

Feb. 20, 1945.

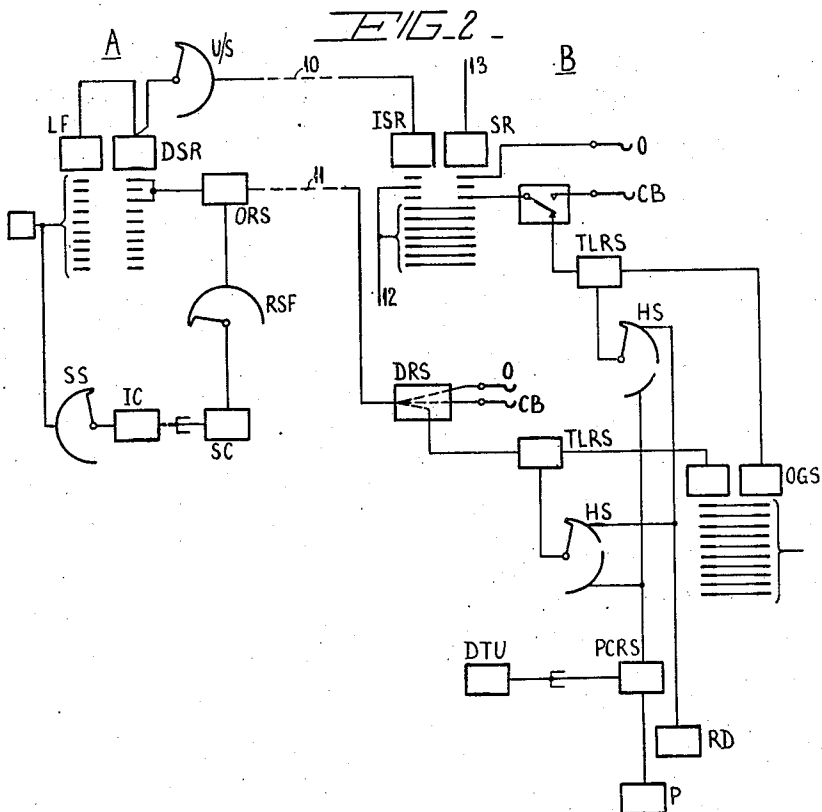
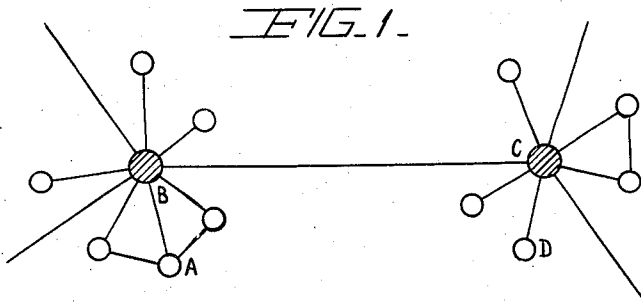
R. TAYLOR ET AL

2,369,868

TELEPHONE SYSTEM

Filed April 15, 1940

10 Sheets-Sheet 1



Inventors
REGINALD TAYLOR
GEORGE THOMAS BAKER

by
Chas. M. Condy
Attorney

Feb. 20, 1945.

R. TAYLOR ET AL

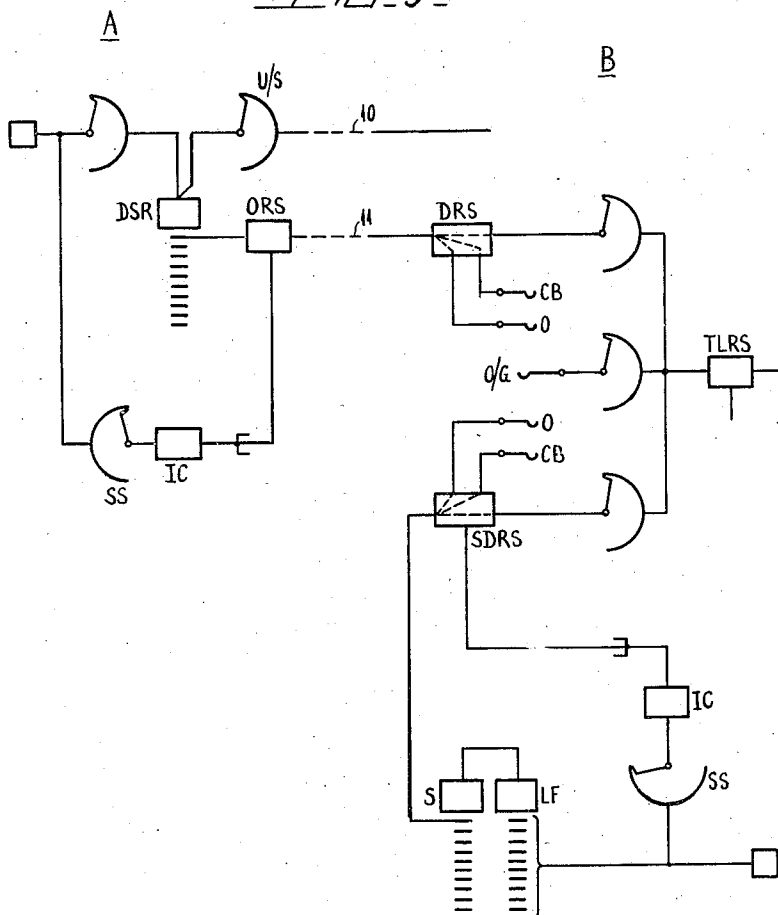
2,369,868

TELEPHONE SYSTEM

Filed April 15, 1940

10 Sheets-Sheet 2

FIG. 3



Inventors
REGINALD TAYLOR
by GEORGE THOMAS BAKER
Chas. F. Candy
Attorney

Feb. 20, 1945.

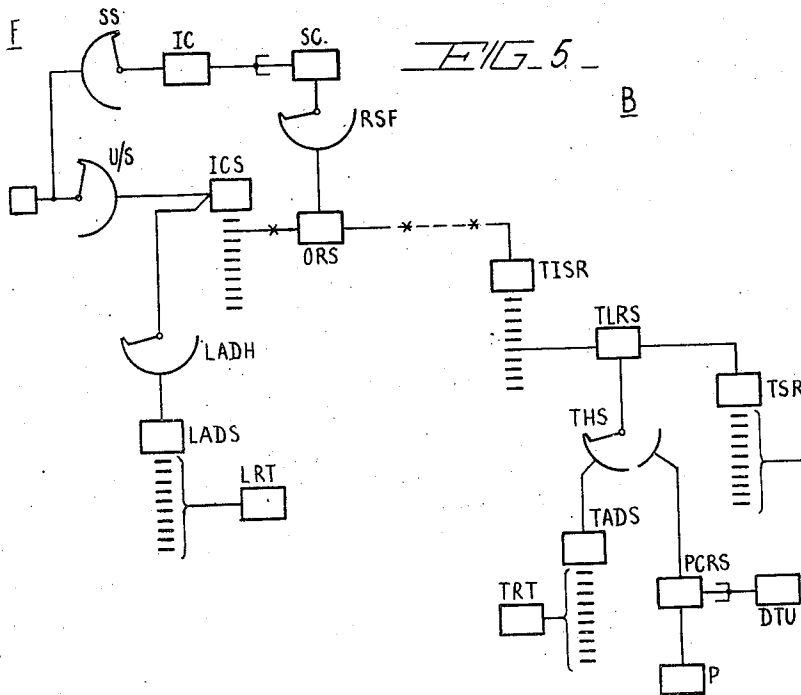
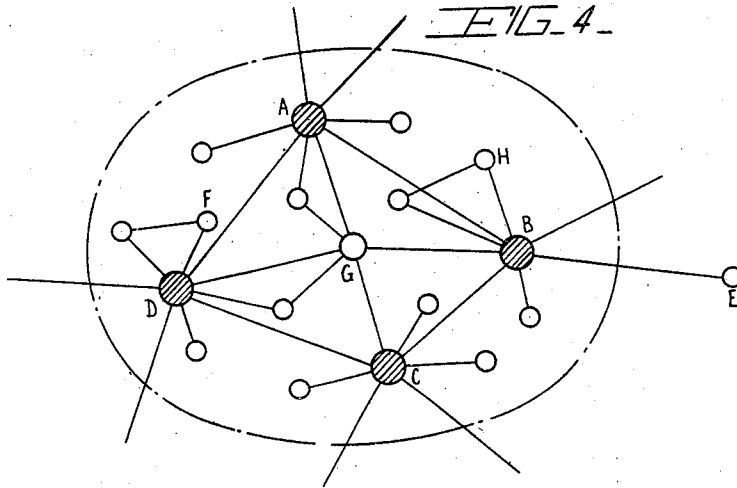
R. TAYLOR ET AL

2,369,868

TELEPHONE SYSTEM

Filed April 15, 1940

10 Sheets-Sheet 3



Inventors
REGINALD TAYLOR
By GEORGE THOMAS BAKER
Chas. F. Candy
Attorney

Feb. 20, 1945.

R. TAYLOR ET AL

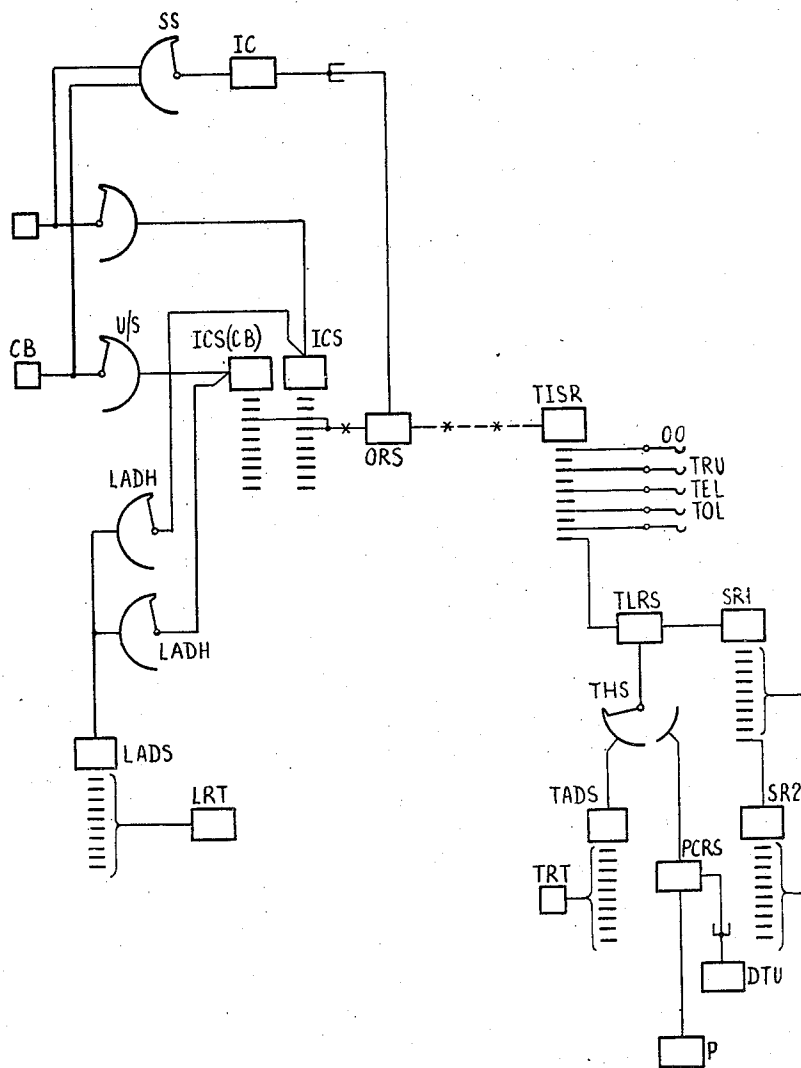
2,369,868

TELEPHONE SYSTEM

Filed April 15, 1940

10 Sheets-Sheet 4

FIG. 6



Inventors
REGINALD TAYLOR
by GEORGE THOMAS BAKER
Chas. H. Candy
Attorney

Feb. 20, 1945.

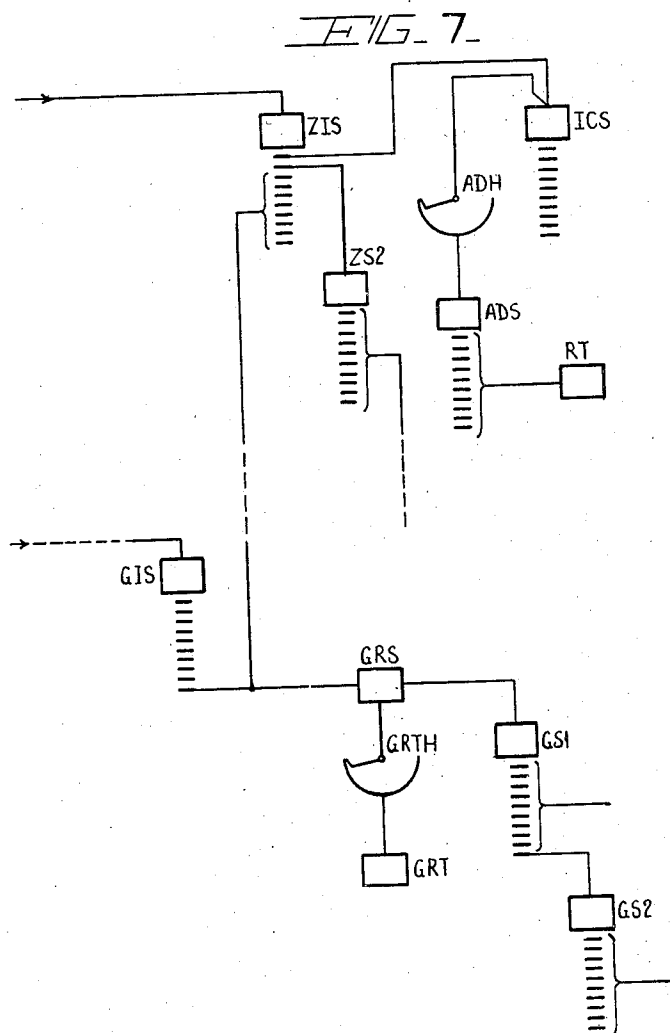
R. TAYLOR ET AL

2,369,868

TELEPHONE SYSTEM

Filed April 15, 1940

10 Sheets-Sheet 5



Inventors
REGINALD TAYLOR
by GEORGE THOMAS BAKER
Chas. H. Condy
Attorney

Feb. 20, 1945.

R. TAYLOR ET AL

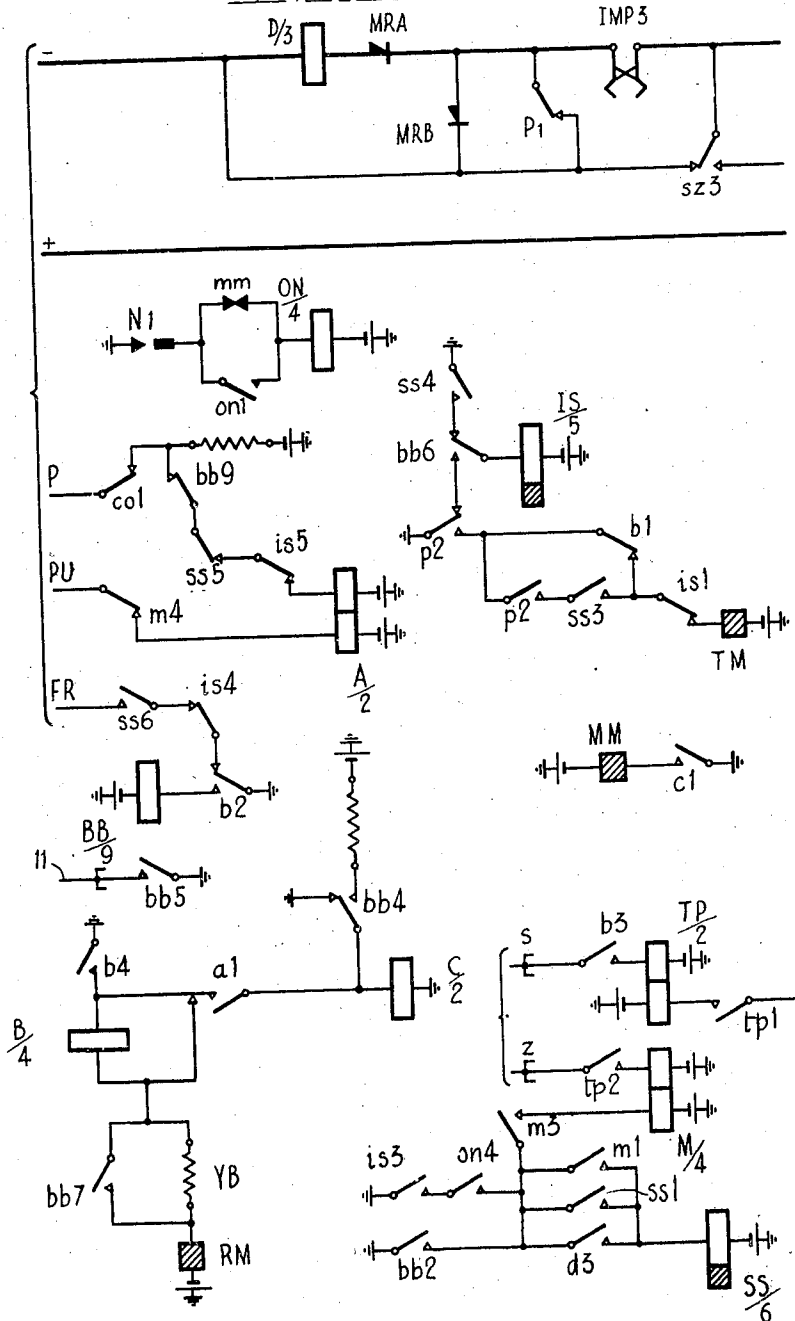
2,369,868

TELEPHONE SYSTEM

Filed April 15, 1940

10 Sheets-Sheet 6

FIG. 8



Inventors
REGINALD TAYLOR
by GEORGE THOMAS BAKER
Chas. H. Condy
Attorney

Feb. 20, 1945.

