

Nov. 1, 1949

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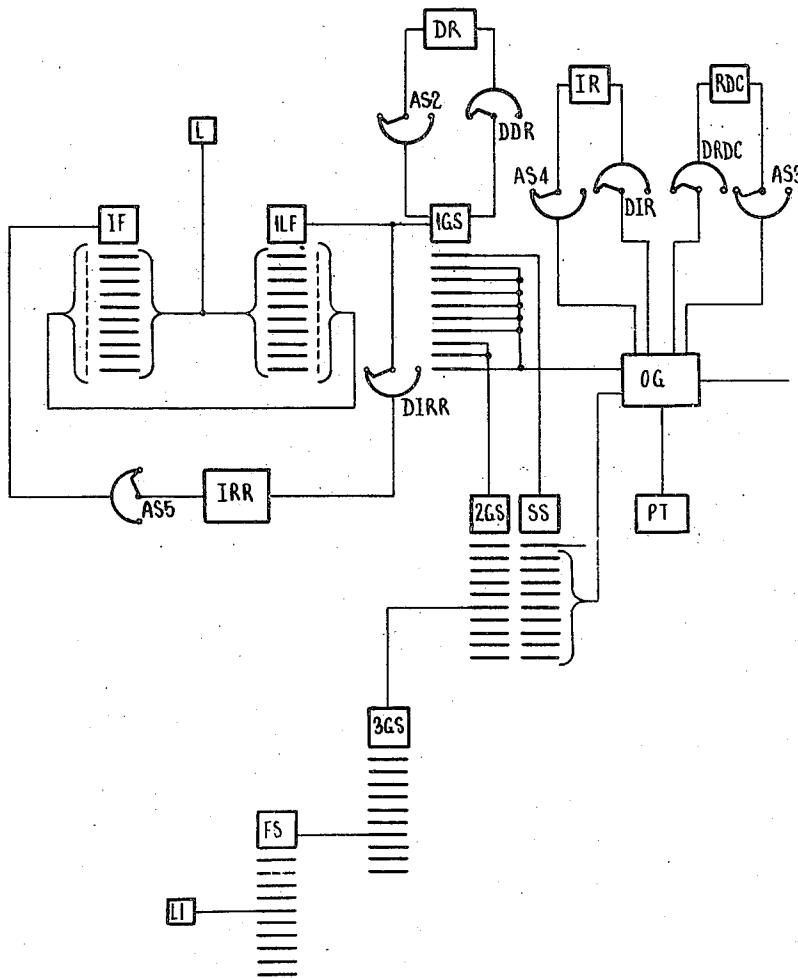
2,486,722

AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

Filed June 12, 1939

19 Sheets-Sheet 1

FIG. 1



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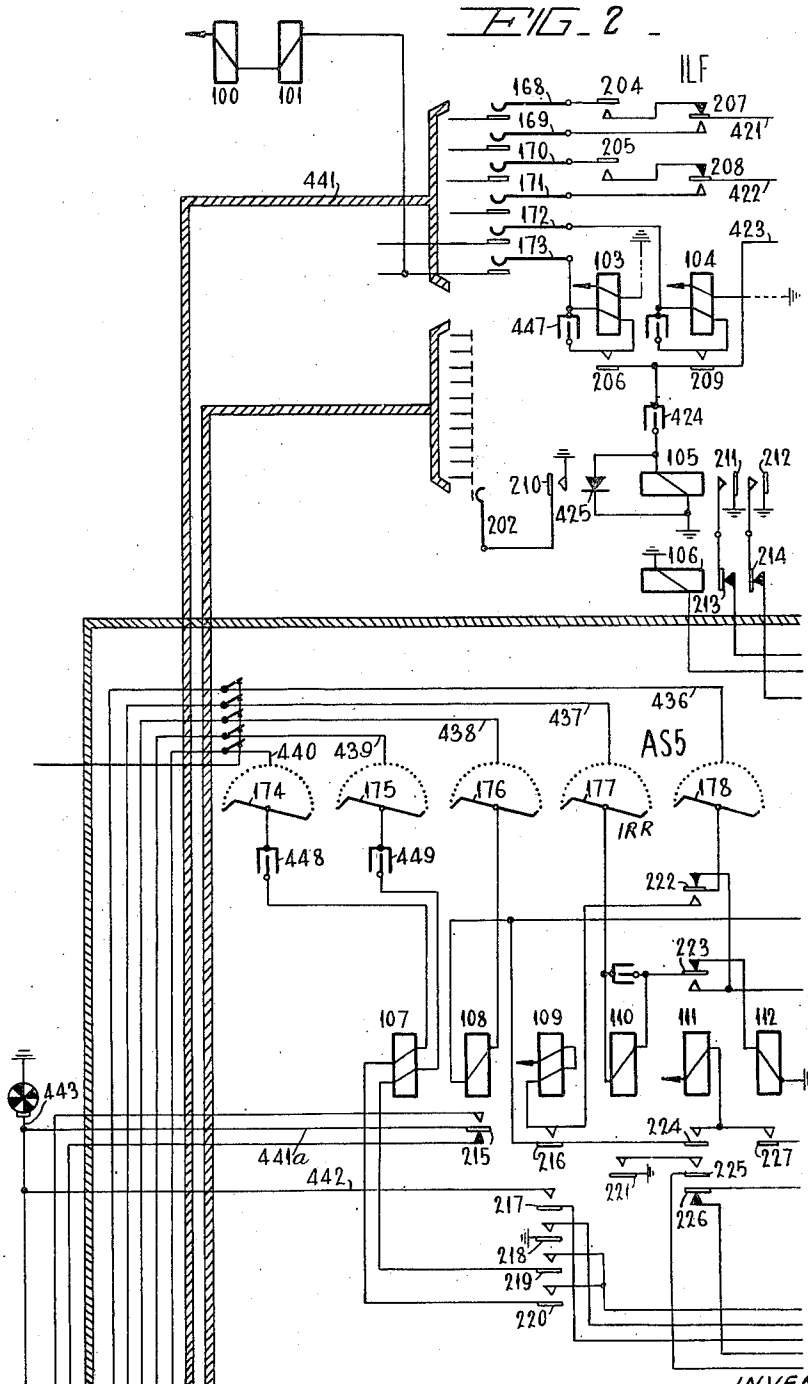
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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

Filed June 12, 1939

19 Sheets-Sheet 2



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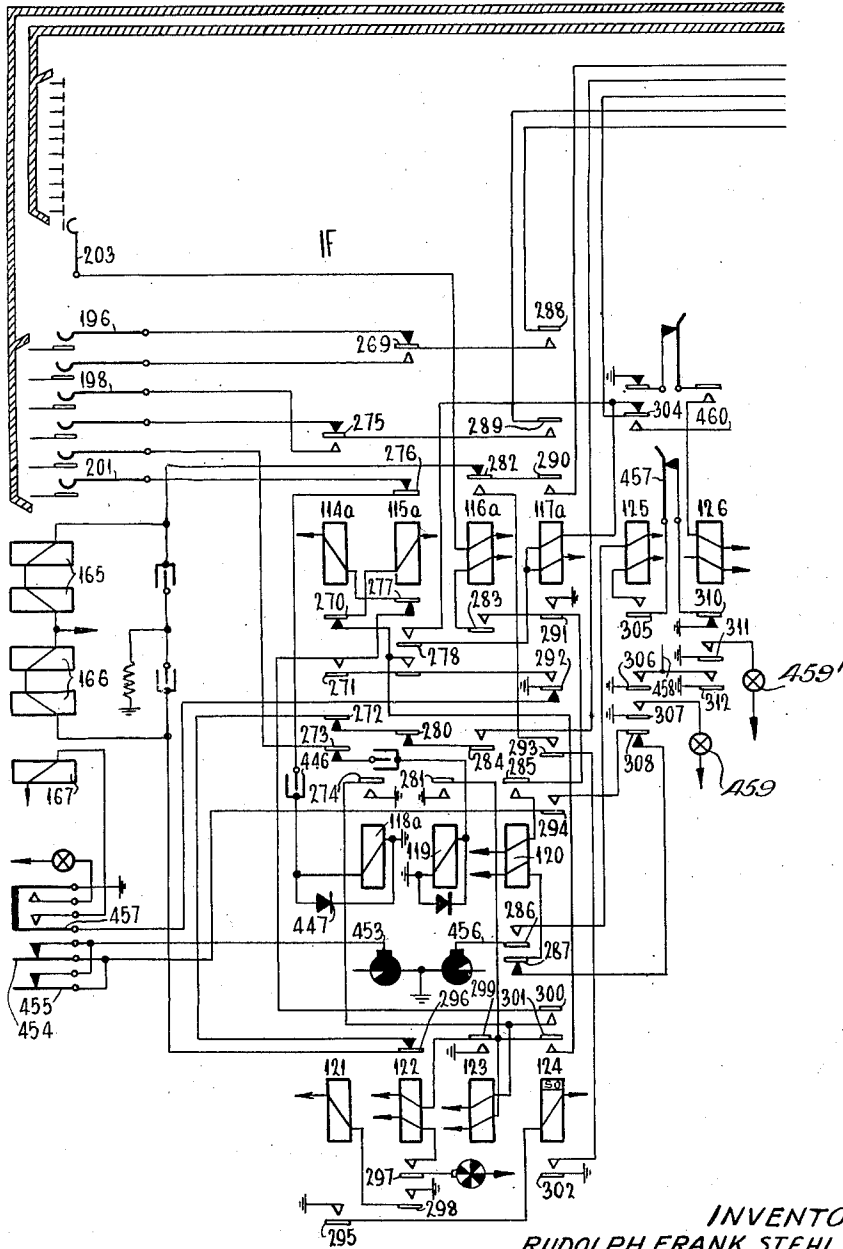
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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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FIG. 3



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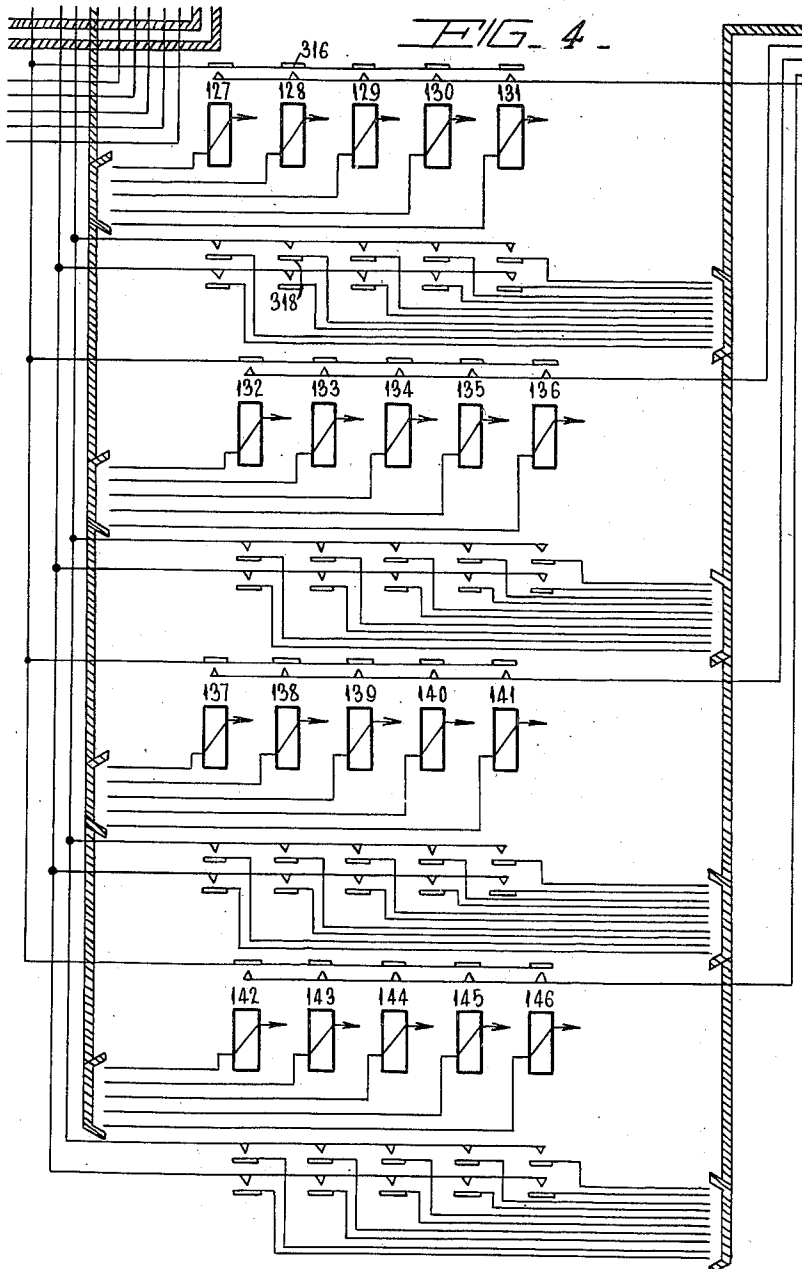
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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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19 Sheets-Sheet 4



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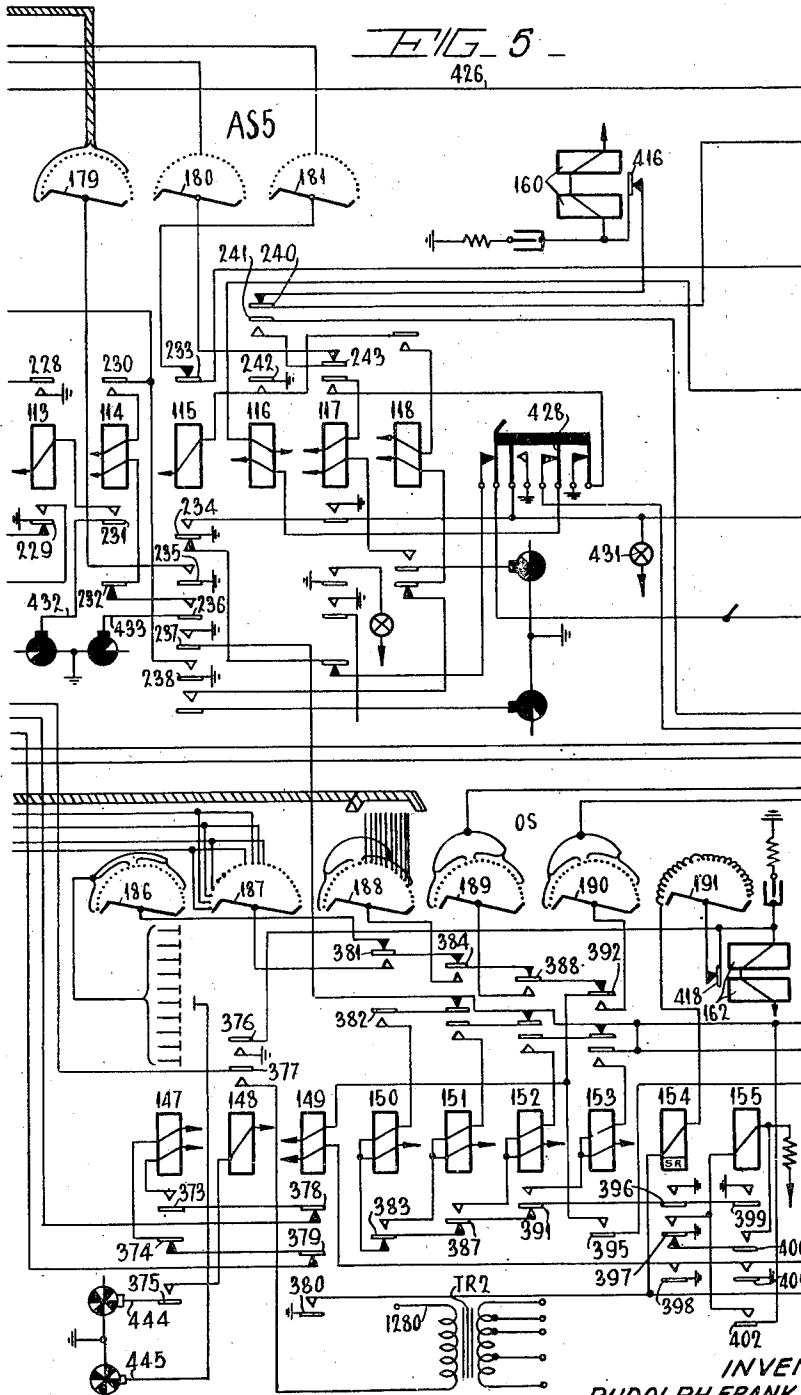
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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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19 Sheets-Sheet 5



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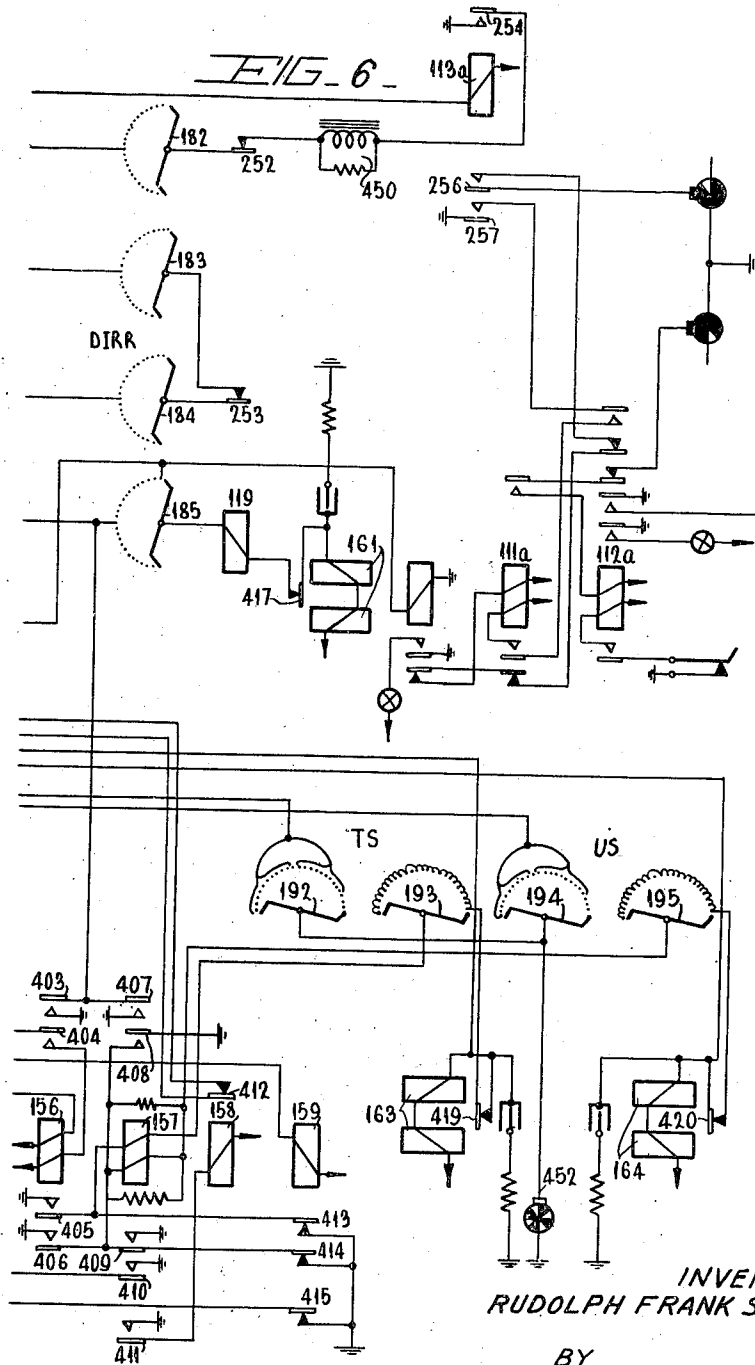
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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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19 Sheets-Sheet 6



