

Feb. 10, 1942.

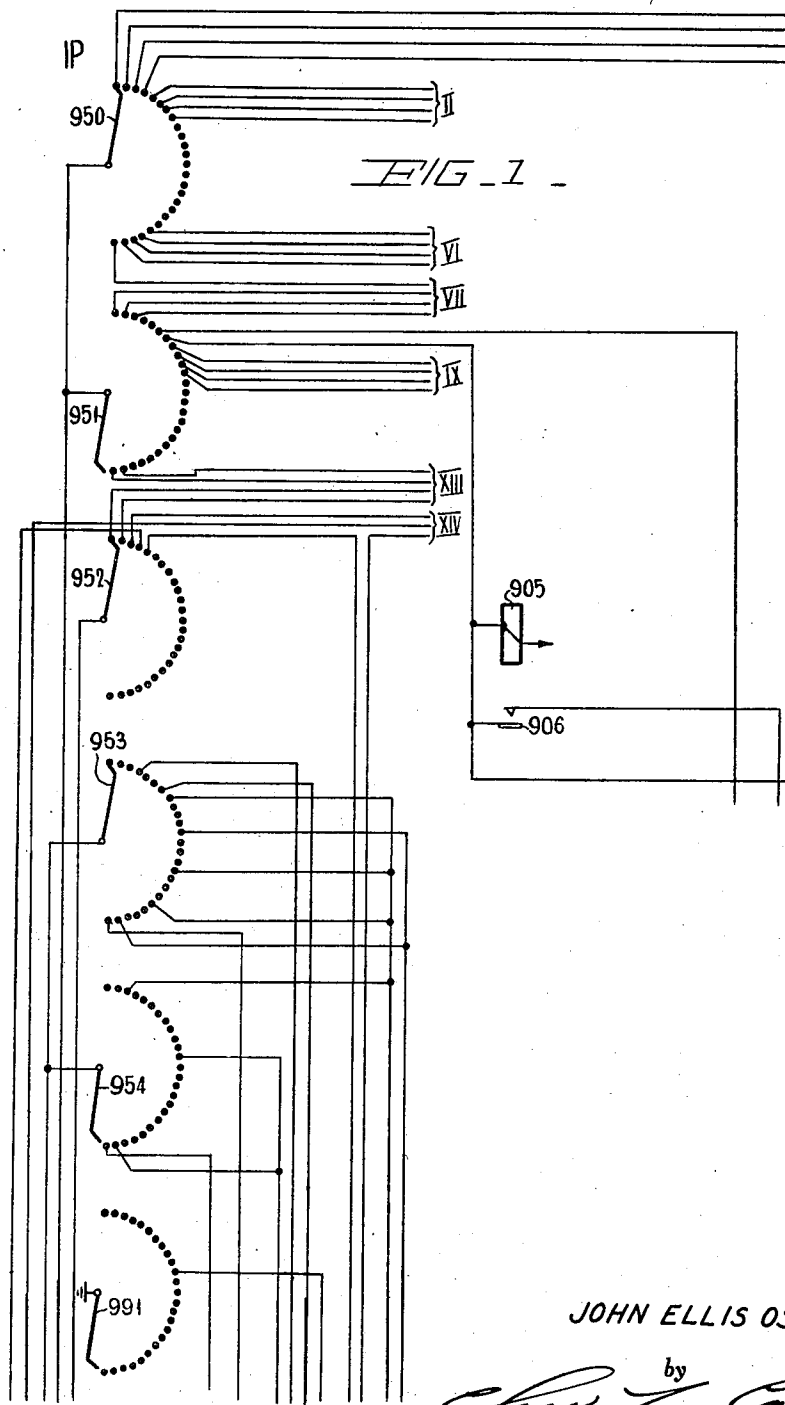
J. E. OSTLINE

2,272,475

TELEPHONE SYSTEM

Filed June 12, 1939

30 Sheets-Sheet 1



Inventor:
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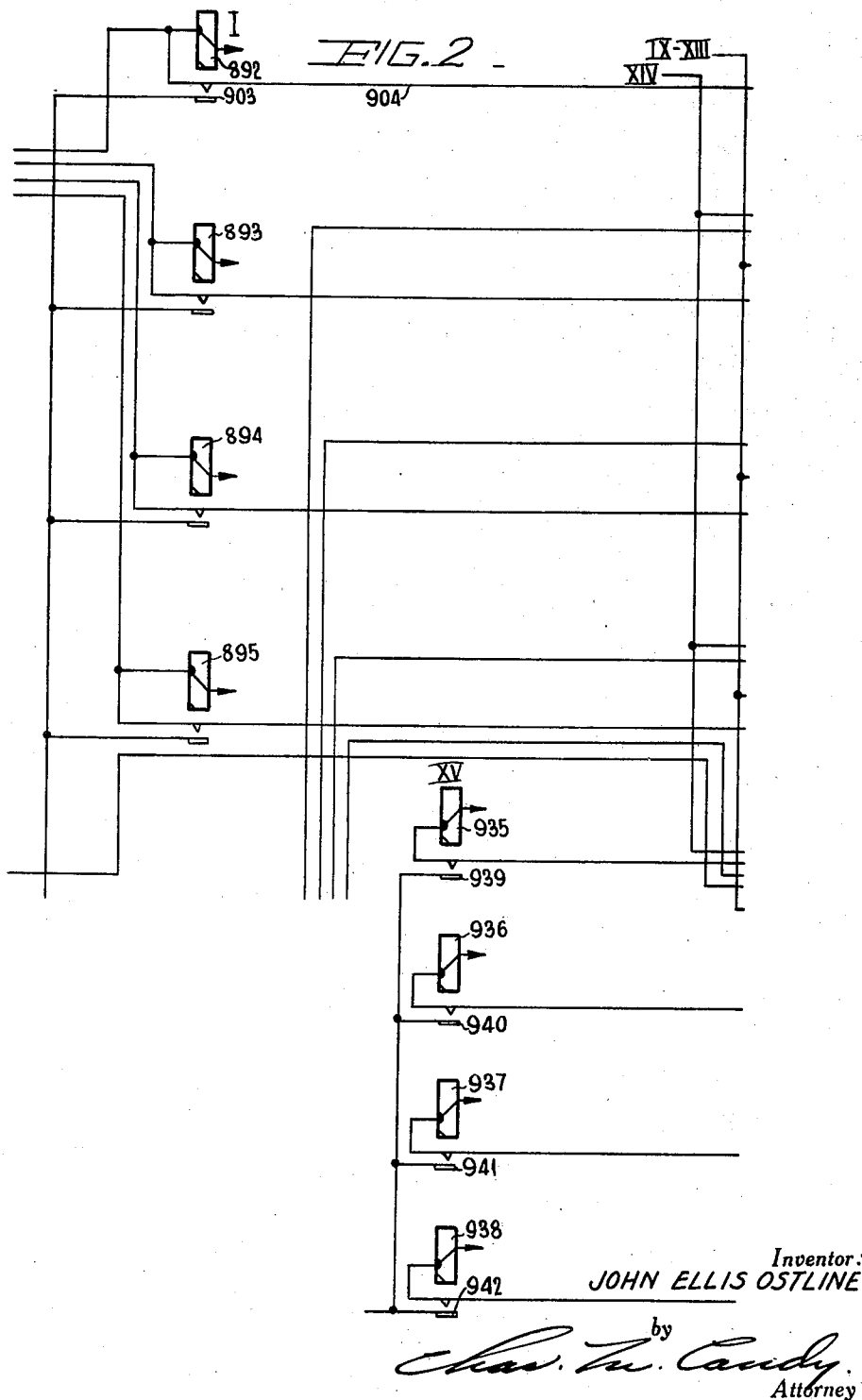
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TELEPHONE SYSTEM

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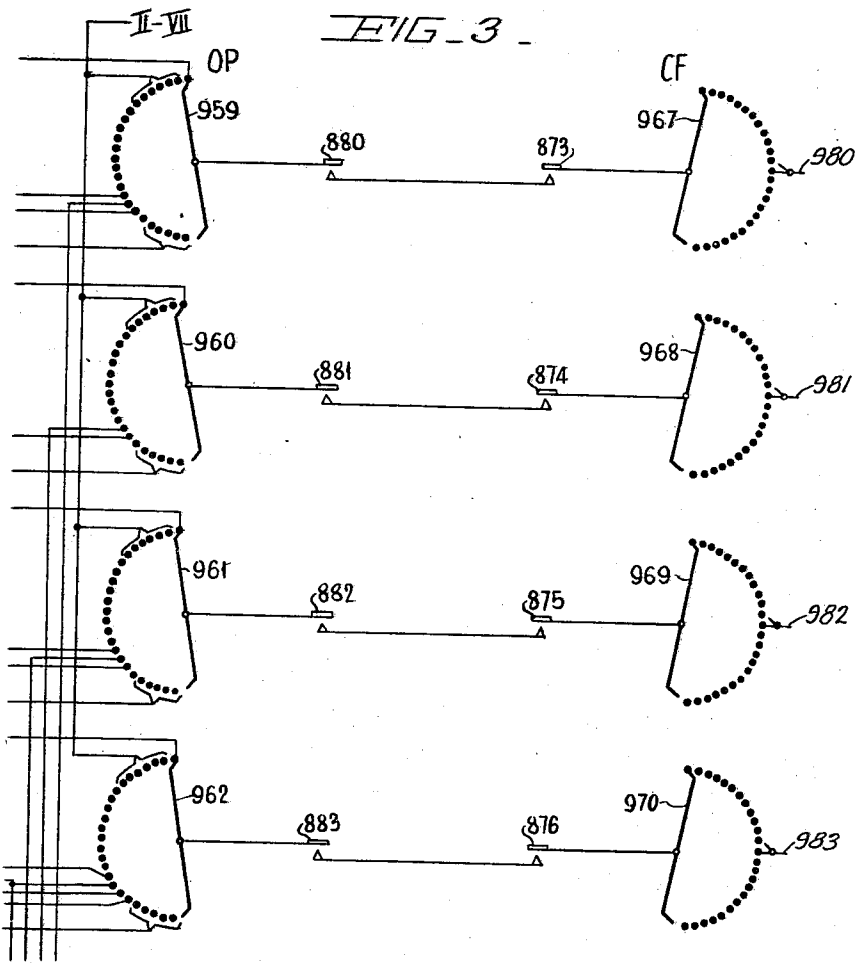


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J. E. OSTLINE
TELEPHONE SYSTEM
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30 Sheets-Sheet 3



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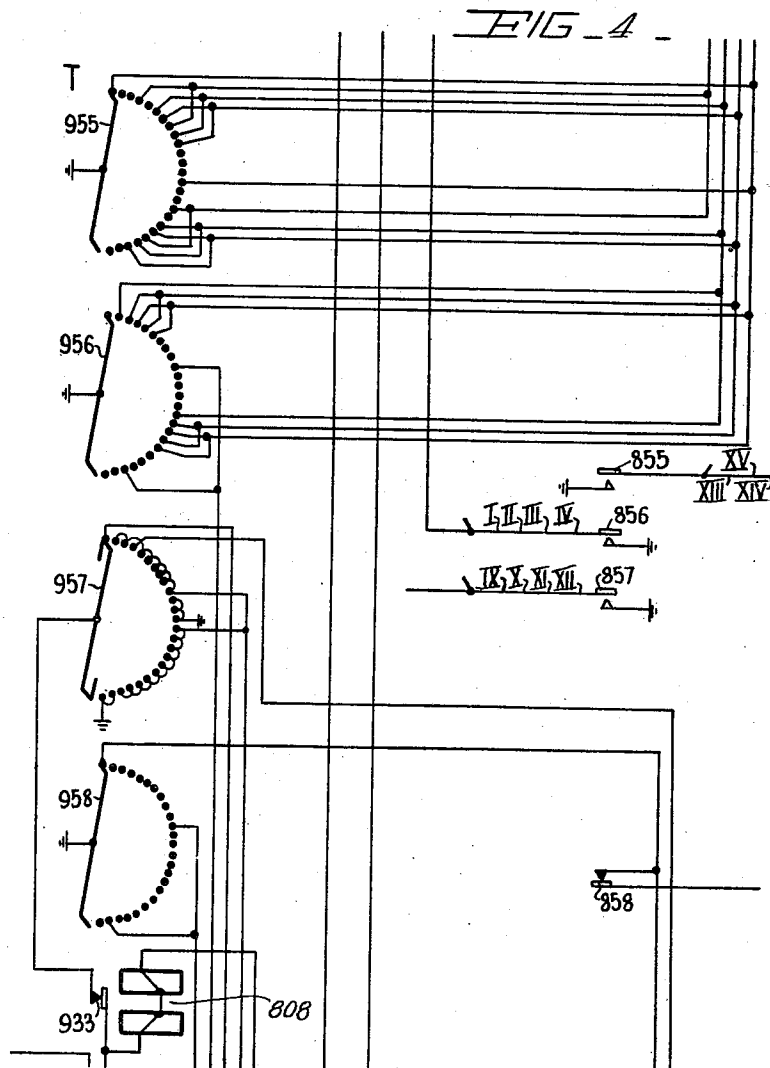
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TELEPHONE SYSTEM

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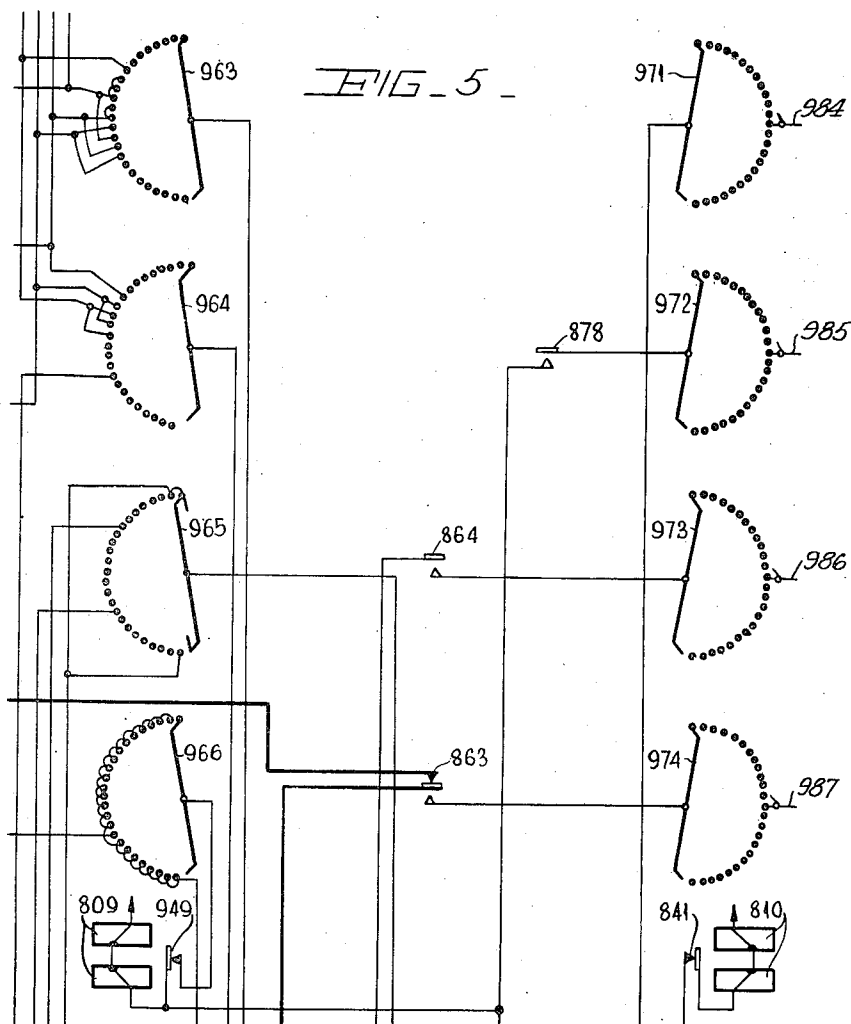
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TELEPHONE SYSTEM

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30 Sheets-Sheet 5



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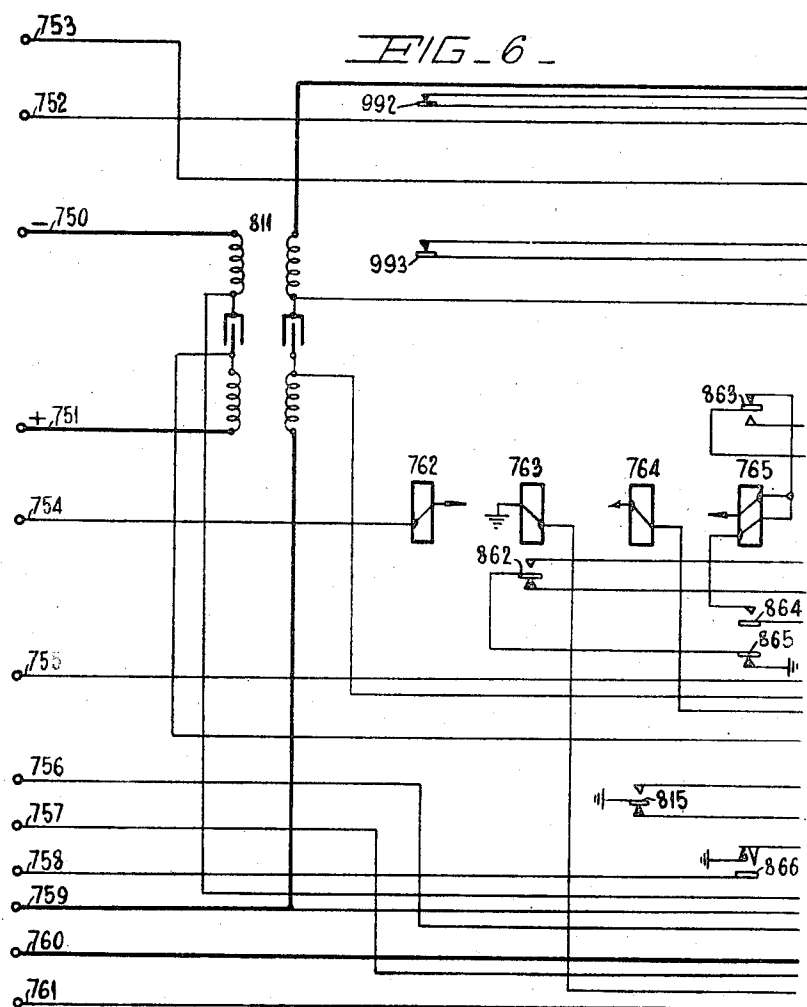
J. E. OSTLINE

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TELEPHONE SYSTEM

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30 Sheets-Sheet 6



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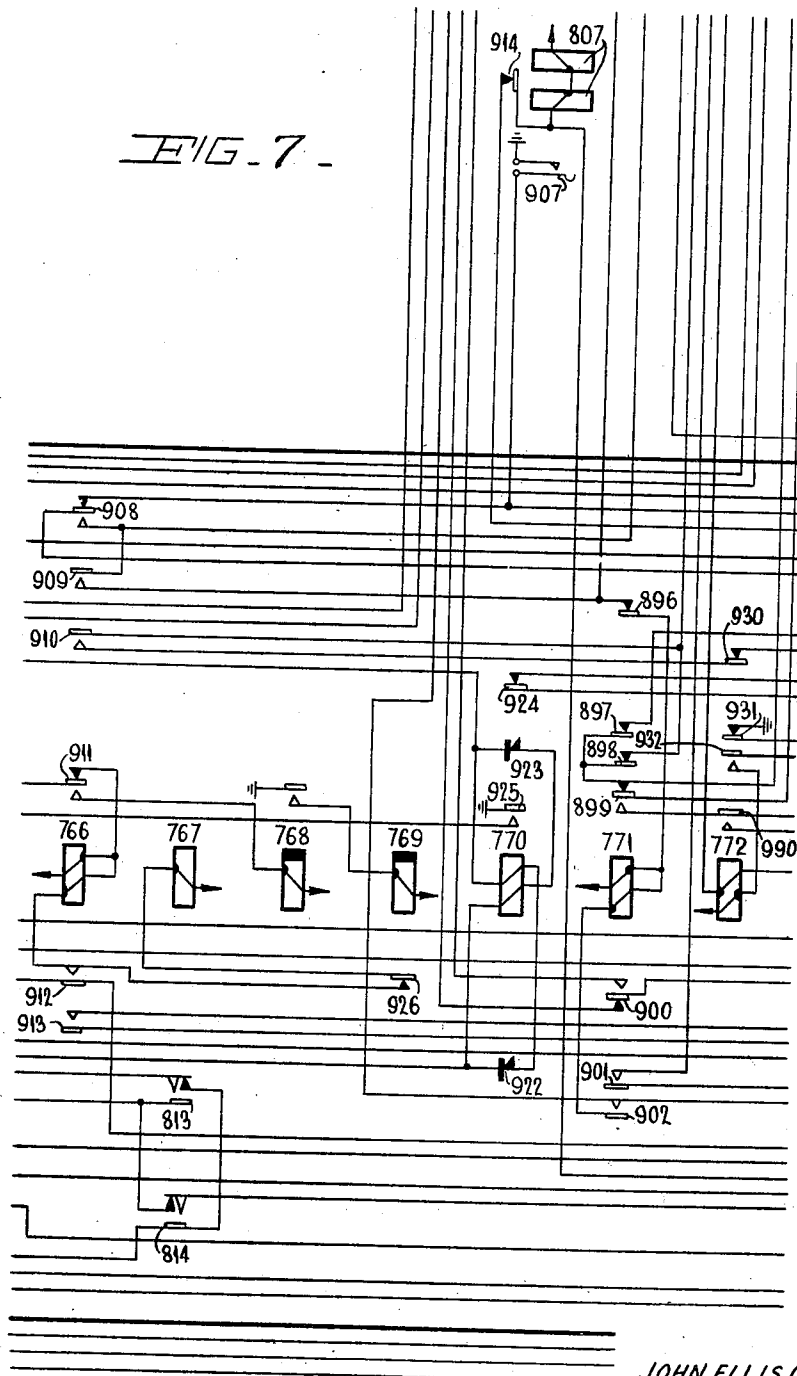
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FIG. 7.