R. TAYLOR ET AL

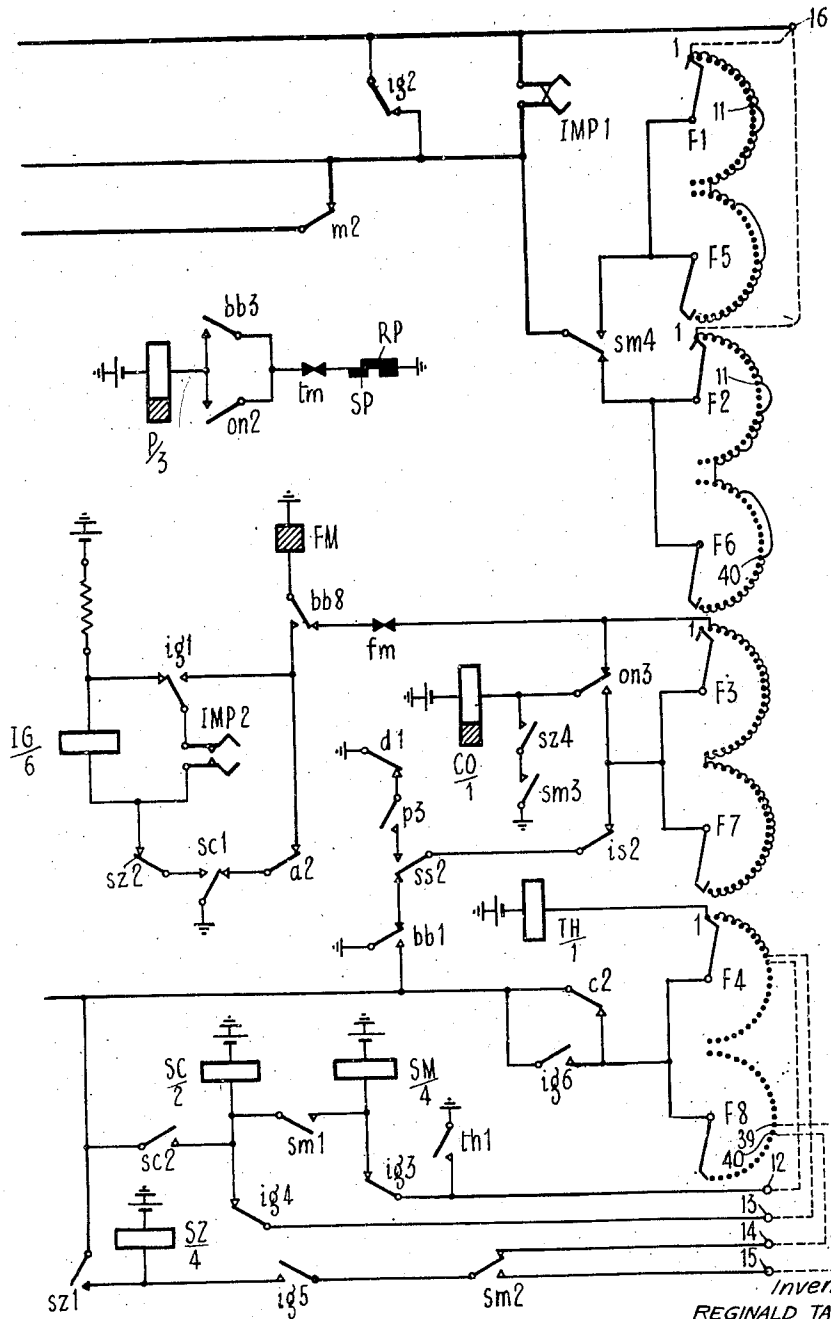
2,369,868

TELEPHONE SYSTEM

Filed April 15, 1940

10 Sheets-Sheet 7

FIG. 9.



Inventors
REGINALD TAYLOR
GEORGE THOMAS BAKER
by
Chas. H. Candy
Attorney

Feb. 20, 1945.

R. TAYLOR ET AL

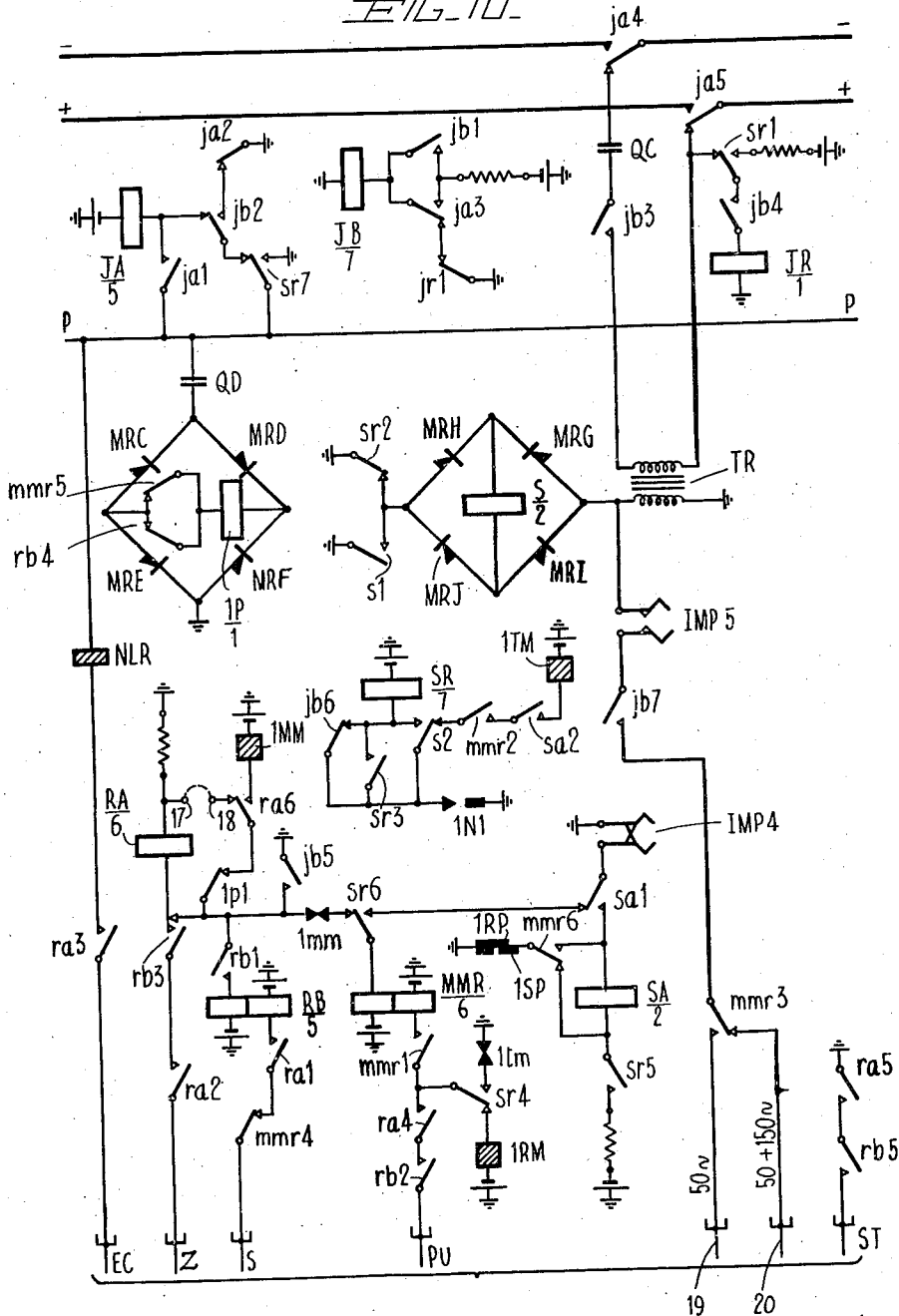
2,369,868

TELEPHONE SYSTEM

Filed April 15, 1940

10 Sheets-Sheet 8

FIG. 10.



Inventors
REGINALD TAYLOR
GEORGE THOMAS BAKER
by
Chas. M. Condy
Attorney

Feb. 20, 1945.

R. TAYLOR ET AL

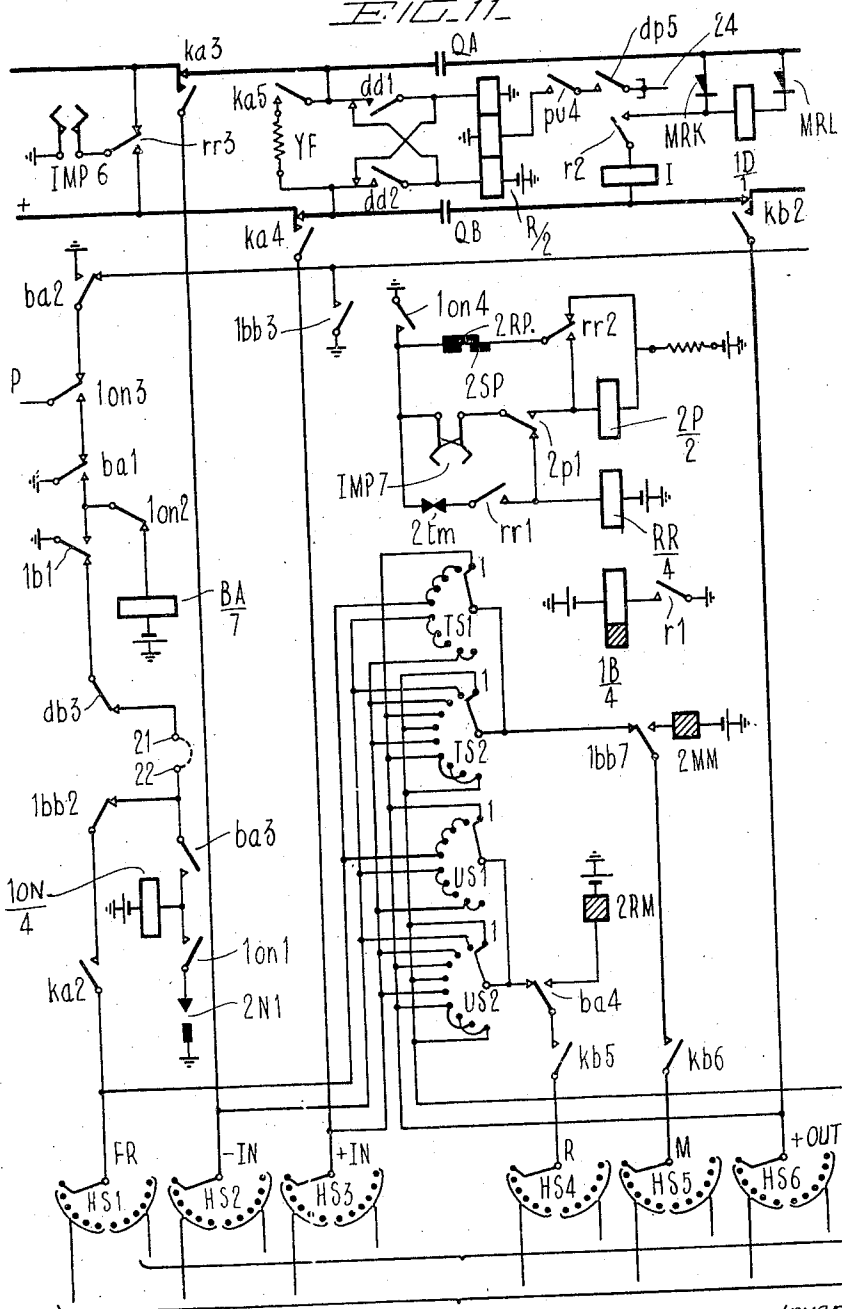
2,369,868

TELEPHONE SYSTEM

Filed April 15, 1940

10 Sheets-Sheet 9

FIG. 11



Inventors
REGINALD TAYLOR
GEORGE THOMAS BAKER

by
Chas. W. Candy
Attorney

Feb. 20, 1945.

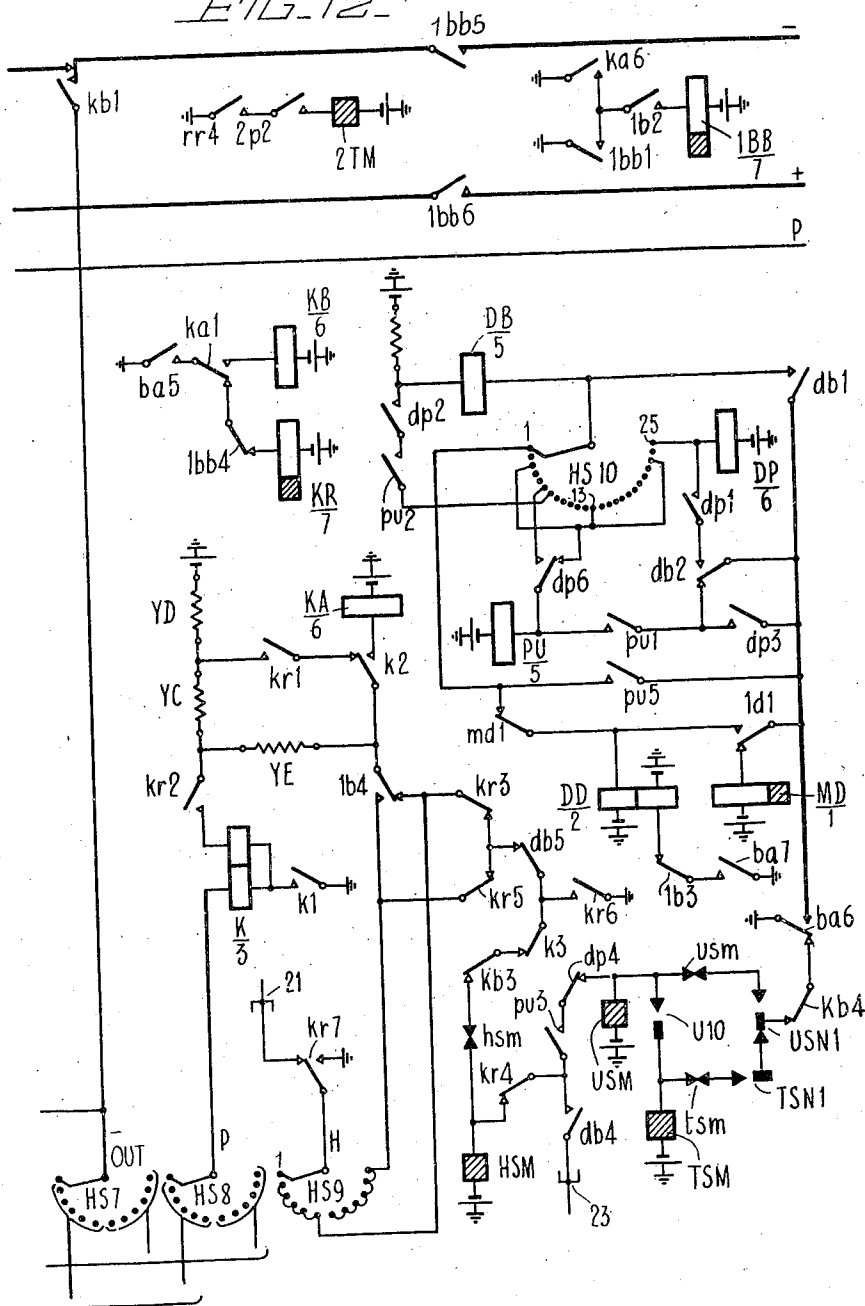
R. TAYLOR ET AL

TELEPHONE SYSTEM

Filed April 15, 1940

10 Sheets-Sheet 10

FIG. 12.



Inventors
REGINALD TAYLOR
GEORGE THOMAS BAKER

By GEORGE THOMAS BAKER
Esq. for the Cardy
Attorney

UNITED STATES PATENT OFFICE

2,369,868

TELEPHONE SYSTEM

Reginald Taylor and George Thomas Baker, Liverpool, England, assignors, by mesne assignments, to Automatic Electric Laboratories, Inc., Chicago, Ill., a corporation of Delaware

Application April 15, 1940, Serial No. 329,608
In Great Britain May 5, 1939

27 Claims. (Cl. 179—7.1)

The present invention concerns improvements in or relating to arrangements for setting up connections in telephone systems and is more particularly concerned with improved arrangements for dealing with connections which require to be recorded for charging purposes, that is to say, connections which come outside the range in which the charge may be determined by operating a meter individual to a calling subscriber one or more times and whereby such calls may be charged on the basis of duration as well as distance.