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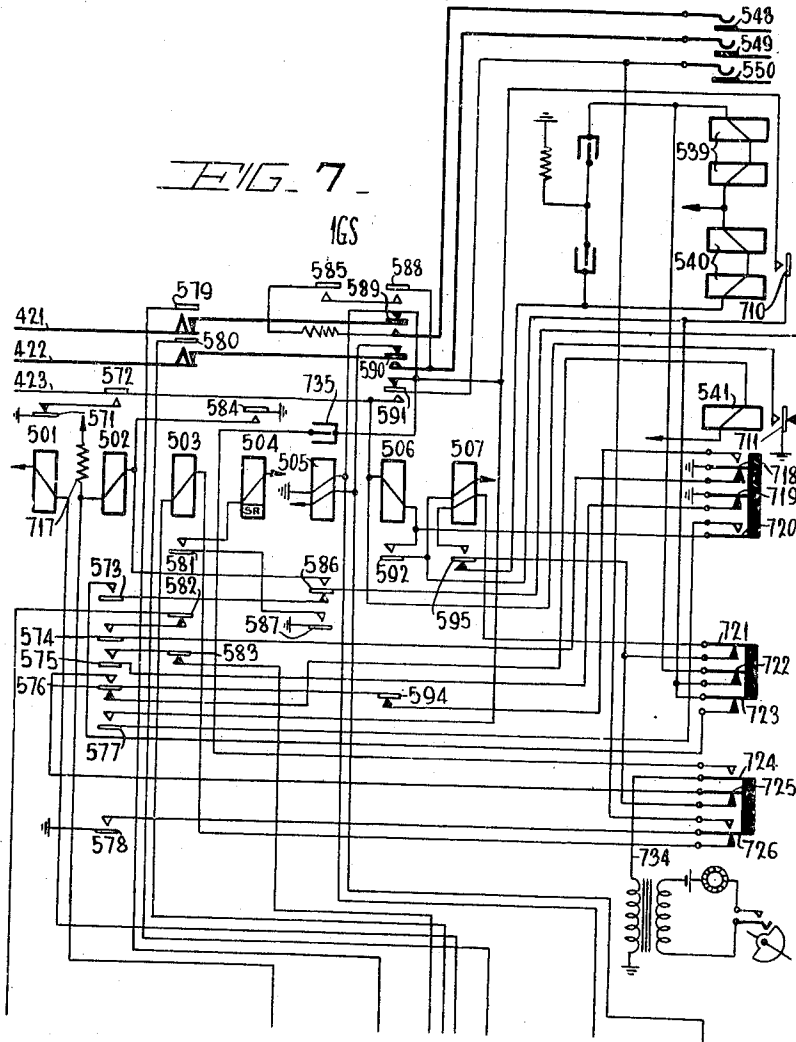
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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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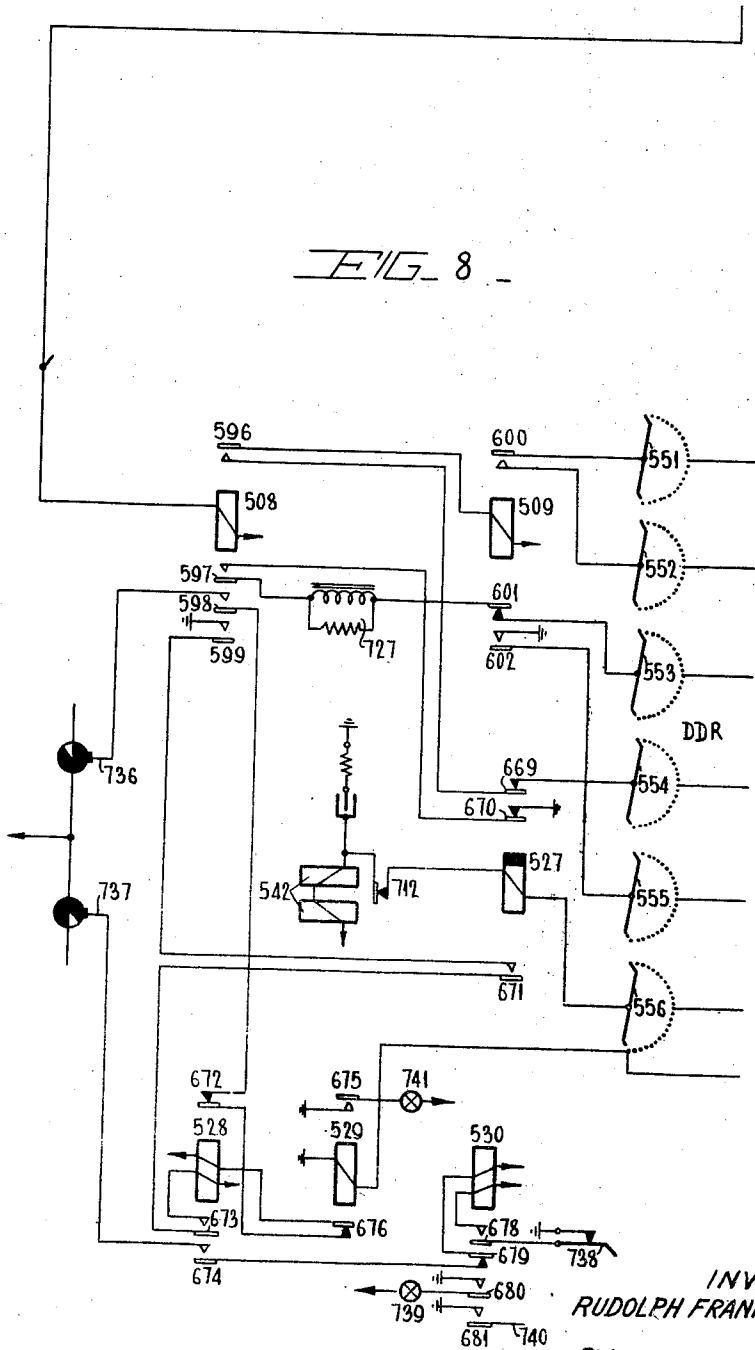


FIG. 8

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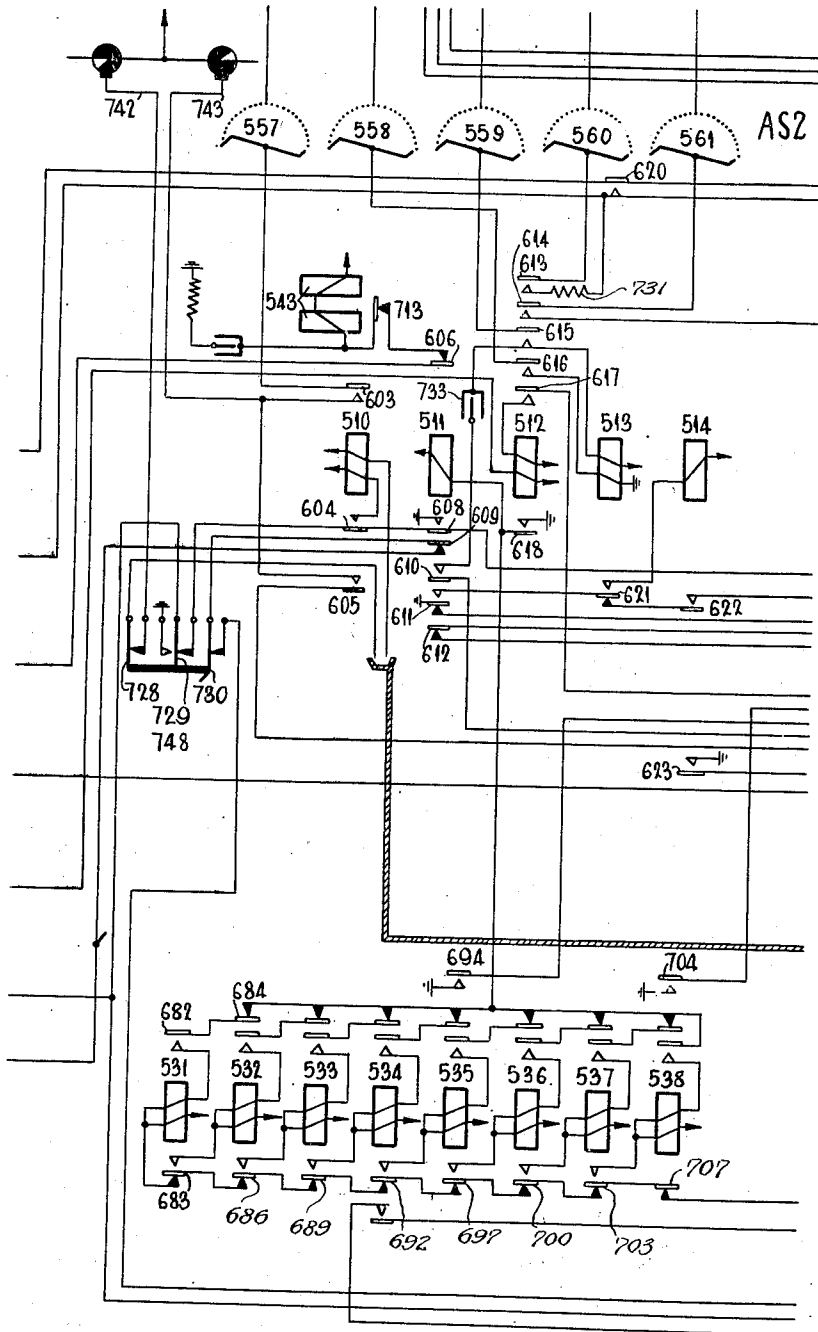
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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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FIG. 9



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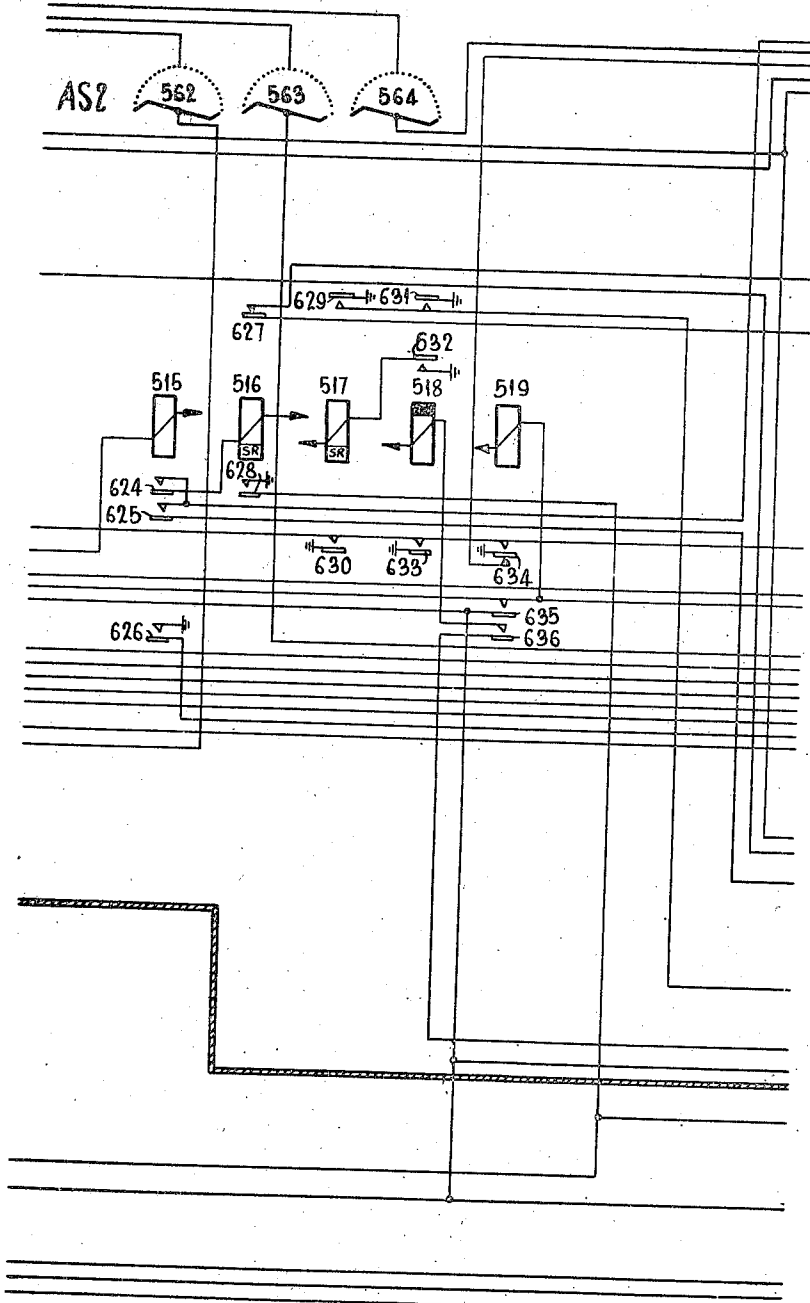
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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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FIG. 10



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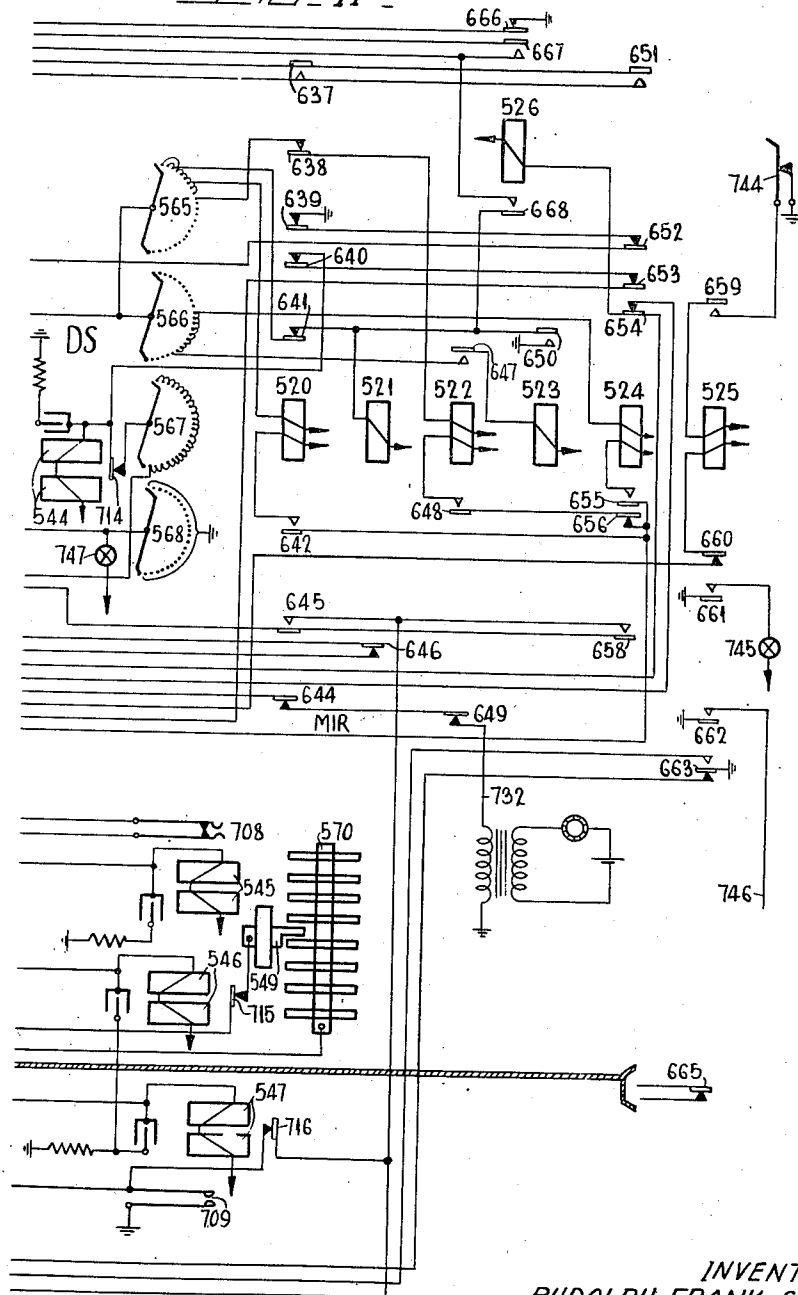
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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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FIG. 11



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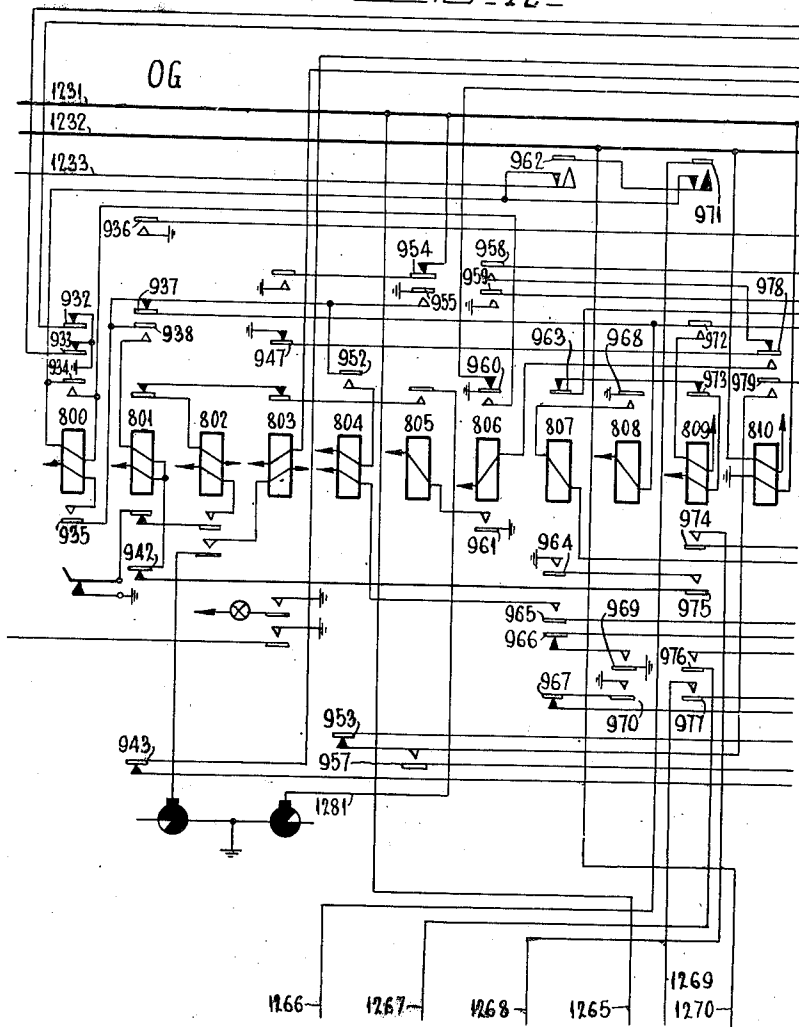
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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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FIG. 12