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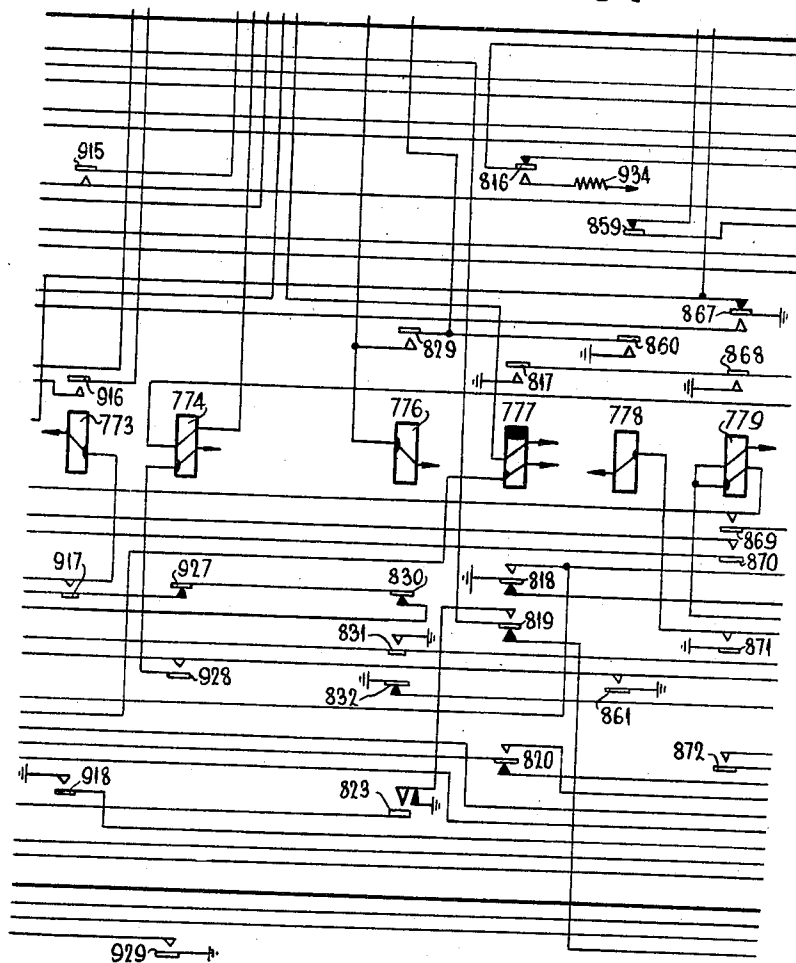
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FIG. 8.



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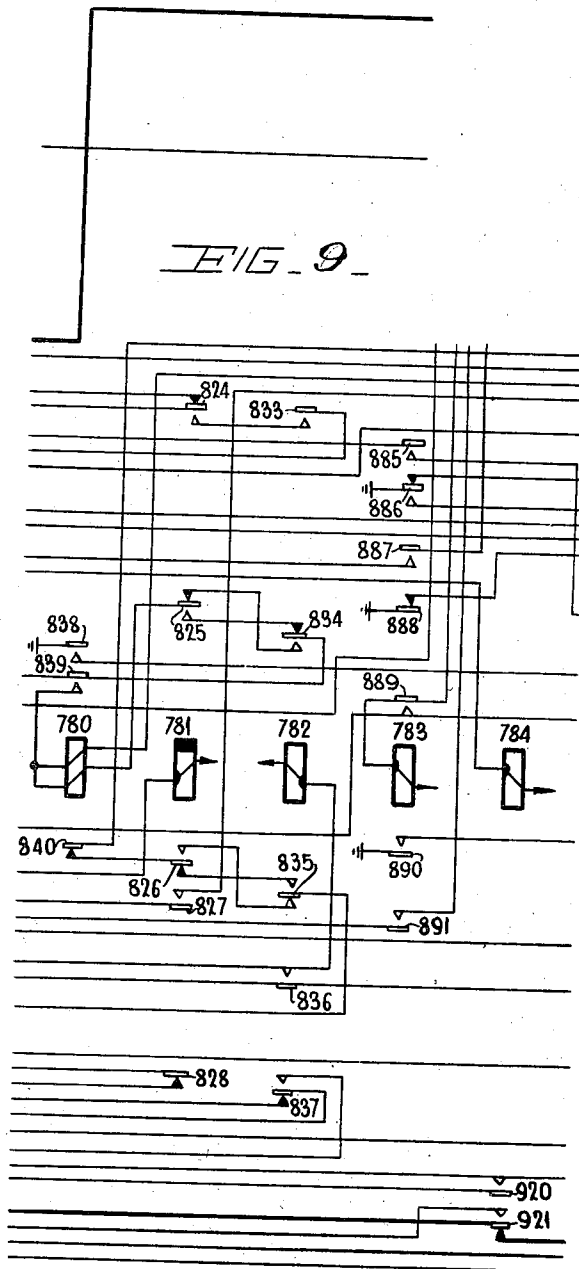
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FIG. 9



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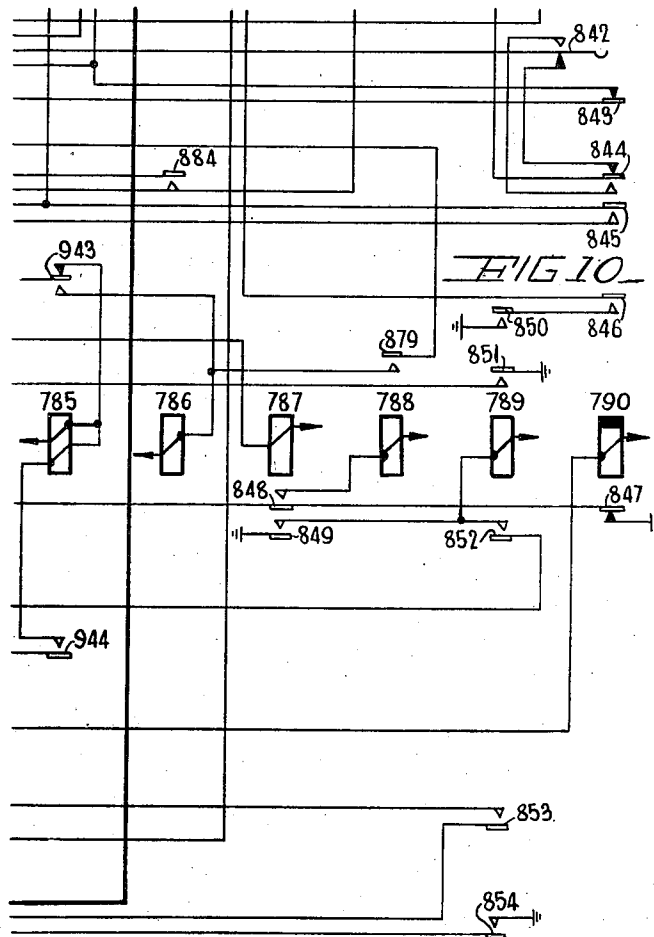
J. E. OSTLINE

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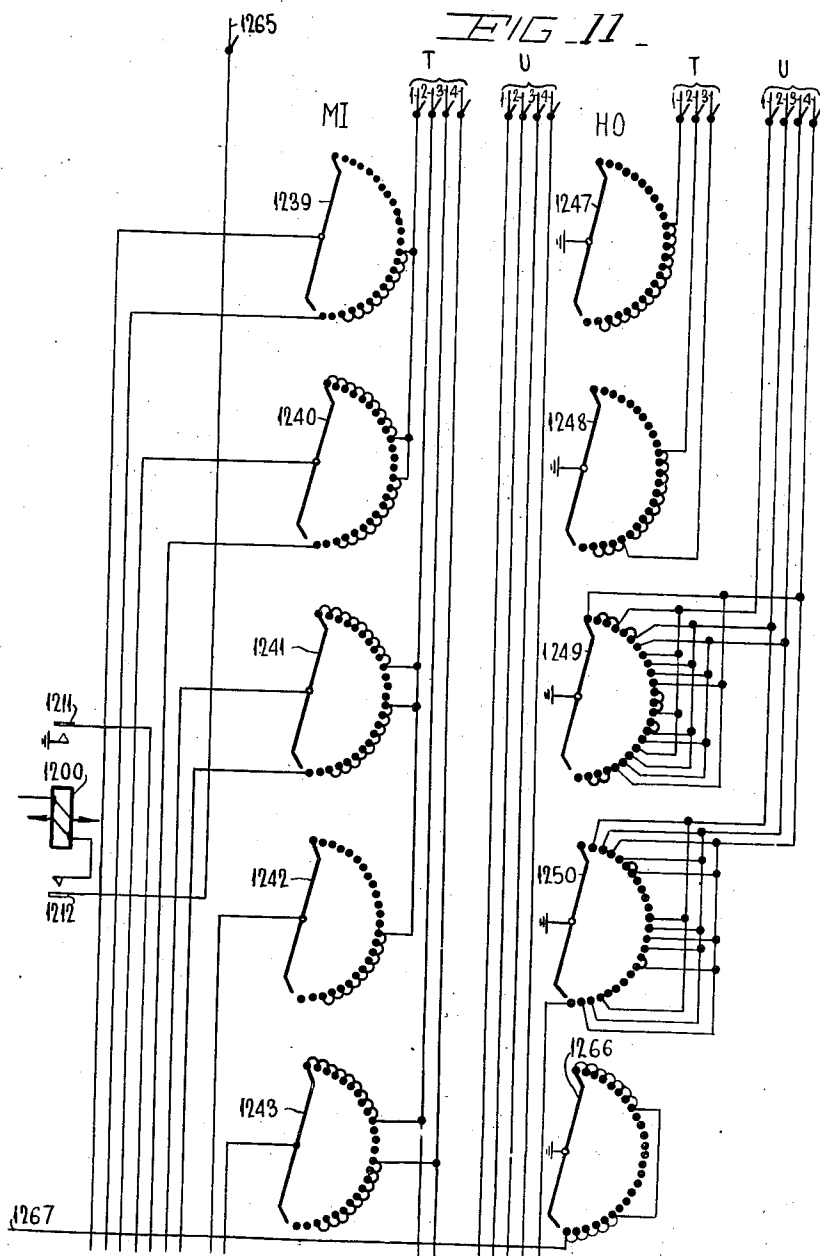
J. E. OSTLINE

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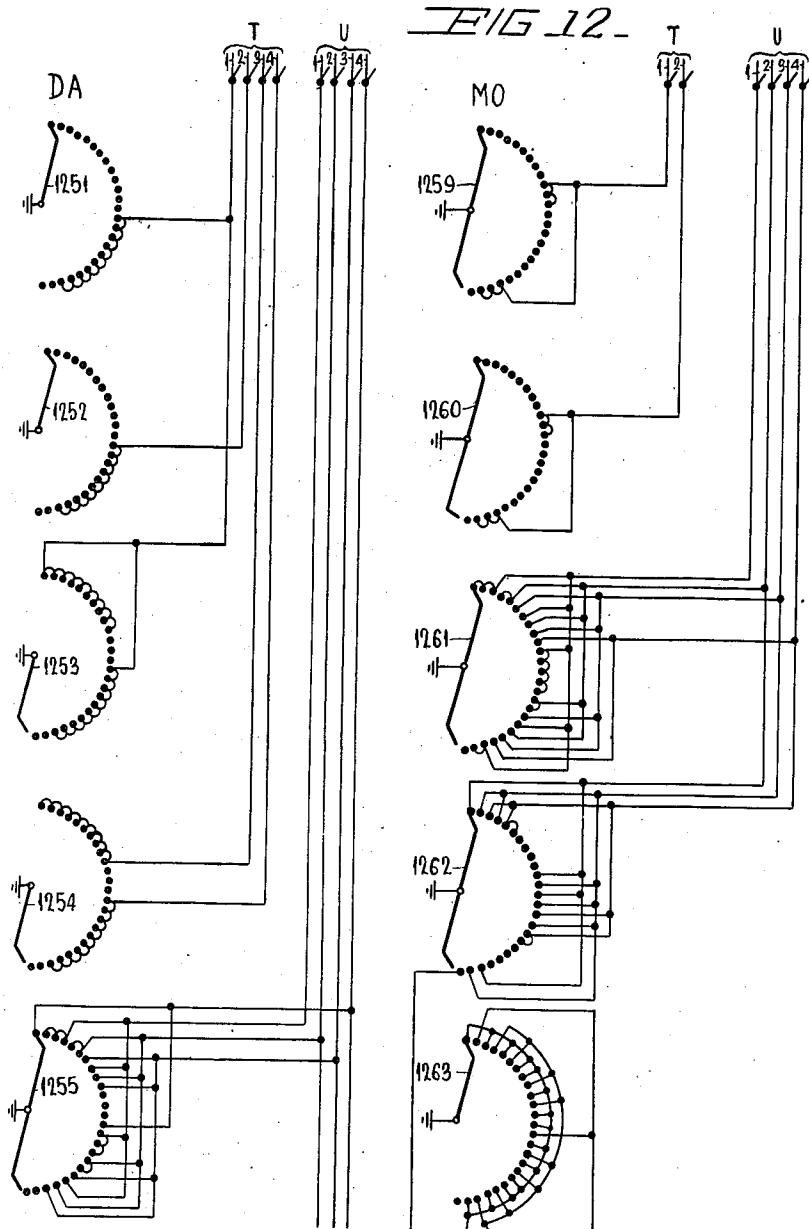
J. E. OSTLINE

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TELEPHONE SYSTEM

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30 Sheets-Sheet 12



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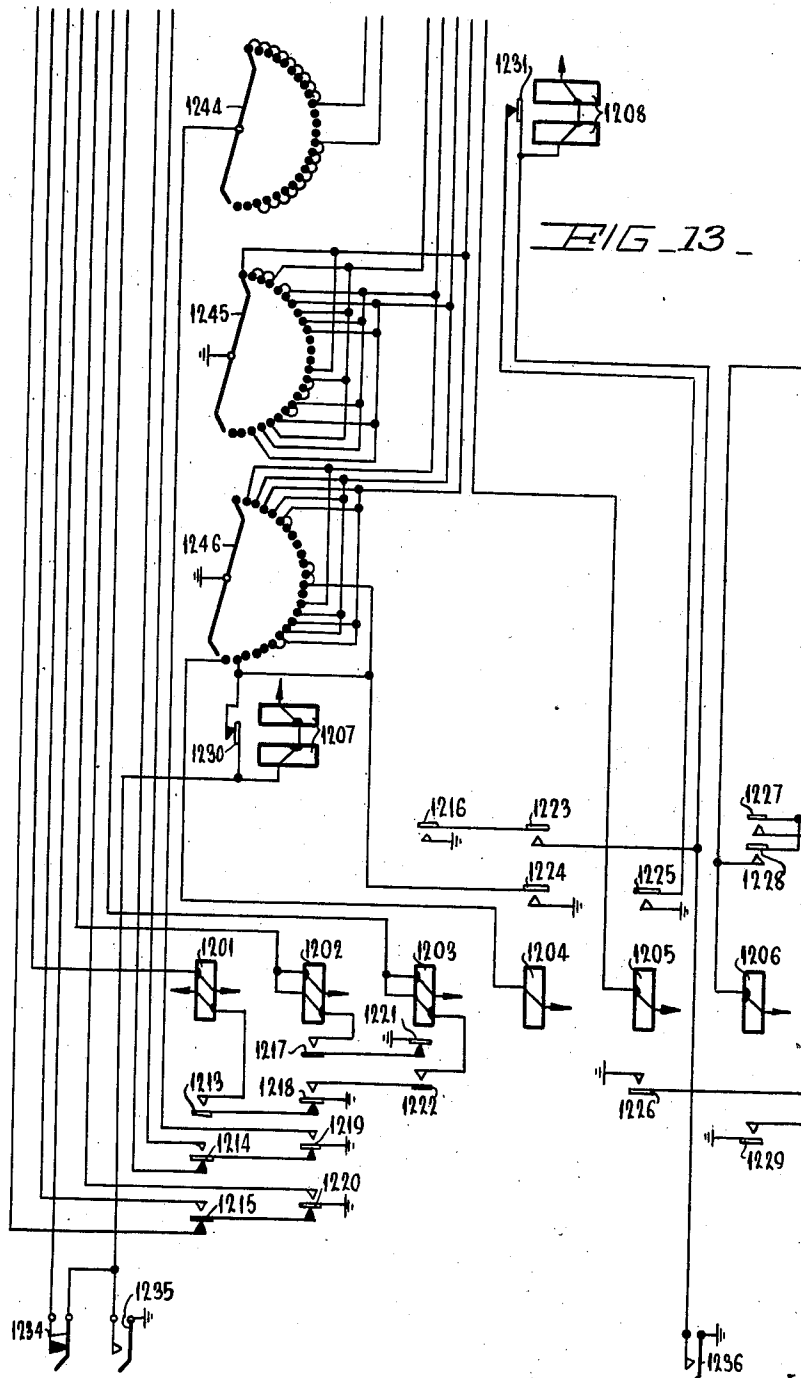
J. E. OSTLINE

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TELEPHONE SYSTEM

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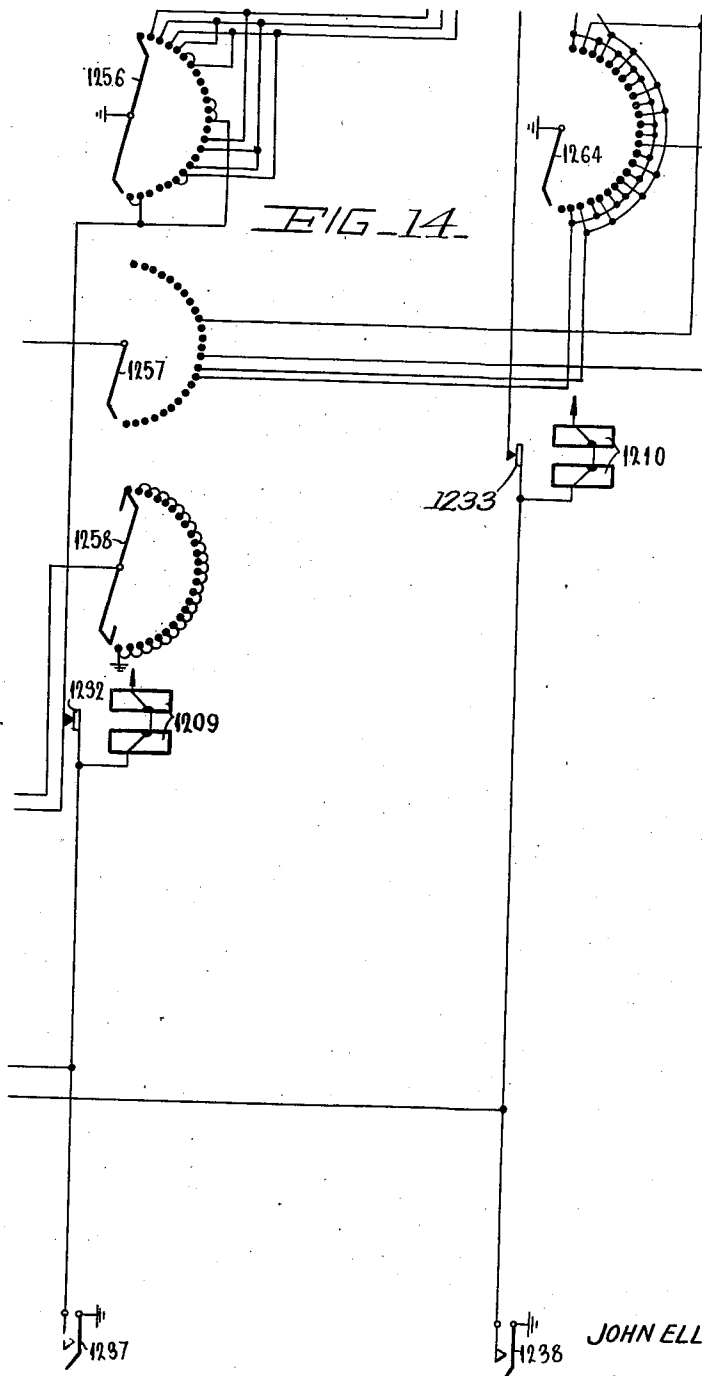
J. E. OSTLINE