Generally speaking it is usual for connections local to an exchange area having a linked numbering scheme to be charged by operating the subscriber's individual meter and in addition, thereby exchanges are also charged in this manner, although they are not in the area having the same linked numbering scheme as the area in which the call originates.

The characteristic feature of the present invention is that call recording is adapted to take place at the same exchange in an area as that at which the route to the destination exchange is determined, so that the number of the subscriber wanted in the linked numbering scheme with which the destination exchange is associated is transmitted in full from the originating area direct to the destination area after the call has been set up to an exchange in the destination area, while the recording takes place at the exchange in the originating area from which such number is transmitted.

This invention may be applied in a variety of circumstances, for instance, exchanges at present in existence may be broadly classified into two different types, in one of which the linked numbering scheme is upon a decimal basis, and each subscriber's number in the area covered by the linked numbering scheme has a given number of digits, for instance, 4, 5 or 6, each of which digits is represented by the setting of switches for establishing a connection having a direct numerical relation thereto. A second type of area is one in which the linked numbering scheme is based upon the initial digits representing an exchange name, and other digits representing the number of the subscriber attached to that exchange. Frequently, such exchange designating digits are represented by letters, and are caused by means of a register-translator to be translated into routing digits for transferring the call from the originating to the destination exchange the setting of the switches for such routing having no numerical relation to the numeri-

cal values which may be assigned to such exchange-designating digits. On the other hand the numerical digits correspond to the setting of the switches in the destination exchange required to establish connection to a subscriber.

In this specification the first class of linked numbering scheme will be referred to as a "non-register-translator network" and the second form of linked numbering scheme will be referred to as a "register-translator network."

The invention has application to setting up calls between one non-register-translator network and another non-register-translator network, between a register-translator network and a non-register-translator network, between a non-register-translator network and a register-translator network, between a register-translator network and another register-translator network and between a register-translator network and exchanges in the near vicinity of such network which may be of such a distance as to necessitate the desirability of call recording facilities but otherwise are such that they could be included in the register-translator network.

It will be appreciated that generally speaking the register translator networks are of very much greater extent than the non-register-translator networks.

At present in non-register-translator networks requiring say 5 or 6 digit numbers, metering is usually performed on a unit fee basis, that is to say for local calls a single operation of a calling apparatus meter is effected while long distance calls are routed via a manual operator, for instance, by dialing "0."

In other cases a number of adjacent non-register-translator networks are combined into a composite network of reasonable size. Intercommunication between various networks is made by dialling the required wanted number on the called network together with one or more prefix digits indicating such network. As each non-register-translator network will usually have its own linked numbering scheme, and with a view to keeping the number of digits down to a minimum, say no more than 7 when calling from one register-translator network to another in the composite network, a simplified form of register-translator or route-discriminator is associated with the outgoing junctions of each network so as to route the call to the desired network.

Such networks may be arranged to operate on a multi-fee basis. The number of times a subscriber's meter is operated in response to the setting up of a call is determined by the route-

discriminator in accordance with the particular number dialled. For calls outside the composite areas access to a manual number will usually be obtained by dialling "0."

Thirdly, in the case of congested multi-exchange networks, register-translators will be used on all calls within the network, irrespective of whether the calling party is on the originating exchange or not, and in this case multi-fee metering facilities can readily be incorporated. The number of times a subscriber's meter is operated for a given cause may for instance be determined in accordance with the particular level to which the first or second code selector switch is set by the register-translator. For calls outside such areas the code letters "TOL" or "TRU" may be dialled and the calling party will be routed to a manual board at a toll or trunk exchange respectively. Alternatively, access can be had to an operator by simply dialling "0."

One of the applications of the invention is to the extension of such networks, in view of the use of call recording or automatic ticketing apparatus, to a size whereby subscriber dialling may become a feasible proposition over distances hitherto requiring the charging of a fee by an operator, based both upon the distance between subscribers and on the duration of the call. In this connection it may be mentioned that charging on a duration basis may be effected by repeat multi-fee metering, but generally speaking it is usually considered preferable to limit the multiple fee to a value of the order of four unit fees or even less, as larger charges which cannot be checked should preferably not be made on a subscriber's individual meter.

Another application of the invention is to the construction of a national telephone exchange network which will permit calls being automatically set up by any subscriber to any other subscriber, regard being had to the desirability of reducing interference to existing networks and trunk and toll line layouts to a minimum, while at the same time keeping the additional equipment to a minimum.

While the invention has particular application to known telephone systems of the type described above, it is not limited thereto, but it is adapted to be used in addition in new telephone systems.

According to a subordinate feature of the invention, calls set up from non-register-translator networks including main and satellite exchanges to other exchanges or networks for which call recording is required, are routed under subscriber's control to a main or central exchange of the calling network where route-determining means are provided, for routing the call to the desired distant exchange or network, automatic recording of the call being effected at the same main or central exchange.

While the characteristic feature of the invention as described above relates to the provision of route-determining and call recording means at the same central exchange of a network there may be circumstances in which all calls from a non-register-translator network for which call recording service is required may pass through a nearby register-translator network and according to a further feature of the invention a single group of junction lines is provided between the central exchange (which may be a main exchange) of a non-register-translator network to a central or sub-central exchange of a register-translator network and as an idle one of such

junction lines would be automatically selected under subscriber control there is no necessity for providing any route-determining means at the central exchange of the non-register-translator network, and further according to this feature of the invention route-determining means would be provided at the central or sub-central exchange of the register-translator network while the call recording equipment would be provided at the central exchange of the non-register-translator network, the distinguishing digits of the wanted exchange being transmitted under subscriber control to the route-determining means at the central or sub-central exchange of the register-translator network.

According to a further feature of the invention in a telephone arrangement or like system comprising a register-translator network having access to a plurality of other networks which may be register-translator networks or non-register-translator networks or both, the register-translator is adapted to be taken into use at the origination of an inter-network call to route the call to a central or sub-central exchange of the register-translator network and a second register-translator is adapted to be taken into use at said central or sub-central exchange to route the call to the desired network, call recording equipment being also adapted to be taken into use at said central or sub-central exchange for recording the call.

According to a further feature of the invention and particularly applicable in register-translator networks, a register-translator is provided which is adapted either to route a call to an operator's position or to route a call to a call recording position for inter-network calls according to the value of the digit received after the register-translator has been taken into use.

By this feature of the invention it is possible to utilise the existing arrangement whereby for calls to an operator the subscriber dials the digit "0," in this case a call would be routed to an operator either by dialling digit "00" or by dialling the digit "0" and delaying to dial any subsequent digit, while if a subsequent digit has followed the first digit other than digit "0" then the call would be routed to a call recording position.

According to a further feature of the invention a register-translator-network may be extended by adding exchanges or exchange networks which would involve the possibility of calls being made between subscribers in the extended network which should be charged for by call recording and according to a further feature of the invention a register-translator is adapted to be taken into use at the exchange at which or at a satellite of which the call originated while a second register-translator is adapted to be taken into use at a central or sub-central exchange by which access is had to the wanted exchange, recording equipment being also adapted to be taken into use at a central or sub-central exchange to enable the call to be recorded.

A further feature of the invention is concerned with special arrangements to enable calls to be set up for a very large area or nationally according to which feature the network covering the whole area is divided into a number of zones each having one or more zone central exchanges and each zone being divided into groups while the groups in turn each have one or more group central exchanges and each group is sub-divided into a number of exchanges or exchange networks,

each of such exchanges or networks having its own linked numbering scheme. In such a network according to this feature of the invention route-determining means by which the route-controlling digits by which a call is to be set up from the calling group or zone to the called group or zone are determined, together with means for recording particulars of the call are located at a group central exchange or a zone central exchange in the calling group or zone.

The following arrangements correspond to subsidiary features of the invention which while they are protected in co-pending applications have particular application in carrying out the features of the invention.

In call recording it is necessary to identify the number of the calling line and according to one subsidiary feature of the invention the identity of the calling line is ascertained and stored at the calling exchange on the initiation of the call over the junction line and subsequently the stored identity together with that of the calling exchange is transmitted to the recording exchange on the termination of the connection.

According to another subsidiary feature of the invention mechanical impulse generators are provided for storing digits dialled by a subscriber until the appropriate equipment is in a position to receive the same.

According to a further subsidiary feature of the invention the information to be recorded is stored until the end of the connection and is then transferred to a recording or printer controlling unit at which other information is added and the whole of the information to be recorded or printed is duly transferred in rapid manner to the printer and recorder so that only a few printers and recorders need be provided for a large number of recording positions.

Another feature of the invention which is particularly advantageous for use in transferring a number rapidly over the connection in code and storing it in a cheap manner until it is required, concerns an impulse regenerator which is adapted to respond to two sets of pulses, the pulses of one set having a definite timed relationship with respect to the pulses of the other set and in which the two sets of pulses are adapted to be re-transmitted in substantially the same form as received. Conveniently the impulse regenerator is constructed as described in McClew and Woodland's United States Patent No. 2,188,461, issued January 30, 1941, and according to the invention a member is moved by a receiving magnet to an extent determined by one set of pulses while pins are displaced during such movement in response to a second set of pulses acting upon a marking magnet, such second set of pulses having a definite timed relationship with respect to the first set, an impulse generator controlled thereby is adapted when released to operate and generate pulses corresponding in number to said first set of pulses and to the extent of movement of said member while a further impulse generator is provided adapted to be operated as each displaced pin is encountered to generate pulses corresponding to the second set of pulses.

These and other features of the invention will be better understood from a description of the following embodiments thereof which are given by way of example, reference being had to the accompanying drawings.

Fig. 1 shows the layout of two non-register-translator telephone networks which may be two out of a number of such networks in which for

inter-network calls a simplified form of register-translator equipment, which will be known by the term "route discriminating equipment," is utilised, and in which on such calls fee charging which is on a distance and duration basis is to be effected by means of automatic call recording equipment.

Fig. 2 shows the trunking principles involved in setting up calls from exchanges A and B in Fig. 1, the arrangements being such that inter-network calls which require automatic call recording commence with digit 8.

Fig. 3 shows alternative trunking arrangements in which calls requiring call recording facilities commence with the digits 01 to 09 and in which access to a main exchange manual board is had by dialling the digits "00."

Fig. 4 shows the layout of a register translator network with a number of tandem or sub-central exchanges therein at which will be located call recording equipment required in connection with certain types of calls either completed within the area or to exchanges or networks outside the area.

Fig. 5 shows a trunking diagram for the routing and recording of a typical call from an exchange within a register translator area to an outlying exchange or network via a sub-central exchange.

Fig. 6 shows the trunking arrangements involved in local and sub-central register-translator exchanges when different classes of traffic requiring calling subscriber identification are combined in a common group at a central exchange or point.

Fig. 7 is concerned with trunking arrangements for the purpose of automatically setting up and recording calls on a national basis and shows typical trunking arrangements involved in a distribution of incoming calls at a zone centre exchange and also at a group exchange in the zone.

Figs. 8-12 show circuit arrangements of certain new elements in the above trunking diagrams.

Of these figures, Figs. 8 and 9 when arranged side by side show the circuits of a simplified "0" level register translator, Fig. 10 shows the circuits of an outgoing relay set provided with calling line identification storage facilities and Figs. 11 and 12 when arranged side by side show the circuits of a toll line relay set. These pieces of apparatus are particularly adapted for use in register translator areas of the type shown in Figs. 4 and 5, but it will be appreciated that the circuits of equivalent apparatus in other areas may be designed on a similar basis.

For the purpose of identifying a calling point, identification and storage equipment of the type disclosed in our Patent No. 525,902, issued November 28, 1940, may be utilised, while equipment and circuits on the general lines described in Ostline's application No. 278,729, filed June 12, 1939, may also be brought into use for the purpose of carrying out the invention.

Reference should now be had to Fig. 1 and it will be understood that intercommunication between the two networks shown and also between either of these networks and other networks which are not shown would hitherto be effected via the manual boards of the main exchanges B and C through which inter-network calls are set up, and arrangements will be described whereby such calls may be set up and recorded automatically.

For the purpose of simplicity each network is merely assumed to comprise a main exchange such as B or C and a number of satellite exchanges such as A and D and the setting up of

calls by subscribers on exchanges A and B will now be considered, reference being had to the trunking diagram of Fig. 2.

It will be understood that each network will have its own linked numbering scheme, and a two or three digit code will be prefixed to the wanted subscriber's number in the case of inter-network calls. For the purpose of discrimination between local linked number and inter-network calls, all calls of the latter class will be prefixed by a common previously unused first digit, such as 8, followed by one or more prefix digits together with the called number in the required network. The dialling of a first digit 8 by subscribers having unrestricted access facilities will cause the connection to be routed at the main exchange to a toll line relay set which can take into use translating and call recording equipment, the translating or so-called route discriminating equipment bringing about routing of the call to the required network either directly or via intermediate networks.

Considering the case of a call originated by a subscriber on the satellite exchange A, it will be seen that two groups of junctions are assumed to be provided from this exchange to its parent exchange B, these being divided up into ordinary and high grade junctions.

When the subscriber removes his receiver he is connected via the line finder LF to a discriminating selector repeater DSR associated therewith, and this switch thereupon associates itself with an incoming selector ISR at the main exchange via the hunting switch U/S and the ordinary junction line 10 in well-known manner.

If the first digit dialled is any of the numbers 1-7 and 9 which indicate that a subscriber in the local linked numbering scheme is required either of satellite exchange A, of the main exchange B or of any of the other exchanges in the calling network, selector repeater DSR after having been stepped in parallel with the incoming selector ISR in accordance with the digit dialled will either release the junction in the case of a local or adjacent exchange call and connect up with a local second selector, or will retain the junction connection and will repeat subsequent digits dialled over the junction 10, incoming selector ISR and outlets such as 12 to switches connecting with the required subscriber either on the main exchange B or on other exchanges in the calling network directly connected to this exchange.

In case the first digit dialled is "0" the ordinary junction 10 is released and the call is routed over the high grade junction 11 to the main exchange manual board, a suitable discriminating signal being sent from the satellite exchange outgoing relay set ORS to the main exchange discriminating relay set DRS so as to cause the connection to be routed to the main exchange manual board jack 0. In case a coin box subscriber should be calling, a different signal will be extended to the relay set DRS so as to cause the connection to be routed to a coin box jack CB at the main exchange manual board.

If the calling party wishes to set up an inter-network call, the first digit dialled will be 8 in which case the ordinary junction 10 is released as before and the high grade junction 11 is taken into use from the DSR level 8, a distinctive signal being transmitted from the outgoing relay set ORS to switch the connection at the relay set DRS to the toll line relay set TLRS. Coin box subscribers dialling this digit and not being en-

titled to originate such calls on an automatic basis are barred access thereto either by the extension of a suitable signal from the relay set ORS which causes the relay set DRS to transfer the connection to the coin box (CB) jacks on the main exchange manual board or due to the fact that there will be no access to the relay set ORS from level 8 of the special group of DSR switches provided for such subscribers.

When the relay set TLRS is seized, access is had to an outgoing selector OGS, while the hunter switch HS is caused to associate itself with an idle route discriminator RD. Before the question of call recording is considered, the routing of the call to its required destination will be described, and in this connection one or more digits subsequent to the first dialled digit are received on the route discriminator which in response thereto effects the necessary translation and transmits the required routing digits out via the toll line relay set, the outgoing switch and subsequent switches to gain access to the incoming switch at the main exchange of the desired network. The toll line relay set will be provided with an impulse storage and regenerating device for instance of the electro-mechanical type disclosed in McClew and Woodland's United States Patent No. 2,188,461, and this will serve to store the remainder of the digits dialled during the transmission of the translated digits from the route discriminator.

When the routing digits have all been sent out, the impulse storage and regenerating device in the relay set TLRS is caused to send out the digits stored therein in untranslated form, so as to complete the connection to the wanted party.

Considering the question of recording such calls, the minimum amount of information required to enable the call to be charged against the calling subscriber will consist of the calling number and the called number, and if the call is to be charged on a time basis, the duration of the call, together possibly with the time and date.

For the purpose of calling number identification it will be understood that as a result of the setting up of an inter-network call, the outgoing relay set ORS at exchange A will be caused, either during the setting up of the connection, or on reply of the called party, or during or at the end of conversation, according to which proves the most convenient, to associate itself over finder switch RSF with a storage control relay set SC which in turn connects with an identification control relay set IC. This on being seized sets into operation an identification switch SS which operates in the manner described in British Patent 525,902, whereupon the identity of the calling line will be determined and stored in the outgoing relay set ORS, storing being effected as described for instance in British Patent 525,902.

In connection with the storing of the calling number at the originating exchange until it is required at the exchange where call recording equipment is provided, if this is effected by means of storage relays and a uni-directional sending switch as described in British Patent 525,902, then it will not be necessary to provide the relay set SC and the finder switch RSF since the calling number can be communicated direct to the relay set ORS. Use might however be made of an electromechanical storage and regenerating device in the relay set ORS, and in this instance it may prove preferable to utilize a common storage control set SC and finder switch RSF as shown in

Fig. 2 in order that the signals characterising the identity of the calling party may be firstly received on either relays or a stepping switch in the common relay set SC. The relays or stepping switch convert the signals received into markings suitable for setting the regenerator in the relay set ORS in such a manner that the number can be subsequently retransmitted therefrom in code to the distant exchange.

