 1028; earth at armature 1058, wiper 1026 of switch S in position 1, winding of relay 1028 to battery. In addition at armature 1059 relay 1036 closes a start circuit for the impulsing machine which drives impulsing contacts 1084 and 1092. It should be pointed out in connection with these impulsing contacts that contacts 1084 have a 33% break period while contacts 1092 have a 66% break period and in addition the phase of the impulsing

contacts is so arranged that springs 1084 are open when springs 1092 are closed.

Relay 1028 in operating at armature 1061 closes an obvious circuit for relay 1029 which in operating at armature 1065 closes an obvious circuit for relay 1030. Relay 1030 in operating at armature 1070 closes a circuit over armature 1074, winding of relay 1037, resistance 1083 to battery. Relay 1037 in operating at armature 1079 completes a circuit in parallel with its own winding for connecting the impulsing springs 1084 in series with the magnet 1051 of the switch S. This circuit extends as follows: earth, armatures 1070, 1074, impulsing contacts 1084, armatures 1079, 1085, windings of magnet 1051 to battery.

It is to be noted that impulsing springs 1092 are connected in series with the winding of relay 1028, but the springs have no effect on relay 1028 at this time owing to the short-circuit which extends over wiper 1026 of the switch S in positions 1 and 2.

In addition relay 1037 at armature 1077 completes an energizing circuit from earth at armature 1071 for magnet 1047 of the switch OP1. This magnet energizes preparatory to stepping its wipers.

When wiper 1026 steps on to contact 3, the original circuit of relay 1028 is opened and the relay is now dependent on the impulsing springs 1092. Hence when wiper 1026 is stepped on to contact 3 on the opening of the contacts 1084 at the end of the second effective pulse, springs 1092 close. At the end of the make period springs 1092 open and relay 1028 releases. An alternating current signal is now transmitted over conductor 1086 connected to one terminal of a 60 cycle current source, armatures 1060, 1063, armature 1088 and its resting contact, conductor 986 and thence through the toll line control circuit to the positive toll line conductor, loop at the distant exchange, negative toll line conductor, through the toll line control circuit, to conductor 987, armature 1089 and its resting contact, armatures 1066, 1062, conductor 1087 to the other terminal of the current source. At the end of the break period relay 1028 operates to terminate the pulse and simultaneously magnet 1051 de-energizes to step the wipers of the switch S to position 4. With wiper 1024 in position 4 the following circuit is closed: earth on wiper 1012 of switch OP1 on contact 1, contact 4 and wiper 1024 of the switch S, armature 1094, winding of relay 1038 to battery. Relay 1038 operates and locks over bank multiplying and contact 4, wiper 1026 to earth at armature 1058; at armature 1076 it closes a shunt across the impulsing springs 1092 to prevent any further release of relay 1028; at armature 1071 opens the energizing circuit of magnet 1047 which releases and steps the wipers of the switch OP1 to position 2 and at armature 1074 opens the circuit of relay 1037 and the pulsing circuit for the magnet 1051. However, relay 1037 on release closes the following self-interrupting circuit for magnet 1051: earth on wiper 1027, contact 4 and bank multiplying armature 1032, interrupter contacts 1091, windings of magnet 1051 to battery. The wipers of the switch S are thus stepped on to contact 15 when the following circuit is completed for relay 1037: earth at wiper 1027 on contact 15, armature 1075 winding of relay 1037 to battery. Relay 1037 operates and causes the magnet 1051 to be again under the control of the impulsing springs 1084. The wipers of the switch S are thus rotated to position 23 where the first self-

interrupting circuit is again effective to rotate the wipers on to contact 1. The object of returning switch S to normal partly by times stepping is to ensure that a sufficient interval elapses between the trains of impulses transmitted over the toll line as will be described later. In position 1 the circuit over wiper 1026 for relay 1028 is again completed while the circuit for relay 1038 is opened. Relay 1038 releases and at armature 1074 again closes the circuit for relay 1037. In addition when the wipers of the switch OP1 are stepped on to contact 2, earth is extended over wiper 1012, winding of relay 1033 to battery. Relay 1033 operates and locks over its armature 1090, armature 1102 to earth at armature 1055. At armatures 1088 and 1089 relay 1033 disconnects conductors 986 and 987 from the A. C. source and loops them over the upper winding of relay 1032.