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TELEPHONE SYSTEM

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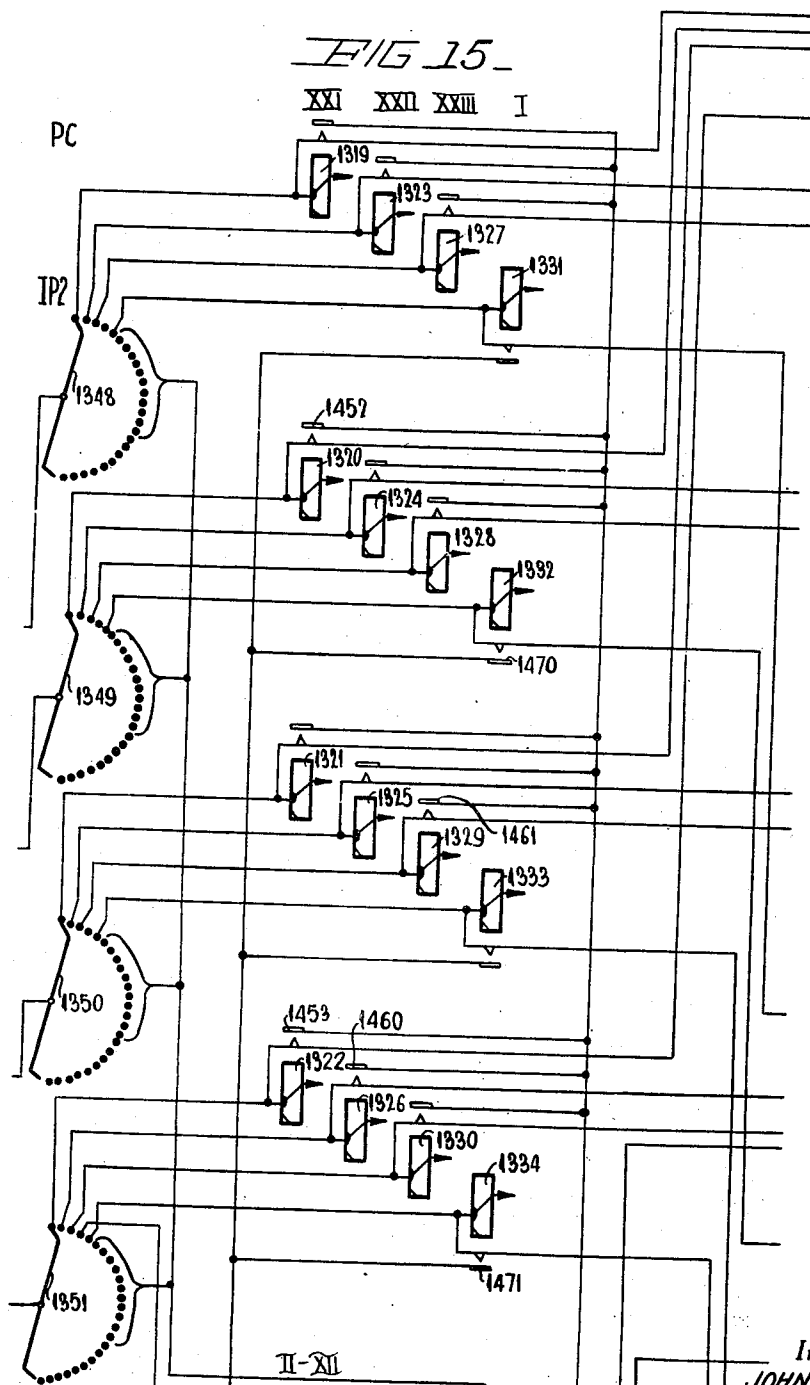
J. E. OSTLINE

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TELEPHONE SYSTEM

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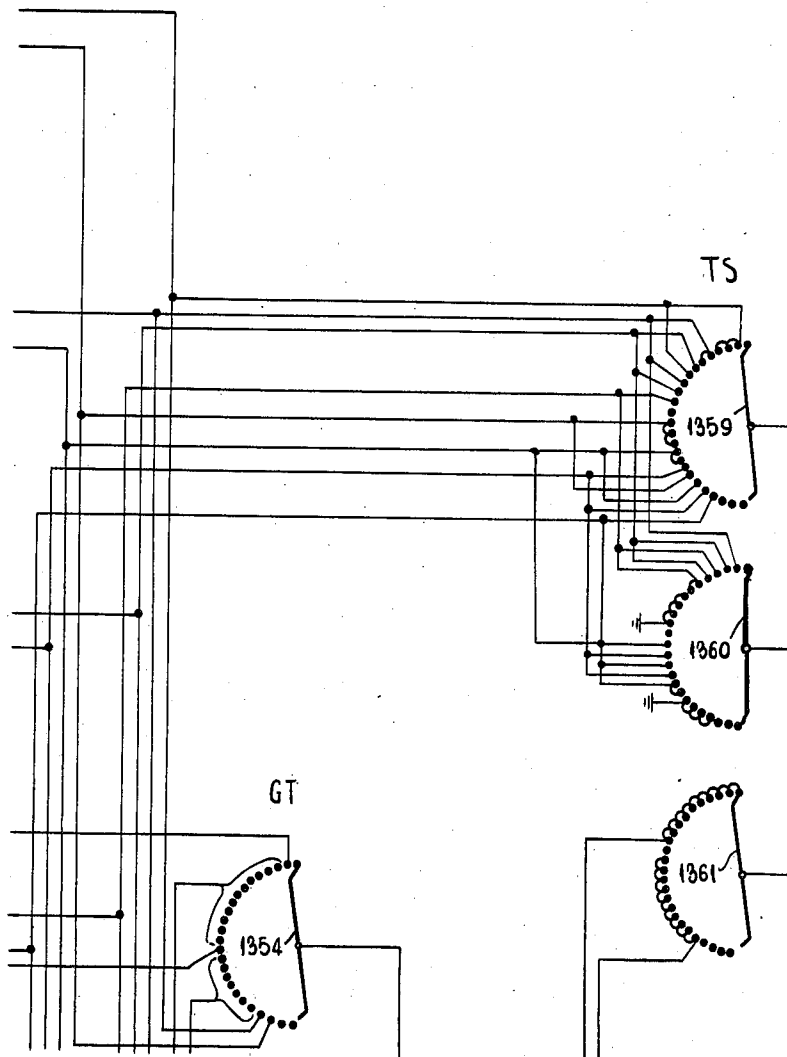
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FIG 16



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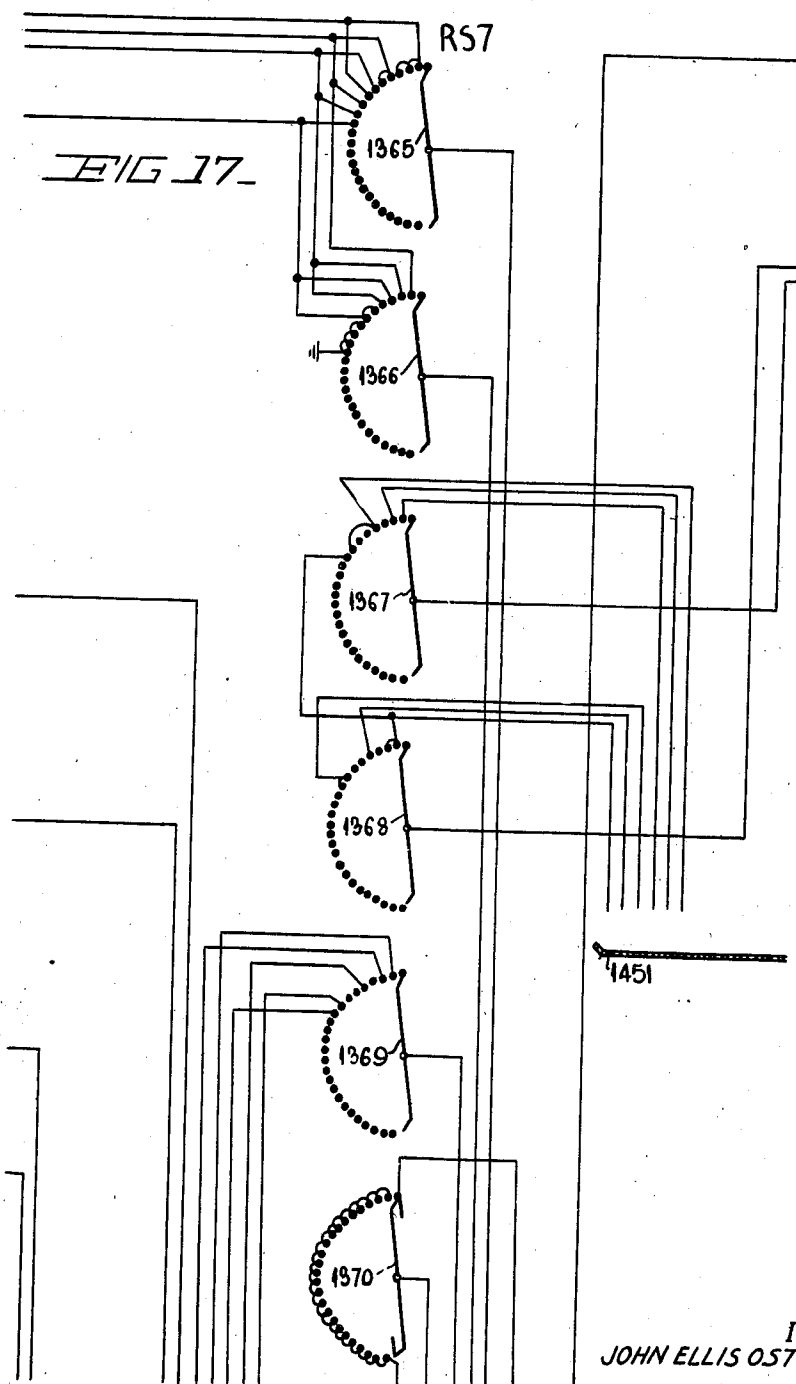
J. E. OSTLINE

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TELEPHONE SYSTEM

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30 Sheets-Sheet 17



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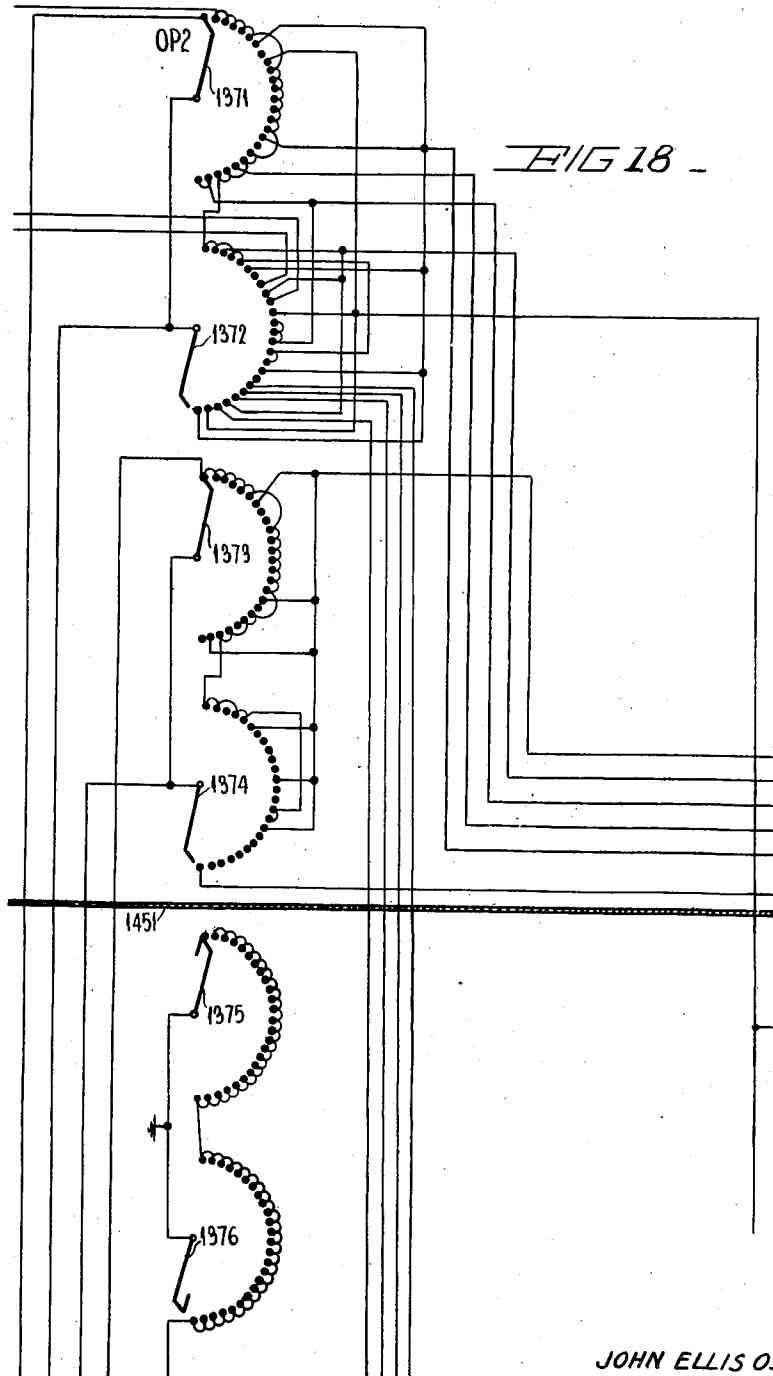
J. E. OSTLINE

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TELEPHONE SYSTEM

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30 Sheets-Sheet 18



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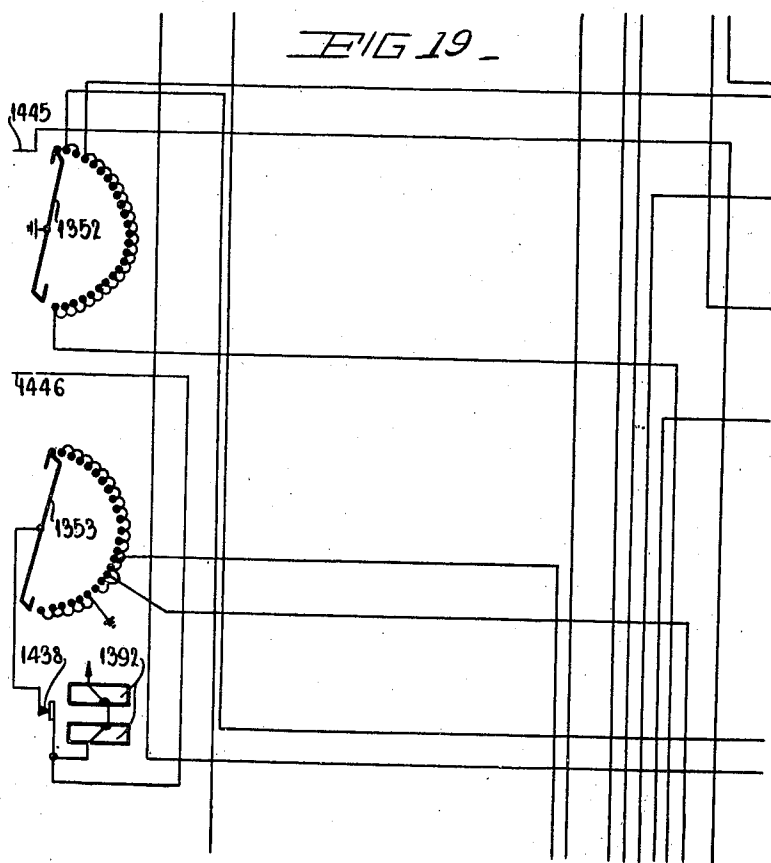
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TELEPHONE SYSTEM

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30 Sheets-Sheet 19



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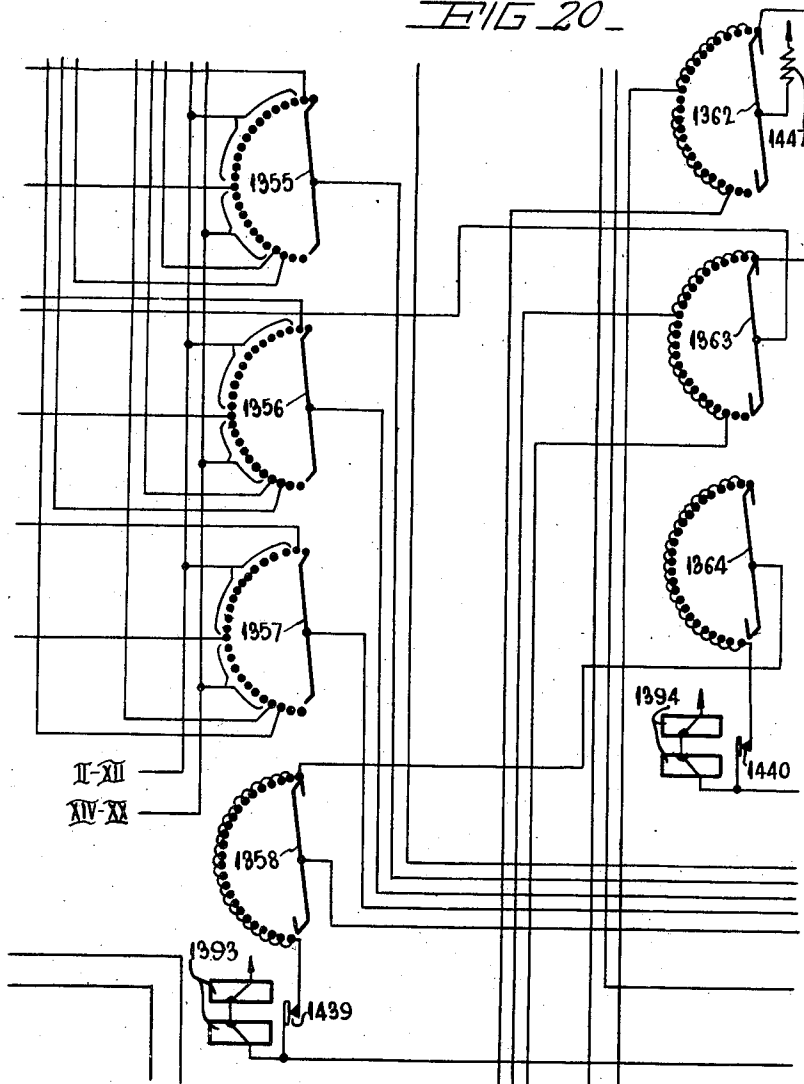
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FIG 20



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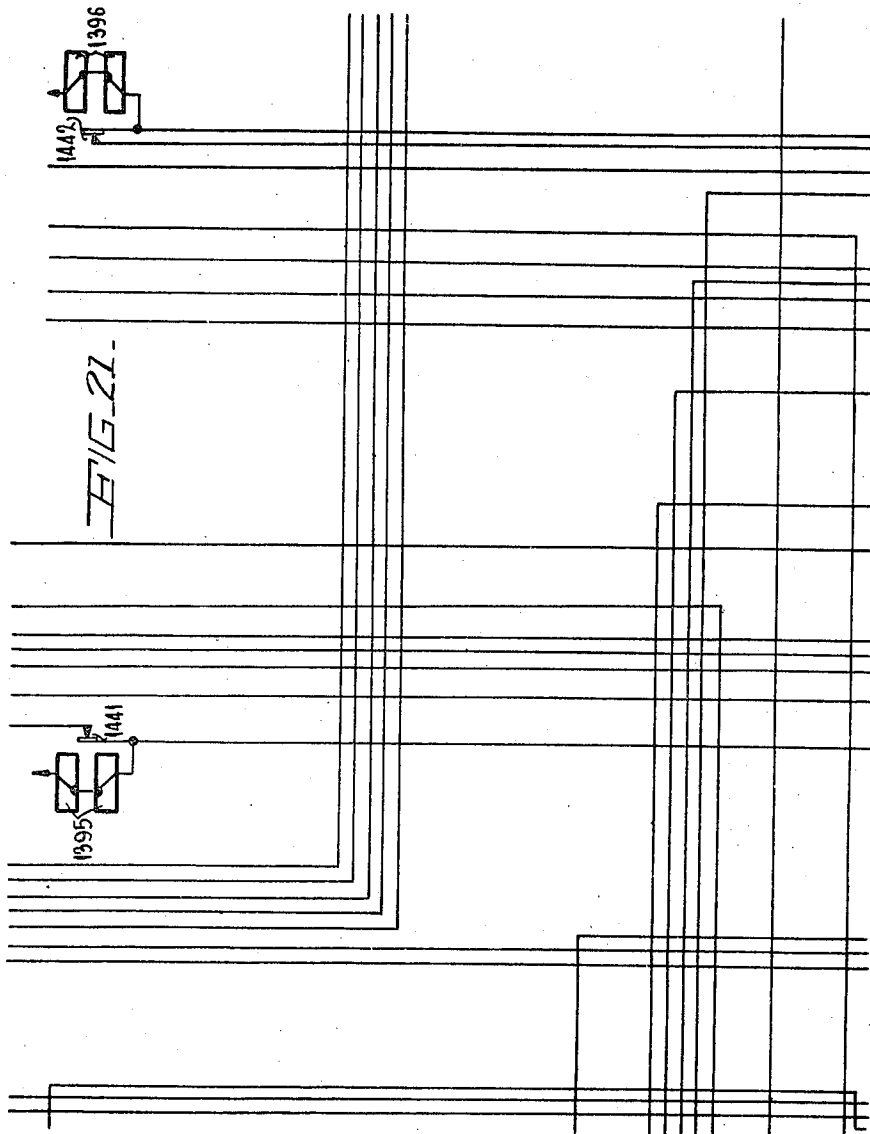
J. E. OSTLINE