As regards the called number, the digits dialled into the toll line relay set TLRS are stored for instance on relays and at termination of conversation the hunter switch HS, which it will be noted has its bank split so as to gain access successively to the route discriminator and to call recording equipment as required, is caused to associate itself with a printing or recording controller PCRS whereupon the calling party's number will be transmitted thereto from the outgoing relay set at exchange A and the junction II will be released after which the called party's number will be transmitted thereto together with the duration of the connection which will have also been recorded on suitable timing equipment in the toll line relay set. The date and time of day will also be picked up from common equipment such as DTU and the controller will extend the information it has received to the ticket printer and/or puncher P. The total charge for the call may be calculated manually or by suitably adapted calculating equipment and it is proposed that if it is desired to provide tariff determining means these should be included in the printer or recorder controlling apparatus the tariff being determined at the end of conversation.

The general arrangement of the printer or recorder controlling apparatus may conveniently follow the design of the printer controller as described in Ostline's application No. 278,729 filed June 12, 1939, suitably modified to meet the conditions described above while the printer or recorder itself will be such as to be only taken into use when the information is ready for immediate printing and recording.

The route discriminator described differs from the normal register-translators such as are used in multi-exchange areas in that it is only required to receive initial digits of a dialled number and in response thereto to route the call to the required exchange or network whereas the register-translator is adapted to receive a full dialled number and in response thereto to route the call right through to the required party. If therefore the route-discriminator is adapted to perform the full functions of a register-translator then the impulse storage and regenerator device in the toll line relay set can serve for the purpose of storing the called number until this information is required for toll recording purposes, and it will not be necessary to provide storage relays in the toll line relay set for this purpose.

As regards calls originated by main exchange subscribers, such subscribers gain access to the first numerical selector SR over a lead such as 13 and the setting up of calls which require recording follows along the lines already described.

Although in the arrangement described manual board and inter-network calls are routed over one group of junctions, and ordinary linked number calls over another group of junctions, a single group of junctions to the main exchange may be provided to serve all classes of traffic, discriminating signals being utilised to effect the correct routing of the call at the main exchange.

The discriminating selector switches at the

satellite exchanges could of course be replaced by ordinary first selector switches which on seizure would gain access to common discrimination equipment over a hunter switch, this discrimination equipment serving to determine whether the call was to be metered or to be charged for by means of automatic call recording equipment and causing the connection to be routed at the main exchange accordingly. The discrimination equipment may generally follow the lines of that disclosed in Taylor and Baker's Patent No. 2,232,189, issued February 18, 1941.

The invention is not limited to the simple example shown, as obviously each network having its own linked numbering scheme could have associated therewith a number of dependent networks, each having its own numbering scheme. If it was considered desirable to ticket calls from an exchange in a linked numbering scheme to a dependent network thereon this could be readily effected in the manner already described and such calls would then have a common prefix digit such as "8."

As a further extension of the scheme, a number of multi-fee areas each comprising a plurality of exchange networks operating on a multiple fee basis for inter-network calls could be linked up automatically on a call recording basis. In such a case recorded inter-area calls will be routed via the central exchange of each area at which the call recording equipment will be located and it may be that in some circumstances calls between exchanges in adjacent areas but which are only a unit fee distance apart will be completed on a call recording basis. Coin box subscribers setting up such unit fee connections would however be routed to a manual board.

In case no spare first digit is available for use on inter-network calls it might be arranged that for main exchange manual board calls the digits "00" would be dialled, while for calls requiring recording digits 01-09 would be dialled.

Fig. 3 shows typical trunking arrangements at a satellite exchange A and main exchange B in which level O is utilised to gain access to dialled toll exchanges. It will be seen that the equipment at exchange A follows on the lines of that already described in connection with Fig. 2, a discriminating selector repeater being provided in this exchange and having access to a high grade junction II via an outgoing relay set ORS.

If the first digit dialled is 0, access will be had to a discriminating relay set DRS at exchange B and in the case of an ordinary subscriber calling, if he fails to dial a further digit within a predetermined period the connection will be routed to the main exchange manual board. If a coin box subscriber having restricted access is calling, the connection will be immediately routed to the main exchange manual board. When the relay set DRS is seized it associates itself with a free toll line relay set TLRS over a hunter switch and this relay set receives the second digit dialled. If this digit is 0 thereby indicating that a manual board call is required, a signal will be sent back from the relay set TLRS to the relay set DRS so as to transfer the connection to the manual board, but if the second digit is 1-9 then the toll line relay set will direct this digit to a route discriminator in the manner already described in connection with Fig. 2. Call recording is subsequently performed in the manner already described.

In the case of calls originated by main exchange subscribers, if 0 is dialled as a first digit

access will be had from the selector S to a storage and discriminating relay set SDRS which functions in the same way as the relay set DRS except that in addition it has provision for storing the identity of the calling party until this is required for call recording purposes.

Outgoing toll calls from the manual board are handled via the jack O/G which has access to the toll line relay set over a hunter switch in the usual manner, but in this case as the call will be recorded by the operator the toll line relay set will be so designed that the call recording equipment does not function for such calls.

In order that the subscriber need not hold up dialling while a toll line relay set is being found, an impulse storage and regenerative device may be inserted at some intermediate stage. As only the first few digits of a number are ordinarily required by the route discriminator, the storage and regenerative device might be arranged only to re-transmit immediately those dialled digits which are required by the route discriminator. The remainder of the digits dialled will then be held until all the routing digits have been sent out from the route discriminator after which they may be retransmitted to complete the setting up of the connection.

In case the DSR at the satellite exchange is replaced by an ordinary selector switch having access to a common discriminating unit as previously mentioned, the storage and regenerative device in this unit could be arranged to have a controlled sending-out facility thereby avoiding the use of an intermediate storage and regenerative device.

Areas to which the invention may be applied may include networks having dependent networks and/or exchanges thereon and it is often usual in the case of calls from dependent exchanges to dial one or more prefix digits in order to gain access to the parent exchange. In such a case if a call requiring call recording facilities is required, the number of digits to be dialled would include the initial prefix digits to gain access to the main exchange, the digit or digits required to route the connection via the intermediary of the route discriminator, together with the called number on the wanted network. In order therefore that the number of digits to be dialled might be reduced, equipment might be provided at the various dependent exchanges which, in response to the dialling of a digit or digits indicating a call requiring call recording facilities, would effect a predetermined translation to route the call to common route discriminating and/or call recording apparatus at the main exchange, after which some or all of the initial digits would be transmitted thereto together with the remainder of the digits dialled in untranslated form.

The arrangement described with relation to Fig. 3 assumes that the trunk line relay set TLRS has access both to route-determining arrangements as well as to call-recording apparatus in the same way as in Fig. 2, but in the case of calls to or through a register-translator network which may in fact be the only calls for which call recording facilities are to be provided, a single group of direct junctions is provided from a main exchange, such as B, to a central or the sub-central exchange most conveniently situated for receiving calls from the non-register-translator network. In such a case there is no necessity for providing special route determining means, at the central exchange of the non-register-translator network, the route being already deter-

mined when such a junction line is selected and all that is necessary is to provide equipment for giving access to recording equipment so that the equipment shown in Fig. 2 may be simplified to that extent while in the central or sub-central exchange in the register-translator network the seizure of a junction line from the non-register translator network would result in the automatic taking into use of equipment by which the digits representing the exchange or zone and exchange of the wanted party may be translated.

Considering now methods by which the scope of multi-office areas of the register-translator type can be extended so as to include outlying networks or exchanges, and by which calls therebetween can be charged either on a call recording or a multi-fee metering basis in accordance with the particular conditions obtaining there are two preferable methods which can be utilised in the case of extension to existing networks.

According to one method the unusable codes in a register-translator area numbering scheme are used for the purpose of handling calls to outlying districts thereof. It is appreciated that most of these codes cannot be arranged to represent the first letters of an exchange name but they can instead be used either as numerical prefixes or alternatively on a mixed letter and numerical basis if this should prove to be preferable from the subscriber's point of view.

In another method advantage is taken of the fact that at present the dialling of digit "0" in a register-translator area causes the seizure of a register-translator adapted to be seized also when some other digit or digits are dialled, different kinds of access being provided so that said register translator will route the call either to an operator's position in response to the dialling of digit "0" or to another subscriber in response to other digits. It is proposed that a special set of "0" level simplified register-translators shall be provided, it being arranged that all calls requiring the use of call recording equipment are preceded by the digit "0" followed by other extra digits as required, and the full number of the called party in the wanted exchange.

If the first digit dialled is "0" and is not followed by another digit within a short interval of time, say three seconds, the call will be routed to a manual board via which a long distance call may be completed if desired, while the call will also be routed to this manual board if the digits "00" are dialled, the dialling of these two digits being the new method of calling an operator.

If digits 01 to 09 are dialled as the first two digits access to routes requiring call recording facilities will be provided. If the "0" only is dialled as a first digit by a coin box subscriber he is either immediately routed to a manual board or given NU tone from one of the first code selectors which would be taken into use by such subscribers.

Each exchange will thus be provided with a single group of "0" level register-translators which give access to means for routing long distance traffic whether this is handled either on a full automatic basis or via a manual board. These register-translators are in turn arranged to give access to call recording and/or register-translator apparatus grouped at a central exchange in the area.

A description will first be given of the first scheme by reference to the register-translator layout of Fig. 4. Four of the exchanges shown shaded A-D within the existing area as defined by the dotted line are assumed to serve as sub-

central exchanges. Calls to outlying networks or exchanges such as E will be routed via one or more sub-central exchanges, at which call recording equipment will be provided in addition to register-translator equipment.

It will be understood that certain of the exchanges within the normal register translator area but near the fringe thereof may be operated on a single or multi-metering basis to exchanges outside the area, while calls from other exchanges within the area to the same outlying exchange will be operated on the call recording basis. Again it may be desirable to utilise call recording for certain calls within the area, for instance when such calls extend from one end of the area to the other.

Considering now the case of a call originated at exchange F and in which the required subscriber is on exchange E, it will be assumed by way of example that the required subscriber's number is 746.9762, the digits "746" being a suitable previously unused code in the register-translator area.

Reference should now be had to the trunking diagram of Fig. 5. A calling party on removing his receiver will be connected via his uni-selector U/S to a first code selector ICS at the local exchange which thereupon in known manner associates itself with an idle A digit switch LADS over the hunter switch LADH. In response to the dialling of the first digit 7 one of the level 7 group of local register-translators LRT will be taken in use and will receive the remainder of the digits dialled. The second and third digits dialled, namely 46, are thereupon translated to, say 985, so as to route the call via exchanges such as D and G to the sub-central or tandem exchange B having access to the outlying exchange E. The routing digits are then followed by the complete number dialled, namely 746.9762, which will be required at said exchange B both for the purpose of enabling the call to be routed out to the desired network or exchange, and also for the purpose of call recording. The transmission of the routing digits 985 will gain access via the sub-central incoming selector TISR to a toll line relay set such as TLRs, and this thereupon associates itself with an idle A digit switch TADS over the hunter switch THS, the banks of which are split so as to gain access successively to A digit switches and call recording equipment as required.

During the hunting of the switch THS a signal will be sent back to hold up the register-translator at the local exchange and when an idle switch TADS has been found, the local register-translator LRT will commence to send out the complete number dialled.

The register-translators such as TRT taken into use at the tandem exchange may be in a special group arranged to provide translations for routing calls to outlying exchanges and/or networks served by the tandem exchange, which networks may include one or more register-translator networks. As before, digit 7 will be received on the A digit switch and subsequent digits will be on the level 7 group of register-translators TRT. In response to the second two digits 46 a translation will be effected to route the call via the selector TSR to the required exchange or network E, after which the numerical digits 9762 are transmitted to gain access with the called party thereat. The complete called subscriber's number is stored in the toll line relay set, and at conclusion of conversation call recording is carried out in the manner already described in connection with Figs. 2 and 3, the calling line identification

being initiated and stored at the calling exchange at any convenient stage during the call.

It may be that calls to the outlying exchange E can be set up on a single or multi-metering basis owing to the close proximity of the calling and called exchanges, and in such a case calls to exchange E will be operated on an ordinary single or multi-metering basis when originated by subscribers at exchange B and possibly in the near vicinity thereof, while calls to exchange E from other exchanges in the register-translator area will be operated on a call recording basis. Under these conditions the same group of register-translators at the tandem exchange B will be used for all classes of call since the existing register-translators will already have been arranged to cater for routing out to the outlying exchange involved.

In the case of calls from say exchange H to exchange E, it is feasible that the six translations normally available in the existing register-translator at exchange H will be sufficient to allow for the provision of routing out to the required exchange E and also for repeating the dialled three digit code to the tandem exchange B. In this case therefore there will be no necessity to take into use a register-translator at the tandem exchange, and the toll line relay set thereat if call recording is required will simply store the called number until the end of the conversation.

It is appreciated that where existing register-translators are made use of it will not be possible to cater for more than four numerical digits in addition to the code letters and/or digits, and in some circumstances it may prove desirable to modify the existing equipment so as to provide for the storing of five or more numerical digits.

Consideration will now be given to the second proposed method by which a special group of register-translators is provided in an originating exchange for handling calls requiring call recording facilities whether recording be effected manually by an operator or automatically.

Since the number of routings to be made by these translators will be small compared with the number of translations to be made by translators serving other A digit switch levels, they may be of simpler construction. As described in connection with the first method it is necessary when setting up a recorded connection to route the call through from the calling exchange to a sub-central exchange which handles traffic to the required exchange after which the complete number dialled is repeated thereto and for the purpose of storing and re-transmitting the wanted number the special group of "0" level register-translators may be provided with electro-mechanical impulse storage and regenerative mechanisms, of the type already mentioned.

As a preferred alternative it may be arranged that when for instance a call is originated at exchange F in Fig. 4 and is destined for exchange E, the "0" level register-translator at exchange F will not, as described already, route the call directly to the tandem exchange B nearest to the outlying exchange E in response to the dialling of a toll code number commencing with digits 01-09, but will simply route the call to the parent tandem exchange D of the calling exchange F and at this exchange D there will be located the call recording equipment for exchanges such as F.

The advantage of this scheme is that the "0" level translators at each group of exchanges operating into a parent tandem exchange will only have to have provision for effecting two routings,

one to a manual board at the parent tandem exchange and another to a relay set thereat which has access firstly to a register-translator or route-discriminator which effects routing of the call to the required outlying exchange and secondly to call recording equipment. This method enables the equipment in the "0" level register-translators to be reduced to a minimum. Such an "0" level register-translator is described later with reference to Figs. 8 and 9.

In connection with the handling of call recorded traffic it is further proposed according to the invention that all types of traffic requiring identification of the calling party should be combined in a common group to a central point, and in order that certain types of subscribers, for instance coin box subscribers, may have restricted access facilities, access will be had to this common group from two different switch levels one of which is barred on those selectors serving the special subscribers having restricted access. Means will be provided at said central point to separate the various types of traffic.

Referring now to Fig. 6 it will be seen that two groups of first code selectors ICS (CB) and ICS are provided at the calling exchange for coin box and regular subscribers respectively, each having access to the same group of local register translators LRT, the other equipment involved being the same as that described in connection with Fig. 5. Both the regular and coin box first code selectors have access over level such as 8 to the outgoing junctions to the main exchange, and this level would be used in the case where either type of subscriber required access to a manual board at the subcentral exchange. In accordance with the particular routing digit received on the incoming selector TISR at the subcentral exchange, access will be had either to an ordinary manual position via the jack designated 00 or to trunk, toll or telegram positions via the jacks labelled TRU, TOL and TEL. Other types of connections which require to be set up via a manual position may be given access via other levels of selector TISR to different jacks. Suitable discrimination will be given to these positions as to which type of subscriber is calling whether ordinary or coin box, the discriminatory signals being transmitted from the outgoing relay set ORS in accordance with the particular type of first code selector from which it has been seized. In the case of a call originated by an ordinary subscriber, it could either be arranged that immediately the operator plugged in to the jack subscriber identification equipment will be started up from the outgoing relay set ORS at the local exchange, after which the calling number will be transmitted to the central point or alternatively the actual starting up of the identification equipment could be under control of the operator. This latter arrangement would be generally employed from the "00" operator's position since such an operator may in some cases be merely assisting subscribers, while in other cases she may complete a call therefor possibly to some exchange which requires call recording facilities when she will require to know the identity of the calling party. In all these cases the calling number will be preferably displayed on some form of indicator in front of the operator, the actual period of display being under her control.

It will be noted that level 1 of the incoming selector TISR is arranged to connect via a toll relay set TLRS to outgoing selectors SR1 and

SR2 and it will be arranged that where a calling party desires such a connection, the first code selector at the local exchange will be raised to a level such as 7, so that if the calling party is a regular subscriber the connection can be completed in the manner described in connection with Fig. 5, while if the calling party is a coin box subscriber, the connection will not be completed because the coin-box first code selector 10 ICS (CB) does not have access to the outgoing junctions over level 7. A "number unobtainable" tone in such a case will be given to the calling party and the register-translator taken into use will be released.