During the above operation, the called party's number has been stored on the counting relay groups I to VII. These digits are received in the converter over wipers 1000 to 1003 of the switch IP1 and serve to operate the appropriate relays in the relay groups I to VII. These digits are in code and the combination of relays which are operated will be apparent from Fig. 18 if the relay references 1041, 1042, 1043 and 1044 are substituted for the references 1, 2, 3 and 4 respectively appearing in the upper horizontal row. The first digit will cause the operation of the appropriate ones of relays 1041 to 1044 over wipers 1000 to 1003 in position 1. At the same time as each digit is being received an earth pulse is transmitted from the toll line control circuit over conductor 995 wiper 1006 and bank multiplying winding of magnet 1046 to battery. The magnet thus energizes and when the earth pulse is terminated at the end of the digit, the wipers of the switch IP1 are stepped to position 2 in order that the second digit is stored on counting relay group II. The remaining digits are stored in a similar manner and at the end of digit storing the wipers of switch IP1 are on contact 2.

It will be remembered that the first two digits represent the zone of the called party and in order to secure the transmission over the toll line of the correct non-decimal impulse trains, the two directional switch TD4 is operated in accordance with the numerical values of the first two digits.

Assuming that by the time the circuit of relay 1037 is completed for the second time as described above, the first digit has been stored on group I of the counting relays, relay 1037 operates and completes a circuit for magnet 1051 as before. The wipers of the switch S are stepped through position 2 to the third position in the manner previously described when relay 1028 is placed under the control of the impulsing springs 1092 which have just closed. At the end of the make period relay 1028 releases and a circuit is completed from earth at armature 1061, armature 1064, wiper 1014 on contact 2, windings of vertical magnet 1048 of the switch TD4. The magnet of the switch S and the vertical magnet of the switch TD4 now step together, the number of impulses which are to be delivered to the vertical magnet being determined by wipers 1022 and 1023 of the switch S in conjunction with wipers 1008 to 1011 of the switch OP1. Thus suppose the numerical value of the first digit is "1." Then relays 1041 and 1042 will be operated and when relay 1028 has transmitted the first impulse and switch S is stepped to position 4, the following

circuits are completed: earth at armature 1067, locking armature 1095, contact 2 and wiper 1008 of switch OP1, contact 4 and wiper 1022 of switch S, right hand winding of relay 1039 to battery. Earth at armature 1067 is also extended over locking armature 1036, contact 2 and wiper 1009 of switch OP1, contact 4 and wiper 1023 of the switch S, left-hand winding of relay 1039 to battery. Relay 1039 operates only when both its windings are energized. In this case therefore armature 1099 is operated and completes a circuit for relay 1038 which operates, shunts the impulsing contacts 1092 and causes the release of relay 1037 and the return to normal of the switch S as previously described.

If however, the numerical value of the digit has been "0," relay 1044 only would have been operated. In this case with the switch S in position 4, no circuit would have been closed for 1039, and relay 1028 continues to repeat impulses to the vertical magnet and it will be noted from the connections made to wipers 1022 and 1023 that the two windings of relay 1039 are not energized together until the wipers are on the 13th contacts, i. e., until 10 impulses have been delivered to the vertical magnet. Armature 1099 is then operated to energize relay 1038 with the results described above.