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TELEPHONE SYSTEM

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30 Sheets-Sheet 21



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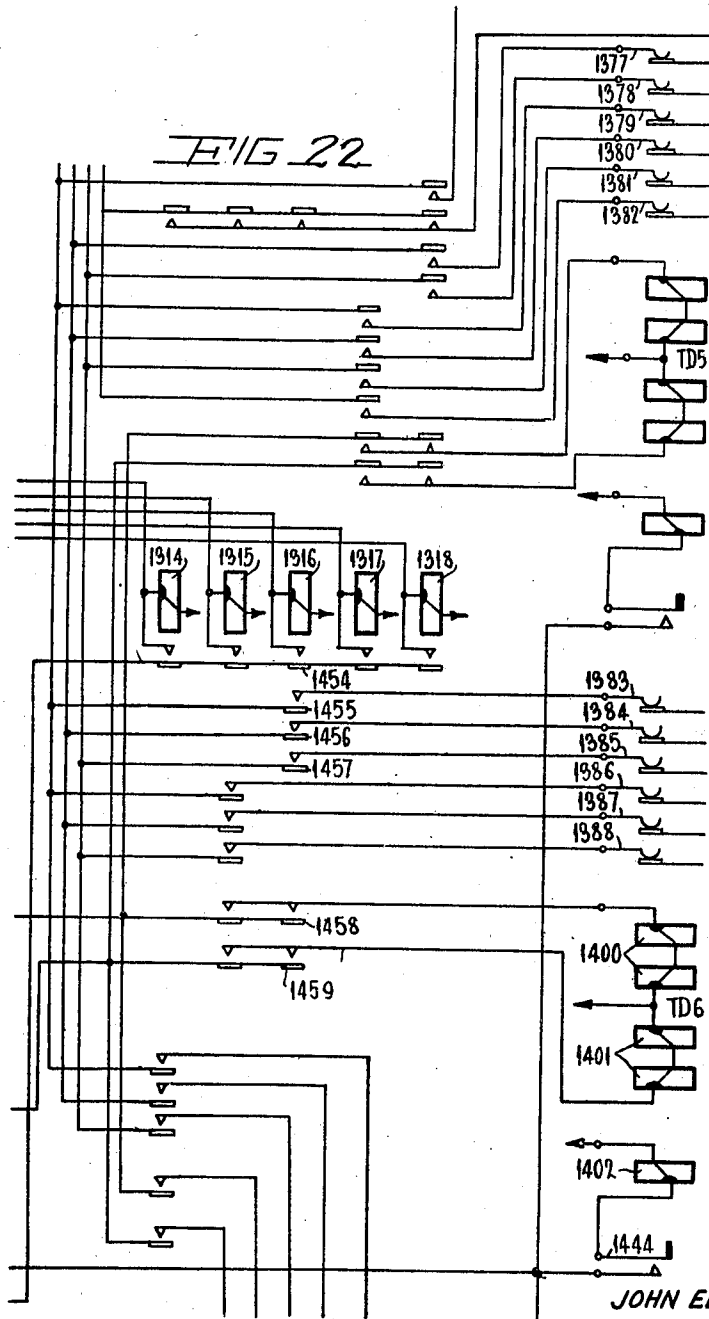
J. E. OSTLINE

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30 Sheets-Sheet 22



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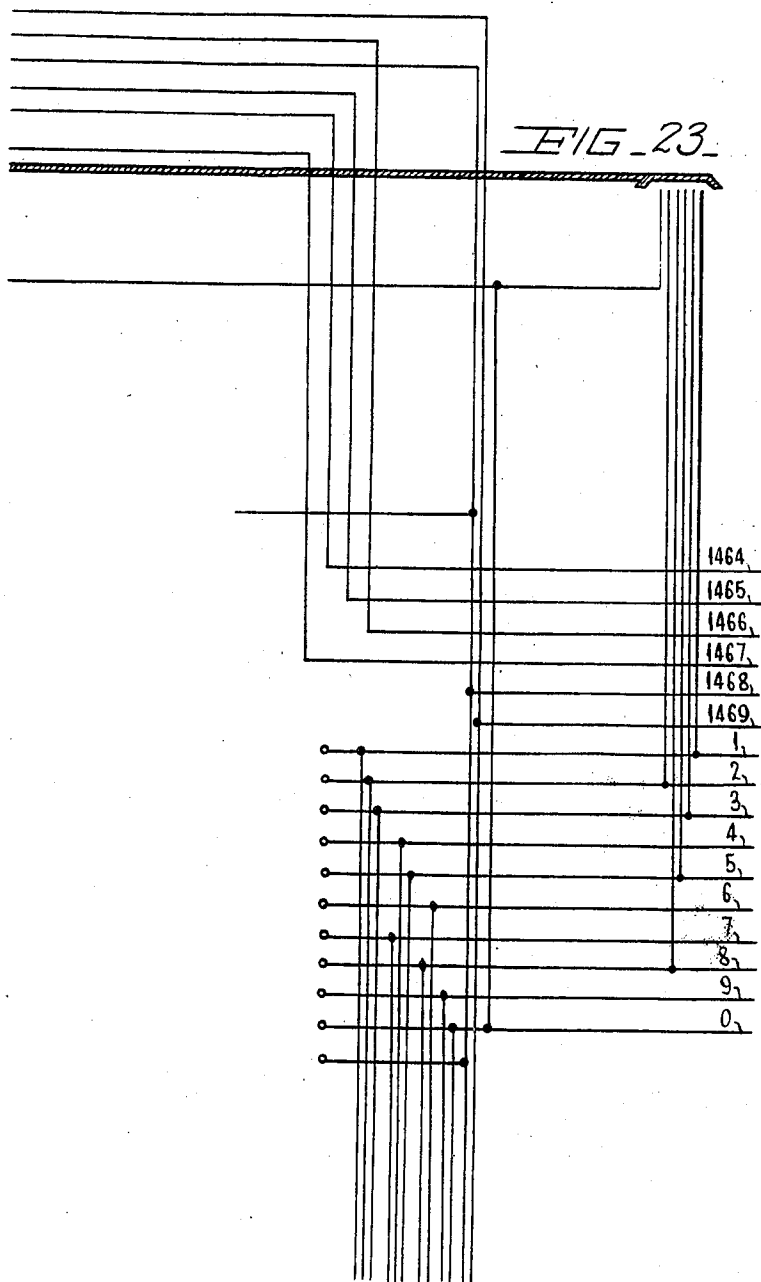
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TELEPHONE SYSTEM

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30 Sheets-Sheet 23



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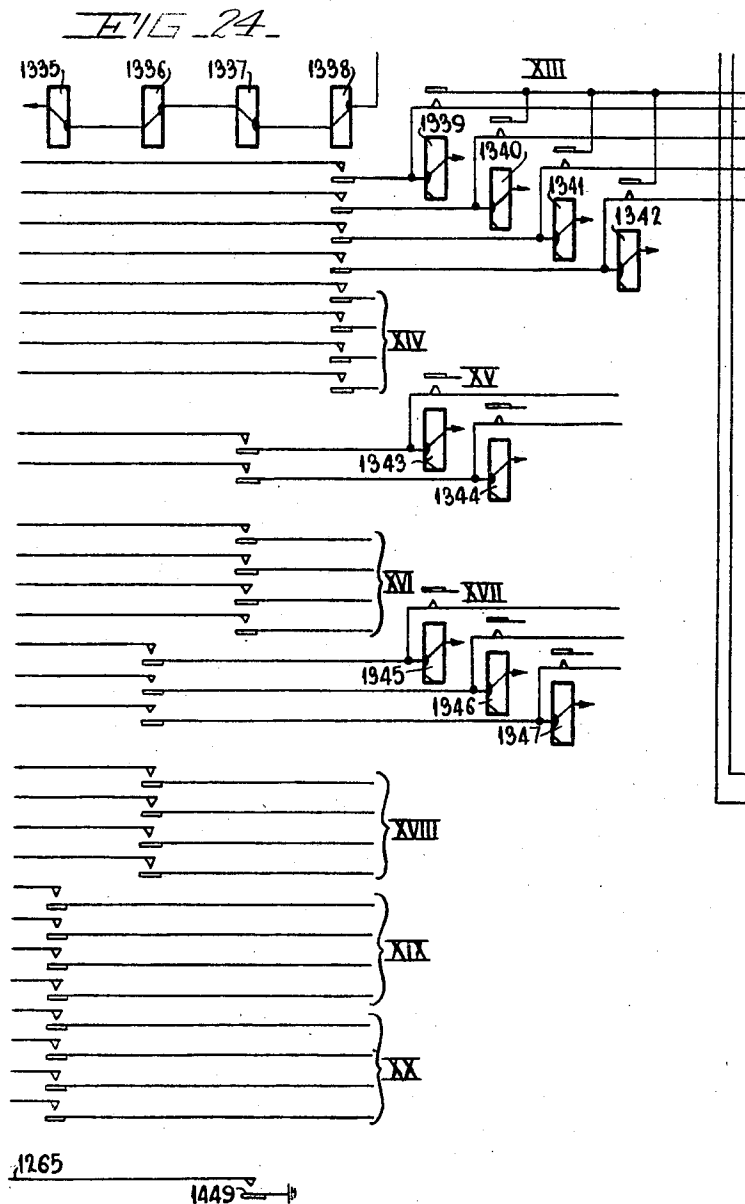
J. E. OSTLINE

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30 Sheets-Sheet 24



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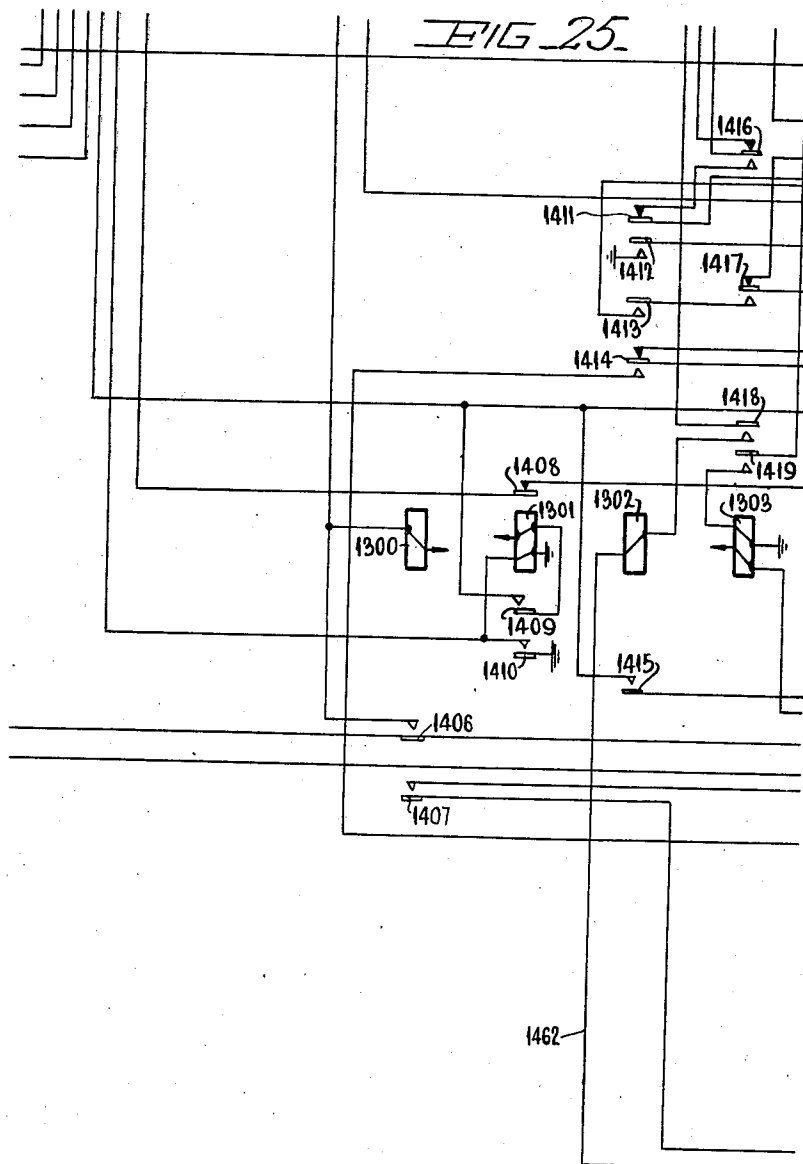
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TELEPHONE SYSTEM

Filed June 12, 1939

30 Sheets-Sheet 25



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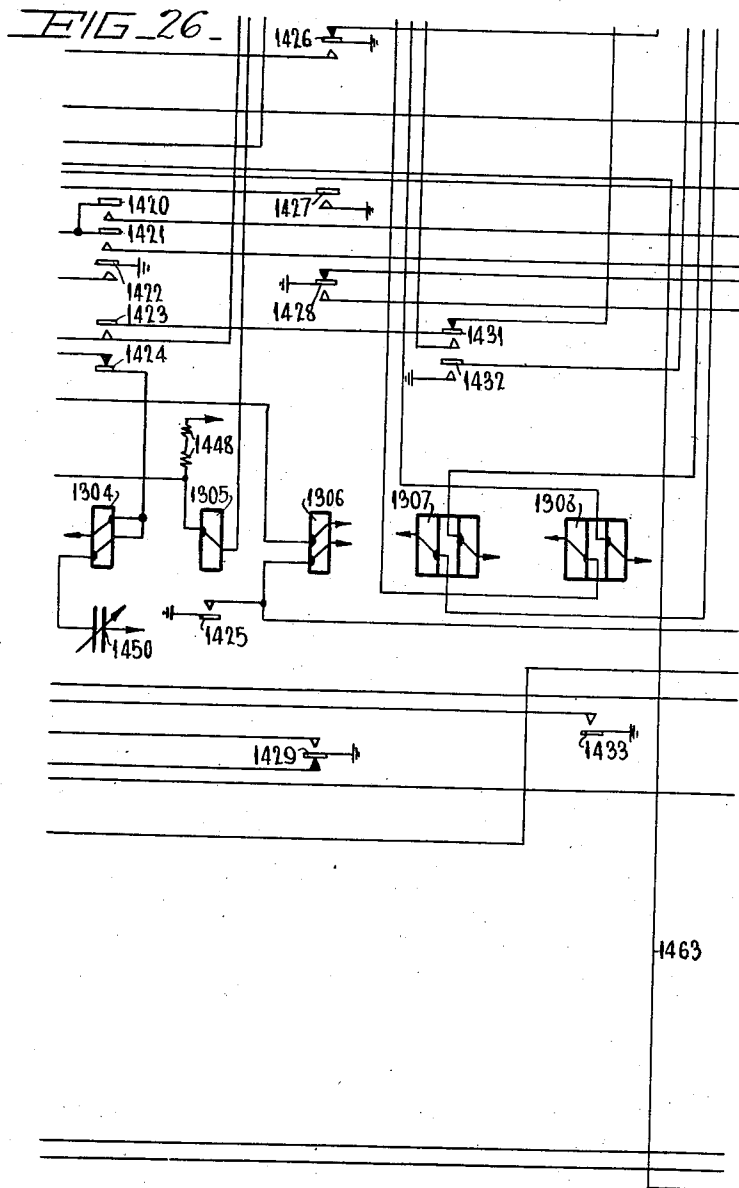
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TELEPHONE SYSTEM

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30 Sheets-Sheet 26



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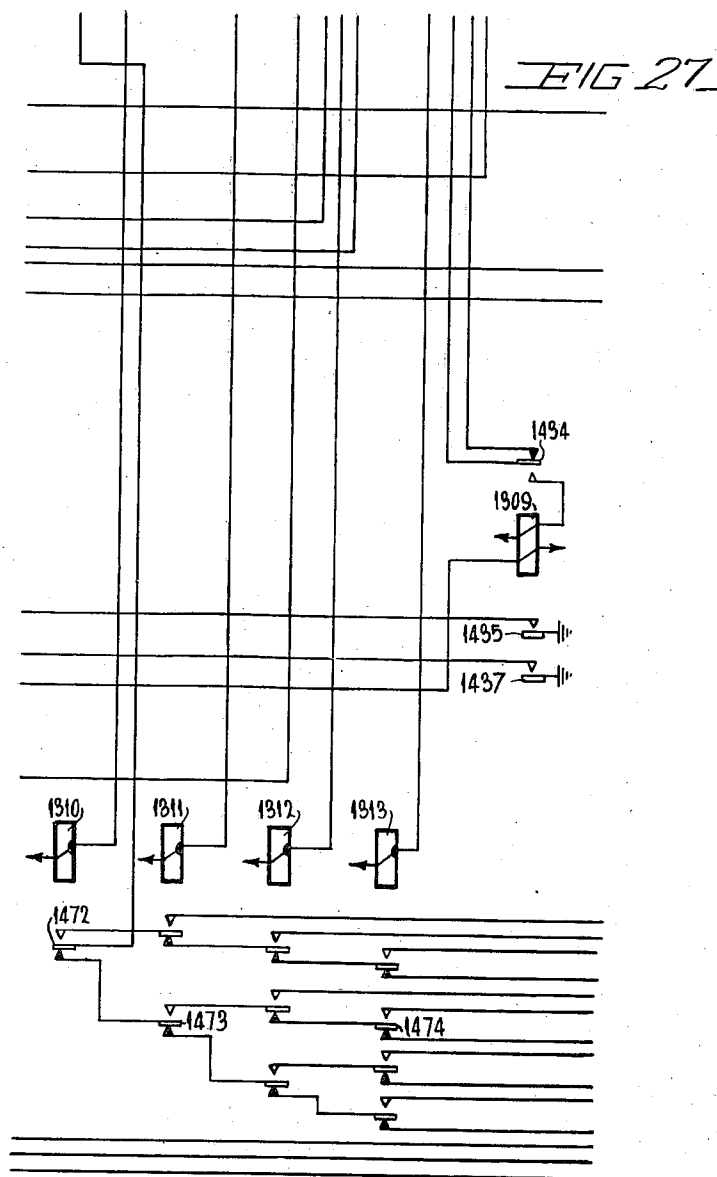
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TELEPHONE SYSTEM

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30 Sheets-Sheet 27



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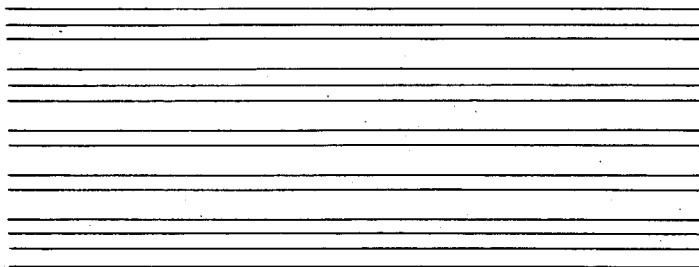
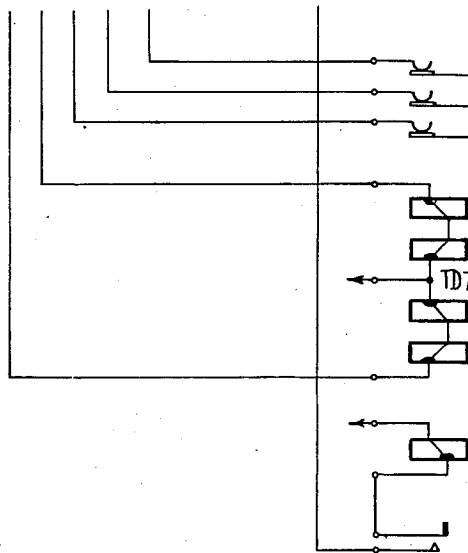
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FIG. 28.