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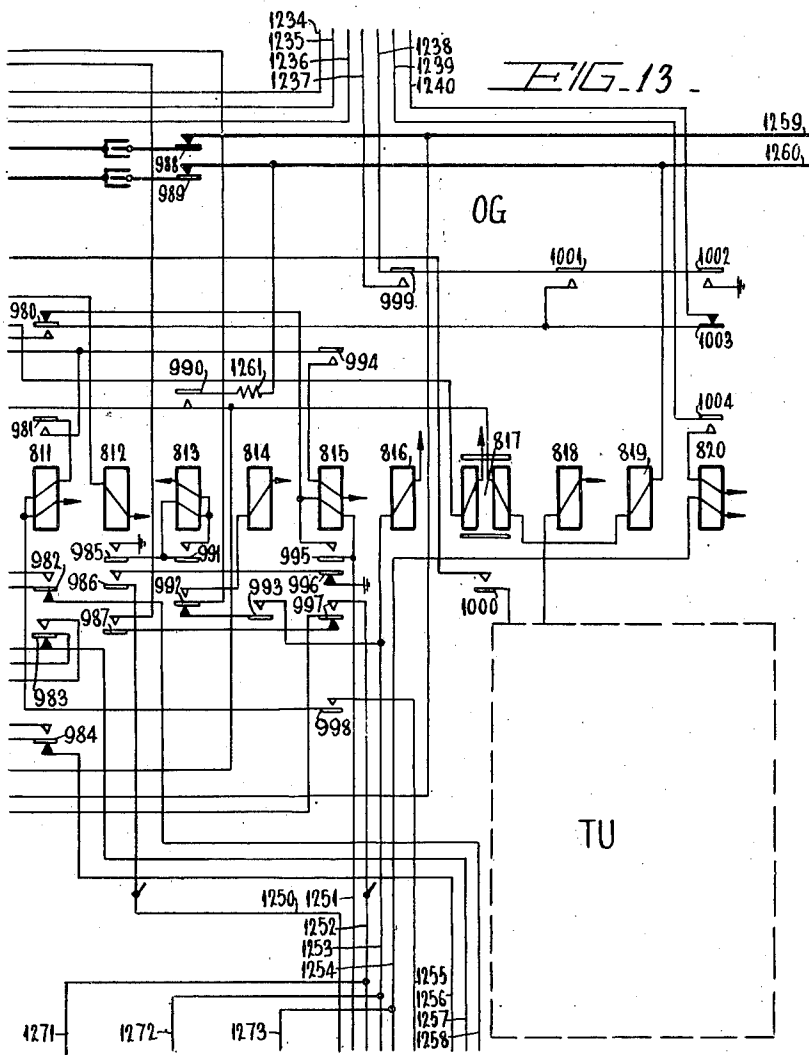
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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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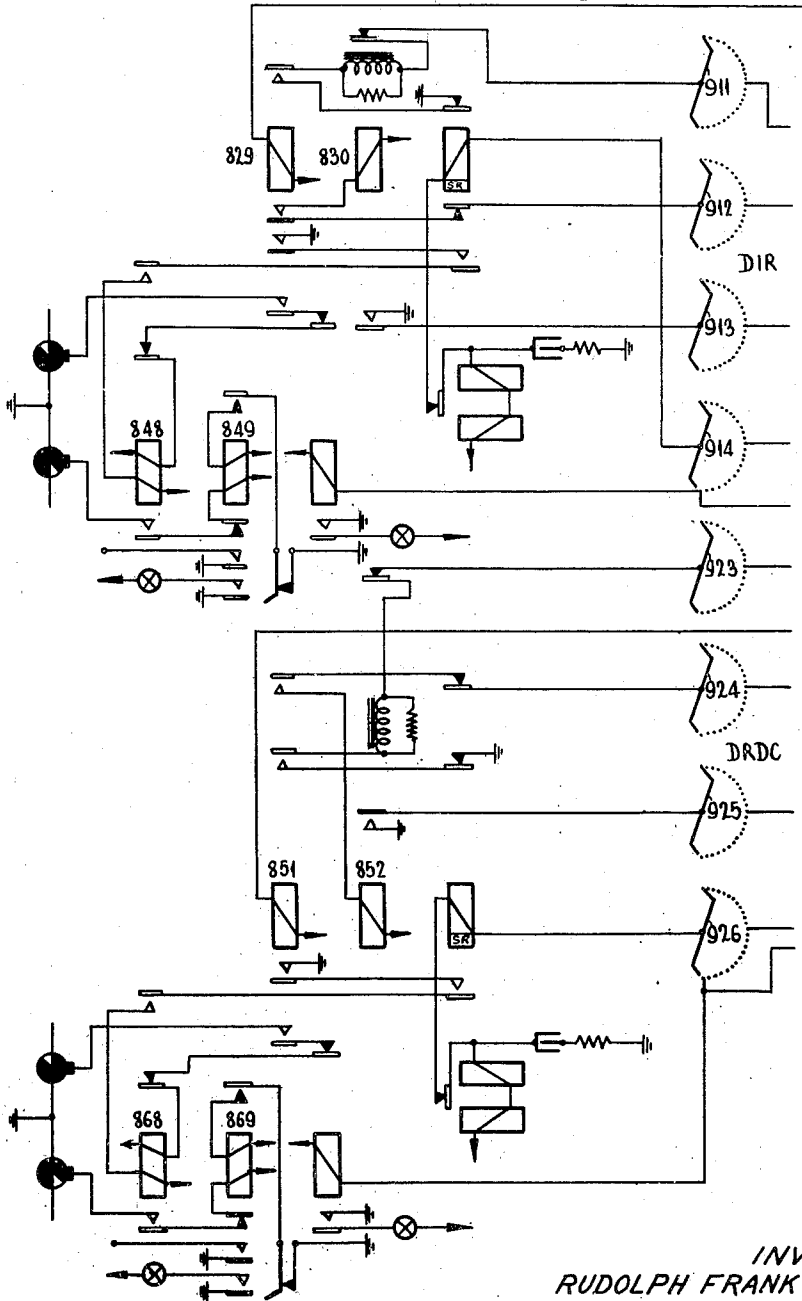
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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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FIG. 14



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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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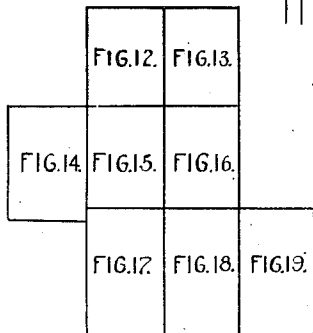
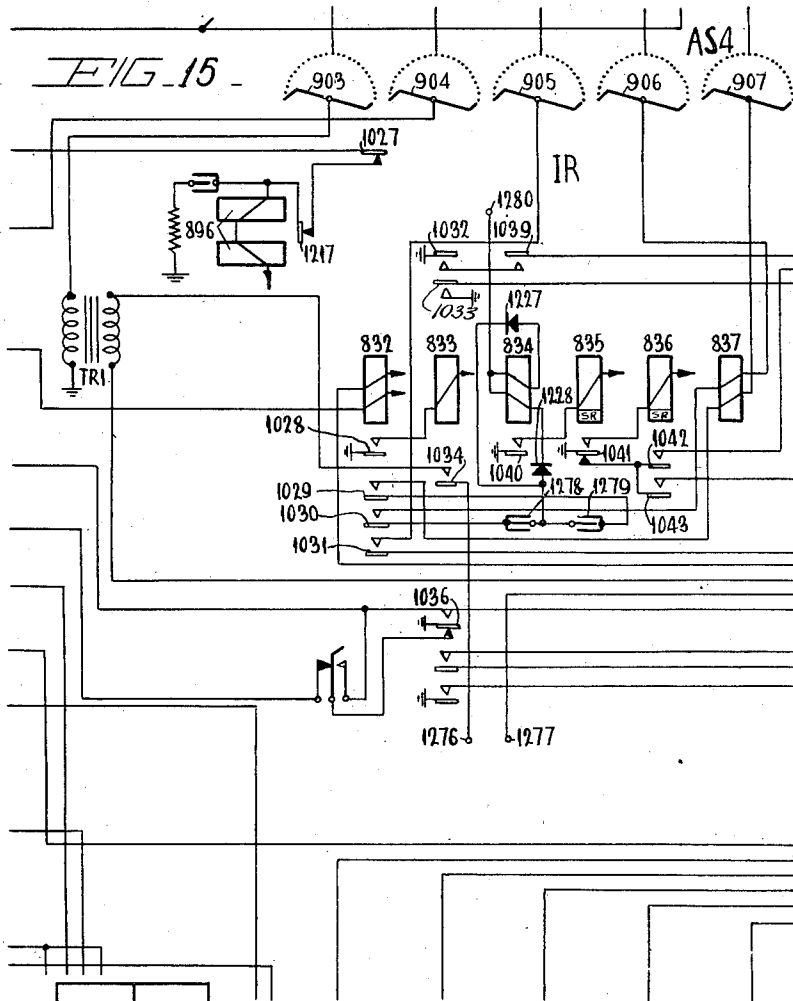


FIG. 22.

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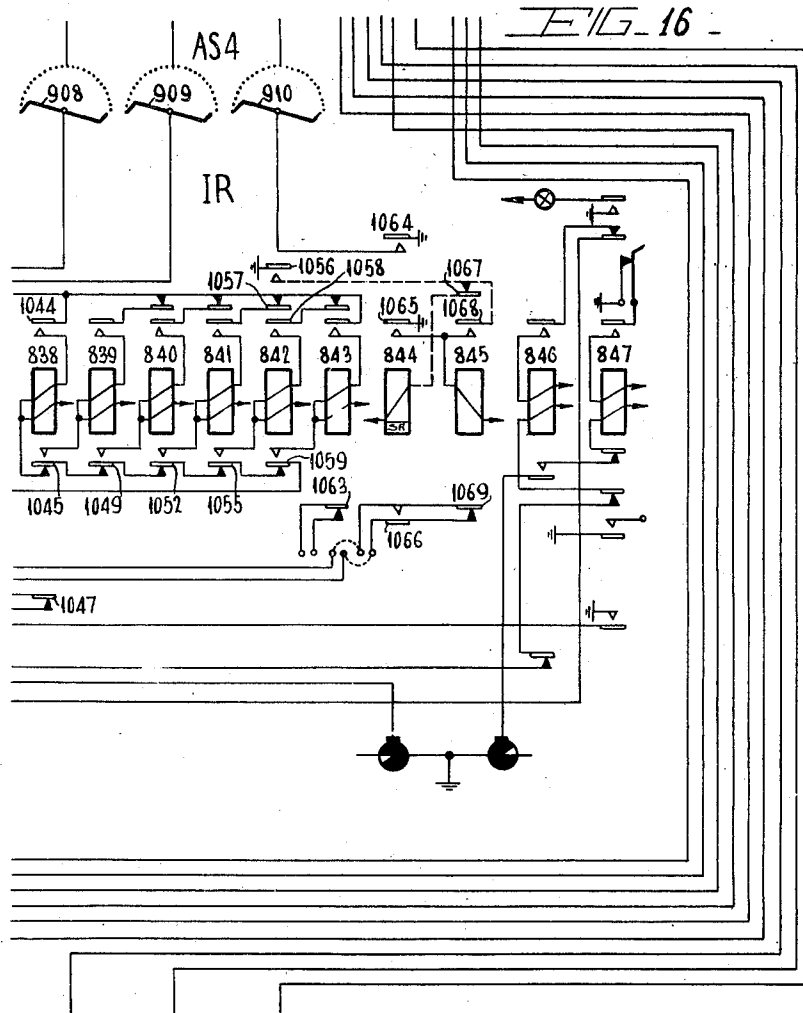
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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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19 Sheets-Sheet 16



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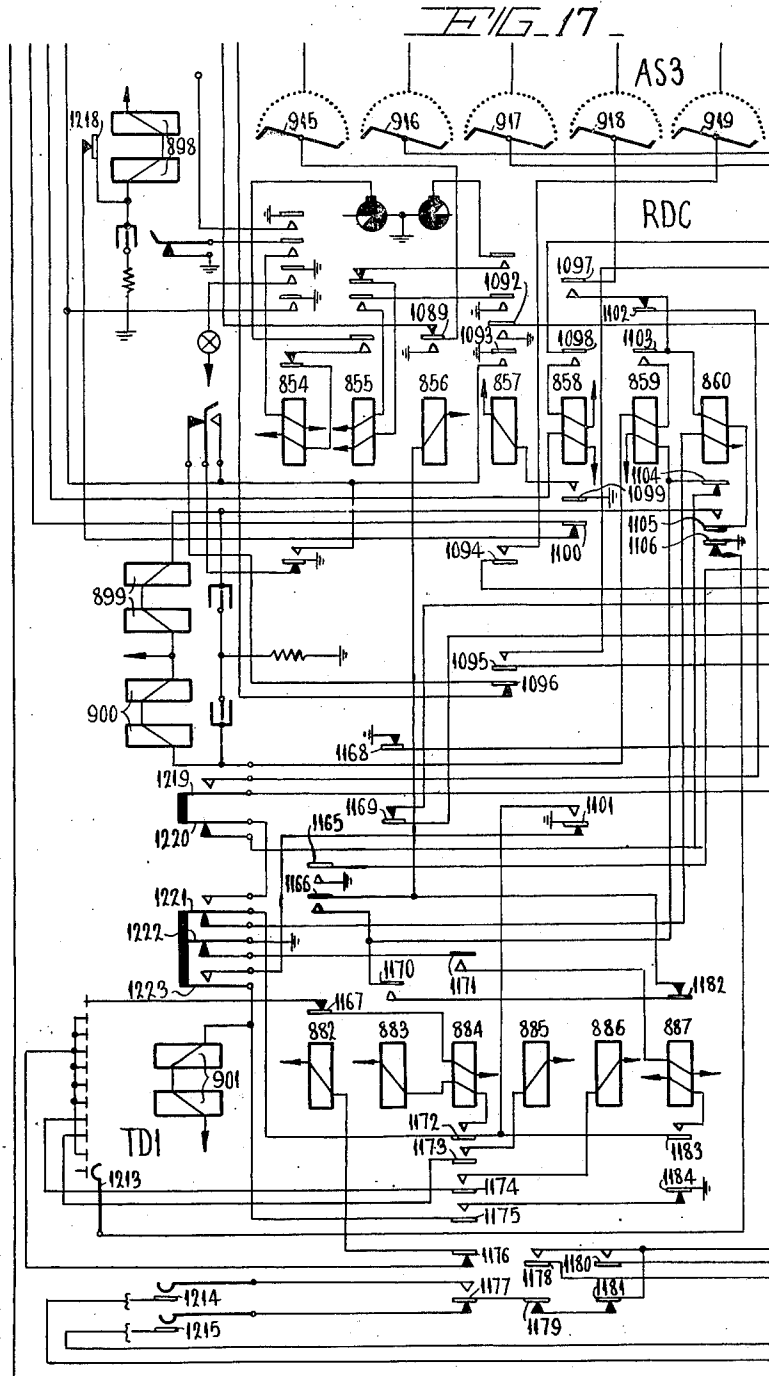
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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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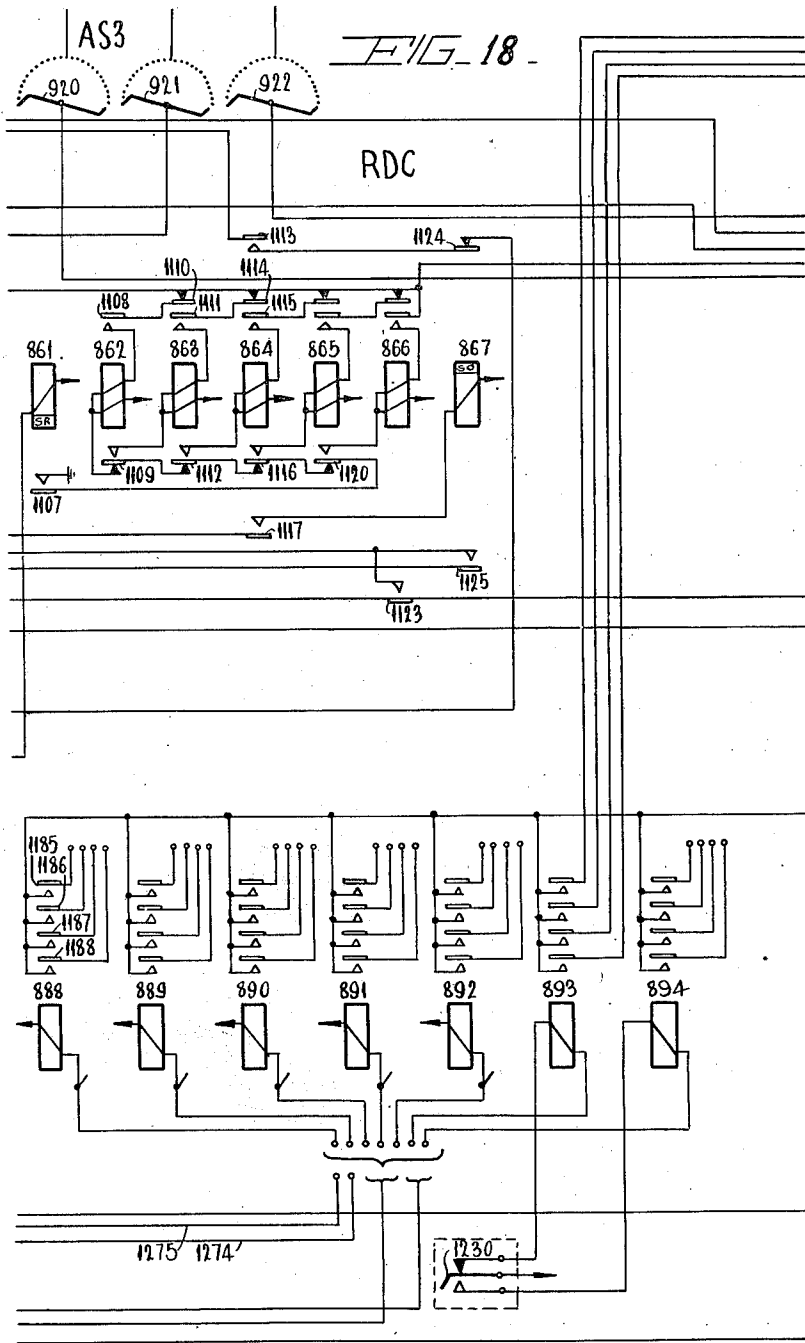
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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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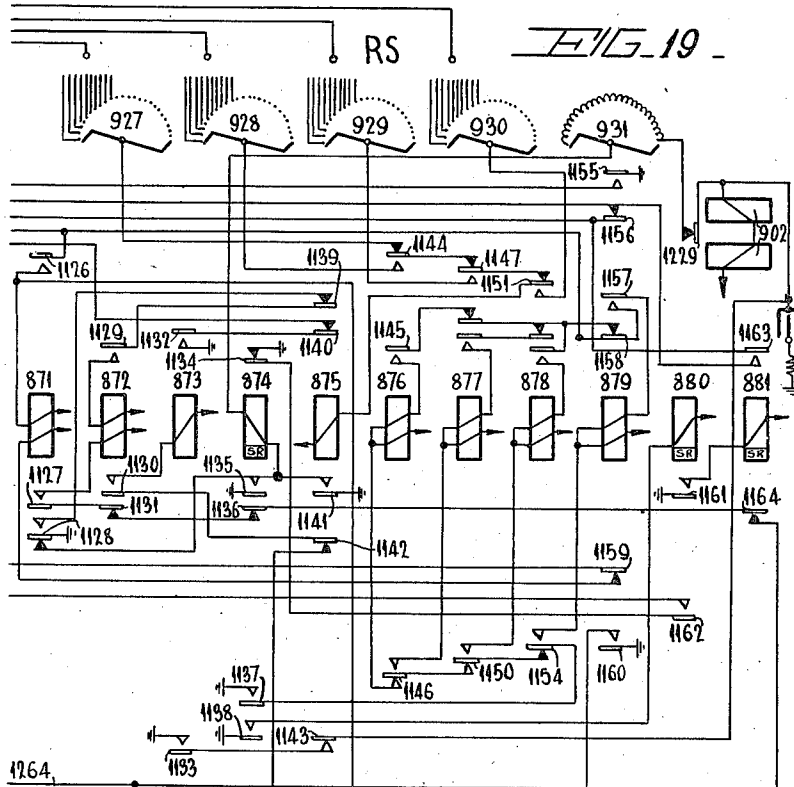


FIG. 19

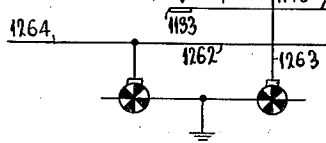


FIG. 20

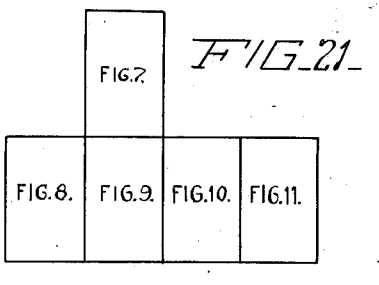


FIG. 21

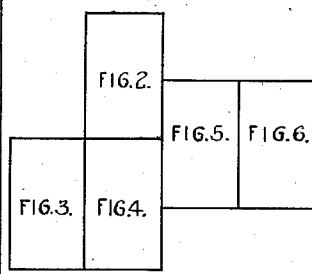


FIG. 2

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UNITED STATES PATENT OFFICE

2,486,722

AUTOMATIC TOLL-TICKETING TELEPHONE SYSTEM

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Application June 12, 1939, Serial No. 278,601
In Great Britain June 21, 1938

39 Claims. (Cl. 179—7.1)

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The present invention relates to telephone systems and while it is more particularly concerned with systems having facilities for automatically recording particulars of a call, certain features of the invention have a broader aspect.

In connection with the automatic recording of particulars of a call it will be understood that there is certain essential information which must be recorded in order that the total cost of the call may be determined and debited to the correct subscriber. This essential information comprises the calling and called parties' directory numbers, the charging rate or tariff for the connection and the duration of the connection. Other information may also be recorded but the above is the information usually necessary for accounting purposes.

The object of the invention is to provide apparatus and circuits, in an automatic telephone system, for determining the called party's number, the tariff or rate of charge to be applied to a connection, the calling party's number, and the duration of the connection, and for controlling the transmission of this information to recorder apparatus in order to make a permanent record thereof.

According to one feature of the present invention, impulses transmitted by the calling party are arranged to effect the setting up of a connection and the operation of recording equipment either directly or indirectly by means of mechanical impulse repeaters and calling party identification is effected by transmitting to the recording equipment impulse trains corresponding to the calling party's number.