It is to be noted that if, when the circuit of relay 1037 is completed for the second time, the first digit has not yet been stored, it is essential that relay 1037 should be prevented from operating. Thus at this time the wipers of the switch OP1 are in position 2 and if the first digit has not yet been stored, the wipers of the switch IP1 are still in position 1. Earth is then extended from wiper 1004 of the switch IP1 on contact 1, contact 2 and wiper 1013 of switch OP1, resistance 1083 to battery. Relay 1037 is thus shunted and can only operate when wiper 1094 has stepped on to contact 2, i. e., when the first digit has been stored. A similar precaution is taken with regard to the storing of the 2nd and subsequent digits although the detailed circuits are not shown.

The switch OP1 makes one step on to contact 3 on the release of relay 1037 at the end of the vertical movement of the two-directional switch TD4 and hence the next series of impulses are repeated in a similar manner to the rotary magnet 1049. The numerical values of the two zones digits are thus recorded by the vertical and rotary setting of the two-directional switch TD4. The impulse trains which have to be transmitted are determined by cross-connections extending between the banks of the two-directional switch and the two banks associated with wipers 1024 and 1025 of the switch S. In this particular case provision is made for the transmission of up to five impulse trains by means of cross-connections extending from the banks associated with wipers 1016 to 1020 of the switch TD4, and further each impulse train may comprise up to 20 impulses.

Impulse transmission from the converter commences when the wipers of the switch OP1 are stepped to position 4 at the end of the rotary movement of the switch TD4. Before impulse transmission commences, however, a signal has to be transmitted from the distant exchange to indicate that the equipment is in a condition to receive impulses. Prior to the reception of this signal, earth is extended from armature 1103 (Fig. 45), contact 4 and wiper 1013, resistance 1083 to battery to prevent the operation of relay

1037. When the signal which comprises the connection of battery and earth to the toll line conductors is received, relay 1032 operates and locks over its "X" armature 1101 to earth at armature 1069 and at armature 1103 removes the shunting earth to enable relay 1037 to operate to initiate impulse transmission. In addition relay 1032 opens its original energizing circuit at armature 1100 and at armature 1102 opens the locking circuit of relay 1033 which releases to prepare the impulse repeating circuit to the toll line conductors at armatures 1088 and 1089.

On the operation of relay 1037 the impulsing springs 1084 are again connected to magnet 1051 and the wipers of the switch S are again stepped from position 1 to position 2. At the commencement of the next break period of impulsing springs 1084, the wipers of the switch S are stepped to position 3. With the wipers in this position and with the wipers of the switch OP1 in position 4 the following circuit is closed: earth at wiper 1027 on contact 3, armature 1081 and its operated contact, lower winding of relay 1031, armature 1057 and its operated contact, bank multipling and contact 4, wiper 1015, interrupter springs 1109, windings of magnet 1047 to battery. Relay 1031 only operates over this circuit and locks over its "X" armature 1086 to earth at armature 1072. At armature 1085, relay 1031 disconnects the impulsing springs 1084 from the winding of magnet 1051 and connects them to the winding of relay 1034.

As before when switch S steps to position 3, relay 1028 comes under the control of springs 1092 and relay 1028 releases when springs 1092 open and at armature 1060 and 1062 transmits the first of a train of alternating current impulse over the toll line and also relay 1034 operates over the following circuit: earth at armature 1070, armature 1074, impulsing springs 1084, armatures 1079, 1085, 1093, winding of relay 1034 to battery. Relay 1034 operates and prepares a locking circuit for itself in series with the lower winding of relay 1035 over its "X" armature 1105, make-before-break contacts associated with armature 1106 to earth at armature 1078. Relay 1035 operates over this locking circuit when springs 1084 next open and at armature 1093 disconnects the impulsing springs from relay 1034 and connects them to magnet 1051. In addition at armature 1094 relay 1035 connects relay 1038 to wiper 1025 of the switch S.

It will be noted that contacts 5 to 14 associated with wiper 1024 of the switch S are connected to terminals marked 2, 4, 5, 8 and so on up to 20. Similarly contacts 4 to 13 associated with wiper 1025 are connected to terminals marked 1, 3, 5, 7 and so on up to 19. If now the first impulse train to be transmitted by the converter is to comprise 18 impulses, a cross-connection is made from the bank contact on which wiper 1016 of the switch TD4 is set to terminal 18 associated with wiper 1024.