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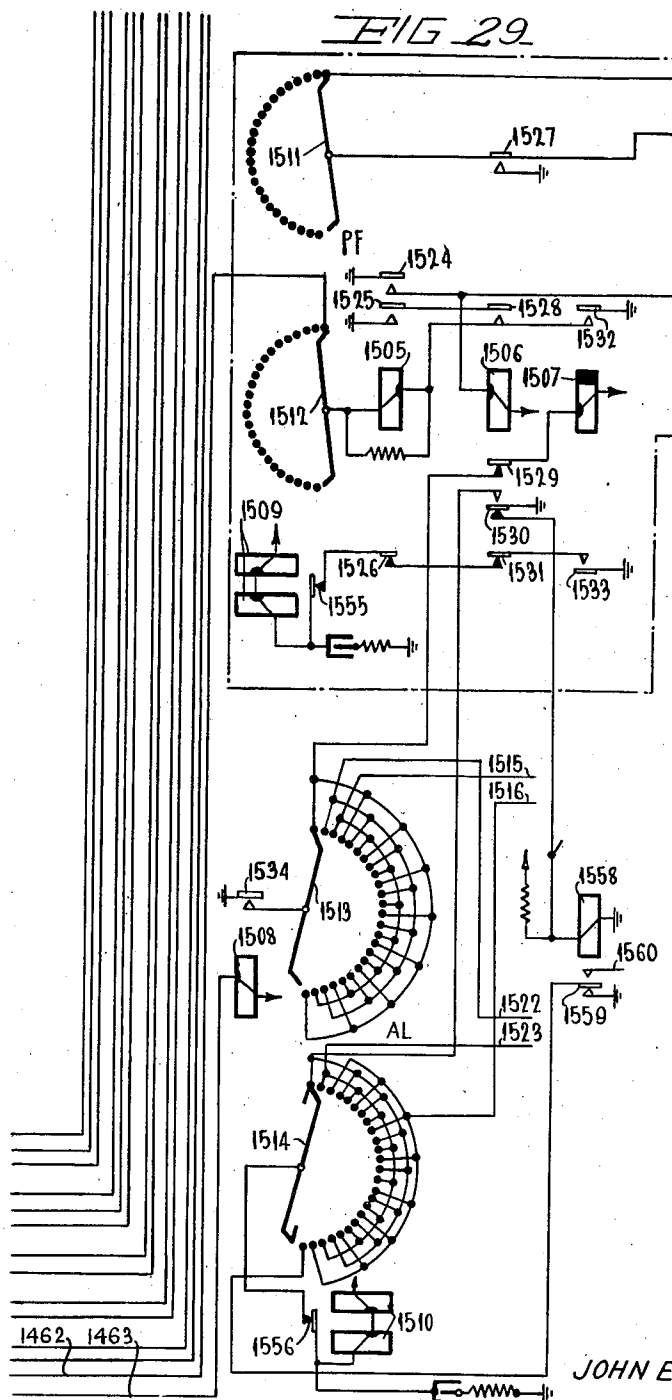
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TELEPHONE SYSTEM

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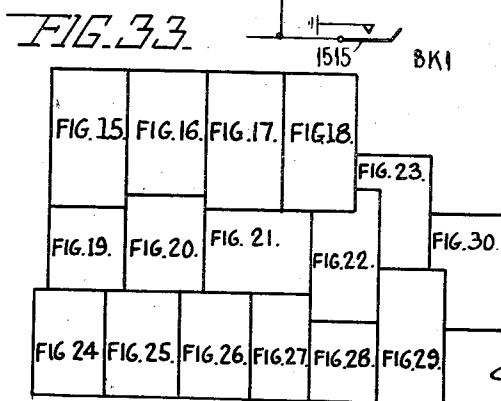
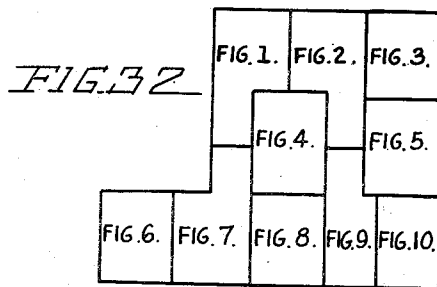
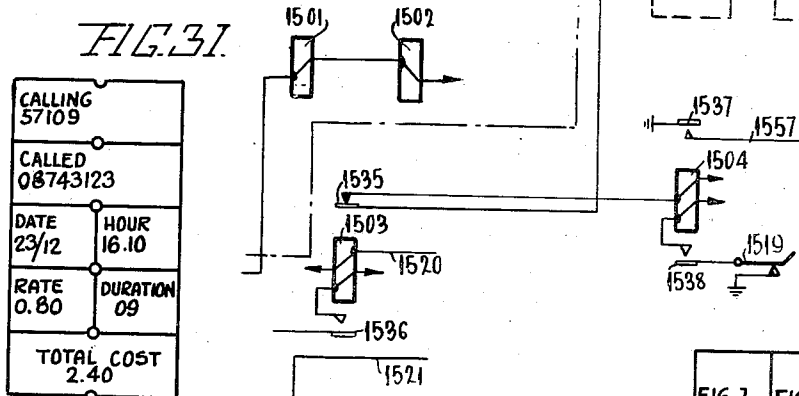
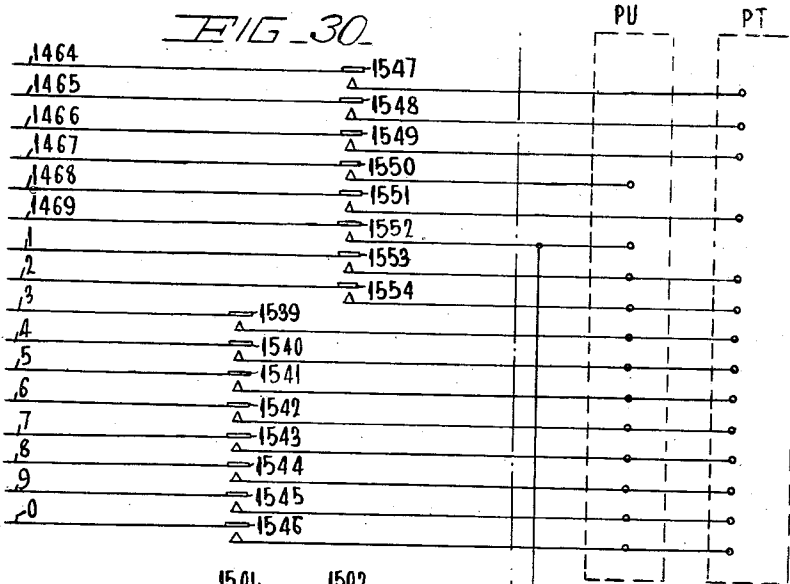
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TELEPHONE SYSTEM

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30 Sheets-Sheet 30



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UNITED STATES PATENT OFFICE

2,272,475

TELEPHONE SYSTEM

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

Application June 12, 1939, Serial No. 278,729
In Great Britain June 14, 1938

21 Claims. (Cl. 179-7.1)

The present invention concerns improvements in or relating to telephone systems and in particular, is concerned with improved methods of recording information in connection with such systems.

It is a general practice in existing telephone systems to have information recorded in writing by an operator, but it has also been proposed to employ printing equipment which is operated during the progress of a call in accordance with the various particulars of the call including its duration. The tickets printed by such equipment are made available to those subscribers recorded on the tickets who have actually initiated calls.

The object of the present invention is to provide improved recording or printing arrangements for use in telephone systems and one of the features of the invention is the provision of registering means for storing particulars of a connection whereby the actual recording or printing only takes place after the registration has advanced to a predetermined stage, for instance at the end of a call, although certain information which is always readily available such as the time that a call takes place can if convenient be made available at the time of the actual recording or printing operation.

It should be understood that the invention while it describes the printing of a ticket is not limited thereto as several of the features of invention are applicable to other means of recording such as by punching or otherwise marking a tape or other suitable medium.

Further the invention is not specifically limited to fully-automatic recording as an operator may control the setting of the particulars of a call on a register associated with a junction line, or may effect the actual printing or recording of the information from particulars of the call displayed before the operator under the control of the registering equipment associated with the junction line.

Among the advantages derived from the invention may be mentioned the possibility not only of ascertaining the duration of a call before taking a recorder or printer into use, but also of determining the total charge, and in consequence another feature of the invention relates to means operated after and as a consequence of the release of the connection, for calculating the total charge for a call controlled jointly by means which determine the charging rate for a call and means which indicate the duration of the connection.

In one arrangement according to this feature of the invention the total charge is adapted to be determined whether the total charge is a simple multiplication of the duration of the call in units of time by the charging rate, or whether

it is arbitrarily determined by the telephone administration having due regard both to the charging rate and duration of call.

A further feature of the invention which becomes possible by the deferring of the printing until all information is available is an arrangement whereby the printers or recorders are arranged in a common group adapted to be taken into use when the information is available so that not only are the printers or recorders in use for a minimum of time but also the number required can be very considerably reduced.

A still further feature of the invention which also becomes possible by deferring the printing or recording until all information is available is that the recorders or printers need not be of special design but can follow, for instance in the case of a printer, a typewriter design modified for electrical operation. The preferred characteristics of printers or recorders to be used according to the invention are, firstly, that they should print or record the character instantaneously in response to control from a storage device, for instance, the storage device may determine and cause the operation of a particular electro-magnet which results in the printing or recording of a character corresponding to that electromagnet; secondly, that the printer or recorder should automatically after the printing or recording of one character be prepared for printing or recording another character; thirdly, that the printer, if the information is printed on a ticket, should be capable of being so controlled from the storage device or in other suitable manner that after the printing of the last character of a particular piece of information the printer can be operated so that the first character of the next piece of information will be printed in the appropriate place on a ticket. for instance, so many spaces from the last character printed or on the beginning of the next line on which information is to be printed. According therefore to this feature of the invention a printer used for recording particulars of telephone connections is adapted to be electromagnetically controlled over leads extending from a position where such particulars are registered in such a manner that it prints in rapid succession in appropriate places on a ticket, roll of paper or any other suitable medium all the information required to be printed.

A further feature of the invention relates to the employment of two printing mechanisms taken into use simultaneously by one of which the particular items of information are printed on a detachable ticket in a form suitable for a subscriber and only the other of which particular items of information are printed in a single line in a form suitable for permanent record purposes. Preferably the ticket is printed from a

roll of tickets so arranged that each ticket can be readily detached in any well-known manner.

These tickets are conveniently pre-printed with the titles of the various pieces of information which are to be recorded on the ticket. Conveniently there may be one piece of information on the line or if the piece of information is of sufficiently small dimensions, then two pieces of information may be printed on a line. The information printed for record purposes could be printed on a roll of paper of sufficient width to take all the information of a particular connection in a straight line and information regarding successive connections recorded on lines immediately following each other so that all corresponding pieces of information of connections will fall in a single column.

According to a further feature of the invention the information to be printed or recorded is adapted to be collected on apparatus individual to a connection which is thus enabled to record the total time that the connection is in being, a storage device adapted to be temporarily associated with the particular connection after that connection has been completed and the total duration thereof has been determined, and printers or recorders adapted to be temporarily taken into use when the storage device is ready for the purpose of printing the information collected by the storage device which might include the day, hour and minutes that the connection took place independently of the equipment individual to the connection.

A calling subscriber often wishes to be advised of the total charge for a connection, and for this purpose he usually makes a personal request to the operator. It is proposed, according to a further feature of this invention, to avoid the necessity of such personal request and enable the subscriber to make his wishes known in this respect by dialling a special digit which is adapted to come out as a special sign on the recorder and if desired to operate a signal when the record is being made so as to advise an attendant that such information is required, who can then ring up the calling party and advise him. Preferably the subscriber, after dialling the wanted party's number, dials the digit "0" and this is transmitted either in code or as a series of pulses to a storage equipment which controls the recorder and when the connection is completed is adapted to signal an attendant, and at the same time it is recorded as an asterisk or other mark serving a similar purpose after the called party's number so that the attendant can quickly identify the calling party requiring the information as well as the information to be communicated to the calling party.

A further feature of the invention is concerned with a suitable modification of the ticket printer and the tickets themselves according to which the tickets are fed in a continuous manner from a roll perforated at regular intervals along the direction of movement, said perforations engaging with a sprocket wheel or its equivalent on the printer to ensure that each ticket is in the same relative position during printing as its predecessor.

A still further feature of the invention is to provide arrangements whereby the storing means associated with an outgoing trunk line for registering particulars of a call for automatic recording on the termination of a connection are adapted to be rendered ineffective for calls transmitted over the trunk line, for instance, from an

operator's position, which do not require to be automatically recorded.

The invention will be described with reference to the automatic ticketing of inter-zone calls which are set up as described in greater detail in my co-pending applications Ser. No. 278,727 filed June 12, 1939, and Ser. No. 278,728 filed June 12, 1939.

The toll line control circuit TLCC illustrated in Figures 1-10 of the accompanying drawings which are the same as Figures 31-40 of my co-pending application Serial No. 278,727, filed June 12, 1939, and the same as Figures 26-35 of my co-pending application Serial No. 278,728, filed June 12, 1939, show by way of an example an arrangement for storing particulars of a call. These figures should be arranged as shown in Figure 32 to give the complete circuit.

It will be understood however that it is not essential that the particulars should be transferred to the storage device by coded impulses as they may be transmitted by means of series of impulse trains, the number of impulses in each train corresponding to the numerical designations to be stored or the individual storage devices in the toll line control circuit may be controlled directly or indirectly from an operator's position.

It is also not essential that the storage devices should be individual to an outgoing line as they may be provided in association with the parts of connections which have access to outgoing lines over selector switches.

Figures 11-14 illustrate the date and time unit and Figures 15-28 and part of Fig. 29 illustrate the printer controller to which the particulars recorded in the toll line control circuit are transferred on the completion of a connection and which assess the total charge for a connection. These figures should be arranged as shown in Figure 33 to give the complete circuit.

Part of Figure 29 and Fig. 30 illustrate the printer unit, while Figure 31 shows the type of ticket printed and the holes which are engaged by a sprocket wheel on the typewriter to ensure definite alignment of the tickets so that the various pieces of information are recorded in correct positions under their various headings.

The toll line control circuit TLCC is arranged to store the called party's number, the calling party's number, the rate at which the call is to be charged and, if transmitted, a special digit indicating certain features of the call. This information is transmitted to the toll line control circuit from a register translator taken into use in the originating exchange according to the particular example which is being described herein.

The toll line control circuit in addition to controlling the operation of the printer performs certain other functions, such as controlling the switch CF (Fig. 9) to hunt for an idle converter or register translator to which the digits representing the called party's number are repeated for the purpose of enabling the converter to set up a call in the distant exchange. It supervises the setting up of the connection and times the call and stores this information and finally at the end of the call it again sets the switch CF in operation to hunt for an idle printer controller PC (Figs. 15-29) to which it transmits all the stored information whereupon the connection is released together with the toll line circuit.

Detailed description of toll line control circuit.

The impulses are transmitted in code as described in my co-pending applications previously referred to and when a connection is extended

to the toll line control circuit earth potential is extended over conductor 750 (Figure 6), upper primary winding of transformer 811, make-before-break contacts associated with armature 813, winding of relay 764 to battery. Relay 764 in operating at armature 815 closes an obvious circuit for relay 777. Relay 777 in operating at armature 819 extends earth from make-before-break contacts associated with armature 823 to conductor 752 to guard the toll line control circuit and at armature 818 closes an obvious circuit for relay 781. Relay 781 in operating at armature 826 closes a self-interrupting circuit for the magnet 810 of the converter finder switch CF (Fig. 5). This circuit extends as follows: earth, armature 832 (Fig. 8), armatures 835, 826, 840, self-interrupting contacts 841, windings of magnet 810, to battery. A busy converter is indicated by an earth on the appropriate contact associated with wiper 971 which is extended over armature 844 in its resting position, cam springs 842 in their resting position to the upper winding of relay 780, the other terminal of this winding being connected to earth over the following circuit: earth at armature 817 (Fig. 8), armatures 834, 825 in its operated position both windings of relay 780 in series. Relay 780 is thus short-circuited and does not operate so that the wipers of the switch CF are rotated until they reach an idle converter. When this occurs relay 780 operates from earth at armature 817 as traced above over wiper 971 to battery in the converter. Relay 780 in operating at armature 840 opens the energising circuit to the magnet 810; at armature 839 closes a locking circuit for itself independent of relays 781 and 782 and at armature 838 closes an obvious circuit for relay 787. Relay 787 in operating at armature 848 closes a circuit for relay 788 to earth at armature 847 and at armature 849 closes a circuit for relay 789. Relay 788 in operating at armature 879 closes a circuit from earth at armature 886 (Fig. 9) for relay 786 which operates. The operation of relays 786 and 788 causes wiper 959 to 962 of the switch OP to be connected to wipers 967 to 970 of the switch CF over the pairs of contacts 880, 873; 881, 874; 882, 875 and 883, 876. Further relay 787 at armature 863 and 864 connects wipers 973 and 974 of the switch CF to the toll line conductors 759 and 760. Relay 789 in operating at armature 852 extends earth at armature 849 over the winding of relay 778 to battery (Fig. 8) and at armature 853 connects relay 763 (Fig. 6) to the positive conductor 751 over make-before-break contacts of armature 814. Relay 763 operates on its connection to conductor 751 and at armature 862 extends earth from armature 865 over the windings of relay 779 to battery. Relay 779 operates and locks over armature 869 to earth at armature 851 (Fig. 10). Further its connection to this conductor serves as an indication in the register-translator that the toll line control circuit is ready to receive impulses therefrom. Relay 779 in operating at armature 871 closes an alternative circuit for relay 778 independent of relay 787 and 789.

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

Digit transmission from the register-translator now commences and in this connection it will be appreciated from the description in the previously-mentioned copending applications of the

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

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

Coded impulse transmission is effected by transmitting for each digit four impulses over the negative conductor and one or two impulses over the positive conductor, the position of the positive conductor impulses with respect to the negative conductor impulses serving to distinguish different digits. Thus assuming the digit 1 is to be transmitted the first two impulses only are transmitted over the positive conductor. The first impulse therefore interrupts both the positive and negative conductors 751 and 750 and both relays 764 and 763 will de-energise. Relay 764 at armature 815 and its resting contact closes the following circuit: earth, armature 815 and its resting contact, armature 820 and its operated contact, armature 837, winding of magnet 807 of switch IP to battery. Magnet 807 energises but since it operates on the reverse-drive principle the wipers are not stepped at this time. It will be noted that at armature 815 and its operated contact the circuit for relay 777 is opened but this relay is sufficiently slow-to-release to enable it to remain operated for the duration of the impulse series. Relay 763 at armature 862 closes the following circuit: earth, armature 865, armature 862 in its resting position, armature 870, armature 900 in its resting position, wiper 950 of switch IP on contact 1, winding of relay 892 to battery. Relay 892 operates and locks at armature 903 to earth at armature 856 (Fig. 4) of relay 778 (Fig. 8). In addition the impulse is also transmitted over conductor 904, contact 1 and wiper 959 of the switch OP, armatures 880, 873, wiper 967 of the switch CF to the converter.

At the end of the first impulse relays 763 and 764 reoperate and earth is thus removed from wiper 950 and from the winding of magnet 807. The switch IP is thus stepped on to contact 2. On the second impulse relays 763 and 764 again release and earth is again extended to wiper 950 in position 2 to the winding of relay 893. Relay 893 operates and locks. The impulse is also transmitted over contact 1 and wiper 960 of switch OP, armatures 881 and 874, wiper 968 of the switch CF to the converter. At the end of the second impulse relay 763 and 764 re-operate and earth is again removed from wiper 950 and from the winding of magnet 807. The switch IP is thus stepped on to contact 3. On the third impulse relay 764 only releases so that no earth potential is applied to wiper 950 and no impulse is repeated to the converter. The wipers of the switch IP are however stepped to position 4. In this position the following circuit is completed: earth, armature 861, (Fig. 8), wiper 953 of switch IP on contact 4, armatures 898, 897, winding of magnet 809 of the switch OP to battery. A branch of this circuit also extends over contact 878 of relay 788, wiper 972 of the switch CF to the converter.

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

The second digit is stored on group II of the counting relays. These relays are not shown but are connected to contacts 5 to 8 associated with wiper 950 as shown by the bracketed conductors II. Further on the 4th impulse of the second digit the wipers of the switch OP are stepped from position 2 to position 3 by earth connected to wiper 953 on contact 8, armature 897 and then as previously traced. The third digit is stored on group III of the counting relays connected to contacts 9 to 12 associated with wiper 950 while the wipers of the switch OP is stepped from position 3 to position 4 by earth connected to wiper 953 on contact 12, armature 899 and thence over armature 897 as previously traced. The fourth, fifth, sixth and seventh digits are recorded in a similar manner, the impulse repeating circuit for the seventh digit extending over contact 25 associated with wiper 950 and contacts 1-3 associated with wiper 951.

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

bracketed contacts 2-7 associated with wipers 959 to 962.

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

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

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

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

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

It will be appreciated that the switch IP must be capable of responding to 56 impulses during the reception of the 14 digits. The switch however has only 50 contacts and to enlarge its capacity, wipers 950 and 951 are disconnected at the termination of the 50th impulse and wiper 952 is connected up instead. When wiper 954 is positioned on contact 25 to receive the 50th impulse, the following circuit is closed: earth at armature 861, wiper 954 on contact 25, armature 896, upper winding of relay 771 to battery. Relay 771 is a two-step relay and closes its "X" armature 902 only at this time. After the 50th impulse has been received however and the switch IP has been moved a further step, the earth applied to the upper winding of relay 771 is removed and the relay operates fully over the following circuit; earth at armature 861, arma-

ture 902, both windings of relay 771 in series to battery. At armature 900 relay 771 prepares the circuit for extending earth over wiper 952 instead of wipers 950 and 951 for the reception of the 51st to 56th impulses.

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

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

The converter completes its operation as described in my pending application Serial No. 278,727, filed June 12, 1939, and then battery is removed from wiper 971 to cause the release of relay 780 followed by the release of relays 787, 788 and 786 while relay 789 is maintained over its locking armature 852 to earth at armature 871. The speaking circuit is now completed through the toll line control circuit over transformer 811, the lower secondary winding of which is connected directly to the outgoing conductor 759 of the toll line while the upper secondary winding is connected to outgoing conductor 760 over armature 863 of relay 787 and its resting contact, resting contact and armature 921 of relay 784 to conductor 760.

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

The circuit remains in this condition until a momentary alternating current signal is returned from the distant exchange indicating that the connection has been completed to the desired

subscriber. This signal causes the momentary operation of relay 770, half waves of one polarity passing from the lower terminal of the upper secondary winding of transformer 811 through the upper winding of relay 770, metal rectifier 922 in the conducting direction to the upper terminal of the lower secondary winding while half-waves of the other polarity pass from the upper terminal of the lower secondary winding, lower winding of relay 770, metal rectifier 923 in the conducting direction to the lower terminal of the upper secondary winding. The two windings of relay 770 are so arranged that both half waves act in the same sense to cause the operation of the relay. Relay 770 at armature 925 operates relay 765 to close its "X" armature 864 and at the end of the signal this relay operates fully over: earth, armatures 818, 864, both windings of relay 765 in series to battery. In the case where the call is being set up by an operator it will be remembered that relay 776 is operated. Hence the operation of relay 765 at armature 866 causes booster battery from conductor 758 to be extended over armature 823 of relay 776, armature 819 to private conductor 752 which without releasing the switches back to Hautrage serves to give an indication at the operator's position that the setting up of the connection has been completed.