In regard to incoming calls from outlying exchanges to a multi-office register-translator network, direct junctions will be provided from the calling exchange or the main exchange of the calling network to one of the central or subcentral exchanges in the register-translator network. The incoming junctions will preferably be terminated on a new rank of first code selectors and these will have access to the ordinary register-translators provided in the subcentral exchange, and the routing of calls to exchanges within the register translator area will proceed in the ordinary well-known manner. As regards the charging of such calls, discriminating equipment will be provided at the originating exchange to determine whether charging shall be on an ordinary metering or call recording basis. These discriminators will also be provided with impulse storage and regenerative devices so as to enable some or all of the digits dialled therein to be repeated to the sub-central exchange for the purpose of setting up the call via the sub-central register-translators. In case a call requires recording, the discriminator at the originating exchange will be arranged to transmit a signal to the sub-central exchange so as to cause call recording equipment to be taken into use. The recording equipment will store particulars of the wanted party's number during conversation, while the identity of the calling party will be determined and stored at an outgoing relay set in the originating exchange. At the end of conversation a printing or recording controller will be taken into use and the particulars required for charging purposes will be communicated thereto in the manner already described.

In the typical trunking diagrams of Figs. 1-6 which have now been described, the circuits of most of the items of apparatus involved therein are known to those versed in the automatic telephone switching art, while in some cases relevant patent specifications have been cited.

Consideration will, however, be given to the circuit operations involved in setting up calls via the intermediary of a simplified "0" level register-translator located at an exchange such as F in the register-translator area of Fig. 4, it being assumed that such register-translators are adapted in response to the dialling of digit "0" or digits "00" to route the call to a manual board at the parent tandem exchange D, and in response to the dialling of any of the pairs of digits 01-09 to route the call to exchange D, after which the complete number dialled, with the exception of the first digit "0" which is of no further use in the setting up of the call, is repeated in unchanged form thereto.

A toll line relay set is taken into use at exchange D and gains access firstly either to a register-translator which has facilities for routing the call to any of the outlying exchanges

either directly or via the intermediary of other exchanges in the area. The toll line relay set also can gain access to call recording equipment of the type already described.

Referring now to Figs. 8 and 9 the register-translator shown therein is provided with a single stepping switch F which receives the second digit of the called number and in response thereto brings about the routing of the call to the parent tandem exchange manual board or toll line relay set in accordance with the particular second digit dialled.

For the purpose of routing and call recording it is also necessary to have details of the full called number at the tandem exchange and the storage and retransmission of this information is effected by means of a mechanical impulse and storing regenerative device of the type already mentioned.

Considering the circuit operations, it will be understood that the circuits of the first code selector and A digit selector may be of the type disclosed in our British Patent No. 469,184 which also disclosed a typical ordinary register-translator. When an A digit selector switch seizes the "0" level register-translator of Figs. 8 and 9 in response to the dialling of the first digit "0," its wiper switching relay responds to battery marking the idle condition of the register translator. Such battery is connected to the P lead via the upper winding of relay A in parallel with resistance YA and thereupon extends an earth forward to operate relay A, whereupon relay B is operated in series with the magnet RM (non-operative in this condition), and this relay in turn brings up relay BB. Relay BB in operating at armature bb3 brings up relay P, at armature bb5 extends earth on to the common motor start lead 11 to set in operation the S and Z pulse delay timing equipment associated with relays TP and M and to set in operation the motor which drives the impulsing springs IMP1 and IMP2 required by the register-translator for sending out the translated dialled code. At armature bb1 an impulsing circuit is prepared to a regenerator receiving magnet RM, at armature bb8 an impulsing circuit is prepared to the magnet FM of the reverse drive electro-magnetically operated switch F, while at armature bb9 the upper winding of relay A is disconnected from the incoming P lead but this relay remains held over the pulsing lead PU which is earthed at the first code selector impulsing relay armature.

The dialled digit received at the register-translator will be any of the digits 1-0 and this will be received on relay A which in responding thereto at armature a2 repeats the impulse train to the magnet FM and steps the switch wipers round to a position corresponding to the digit dialled. At the same time at armature a1 the impulse train is repeated to the regenerator receiving magnet RM, it being noted that resistance YB in series therewith is now short-circuited by armature bb1 so as to enable the magnet to respond to the impulses; the resistance YB serves to prevent premature operation of the magnet RM during the energisation of relay A.

During the impulse train relay B is intermittently short-circuited by armature a1 but it remains operated due to the slugging effect of the short-circuiting, while relay C operates on the first release of relay A and subsequently holds throughout the train, and at its armature c1 energises the regenerator marking magnet MM.

Considering briefly the impulse storing and re-

generating device, it will be understood from details given in the prior specification that it comprises essentially a receiving disc and sending disc which are arranged on either side of a plate carrying a circular row of pins. The receiving disc is rotated step-by-step in response to the impulses received on the magnet RM and carries with it a marking lever which is released on de-energisation of the marking magnet MM at the end of each train of impulses, and pushes a pin corresponding to the digit dialled through the pin plate into the path of the sending disc. For each digit received a corresponding pin is pushed through the plate and these pins serve to regulate the movement of the sending disc which controls the generation of outgoing impulses by the regenerator impulse springs IMP3.

Returning again to the storage of the first digit on the regenerator, when the magnet RM responds and commences to rotate the receiving disc step-by-step, the first movement of this disc brings about the mechanical operation of the regenerator off normal springs and a circuit is thereupon prepared for relay ON over contacts N1.

At the end of the impulse train relay A remains steadily operated and on release of relay C after its slow period governed by the short-circuiting of its winding, the circuit for the marking magnet MM is opened and this magnet restores thereby causing the lever carried by the receiving disc to release and to push a pin corresponding to the digit dialled into the path of the sending disc.

At the same time the contacts mm controlled by the marking magnet close after having been opened during the energisation of the magnet and in so doing complete a circuit for relay ON which thereupon operates and locks for the remainder of the setting operation over its armature on1 and off-normal contacts N1 to earth.

While the magnet RM of the regenerator is being operated over contact a1, the magnet FM of switch F is operated over contact a2 so that the second digit is registered on both the regenerator and the switch F.

It will be remembered that in case the calling subscriber wishes to gain access to a manual board subscriber, the two digits "00" will be dialled in which case the second digit "0" will be stored on the regenerator, while the switch F will be set to position 11. Contact 11 on the F4 bank is cross connected to a terminal 12 so that on release of relay C at the end of the train earth is extended over wiper and bank F4 to bring up relay SM, which in a manner to be later described initiates the routing of the call to the manual board. Contacts 2-10 on the F4 bank corresponding to a second digit 1-9 which are dialled when a toll call is being set up, are cross connected to a terminal 13 so that relay SC is operated in this case and at armature sc2 completes a locking circuit for itself.

In response to the dialling of digits 1-9 as a second digit, the register translator is caused to send out trains of pulses to effect the routing of the call to the parent tandem exchange and hence when relay SC operates a circuit is prepared to relay IG.

Connected in parallel with this relay are a pair of impulsing springs IMP2, which it will be understood are operated in conjunction with the outgoing loop impulsing springs IMP1 in such a manner that when springs IMP1 are closed the IMP2 springs are open and vice versa.

The motor controlling these impulse springs

has previously been set into operation, and when impulsing springs IMP2 make their first break after the operation of relay SC, relay IG is operated. At armature *ig1* the impulsing springs IMP2 are connected up to the magnet FM of switch F and at armature *ig2* a short-circuit is removed from the impulsing springs IMP1. At armatures *ig3* and *ig4* the circuits to relays SC and SM are disconnected from the bank F4 of switch F, and bank F8 is now connected up at armature *ig5* to relay SZ so that it may now be used for the purpose of controlling the total number of trains of impulses to be sent out from the register-translator. At armature *ig6* the earth supply to wipers F4 and F8 is rendered independent of the armature *c2* so that if further impulse trains are being received during the ensuing transmission, each resultant operation and release of relay C will be without effect on this part of the circuit.

The above-described relationship between the impulse springs IMP1 and IMP2 is such that for each step the F switch is caused to take by means of the impulse springs IMP2 an impulse will be sent out over the left-hand negative and positive conductors via the impulse springs IMP1. Initially, however, the impulse springs IMP1 are short-circuited over a path including resting armature *sm4* and wiper F2 in any of the positions 1-11 and strapping connection to terminal 16 connected with the upper side of the impulse springs.

It will be assumed at this stage that for the purpose of routing the call through to a toll line relay set at the parent tandem exchange, it will be necessary for the register-controller to transmit the routing digits 3148 and these routing digits will be therefore transmitted in response to the dialling of any of the pairs of digits 01-09 indicative of a toll call.

Considering now the stepping of the switch F by the impulse springs IMP2, it will be seen that impulse springs IMP1 are ineffective until wiper F2 reaches the 12th position when the short-circuit is removed therefrom. Three impulses will be delivered to line during the transit of wiper F2 to position 15 and these serve in known manner to raise the first code selector wipers to level 3. The next four contacts on the bank are strapped so that as the wiper steps over these contacts, the impulse springs again remain short-circuited and by this means an interdigital pause is provided. The succeeding code digits 1, 4 and 8 are produced in like manner the control of wiper F2 being transferred to wiper F6 when the wiper F2 leaves its bank and the call is routed to the tandem exchange via an outgoing relay set at the originating exchange which will be shortly described.

When the F switch wipers F6 reach position 40 all routing digits will have been sent out and a circuit is therefore completed over wiper F8 in position 40, to operate relay SZ which locks at its armature *sz1*, disconnects the driving circuit to the magnet FM at armature *sz2* and at armature *sz3* short-circuits the impulsing spring IMP1 and introduces into the outgoing loop the regenerator impulsing springs IMP3.

At this stage of the call a toll line relay set at the parent tandem exchange will have been seized and this relay set will be endeavouring to gain access to one of a common group of register-translators suitable for routing the call to the required outlying exchange. In order to prevent

the sending out of further digits until an idle routing register-translator has been seized it is arranged that the battery connections to the line at the toll relay set are normally such that relay D will be inoperative.

When a free register-translator is found, the battery connection is reversed so that rectifier MRA becomes conductive and rectifier MRB non-conductive and relay D now operates. Relay D in operating energises relay SS at armature *d3*, whereupon an energising circuit is completed for the regenerator transmitting magnet TM.

It will now be understood that the pin in the regenerator which was displaced to mark the termination of the sending out of the previous call is pushed out of the path of the sending disc and back to its normal position by a resetting pin, designated RP and in circuit with relay P, but owing to the stepped head on the reset pin the sending disc is not immediately released and remains held until magnet TM is de-energised. Magnet TM at its contacts *tm* disconnects relay P which thereupon opens the magnet energising circuit at armature *p2* and as fully described in McClew and Woodland's Patent No. 2,188,461 the sending disc is released and rotates until the reset pin comes up against the stop pin indicating the termination of the first train of impulses received thereon.

During the sending out of the train, it will be noted that since the reset pin RP is not connecting with any stop pin such as SP, relay P cannot be re-operated, while during this time the first digit received on the register-translator is sent out in regenerated form by way of the impulse springs IMP1 controlled from the regenerator device and is delivered to the routing register-translator taken in use at the tandem exchange.

On release of relay P it will be noted that a circuit is completed via armature *p2* for the slow-to-release relay IS which serves for the purpose of timing the subsequent interdigital pause.

Previous to, and during this time, further trains of dialed impulses may be received on the receiving disc and it will be appreciated that the two operations of reception of certain digits and retransmission of earlier digits may go on simultaneously but independently of each other.

When the sending disc comes up against the stop pin indicating the termination of the first train of impulses, relay P is again operated and relay IS is disconnected. After the release time of relay IS which determines the interdigital pause, the sending magnet TM again receives a momentary energization in order to release the sending disc once more to generate a second train of impulses in the manner described.

When all the digits received have been retransmitted the sending disc will catch up with the receiving disc, whereupon the off-normal contacts NI open and release relay ON. Furthermore, if the complete number has been dialed and sent out correctly the route-discriminator will receive a full set of digits for routing the call to the wanted party and as a result the battery connections to the line conductors are restored to normal so that relay D releases and extends earth over armature *d1*, *p3*, *ss2* and *is2*, F switch wiper F3 or F7 and bank, armature *on3* to battery via relay CO.

Relay CO in operating at armature *co1* disconnects the idle marking battery from the incoming P lead, whereupon the wiper switching relay in the A digit selector is released. This relay in releas-

ing initiates the restoration to normal of the A digit selector switch and also extends a signal to the first code selector to cause it to release the connection to the register-translator and to connect the calling subscriber through the outgoing relay set to the parent tandem exchange. The A digit selector switching relay in releasing also disconnects the circuit to relay A in the register-controller over the PU lead, whereupon relays B, BB and other relays including relay SS held operated therefrom are released and a homing circuit is completed for the stepping switch F from earth over armatures *bb1*, *ss2*, *is2*, wipers and banks F3 or F7, F switch magnet interrupter contacts *fm*, armature *bb8*, magnet FM to battery. The wipers of switch F are accordingly rotated to the home position 1 where the homing circuit is disconnected at wiper F3 on contact 1.

The register-translator and the A digit switch are now available for further common use and the call being set up proceeds in a manner to be later described.

In case the first two digits dialled by the calling party are the digits "00" relay SM is operated at the end of the second digit over wiper and bank F4. This relay in operating brings up relay SC at its armature *sm1* and at armature *sm4* connects up the banks F1 and F5 to the impulse springs IMP1 so as, in this instance, to route the call by means of routing digits such as 3147 to a manual board at the parent tandem exchange. It will be noted also that in this case the circuit to relay SZ is completed via F8 bank contact 39, terminal 15 and operated armatures *sm2* and *ig5*. With a manual board call no numerical digits are required to be sent out from the regenerator and hence as soon as relay SZ operates a circuit is completed to relay CO over armatures *sm3* and *ss4* so as to bring about release of the register-translator and A digit selector. In this case therefore when relay CO operates the digit "0" will be stored on the regenerator and when relays A, B and BB release, relay ON in remaining operated will maintain relay P, while at armature *bb6* a circuit will be completed to relay IS from the earthed armature *ss4* during the slow release time of relay SS. Relay IS in operating maintains a circuit to relay SS from earth over armatures *is3*, *on4*, *ss1*.

In the time elapsing between the release of relay B and the subsequent operation of relay IS earth is extended over armatures *p2*, *b1* and *is1* to energise the regenerator transmitting magnet TM. On operation of relay IS this circuit is disconnected and the magnet TM in releasing initiates the sending out of the stored digit "0" from the regenerator. This sending out operation is in this case without effect, since on commencement of the sending out of the stored digit from the regenerator relay P is released and short-circuits the regenerator impulse springs IMP3. When the full train of impulses has been sent out relay ON releases and in turn releases relays SS and IS. On release of these two relays earth is extended over armatures *bb1*, *ss2* and *is2* and wipers and banks F3 or F7 to bring about the homing of the switch F and the register translator is now ready for further use.

It will be noted that when the register-translator is seized an operating circuit is completed over armatures *bb1* and *c2*, and wiper F4 in position 1 to energise the thermostatic delay relay TH. This relay requires about four seconds to close its contacts, and hence should the calling party dial a single digit "0" and then pause for four seconds or more, relay TH will operate and

at its armature *th1* will bring up relays SM and SC to route the call to the tandem exchange operator.

In the case of a dialled toll call, if the calling party should take longer than a predetermined time in completing dialling of the required number, relays TP and M are operated in the following manner. Common leads S and Z connected to these relays extend to a so-called delay set comprising S and Z pulse cams arranged to supply earthed impulses bearing a definite time relationship to these leads. Hence after relay B has operated in the register translator an S pulse will operate relay TP which locks over its lower winding. On reception of a Z pulse which may for instance be thirty seconds after the S pulse, relay M is operated over its upper winding and thereupon locks over its lower winding to earth via armatures *m3* and *bb2*. At armature *m1* a circuit is completed for relay SS, while at armature *m2* the outgoing loop is disconnected to release the selector train already set up from the register translator. At armature *m4* relay A is disconnected from the PU lead and releases, whereupon relays B, BB and SS release in turn. Earth is also extended on to the forced release lead FR over armatures *b2*, *is4* and *ss6*, during the release of relay SS, and it will be understood this brings about forced release of the A digit selector and the returning of "number unobtainable" tone to the calling subscriber from the first code selector. The register-translator is also restored to normal in readiness for further common use.

It will be appreciated that the register-translator can be adapted to send different sets of routing digits in response to the differing pairs of dialled digits 01-09, and in case as described in the foregoing description the call is to be routed direct from the originating exchange to that tandem exchange which is nearest to the required outlying exchange in response to the dialling of a pair of digits 01-09, then of course the register-translator will have to be adapted to send out two or more different sets of routing digits. To carry this into effect additional apparatus will be required in the register-translator which if the number of sets of routing digits is sufficiently large will approach in design the normal type of register-translator disclosed in our British specification No. 469,184.

Consideration will now be given to the circuits of the outgoing relay set at the originating exchange, and the toll line relay set at the parent tandem exchange.

The former which is shown in Fig. 10 is adapted on seizure to set in operation calling line identification equipment by which the identity of the calling number is communicated to it in code and this is stored on an impulse storage and regenerative device until such time as the distant toll line relay set signals that it requires it.