It will be understood that an important feature in arrangements of this nature is the provision of a register which will record the called party's number for those calls on which a record is to be made.

According to this feature of the invention, a mechanical impulse repeater is taken into use to respond to impulses transmitted by a calling party, the mechanical impulse repeater only being made effective to repeat impulses on calls which are to be recorded.

According to a further feature of the invention, a mechanical impulse repeater is automatically taken into use to receive impulses transmitted by the calling party certain of which impulses also effect the setting up of a connection and in accordance with the position taken up by a storage device which responds to certain of the impulses transmitted by the calling party, the mechanical impulse repeater is adapted to be

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released or to retransmit all the impulses transmitted by the calling party.

According to another feature of the invention, a mechanical impulse repeater is adapted to be taken into use on the initiation of a call to receive impulses transmitted by a calling party and is adapted subsequently on a stage of the connection being reached at which recording is effected to repeat impulses, stored by it to impulse responding equipment taken into use at said stage to enable the called party's number to be recorded.

According to yet another feature of the invention, a mechanical impulse repeater is automatically taken into use to receive impulses transmitted by the calling party during the setting up of a connection and is adapted to retransmit impulses stored by it to impulse responding equipment by which the recording equipment is controlled.

According to still another feature of the invention, all the impulses transmitted by the calling party are adapted to control a mechanical impulse repeater while the initial impulses are arranged to control the setting up of a connection to a recording point independently of the mechanical impulse repeater and subsequently all the impulses stored by the mechanical impulse repeater are transmitted to the recording point for the purpose of recording the called party's number and controlling the further setting up of the connection after the said initial impulses have been received.

It is to be understood that by the expression "mechanical impulse repeater" is meant a registering and sending device in which the length of a train of outgoing impulses is determined by a mechanical marking corresponding to the received train rather than by an electrical marking as is more usual. An example of a device of this nature is found in British Patent No. 458,095.

The invention will be better understood from the following description of one embodiment taken in conjunction with the accompanying drawings in which

Fig. 1 shows the trunking layout of the system, Figs. 2-6 show the skeleton circuits of a known type of finder switch and also the detailed circuits of the equipment for determining the calling party's number. These figures should be arranged as shown in Fig. 20 to give the complete circuit.

Figs. 7-11 show the detailed circuits of the first group selector and the discriminating register which includes a mechanical impulse repeater.

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These figures should be arranged as shown in Fig. 21 to give the complete circuit.

Figs. 12-19 show the detailed circuits of the outgoing repeater, the rate or tariff-determining circuit and a repeating register for repeating the calling party's number to the ticket printing mechanism. These figures should be arranged as shown in Fig. 22 to give the complete circuit.

BRIEF DESCRIPTION OF SYSTEM

Referring first to Fig. 1 a description will be given of the general layout of the system and for this purpose it is to be understood that the telephone network is divided up a number of areas or zones, each zone having a central exchange through which all calls are trunked which are to be extended to exchanges in other zones and in general through which calls are trunked between exchanges in the same zone. The necessary recording equipment is located at the central exchange, the layout of which is shown in Fig. 1.

It is believed that Fig. 1 will best be understood by describing briefly the manner in which various types of calls are set up and in this connection it is pointed out that four types of calls are possible, a call to a subscriber of the same exchange, of an exchange within the same zone, of an exchange in another zone and finally calls for special services. The particulars of a call are automatically recorded only where the call is to be extended outside the originating exchange i. e. on calls to another exchange in the zone or to an exchange in another zone.

If the subscriber L wishes to set up a connection to a subscriber L1, the removal of his receiver causes a line finder such as 1LF to hunt for and extend the calling party's line to the associated 1st group selector 1GS in the usual way. When the 1st group selector is seized a discriminating register DR is taken into use over a preselecting distributor DDR, the register then being associated with the group selector by the operation of a hunting switch AS2. The discriminating register DR includes a discriminating switch DS (Fig. 11) and a mechanical impulse repeater MIR (Fig. 11). Dial tone is transmitted to the calling party from the discriminating register DR. The calling party now transmits the required number and it should be mentioned that all subscribers have a 5 digit directory number. The first impulse series transmitted by the calling party is effective in operating the 1st group selector 1GS to the second or third level, in operating the discriminating switch DS and the impulses are also stored on the mechanical impulse repeater. Discrimination takes place on a local call on the reception of the first impulse series or digit and the discriminating register DS is released and the mechanical impulse repeater is restored to normal without retransmission of the stored digit. The remaining digits are now transmitted over the 1st group selector 1GS to set the 2nd and 3rd group selectors 2GS and 3GS and the final selector FS. The 2nd and 3rd group selectors are of standard construction and hence are not shown in detail.

On a call to an exchange within the zone the five digit directory number of the called subscriber will again be transmitted by the calling party but in this case since the particulars of the call are to be automatically recorded, the discriminating register DR is held until the mechanical impulse repeater has retransmitted all the digits dialled. The first digit in this case

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is either 1 or 4 to 9 and the 1st group selector has access over these levels to junction lines extending to other exchanges within the zone, the connection with the junction line being effected over an outgoing repeater such as OG. It will be understood that although all the levels are shown as connected together, this has been done merely for convenience and in fact each level has access to different junction lines.

When the outgoing repeater OG together with its associated ticket printing mechanism PT has been seized, a rate or tariff-determining circuit RDC is seized over the preselecting distributor DRDC and is associated with the outgoing repeater OG over the hunting switch AS3. The first digit retransmitted by the mechanical impulse repeater, which is the first dialled by the calling party, is repeated in the outgoing repeater first to the ticket printing mechanism PT in order that the called party's number may be printed and second to the rate determining circuit where it effects the vertical setting of a two-directional switch TD1 (Fig. 17). This digit is however not retransmitted over the outgoing junction line since as regards the setting up of the connection it has already been employed in setting the 1st group selector 1GS. The second digit retransmitted by the mechanical impulse repeater will again be repeated to the ticket printing mechanism and to the rate-determining circuit where it effects the rotary setting of the two-directional switch. In addition this digit is also repeated over the junction line to set the incoming selector switch (not shown) at the distant exchange.

Now the first two digits in a subscriber's directory number are indicative of the exchange to which he belongs and hence it will be seen that the setting of the two-directional switch TD1 enables the rate at which the call is to be charged to be determined. This rate is registered in the rate determining circuit for subsequent transmission to the ticket printing machine PT.

The remaining digits retransmitted by the mechanical impulse repeater are repeated to the ticket printing machine and over the junction line to complete the connection at the distant exchange. When all the dialled digits have been transmitted to the ticket printing machine, the impulse series representing the rate which is stored in the rate determining circuit are transmitted to the ticket printing machine. When this operation has been completed the rate determining circuit is restored to normal and disconnected from the outgoing repeater.

It is now necessary to determine the calling party's number and transfer it to the ticket printing machine. For this purpose when the ticket printing machine is ready to receive impulses representing the calling party's number, an identification repeater IR is seized over a preselecting distributor DIR and is connected to the outgoing repeater OG over the hunting switch AS4. The identification repeater causes a 400 cycle current to be transmitted back over the private conductor to the line finder 1LF. This causes an identification repeater register IRR to be seized over a preselecting distributor DIRR. The identification repeater register is then associated with the line finder 1LF over the hunting switch AS5, the latter switch also serving to connect up the appropriate identification finder switch IF, the arrangements being such that the position to which the switch AS5 is set serves to determine the thousands digit of the calling party's number and also the 200 line group which includes it, since

the line finders employed are 200 point switches. The identification finder is now operated automatically to find the calling line as indicated by the presence of 400 cycle current on the private conductor thereby determining the tens and units digits of the number. Further the hundreds digit is determined by the wiper set of the identification finder which is employed. It will be understood that the ten-thousand digit in an exchange having a capacity of less than 10,000 lines as in the present case will be the same for all subscribers and hence can be determined by a permanent marking in the identification repeater register. The calling party's number is thus completely stored in the identification repeater register and the next operation is to secure the transmission to the ticket printing machine. This is effected by alternating current impulses of 50 cycles transmitted from the identification repeater register over a simplex circuit comprising the line conductors of the identification finder IF, the line finder ILF, the 1st group selector IGS, the outgoing repeater OG and thence to the identification repeater where the impulses are repeated to the ticket printing machine PT. On the termination of impulse transmission the identification repeater register IRR and the identification finder IF are restored to normal together with the identification repeater IR.

On the reply of the called party a timing arrangement is set in operation in the outgoing repeater and serves to repeat impulses to the ticket printing machine after the lapse of predetermined intervals of time. All the necessary information for accounting purposes is thus transmitted to the printing machine to enable a ticket or strip to be printed. Alternatively of course the record could be punched on a card or strip.

Returning now to a consideration of the various types of calls which may be set up, the two remaining types are calls for special services and calls to exchanges in other zones. In both these types of call the first digit dialled is "0" and hence discrimination must take place on the second digit. Calls for special services however are of three digits only and are set up within the local exchange while on a call to an exchange in another zone an eight digit number must be dialled, the second and third digits representing the required zone while the remaining five of course represent the directory number of the call subscriber.

Considering first a call for a special service, the first digit raises the 1st group selector to the tenth level over which it hunts for an idle selector such as SS. This digit is also stored on the mechanical impulse repeater and operates the discriminating switch. The second digit is now received and is also "0." This is again stored on the mechanical impulse repeater and operates the discriminating switch. A call of this nature is not recorded automatically and hence the mechanical impulse repeater is restored and the discriminating register released. The second digit also effects the setting of the selector SS to the 10th level while the third digit sets the selector in a rotary direction in accordance with the service required. An operator may possibly deal with the call and if it is chargeable make out a ticket in the usual way.

A call to an exchange in another zone is however recorded automatically and hence the mechanical impulse repeater and the discriminating register are not released. The second digit dialled serves to set the selector SS to any of

levels 1 to 9 over which access is had to junction lines extending to different zones over outgoing repeaters. The determination of the rate and the calling party's number is effected in a similar manner to that described above but it should be noted that since the first two digits dialled are employed in setting the switches IGS and SS, the third and subsequent impulses only will be transmitted over the junction line.

It will be noted from the above brief description that the setting up of the connection and the recording of the various particulars are effected without any translation of the impulses dialled by the calling party. Further a record is made only of calls which are to be extended to other exchanges and the mechanical impulse repeater is only effective on such calls.

A further point to be noted is in connection with the outgoing repeaters. These repeaters are identical irrespective of which junction line they are associated and the rate determining circuits and the identification repeaters are provided in common to all the outgoing repeaters. The rate determining circuits are so arranged that the correct sequence of operations occurs whether a five digit or an eight digit number is dialled.

DETAILED DESCRIPTION OF SYSTEM

With this brief description of the system, a detailed description will now be given of the various circuits.

The calling party's line is extended by the operation of the finder switch ILF (Fig. 2) over wipers 168, 170 and 173 or 169, 171 and 172 according to which of the switching relays 163 and 164 operate, and thence over armatures 204, 205 and 206 or 207, 208 or 209 and conductors 421, 422 and 423 to the first group selector IGS. On the seizure of the first group selector earth is fed back over conductor 423, locking contact and locking winding of the operated switch relay to operate the calling party's cut-off relay 101 and to maintain the calling party's line relay 100 operated.

The circuits of the line finder ILF are not shown in detail since its method of operation is well-known and reference may be made for instance to British Specification No. 376,265 for further details.

DETAILED DESCRIPTION OF FIRST GROUP SELECTOR AND DISCRIMINATING REGISTER

When the line finder ILF finds the calling line, the calling party's loop circuit is extended over conductors 421 and 422 (Figs. 2 and 7), make-before-break contacts associated with armatures 579 and 580, armatures 589 and 590, upper and lower windings of relay 505 of the first group selector IGS to earth and battery respectively. Relay 505 operates and at armature 586 closes the following circuit for relay 502: earth at contact 711 of the release magnet 541, armature 586, relay 502 to battery over resistance 717. Relay 502 in operating at armature 572 extends earth from armature 571 over conductor 423; at armature 574 it extends earth from vertical off-normal springs 718, over armatures 582 to relay 508 of the distributor switch DDR, to battery, at armature 575 it extends earth from vertical off-normal springs 719 over armatures 575 and 583, to the appropriate contact in the bank associated with wiper 562 of the switch AS2; and at armature 578 it marks the corresponding contact in the bank associated with wiper 563 of the switch

AS2 over 11th step springs 726 and the winding of relay 503.

The distributor switch DDR is a preselecting switch and assuming that the switch AS2 has been preselected, the following self-interrupting circuit is completed for magnet 543 of the switch AS2 on the operation of relay 508: earth at armature 670 (Fig. 8), armature 597, resistance and inductance combination 727, armature 601, wiper 553, and bank contact, armature 606, interrupter contacts 712, magnet 543 to battery. The wipers of the switch AS2 are thus rotated until they reach the contacts which have been marked by the first group selector IGS as pointed out above. When this occurs, earth is extended from vertical off-normal springs 719, armatures 575, 583, bank contact and wiper 562 of the switch AS2, bank contact and wiper 554 of the switch DDR, armature 669, 596, winding of relay 509 to battery. Relay 509 in operating at armature 601 opens the energising circuit to magnet 543 and at armature 602 extends earth over wiper 555 and bank contact, lower winding of relay 512 to battery. Relay 512 in operating at armature 613 and 614 closes a holding circuit for relay 505 to avoid any possibility of this releasing when relay 503 operates and before relay 513 operates as described later. This holding circuit extends from earth over the upper winding of relay 505, bank contact and wiper 560, armature 613, resistance 731, bank contact and wiper 552, armature 600, wiper 551 and bank contact, impulsing contacts 708, armature 614, wiper 561 and bank contact, lower winding of relay 505 to battery. In addition relay 512 at armature 617 locks over armature 646, wiper 563 and bank contact and thence to earth as described above, relay 503 in the first group selector energising in this locking circuit. Furthermore, at armature 618 relay 512 completes an obvious energising circuit for relay 511. Relay 503 in operating at armature 581 closes a circuit from earth at armature 587 for slow-to-release relay 504. This relay operates and at armature 584 closes an energising circuit for relay 502 which is independent of relay 505. In addition relay 503 at armatures 579 and 580 extends the calling party's loop circuit over bank contacts and wiper 558 and 559 of the switch AS2, armatures 616 and 615, lower and upper windings of relay 513 to earth and battery, respectively. Relay 513 operates and closes armature 620 so that relay 505 in the first group selector is now maintained energised over: earth, upper winding of relay 505, bank contact and wiper 560, armature 613, resistance 731, armature 620, impulsing spring 708 of the mechanical impulse repeater MIR, armature 614, wiper 561 and bank contact, lower winding of relay 505 to battery. In addition relay 513 at armature 621 closes a circuit for relay 514 from earth at armature 611. Further relay 512 at armature 618 closes an obvious circuit for relay 511 which operates (as previously described) and at armature 609 removes one of the multiple earths from contact 25 of the bank associated with wiper 556 of the distributor switch and at armature 608 extends earth over springs 723, bank contact and wiper 556, relay 527, interrupter contacts 712, magnet 542 to battery. The wipers of the distributor switch DDR are thus stepped in search of another idle register and relay 509 releases on the first step. Relay 527 remains energised while the switch is stepping over contacts of busy registers in order to maintain the circuit over wiper 554 open at armature 669

and the circuit over wiper 553 open at armature 670 to prevent the distributor switch from interfering with the operation of a busy register which might occur if relay 508 had not released.

Dial tone is also transmitted to the calling subscriber on the operation of relay 512 over the following circuit: dial tone source 732, armatures 649, 644, 610, condenser 733, upper winding of relay 513 to battery and thence over the calling party's loop circuit by induction over the lower winding of the relay.

A. Calling subscriber dials

The impulses transmitted by the calling party are effective on relay 513 which at armature 620 repeats them to relay 505 to cause the vertical movement of the first group selector IGS and at armature 621; repeats them to relay 515 to cause the operation of the mechanical impulse repeater and for other purposes. The circuit for repeating the impulses to the vertical magnet 539 under the control of relay 505 extends as follows: earth at release magnet contacts 711, armatures 586, 573, rotary off-normal springs 723 and 722, magnet 539 to battery. In addition a parallel branch of this circuit extends over rotary off-normal springs 723, relay 507 to battery. Relay 507 operates and at armature 595 closes a short-circuit around its lower winding from rotary off-normal springs 721 to make the relay slow-to-release so that it is maintained operated during the vertical movement and at armature 595 holds open the circuit of the rotary magnet 540 which is prepared at vertical off-normal springs 718 in their operated position on the first vertical step of the switch. The circuit for repeating the impulses to relay 515 extends from earth at armature 611, armatures 621, 622, relay 515 to battery. Relay 515 in operating at armature 624 closes the following circuit for slow-to-release relay 516: earth at armature 606 (Fig. 11), armature 624, relay 516 to battery. This earth is also extended over armature 625, receiving magnet 545 of the mechanical impulse repeater MIR to battery. Finally at armature 626 earth is extended over armatures 653, 640, magnet 544 of the switch DS to battery. The normal position of the switch DS is the 25th contact and as soon as the wipers are stepped off this contact, earth is extended over wiper 568 to light the lamp 747 and also over the appropriate contact in the bank associated with wiper 556 to afford a further guarding earth. Relay 516 operates in the above-traced circuit and remains operated for the duration of the impulse series. At armature 628 relay 516 extends earth in parallel to the marking magnet 547 of the mechanical impulse repeater and over armatures 707, 703, 700, 697, 692, 689, 686, and 683 to battery over relay 531. Relay 531 is a two-step relay and at this stage closes its "X" armature 682. It operates fully and locks over both windings, armatures 682 and 684 to earth at armature 618 when relay 516 releases at the end of the impulse series. Further at armature 683 it prepares a point in the circuit for energising relay 532 on the reception of the second impulse series.

Thus the impulses dialled by the calling party have the effect first to cause the operation of the first group selector under the control of relay 505 and second to cause the impulses to be stored in the mechanical impulse repeater MIR and on the switch DS under the control of relay 515.

On the termination of the first series of impulses, relay 507 in the first group selector IGS

releases to initiate the hunting movement of the switch over the selected level. Thus at armature 595, relay 507 closes the following circuit for the rotary magnet 540; earth at vertical off-normal springs 718 in their operated position, armatures 594, 576, 11th step springs 725, armature 595, winding of rotary magnet 540 to battery. The rotary magnet energises and the wipers are stepped on to the first set of contacts in the level. In addition the energisation of the rotary magnet 540 closes the following circuit for relay 506 in series with relay 507: earth at armature 571, armature 572, winding of relay 506, vertical off-normal springs 720, armature 577, rotary magnet springs 710, upper winding of relay 507 to battery. If the outlet on to which the wipers are stepped is busy, earth will be fed back over the guarding conductor and wiper 550, armatures 591, 577, vertical off-normal contacts 720 to short-circuit the winding of relay 506. Relay 507 however operates from this earth over rotary magnet springs 710 and its upper winding and at armature 595 opens the above-traced circuit for the rotary magnet. The magnet thus releases and in turn opens the circuit for relay 507 which releases whereupon the circuit is again closed for the rotary magnet. This interaction continues until the wipers of the group selector reach an idle outlet. In this case no earth potential is extended over 550 so that relays 506 and 507 operate in series on the closure of rotary magnet springs 710. Relay 506 in operating at armature 592 closes a locking circuit for itself in series with the upper winding of relay 507 to earth at armature 571 which locking circuit is independent of the springs 710. At armature 594, relay 506 opens the energising circuit to the rotary magnet 540; at armature 591 it extends earth from armature 571 over armature 572 to wiper 550 to guard the seized outlet, at armature 588 it completes an impulsing loop to wipers 548 and 549 which loop is controlled by armature 585 of relay 505 to enable subsequent impulses transmitted by the mechanical impulse repeater to be repeated if necessary by relay 505 over the selected outlet.