The circuit over which magnet 1051 is now energized extends as follows: earth at armature 1070, armature 1074, impulsing springs 1084, armatures 1079, 1085, 1093, winding of relay 1040 and shunt resistance 1107, winding of magnet 1051 to battery. Relay 1040 also operates over this circuit and at armature 1106 and its operated contacts closes an additional circuit for relay 1035 over its upper winding to earth at armature 1078 while at its resting contacts it

opens the circuit extending over the winding of relay 1034 and the lower winding of relay 1035. Relay 1034 thus releases while relay 1035 remains held. When the above-traced circuit for the magnet 1051 and relay 1040 is opened at springs 1084 the wipers of the switch S are stepped to position 4. In this position a circuit is extended from terminal 1 and corresponding contact over wiper 1025 armature 1094 in its operated position to the winding of relay 1038. Since in the example chosen the first train is to comprise 18 impulses, there is no cross-connection from the contact on which wiper 1016 of the switch TD4 is standing to terminal 1 and hence relay 1038 is not operated.

Relay 1040 also releases at this time and causes the release of relay 1035 which at armature 1094 connects wiper 1024 to the winding of relay 1038. Impulsing springs 1092 next open to cause the release of relay 1028 to cause the transmission of the 2nd impulse over the toll line and in addition relays 1034, 1035, and the magnet 1051 are operated as previously described under the control of springs 1084. This interaction continues with two impulses sent over the toll line for each step of the switch S until the wipers 1024 and 1025 are stepped on to contact 13 when the following circuit is completed; earth, wiper 1012 on contact 4, wiper 1016 and bank contact cross-connected to terminal 18, contact 13 and wiper 1024, armature 1094 and its resting contact, winding of relay 1038 to battery. Relay 1038 operates to terminate impulse transmission over the toll line and to cause the wipers of the switch OP1 to be stepped on to contact 5 as previously described. In addition the switch S is restored to normal. The time required to restore switch S and bring it to position 3 in readiness for the transmission of the next series of impulses provides a pause sufficient to distinguish between successive impulse trains.

Assuming five impulse trains are to be transmitted, the operations for each of the remaining trains are similar to those described above and will not be further discussed.

When the fifth impulse train has been transmitted earth is extended from wiper 1012 on contact 9 to wiper 1021. The contacts in the levels associated with wiper 1021 are strapped together and connected to terminal 1108 whereupon earth on wiper 1012 is extended over interrupter contacts 1139 to the windings of magnet 1047. The wipers of switch OP1 are thus stepped on to contact 10.

Relay 1031 is released on the operation of relay 1038 and does not operate again owing to the position of wiper 1015. The circuit is now in a condition to transmit without conversion the five digits representing the called party's number under the control of the wipers 1022 and 1023 in a similar manner to the transmission of impulses to the vertical and rotary magnets of the switch TD4 except that the five digits are transmitted over the toll line, relay 1033 having released as pointed out above.

When the last of the five digits has been transmitted, the wipers of the switch OP1 will be in position 15. Earth is then extended from wiper 1012 on contact 15, bank multiplying associated with wiper 1007 of the switch IP1, interrupter contacts 1112, winding of magnet 1046, to battery. The wipers of switch IP1 are thus advanced to position 9. When wiper 1005 moves off contact 8 relay 1036 is disconnected from the conductor incoming from the toll line control cir-