When the outgoing relay set is seized it will be understood that earth is extended forward on the private lead P to operate relay JA and this relay brings up relay JB at its armature *ja3* and at its armatures *ja4* and *ja5* connects the incoming left-hand and positive conductors through to the outgoing junction to the parent tandem exchange. An impulse repeating loop is thereupon extended forward from the first code selector right through the outgoing relay set to the incoming selector at the parent tandem exchange and the remainder of the routing digits transmitted from the register-translator serve to

route the call to a toll line relay set at the tandem exchange which is shown in Figs. 11 and 12.

Returning again to the outgoing relay set it is assumed that immediately on seizure calling line identification equipment will be set into operation to communicate details of the identification of the calling party's number to the outgoing relay set where it will be stored. Hence relay JB in operating at armature *jb5* extends earth via armature *rb3* to operate relay RA, assuming that the strapping connections between terminals 17 and 18 are disconnected. In other circumstances where the outgoing junctions to the tandem exchange are assumed to serve both call recorded traffic and ordinary metered traffic the terminals 17 and 18 will be strapped so that relay RA can only be operated if a discriminating signal of alternating current (indicating that the call is to be recorded) has been sent forward over the private lead P to operate relay IP which is an ordinary direct current relay connected in a full wave rectification circuit comprising rectifiers MRC—MRF and connected to the incoming P lead via condenser QD.

Relay RA in operating at its armature *ra6* completes an energising circuit for the regenerator marking magnet IMM via armatures *jb5*, *lp1* and *ra6* and at armatures *ra1*—*ra5* connects the outgoing relay set to the common leads extending to the calling line identification equipment.

In connection with the calling line identification equipment it will be understood that this is of the general type already mentioned in which the private lead associated with each line in an exchange is marked with a code which is indicative of that particular line. The marking thereupon passes along the P lead of the connection set up by the calling party and is received at the outgoing relay set where this information is required.

As regards the code, this may be preferably of the well-known five unit type in which every digit to be transmitted or stored consists of five parts and by sending signals in one or more of these parts the various digits are indicated. Parts or units without a signal are known as spacing pulses and those with a signal are called marking pulses. In the five unit code every digit comprises two marking pulses and three spacing pulses, the marking signals being transmitted along the private lead to the outgoing relay set, while the spacing or synchronising pulses are supplied independently of the talking train over common leads from the identification equipment to the outgoing relay set.

Assuming for instance that the five parts of the code are designated V, W, X, Y, Z, respectively, then digit 1 will be transmitted by sending a marking pulse in the parts V, W, the coding for the various digits being indicated in the following table:

VW—1		
VX—2	WX—5	
VY—3	WY—6	XY—8
VZ—4	WZ—7	XZ—9 YZ—0

Thus for a four digit number a total of four groups of five pulses each will be transmitted and may be stored on the impulse storage and regenerative device on the outgoing relay set in the same five unit code as received. Each five pins in sequence on the regenerator form a digit and pins in each of these groups of five are displaced in accordance with the marking pulses received.

On referring back to the circuit of the outgoing

relay set it will be understood that when relay RA operates, if the subscriber identification equipment, or line marking equipment as it may be alternatively termed, is not already in operation and performing a cycle of identification then there will be an earth potential on the common lead S which will bring up relay RB over its right-hand winding, and this relay thereupon locks via armatures *rb1* and *jb5* to earth on its left-hand winding. At armature *rb2* the regenerator receiving magnet IRM is connected up to the pulsing lead PU in readiness for receiving spacing impulses, while at armature *rb3* the initial energising circuit for relay RA is opened and this relay is now held operated to the common lead Z which it will be understood is earthed in the line marking equipment and remains earthed until shortly before the end of a complete identification cycle, when earth is momentarily removed therefrom in order to signal the completion of a cycle to all calls which have received a complete identification. At armature *rb5* earth is extended from armature *ra5* on to the common start lead ST in order to initiate a line marking cycle. During the identification or line marking cycle each step thereof causes an earth spacing impulse to be applied to the PU wire, and the regenerator receiving magnet IRM therefore steps the receiving disc and marking arm around the circular row of pins.

Each time a marking impulse which, it will be understood, is of the alternating current type, is received over the private lead relay IP will be operated, and in so doing at its armature *lp1* disconnects the marking magnet IMM. This magnet in restoring releases the marking lever carried by the receiving disc, and a pin opposite which it is positioned is pushed into the path of the sending disc, while at the same time contacts *lmm* controlled by the marking magnet close after having been opened during the energisation of the magnet, and in so doing complete a circuit for relay MMR over its left-hand winding. Relay MMR at its armature *mmr5* disconnects the circuit of relay IP which releases to re-energise the marking magnet IMM, while at its armature *mmr1* it locks over its right-hand winding to the earthed pulse lead PU until the pulse is completed.

At the end of the pulse relay MMR releases and reconnects relay IP on to the private lead in readiness for a subsequent marking pulse.

Assuming that the subscriber's number is 1359, then twenty code signals will be received by the regenerator, of which pulses Nos. 1 and 2, 6 and 9, 12 and 13, 18 and 20, are marking pulses, the remainder being spacing pulses. Corresponding pins are displaced in a row of twenty consecutive pins on the regenerator, and in this manner the subscriber's number can be stored in code by means of displaced pins.

If the calling subscriber has the usual register-translator exchange number comprising three letters and four numerical digits the first part of the number will be the same for all subscribers on the exchange and hence this can be received directly from the line marking equipment without having to be transmitted over the talking train.

The code signals indicative of the initial digits of the number are received from the line marking equipment via the "exchange code" common lead EC which connects with the P lead and relay IP via a non-linear resistance NLR which, in response to the application of a suitable alternating current potential on to lead EC, lowers its resistance sufficiently to allow relay IP to operate in

series therewith. The five unit code is utilised to communicate the initial digits of the number to the impulse regenerator and when this has been completed the numerical part of the number is communicated over the P lead in the manner already described.

When the identification cycle is completed, earth is momentarily removed from the Z common and relay RA releases. The circuit now remains in this condition until the end of the call when the calling subscriber restores his receiver, but before considering what will happen at this point, consideration will first be given to the setting up of the toll call via a toll line relay set at the parent tandem exchange.

During the identification cycle which is initiated on seizure of the outgoing relay set, trains of routing impulses will be extended therethrough to set up the call to a parent tandem exchange toll line relay set such as is shown in Figs. 11 and 12.

As already described in the description associated with the various trunking diagrams, the function of this relay set is firstly to gain access over a 25 point unselector switch HS to routing and translating equipment serving the switch train, and afterwards to gain access to call recording equipment. It is also adapted to store the called number on an impulse storage and regenerative device, while furthermore the duration of the call which is also required for the purpose of call recordings, is determined therein by means of two 10 point reverse drive electromagnetically operated stepping switches TS and US operating in conjunction with the 25 point switch HS which is actuated by a six seconds earth pulse during conversation for timing purposes.

Other particulars which are required for the purpose of call recording such as the identity of the calling number and the time of occurrence of the call may be obtained respectively from the outgoing relay set at the originating exchange as already described, and from a common date and time unit to which access is had from the call recording equipment when this information is required.

When the toll line relay set is seized a loop is extended forward from relay D and the impulse springs of the originating exchange register-translator of Figs. 8 and 9 via the code selector train, the outgoing relay set, junction to the tandem exchange and incoming tandem exchange selector train to operate relay R in the tandem exchange toll line relay set. The battery connections to line via this relay are such as not to operate relay D in the register-translator and so hold up the sending out of the impulse trains stored in the regenerator until access has been had via the hunting switch HS to the routing register-translator equipment serving the toll switch train.

Relay R in operating at its armature *r1* brings up relay IB and this relay in turn brings up relay BA. Relay BA in operating at its armature *ba1* completes a locking circuit for itself, at armature *ba2* extends a guarding and holding earth on to the P lead, at armature *ba5* completes an operating circuit for relay KR and at armature *ba6* completes an operating circuit for relay MD.

Relay KR in operating at armature *kr6* completes a self-interrupted driving circuit for the magnet HSM of switch HS via the magnet interrupter contacts *hsm*.

It will be remembered that the hunter switch HS is arranged to have access either to register-translators or to printer controllers, and it is

initially arranged that hunting shall only take place over bank contacts wired out to register-translators. This is ensured by arranging that an operating circuit for the wiper switching relay K can only be completed via contacts on the banks of switch HS which are wired out to register-translators, and whenever the wipers of this switch are resting on such contacts, earth will be extended from armature *kr7* over the homing bank and wiper HS9, armatures *lb4*, *k2* and *kr1*, resistance YC, armature *kr2*, windings of relay K in series to the testing or P wiper HS3 of switch HS.

If the outlet on which the HS switch wipers are standing is engaged then relay K will fail to operate and the switch will step its wipers on to the next set of contacts. A self-interrupted driving operation continues until an idle register-translator is found, when wiper HS8 will encounter an idle resistance marking battery and relay K will operate. In operating it disconnects the magnet driving circuit at armature *k3* to arrest the motion of the switch, operates relay KA at armature *k2* and at its armature *k1* extends a guarding and holding potential on to the test wiper HS8 by way of its low resistance lower winding.

Relay KA in operating at its armature *ka1* disconnects the circuit of the slow-to-release relay KR and brings up relay KB, at armatures *ka3* and *ka4* the incoming negative and positive conductors are connected through to the hunter switch wipers HS2 and HS3, a holding circuit being maintained to relay R via resistance YF and armature *ka5*, while at armature *ka6* an operating circuit is completed for relay IBB.

Relay K in operating also at its armature *k2* disconnects one section of its original operating path and its upper winding of this relay is now energised in an opposing direction to its lower winding from earth via armature *k1*, upper winding, armature *kr2*, resistance YC and YD to battery in order that suitable release conditions for this relay may be obtained in the remote case where K relays in two toll line relay sets attempt to switch substantially simultaneously into the same register-translator.

In this case of a dual connection, the two K relays are allowed to operate to the same idle marking battery, but the holding flux produced in each due to the current through their low resistance lower windings will be halved, while the opposing flux due to their upper windings will remain the same. In these circumstances both the K relays will release satisfactorily and cause the respective hunter switches to continue searching.

Due to the difference in speed of any two switches, after a few steps one will reach a free outlet before the other, whereupon the associated K relay will operate to guard the outlet and to disconnect the magnet driving circuit.

The energisation of the upper winding of relay K in an opposing direction to that of the lower winding is maintained until release of relay KR after which the circuit to the upper winding is disconnected and relay K remains securely held on its lower winding alone.

Relays KB and IBB in operating at armatures *kb1* and *kb2* and *ibb5* and *ibb6* connect the outgoing negative and positive conductors on the right-hand side of the circuit through to the negative and positive out pulsing leads of the register-translator, while at armature *kb3* the magnet driving circuit is further disconnected.

Relay IBB in operating further at its armature *lbb1* locks independently of relay KA.

The distant register-translator at the originating exchange is now connected through the toll line relay set to the register-translator which is in turn connected out via the toll line relay set to the outgoing toll train switches at the tandem exchange.

It will be understood that the battery connections to the incoming negative and positive leads in the tandem register-translator are the reverse to those obtaining with relay R so that relay D in the local register-translator now operates and initiates the sending out of the dialled number stored in the impulse regenerator therein.

This information is received in the tandem register translator in order to effect the necessary translation to set up the call to the required subscriber, while at the same time the information is communicated therefrom to the impulse storing and regenerative device in the toll line relay set in the following manner.

On the operation of relays KB and IBB it will be noted that the regenerator receiving and marking magnets 2RM and 2MM are connected up over wipers HS4 and HS5 to the register-translator seized, and it will be understood that the marking magnet 2MM is immediately energised to lift the marking lever clear of the pins in readiness for the reception of impulses on the receiving magnet 2RM.

It will be understood that the decimal impulse trains received in the register-translator are also changed over into the five-unit code form previously described in connection with the line marking equipment, and are transmitted over banks and wipers HS4 and HS5 to the regenerator receiving and marking magnets 2RM and 2MM. For each digit received the receiving magnet 2RM receives five pulses, and a marking pulse is delivered over bank and wiper HS5 on two out of each group of five impulses, each marking pulse comprising a disconnection of the earth potential applied to bank HS5 and releases the marking magnet 2MM so as to displace certain pins in accordance with the particular digits involved as described in connection with the storage of the calling number in code form in the outgoing relay set regenerator.

When the tandem register-translator completes the sending out of the routing digits to route the call to the required subscriber its function is completed and it thereupon removes the marking battery from the contact on which wiper HS3 is standing, thereby releasing relay K in the toll line relay set. Relay K in releasing in turn releases relays KA and KB, and furthermore since the register-translator at the originating exchange will have dropped out of the connection by this time, the conversational channel will be completed, the completion of this channel in the toll line relay set being completed over the resting armatures *ka3* and *ka4*, condensers QA and QB and resting armatures *kb1* and *kb2*. Relay KB in releasing also at armature *kb3* completes a homing circuit for the HS switch over the following circuit: lead 21 which is earthed via delayed alarm equipment which comes into operation if the switch should fail to home, armature *kr7*, wiper and bank HS9, armatures *kr3* and *kr5* according to the position of the wiper HS9 on the bank, armatures *db5*, *k3* and *kb3*, magnet interrupter contacts *hsm*, magnet HSM to battery, and the HS switch wipers are accordingly rotated to the home position.

On the completion of the setting up of the call, the called subscriber is rung from the distant exchange final selector in the usual way, and when he replies a battery reversal will be extended backwardly over the speaking conductors so that rectifier MRL in series with relay ID in the toll line relay set will become conductive and rectifier MRK non-conductive. Relay ID can now therefore operate in series with the impedance retard I and at armature *ld1* it disconnects the circuit of relay MD which has been held operated since the seizure of the toll line relay set. At the same armature a circuit is completed to relay DD which at its armatures *dd1* and *dd2* repeats the line reversal back to the first code selector at the originating exchange for supervisory purposes. On release of relay MD after its slow release period, which period serves to guard against bringing about call charging by momentary operations of relay ID due to line disturbances, a circuit is completed to relay DB over the HS10 wiper in position 1.

Relay DB in operating locks over its armature *db1* and connects up the six seconds earth pulse lead 23 to magnet HSM at armature *db4*.

An earth pulse is delivered over lead 23 every six seconds and the magnet HSM advances the HS switch wipers step by step in accordance therewith. It is arranged in this circuit that fee charging does not take place until the switch HS has taken two steps, that is to say until six to twelve seconds have elapsed, and during this period the calling subscriber has time to release the connection if a wrong number has been obtained. This feature can of course be deleted if not required.

After the stipulated period has elapsed relay PU is operated over wiper HS10 in position 3 and at armature *pu3* the magnet USM of the units minute timing switch US is also connected up to common lead 23 so that the next six seconds earth pulse will energise magnet USM and at the end of the pulse the magnet will release to advance the wipers US1 and US2 from the home position 1 to position 2 thereby indicating the commencement of the first minute. Relay PU then releases until the HS switch reaches position 13 when it is again operated and advances the units minute timing mechanism to be advanced a further step to position 3 thereby indicating the commencement of the second minute. After another ten steps of the HS switch, i. e., after elapse of another minute, the units minute timing switch US is advanced to position 4, thereby indicating the commencement of the third minute.

When wiper HS10 reaches contact 25 relay DP is operated and locks over its armature *dp1*, and armatures *db2* and *ba6* to earth. Relay DP in operating prepares a new operating circuit for relay PU over contact 6 of the HS10 bank so that this relay will be again operated twelve seconds before the elapse of the three minute period which occurs when the wiper HS10 reaches contact 8. Relay PU in operating this time does not complete any circuit to the magnet USM since this circuit is disconnected at armature *dp4*, but instead a circuit is completed over armatures *dp5*, and *pu4* to extend an earthed pip-pip tone transformer connected to common lead 24 to the centre winding of relay R from whence a pip-pip warning tone is extended by induction on to the line conductors to advise the subscriber that his first chargeable period has elapsed. When wiper HS10 reaches the next contact 9 earth is ex-

tended by way of armatures *pu2* and *dp2* to short-circuit and release relay DB, whereupon at armature *db5* a homing circuit is completed for the switch HS. Relay DP falls away on release of relay DB but relay PU remains locked over armatures *pu1* and *db2* to the earthed armature *ba6* until relay DB is re-operated when the switch HS reaches the home position 1.

The switch HS now commences another cycle and a further three minutes are recorded on the units minute counting switch US. If conversation continues, then at the beginning of the ninth minute, the wipers of the units minute switch US will be advanced from position 9 to position 10 in which position the contacts U10 are mechanically closed and complete a circuit to the tens minute switch magnet TSM. Hence at the beginning of the tenth minute both the magnets USM and TSM will receive an energising pulse and will respectively advance wipers US1 and US2 to position 1, and wipers TS1 and TS2 from position 1 to position 2.

The stepping on of the units and tens counting switches US and TS continues until the end of conversation when the calling party hangs up his receiver, and assuming that twenty minutes have been timed, the units switch will have its wipers positioned on the home position 1, while the wipers of switch TS will be positioned on contact 3.

By means of these two switches US and TS a conversation duration of up to ninety-nine minutes can be stored and appropriate warning tones are given to the subscriber prior to each new three minute period.