If the first group selector fails to find an idle outlet, it is rotated on to the 11th contacts in the bank where the 11th step springs are operated. In this case the energising circuit for the rotary magnet is opened at springs 725 while at spring 726 and the resting contact the holding circuit for relays 503 in the group selector and 512 in the register is opened and both these relays release. In addition at spring 726 and the operated contact earth is extended from armature 578 to wiper 550 to operate an overflow meter if desired. Relay 512 in releasing causes the register to be restored to normal in a manner to be pointed out subsequently while the release of relay 503 at armatures 579 and 580 completes a circuit for transmitting busy tone to the calling party from busy tone source 734, springs 724 of the 11th step springs, condenser 735 to earth over the upper winding of relay 505 and thence by induction over the lower winding of the relay to the calling subscriber. In addition relay 503 in releasing at armature 581 opens the circuit for relay 504 which releases, relay 582 being now held over the operated armature 585 of relay 505. When the calling party replaces his receiver relay 505 releases and at armature 586 opens the circuit for relay 502. Relay 502 in releasing at armature 572 removes earth from conductor 423 to enable the finder switch to release; at armature 578 it removes earth from

wiper 550 and at armature 576 it closes the following circuit for the release magnet 541: earth at off-normal springs 718 in their operated position, armatures 594, 576, winding of release magnet 541 to battery. The release magnet energises to restore the switch wipers to normal. The first group selector is now available for use on another call.

The above operations of the selector IGS of finding an idle outlet in the selected level take place on all calls and the subsequent operations depend upon the destination of the call. In this connection it is pointed out that the number of digits called by the calling subscriber may be three, five or eight.

On five digit calls discrimination between a local call and one to another exchange within the zone takes place on the first digit while discrimination between 3 and 8 digit calls takes place on the second digit. Discrimination is effected over wipers 565 and 566 of the switch DS which it will be remembered was set by the first series of impulses dialled by the calling party. It will of course be understood that for a more complex system it may be necessary to postpone discrimination until after the second digit has been received and this could be arranged by suitable alterations in the circuits controlled and over wipers 565 and 566 of the switch DS.

B. Call to subscriber in originating exchange

It will first be assumed that the calling party wishes to set up a connection to a subscriber in his own exchange. Now as shown in Fig. 1 the first group selector has access to second local group selectors over levels 2, and 3 so that the first digit dialled by the calling party will be one of these two. Assuming that 3 is dialled then when relay 516 (Fig. 10) releases at the end of the first impulse series, the marking magnet 547 is de-energised at armature 628 and in addition the following circuit is closed: earth at armature 639 (Fig. 11), armatures 652, 627, wiper 565 on contact 3, armature 641, winding of relay 521 to battery. Relay 521 in operating at armature 646 opens the locking circuit of relays 512 and 503 thereby releasing both relays. Relay 512 at armatures 613 and 614 opens the loop circuit extending to relay 505 of the first group selector from the mechanical impulse repeater; at armatures 615 and 616 it opens the impulsing loop extending to relay 513 from the subscriber's instrument and at armature 618 it opens the circuit of relay 511 and removes the holding earth from the counting relays 531 to 538. Relay 505 in the first group selector now releases and does not again operate since subsequent impulses are transmitted straight through the first group selector. Relay 513 also releases and at armature 621 opens the circuit for relay 514. Relay 511 in releasing at armature 610 opens the dial tone circuit and at armature 612 closes the following circuit for relay 519: earth at off-normal springs 709 of the mechanical impulse repeater, armature 612, winding of relay 519 to battery. Relay 519 in operating at armature 634 extends earth to the contact associated with the register in the bank of wiper 556 of the distributor switch. This is necessary since relay 511 on releasing removes guarding earth from this contact at armature 608 and the register must be busied until the mechanical impulse repeater and the switch DS are restored to normal. Further at armature 611 and its resting

contact, relay 511 extends earth over the bank multiplying associated with wiper 567 of the switch DS, interrupter contacts 714, winding of magnet 544 to battery. The wipers of the switch DS are thus restored to their normal or 25th contacts where the circuit for the magnet is opened.

Returning now to the operation of relay 519, this relay at armature 635 closes a locking circuit for itself dependent only on off-normal springs 709; and at armature 636 closes a circuit from earth at off-normal springs 709, disc 570 of the mechanical impulse repeater, pin-resetting plunger 543, magnet springs 715, armature 636, winding of relay 518. Relay 518 is a slow-to-operate relay and on operating at armature 633 extends a further guarding earth to the bank associated with wiper 556 of the distributor switch DDR; at armature 632 it closes an obvious circuit for slow-to-release relay 517 and at armature 631 it extends earth to the winding of the transmitting magnet 546. Relay 517 in operating at armature 629 maintains the circuit of magnet 546 and at armature 630 provides a further guarding earth for the register. The magnet 546 in operating causes the pin-resetting plunger 549 to restore the pin in the disc 570 and also opens the circuit of relay 518 which releases and in turn causes the release of relay 517. The magnet 546 is now de-energised whereupon the pin-setting plunger 549 is removed from the path of the movable pins in the disc 570 and the disc rotates to enable the impulsing springs 708 of the repeater to be operated in accordance with the first digit dialled. This digit is of course not effective in setting up the connection but the motion of the disc 570 must take place in order to restore the repeater to a normal condition. The mechanical details of this mechanism are described in detail in the previously mentioned British Patent 458,095.

The disc is stopped when the pin-resetting plunger contacts with the next displaced pin at which time the off-normal contacts 709 are opened and relay 519 releases. Guarding earth is now removed at armature 634 and the register is available for setting up another call.

The remaining impulse series are now transmitted straight through the first group selector to complete the connection in the usual way.

C. Call to another exchange in same zone

It will now be assumed that the calling party wishes to set up a connection to a subscriber at another exchange within the same zone. A five digit number is again dialled but the first digit in this case will be either 1, 4, 5, 6, 7, 8 or 9. In this case on the release of relay 516 at the termination of the first series of impulses, earth will be extended from armature 639 over armatures 652, 627, wiper 565, upper winding of relay 520 to battery. Relay 520 in operating at armature 642 closes a locking circuit for itself from earth at armature 623; at armature 639 it opens a point in its own energising circuit; at armature 640 it opens a point in the impulse repeating circuit to the magnet 544 of the switch DS; at armature 644 it disconnects dial tone and at armature 645 it closes a circuit from earth at off-normal springs 709, marking magnet contacts 716 (closed at the end of the first digit), armature 645, winding of relay 519 to battery. Relay 519 operates followed by relays 517 and 518 to initiate transmission of the first impulse series from the mechanical impulse repeater as described previously. In this case however the impulse series is repeated by relay 505 of the first group selector over the

selected outlet, relays 517 and 518 serving to introduce the necessary delay between the impulse series. The circuit for controlling relay 505 extends as follows: earth, upper winding of relay 505, bank contact and wiper 560, armature 613, resistance 731, armature 637, impulsing springs 708 of the mechanical impulse repeater MIR, armature 614, wiper 561 and bank contact, lower winding of relay 505 to battery. It will, of course, be understood that while the first series of impulses are being transmitted, the calling party will normally be dialling the remaining digits. These will be received by relay 513 and repeated to the receiving magnet 545 as previously described. The operation and release of relay 513, however, has no effect on relay 505 at this time since its impulse repeating armature 620 is short-circuited by armature 637 of relay 520.

The mechanical impulse repeater MIR continues to receive and to retransmit the digits dialled by the calling subscriber in the well-known manner. It is to be noted that relay 531, as previously described, operates fully when the first digit has been received. At the termination of the second digit relay 532 operates and opens the circuit for relay 531 which releases and so on for relays 533, 534 and 535. Relay 535 in operating at armature 654 extends earth over armature 654, winding of relay 526 to battery. Relay 526 in operating at armature 656 removes earth from the energizing circuit of relay 516 and the receiving magnet 545 and at armature 667 it prepares a point in a circuit which is closed on the release of relay 519 when the mechanical impulse repeater is restored to normal. This circuit extends as follows: earth at armature 634 (Fig. 10), armature 667, wiper 564 and bank contact, winding of relay 501 to battery. Relay 501 in operating at armature 571 removes earth from conductor 423 for a purpose which will be explained later. In addition a parallel branch of this circuit extends over armature 668 of relay 526, winding of relay 521 to battery. Relay 521 operates to cause the release of the register as previously described.

D. Special service call

Consideration will now be given to the case of a "special service" call. Such a call is set up as previously described by dialling a three digit number, the first two digits of which are "0." At the termination of the first digit and on the release of relay 516, a circuit is extended from earth at armature 639, armatures 652, and 627, wiper 565 on contact 10, armature 638, upper winding of relay 522 to battery. Relay 522 in operating at armature 648 closes a locking circuit for itself from earth at armature 623, armatures 658, and 648, lower winding of relay 522 to battery and at armature 649, relay 522 disconnects the dial tone source 732.

The next digit dialled is now received on the mechanical impulse repeater and this digit is also stored by the switch DS. At the termination of the second digit and on the release of relay 516, earth is extended from armature 639, armatures 652, and 627, wiper 566 on contact 20, armature 647, winding of relay 523 to battery. Relay 523 in operating at armature 650 closes an obvious circuit for relay 521 which operates to cause the release of the switch DS and the mechanical impulse repeater when the second digit has been retransmitted. The third digit, as in the case of the local call previously described, is transmitted straight through the first group selector and

thence over the selected outlet to set the selector SS.

E. Call to an exchange in another zone

On a call for an exchange to another zone the operation of the register is the same as that on a "special service" call up to the reception of the first digit. In this case however the second digit may be any of the digits 1 to 9 and consequently on the release of relay 516 earth is extended over wiper 566 and bank contact, winding of relay 524 to battery. Relay 524 in operating closes a locking circuit for itself to earth at armature 623 over armature 655; at armature 656 it opens the locking-circuit for relay 522 which thereupon releases; at armature 651 it short-circuits armature 620 of relay 513 (Fig. 9) to prevent the further operation of relay 513 from affecting relay 505; at armature 652 it disconnects the earth applied over wipers 565 and 566 of the switch DS; at armature 653 it opens the circuit to the magnet 544 of the switch DS and finally at armature 658 it closes a circuit for relay 519 to initiate the transmitting operation of the mechanical impulse repeater.

The impulses continue to be received and retransmitted and the counting relays 531 to 538 are operated to count the number of impulse series received. On the termination of the 8th series relay 538 in operating at armature 704 extends earth to the winding of relay 526. Relay 526 operates with the same result as previously described. The register is again made available to set up another connection.

It will be noted that armature 620 of relay 513 and the impulsing springs 708 of the mechanical impulse repeater are arranged in series. The reason for this is that at different stages during the setting up of a connection relay 505 is controlled either by armature 620 or the impulsing springs. Thus on a call within the zone the first digit dialled by the calling party is repeated at armature 620 to relay 505 to control the positioning of the first group selector while the further operation of relay 505 to repeat the digits stored in the mechanical impulse repeater is controlled by impulsing springs 708 which become effective only after the first digit has been received. Similarly on a call outside the zone the first two digits dialled by the calling party are repeated at armature 620 to relay 505 to control the positioning of the first group selector and the selector switch SS while the further operation of relay 505 is again controlled by impulsing springs 708 which in this case only become effective after the first two digits have been received. It will be understood, however, when relay 505 is controlled by springs 708, relay 513 will still be receiving dialled impulses and hence provision must be made for rendering impulsing armature 620 ineffective. This is done by armature 637 of relay 520 which short-circuits armature 620 on a zone call after the first digit has been received and by armature 651 of relay 524 which short-circuits armature 620 on an inter-zone call after the first two digits have been received.

F. Alarm and supervisory circuit

A description will now be given of the various alarm and supervisory arrangements with which the circuit is provided and in the first place consideration will be given to the distributor switch DDR. This switch as previously pointed out is a preselecting switch and hence when relay 508 is operated, the register associated with the particu-

lar contacts on which it is set, is immediately seized. Trouble may however arise due to the switch wipers sticking on a particular set of contacts. Magnet 542 will continue to operate over the self-interrupting circuit and relay 527 will thus remain operated. Now when relay 508 is energised, at armature 598 it connects conductor 736 to the upper winding of relay 528 over armatures 672 and 676. Earth pulses are transmitted every 3 seconds over conductor 736 and serve to energise relay 528. Relay 528 in operating at its "X" armature 673 locks over armature 671 to earth at armature 599 and at armature 674 connects conductor 737 to the upper winding of relay 530 over armature 679. Earth pulses are also transmitted over conductor 737 with a 3 second delay with respect to those over conductor 736. Therefore if relay 527 is still operated 3 seconds after relay 528 operates relay 530 operates and locks at armature 678 to earth at the key 738. At armature 680 the lamp 739 is lighted and at armature 681 earth is extended over conductor 740 to give an audible alarm. The alarm condition is removed by opening key 738.

In addition if at any time all the registers become busy, earth is disconnected from contact 25 of the bank associated with wiper 556 so that when the wipers reach this contact during the preselecting movement, relay 529 which was previously short-circuited by this earth connection operates together with relay 527 in series with the magnet 542. The magnet does not however operate in this circuit. Relay 529 in operating at armature 675 closes a circuit for lighting the lamp 741 and at armature 676 opens the circuit from conductor 736 to the upper winding of relay 528 to prevent the time alarm from becoming effective. As soon as a register becomes available, earth will again be applied to contact 25, relay 529 will be short-circuited and the magnet 542 will operate to cause the distributor switch to hunt for the idle register. If while the preselecting movement is held up relay 508 operates the setting up of the connection will be delayed until a register becomes available.

With regard to the alarm arrangements for the register it is to be noted that earth impulses are transmitted every 2 minutes over conductor 742, springs 728, armature 665, upper winding of relay 510 to battery. If the register is in use, relay 510 in operating closes a locking circuit for itself from earth at armature 608, armature 604, lower winding of the relay to battery. Two minutes after this earth pulse, a similar pulse is transmitted over conductor 743. If the register is operating normally it should by this time have been released but assuming a fault has occurred which either prevents the operation of the register or prohibits its release, the second earth pulse will be extended first over armature 603, wiper 557 and bank contact to shunt relay 502 in the first group selector and second over armatures 605 and 660, lower winding of relay 525 to battery.

Relay 502 releases when it is short-circuited and at armature 572 removes earth from conductor 423 to allow the operated switching relay of the finder switch to release and thereby open the loop circuit to the first group selector and restore the finder switch to normal. Further the opening of armature 572 opens the circuit of relays 506 and 507 if the first group selector has completed or is completing its hunting movement. As a result of the opening of the loop circuit relay 505 releases followed by relay 504 and as a result of the release of relay 506 a circuit is

completed for the release magnet 541 which operates to restore the switch to normal. The circuit for the release magnet extends from earth at vertical off-normal springs 718, armatures 594, 576, windings of release magnet 541 to battery. Relay 503 also releases on the opening of armature 578 and the first group selector is thus returned to normal. If the calling party's receiver is still removed a further finder-selector link is associated therewith and the setting up of the connection proceeds as before. Relay 525 of the register in operating at armature 659 locks to earth at the key 744; at armature 661 it closes a circuit for the lamp 745 and at armature 662 it extends earth over conductor 746 to cause an audible alarm to be given and at armature 663 and its resting contact it removes one of the multiple earths connected over springs 730 and armature 609, if relay 511 is not operated, to contact 25 of the bank associated with wiper 550 (Fig. 8) and at its operated contact it extends earth to the appropriate contact in the same bank to mark the register as busy. The alarm condition is removed by opening the key 744 but the register may be again busied if desired by operating the key 748 to bring springs 729 into their operated position.

DETAILED DESCRIPTION OF OUTGOING REPEATER AND ASSOCIATED CIRCUITS

When the connection is extended to the outgoing repeater OG (Figs. 12 and 13) over the 1st group selector (Fig. 7) or 1st and 2nd group selectors (Fig. 1) and conductors 1231 and 1232, relay 810 operates and at armature 978 closes a circuit from earth at armature 947 for relay 806. Relay 806 in operating at armature 961 closes an obvious circuit for relay 805; at armature 960 and its resting contact removes earth from conductor 1236 to give an indication to the ticket printer that the associated repeater has been seized. The ticket printing mechanism is associated with the outgoing repeater over conductors 1234—1240, the ticket printer itself not being described in detail since it is of known construction. In addition relay 806 at armature 960 and its operated contact extends earth over the winding of relay 800, make-before-break contacts associated with armature 962 to the guarding conductor 1233. This earth however performs no function at the moment since the group selector IGS is held and maintains earth on the guarding conductor at armature 572 (Fig. 7). In addition relay 806 at armature 959 closes a circuit for the polarising winding of relay 817. Relay 805 in operating at armature 955 closes a circuit over armature 937 for relay 808. Relay 808 in operating at armature 970 extends earth over armatures 967, 984, conductor 1256, winding of relay 851 to battery. Relay 851 is the start relay for the rate-determining circuit distributor DRDC and on its operation it causes a preselected rate-determining circuit such as RDC to be seized and operated to find the outgoing repeater OG. The operation of this distributor as well as that of the identification register IR is precisely similar to that of the distributor DDR (Fig. 8) and since the operation of the latter distributor has been fully described it is believed that the operation of the two distributors DRDC and DIR will be easily understood without further detailed description.

When relay 851 operates, earth is extended over wiper 923 and bank contact, armature 1100,

interrupter contacts 1218, windings of magnet 898 to battery. The wipers of the switch AS3 are thereupon rotated in search of the outgoing repeater OG. When the wipers of the switch AS3 reach the contacts associated with the outgoing repeater, the following circuit is closed: earth at armature 969 (Fig. 12), armatures 966, 983, conductor 1257, bank contact and wiper 915, armature 1089, bank contact and wiper 924 to battery over the winding of relay 852. Relay 852 operates and removes earth from wiper 923 to prevent further rotation of the wipers of the switch AS3 and also extends earth over wiper 925 to battery over the lower winding of relay 858. Relay 858 in operating locks in series with relay 807 in the outgoing repeater over the following circuit: earth at armature 968, winding of relay 807, armature 982, conductor 1258, bank contact and wiper 916, armatures 1156 and 1098, upper winding of relay 859 to battery. In addition relay 858 at armature 1099 closes a circuit for relay 857 and at armature 1101 closes a circuit over vertical off-normal springs 1221 for the lower winding of relay 858. Relay 857 in operating at armature 1093 extends earth over bank contact and wiper 928 to cause the distributor to hunt for the next idle rate-determining circuit and at armature 1096 it removes one of the multiple earth connections from contact 25 of the bank associated with wiper 926.

A. Determining rate of call to another exchange in same zone

The circuits remain in this condition until impulses are received from the mechanical impulse repeater and it will be assumed that the connection is to be set up to another exchange in the same zone. In this case five impulse series will be transmitted by the repeater and will be received in the outgoing repeater OG by relay 810 which at armature 978 repeats the impulses to relay 812 over the following circuit: earth at armature 947, armatures 978, 958, winding of relay 812 to battery. Relay 812 in operating at armature 995 closes a circuit for relay 813; at armature 986 it repeats the impulses to the rate-determining circuit as follows: earth at armature 996, armature 986, conductor 1250, bank contact and wiper 918, armature 1097, upper winding of relay 860, armature 1105, winding of vertical magnet 899 of the switch TDI to battery, and at armature 987 it repeats the impulses to the ticket printer from earth at armature 932, armatures 987, 997, 943, pulse-in conductor 1234 to the printer. Relay 813 in operating at armature 991 closes a short-circuit around its lower winding to make the relay slow-to-release; at armature 992 and its operated contact it closes a circuit for relay 814 from earth at armature 933 and at armature 990 it closes an impulse-repeating loop across the positive and negative conductors 1259 and 1260 outgoing from the repeater while at armature 988 and 989 it opens the through speaking connection. The loop circuit extends as follows: positive conductor 1259, armatures 957, 979, 990, resistance 1261, negative conductor 1260. Armatures 957 and 979, are however short-circuited by armature 953 and hence no impulses are transmitted over the outgoing conductors until relay 804 operates to remove the short-circuit.

As pointed out above the first digit on a call to another exchange in the same zone may be any of the digits 1, 4, 5, 6, 7, 8 or 9. At the end of the first series of impulses therefore vertical wiper 1213 of the two-directional switch TDI will be positioned opposite a level corresponding to one

of these digits. In addition relay 860, the original circuit of which has been opened at vertical off-normal springs 1221 and which has been held during impulsing over its upper winding, releases and at armature 1106 extends earth over the vertical wiper 1213, the vertical bank commoning, armature 1176, winding of relay 882 to battery; and at armature 1104 extends earth from armature 1101 over vertical off-normal springs 1221 in their operated position rotary off-normal springs 1220 in their resting position, armature 1104, lower winding of relay 859 to battery. This earth potential is also extended on the operation of relay 882 over armature 1166, winding of relay 856 to battery. In addition relay 882 at armature 1167 opens a point in the circuit of relay 884 to prevent the latter relay operating if the second digit is "0." Relay 859 in operating at armature 1103 extends the impulse repeating circuit over its upper winding, winding of rotary magnet 900 to battery. Relay 856 in operating at armature 1089 extends earth over wiper 915 and bank contact, conductor 1257, armature 955, lower winding of relay 804 to battery. Relay 804 in operating locks at armature 952 to earth at armature 955 and at armature 953 opens the previously described short-circuit across armatures 957 and 979 so that the second and following series of impulses will be repeated over the outgoing positive and negative conductors 1259 and 1260.