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

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

The first earth pulse transmitted over conductor 755 passes over armatures 830, 927, 913, winding of relay 773 to battery. Relay 773 operates and at armature 918 closes the following circuit for magnet 807 of the switch IP: earth at armature 918, armature 837, winding of magnet 807 to battery. The magnet energises and at the end of the pulse releases to step the wipers of the switch IP on to contact 2. The switch IP is therefore caused to take one step every 5 seconds for the duration of the conversation. On the reception of the fourth pulse when wiper 953 is on contact 4, the following circuit is closed: earth at armature 861, wiper 953 on contact 4, armatures 910, 930, contact 1 and wiper 957 of the switch T, interrupter contacts 933, windings of magnet 808 upper low resistance winding of relay 777 to battery. The magnet energises and at its interrupter contacts opens the above-traced circuit whereupon the magnet releases to step the wipers on to contact 2. In addition when wiper 953 is moved on to contact 5 at the end of the fourth pulse a further point is opened in the energising circuit for magnet 808. With wiper 957 on contact 2 however a further circuit

is closed for magnet 808 as follows: earth at armature 931 (Fig. 7), bank multiplying and wiper 957, interrupter contacts 933, windings of magnet 808 upper winding of relay 777 to battery. The wipers of the switch T are now stepped on to contact 4 where the energising circuit for the magnet is opened. The switch T now remains in this position until three minutes have elapsed and wiper 991 is on contact 11 when earth is extended over the upper winding of relay 772, contact 4 and wiper 957, interrupter contacts 933 windings of magnet 808 upper winding of relay 777 to battery. Relay 772 is a high resistance relay and operates over this circuit although the magnet does not. Relay 772 locks over its lower winding and armature 932 to earth at armature 867 and at armature 930 and 931 opens points in the first two energising circuits traced above for magnet 808. Further stepping of the switch T is now under the control of the switch IP and it is arranged that the switch T makes one step every minute which elapses. Thus on each reception of the 12th pulse with wiper 953 of the switch IP on contact 12 or 24, the following circuit is closed: earth at armature 861 (Fig. 8), wiper 953 of the switch IP on contact 12 or 24, armatures 899, 990, 916, windings of magnet 808 to battery. The wipers of switch T are thus stepped on to the next contact at the termination of the 12th pulse. The reason for stepping switch T on to contact 4 at the end of 20 seconds is that although charges for calls are based on a minimum call of 3 minutes the subscriber is allowed a grace period of 20 seconds before timing is effective.

The number of 10 minute intervals which elapse during a conversation are recorded on the switch OP which it will be remembered is in position 8. For this purpose when the switch T has made 10 steps and is on contact 11, the next 5 second pulse causes earth to be extended over wiper 958 of the switch T on contact 11, armature 915, windings of magnet 809 to battery. At the end of the pulse the wipers of switch OP are stepped on to contact 9.

It will be appreciated that in order for the positions of the wipers of the switch T to be the same for successive semi-rotations it is essential to arrange that at the end of the first 10 minute period the wipers of the switch T are brought on to contact 14; at the end of the second 10 minute period the wipers are brought on to contact 1 and so on. Thus at the end of the 10th minute wiper 957 is stepped on to contact 11 which is multiplied to contacts 12 and 13 and connected to earth. An obvious self-interrupting circuit is thus completed for magnet 808 and the wipers are stepped to contact 14.

It will also be understood that it is necessary to give the wipers of the switch IP an additional step when they reach the 25th contact and hence this contact associated with wiper 953 is connected to the contact associated with armature 908 while the 25th contact associated with wiper 954 is connected to the contact associated with armature 909. Hence at the termination of the 24th pulse a circuit is completed as follows: earth at armature 861, wiper 953 on contact 25, armatures 908, 833, 824, interrupter contacts 914, windings of magnet 807 to battery. Wipers 950, 952 and 953 are thus stepped off the 25th contact and wipers 951, 954, and 991 are stepped on to contact 1 in order to receive the next pulse. Similarly at the termination of the 48th pulse with wiper 954 on contact 25 a similar circuit is

closed which extends in addition over armature 909 so that wipers 951, 954, and 991 are stepped off contact 25 wipers 950, 952 and 953 are stepped on to contact 1.

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

Timing is stopped by the termination of conversation, when the calling party replaces his receiver, relays 763 and 764 release. Relay 764 at armature 815 opens the circuit for relay 777. Relay 777 in releasing slowly at armature 819 and its operating contact removes earth from conductor 752 but this earth is replaced at its resting contact from armature 854 (Fig. 10) and finally at armature 818 relay 777 opens the circuit of relays 781, 765 and 766. During the release period of relay 781 however a circuit is closed from earth at armature 818 of relay 777, armature 927, wiper 963 and bank contact as determined by the number of 10 minute intervals, winding of one of the relays 935 to 938 to battery. A parallel branch of this circuit extends over armatures 843 and 816 to wiper 964 and bank contact to a winding of another of the same relays. Thus if the call lasts for less than 10 minutes, the switch OP will not have been stepped and thus will remain on contact 8. On the release of relay 777 therefore relay 935 is operated over wiper 963 but no relay is operated over wiper 964 in accordance with the table shown in Fig. 18 of my co-pending application Serial No. 278,727, filed June 12, 1939. Relay 935 locks over armature 939 to earth at armature 855 (Fig. 4). This earth is also extended over the contact associated with armature 939 to bank contact 18 associated with wiper 962. If the number to be stored is such that another one or two of the relays 935, 936, 937 and 938 are operated, the locking earth will be extended to appropriate contacts associated with wipers 959 to 962 in a similar manner.

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

The circuit for extending earth to wipers 963 and 964 is opened at armature 827 when relay 781 finally releases. In addition relay 781 at armature 828 closes the following circuit for relay 790: earth at armature 815, armatures 820, 828, 872, winding of relay 790 to battery, at armature 824 closes a self-interrupting circuit for magnet 807 to earth at off-normal springs 907 to return the switch IP to contact 1 and finally

at armature 826 relay 781 closes a self-interrupting circuit for magnet 810 of the switch CF. Relay 790 at armature 845 completes an energising circuit for magnet 809 of the switch OP over wiper 966 to earth at armature 888. The switch OP is thus stepped to position 17 unless it is already at this position. A circuit is now closed for relay 783 as follows: earth, armatures 850, 846 (Fig. 10), wiper 965 on contact 17 winding of relay 783 to battery. Relay 783 operates and locks over armature 889 to earth at armature 851.

It should be explained that the switch CF has access over contacts 1 to 20 to the converters and over contacts 21 to 25 to printer-controllers. In order to connect the toll line control circuit with an idle printer-controller the switch CF has thus to be rotated automatically to contact 21 from whence it is stepped until it finds an idle printer-controller. The circuit for automatically rotating the wipers of the switch CF to position 21 extends as follows: earth at armature 832 (Fig. 8), armatures 835, 826, 840, interrupter contacts 841, windings of magnet 810 to battery. When the wipers of the switch reach the 21st contact, cam springs 842 are operated and the following test circuit is completed: earth at armature 868 (Fig. 8), armature 834 and its operated contact, armature 825 and its resting contact, both windings of relay 780 in series, cam springs 842 in their operated position, contact and armature 844, wiper 971. A busy printer-controller is indicated by earth which is extended over wiper 971 to shunt relay 780 while an idle printer-controller is indicated by battery which operates relay 780. Relay 780 in operation locks over its upper winding and armature 839; at armature 840, relay 780 opens the energising circuit for the magnet 810 and at armature 838 closes as before a circuit for relay 787 which operates followed by relay 788 which is operated from earth at armature 890 (Fig. 9).

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

The transfer commences on the operation of relay 783 as described above when impulsing conductor 753 delivering earth pulses at the rate of 15 per second is connected over armature 885 of relay 783, armature 943, upper winding of relay 785 to battery. Relay 785 operates its "X" armature 944 at the commencement of the first pulse and at the termination thereof operates fully over both windings in series to earth at armature 861. At armature 943, relay 785 transfers the impulsing conductor to the winding of relay 786. Relay 786 at armature 884 repeats the pulses from earth at armature 886 (Fig. 9) to magnet 809 of the switch OP. On the reception of the second pulse relay 786 operates to energise magnet 809 and at armatures 889 to 883 connects wipers 959 to 962 to wipers 967 to 970 over armatures 873 to 876 of relay 788. It will be noted that contacts 17 associated with wipers 959, 961 and 962 of the switch OP are connected to counting relay group XIV (not shown) on which the "rate" digit is stored. The charging

rates are so devised that the rate digit may be any one of five digits and hence three relays only of the group XIV are employed. Earth is thus extended from armature 855 (Fig. 4) of relay 778 (Fig. 8) over the locking contacts of the operated counting relays, contacts 17 in the banks of wipers 959, 961 or 962, armatures 880, 882 or 883, armatures 873, 875 or 876, wipers 967, 969 or 970 of the switch CF to the printer-controller. At the termination of the second pulse, relay 786 releases and the wipers of the switch OP are stepped on to the 18th contacts. Contacts 18 of wipers 959 to 962 are connected to the contacts associated with the locking armatures of the relays in group XV on which the number of 10-minute periods are stored. This information is transmitted to the printer-controller in a similar manner as that described for the "rate" digit. With the switch OP on contacts 19, connections are completed from wipers 955 and 956 of the switch T in order to transfer the minute periods to the printer-controller. Contact 20 associated with wiper 962 is connected to the locking circuit of relay 905 so that a circuit is now completed to the printer-controller if the calling party requires the cost of the connection. Contacts 21-25 of the switch OP are connected to counting relay groups IX to XIII to transfer the calling party's number to the printer-controller. The wipers of the switch OP are not stepped on to contact 1 and continue to step on to contact 8 under the control of relay 786 during which time the called party's number which is stored on counting relay groups I to VII is transferred to the printer-controller.

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

All the necessary information has now been stored in the printer-controller and the toll line control circuit can now be released. When wiper 95 of switch OP reaches contact 3, a circuit is completed from earth at armature 850 (Fig. 10), armature 846, wiper 965 on contact 8, armature 891 to the junction of the windings of relay 779. The lower winding of this relay is thus shunted and since the upper winding cannot maintain the relay alone, it releases. Relay 779 at armature 869 opens its own locking circuit; at armature 868 opens the locking circuit for relay 780 which releases; at armature 867 and its operated contact opens the circuit for relay 772 which releases; at armature 871 opens the circuit of relay 778 which releases and one point in the locking circuit for relay 789 and at armature 872 opens the circuit of relay 790 which releases slowly.

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

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

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

Relays 778 in releasing at armatures 855, 856, 857 (Fig. 4) and 860 removes the holding earth from all the counting relay groups and the operated relays thus release. Further at armature 861 it removes a general holding earth to enable the release of relays 782 and 785.

Relay 790 in releasing at armatures 844 and 845 restores the original test circuit of the switch CF to enable it to hunt for a converter when the toll line control circuit is seized on a subsequent call.

It will be noted that the switch CF is still on contacts leading to the printer-controller. When the toll line control circuit is taken into use on another call, the following self-interrupting circuit is closed on the operation of relay 781; earth at armature 832 (Fig. 8), armatures 835, armatures 826 and its operated contact, armature 840, interrupter contact 841, windings of magnet 810 to battery. The wipers are thus stepped to contact 1 during which time no test circuit is operative to stop the switch since the cam springs 842 are in their operated position. In position 1 however these springs are returned to normal and a test circuit is then closed over wiper 971 as described previously.

Provision is also made in the above circuit for an alteration in certain of the rates if a call is set up between the hours of 19 and 7 o'clock. The rate digits 1 and 2 represent charging rates of 5 and 3 francs respectively and it is arranged that during this period the rate in both cases is reduced to 1 franc 80 centimes. This is effected by an earth which is extended from the date and time unit in a manner to be explained later, to conductor 754 to cause the operation of relay 762. It should be explained that digits 1 and 2 cause the operation of the first and second and the first and third relays respectively of the appropriate relay group. It will be noted however that contacts 4 and 5 associated with wiper 952 of the switch IP (Fig. 1) are connected to the windings of the storage relays over armatures 993 and 992 respectively. Consequently with relay 762 operated, the first only of the counting relays is operated in response to the reception of rate digit 1 or 2. Now the operation of the first relay of the group represents the digit 7 which is equivalent to a rate of 1 franc 80 centimes. A conversion of the rate has thus taken place.

Detailed description of date and time unit

The date and time unit (Figs. 11-14) which is provided in common to the exchange operates continuously and is adapted to be connected for a short period to any printer-controller to enable the time in hours and minutes and the date in day of the month and month to be recorded in the printer-controller. With regard to the time this is given in the Continental manner

that is to say the day commences at midnight and the hours are numbered from 1 to 24.

The whole circuit is operated by minute-impulses delivered from a master clock. These impulses are repeated by relay 1200 to the magnet of the switch MI which records the minutes. When 60 minutes have been recorded the switch HO which records the hours makes one step. When the 24th hour has been recorded the switch DA which records the day of the month makes one step. The switch MO which records the months makes one step after the switch DA has recorded the appropriate number of days. At all times markings are extended to the groups of conductors 1, 2, 3 and 4 of the tens groups T and 1, 2, 3 and 4 of the units groups U associated with each switch so that whenever a printer-controller is connected to the date and time unit, the markings are immediately extended over these conductors to the printer-controller and the date and time is recorded therein.

A detailed description will now be given of the operation of the unit and for convenience it will be assumed that the unit is started up from the position shown at midnight on December 31st-January 1st, 1937. At the end of the first minute, relay 1200 is operated and at armature 1211 extends earth over key 1234 to the windings of the magnet 1207 of the switch MI. At the end of the impulse when relay 1200 releases, the wipers of the switch MI are stepped to position 2. The counting of the minutes as regards the units is controlled over wipers 1245 and 1246, both of which are earthed and the contacts in the banks are so connected to conductors 1, 2, 3 and 4 of the units group U that at any moment the units portion of the number of minutes is indicated by markings extended to the conductors in accordance with the code given in Fig. 18 of my copending application Ser. No. 278,727, filed June 12, 1939. Thus prior to the first minute pulse, wipers 1245 and 1246 will be on contacts 1 and contact 1 associated with wiper 1245 is connected to conductor 4 while contact 1 associated with wiper 1246 is disconnected to indicate the digit 0. After the first minute pulse wipers 1245 and 1246 will be on contacts 2. In this position wiper 1245 is connected to conductor 1 while wiper 1246 is connected to conductor 2 to indicate the digit 1. Similar connections are made from succeeding contacts associated with these wipers. At the end of the 10th impulse, the wipers of the switch MI will be stepped to position 11 and in this position a circuit is closed from earth at wiper 1246 on contact 11, bank multiplying, interrupter contacts 1230, windings of magnet 1207 to battery. Contacts 11, 12 and 13 associated with wiper 1246 are multiplied together so that the switch is automatically stepped by the above self-interrupting circuit to contact 14.

It will also be seen that earth is extended from armature 1219 of relay 1202 over armature 1214 to wiper 1242 and from armature 1220 of relay 1202 over armature 1215 to wiper 1239. Contacts 1 to 14 associated with these wipers are disconnected so that during the first 10 minutes no earth is extended to conductors 1, 2, 3 or 4 of the tens group T. When the wipers are stepped to position 14 i. e. at the end of the 10th minute, earth is extended over wiper 1239 to conductor 1 and over wiper 1242 to conductor 2 thereby indicating the digit 1. Further, earth over wiper 1245 on contact 14 is extended to conductor 4 while contact 14 associated with

wiper 1246 is disconnected thereby indicating the digit 0. Contacts 14 to 23 associated with wipers 1239 and 1242 are multiplied so that the same combination of conductors are earthed from the 10th to the 19th minute as from the 1st to the 9th minute. At the end of the 20th impulse, the wipers are stepped to position 24 where earth is extended over wiper 1246 on contact 24, interrupter contacts 1230, windings of magnet 1207 to battery. The wipers are now stepped to position 25 where a circuit is completed from earth at armature 1220, armature 1215, wiper 1239 on contact 25, upper winding of relay 1201 to battery. Relay 1201 at armature 1215 and its resting contact disconnects earth from wiper 1239 and at its operating contact connects earth to wiper 1240 at the same time opening its own energising circuit. It now locks over armature 1213 to earth at armature 1218. Further at armature 1214 and its resting contact earth is removed from wiper 1242 and extended at its operating contact to wiper 1243. With the switch in the 25th position, a circuit is also completed from earth at wiper 1246 on contact 25, winding of relay 1204 to battery, relay 1204 being slow-to-operate but quick-to-release. Relay 1204 in operating at armature 1224 closes an obvious self-interrupting circuit to magnet 1207 so that the wipers are stepped to position 1 where the circuit of relay 1204 is opened. It will be seen that in this position, earth on wiper 1240 is extended to conductor 1 of the tens group T while earth on wiper 1243 is extended to conductor 3 to indicate the digit 2. As before a marking is extended over wiper 1245 to indicate the digit 0.

The markings extended over wipers 1240 and 1243 remain the same while the switch steps from contacts 1 to 10. From contacts 14 to 23 the markings are altered to indicate the digit 3.

At the end of the 39th minute the wipers are stepped on to position 24 where a self-interrupting circuit is again closed for magnet 1207 and the wipers are stepped to position 25. In this position earth is extended over wiper 1240, upper winding of relay 1202 to battery. Relay 1202 closes its "X" armatures 1217 and when wiper 1240 leaves the 25th position it operates fully from earth at armature 1221 and at armature 1219 and its resting contact removes earth from wiper 1243 and at its operated contact extends it to wiper 1244; at armature 1220 and its resting contact it removes earth from wiper 1240 and at its operating contact connects earth to wiper 1241. In addition relay 1202 at armature 1218 opens the locking circuit of relay 1201 which releases. As before relay 1204 operates with the switch in the 25th position and closes a self-interrupting circuit for magnet 1207 to step the wipers on to position 1. Markings now extend over wipers 1241 and 1244 in positions 1 to 10 to conductors 2 and 3 of the tens group T to indicate the digit 4 and in positions 14 to 23 to conductors 2 and 4 to indicate the digit 5.

At the end of the 59th minute, the wipers are stepped to position 24 where a self-interrupting circuit is closed to step the wipers to position 25 where a circuit is closed for relay 1203 over wiper 1241 and for relay 1204 over wiper 1246. The operation of relay 1204 also causes the wipers of the switch MI to be stepped to position 1. Relay 1203 operates its "X" armature 1222 and when wiper 1241 of the switch MI leaves position 25 it operates fully. Earth is now extended from armature 1216 over armature 1223, windings of

magnet 1208 to battery. The magnet is thereby energised. Further relay 1202 is released at armature 1221 of relay 1203. Relay 1204 also releases when the wipers are stepped to position 1 whereupon earth is removed from magnet 1208 whereby the magnet deenergises and the wipers of the switch HO are stepped from contact 1 to contact 2. Relay 1202 at armature 1218 opens the locking circuit to relay 1203 which also releases. The switch MI together with relays 1201 to 1204 are now in a position to commence recording the second hour.

Referring now to the switch HO, the units digit of the hours is indicated by earth extended over wipers 1249 and 1250 to conductors 1, 2, 3 or 4 of the units group U while the tens digit is indicated by earth extended over wipers 1247 and 1248 to conductors 1, 2 and 3 of the tens group T. It will be appreciated that three conductors only are provided in the tens group since this digit will be zero, 1 or 2. The connections between the contacts associated with wipers 1249 and 1250 and the conductors 1, 2, 3 and 4 are the same as those between the contacts of wipers 1245 and 1246 of the switch MI and the four units conductors, with the exception that since the switch HO counts from 1 to 24 instead of in groups of 10, the contacts representing the last hour of the first ten and the first hour of the second ten are consecutive and so are the last hour of the second ten and the first hour of the third ten.

With the wipers on position 1, conductor 4 is earthed over wiper 1249 thereby indicating the digit 0. With the wipers on position 2, conductors 1 and 2 are earthed over wipers 1249 and 1250 respectively. In succeeding positions the appropriate conductors are earthed. After the 10th hour, the wipers are stepped to position 11 whereby conductors 1 and 2 of the tens group T are earthed over wipers 1247 and 1248 respectively to indicate the digit 1, while conductor 4 is earthed over wiper 1249 to indicate the digit 0. Further at the end of the 20th hour, the wipers are stepped to position 21 where conductors 1 and 3 of the tens group are earthed over wipers 1247 and 1248 respectively to indicate the digit 2, while conductor 4 of the units group is again earthed over wiper 1249. At the end of the 24th hour the wipers are stepped to position 25 where earth is extended over wiper 1250 on contact 25, winding of relay 1205 to battery. Relay 1205 in operating at armature 1225 closes an obvious self-interrupting circuit for magnet 1208 over interrupter contacts 1231 to step the wipers of the switch HO on to contact 1 and at armature 1226 closes an energising circuit for magnet 1209 of the switch DA on which the days of the month are recorded. When the wipers of switch HO are in position 1, relay 1205 releases, magnet 1209 de-energises, and the wipers of switch DA are stepped from position 1 to position 2.