When the calling subscriber hangs up relays R, IB and IBB release in turn, but relay BA remains operated to guard the toll line relay set over its armature *ba2* and to provide for the switching through of this relay set to call recording equipment.

Call recording now takes place in the following manner. Should it be desired to record effective calls only it will be understood that terminals 21 and 22 in the circuit of relay ION are strapped so that if relay DB has not been operated as a result of the called party replying, then on release of relay IB relay ION will be operated to release relay BA at its armature *ion2* and so initiate the release of the toll line relay set without having gained access to the call recording equipment.

Should relay DB have been operated and locked however, or should the strapping connection between terminals 21 and 22 not be provided, relay KR in re-operating on the release of relay IBB over armatures *ba5*, *ka1* and *lbb4* will cause at *kr6* the hunter switch HS to step over that part of its bank giving access to register-translators and hunt over that part of its bank giving access to printer controllers, the testing circuit in this instance extending from earth (*kr7*, alarm lead 21), wiper and first part of bank H9, resting armatures *lb4* and *k2*, armature *kr1* and resistance YC in parallel with resistance YE, armature *kr2*, windings of relay K in series to the testing wiper HS8.

When a free printer controller which is marked, as in the case of a free register translator, by a resistance marking battery, is found relay K operates to cut the drive and to once again bring in relays KA and KB and to release relay KR. Relay KA in operating at armatures *ka3* and *ka4* switches the incoming negative and positive leads into the printer controller in readiness for

the reception of code signals indicative of the calling number, while relay KB in operating at its armature *kb5* and *kb6* prepares a circuit for transmitting the duration of conversation over the banks of the switches US and TS to the printer controller.

The first information to be received by the printer controller is the identity of the calling party in order that the junction between the originating exchange and the tandem exchange may be freed as soon as possible, and the sending out of this information is initiated by the transmission from the printer controller of a 50 cycle alternating current pulse.

Returning again to the circuit of the outgoing relay set of Fig. 10, when the calling subscriber replaces his receiver the seizing earth extended forward from the first code selector over the P lead is removed, and relay JA thereupon releases.

If the call is as being described, such as to require call recording as distinct from single or multi-fee metering, then during the hunting for a free printer controller at the tandem exchange a battery will be extended from the lower winding of relay R of the toll line relay set on to the positive junction lead, relay DD having been operated on its right hand winding on release of relay IB. This battery potential extends over the positive wire to operate relay JR in the outgoing relay set. Hence when relay JA thereat releases relay JB will remain locked over its armature *jb1* to the resistance battery, and earth will be extended over armatures *ja2*, *jb2* and *sr7* to re-guard the P lead. The momentary disconnection of the earth potential therefrom during the release time of relay JA provides the requisite disconnect period for the release of intermediate switches and apparatus in the train between the first code selector and the outgoing relay set.

When the toll line relay set finds a printer controller the negative battery is disconnected from the positive lead at *ka4* at the toll line relay set and relay JR releases and commences to short-circuit and release relay JB.

A 50 cycle alternating current impulse is transmitted from the printer controller relay set on seizure to the outgoing relay set and this extends via condenser QC and the windings of transformer TR to operate relay S. Relay S in operating at armature *s2* operates relay SR from the earthed regenerator off-normal springs IN1 and provides an auxiliary operating earth for itself at armature *s1*. Relay SR in operating at armature *sr1* re-operates relay JR so that the short-circuit is removed from relay JB before it has had time to release. At armature *sr2* the circuit for relay S is made dependent on the armature *s1*, at armature *sr3* a locking circuit is completed for relay SR, at armature *sr6* relay MMR is operated over its left-hand winding from the earthed regenerator interrupter springs IMP4. Relay MMR thereupon locks on its right-hand winding to earth via armatures *mmr1* and *sr4* and regenerator sending magnet interrupter contacts *l7m* while at armature *sr7* a guard earth is maintained on the P lead independently of relays JA and JB.

At the conclusion of the alternating current signal from the toll line relay set relay S releases, whereupon earth is extended over regenerator off normal contacts IN1, and armatures *s2*, *mmr2* and *sa2* to energise the regenerator sending magnet ITM, relay SA having operated on the operation of relay MMR. Magnet ITM in energising opens the holding circuit of relay MMR at con-

tacts *itm*, whereupon relay MMR in releasing opens the magnet energising circuit at armature *mmr2*.

On release of the magnet *ITM* the sending disc is released in the usual manner and commences to rotate under the stored up energy of the regenerator driving clock spring.

The sending disc in rotating sends out the calling subscriber's number in the five unit code form previously described, discrimination between marking and spacing impulses being effected by transmitting a 50 cycle impulse for each spacing impulse and by transmitting a 50 cycle impulse together with a 150 cycle impulse for each marking impulse.

Assuming that a four digit number is to be transmitted, then a total of twenty impulses will be transmitted over the line and the 50 cycle frequency which is transmitted during every pulse operates a suitably tuned relay in the printer controller relay set which advances a receiving switch step-by-step through twenty positions. Whenever a marking pulse is transmitted comprising the 50 and 150 cycle impulses together, then another relay is operated in addition and connects earth to a wiper of said receiving switch which energises a particular storage relay in accordance with the position of the wiper. Four sets of storage relays will be provided in the printer controller relay set, each set comprising relays V, W, X, Y and Z by means of which the received five unit codes can be interpreted on an ordinary numerical basis.

For the purpose of sending out the required marking and spacing impulses comprising the code, the regenerator in the outgoing relay set is provided with two sets of impulse springs *IMP4* and *IMP5*, the former being closed whenever the latter are open and vice versa.

When the sending disc is freed and commences rotation it closes the impulse springs *IMP5*, whereupon impulse springs *IMP4* open and release relay SA in readiness for re-operating relay MMR. With relay MMR normal a combined earthed 50 and 150 cycle frequency source connected up over common lead 20 is extended via the impulsing springs *IMP5* to the transformer TR and the 50 and 150 cycle frequencies then extend through over the line to the tandem exchange printer controller relay set. The receiving switch thereat is caused to step off its home position 1 to position 2 connecting with the V storage relay in the first group in readiness for receiving the calling number, it being noted that the reception of the two frequencies at this initial point in the operations are without effect on the storage relays.

At the end of the impulse, impulse springs *IMP5* open and impulse springs *IMP4* close to pull up relay MMR. If the reset pin *IRP* in the sending disc has not now come up against a displaced stop pin such as *ISP* indicating the first marking impulse stored on the regenerator then relay MMR in operating will lock over its right-hand winding to the earthed sending magnet interrupter contacts *itm*. The second time the springs *IMP5* close, since relay MMR is operated, a 50 cycle earthed alternating current source connected to common lead 19 extends via transformer TR and the junction line to the printer controller relay set, and this spacing pulse brings about the stepping of the receiving switch thereat to the second position 2.

The transmission of 50 cycle frequency impulses

continues until the re-set pin in the sending disc encounters a displaced stop pin, when a circuit will be completed from the earthed re-set pin *IRP* and stop pin such as *ISP*, armature *mmr6*, winding of relays SA to battery via armature *sr5*, and relay SA in operating locks to the impulse springs *IMP4* (now closed), via its armature *sal*. The magnet *ITM* is again energised and at contacts *itm* releases relay MMR which in turn disconnects the energising circuit for magnet *ITM*. With relay MMR normal the next code pulse to be sent out to line will be a 50+150 cycle pulse or marking impulse, and will bring up a corresponding storing relay in the printer controller relay set.

If the next pin is not displaced then when the impulse springs *IMP4* reclose at the end of the 50+150 cycle impulse, relay MMR will be operated, relay SA having been released during the open period of the springs *IMP4* when springs *IMP5* are closed and in this manner the information stored in code on the regenerator in the outgoing relay set is sent out in the same code to the tandem exchange printer controller.

When all the signals stored in the regenerator have been re-transmitted the sending disc S will catch up with the receiving disc R, whereupon the off-normal contacts *INI* open and release relay SR which removes the guarding potential from the P lead.

To ensure that the junction is not seized again before the tandem exchange equipment is ready to handle further calls it will be arranged to extend a holding battery potential over the positive line back to the outgoing relay set so as to maintain relays JR and JB operated and so maintain a guarding earth on the P lead on release of relays SR.

As soon as a junction becomes available for further calls the holding condition is removed therefrom at the tandem exchange and relay JR in releasing shunts down relay JB to free the junction for further outgoing traffic.

In case the call should not be completed and recorded and particulars thereof should not be therefore required relay JR will not be held operated over the positive line on the release of relay JA when the calling subscriber hangs up so that relay JB will be short-circuited and released. Relay JB in releasing at armature *jb6* operates relay SR and this relay in operating initiates the sending out of the stored information from the regenerator, but the impulses are ineffective in this instance since the secondary circuit of the transformer TR is disconnected at armature *jb3*.

Returning again to the toll line relay set of Figs. 11 and 12, it will be understood that when all the particulars of the calling number have been received by the printer controller relay set an earth is extended over bank and wiper *HS1* to operate relay *ION*. Relay *ION* in operating locks over its armature *ion1* to the earthed off normal contacts *2N1* of the regenerator and at armature *ion2* disconnects relay BA. During the release period of relay BA an unguard is given on the incoming P lead so as to allow the earlier part of the switch train in the tandem exchange to release, and this equipment in releasing removes the holding condition back to the outgoing relay set at the originating exchange so as to free this for further common use as already described.

Relay *ION* in operating also at armature *ion3* allows the incoming P lead to be re-guarded from

the resting armature *ba1* and at armature *lon4* completes an operating circuit for relay *RR*.

Relay *RR* in operating locks over its armature *rr1* and completes an operating circuit for relay *2P* at armature *rr2*. Relay *2P* in operating at armature *2p2* completes an energising circuit for the regenerator sending magnet *2TM* and at its armature *2p1* renders the operation of relay *RR* dependent on the sending magnet interrupter contacts *2tm*, so that when these contacts are opened relay *RR* restores and disconnects the magnet energising circuit.

The magnet *2TM* in releasing frees the regenerator sending disc in the usual manner, and this in rotating drives two sets of impulse springs *IMP6* and *IMP7* arranged in the same manner as those in the outgoing relay set.

Meanwhile the receiving equipment in the printer controller relay set will have been made suitable for receiving code impulses indicative of the called number from the impulse springs *IMP6*, it being arranged that spacing pulses will be transmitted by means of impulses over the positive *IN* lead to the printer controller via armatures *ka4* and *rr3* and marking pulses over the negative *IN* lead via armatures *ka3* and *rr3*.

The first impulse transmitted from the regenerator will always be effected with relay *RR* normal, and accordingly it will extend from the impulse springs *IMP6* via armatures *rr3* and *ka3*, the negative *IN* lead and wiper and bank *HS2*.

During the extension of this pulse, the break impulse springs *IMP7* open and release relay *2P* so that when they reclose at the end of the impulse, relay *RR* will be operated. If no displaced pin such as *2SP* is encountered by the reset pin *2RP* in the sending disc then the next pulse will be sent with relay *RR* operated over the positive *IN* lead. Until such time as a displaced pin is encountered spacing pulses comprising pulses over the positive *IN* lead, and wiper and bank *HS3* will be sent into the printer controller, while as soon as a displaced pin is encountered the sending out is stopped by the re-set pin *2RP* engaged with the displaced stop pin *2SP*, and a circuit is completed from armature *lon4*, the reset pin *2RP*, typical pin such as *2SP* and armature *rr2* to re-energise relay *2P*. Relay *2P* in operating completes an energising circuit for magnet *2TM* which in turn disconnects the circuit of relay *RR*, and this relay in turn disconnects the energising circuit of magnet *2TM*.

The sending disc is again released and since relay *RR* is normal the first impulse delivered will be a marking impulse comprising an earth on the negative *IN* lead.

During this impulse the break impulse springs *IMP7* in opening release relay *2P* as before, and at the end of the impulse when these impulse springs re-close relay *RR* is operated and spacing pulses comprising earth on to the positive wire continue to be sent out until another displaced pin indicating a marking pulse is encountered.

In this manner the called number is transmitted from the toll line relay set into the printer controller.

When the printer controller has received the called number it now prepares for receiving the duration of the call from the toll line relay set.

It will be noted that the banks *TS1* and *TS2* and *US1* and *US2* of the switch *TS* and *US* are connected up to five wipers *HS1*, *2*, *3*, *6* and *7*, while the banks are moreover strapped in such a manner that in accordance with the setting

of the wipers a set of five storage relays *V*, *W*, *X*, *Y* and *Z* in the printer controller connected up respectively to the banks of wipers *HS1*, *2*, *3*, *6* and *7* can receive information as to the duration of the call in five unit code form.

The tens duration is first transmitted over these five leads to a set of storage relays in the printer controller and this is effected by the connection at the printer controller of an earth to the bank of wiper *HS5*, so that this earth extends over armatures *kb6* and *lb7* to wipers *TS1* and *TS2* of the tens switch *TS*.

Assuming for example that the duration of the call is twenty minutes, then the wipers *TS1* and *TS2* will be in position *3*. Wipers *HS1* and *HS3* will be earthed, thereby operating relays *V* and *X* in the printer controller, the operation of which corresponds to the digit *2* as already described in connection with the first description of a five unit code.

After the tens duration has been received a second set of storage relays is connected up to the banks *HS1*, *2*, *3*, *6* and *7* and an earth is now extended over the bank of wiper *HS4*, which earth extends over armatures *kb5* and *ba4* to wipers *US1* and *US2*.

These wipers will be positioned on the home contact if the duration of the call is twenty minutes, and hence earth will be extended over wipers *HS6* and *HS7* to operate the units storage relays *Y* and *Z* which set up a units digit "0" in the printer controller.

The printer controller now has all the information it requires from the toll line relay set for recording the call and it thereupon removes the resistance holding battery from the test bank *H8*. Relay *K* now releases and in turn releases relays *KA* and *KB*. Relay *R* releases on release of relay *K* and in turn drops relay *1B* and other relays held operated therefrom, while on release of relay *KB* a homing circuit is completed for the hunter switch *HS*. At the same time homing circuits are completed for the switches *US* and *TS* in turn, the first circuit extending from earth over armatures *ba6* and *kb4*, *US* switch off normal contacts *USN1*, magnet *USM* interrupter contacts *usm*, magnet *USM* to battery. When this switch reaches its home position the homing circuit is disconnected at the contacts *USN1* which in restoring completes a homing circuit to the switch *TSM*. In this manner the toll line relay set is freed for further common use.

General consideration will now be given to arrangements for dialling on a national basis and for this purpose a country may be divided up into a number of zones, these being preferably based on the existing trunk network layout. A subdivision is then made into groups, each group comprising a number of exchanges and/or exchange networks. Each group may be made dependent on what may be termed a group centre exchange for calls extending from one group to another, while a zone centre exchange will be provided for each zone, each zone centre having direct connection with the majority of other zone centres and possibly with group centres in other zones in cases where there is a sufficiently high community of interest therebetween.

Under these conditions national subscriber to subscriber dialling may be effected by dialling such digits as will bring about the selection of the required zone and the group in that zone followed by the network or exchange in the group. Succeeding digits will then route the call to the wanted party.

Considering the case of the British telephone network, the country is divided generally into seventeen zones, these being each sub-divided into groups.

For the purpose of national dialling, all call recorded calls will have at least three prefix digits in addition to the ordinary number on the wanted exchange or network, these digits being 011-099 and giving ninety different selections. It is not proposed that for a given called exchange, the number of digits dialled shall be the same irrespective of the situation of the calling exchange, but rather that the total number of digits to be dialled shall be inversely proportional to the community of interest between the calling and called exchanges. For instance, there is a high community of interest between Liverpool and Manchester and it will be arranged that a smaller number of digits will be required to effect intercommunication between subscribers in these areas than say between Liverpool and Newcastle, where the community of interest is not so high. It is intended to utilise this principle throughout the national dialling scheme.

In the case of the London register-translator area, this has a high community of interest with the Home Counties to which calls would be set up on a call recorder basis and for this purpose forty prefix digits say 011-040 might be allocated in the London area directory. The remaining fifty codes 051-090 would serve for routing to the various zone centres in the country, each of the seventeen zones possibly requiring one, two or three code prefixes in accordance with its requirements. The called party's local number might be an ordinary 4-7 digit number in the case of non-register-translator areas, or a 7 digit number consisting of three code digits or letters, together with a 4 digit numerical in the case of a register-translator area, and these will be preceded by one or more code digits depending on the community of interest between the calling and called exchanges.

For instance in the case of a call from a London register-translator exchange subscriber to a Birmingham register-translator subscriber, digits 081 followed by the 7 digit Birmingham number may be dialled. In response to the dialling of 081 at the calling party's local exchange, the local register-translator sends out routing digits to connect up with a central or sub-central exchange in the London area serving the trunk lines to the Birmingham zone centre and functioning as a tandem centre. The complete number dialled including the prefix digits 081 or alternatively, the complete number received in the local register-translator is then repeated to the tandem centre where the call recording equipment will be situated and where the digits 81 are translated by the tandem register-translator (digit 0 having been received on the tandem A digit switch) to give a routing to the desired zone centre, in this instance Birmingham. The remainder of the dialled number is then transmitted to the Birmingham zone centre, it being understood that for the purpose of impulsing over the trunk lines a suitable long distance D. C. or voice frequency dialling scheme could be utilised.