cuit. Relay 1036 at armature 1058 removes the general holding earth and also at armature 1059 removes earth from the start conductor for the impulsing machine. Relay 1028 therefore finally releases and causes the release of relays 1029 and 1030. In addition relay 1036 at armature 1056 closes a self-interrupting circuit for magnet 1047 over wiper 1015 and bank multiplying and the wipers of switch OP1 are restored to normal. Relay 1030 in releasing at armature 1067 extends earth over vertical off-normal contacts 1110 to the winding of release magnet 1050 of the switch TD4. The magnet thereupon operates and restores the switch to normal. In addition relay 1030 at armature 1068 restores the self-interrupting circuit for magnet 1046, this circuit having been interrupted when the wipers of switch OP1 move away from position 15. With the completion of the above-mentioned circuit however the wipers of the switch IP1 are rotated to the next normal position with the wipers on contacts 13 where the self-interrupting circuit is opened at wiper 1007. In this position relay 1036 is again connected to wiper 1005 and the converter is available for another call.

It will be understood that while the operation of the converter has been described with reference to a system where the called party's number comprises a two digit zone number and a five digit local number, it is easily adapted by a slight alteration in the cross-connections for operation where the called party's number comprise a single zone digit and a six-digit local number. In this case the first digit of the local number is employed to determine the rotary setting of the two directional switch TD4 and in addition this digit is again transmitted as the first digit of the local number. This is effected as follows. It will be remembered that in the description given above when the five routing digits have been transmitted the wipers of the switch OP1 are in position 9. In this position earth on wiper 1012 is extended to wiper 1021. In this case the contact on which wiper 1021 will be set is connected to terminal 1108 and thence to magnet 1047 so that the wipers of the switch OP1 are stepped on to position 10 from which position the first of the 5 local digits are transmitted. No digit is therefore transmitted with the wipers of switch OP1 in position 9. Where the called party's number comprise one zone digit and six local digits, no cross-connection is effected between the contact on which wiper 1021 is set and terminal 1108. In this case therefore the digit which determined the rotary setting of switch TD4 is again transmitted without conversion due to the connection between contacts 3 and 9 in the banks associated with wipers 1008-1011 of the switch OP1. The transmission of remaining digits takes place as previously described.

In the description of the converter given above it was assumed that five routing digits were to be transmitted. This is the maximum number which can be transmitted and it is possible that in certain cases fewer will be required. For instance if two routing digits only are required, then the contacts on which wipers 1018, 1019 and 1020 are set are all cross-connected to terminal 1108 to cause the wipers of the switch OP1 to be out above for a two digit zone, wiper 1021 will also be cross-connected to terminal 1108 to step the switch to position 10 to enable the digits of the local number to be transmitted while for a one digit zone number the first digit of the local

number will be transmitted with the wipers of switch OPI in position 9.

In the above description the alternating current impulses are transmitted from the converter, through the toll line control circuit to the line. Since, however, impulsing will take place over lines having different characteristics it may be necessary to make adjustments in the impulse transmitting circuits to compensate for these differences. Now there is no indication stored in the converter as to the kind of junction lines which are to be employed but the toll line control circuit has this information stored therein. It may, therefore, be advisable for the converter to transmit direct current impulses to the toll line control circuit where they will be transformed into alternating current impulses in a circuit having the appropriate characteristics.

What is claimed is:

1. In a telephone system divided into zones, each of said zones being identified by a digit or digits individual thereto, a plurality of exchanges in each of said zones, each of the exchanges in a given zone being identified by a particular digit or digits individual thereto, a plurality of lines at each of said exchanges, switching apparatus operative to set up connections between said lines, means including a register-translator for selectively operating said switching apparatus, and means for associating said register-translator with a calling line in a local zone, said register-translator including a two-digit switch operative in response to digits received over said calling line, said register-translator being so connected and arranged that in the event said two-digit switch is operated in response to a preliminary digit or digits indicating that the connection is to be extended from the local zone to a distant zone said two-digit switch is released and rendered operative in response to two additional digits identifying the distant zone and that in the event said two-digit switch is operated in response to two digits identifying a particular exchange in the local zone said two-digit switch is retained operated.