The switch DA which records the day of the month has to be arranged to have a minimum of 28 settings and a maximum of 31 according to the least and greatest number of days in the month. In order to cope with this the markings for the conductors of the tens group are extended over the four wipers 1251 to 1254, all the wipers being single ended with wipers 1251 and 1252 being spaced 180° apart from wipers 1253 and 1254. The connections to the conductors of the units group are again extended over two wipers, 1255 and 1256, the wipers being double-ended. The connections from these wipers to the conductors of the units group are again the same as

for wipers 1245 and 1246 of the switch MI and since the days are counted in groups of 10, the two sets of contacts in each bank which count successive groups of 10 are spaced apart by two contacts.

With the wipers in position 1, no earth is extended to the conductors of the tens group while earth is extended over wiper 1255 to conductor 4 of the units group to indicate the digit 0. As the wipers are stepped from positions 1 to 11, earth will be extended over wipers 1255 and 1256 to the appropriate conductors as explained previously in connection with switches MI and HO. At the end of the 10th day, the wipers are stepped on to contact 11 and a self-interrupting circuit is completed over wiper 1256 and interrupter contacts 1232 for magnet 1209. The wipers are now stepped to position 14 where earth is extended over wipers 1251 and 1252 to conductors 1 and 2 of the tens group respectively to indicate the digit 1 while earth is extended over wiper 1255 to conductor 4 of the units group to indicate the digit 0. At the end of the 19th day the wipers are stepped to position 24 where a further self-interrupting circuit is completed for the magnet 1209 and the wipers 1255 and 1256 are stepped to position 1. Further wipers 1251 and 1252 are stepped out of contact and wipers 1253 and 1254 are stepped into contact with their banks. In this position conductors 1 and 3 of the tens group are earthed over wipers 1253 and 1254 respectively to indicate the digit 2 and conductor 4 of the units group is earthed over wiper 1255 to indicate the digit 0. The wipers continue to step to give the appropriate indications in a manner which it is believed will now be easily understood.

The stepping of the switch MO on which the months are recorded is effected under the control of wiper 1257 of the switch DA in conjunction with wipers 1263 and 1264 of the switch MO, these two wipers being single-ended and spaced apart by 180°. The units digit in the month number is determined by earth extended over wipers 1261 and 1262 while the tens digit is determined by earth extended over wipers 1259 and 1260. With the present assumption that the apparatus is started up at midnight on December 31st-January 1st, the wipers of the switch MO will be on position 1 and earth will be extended to conductors 1 and 2 of the units group over wipers 1261 and 1262 respectively. Now the wipers of the switch MO should be stepped to position 2 after the switch DA has made 31 steps, January having 31 days. At the end of the 31st day the wipers of the switch DA will be on position 16 and in this position a circuit is closed from earth at wiper 1263 on contact 1, bank multiplying, contact 16 associated with wiper 1257 of the switch DA, winding of relay 1206 to battery. Relay 1206 in operating locks at armature 1228 to earth over wiper 1258 and bank multiplying; at armature 1229 closes an energising circuit for the magnet 1210; at armature 1227 closes a self-interrupting circuit for magnet 1209 which thereupon rotates its wipers into the position shown where the energising and locking circuits of relay 1206 are opened. The relay releases and at armature 1229 opens the circuit for magnet 1210 which de-energises and steps the wipers on to position 2 where earth is extended to the appropriate conductors of the units group to indicate the digit 2.

The switch DA continues to be stepped from position 1 and at the end of the 28th day the wipers are stepped on to position 10 whereupon a circuit is again closed for relay 1206 over wiper

1263 on contact 2, contact 10 and wiper 1257. Relay 1206 operates with results as previously described. Thus it will be seen that the connections between wipers 1257 and the wipers 1263 and 1264 are so arranged that the switch MO is only stepped after the lapse of the number of days contained in the particular month.

It has been assumed that the unit was set in operation at the beginning of 1937. The next leap year therefore occurs in 1940. During this year wiper 1264 of the switch MO will be stepping over contacts 13 to 24 of the associated bank. In order to take care of the fact that February of this year will have 29 days, contact 14 associated with wiper 1264 is connected to contact 14 associated with wiper 1257 of the switch DA. The wipers of the switch DA step to position 14 at the end of the 29th day so that the stepping of the wipers of switch MO from contacts 14 to 15 is delayed for one day.

At the end of the fourth year the wipers of the switch MO will be stepped to position 25 and a self-interrupting circuit is completed from earth at wiper 1262, interrupter contacts 1233 to magnet 1210 to step the wipers to the position shown.

It will of course be appreciated that while for convenience of description the unit has been assumed to be set in operation at a particular time and on a particular date, it can in practice be set in operation at any time on any date, the keys 1235 to 1238 being provided for giving the appropriate settings to the various switches manually, while key 1234 is provided for preventing operation by the minute pulses during this setting operation. In addition the keys 1235 to 1238 enable corrections to be made in the settings of the various switches during the operation of the unit.

It will be understood that it is undesirable for the stepping of any of the switches to occur while the unit is connected to a printer-controller. To avoid this earth is fed over conductor 1265 from the printer-controller so that if relay 1200 is operated during the association of the two units, it locks over armature 1212 to conductor 1265. Since the various switches are stepped on release of relay 1200, stepping is delayed until the printer-controller is disconnected from the date and time unit.

It will be remembered that when discussing the operation of the toll line control circuit it was pointed out that the rate digit was susceptible to alteration during the period from 19 to 7 o'clock. This alteration in the rate is effected under the control of wiper 1266 of the switch HO. This wiper is directly earthed and this earth is extended to conductor 1267 when the wiper is on contacts 1 to 8 and 20 to 25, i. e. between the hours of 19 and 7. Conductor 1267 is connected to conductor 754 of the toll line control circuit (Fig. 6) and when earthed serves to operate relay 762 with the results previously described.

Detailed description of printer-controller

When the printer-controller (Figs. 15-29) is seized from a toll line control circuit, earth is extended from wiper 971 of the toll line control circuit (Fig. 5) to conductor 1445 and thence over armature 1408, winding of relay 1305, contact 1 and wiper 1362 of switch TS, resistance 1447 to battery, the battery connected to the winding of relay 1305 over resistance 1448 serving as a marking battery. Relay 1305 operates and at armature 1425 closes an obvious circuit

for the lower winding of relay 1306. Relay 1306 at armatures 1426, 1427, 1428 and 1429 provides a locking earth for the various counting relay groups.

The information stored in the toll line control circuit is now transferred to the printer-controller and the transfer takes place in the following order; digit representing the rate at which the call is to be charged; digit representing the duration of the call; digits indicating that the calling party requires the cost of the connection to be communicated to him without delay; digits representing the calling party's number and finally digits representing the called party's number.

Consideration will first be given to the reception in the printer-controller of the digits representing the rate and duration. As previously pointed out the rate is represented by a single digit and in the printer-controller is stored on counting relay group XXI comprising relays 1319-1322 inclusive. These relays are connected to position 1 associated with wipers 1348-1351 respectively of the switch IP2. These four wipers are connected respectively with wipers 967-970 of the switch CF (Fig. 3) of the toll line control circuit and it will be understood that as switch OP of the toll line control circuit steps, the information stored on the various groups of counting relays in that circuit will be transferred over wipers 967-970 of the switch CF (Fig. 3), wipers 1348-1351 of the switch IP2 to the appropriate groups of counting relays accessible thereto.

In position 1 the relays of group XXI are first operated in accordance with the charging rate digit and then as each digit is transferred to the printer-controller, earth is extended from the toll line control circuit and its wiper 972 over conductor 1446, windings of magnet 1392 of the switch IP2 to battery. The wipers of the switch IP2 are thus stepped from position to position as the digits are received to enable the correct counting relay group to be connected to the wipers of the switch.

When the rate has been stored on group XXI of the counting relays the wipers of the switch IP2 are stepped to position 2 where earth is extended over wiper 1352 on contact 2, windings of relays 1338, 1337, 1336 and 1335 in series to battery. These relays operate and serve to connect the date and time unit with the printer-controller to store the time of the day and the day of the month on counting relay groups XIII to XX inclusive. Of these relay groups, groups XIII, XV and XVII only are shown and comprise relays 1339-1342, 1343 and 1344 and 1345-1347 respectively. The remaining counting groups are connected to the groups of conductors with the appropriate references. In addition to its function of connecting relay groups XIII and XIV to the date and time unit, relay 1337 at armature 1449 extends earth over conductor 1265 leading to the date and time unit for a purpose which was explained in the detailed description of that unit.

The duration of the call is represented by two digits which are stored on relay groups XXII and XXIII comprising relays 1323 to 1326 and 1327 to 1330 respectively. When these two digits are stored, the wipers of the switch IP2 are stepped to position 4 in which position the circuit over wiper 1352 for relays 1338, 1337, 1336 and 1335 is opened and the relays release to disconnect the date and time unit from the printer-controller. In addition wiper 1352 on contact 4 extends earth over wiper 1363 on contact 1, arma-

tures 1414, 1424, upper winding of relay 1304 to battery. It will be noted that the relay is self-interrupting at armature 1424 and the operate and release times of the relay can be adjusted by the variable condenser 1450 connected between its lower winding and battery, in order to vary the rate at which it generates impulses.

Relay 1304 on its first operation at armature 1423 transmits a pulse from earth at wiper 1352 as described above and then over armature 1431, winding of magnet 1395 of switch RS7 to battery. The wipers of the switch RS7 are thus stepped to position 2. It should be explained at this time that the switch RS7 performs two distinct functions. In the first place it converts the rate digit into the equivalent cash value—in the present embodiment into francs and centimes—and also it selects one of the two-directional switches TD5, TD6 or TD7 and certain wipers of the selected switch in order to effect the calculation of the total cost of the call. With regard to the relation between the rate digit and the equivalent cash value, this is shown in the following table:

Rate digit	Cash value in francs and centimes
1	5.00
2	3.00
3	1.20
4	1.80
5	0.80
6	
7	
8	

The rate digits 3, 5 and 6, are reserved for possible additions while digit 9 is employed where unit rate calls such as to Blaton are ticket printed.

The conversion of the rate digit into francs and centimes is effected over wipers 1367 and 1368 of the switch RS7. For this purpose the appropriate contacts associated with these wipers are connected to one of six conductors which in turn are connected through the cable 1451 to corresponding ones of the 10 digit conductors extending to the printer unit. Subsequently as will be described later the wipers 1367 and 1368 are earthed in turn and this earth is extended over the appropriate digit conductor to cause the particular digit to be printed.

The selection of the two directional switch and the wipers of the switch is effected over wiper 1369 of the switch RS7 and for this purpose contacts 3, 2, 9, 5 and 8 associated with this wiper are connected to relays 1318, 1317, 1316, 1315 and 1314 respectively which relays at their operated armatures prepare points in the circuits for the vertical and rotary magnets of the switches and also prepare circuits which extend over the wipers of the switches.

Returning now to the detailed description it will be assumed by way of example that the rate digit "8" has been stored in relay group XXI by the operation of relay 1320. The connections between the locking contacts of the relays of group XXI and the contacts associated with wipers 1365 and 1366 are so arranged that after the switch wipers have made a number of steps equivalent to the numerical value of the digit stored on group XXI, earth is extended from the locking contacts of the counting relays over bank contact and both wipers to stop the rotation of the switch. Thus when wipers 1365 and 1366 are positioned on the 9th contacts due to the automatic stepping controlled by relay 1304

the following circuits will be completed: firstly earth at armature 1429 (Fig. 26), locking armature 1452 of relay 1320, contact 9 and wiper 1365 of the switch RS7, left-hand winding of relay 1307 to battery: and secondly earth at contact 9 and wiper 1366 of the switch RS7, right-hand winding of relay 1307 to battery. Relay 1307 energises when both its windings are energised and at armature 1431 and its resting contact opens the pulsing circuit for the magnet 1395 of the switch RS7. The switch wipers thus remain at position 9.

Further relay 1307 at armature 1432 closes the following circuit: earth at armature 1432, wiper 1369 of switch RS7 on contact 9, winding of relay 1316 to battery. Relay 1316 operates and locks at armature 1454 to earth at armature 1428; at armature 1459 it completes an energising circuit for the vertical magnet 1401 of the two-directional switch TD6 and at armature 1458 it prepares a circuit for the rotary magnet 1400 of the switch TD6, thereby selecting the switch TD6, while at armatures 1455, 1456 and 1457 it connects up wipers 1383, 1384 and 1385 respectively of the switch TD6.

The circuit for energising the vertical magnet 1401 extends as follows on the next energisation of relay 1304: earth at armature 1422 (Fig. 26), armature 1417, wiper 1361, of the switch TS on contact 1, bank multiplying, armature 1459, windings of magnet 1401 to battery. The magnet 1401 energises preparatory to raising the wipers to the first level. Further the operation of relay 1304 extends earth over armatures 1423 and 1431 to magnet 1394 which energises and at the termination of the pulse de-energises to step the wipers of the switch TS to position 2, while the circuit of the vertical magnet 1401 is opened. The magnet of the switch TS and the vertical magnet operate in unison under the control of relay 1304 until the circuit of the vertical magnet is finally opened as described below.

It should be pointed out that the two-directional switch is set as regards the vertical movement in accordance with the number of 10 minute intervals that the call has lasted and as regards the rotary movement in accordance with the excess number of minute intervals. Now the number of 10 minute intervals is recorded on relay group XXII and the number of minute intervals on relay group XXIII and the contacts associated with the locking armatures of the first group are connected to contacts 2 to 11 associated with wipers 1359 and 1360 of the switch TS while those of the second group are connected to contacts 13 to 22 associated with the same wipers. These connections are effected in the same manner as those to wipers 1365 and 1366 of the switch RS7 and hence the number of steps taken by the switch TS over the first part of its banks corresponds numerically with the number of 10 minute intervals and over the second part of its banks to the number of minute intervals.

Assume by way of example that the call lasted for 9 minutes. Then the digit 0 will be stored on relay group XXII by the operation of relay 1326 and the digit 9 will be stored on relay group XXIII by the operation of relay 1329.

Returning now to the operation of the switch TS and the vertical magnet 1401, it will be seen that the switch TS will be stepped until wipers 1359 and 1360 are positioned on contact 11 when the vertical magnet 1401 has raised the wipers of the switch TD6 to the 10th level. With wipers

1359 and 1360 on contact 11, the following circuits are closed: firstly from earth at armature 1429 (Fig. 26), locking armature 1460, contact 11 and wiper 1359, right hand winding of relay 1308 to battery: and secondly, earth at contact 11 associated with wiper 1360, left hand winding of relay 1308 to battery. Relay 1308 energises and at armature 1433 closes a circuit for relay 1303 which energises and at armature 1417 opens the pulsing circuit to the vertical magnet 1401, this circuit being also opened when wiper 1361 is stepped to contact 11. Relay 1303 locks over its armature 1419, contact 11 and wiper 1362, resistance 1447 to battery.

At the end of the 11th pulse delivered by relay 1304, the wipers of the switch TS are stepped to position 12 where the circuit for relay 1308 is opened together with the locking circuit of relay 1303 so that both these relays release. Relay 1303 at armature 1416 closes a new circuit for relay 1304. The first circuit for relay 1304 extended from earth on wiper 1352 and contact on which it is resting between contacts 4 and 25 over wiper 1363, armatures 1414 and 1424 to battery over the relay winding. With wiper 1363 on contact 12, the circuit extends over wiper 1363, armature 1416, contact 11, bank multiplying of contacts 1-11, and thence as before. This circuit is not completed until relay 1303 has released so that the operation of relay 1304 is delayed slightly before delivering the 12th pulse. In addition at armature 1417 relay 1303 now closes the following circuit for the rotary magnet 1400 of the switch TD6 on the next operation of relay 1304; earth at armature 1422, armature 1417, wiper 1361 on contact 12, armature 1458, windings of rotary magnet 1400 to battery.

The rotary magnet 1400 and the switch TS now step in a similar manner to that described previously. When the wipers of the switch TS reach position 21, i. e. after 9 steps, a circuit is closed over locking armature 1461 of relay 1329 and wiper 1359 for the right hand winding of relay 1308 and from earth on contact 21 and wiper 1360 for the left hand winding of relay 1308. Relay 1308 operates followed by relay 1303 with the results described previously. The two directional switch TD6 is now set as regards both the vertical and rotary movement and over its wipers and contacts on which these are set, circuits are prepared for transferring the total charge of the call to the printer unit as will be described later.

During the above operation of the two-directional switch TD6, the remaining information has been transferred from the toll line control circuit to the printer-controller. Thus if the calling party requires the cost of the call earth is extended over wiper 1351 of the switch IP2 on contact 4, winding of relay 1300 to battery. Relay 1300 operates and locks over armature 1406 to earth at armature 1429. The calling party's number is stored on relay groups I to V while the wipers of the switch IP2 are stepped from positions 5 to 9. Relay group I comprising relays 1331, 1332, 1333, and 1334 is shown but in order to simplify the drawings the remaining groups are not shown, they being precisely similar to group I. Finally the called party's number is stored on relay groups VI to XII (not shown) as the wipers of the switch IP2 are stepped from position 10 to position 16. When the last digit of the called party's number has been stored, the wipers of switch IP2 are stepped to position 17

when the following circuit is closed: earth, lower winding of relay 1301, contact 17 and wiper 1353, interrupter contacts 1438, windings of magnet 1392 to battery. Relay 1301 only energizes in this circuit and locks over its upper winding and armature 1409 to earth at wiper 1352. In addition relay 1301, at armature 1410 shunts its lower winding to enable the magnet 1392 to energise and steps the wipers to position 18 and at armature 1408 relay 1301 opens the circuit to relay 1305 thereby opening the circuit of relay 1305 and disconnecting battery potential from conductor 1445 to allow the toll line control circuit to release as previously described. Relay 1305 releases but relay 1306 remains held over its upper winding to earth at wiper 1352. The wipers of the switch IP2 now remain at position 18 until the information has been transferred from the printer-controller to the printer unit as will be described later.

Relay 1303 in operating at the end of the rotary movement of the switch TD6 as described above, also closes the following circuit: earth at wiper 1352 of the switch IP2 on contact 18, wiper 1363 on contact 21, armature 1416 and its operated contact armature 1411 and its resting contact, conductor 1463. Earth extended over this conductor causes a printer unit to be seized over a preselecting allotting switch AL (Fig. 29) as will be described later. Further the operation of relay 1303 causes battery to be extended over resistance 1447 (Fig. 20), wiper 1362 on contact 21, armature 1418, winding of relay 1302 to conductor 1462 to cause the printer-controller finder switch PF (Fig. 29) permanently connected with the selected printer unit to hunt for the printer-controller. When the finder switch finds the marked printer-controller, relay 1302 operates to earth in the printer unit. Relay 1302 at armature 1415 closes the following circuit: earth at wiper 1352 of the switch IP2, armature 1415, lower winding of relay 1309 to battery and at armature 1411 opens the circuit to conductor 1463 to prevent the next printer unit being seized over the wipers of the allotting switch AL. Relay 1309 operates over the above-traced circuit and at armature 1435 closes a circuit for the lower winding of relay 1306 which is at present held over its upper winding and at armature 1437 provides a new energising circuit for relay 1304.

The next operation which takes place is the conversion of all the coded information into its numerical value and the operation of the printers to print the numerical values. The control of the printers is effected over the group of conductors numbered 1, 2, 3 to 0 together with the conductors 1464 to 1469.

On the next operation of relay 1304, the following circuit is closed assuming relay 1300 has been operated as described above: earth, armature 1412, 1420, wiper 1371 of switch OP2 on contact 1, armature 1407 to conductor 1469.

It should be explained that two printers PT and PU (Fig. 30) which take the form of electric typewriters are employed, one of which PT prints a ticket in the manner shown in Fig. 31 while the second PU prints the items for a particular call along one line, the different items being separated by for instance a star, while corresponding items for successive calls are all printed in the same column so that the whole record may be made on a continuous roll of paper. The control of the shifting and spacing mechanisms of the ticket printer PT is effected over wipers 1371 and 1372 of the switch OP2 while the similar

control of the record printer PU is effected over wipers 1373 and 1374.

The effect of earth extended over conductor 1469 is to cause the record printer PU to print a star at the beginning of the line to give an indication that the calling party wishes to know the cost of the call.