Further relay 813 in releasing after the termination of the first impulse series at armature 992 extends earth during the release time of relay 814 from armature 933 over armatures 992 and 993, winding of relay 816 to battery. Relay 816 operates and at armature 999 connects conductors 1237 and 1238 leading to the printer in order to give an "end of digit" signal.

On the reception of the second digit the impulses will be extended to the rate-determining circuit over conductor 1250 as before and thence over bank contact and wiper 918, armature 1097 and 1103, upper winding of relay 859, winding of rotary magnet 900 to battery.

At the end of the second series of impulses, relay 859, the original circuit of which was opened at springs 1220 on the first rotary step of the wipers and has been maintained during impulsing over its upper winding, releases and at armature 1102 extends the impulse-repeating circuit over rotary off-normal springs 1219 and their operated position, winding of relay 861 to battery. Relay 861 therefore operates on the receipt of the third series of impulses and since it is a slow-to-release relay it remains operated for the whole of the impulse series. In addition relay 861 extends earth from armature 1107 over armatures 1120, 1116, 1112, and 1109 to the lower winding of relay 862 and thence to battery. Relay 862 is a two-step relay and at this time operates its locking contact 1108 only. When relay 861 releases at the end of the third impulse series, relay 862 operates fully both windings in series, armatures 1108, 1110, to earth at 1092. Relay 862 at armature 1109 prepares the energising circuit for relay 863 which is operated to close the armature 1111 on the operation of relay 861 at the beginning of the 4th series of impulses. At the end of the 4th series relay 863 operates fully and at armature 1112 it prepares the operating circuit of relay 864 and at armature 1110 opens the locking circuit for relay 862 which releases. When relay 864 operates fully over armature 1115 at the termination of the 5th impulse series that is to say at the

end of the last digit dialled by the calling subscriber it opens at armature 1114 the locking circuit of relay 863 which releases and at armature 1113 extends earth from armature 1168, armatures 1124 and 1113, wiper 917 and bank contact, conductor 1254, lower winding to relay 820 to battery. Relay 820 at armature 1004 locks to earth in the printer over conductor 1239 and armature 1002 earths conductor 1233, leading to the printer in order to condition this mechanism for the printing of a 5-digit number instead of an 8-digit number. In addition relay 864 at armature 1117 closes a circuit from earth at armature 1165 for relay 867. Relay 867 is a slow-to-operate relay and in operating at armature 1124 opens the circuit over the lower winding of relay 820, but this relay is maintained energised from earth in the printer unit until the necessary conditioning has been effected therein.

It will be remembered in the description of the operation of the first group selector that after all the impulses have been repeated by the mechanical impulse repeater, earth is removed from the private conductor. Relay 800 in the outgoing repeater now operates from earth at armature 960, upper winding of relay 800, make-before-break contacts associated with armature 971, armature 962, conductor 1233 to battery over the operated switching relay in the finder switch. Relay 800 in operating locks over its lower winding and armature 935 to earth at armature 955; at armature 934 closes a short-circuit around its upper winding to make it slow-to-release and at armature 932 opens the impulse-repeating circuit extending over armature 987 of relay 812 so that no further impulses which may be accidentally transmitted to the outgoing repeater are effective on the printer.

In the case of a call to another exchange in the same zone, the tariff or rate at which the call is to be charged is determined in accordance with the position of wiper 1215 of the two-directional switch TD1. This switch has been set in accordance with the first two digits dialled by the calling party, which digits are individual to the required exchange. Now it is to be pointed out that the rate at which the call is to be charged depends on the distance between the originating and terminating exchanges and while calls between one exchange and a number of exchanges in the zone will be at the same rate, calls between the one exchange and certain other exchanges may be at a different rate or rates. In order to enable such a scheme to be carried out the contacts in the bank associated with wiper 1215 and which corresponds to exchanges for which the charging rate is the same are commoned and connected to the appropriate one of the seven tariff or rate relays 888 to 894 inclusive. For instance assuming that calls to certain exchanges within the zone are charged at one rate while calls to the remaining exchanges are charged at another rate, then the contacts on which wiper 1215 is set in response to calls to said certain exchanges are commoned and connected to the winding say of relay 888 while the contacts on which wiper 1215 is set in response to calls to the remaining exchanges are commoned and connected to relay 889.

Each of the relays 888 to 894 have four armatures and on the operation of these armatures a marking is extended first to a contact in the bank associated with wiper 927 of the switch RS to give the tens value of the rate in francs, second to a contact in the bank associated with wiper

928 to give the units value of the rate in francs, third to a contact in the bank associated with wiper 929 to give the tens value of the rate in centimes and finally to a contact in the bank associated with wiper 930 to give the units value of the rate in centimes. The switch RS is then stepped by timed impulses which are also repeated to the ticket machine until wiper 927 reaches the marked contact. It is then returned to normal and three more stepping operations are effected under the control wipers 927, 928 and 929 respectively. The rate at which the call is to be charged is thus transmitted to the ticket machine. In connection with the arrangement of the armatures of the relays 888 to 894, the connections between these relays and the banks of the switch RS have been shown in respect of relay 893 only in order not to render the drawing unnecessarily complicated.

It will also be understood that although the circuit has been designed to give the rate in francs and centimes, it could readily be altered to give the rate in any desired currency.

A description will now be given of the above operation in detail and for this purpose it will be assumed that the call is to be charged at the lowest rate and hence relay 888 is operated over wiper 1215. When the printer is ready to receive the rate indication from the rate determining circuit, earth is connected to conductor 1240 (Fig. 13) which earth is extended over armatures 1003, 980, lower winding of relay 815, conductor 1251, bank contact and wiper 919, armatures 1094, 1125, 1169, 1159, lower winding of relay 871 to battery. Relay 815 in operating locks over its upper winding, armatures 994, 937 to earth at armature 955; at armature 995 it short-circuits its lower winding to make it slow-to-release; at armature 997 it disconnects the pulse-in-conductor 1234 from the impulse-repeating armature 987 of relay 812 and connects it to conductor 1252 and thence over bank contact and wiper 920, armature 1149 and thence to earth over the impulse-repeating armature 1132 of relay 873. Relay 871 in operating locks over armature 1126 to earth at armature 1092 and at armature 1127 it closes a circuit from conductor 1262, armatures 1164, 1136, 1131, 1127, lower winding of relay 872 to battery. Earth impulses are transmitted over conductor 1262 at the rate of 10 per second and relay 872 operates on the first impulse and locks over armatures 1129, 1139 to earth at armature 1128. In addition at armature 1130, relay 872 closes a circuit from conductor 1263, armatures 1142, 1130, winding of relay 873 to battery. Earth impulses are also transmitted at the rate of 10 per second over conductor 1263 the first impulse being transmitted $\frac{1}{2}$ second after the operation of relay 872. The first operation of relay 873, at armature 1132, causes an impulse to be transmitted over the above-traced circuit to the printer while at armature 1133 an impulse is transmitted over armature 1143 to battery over the winding of magnet 902. The wipers of the switch RS thus make one step for each impulse transmitted to the printer. When wiper 927 of the switch RS reaches the contact marked by the operated armature 1138 of relay 888 a circuit is completed at the end of this impulse as follows: earthed conductor 1264, armature 1138, bank contact and wiper 927, armatures 1144, 1147, 1151, winding of relay 875 to battery. Relay 875 in operating at armature 1139 opens the locking circuit for relay 872 which releases and opens the circuit for relay 873; at armature 1140 it opens the impulse-repeating circuit to the

printer; at armature 1141 it closes a circuit for slow-to-release relay 874 in series with magnet 992 and at armature 1143 it opens the impulse-repeating circuit to the magnet 902. The circuit for operating relay 874 extends from earth at armature 1141, winding of relay 874, wiper 931, bank commoning, interrupter springs 1229, winding of magnet 902 to battery. The magnet operates over this self interrupting circuit to restore the wipers to normal, relay 874 remaining operated during the movement. Relay 874 at armature 1135 provides its own operating earth, at armature 1136 it disconnects the impulsing conductor 1262 from the circuit to relay 872; at armature 1137 it extends earth over armatures 1154, 1150, 1146, lower winding of relay 876 to battery. Relay 876 is a two-step relay and operates its "X" armature 1145 only at this stage. Finally relay 874 at armature 1138 closes a circuit for slow-to-release relay 880 which at armature 1161 closes a circuit for slow-to-release relay 881.

When the wipers of the switch RS are returned to normal, relay 874 restores slowly and at armature 1134 earth is extended over armatures 1162, 1095, wiper 921 and bank contact, conductor 1253, winding of relay 816 to battery. Relay 816 at armature 999 connects together conductors 1237 and 1238 to give an "end of digit" signal to the printer. In addition relay 874 at armature 1137 allows relay 876 to operate fully indicating that the first digit of the rate has been transmitted. Finally relay 874 at armature 1138 opens the circuit of relay 880 which releases followed by relay 881. Relay 881 at armature 1164 again complete the circuit from conductor 1262 to relay 872. Relay 872 operates on the reception of the next earth pulse to initiate the transmission of the next rate digit to the printer. The second, third, and fourth digits are determined by markings extended over armatures 1187, 1186 and 1185 of relay 888 and their transmission takes place in a manner similar to that described above, relay 877, 878 and 879 operating at the end of the transmission of the second, third and fourth digits respectively and relay 879 in operating fully over armature 1157 initiates the release of the rate-determining circuit.

Relay 879 in operating at armature 1155 extends earth over wiper 922 and bank contact, conductor 1255, armature 998, lower winding of relay 811 to battery. Relay 811 is a two-step relay and operates its armature 981 only at this stage. In addition relay 879 at armature 1156 opens the locking circuit of relays 858 and 807 but this armature is short-circuited by the operated armature 1163 of relay 881 and hence relays 858 and 807 are maintained until relay 881 releases. Further relay 879 at armature 1158 opens the locking circuit of relay 878 which release and at armature 1160 relay 879 extends earth to the appropriate contact in the bank associated with wiper 926 in order to busy the rate-determining circuit until it is completely restored to normal.

On the release of relay 881 the locking circuit of relays 858 and 807 is opened and these relays release. Relay 858 in releasing at armature 1101 extends earth over vertical off-normal springs 1223, winding of release magnet 901 to battery. The release magnet operates to restore the switch wipers to normal and to open the circuit of relay 882. In addition relay 858 at armature 1099 opens the circuit for relay 857 which releases and at armature 1092 opens the locking

circuit for relay 864, 871, 879 and the operated one of the relays 888 to 894. The locking circuits of all the relays are now opened and on the release of relay 879, guarding earth is removed from the contact associated with wiper 926 and the rate-determining circuit is now available for use on another call.

As pointed out above relay 807 in the outgoing repeater OG releases on the release of relay 881, while relay 811 operates fully on the release of relay 879. When the printer is ready to receive the next series of impulses representing the first digit in the calling party's number, earth is extended over conductor 1240, armatures 1003, 980, 968, 973, lower winding of relay 809 to battery. Relay 809 operates and locks over its upper winding and armatures 972 and 937 to earth at armature 955. Relay 809 at armature 977 closes the following circuit: earth at armature 970, armatures 967, 984, 977, conductor 1269, winding of relay 829 to battery. Relay 829 operates in the above circuit and causes the distributor DIR to seize the preselected identification register IR in a similar manner to that described for the distributor DDR (Fig. 8). Earth is thus extended over wiper 911 and bank contact armature 1027, interrupter springs 1217, winding of magnet 896 to battery.

B. Determining rate of call to exchange in another zone

Before proceeding with the description of the determination and recording of the calling party's number a description will first be given of the operation of the rate determining circuit when a call is set up to an exchange in another zone. In this case the first digit dialled by the calling party will be the digit "0" and hence the wipers of the two-direction switch TDI will be raised to the tenth level. When relay 860 de-energises at the termination of the first impulse series it extends earth from armature 1106 over the vertical wiper 1213 of the switch TDI, the tenth vertical contact, armature 1167, upper winding of relay 884 to battery. Relay 884 in operating at armature 1172 closes a circuit from earth at armature 1101, armature 1172, lower winding of relay 884, winding of relay 883 to battery; at armature 1177 it connects up wiper 1214 of the switch TDI and at armature 1175 it closes a circuit from earth at armature 1184, winding of the release magnet 901 of the switch TDI to battery. The release magnet operates over the circuit and restores the wipers to normal when the following circuit is closed: earth, vertical off-normal springs 1222 in their resting position, armature 1171, upper winding of relay 887 to battery. Relay 887 in operating locks over its lower winding armature 1183 to earth at armature 1101 and at armature 1184 opens the above-traced circuit to the release magnet which thereupon de-energises. In addition the following circuit is closed on the restoration to normal of the switch TDI: earth at armature 1101, vertical off-normal springs 1221, lower winding of relay 860 to battery. Relay 860 operates to prepare again the circuit to the vertical magnet 899 so that the second series of impulses will again cause the vertical movement of the switch.

The second digit may be any of the digits 1 to 0 but since the operation where the second digit is 2 or 3 is not standard, it will be assumed that in the present instance the second digit is other than these two. No further switching oper-

ations will then take place over the vertical wiper at the end of the vertical movement. On the release of relay 860 however the following circuit is closed for relay 856: earth at armature 1101, vertical off-normal springs 1221, rotary off-normal springs 1220, armatures 1104, 1170, 1182, winding of relay 856 to battery. Relay 856 operates with the results previously described. It is to be noted however that in this case retransmission from the outgoing repeater over the junction line only occurs after the 2nd digit.

The third digit controls the rotary movement of the switch TDI and in accordance with its final setting, one of the relays 888 to 894 is operated to control the transmission of the rate digits to the printer in the manner previously described.

It should be pointed out that of the charges which are made on calls to exchanges in other zones those for calls to the zones for which the second digit is 2 or 3 are the same irrespective of the terminating exchange within the zone. Consequently in these two cases the rate is determined at the termination of the second digit. Thus for instance if the second digit is 2, then at the end of this second impulse series, earth is connected up over the vertical wiper 1213, the second vertical bank contact, armature 1173, winding of relay 885 to battery. Relay 885 in operating at armature 1179 disconnects the wipers 1214 and 1215 of the switch TDI from the relays 888 to 894 and prepares a circuit at armature 1178 over conductor 1274 which is connected directly to the appropriate one of the relays 888 to 894 to give the tariff or rate for a call to this zone. Similarly on a call where the second digit is 3, relay 886 is operated over armature 1174, and at armature 1181 again disconnects the relays 888 to 894 from the wipers 1214 and 1215 of the switch TDI and at armature 1180 prepares a circuit over conductor 1275 for operating the appropriate one of the relays 888 to 894.

It will be noted that while seven relays 888—894 are provided relays 893 and 894 are alternative, the one which is used being determined by the position of the key 1230. This is in order to provide night rate facilities on a particular class of call. Normally on this class of call relay 893 will be operated for rate determination, but within certain periods of the day the key 1230 is operated so that on a call of this particular kind relay 894 is operated to give a lower rate.

The further operation of the rate determining circuit is substantially the same on a call to another zone as previously described for a call within the zone except that 8 digits are received by the outgoing repeater and consequently all the counting relays 862 to 866 will be operated. It is to be noted that relay 867 which sends a signal to the printer on a 5-digit number is not operated in this case. Relay 866 however in operating fully at the end of the 8th digit closes a circuit at armature 1123 for relays 871, and relay 815 in series to earth in the printer in order to initiate the transmission of the rate to the printer.

It is to be noted that delayed alarm facilities are also provided in the rate-determining circuit and in the associated distributor. In the rate-determining circuit relays 854 and 855 operate in a manner similar to relays 510 (Fig. 9) and 525 (Fig. 11) of the discriminating register while in the associated distributor relays 868 and 869 operate in a manner similar to relays 528 and 530 (Fig. 8) of the distributor DDR. The operation of relays 510, 525, 528, and 530 having been described in detail it is believed that the delayed alarm

operation in the rate-determining circuit and the associated distributor will be easily understood.

C. Determining and recording calling party's number

A description will now be given of the determination and recording of the calling party's number and in this connection it will be remembered that when the printer is ready to receive this number an identification register IR is seized and the switch AS4 hunts for the outgoing repeater OG. When the wipers reach the required contacts, earth is extended from armature 969, armatures 966, 983 and 976, conductor 1267, bank contact and wiper 904, bank contact and wiper 912 and thence over the winding of relay 830 to battery. Relay 830 in operating opens the self-interrupting circuit to the magnet 896 and extends earth over wiper 913, lower winding of relay 832 to battery. Relay 832 in operating closes the following locking circuit for itself: earth at armature 968 (Fig. 12), winding of relay 807, armatures 982, 974, conductor 1268, bank contact and wiper 905, armatures 1031, 1069, upper winding of relay 832 to battery. In addition relay 832 at armature 1028 closes a circuit for relay 833. Relay 807 operates in the above-traced locking circuit and at armature 964 extends earth over armatures 975 and 942, lower winding of relay 801 to battery. Relay 801 is a two-step relay and operates its "X" armature 938 only at this stage. Relay 833 in operating at armature 1036 extends earth over bank contact and wiper 914 to cause the distributor DIR to hunt for another idle identification register and at armature 1034 completes a circuit from terminal 1276 of the 400 cycle current source over armature 1034, primary winding of transformer TR1, armature 1047 to terminal 1277 of the 400 cycle source. The induced currents in the secondary winding flow from earth, secondary winding, wiper 903 and bank contact, conductor 1266, armatures 971, 962, conductor 1233, wiper 550 (Fig. 7), armature 591, conductor 423 (Figs. 7 and 2), condenser 424, winding of relay 105 and shunt rectifier 425 to earth to cause the operation of relay 105 and the seizure of a preselected identification repeater register.

DETAILED DESCRIPTION OF THE IDENTIFICATION REPEATER REGISTER

Relay 105 responds to the alternating current signal and at armature 212 extends earth over armature 214, conductor 426, winding of relay 113a to battery. Relay 113a operates to cause the identification repeater register IRR which has been preselected by the distributor DIRR to be seized. Thus relay 113a at armature 254 extends earth over the resistance-inductance combination 450, armature 252, wiper 182 and bank contact, armature 240, interrupter springs 416, winding of magnet 160 to battery. The magnet operates to step the wipers to a position marked by earth from armature 211, armature 213 of relay 106 to a contact associated with wiper 181. It is to be understood that relay 106 is common to all line finders serving the same group of subscribers as the line finder LF1 and by searching for this marking the switch AS5 is arranged over other wipers to take into use the identification finder switch which is allocated to this group of line finders. On reaching the required contacts the above-mentioned earth is extended over wiper 181, armature 233, bank contact and wiper 183, armature 253, wiper 184 and bank contact, upper winding of relay 116 to battery. Relay 116 at armature 240 opens the

circuit to the magnet 160 and at armature 241 completes the following locking circuit for itself over: earth, winding of relay 106, bank contact and wiper 180, armatures 243, 241, 412, springs 428, lower winding of relay 116 to battery. Relay 106 operates over the above locking circuit and at armature 214 opens the circuit for relay 113a which releases and at armature 213 it removes marking earth from the contact associated with wiper 181.

In addition relay 116 at armature 242 closes a circuit for relay 115. Relay 115 in operating at armature 234 closes a circuit for lighting the busy lamp 431 and also extends earth over bank contact and wiper 185, winding of relay 119, interrupter springs 417, winding of magnet 161 to battery. The distributor DIRR thereupon hunts for the next idle identification repeater register in a similar manner to that described for the other distributors. Further relay 115 at armature 235 extends earth over wiper 179 and bank contact to operate the appropriate one of the twenty relays 127 to 146 in order to record the particular 200 line group which includes the calling party. It is pointed out that the present equipment has been designed for use in a 4000 line exchange and hence 20 relays 127 to 146 are necessary for determining the 200-line group. It will however be understood that by suitable addition of relays the equipment could deal with larger number of lines.