2. In a telephone system divided into zones, each of said zones being identified by a digit or digits individual thereto, a plurality of exchanges in each of said zones, each of the exchanges in a given zone being identified by a digit or digits individual thereto, a plurality of lines at each of said exchanges, switching apparatus operative to set up connections between said lines, means including a register-translator for selectively operating said switching apparatus, means for associating said register-translator with a calling line in a local zone, and means included in said register-translator and responsive to a preliminary digit or digits received over said calling line indicating that the connection is to be extended from the local zone to a distant zone for preparing said register-translator to receive an additional digit or digits identifying the distant zone and a further digit or digits identifying a particular exchange in the distant zone and for partially operating said switching apparatus.

3. In a telephone system, first and second exchanges, a first grade trunk and a second grade trunk directly interconnecting said exchanges, switching apparatus operative to set up connections between said exchanges, and means included in said first exchange and governed in accordance with the final destination of a connection for selectively operating said switching apparatus to determine the grade of trunk re-

quired for said connection and to set up a connection over said determined first grade trunk or said second grade trunk, whereby the transmission quality of the connection is determined.

4. In a telephone system, first and second exchanges, a first grade trunk and a second grade trunk directly interconnecting said exchanges, switching apparatus operative to set up connections between said exchanges, means including a register in said first exchange for registering the final destination of a connection, and means controlled by said register depending upon the final destination registered for selectively operating said switching apparatus to set up a connection to said second exchange either over said first grade trunk or said second grade trunk, whereby the transmission characteristics of the connection is determined.

5. In a telephone system, first and second exchanges, a first-class trunk and a second-class trunk directly interconnecting said exchanges, switching apparatus operative to set up connections between said first and said second exchanges, means in said first exchange for registering the numerical digits of a called number, and means controlled in response to said registration and determined by the digits registered for selectively operating said switching apparatus to set up a connection either over said first-class trunk or said second-class trunk to said second exchange, the class of the trunk selected being determined by the setting of said register.

6. In a telephone system, three exchanges, a first group of trunks including both first and second grades of trunks extending between a first and a second of said exchanges, a second group of trunks extending between said second and a third of said exchanges, switching apparatus operative to set up connections between said exchanges, and automatic means in said first exchange for selectively operating said switching apparatus, whereby a connection from said first exchange to said second exchange includes a second grade trunk in said first group and a connection from said first exchange to said third exchange includes a first grade trunk in said first group and a trunk in said second group.

7. In a telephone system, first and second exchanges, a first-class trunk and a second-class trunk interconnecting said exchanges, switching apparatus operative to set up connections between said first and said second exchanges, means in said first exchange for registering the numerical digits of a called number, means controlled by said registration for selectively operating said switching apparatus to set up a connection over said first-class trunk or said second-class trunk to said second exchange, the class of the trunk selected being determined by the setting of said register, and means in said second exchange controlled by the registering means in said first exchange for registering the numerical digits of said called number.

8. In a telephone system, a plurality of exchanges, a trunk circuit including a plurality of impulsing paths, switching apparatus associated with said trunk circuit and operative selectively to set up local and inter-exchange connections, a register sender including a digit register and an impulse sender, means for selectively operating said digit register, means controlled by a first operation of said digit register for causing said impulse sender to send impulses over a first of said impulsing paths, thereby to operate said switching apparatus to set up a local connection,

and means controlled by a second operation of said digit register for causing said impulse sender to send impulses over a second of said impulsing paths, thereby to operate said switching apparatus to set up an inter-exchange connection.

9. In a telephone system, a plurality of lines, means comprising switching apparatus operative in response to numerical digits transmitted thereto for setting up a connection between two of said lines, a register-translator, and means for transmitting numerical digits to said switching apparatus and code digits to said register-translator, said register-translator being adapted to receive code digits and to transmit numerical digits to said switching apparatus.