Typical incoming trunk arrangements which might be involved at the Birmingham zone centre exchange are shown in Fig. 7 and on reference to this figure it will be understood that the incoming selector ZIS on being seized under the above conditions will receive a train of impulses to raise its wipers to a level such as "0." This level gives access to a first code selector ICS so that

when the seven digit called number is transmitted from the originating tandem centre, this will be received on the register-translator RT for the purpose of setting up a connection in well-known manner to the wanted subscriber in the Birmingham register-translator area.

Since Birmingham constitutes a zone centre it may be desired to gain access from London to an exchange in any of the other groups in the Birmingham zone and in this instance it may be arranged that the London subscriber shall dial four prefix digits instead of three as in the previous case of a call to the Birmingham director area, since in this instance the community of interest between the calling and called exchanges will not be so high.

On this type of call the initial digits dialled may be for example: 082 or 083 and in each case this will be followed by a fourth digit comprising any of the digits 1-0, by means of which the desired group centre may be selected on a decimal basis.

In response to the dialling of initial digits 082 a routing will be effected to the incoming zone selector switch ZIS. The fourth and subsequent digits dialled will then be sent out from the distant tandem register-translator in untranslated form and in this particular instance it will be arranged that the fourth digit may be any of the digits 1-8 so that access can be had from levels 1-8 of the selector ZIS to eight sets of junctions to different group centres, one of which is shown at the bottom of Fig. 7.

In response to the dialling of initial digits 083 it will be arranged that the selector ZIS will be taken into use from the tandem centre and will be stepped vertically by a further routing digit to a level such as 9 which connects with second selectors ZS2. Any of the digits 1-0 may be dialled as a fourth digit in this instance, and this digit will be effective on selector ZS2 to select any one of ten sets of junctions to different group centres.

With the arrangements described selection of any one of eighteen group centres can be made and it will be appreciated that the arrangements can be readily modified to cater for a greater or less number of group centres in a zone as required.

When selection of the desired group centre is effected a group relay set GRS is taken into use thereat and thereupon associates itself with a group translator GRT over a hunter switch GRTH. The first digit or digits of the dialled number received at the group centre are directed into the group translator which in response thereto retransmits the necessary routing digits via selectors such as GS1 and GS2 to set up a connection to the wanted exchange. The last digit or digits of the number which are not required by the group translator for translation purposes will be conveniently stored in the relay set GRS on a storage and regenerative device and after the routing digits have been sent out these stored digits will be retransmitted to complete the setting up of the connection.

In the case of long distance calls originated by subscribers in non-register translator areas, a suitable prefix digit or digits will be dialled to gain access to a group centre exchange at which will be located register-translator or route-determining equipment which will receive the remainder of the dialled digits and which in response thereto will effect a routing to the desired distant exchange in the manner already

described. These group centre exchanges will also be provided with call recording equipment.

In connection with the handling of calls incoming to a group centre from other group centres in the same zone or from adjacent networks it may prove desirable to receive such calls on an incoming selector GIS. Levels 2-0 of this selector may connect up into the group centre linked numbering scheme while level 1 may extend to the group relay set GRS so that for calls extending via the group centre to exchanges outside its linked numbering scheme the translator GRT will be brought into use. Hence for calls into the group centre linked numbering scheme, where the community of interest between the calling and called exchanges is likely to be high less digits will need to be dialled than for calls outside the group centre linked numbering scheme where the community of interest is less.

Instead of dividing the country up into zones it might alternatively be divided up into regions which would generally be larger than zones and which would each have one or more regional centres in accordance with the size and telephonic density thereof. These tandem or regional centres would be provided with call recording equipment and regional register-translators and would have access to other regional centres, all long distance calls being routed therethrough.

In the case of such calls it may be arranged that a subscriber will firstly dial certain initial digits representative of the wanted region, in response to which he will be routed to his local regional centre where searching will take place for a free regional register-translator. When this is found the subscriber will receive a second dial tone and will then proceed to dial the remainder of the number into the regional register-translator which thereupon handles the setting up of the connection either directly or via the intermediary of other register translators in the distant region. In this case it may be found desirable for the sake of uniformity to keep the number of initial digits constant, particularly if the various regions can conveniently be given distinctive designations corresponding to the first three letters of the name of the region.

We claim:

1. In an automatic telephone system or the like, a plurality of interconnected networks each including a main exchange and at least one sub-exchange, a calling line in one of said sub-exchanges, means for extending a connection from said calling line to the main exchange in the same network as said one sub-exchange and for transmitting over said connection to said main exchange a code indicative of some other network, a plurality of routes over which said connection may be extended to said other network, means in said main exchange controlled by said code for choosing one of said routes and for then transmitting a variable code depending upon the route chosen to control automatic switching equipment to extend said connection to said other network over the chosen route, means in said one sub-exchange operated to determine the identity of said calling line, and means in said main exchange controlled by said last means for recording the identity of said calling line.

2. In an automatic telephone system or the like, a plurality of interconnected networks each including a main exchange and at least one sub-exchange, each of said networks having its own numbering system for identifying the lines of subscribers in that network, means for extending

a connection from a sub-exchange in any network to said main exchange in that network and for transmitting over said connection to said main exchange a code indicative of some other network, a plurality of routes over which said connection may be extended to said other network, means in said main exchange controlled by said code for choosing one of said routes and for then transmitting a variable code depending upon the route chosen to control automatic switching equipment to extend said connection to said other network over the chosen route, and apparatus in said main exchange for recording certain items of information pertaining to said connection.

3. In a system as claimed in claim 2, wherein at least one of said networks is a non-register translator network, certain trunk lines between the sub-exchange and the main exchange of said one network over which are extended all connections between said two exchanges on calls local to said one network, and other trunk lines between the sub-exchange and the main exchange of said one network over which are extended all connections on calls outgoing to another network from the sub-exchange in said one network.

4. In an automatic telephone system or the like, a register-translator network and a non-register translator network each having a central exchange and other exchanges, trunk lines connecting said central exchanges, means in the central exchange of the non-register-translator network for seizing one of said trunk lines and for transmitting thereover digits characterizing a wanted exchange in the register-translator network, control equipment in the central exchange of the register-translator network effective to receive said digits, to translate them into a routing code and to control the extension of a connection to said wanted exchange in accordance with said routing code.

5. In an automatic telephone system or the like, a plurality of interconnected networks each including a main exchange and at least one sub-exchange, a register-translator in one of said sub-exchanges effective on a call from that exchange to an exchange in a different network to control switching equipment to extend said call to the main exchange in the same network as said sub-exchange, a register-translator in said main exchange then effective to control switching equipment in said main exchange to extend said call to the desired network, and call recording equipment at said main exchange for recording certain items of information pertaining to said call.

6. In a system as claimed in claim 5, wherein certain calls from said one sub-exchange to another exchange in the same network as said one sub-exchange are extended to the main exchange of said same network over the same trunk lines as calls from said one sub-exchange to exchanges in other networks, discriminating means effective on said certain calls to render said call recording equipment ineffective.

7. In a system as claimed in claim 5, selecting means in said main exchange having access both to said second register-translator and to said call recording equipment, said selecting means operated on a call from said one sub-exchange to an exchange in a different network to render said second register-translator and said equipment effective successively.

8. In an automatic telephone system or the like, a plurality of interconnected networks each

including a plurality of main exchanges and at least one satellite exchange for each main exchange, a register-translator in one of said satellite exchanges effective on a call from that exchange to an exchange in a different network to control switching equipment to extend said call to a particular one of said main exchanges in the same network as said one satellite exchange through one or more others of said main exchanges in tandem, a register-translator in said particular main exchange then effective to control switching equipment to extend said call to the desired network, and call recording equipment at said particular main exchange for recording certain items of information pertaining to said call.

9. In a telephone or like system, a local exchange, a plurality of distant exchanges each connected to said local exchange by one or more trunk lines, a plurality of switches in said local exchange each having access to said trunk lines, each of said switches having individual registering means, other registering means common to all of said switches, means operated to seize one of said switches when it is desired to extend a call to any one of said distant exchanges, means for thereupon associating said common registering means individually with said one switch, means for transmitting to said one switch information indicative of the wanted exchange, said common registering means and said registering means individual to said one switch both effective to register said information, said common registering means effective to operate said one switch in accordance with the information registered, thereby to seize one of said trunk lines for the extension of the call to the wanted exchange, call recording equipment at said local exchange, and means controlled by said registering means individual to said one switch for transmitting said registered information to said recording equipment.

10. In a telephone system or the like, a first exchange, a plurality of second exchanges, a tandem exchange via which calls are extended from said first exchange to said second exchanges, one or more trunk lines connecting each of said second exchanges to said tandem exchange, a switch in said tandem exchange having access to said trunk lines, means operated when it is desired to extend a call from said first exchange to one of said second exchanges for completing a connection from said first exchange to said switch and for then transmitting over said connection information indicative of the wanted exchange, means associated with said switch for receiving said information and operating said switch in accordance with the information received, thereby to seize one of said trunk lines for the extension of the call to the wanted second exchange, storage means at said tandem exchange controlled by said receiving means to store said information, call recording equipment at said tandem exchange, and means controlled by said storage means for transmitting said stored information to said recording equipment.

11. In a telephone system or the like, a plurality of networks each having a central exchange and other exchanges, a calling line in one of said other exchanges, control equipment at the central exchange in the same network as said one other exchange, means for extending a connection from said calling line to said control equipment, a calling device operated to transmit over said calling line and said connection directly to

said control equipment digits characterizing a wanted exchange in a different network, said control equipment effective to translate said digits into a routing code and to transmit said code, and switching apparatus controlled by said code to extend the connection from said central exchange to said wanted exchange.

12. In a telephone system or the like, a plurality of networks each having a central exchange and other exchanges, a calling line in one of said other exchanges, control equipment at the central exchange in the same network as said one other exchange, means for extending a connection from said calling line to said control equipment, a calling device operated to transmit over said calling line and said connection directly to said control equipment digits characterizing a wanted exchange in a different network, a register in said control equipment effective to receive and store said digits, another register associated with said control equipment effective to receive said digits and transmit a translation thereof, switching apparatus effective to receive said translation and, in accordance therewith, to extend the connection from said central exchange to said wanted exchange, call recording equipment at said central exchange, and means controlled by said first register for transmitting said stored digits to said recording equipment.

13. In a telephone system, two exchanges, two subscribers' stations, means at one of said stations operated to complete a connection to one of said exchanges and to transmit thereover information for directing the extension of said connection to the other of said stations, means at said one exchange for storing said information, other means at said one exchange automatically controlled by said information to extend said connection to the other of said exchanges and to transmit thereover variable digits depending upon said information, a register translator at said other exchange effective to receive said digits and to transmit a translation thereof, switching apparatus effective to receive said translation and, in accordance therewith, to complete the connection to said other subscriber's station, call recording equipment at said one exchange, and means controlled by said second means after said completion of said connection to said other station for transmitting said stored information to said recording equipment.

14. In a telephone system, a first exchange, a plurality of second exchanges, a calling subscriber's station, means at said station operated to complete a connection to said first exchange and to transmit thereover one or more digits indicative of a particular one of said second exchanges and one or more other digits indicative of a particular wanted subscriber's station accessible to said particular second exchange, means at said first exchange for storing said digits, other means at said first exchange controlled by the digits indicative of said particular second exchange to extend said connection to said particular second exchange and to transmit thereover said digits indicative of said wanted subscriber's station, a register translator at said particular second exchange effective to receive said last digits and to transmit a translation thereof, switching apparatus effective to receive said translation and, in accordance therewith, to complete said connection to said wanted subscriber's station, call recording equipment at said first exchange, and means controlled by said second means after said completion of the connection to said wanted sub-

scriber's station for transmitting to said recording equipment variable information depending upon said stored digits.

15. A telephone system as claimed in claim 14, wherein said third means includes a numerical switch at said first exchange.

16. A telephone system as claimed in claim 14, wherein said third means includes a register translator effective to receive said digits indicative of said particular second exchange and to transmit a translation thereof, and automatic switching apparatus effective to receive said translation and, in accordance therewith, to extend said connection to said particular second exchange.

17. A telephone system as claimed in claim 14, wherein said third means includes a register translator effective to receive said digits indicative of said particular second exchange and to transmit a translation thereof, and automatic switching apparatus including a numerical switch in said first exchange effective to receive said translation and, in accordance therewith, to extend said connection to said particular second exchange.

18. A telephone system as claimed in claim 14, wherein said second exchanges are included in a zone having a zone central exchange, wherein said first exchange is included in a different zone, and wherein said third means is effective to extend said connection to said particular second exchange via said zone central exchange.

19. In a telephone system, an originating exchange, a tandem exchange, trunk lines outgoing from said tandem exchange to a plurality of distant exchanges, a numerical switch in said tandem exchange having access to said trunk lines, means for extending a connection from said originating exchange to said tandem exchange, means for then seizing said switch and operating it directly to seize a trunk line to any desired one of said distant exchanges, thereby to further extend said connection from the originating exchange over the seized trunk line, a register in said tandem exchange, means for storing in said register, before the release of said connection, certain items of information pertaining to said connection, recording equipment, means operated to initiate the release of said connection, means responsive to said operation for causing said switch to release said trunk line and also causing said register to transmit said stored items of information to said recording equipment, and means for at times extending another connection over said trunk line before said recording equipment has finished receiving the items of information stored in said register.

20. In a telephone system, an originating exchange, a terminating exchange, a tandem exchange, means for completing a connection from said originating exchange to said terminating exchange via said tandem exchange, said connection including a trunk line outgoing from said tandem exchange, a register in said tandem exchange, means for storing in said register, before the release of said connection, certain items of information pertaining to said connection, means operated to initiate the release of said connection, means responsive to said operation for releasing said trunk line and also causing said register to transmit said stored items of information, and means for at times extending another connection over said trunk line before said register has finished transmitting the items of information stored in said register.

21. A system as claimed in claim 20, wherein said register comprises a mechanical impulse storing and regenerating device.

22. In a telephone system, three exchanges, means for completing a connection from the first of said exchanges to the second and a connection from the second of said exchanges to the third, thereby to extend a call from said first exchange to said third exchange via said second exchange over said two connections in series, said first two exchanges each having a register, means effective before the termination of said call for storing in one of said registers certain items of information pertaining to said call and storing in the other of said registers certain other items of information pertaining to said call, recording equipment in said second exchange, means controlled by said register in said first exchange responsive to the termination of said call for transmitting the items of information stored in that register over said first connection to said recording equipment, means then controlled by said register in said second exchange for transmitting the items of information stored in that register to said recording equipment, and means operated responsive to the completion of said transmission of the items of information from said first exchange to said recording equipment for releasing at least a part of said connection from said first exchange to said second exchange, thereby to permit said part to be used for another call while said recording equipment still is receiving the items of information stored in the register in said second exchange.

23. A system as claimed in claim 22, wherein said register in said first exchange comprises a mechanical impulse regenerator.

24. A system as claimed in claim 22, wherein each of said registers comprises a mechanical impulse regenerator.

25. In a telephone system, three exchanges, means for completing a connection from the first of said exchanges to the second and a connection from the second of said exchanges to the third, thereby to extend a call from said first exchange to said third exchange via said second exchange over said two connections in series, said first two exchanges each having a register, means effective before the termination of said call for storing in one of said registers certain items of information pertaining to said call and storing in the other of said registers certain other items of information pertaining to said call, recording equipment in said second exchange, means controlled by said register in said first exchange responsive to the termination of said call for transmitting the items of information stored in that register over said first connection to said recording equipment, means then controlled by said register in said second exchange for transmitting the items of information stored in that register to said recording equipment, other means operated responsive to the termination of said call for releasing said connection from said second exchange to said third exchange, thereby to permit the equipment employed in that connection to be used in another call while said recording equipment still is receiving the items of information stored in either of said registers, and means operated responsive to the completion of said transmission of the items of information from said first exchange to said recording equipment for releasing at least a part of said connection from said first exchange to said second exchange, thereby to permit said part to be used

for another call while said recording equipment still is receiving the items of information stored in the register in said second exchange.

26. In a telephone system, two exchanges connected by a trunk line, a calling subscriber's line in one of said exchanges, means for extending a call from said calling subscriber's line over said trunk line to a wanted subscriber's line, a register in said one exchange, means for identifying said calling line and storing the identification thereof in said register before the termination of said call, and means controlled by said register after the termination of said call for transmitting the stored identification over said trunk line.

27. In a telephone system, two exchanges, a plurality of storage units in one of said exchanges, said one exchange also having a register translator common to said units, means for extending a connection from the other one of said exchanges to any one of said storage units, means

5 responsive to the extension of said connection to said one unit for seizing said register translator and associating it individually with that unit, means at said other exchange then operated to transmit over said connection a plurality of successive impulse trains, said register translator effective to receive said trains and to control the further extension of said connection in accordance therewith, said register translator also effective to translate said impulse trains into a code and to store said code in said one storage unit, means for then releasing said register translator, means operated subsequently to initiate the release of said connection, and means controlled by said one storage unit responsive to said operation of said release initiating means for transmitting said code.

REGINALD TAYLOR.
GEORGE THOMAS BAKER.