In addition relay 115 at armature 236 connects the impulsing conductor 433 over armature 232 to the lower winding of relay 114; at armature 237 closes a circuit for relay 159 and at armature 238 extends earth over the winding of relay 108, wiper 176 and bank contact, conductor 438, armature 304, both windings of relay 117a in series to battery. Relay 117a only operates over this circuit.

Impulses are transmitted over conductor 433 at the rate of 10 per second and on the first impulse relay 114 operates and locks over armature 230 to earth at armature 238. At armature 231, relay 114 connects impulsing conductor 432 also delivering impulses at the rate of 10 per second to relay 113. Relay 113 at armature 228 repeats the impulses over armature 22, wiper 178 and bank contact, conductor 436, armatures 290, 282, winding of vertical magnet 165 of the identification finder to battery and at armature 229 repeats the impulses over armature 226, winding of magnet 163 of the switch TS to battery. The vertical magnet and the magnet 163 are thus operated in synchronism.

The vertical magnet operates to raise the wipers to the level which is marked by earth from armature 210 (Fig. 2) vertical wiper 202 of the line finder which has connected with the calling party's line. When this level is reached this earth is extended over vertical wiper 203 of the identification finder, upper winding of relay 116a to battery. Relay 116a in operating locks over its lower winding, armature 283 to earth at armature 291; at armature 282 opens the impulse repeating circuit to the vertical magnet 165 and at armature 284 it closes the following circuit: earth, winding of relay 112 (Fig. 2), armature 223, winding of relay 110, wiper 177 and bank contact, conductor 437, armatures 284, 280, 272, 296, winding of rotary magnet 166 to battery. Relay 112 only operates in this circuit and at armature 227 extends earth from armature 229 (on the next release of relay 113) to relay 111. Relay 111 in operating locks at armature 224 to earth at armature 238; at armature 223 it places the rotary magnet 166 un-

der the control of the impulse-repeating armature 228 of relay 113 and at armature 226 opens the impulsing repeating circuit to the magnet 163 of the switch TS. The rotary magnet circuit includes relay 110 which operates on each impulse and at armature 221 repeats the impulses to magnet 164 of the switch US over armature 225. The rotary magnet in operating steps the wipers in search of the 400 cycle modulated earth potential which marks the guarding conductor of the line finder LF1. When the identification finder has reached this position, this marking potential is extended over armature 206 assuming relay 103 has been operated, condenser 447, wiper 173 and bank contact, cable 441, bank contact and wiper 201, armature 276, condenser 446, winding of relay 118a and shunt rectifier 447, to earth. Relay 118a in operating at armature 274 closes a circuit for the upper winding of relay 123. Relay 123 in operating at armature 299 closes a circuit for the upper winding of relay 122 which in operating at armature 296 opens the circuit of the rotary magnet and at armature 298 closes a circuit for relay 121 which in operating armature 295 closes a circuit for relay 124 which operates slowly. Relay 124 in operating at armature 300 extends earth from armature 274 over armature 277 to operate relay 114a and at armature 302 extends earth over armatures 293, 282, 290, conductor 436, bank contact and wiper 178, armature 222, both windings of relay 109 in series to battery.

Relay 114a in operating locks at armature 271 to earth at armature 292; at armature 273 opens the other circuit over the other test wiper of the identification finder and at armature 275 extends wiper 198 over armature 299 and conductor 439 to a contact associated with wiper 175.

It will be understood that relay 118a or relay 119 will operate according to the set of wipers over which the calling party is reached i. e. according as to whether the calling party's line is in odd or even hundreds group. It in the present case it has been assumed that the line is in the odd hundred group and relay 118a operates. If, however, the calling line had been in the even group, relay 119 would have operated, and on the operation of relay 124, would have completed a circuit for relay 115a over: earth, armatures 281, 301, 270, winding of relay 115a to battery. Relay 115a in operating, in addition to its switching functions, at armature 278 short-circuits relay 117a which releases and allows relay 108 to operate. Relay 108 in operating at armature 215 connects the impulsing conductor 441a to the outer armatures of the relays 127 to 146 instead of to the inner armatures thereof. Now the operation of one of these relays as previously described determines the 200 line group which includes the calling subscriber while the connection of conductor 441a to one or the other groups of armatures determines the 100 line group which includes the calling subscriber. The thousands and hundreds digits of the calling party's numbers are thus determined.

Relay 109 in operating as described above locks over armature 216 to earth at armature 238 and at armature 217 extends impulsing conductor 442 over armatures 379 and 374 to battery over the upper winding of relay 147. Earth impulses are transmitted over conductor 442 at the rate of 10 per second and relay 147 operates on the first impulse and locks over its lower winding, armatures 373, 378 to earth at armature 218. In addition relay 147 at armature 375 extends impulsing conductor 444 to relay 148. Before pro-

ceeding with the further operation however, consideration will first be given to the registration of the calling party's number on the switch OS.

With regard to the 10,000 digit, this will be the same for all subscribers since the maximum capacity is 4000 lines and is therefore fixed by connecting the impulsing conductor 445 to a particular one of the ten conductors extending to the contacts associated with wiper 186 of the switch OS. The thousands digit is also determined by the operation of one of the relays 127 to 146. Thus relays 127 to 131 represent the first thousand, relays 132 to 136 the second thousand. Since the present capacity of the exchange is 4000, four groups of relays only are provided. It will be assumed that the thousand digit of the calling subscriber is "1," that the two hundred line group which includes the calling party is $\frac{3}{4}$ or since relay 108 is not operated the hundred line group is 3. Relay 128 will therefore have been operated over wiper 179 so that earth impulses from conductor 443 will be extended over armature 316 to contact 1 associated with wiper 187. In addition earth impulses from conductor 441a will be extended over armature 318 to contact 3 associated with wiper 188.

It will of course be understood that the registration of the calling party's number is effected before the operation of relay 147 as described previously. On the operation of relay 148, the magnet 162 of the switch OS is operated to step the wipers under the control of armature 376 of relay 148. Further at armature 377 relay 148 repeats alternating current impulses from the secondary winding of transformer TR2 supplying 50 cycle current, and thence over armature 377 and the simplex circuit comprising armatures 219 and 220, upper and lower windings of the inductance 107, condensers 448 and 449, wipers 174, and 175 and bank contacts, conductors 440 and 439, armatures 289 and 288, 275, and 269, wipers 198 and 196 of the identification finder, wipers 170 and 168 of the line finder, armatures 205 and 204 of the operated switching relay 103, armatures 208 and 207 of relay 104, conductors 422 and 421 (Figs. 2 and 7), make-before-break contacts associated with armatures 580 and 579, armatures 590 and 589, wipers 549 and 548, conductors 1232 and 1231 (Fig. 12), conductors 1265 and 1270, bank contacts and wipers 906 and 907, inductance 837, armatures 1030 and 1029, condensers 1279 and 1278, positive half waves then passing over rectifier 1228, lower winding of relay 834 and negative half waves passing over rectifier 1227 and the upper winding of relay 834, conductor 1280 (Figs. 15 and 5) back to the secondary winding of the transformer TR2. The magnet 162 of the switch OS (Fig. 5) and relay 334 (Fig. 15) are thus operated in synchronism.

When wiper 186 of the switch OS reaches the marked contact, earth is extended over wiper 186, armatures 381, 384, 388, 392, winding of relay 149 to battery. Relay 149 at armatures 378 and 379, opens the locking and operating circuits of relay 147 which releases to open at armature 375 the impulse repeating circuit to relay 148 to prevent further operation of magnet 162 and relay 834. In addition relay 149 at armature 380 closes a circuit extending over slow-to-release relay 154, bank commoning and wiper 191, interrupter springs 418, winding of magnet 162 to battery. The wipers of the switch OS are thus advanced to contact 11, it being understood that the switch OS rotates once for every two digits. Relay 154 is maintained operated during this period

and at armature 396 extends earth over armatures 391, 387, 383, lower winding of counting relay 150 to battery. Relay 150 is a two-step relay and operates its "X" armature 382 only at this stage. Relay 154 also closes a circuit at armature 397 for relay 155 and at armature 398 holds relay 149 operated while the switch OS is being advanced to contact 11. Relay 155 in operating at armature 402 locks to earth at armature 237. When the switch OS is completely advanced to contact 11, relay 154 releases and at armature 397 short-circuits relay 155 over armature 400. The full operation of relay 150 and the release of relay 149 to initiate the transmission of the next digit are however delayed by earth at armatures 399 and 401 respectively until the release of relay 155. Relay 149 in releasing completes the circuit for relay 147 and the second digit of the calling subscriber's number is transmitted to control relay 834. It is to be noted that the marking for the tens and units digits is extended to contacts associated with wiper 189 and 190 over wipers 192 and 194 respectively.

In connection with the operation of relay 834, this relay at armature 1040 closes a circuit for slow-to-release relay 835 which in turn at armature 1041 closes a circuit for slow-to-release relay 836. In addition relay 834 at armature 1039 repeats the impulses it receives from earth at armature 1032 over wiper 908 and bank contact, conductor 1271, armatures 997, 943, pulse-in conductor 1234 to the printer so that the digits representing the calling party's number may be printed. At the end of the first digit relay 835 releases and opens the circuit for relay 836 and during the release period of the latter relay earth is extended from armature 1041 over armature 1042, wiper 909 and bank contact, conductor 1272, winding of relay 816 to battery. Relay 816 in operating at armature 999 connects together conductors 1237 and 1238 to give the "end of digit" signal to the printer. In addition a circuit is also closed during the release period of relay 836 from earth at armature 1041, armatures 1043, 1059, 1055, 1052, 1049, 1045, lower winding of counting relay 838 to battery. Relay 838 is a two-step relay and operates its "X" armature 1044 at this stage, the relay operating fully to earth at armature 1033 of relay 833 when the release of relay 836 opens the original energizing circuit of relay 838.

The remaining digits are transmitted in a similar manner by the successive rotations of the switch OS, wipers 187, 188, 189 and 190 being connected up in turn by relays 150, 151, 152 and 153, and relays 839, 840 and 841 of the identification register IR operating at the end of the 2nd, 3rd and 4th digits.

At the end of the 5th digit relay 156 in the identification repeater register operates from impulsing conductor 452, wiper 194 and bank contact, bank contact and wiper 190, armatures 392, 395, upper winding of relay 156 to battery to initiate the release of the register. Relay 149 is also operated in a parallel branch of this circuit. Relay 156 locks over its lower winding, armature 404 to earth at armature 237; at armature 403 it extends earth to bank contact and wiper 185 to busy the register during release; at armature 405 it closes a circuit for the upper winding of relay 157 over wiper 193 and bank commoning, interrupter springs 419, winding of magnet 163 to battery and at armature 406 it closes a circuit over the lower winding of relay 157, wiper 195 and bank commoning, interrupter springs

420, winding of magnet 164 to battery. Switches TS and US are thus restored to normal. At armatures 408 and 409 relay 157 closes locking circuits for both its windings independent of relay 156; at armature 407 it also applies a busying earth to bank contact and wiper 185; at armature 410 it applies an additional earth to the lower winding of relay 149 and at armature 411 it closes a circuit for relay 158. Relay 158 in operating at armature 412 opens the series circuit for relays 106 and 116. These relays release and relay 116 at armature 242 opens the circuit for relay 115 which in releasing opens the holding circuits of all the operated relays in the register. In addition relay 115 at armature 237 opens the circuit of relay 159 which releases and at armatures 413, 414 and 415 maintains the circuits of the upper and lower windings of relay 157 and of relays 154 and 155 in case relay 115 operates before the switches OS, TS and US are returned to normal. Finally relay 117a in releasing, due to the removal of earth at armature 238 by relay 115, opens the holding circuits for the relays in the identification finder and at armature 292 closes a circuit over operated vertical off-normal spring 457 for the release magnet 167. The release magnet operates to restore the switch wipers of the identification finder IF to normal. It is to be noted that if relay 117a is released earlier i. e. if the calling line is in an even hundreds group, the identification finder is released at this earlier stage.

Also at the end of the 5th digit, relay 842 of the identification register (Fig. 15) operates fully over its "X" armature 1058 and at armature 1056 extends earth over armatures 1067 to operate relay 844. Relay 844 in operating at armature 1065 closes a circuit for relay 845 and at armature 1066 closes an alternative circuit for relays 832 and 807. In addition, relay 844 at armature 1064 extends earth over wiper 910 and bank contact, conductors 1273 and 1254, lower winding of relay 820 to battery. The reason for the operation of relay 820 is that the printer is arranged normally to receive a six-digit calling party number and the locking circuit of relays 832 and 807 would then extend over armature 1063 of relay 843. In the present case where a five-digit number is employed a signal must be sent to the printer to indicate this. Relay 820 as before extends battery to the printer and remains held until the necessary adjustment has been effected in the printer.

Relay 845 in operating locks over armature 1068 to earth at armature 1056 and at armature 1067 opens the circuit for relay 844 which releases slowly and at armature 1066 opens the circuit of relays 832 and 807 and at armature 1065 opens the circuit of relay 845 which however remains held over its locking circuit until relay 842 releases. Relay 832 in releasing at armature 1028 opens the circuit for relay 833 which at its various armatures opens the locking circuits of all the relays in the identification register and renders it available for other calls.

Relay 807 in releasing at armature 964 removes earth from the lower winding of relay 801 to allow this relay to operate fully over armature 938 to earth at armature 955. Relay 801 in operating at armature 937 opens the locking circuits for relays 808, 809, 811 and 815 which thereupon release, the repeater being maintained busy by earth from armature 960 extended over the upper winding of relay 800,

make-before-break contacts associated with armature 962 to conductor 1233.

On the reply of the called party relay 817 in the outgoing repeater operates in series with the inductance 819 and at armature 1000 extends earth from armature 936 to the timing unit TU to set the latter in operation. This unit may take the form of stepping switches controlled by five seconds pulses for instance and derived from a master timing source. The arrangement, however, forms no part of the present invention and hence is not shown in detail. It should, however, be pointed out that on the elapse of each time unit—3 minute or other predetermined interval—relay 818 is operated from earth in the timing unit and at armature 1001 momentarily connects together conductors 1238 and 1240 leading to the printer to cause the printer to operate to give an indication of the time interval.

At the end of conversation when the calling party replaces his receiver, relay 810, is released and at armature 978 opens the circuit of relay 806 which releases followed by relay 805. Relay 806 at armature 960 again extends earth to the printer to allow the ticket to be completed and the locking circuits for the remaining operated relays are opened and the repeater is available for use on another call.

Delayed alarms are provided in the outgoing repeater and are controlled by relays 802 and 803 operating from impulsing conductors 1281 and 1284. Similarly the identification repeater and the associated distributor are provided with alarm relays 846 and 847 and alarm relays 848 and 849 respectively. In addition the identification repeater register and the associated distributor are provided with alarm relays 117 and 118 and relays 111a and 112a respectively. The operation of these relays is however similar to that of the similar alarm relays provided in the discriminating register and the associated distributor which has already been described. It is therefore not considered necessary to give a description of the operation of the above-mentioned pairs of relays. With regard to the identification finder switch IF it should be explained that each of these switches is associated with a spare switch which can be brought into operation after a predetermined time if the switch first seized fails to operate. Thus it will be seen that relay 120 (Fig. 3) operates from the impulsing conductor 453, rotary off-normal springs 454 or 11th step springs 455, armatures 294, 308, 287, lower winding of relay 120 to battery. Relay 120 operates and locks over armature 285 to earth at armature 291 and at armature 286, connects conductor 456 to the upper winding of relay 125. If the identification finder has not completed its operation relay 125 operates on the next earth pulse over conductor 456 and locks over armature 305, key 457 to earth at armature 310 of relay 126 which is the relay in the spare switch which corresponds to relay 125. In addition relay 125 in operating at armature 306 earth conductor 458 to give an audible alarm and lights lamp 459 at armature 307. Finally at armature 304 it disconnects earth on conductor 438 from relay 117a and extends it over conductor 460 to the corresponding relay in the spare switch to set this in operation to find the calling line as described above.

I claim:

1. In a telephone system, subscriber's lines, a mechanical impulse repeater, switching appa-

ratus for setting up a connection between two of said lines, a storage device, means operative in response to the initiation of a call by a subscriber on one of said lines for seizing said switching apparatus and said impulse repeater and said storage device, means controlled by the calling subscriber on said one line for transmitting numerical impulse series over said line, said mechanical impulse repeater and said switching apparatus and said storage device operative in response to certain of said impulse series, means controlled by said storage device in the event that the said certain received numerical impulse series is of a certain value for releasing said mechanical impulse repeater from said calling line to thereby permit the remaining numerical impulse series transmitted by said calling subscriber to affect said switching apparatus and thereby set up a connection to a desired called subscriber's line, and means controlled by said storage device in the event that the said certain received numerical impulse series is not of said certain value for causing said mechanical impulse repeater to respond to the remaining numerical impulse series and to retransmit all of the received numerical impulse series to said switching apparatus to thereby affect the setting up of a connection to a desired called subscriber's line.

2. In a telephone system, a calling line, other lines, switching apparatus operative to set up a connection between said calling line and one of said other lines, a mechanical impulse repeater, means for associating said mechanical impulse repeater with said calling line, a storage device, means controlled by a subscriber on said calling line for transmitting numerical impulse series indicative of the telephone number of one of said other lines, said switching apparatus and said storage device operative in response to certain of said numerical impulse series and said mechanical impulse repeater operative in response to all of said numerical impulse series, and means controlled by said storage device for releasing said mechanical impulse repeater for use in other connections in the event that said certain impulse series is of a particular value.

3. In a telephone system, a calling line, a called line, switching apparatus including a recording stage for setting up a connection between said lines, means controlled by the subscriber on said calling line for transmitting impulse series thereover, a mechanical impulse repeater selectively operative in response to all of said impulse series transmitted for storing said impulse series, a portion of said switching apparatus operative in response to the initial impulse series transmitted to said mechanical impulse repeater for extending a connection from said calling line to said recording stage, and means in said mechanical impulse repeater for retransmitting all of the said stored impulse series to said recording stage to thereby record the number of said called line and for controlling the operation of the remaining portion of said switching apparatus to further extend said connection from said recording stage to said called line.

4. In a telephone system, a calling line, a called line switching apparatus operative in response to numerical impulse series transmitted thereto for setting up a connection from said calling line to said called line, a mechanical impulse repeater automatically associated with said switching apparatus upon the initiation of said call, means under control of the subscriber on said calling line for transmitting a plurality of

numerical impulse series, a portion of said switching apparatus operated responsive to the first series of said plurality of numerical impulse series to partially set up said connection, said impulse repeater operated in response to all of said plurality of numerical impulse series, means including said impulse repeater for retransmitting all of said received impulse series to recording apparatus only in the event that the value of the first numerical impulse series received therein determines that the call is to be recorded for retransmitting all but the first of said plurality of numerical impulse series to operate the remaining portion of said switching apparatus to extend the partially set up connection to said called line.

5. In a telephone system, a plurality of lines, means including successive switching stages for progressively setting up a connection between two of said lines, means for establishing a charge rate applicable to said connection at one switching stage in the setting up of said connection, a mechanical impulse repeater at another stage of said connection operative responsive to impulse series transmitted from the calling one of said lines for repeating said impulse series to said one switching stage, a group of rate relays, a plurality of marking conductors accessible to each of said relays, a two motion switch included in said rate establishing means operative in response to two successive impulse series for selecting a particular one of said rate relays to thereby render certain of said marking conductors effective, a rotary switch, and means including said rotary switch for testing said marking conductors to find said certain conductors during successive rotations thereof and for simultaneously transmitting impulse series indicative of the rate charge in monetary values applicable to said connection to said one switching stage.

6. In a telephone system, a plurality of lines, means including successive switching stages for progressively setting up a connection between two of said lines, means for establishing a charge rate applicable to said connection at one switching stage in the setting up of said connection, a mechanical impulse repeater at another stage of said connection operative in response to impulse series transmitted from the calling one of said lines for repeating said impulse series to said one switching stage, a group of rate relays, a plurality of marking conductors accessible to each of said relays, means included in said rate establishing means operative in response to successive impulse series received at said one switching stage for selecting a particular one of said rate relays to thereby render certain of said marking conductors effective, and means for successively testing said marking conductors to find said certain conductors rendered effective and for simultaneously transmitting impulse series indicative of each effective conductor to said one switching stage.