10. In a telephone system, a plurality of lines, means comprising switching apparatus operative in response to numerical digits transmitted thereto for setting up a connection between two of said lines, a register-translator, and means including a register sender for transmitting in a predetermined order numerical digits to said switching apparatus and code digits to said register-translator, said register-translator being adapted to receive code digits and transmit numerical digits to said switching apparatus.

11. In a telephone system, a plurality of lines, means comprising successive switching stages operative in response to numerical digits transmitted thereto for progressively setting up a connection between two of said lines, a register-translator adapted to receive code digits and to transmit numerical digits to certain of said switching stages, and means including a register sender for transmitting numerical digits to other of said switching stages, thereby to set up said connection partially, and then for transmitting code digits to said register-translator, thereby to cause said connection to be set up completely.

12. In a telephone system, a plurality of lines, means for setting up a connection between two of said lines, an impulse sender operative to transmit different code characters each comprising a cycle of impulses including both effective and ineffective impulses, the particular code character represented by a given cycle of impulses being determined jointly by the number and the position or positions of the effective and ineffective impulses in the given cycle, and means for operating said impulse sender to transmit over said connection a plurality of code characters representing a plurality of items of information pertaining to said connection.

13. In a telephone system, a plurality of lines, means for setting up a connection between two of said lines, an impulse sender operative to transmit different code characters each comprising a cycle of impulses including both effective and ineffective impulses, the particular code character represented by a given cycle of impulses being determined jointly by the number and the position or positions of the effective and ineffective impulses in the given cycle, means for operating said impulse sender to transmit over said connection a plurality of code characters representing a plurality of items of information pertaining to said connection, and means controlled by the effective impulses of the various cycles of impulses transmitted over said connection for registering corresponding code characters.

14. In a telephone system, a plurality of lines, means for setting up a connection between two of said lines, said connection including a plu-

5 rality of conductors, an impulse sender operative to transmit different code characters each comprising a cycle of impulses including both effective and ineffective impulses, the particular code character represented by a given cycle of impulses being determined jointly by the number and the position or positions of the effective and ineffective impulses in the given cycle, means for associating said impulse sender with said connection and for operating said impulse sender to transmit a plurality of code characters representing a plurality of items of information pertaining to said connection, said impulse sender being so connected and arranged that it transmits over a first conductor included in said connection both the effective and the ineffective impulses of each cycle and transmits over a second conductor included in said connection only the effective impulses of each cycle, and means associated with said connection and controlled in accordance with the impulses transmitted over the first and second conductors included therein for registering the code characters transmitted by said impulse sender.

15. In a telephone system, a plurality of lines, means for setting up a connection between two of said lines, said connection including a plurality of conductors, an impulse sender operative to transmit different code characters each comprising a cycle of impulses including both effective and ineffective impulses, the particular code character represented by a given cycle of impulses being determined jointly by the number and the position or positions of the effective and ineffective impulses in the given cycle, means for associating said impulse sender with said connection and for operating said impulse sender to transmit a plurality of code characters representing a plurality of items of information pertaining to said connection, said impulse sender being so connected and arranged that it transmits over a first conductor included in said connection both the effective and ineffective impulses of each cycle and transmits over a secondary conductor included in said connection only the effective impulses of each cycle, a register associated with said connection and operative to store code characters, means controlled by the impulses transmitted over the first conductor included in said connection for conditioning said register to be operated, and means controlled by the impulses transmitted over the second conductor included in said connection for operating said register.

16. In a telephone system, two exchanges, a first grade group of trunks and a second grade group of trunks directly interconnecting said exchanges, switching apparatus operative to set up connections over said groups of trunks, means in one of said exchanges controlled by a calling subscriber for registering information pertaining to the destination of said call, and means controlled by said last mentioned means for operating said switching apparatus to select an idle trunk line in said first grade group in the event that the destination of said call indicates that the other of said exchanges is to function as a tandem exchange, and for operating said switching apparatus to select an idle trunk line in said second grade group in the event that the destination of said call indicates that the said other exchange is to function as a terminating exchange.

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