7. In a telephone system, a plurality of lines, means including successive switching stages for progressively setting up a connection between two of said lines, means for establishing a charge rate applicable to said connection at one switching stage in the setting up of said connection, a mechanical impulse repeater at another stage of said connection operative responsive to impulse series transmitted from the calling one of said lines for repeating said impulse series to said one switching stage, a group of rate relays, a two motion switch included in said rate establishing

means operative in response to two successive impulse series received at said one switching stage for selecting a particular one of said rate relays, and means operative in response to the selection of a particular rate relay for transmitting impulse series indicative of the rate of charge applicable to said connection.

8. In a telephone system, a plurality of lines, means including successive switching stages for progressively setting up a connection between two of said lines, means for establishing a charge rate applicable to said connection at one switching stage in the setting up of said connection, a mechanical impulse repeater at another stage of said connection operative responsive to impulse series transmitted from the calling one of said lines for repeating said impulse series to said one switching stage, and a two motion switch included in said rate establishing means operative in response to three successive impulse series received at said one switching stage for determining the rate of charge applicable to said connection, said two motion switch being arranged to absorb the first series of said successive impulse series and to determine the charge rate applicable to said connection in accordance with the second and third of said successive impulse series.

9. In a telephone system, a plurality of lines, means including successive switching stages for progressively setting up a connection between two of said lines, means for establishing a charge rate applicable to said connection at one switching stage in the setting up of said connection, a mechanical impulse repeater at another stage of said connection operative responsive to impulse series transmitted from the calling one of said lines for repeating said impulse series to said one switching stage, and a two motion switch included in said rate establishing means operative in response to three successive impulse series received at said one switching stage for determining the rate of charge applicable to said connection.

10. In a telephone system, a plurality of lines, means including successive switching stages for progressively setting up a connection between two of said lines, means for establishing a charge rate applicable to said connection at one switching stage in the setting up of said connection, a mechanical impulse repeater at another stage of said connection operative responsive to impulse series transmitted from the calling one of said lines for repeating said impulse series to said one switching stage, and means included in said rate establishing means operative in response to successive impulse series received at said one switching stage for determining the charge rate applicable to said connection.

11. In a telephone system, a plurality of lines, means including successive switching stages for progressively setting up a connection between two of said lines, an outgoing repeater included in said connection at one stage of the setting up of said connection, means for establishing a charge rate applicable to said connection, means for temporarily associating said last mentioned means with said outgoing repeater, and means included in said charge rate establishing means for always transmitting a predetermined number of series of impulses to said outgoing repeater indicative of the charge rate applicable to the connection in monetary units.

12. In a telephone system, a plurality of lines, means including successive switching stages for

progressively setting up a connection between two of said lines, a mechanical impulse repeater, means operative in response to the initiation of a call by a subscriber on one of said lines for automatically associating said mechanical impulse repeater therewith, means for transmitting numerical impulses over said line to operate said mechanical impulse repeater in accordance with the telephone number of a called one of said lines and for operating a portion of said successive switching stages to set up a connection to a certain switching stage, means operative in response to the extension of said connection to said certain switching stage for controlling said mechanical impulse repeater to retransmit all of the received numerical impulses to said certain switching stage to thereby operate the remaining portion of said successive switching stages to extend the connection to said called line, means associated with said certain switching stage operative in response to all of the numerical impulses received at said certain switching stage for producing a record of the telephone number of said called line, means associated with said certain switching stage operative responsive to certain of said numerical impulses received by said certain switching stage for calculating the charge rate applicable to said connection, and means in said last mentioned means for transmitting numerical impulses to said record producing means to thereby produce a record of the charge rate applicable to said connection.

13. In a telephone system, a calling line, other lines, an outgoing repeater, switching apparatus operative to set up a connection between said calling line and said outgoing repeater, a mechanical impulse repeater, means controlled by a subscriber on said calling line for transmitting a plurality of series of numerical impulses indicative of the telephone number of one of said other lines, said switching apparatus operative in response to the initial impulse series to select said outgoing repeater, said mechanical impulse repeater operative in response to all of said plurality of numerical impulse series to retransmit said plurality of impulse series to said outgoing repeater, a rate calculating switch for calculating the charge rate for said connection temporarily associated with said outgoing repeater, a record producing device operative to produce a record of the telephone number of the said called line associated with said outgoing repeater, and means in said outgoing repeater for repeating all of said plurality of impulse series received from said mechanical impulse repeater to said record producing device and for repeating certain of said impulse series to said rate calculating device and for repeating certain of said impulse series to further extend said connection to the called one of said other lines.

14. In a telephone system, a plurality of lines, means comprising switching apparatus operative in response to numerical impulses transmitted thereto for setting up a connection between two of said lines, an outgoing repeater permanently associated with a record producing mechanism included in said connection, a mechanical impulse repeater operative in response to all of said numerical impulses for retransmitting said impulses to said outgoing repeater, means for calculating a charge rate applicable to said connection, means for temporarily associating said last mentioned means with said outgoing repeater,

means in said repeater for repeating all of the impulses received from said mechanical impulse repeater to the record producing mechanism to thereby produce a record of the number of the called subscriber in said connection and for repeating certain of said impulses received from said mechanical impulse repeater to said calculating means to thereby calculate the charge rate applicable to said connection, and means included in calculating means for transmitting series of impulses indicative of the charge rate of said connection to the record producing mechanism to thereby produce a record of the charge rate applicable to said connection.

15. In a telephone system, a plurality of lines, means including successive switching stages for progressively setting up a connection between two of said lines, means for establishing a charge rate applicable to said connection at one switching stage in the setting up of said connection, a mechanical impulse repeater at another stage of said connection operative responsive to impulse series transmitted from the calling one of said lines for repeating said impulse series to said one switching stage, and means included in said rate establishing means operative in response to successive impulse series received at said one switching stage for determining the charge rate applicable to said connection, a record producing device associated with said one switching stage, and means included in said rate establishing means for transmitting impulse series indicative of said determined charge rate to said record producing device to thereby produce a record of the said determined rate of charge applicable to said connection in monetary values.

16. In a telephone system, a plurality of lines, switching apparatus, means for transmitting numerical impulses to said switching apparatus for setting up a connection between two of said lines, an outgoing repeater included in said connection, having permanently associated therewith a record producing mechanism, a mechanical impulse repeater operative in response to all of said numerical impulses for retransmitting said impulses to said outgoing repeater, means for calculating a charge rate applicable to said connection, means for temporarily associating said last mentioned means with said outgoing repeater, and means in said repeater for repeating all of the impulses received from said mechanical impulse repeater to the record producing mechanism to thereby produce a record of the number of the called subscriber in said connection and for repeating certain of the impulses received from said mechanical impulse repeater to said calculating means to thereby calculate the charge rate applicable to said connection.

17. In a telephone system, a plurality of lines, means including successive switching stages for progressively setting up a connection between two of said lines, a mechanical impulse repeater, means operative in response to the initiation of a call by a subscriber on one of said lines for automatically associating said mechanical impulse repeater therewith, means for transmitting numerical impulse series over said line to operate said mechanical impulse repeater accordingly and for operating certain of said successive switching stages to partially set up said connection to a certain switching stage, means operative in response to the extension of said connection to said certain switching stage for controlling said mechanical impulse repeater to thereby retrans-

mit all of the impulse series received therein, and means associated with said certain stage operative in response to all of said retransmitted impulse series for recording the number of the called one of said lines.

18. In a telephone system, a plurality of lines, means comprising switching apparatus operative in response to numerical impulses transmitted thereto for setting up a connection between two of said lines, an outgoing repeater permanently associated with a record producing mechanism included in said connection, a mechanical impulse repeater operative in response to all of said numerical impulses for retransmitting said impulses to said outgoing repeater, and means in said repeater for repeating the impulses received from said mechanical impulse repeater to the record producing mechanism to thereby produce a record of the number of the called subscriber in said connection.

19. In a telephone system, a calling line, a called line, means comprising switching apparatus operative in response to numerical impulses transmitted thereto from said calling line for setting up a connection between said calling line and said called line, an outgoing repeater included in said connection, a mechanical impulse repeater operative in response to all of said numerical impulses for retransmitting said impulse series to said outgoing repeater, a calling line identification unit, means for associating said identification unit with said switching apparatus, means operative in response to said association for finding said calling line, means in said identification unit for transmitting numerical impulses indicative of the telephone number of said calling line over said last mentioned means to said outgoing repeater, and means in said outgoing repeater for repeating said numerical impulses received from said mechanical impulse repeater and said identification unit to record producing mechanism to thereby produce a record of the telephone numbers of said called line and said calling line.

20. In a telephone system, a plurality of lines, means comprising switching apparatus operative in response to numerical impulses transmitted thereto for setting up a connection between two of said lines, an outgoing repeater permanently associated with a record producing mechanism and included in said connection, a mechanical impulse repeater operative in response to all of said numerical impulse series for retransmitting numerical impulse series corresponding to the telephone number of the called line in said connection to said outgoing repeater, means for transmitting numerical impulse series corresponding to the telephone number of the calling line in said connection to said outgoing repeater, and means in said outgoing repeater for repeating said numerical impulse series corresponding to the telephone numbers of the called and calling lines in said connection to said record producing mechanism to thereby produce a record thereof.

21. In a telephone system, a group of lines, a called line, means comprising switching apparatus operative in response to numerical impulse series transmitted thereto for setting up a connection between a calling line in one of said groups of lines and said called line, an outgoing repeater permanently associated with a record producing mechanism included in said connection, a mechanical impulse repeater operative in response

to all of said numerical impulse series for retransmitting numerical impulse series indicative of the telephone number of said called line to said outgoing repeater, a plurality of identification units common to said groups of lines, a line identification finder individual to each of said groups of lines for finding calling lines in its associated group of lines, means operated after the said mechanical impulse repeater has retransmitted said numerical impulse series to said outgoing repeater for automatically selecting an idle one of said identification units, means associated with said identification unit for thereafter selecting the line identification finder having access to the group of lines in which said calling line is located, means including said selected line identification finder for finding said calling line, means controlled jointly by said identification unit and said line identification finder for transmitting impulse series indicative of the telephone number of said calling line to said outgoing repeater, and means in said repeater for repeating all of said numerical impulse series received therein to said record producing mechanism to thereby produce a record of the telephone numbers of said calling and said called lines.

22. In a telephone system, groups of lines, a called line, switching apparatus operative in response to numerical impulses transmitted thereto for setting up a connection between a calling line in one of said groups of lines and said called line, an outgoing repeater permanently associated with a record producing mechanism included in said connection, an identification unit common to said groups of lines, a line identification finder individual to each of said groups of lines, a group of relays included in said identification unit and each relay corresponding to a particular one of said groups of lines, means for operating one of said relays to register the identification of the group of lines including said calling line and for selecting a line identification finder individual to said identified group of lines, said line identification finder operative in response to selection thereof for finding said calling line in said group of lines and for simultaneously transmitting impulses to said identification unit corresponding to the tens and units digits of said calling line's telephone number, means in said identification unit for registering said digits, and means in said identification unit for transmitting impulse series to said outgoing repeater corresponding to the said registered identification of the group of lines including said calling line and for transmitting impulse series corresponding to the registered tens and units digits of said calling line to thereby operate the recording mechanism to record the telephone number of said calling line.

23. In a telephone system, groups of lines, a called line, means comprising switching apparatus operative in response to numerical impulse series transmitted thereto for setting up a connection between a calling line in one of said groups of lines and said called line, an outgoing repeater permanently associated with a record producing mechanism included in said connection, a mechanical impulse repeater operative in response to all of said numerical impulse series for retransmitting numerical impulse series indicative of the telephone number of said called line to said outgoing repeater, an identification unit common to said groups of lines, a line identification finder individual to each of said groups of lines for finding calling lines in its associated

group of lines, means controlled jointly by said identification unit and the line identification finder individual to the group of lines containing said calling line for transmitting impulse series indicative of the telephone number of said calling line to said outgoing repeater, and means in said repeater for repeating the received said numerical impulse series indicative of said called line and said calling line telephone numbers to said record producing mechanism to thereby produce a record thereof.

24. In a telephone system, a group of lines, a called line, switching apparatus operative in response to numerical impulses transmitted thereto for setting up a connection between a calling line in one of said groups of lines and said called line, an outgoing repeater permanently associated with record producing mechanism included in said connection, an identification unit common to said groups of lines, a group of relays included in said identification unit and each relay corresponding to a particular one of said groups of lines, means for operating one of said relays to identify the group of lines including said calling line, means controlled by the operation of said one relay for transmitting impulses to said outgoing repeater to identify the group of lines including said calling line, and means in said repeater for repeating said impulses to said record producing mechanism to thereby record said identification.

25. In a telephone system, a plurality of lines, means including successively operative switching stages for progressively setting up a connection between two of said lines, and register means for operating said switching stages and for determining the identification of the calling and called lines involved in said connection and for establishing a charge rate applicable to said connection.

26. In a telephone system, a plurality of lines, switching apparatus operative to set up connections between said lines, equipment adapted to be selectively operated over an associated calling line to determine the route over which a connection is to be set up by said switching apparatus and to operate said switching apparatus to set up the connection over the determined route and to transmit over the connection the identification of the associated calling line, and means for associating said equipment with said associated calling line.

27. In a telephone system divided into zones, a plurality of lines in each of said zones, switching apparatus operative to set up connections between said lines, equipment adapted to be selectively operated over an associated calling line in a local zone to determine the route over which a connection is to be set up by said switching apparatus and to operate said switching apparatus to set up the connection over the determined route and to transmit over the connection the identification of the associated calling line, means for associating said equipment with a calling line in the local zone, and means controlled incident to the setting up of a connection from a calling line in the local zone to a called line in a distant zone for registering the identification of the calling line transmitted over the connection.

28. In a telephone system divided into zones, a plurality of lines in each of said zones, switching apparatus operative to set up connections between said lines, equipment adapted to be selectively operated over an associated calling line in a local zone to determine the route over which a

connection is to be set up by said switching apparatus and to operate said switching apparatus to set up the connection over the determined route and to transmit over the connection the identification of the called line, means for associating said equipment with a calling line in the local zone, and means controlled incident to the setting up of a connection from a calling line in the local zone to a called line in a distant zone for registering the identification of the called line transmitted over the connection.

29. In a telephone system, a plurality of lines, divided into thousand-line groups, each group of lines being further subdivided into hundred-line subgroups, a plurality of calling line identifiers, means responsive to the extension of a connection from a calling line for seizing an idle one of said identifiers and for connecting a source of identifying potential to a conductor of said calling line, means in said identifier responsive to the potential on said conductor for first determining the thousands group in which the conductor to which said potential has been applied is located and for making a registration indicative thereof, means for then determining the hundreds subgroup of such thousands group in which said conductor is located and for making a registration indicative thereof, means for then determining the tens subgroup of such hundreds group in which said conductor is located and for making a registration indicative thereof, and means for finally locating the conductor in said tens group and for making a registration indicative thereof.

30. In a telephone system, a plurality of lines divided into thousand-line groups, each of said thousand-line groups being further divided into hundred-line groups, each of said hundred-line groups being further subdivided into ten-line subgroups, a plurality of calling line identifiers, an automatic switch for extending a connection from a calling line, means responsive to said extended connection for operating an idle one of said identifiers and for connecting a source of identifying potential to a conductor of said automatic switch and to a conductor of said calling line, means in said identifier responsive to said identifying potential for determining the thousands group in which the calling line conductor to which said potential has been applied is located, means for determining the hundred group of such thousands group in which said calling line conductor is located, means for determining the ten subgroup of said hundred group in which said calling line conductor is located, means for locating said calling line conductor in said ten subgroup, a plurality of registers, and means for registering all said determinations on said registers.

31. In a telephone system, an exchange, a plurality of lines terminating in said exchange divided into groups and subgroups, an automatic switch for extending a connection from a calling line, means responsive to said extended connection from a calling line for connecting a source of identifying potential to a conductor of said automatic switch and a conductor of said calling line, and identifying means common to all of said groups of lines operated responsive to said potential for determining the identification of the particular group of lines in which the said calling line terminates and including circuits connectable to said calling line conductor for determining the identification of said calling line in a particular subgroup of lines.

32. In a telephone system, calling lines, trunks to which said lines have access, recording means in each of said trunks, an identifying selector having access to said lines, means responsive to one of said trunks when taken into use by one of said lines for operating said identifying selector to hunt for and seize said calling line, and means for operating said recording means to record the identity of said calling line as determined by the movement of said identifying selector.

33. In a telephone system, calling lines, trunks to which said lines have access, recording means in each of said trunks, an identifying selector having access to said lines, and a connector circuit accessible in common to each one of said trunks when taken into use by one of said lines comprising means for operating said identifying selector to hunt for and seize said calling line, a settable register circuit responsive to the operation of said identifying selector for registering the movement thereof in reaching said calling line, and pulsing means responsive to the setting of said register circuit for operating said recording means to record the identity of said calling line.

34. In an automatic telephone system including calling lines and a group of line-finder switches having access thereto, means for recording the numbers of the lines on which calls are originated comprising a separate line-finder switch for each group of said line-finder switches having access to said lines, means for automatically actuating said separate line-finder switch to find the terminals of a calling line, settable registers responsive to the movement of said separate line-finder switch to mark the location of the calling line, means for registering the group of said line-finder switches, and means responsive to said last-mentioned means and to the setting of said settable registers for making a permanent record of the line-finder switch group and the numerical identification of said line.

35. In an automatic telephone system, a plurality of lines divided into groups, said groups of lines terminating, respectively, in the banks of a line-finder frame, a group of line finders on said frame having access to said lines, means responsive to any one of said lines when calling for operating an idle one of said line finders to seize said calling line, an outgoing trunk, means for connecting said operated line-finder switch to said outgoing trunk, and means for recording the numerical designation of said line comprising a line-finder group register, a brush set register and a numerical register, an identifying line finder common to said group of line finders, having a plurality of brush sets having access, respectively, to said banks, means responsive to the seizure of said calling line by one of said group of line finders to cause said identifying line finder to seize said calling line, means in said outgoing trunk for operating said group register, means for operating said brush set register and said numerical register in accordance with the operation of said identifying line finder in seizing said calling line, and further means in said outgoing trunk for recording the operated condition of said group register, said brush register and said numerical register.

36. In a telephone system, lines disposed in groups on the terminal banks of a panel frame, automatic switching selectors having access to the terminal banks of said panel frame, each of said selectors being provided with as many brush sets as there are line groups in said terminal banks

for causing the engagement of the selector with any line in any group, an identifying selector provided with as many brush sets as there are line groups in said terminal banks, and a connector accessible to each of said switching selectors when taken into use by one of said lines comprising means for operating said identifying selector to hunt for and seize the terminals of the calling line, relay means responsive to the connection of one of the brush sets of said identifying selector with the terminals of the calling line for marking the brush set so connected, counting means responsive to the terminal movement of said identifying selector for marking the number of terminals in a bank travelled over by said identifying selector prior to reaching the terminal of the calling line, stepping switches responsive to said operated relay means and to said counting means for transmitting a plurality of groups of pulses indicative of the brush set of said identifying selector having access to the group of lines containing said calling line and of the numerical indication of the disposition of said calling line terminal within the line group, and recording means responsive to the operation of said switches for making a permanent record of said plurality of groups of pulses.

37. In a telephone system, a plurality of numerically designated lines, means including a plurality of selectors for connecting a calling with a called line, a plurality of registers variably operable by a calling line in accordance with the digits of the called number to control the setting of the selectors, one after the other, to establish the desired connection, means operable upon the initiation of a call for connecting an idle register with the calling line, means operable when the called number comprises certain combinations of digits for releasing the connected register after the setting of all the selectors, and means for releasing the register after the setting of the first one of the selectors if the called number comprises a predetermined digit.

38. In a telephone system, a plurality of numerically designated lines, means including a plurality of selectors for connecting a calling with a called line, a plurality of registers, each having a plurality of digit switches variably operable by digits of the called number dialed over the calling line, switching means for connecting an idle register with a calling line, means in the registers to connect the associated digit switches, one after the other, with successive selectors to control their setting, means for releasing the connected register after the setting of all the selectors, means in the register for simultaneously setting the first selector with the first digit switch, means operable in response to a first digit of a certain numerical value for releasing the connected register upon the receipt of the first digit from the calling line, and means operable thereupon and controlled directly by the additional digits dialed over the calling line for controlling the setting of the other selectors over the operated first selector.

39. The system according to claim 38, characterized in that the selectors are step-by-step selectors responsive to directive impulses, and means in the register for repeating and sending to the selectors impulses corresponding to the digits dialed over the calling line.

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