Returning now to the operation of relay 1304, the following circuit is also closed at armature 1421: earth at armature 1412, armature 1421, wiper 1373 of the switch OP2 on contact 1, winding of magnet 1393 of the switch GT to battery. The magnet energises and on the release of relay 1304 de-energises to step the wipers of switch GT on to contact 2. In addition the following circuit is also closed when relay 1304 energises: earth at armature 1422, armatures 1417, 1413, winding of magnet 1396 to battery. Magnet 1396 energises and on the release of relay 1304 de-energises to step the wipers on to contact 2. With the wipers of the switch GT on position 2, the locking circuits of the relay group I are extended over wipers 1354 to 1357 of the switch GT to the windings of relays 1310, 1311, 1312 and 1313. The calling party's number is stored on groups I to V and assuming as before that the calling party's number is 57109, relays 1332 and 1334 of group I will be operated. The following circuits are therefore closed: firstly from earth at armature 1427 (Fig. 26), locking armature 1470 of relay 1332, contact 2 and wiper 1355 of the switch GT, winding of relay 1311 to battery: and secondly from earth at armature 1427, locking armature 1471 of relay 1334, contact 2 and wiper 1357, winding of relay 1313 to battery. The conversion to numerical values is effected over the contacts of relays 1311 and 1313 and a circuit is closed immediately on the operation of relays 1311 and 1313 from earth at armature 1412, armature 1420, wiper 1371 on contact 2, armature 1472 in its resting position, armatures 1473 and 1474 in their operated position over conductor 5 to the printer to cause the numeral 5 to be printed. The switches GT and OP2 now continue to be stepped synchronously under the control of relay 1304 to cause the remaining four digits of the calling party's number to be transferred successively from relay groups II to V to the transfer relay group comprising relays 1310 to 1313 which then cause earth to be extended successively over conductors 7, 1, 0 and 9 to cause the printing of these numerals. When this has been completed the wipers of the switch OP2 are stepped to position 7. In this position at wiper 1371 the circuit over the armatures of relays 1310 to 1313 is opened and on the next operation of relay 1304 earth is extended to conductor 1464 leading to the printer unit to cause the operation of the shift mechanism associated with the ticket printer PT, and at wiper 1373 the circuit of the magnet 1393 of the switch GT is opened while on the next operation of relay 1304 earth is now extended over conductor 1469 leading to the printer unit to cause a star to be printed by the record printer PU in order to separate the various items in the line.

Thus with the switch OP2 in position 7 the earth extended over wiper 1371 to conductor 1464 causes the operation of the shift mechanism of the ticket printer in order that the next digit may be printed on a fresh line. Similarly the earth extended over wiper 1373 to conductor 1469 causes a star to be printed by the record printer.

Contact 8 of the switch OP2 is not connected

in order to provide a suitable time for the type-writer carriage to arrive at the beginning of the next line.

The next item to be printed is the called party's number. Now this is always prefixed with the digit "0" which when dialled by the calling party is absorbed in the register-translator as previously described. This digit is therefore reinserted at this stage in order to give the complete number and for this purpose contact 9 associated with wiper 1371 is connected directly to conductor 0 extending to the printer unit.

With the wipers of the switch OP2 in position 10, the next operation of relay 1304 causes earth to be again extended over wiper 1371 to the armatures associated with relays 1310 to 1313 while over wiper 1373 a point is again prepared in the energising circuit to magnet 1393 of the switch GT. The switches GT and OP2 are now stepped synchronously in order to secure the successive transfer of the remaining seven digits of the called party's number from relay groups VI to XII (not shown) to the transfer relays 1310 to 1313 and so secure the successive earthing of the appropriate ones of conductors 1 to 9 leading to the printer unit to cause the called party's number to be printed, both on the ticket and also on the record strip.

At the termination of this operation the wipers of the switch OP2 are on position 17 where as before the circuit over the armatures of the transfer relays is opened and on the next operation of relay 1304 earth is extended to conductor 1464 over wiper 1371 and over wiper 1373 the circuit of magnet 1439 is opened and earth is extended to conductor 1469.

Contact 18 associated with wipers 1371 and 1373 is left blank while the stepping of these wipers over contacts 19 and 20 causes the day of the month to be printed. Contact 21 associated with wiper 1371 is connected to conductor 1465 to cause a stroke to be printed by the ticket printer. The day of the month and the month are printed consecutive on the record strip and hence contact 21 associated with wiper 1373 is left unconnected.

The stepping of wipers 1371 and 1373 over contacts 22 and 23 causes the printing of the month on both the ticket and the record strip while contacts 24 and 25 associated with wiper 1371 are connected to conductor 1468 to cause the spacing mechanisms of the ticket printer to be operated twice. Contact 24 associated with wiper 1373 is again connected to conductor 1469 to cause a star to be printed on the record strip. Following this the time of the day in hours and minutes is printed while wipers 1372 and 1374 step from position 26 to 30, contact 28 associated with wiper 1372 being connected to conductor 1466 to cause the printing of a period between the hours and minutes. With regard to the printing on the record strip, the hours and minutes are again run together so that contact 28 associated with wiper 1374 will be disconnected. Contact 31 associated with wiper 1372 is connected to conductor 1464 to cause the operation of the shift mechanism of the ticket printer while contact 31 associated with wiper 1374 is connected to conductor 1469 to cause a star to be printed by the record printer.

The next item to be printed is the charging rate in francs and centimes. The franc portion of the rate is determined by the position of wiper 1367 of the switch RS1 and the centime portion by the position of wiper 1368 of the switch RS1

as explained previously. Contact 33 associated with wiper 1372 is therefore connected to wiper 1367 and contact 35 is connected to wiper 1368, contact 34 being connected to conductor 1466 to cause the printing of the period between the francs and centimes.

It has been assumed that the rate at which the call is to be charged is 0.80 francs or 80 centimes. With wiper 1372 on contact 33 therefore earth is extended on the operation of relay 1304 over wiper 1372 on contact 33, wiper 1367 on contact 8, conductor 0, cable 1451 to conductor 0 extending to the printer unit to cause this numeral to be printed. The period is next printed and with wiper 1372 on contact 35 a circuit is closed on the operation of relay 1304 which extends over wiper 1372 on contact 35, wiper 1368 on contact 9 whereby earth is extended to conductor 8 leading to the printer unit. The different rates at which calls are to be charged are chosen so that the last digit of the centime part of the rate is always "0." Thus for the five rates which are at present employed, the centime part is respectively 00, 00, 80, 80 and 20. Contact 36 associated with wiper 1372 is thus connected directly to conductor 0 leading to the printer unit in order that this digit may be printed.

Contacts 37, 38 and 39 are multiplied together and connected to conductor 1468 extending to the printer unit to cause the ticket printer to move the ticket three spaces.

The next item to be printed is the duration of the call which is stored on relay groups XXII and XXIII. The switch GT and the switch OP2 are thus synchronously stepped over the next two contacts to cause the number of ten minute intervals and minute intervals to be transferred successively to the transfer relays 1310 to 1313 whereby earth is extended successively over conductors 0 to 9 leading to the printer unit to cause these digits to be printed in accordance with the example previously given.

Contact 42 associated with wiper 1372 is connected to conductor 1464 to cause the operation of the shift mechanism of the ticket printer while contact 42 associated with wiper 1374 is connected to conductor 1469 to cause a star to be printed by the record printer.

The next and final item to be printed is the total cost of the call. This item is obtained by a calculation which is effected by the selected one of the switches TD5, TD6 and TD7. As pointed out previously according to the rate digit one of the five relays 1314 to 1318 are operated to select one of the three switches TD5, TD6 and TD7 and also to select a group of wipers of the selected switch. Thus for the rate digit 2, wipers 1377 and 1378 of the switch TD5 are selected; for the rate digit 1, wipers 1379 to 1382 of the same switch are selected and so on. In the present case it has been assumed that the rate digit is the digit 8 representing a cash value of 80 centimes and hence the wipers 1383 to 1385 of the switch TD6 have been selected. Further the switch is positioned in accordance with the duration of the call and since each wiper has 100 associated contacts and the longest period for which a call can be timed is 99 minutes it will be appreciated that by means of appropriate cross-connections between the contacts associated with the wipers and the conductors 1-0 leading to the printer, the printer may be caused to print a number of digits which represent the

total cost of the call according to any arbitrary scheme of calculation.

It is to be noted that in the case of the rate digit 2 (3 francs), two wipers only of the switch TD5 are connected up, while in the case of the rate digit 1 (5 francs), four wipers of the same switch are employed. The reason for this is that in the first case there is only a maximum of two variable digits in the total cost while in the second case there is a possibility of four variable digits and hence four wipers must be employed. For the remaining rates there are three variable digits and three wipers are employed in each case. In addition with the present scheme of charging the total charge never includes a centime value of less than ten, and hence the last digit is always caused to be printed by a direct connection to conductor 0.

In the example which has been assumed, the rate is 80 centimes and the duration of the call is 9 minutes. It should be explained that in this case the charge is 80 centimes for each three minute interval, a duration of 4 or 5 minutes being reckoned as a six minute call. The total cost will therefore be 2 francs 40 centimes. Contact 9 in the 10th level associated with 1385 will, therefore, be cross-connected not to one of the 10 conductors but to conductor 1468 to cause the operation of the spacing mechanism of the ticket printer; contact 9 in the 10th level associated with wiper 1384 will be cross-connected to conductor 2 and contact 9 in the 10th level associated with 1383 will be cross-connected to conductor 4.

Returning now to the description of the operation of switch OP2, the wipers of this switch after the duration of the call has been printed are stepped over position 43 to position 44. Earth is now extended over wiper 1372, as it steps over contacts 44, 45, 46 and 48, over the selected wipers of the selected two-directional switch to the appropriate ones of the ten conductors extending to the printer unit. It is to be noted however that the earth extended over contact 44 is only effective when relay 1317 is operated, i. e. the rate is 5 francs, since as pointed out above this is the only rate for which the total cost involves a maximum of four variable digits.

In the present case, therefore, the earth at wiper 1372 on contact 44 is ineffective; that extended over contact 45 is further extended over armature 1457, wiper 1385, conductor 1468 to cause the operation of the spacing mechanism of the ticket printer to be operated. Earth at wiper 1372 is next extended over contact 46, armature 1456, wiper 1384, and cross-connection to conductor 2 extending to the printer unit. Earth on wiper 1372 is extended over contact 47 to conductor 1466 to cause the printing of the period on the ticket. Earth at wiper 1372 is extended over contact 48, armature 1455, wiper 1383 and cross-connection to conductor 4 extending to the printer unit. Earth at wiper 1372 on contact 49 is extended directly to conductor 0 to cause the printing of the last digit and finally earth at wiper 1372 on contact 50 is extended to conductor 1464 in order to cause the operation of the shift mechanism of the ticket printer while earth at wiper 1374 on contact 50 is extended to conductor 1467 to cause the operation of the shift mechanism of the record printer. All the items are now printed on the ticket and the record strip and the printer-controller may be released and the printer unit made available

for another call. The release of the printer-controller is effected when the wipers of the switch OP2 are stepped to their 1st position when the locking circuit for relay 1309 is opened. This relay releases and at armature 1437 removes earth from the winding of relay 1304 to prevent this relay from delivering further pulses and at armature 1435 opens the circuit of relay 1306. Relay 1306 releases and opens the locking circuits of all the storing relays including relays 1314 to 1318 and all these relays release. In addition relay 1306 at armature 1428 and its resting contact closes a circuit over vertical off-normal springs 1444 for the release magnet 1402 of the two-directional switch TD6 which is thus restored to normal and at armature 1426 and its resting contact closes an obvious self-interrupting circuit for magnet 1395 of the switch RS7 which is restored to normal in which position the circuit is extended over wiper 1370 on contact 1 to magnet 1393 of the switch GT over wiper 1358 and interrupter contacts 1439. The wipers of the switch GT are thus restored to normal when the circuit is again extended over wiper 1358 on contact 1, wiper 1364 of the switch TS, interrupter contacts 1440, magnet 1394 to battery. The wipers of the switch TS are thus restored to normal. In addition relay 1306 at armature 1429 closes a self-interrupting circuit over contact 18 and wiper 1353 of the switch IP2 whereupon the wipers are rotated to contact 20 and thence to contact 1 by the earth multiple. It will also be noted that relay 1308 releases on the first step of the switch TS in its restoring movement and at armature 1433 opens the circuit of relay 1303 which releases and at armature 1418 opens the circuit of relay 1302 which restores to enable the printer to be taken into use again.

Finally relay 1301 releases when the wipers of the switch IP2 arrive at position 1 and at armature 1408 battery is again connected to conductor 1445 to enable the printer controller to be taken into use by another toll line control circuit.

It should be noted that if no printer unit is available, the printer-controller waits until a printer unit becomes idle. This will be explained in more detail in the description of the printer unit but it should be pointed out that since the toll line control circuit is released when all the information has been transferred to the printer-controller, there is no junction line equipment maintained busy while the printer-controller waits for an idle printer unit.

It will be understood that the operation of the printer-controller may be varied in a number of ways. For instance instead of waiting until the total price has been calculated before a printer is taken into use, a printer may be seized immediately so that printing takes place while the calculation of the total price is being effected.

Detailed description of allotter and printer unit

Three printer units are provided to deal with the printing operations and each printer unit as described above include two printers PU and PT each of which takes the form of an electric typewriter. One of the printers, PT, prints the ticket while the other, PU, prints the items on a continuous roll for record purposes.

When all the necessary information has been transferred from the toll line control circuit TLCC to the printer-controller PC and the calculation of the total charge has been effected

in the printer-controller as described previously and assuming the allotter has in the position shown preselected an idle printer, earth is extended over conductor 1463 to cause the operation of relay 1508. Relay 1508 at armature 1534 extends earth over wiper 1513 of the allotter switch AL, bank contact leading to the preselected printer unit, armature 1529, winding of relay 1507 to battery. Relay 1507 operates and at armature 1533 completes the following self-interrupting circuit for the magnet 1509 of the printer-controller finder switch PF: earth at armature 1533, armatures 1531, 1526, interrupter springs 1555, windings of magnet 1509 to battery. The wipers of the switch PF are thus rotated until the contact associated with wiper 1512 which is marked by battery potential in the printer-controller is reached when relay 1505 operates from earth at armature 1532 over wiper 1512 to battery on conductor 1462. Relay 1505 in operating at armature 1526 opens the circuit of magnet 1509 and at armature 1524 closes an obvious circuit for relay 1506. Relay 1506 operates and at armature 1528 closes a locking circuit for relay 1505 from earth at armature 1525; at armature 1527 it closes a circuit over wiper 1511 of the switch PF for relays 1501 and 1502 which operate to extend conductors 1464 to 1469 and the control conductors 1 to 0 from the printer-controller to the magnets of the printers; at armature 1529 it opens the circuit for relay 1507 which releases slowly and at armature 1530 it removes one earth from the shunt circuit around relay 1558 and extends it over contact 1 associated with wiper 1514 of the switch AL, interrupter springs 1556, windings of magnet 1510 of the switch AL to battery. The switch AL thus steps its wipers on to the next set of contacts leading to the second printer unit in which position the above traced circuit is interrupted provided the second printer unit is idle. It will be understood that conductors 1522 and 1515 leading to the second and third printer units respectively are connected to a relay similar to relay 1507 over normally closed contacts similar to the contacts associated with armature 1529 of the first printer unit. Further conductors 1523 and 1516 are extended to contacts similar to the contacts associated with armature 1530.

With regard to the printers themselves, these are shown diagrammatically by the dotted rectangles PU and PT. Conductors 1 to 0 extending from the printer-controller control the magnets in both printers as indicated by the connecting terminals associated with these conductors. Conductors 1464 to 1469 are however individual to the particular printer, thus conductors 1467 and 1469 control the shift mechanism and the star-printing magnet of the record printer while conductors 1464, 1465, 1466 and 1468 control the shift mechanism, stroke printing magnet, period printing magnet and the spacing mechanism respectively of the ticket printing unit.

As pointed out in the description of the printer-controller, if the calling subscriber wishes to know the cost of the call, conductor 1469 is earthed prior to the printing of any of the items. This earth causes the operation of the star-printing magnet associated with the record printer and is also extended over armature 1535, upper winding of relay 1504 to battery. Relay 1504 operates and locks over armatures 1538 to earth at key 1518. Further at armature 1537 relay 1504

earths conductor 1557 to cause an audible alarm to be given to attract the attention of an attendant to the fact that a calling subscriber wishes to know the cost of the connection. Relay 1504 may be released by opening key 1519.

When describing the printing of the recording roll, it was pointed out that a star was printed between each item and it will be appreciated that the above-described alarm should not be given in such cases. Accordingly the battery supply for the magnets which control the printing of the digits is taken over the upper winding of relay 1503 and conductor 1520 so that on the application of earth to any of the conductors 1 to 0 to print the first digit, relay 1503 operates and locks over armature 1536 to earth at armature 1527. Further at armature 1535 relay 1503 opens the circuit to relay 1504 to prevent any further alarm being given.

No further change occurs in the circuits of the printer unit until all the items have been printed. Battery is then removed from conductor 1462 and relay 1505 releases followed by relay 1506. Relay 1506 opens the circuits of relays 1501, 1502 and 1503 which release and the printer unit is available for connection to another printer-controller.

The printer units can be made busy by the operation of the key BK1 for the first unit and similar keys for the second and third units and in addition make-busy-contacts are provided on each printer PT and PU, the operation of which causes earth to be connected to conductor 1521.

The purpose of relay 1558 is to give an alarm when the allotter switch AL is unable to find an idle printer unit. Relay 1558 is common to the three printer units and when all the latter are busy, the shunt around relay 1558 is removed and the relay operates. At armature 1559 relay 1558 removes earth from contact 25 associated with wiper 1514 of the allotter switch and connects alarm conductor 1560 to contact 25 and an alarm is given.

I claim:

1. In a telephone system, a first set of registers, means for storing in said first set of registers a plurality of variable items of record information pertaining to a telephone connection and including the identification of the calling line involved in the connection, a second set of registers having permanently stored therein a constant item of information pertaining to a telephone connection, a record producing device selectively operative repeatedly to make a plurality of variable entries upon an associated record, and cyclically operative means for selectively operating in accordance with the items stored in said first and said second sets of registers said record producing device and for clearing said first set of registers, whereby said record producing device is operated to make a plurality of different entries corresponding to the items stored in said first and said second sets of registers upon the associated record.

2. In a telephone system, a first set of registers, means for storing in said first set of registers a plurality of variable items of record information pertaining to a telephone connection and including the identification of the calling line involved in the connection, a second set of registers, means controlled in accordance with certain of the items stored in said first set of registers for automatically storing in said

second set of registers a variable item of record information pertaining to a telephone connection, a record producing device selectively operative repeatedly to make a plurality of variable entries upon an associated record, and cyclically operative means for selectively operating in accordance with the items stored in said first and said second sets of registers said record producing device, whereby said record producing device is operated to make a plurality of different entries corresponding to the items stored in said first and said second sets of registers upon the associated record.

3. In a telephone system, a set of registers, means for storing in said set of registers a plurality of variable items of record information pertaining to a telephone connection and including the identification of the calling line involved in the connection, a record producing device selectively operative repeatedly to make a plurality of variable entries upon an associated record, means including a first stepping mechanism for conditioning said record producing device to make the entries in a predetermined order upon the associated record, means including a second stepping mechanism controlled in accordance with the items stored in said set of registers for selectively operating said record producing device, and means for operating said first and said second stepping mechanisms in an established order.

4. In a telephone system, a set of registers, means for storing in said set of registers a plurality of variable items of record information pertaining to a telephone connection and including the identification of the calling line involved in the connection, a record producing device having a plurality of control conductors, means governed in accordance with the application of a predetermined potential to said control conductors for selectively operating repeatedly said record producing device to make a plurality of variable entries upon an associated record, means including a first stepping switch having access to certain of said control conductors for applying said predetermined potential thereto, thereby to condition said record producing device to make the entries in a predetermined order upon the associated record, means including a second stepping switch having joint access to said set of registers and to other of said control conductors for applying said predetermined potential thereto in accordance with the items stored in said set of registers, thereby selectively to operate said record producing device, and means for operating said first and second stepping switches in an established order.

5. In a telephone system, a set of registers, means for storing in said set of registers one or more variable items of record information pertaining to a telephone connection and including the identification of the calling line involved in the connection, a plurality of recorders, each of said recorders being operative to record the item or items stored in said set of registers, means for selecting idle ones of said recorders in a predetermined order, and means for determining whether a recording operation is to be performed in conjunction with a telephone connection and for operating a selected one of said recorders only in the event it is determined that a recording operation is to be performed in conjunction with the telephone connection.

6. In a telephone system, a calling line, a

called line, means for routing a call from said calling line to said called line, a device, means controlled in accordance with the relationship between said calling line and said called line for determining whether said device is to be operated and for conditioning said device to be operated only in the event a predetermined relationship exists between said calling line and said called line, means responsive to the answering of said call on said called line for operating said device, means including a register for storing certain items of record information pertaining to said call and including the identification of said calling line, means including a recorder operative to record the items stored in said register, and means controlled jointly by the operation of said device and the termination of said call for operating said recorder.

7. In a telephone system, a calling line, a called line, means for routing a call from said calling line to said called line, a device, means responsive to the answering of said call on said called line for operating said device, means including a register for storing certain items of record information pertaining to said call and including the identification of said calling line, a recorder operative to record the items stored in said register, and means controlled jointly by the operation of said device and the termination of said call for operating said recorder.

8. In a telephone system, a calling line, a called line, means for routing a call from said calling line to said called line, means including a register operative to store certain items of record information pertaining to said call and including the identification of said calling line, means responsive to the answering of said call on said called line for operating said register, means including a recorder operative to record the items stored in said register, and automatic means controlled by the operation of said register for operating said recorder.

9. In a telephone system, a calling line, a called line, means for routing a call from said calling line to said called line, means including a register operative to store certain items of record information pertaining to said call and including the identification of said calling line, means responsive to the answering of said call on said called line for operating said register, a plurality of recorders, each of said recorders being operative to record the items stored in said register, and automatic means controlled by the operation of said register for operating an idle one of said recorders.

10. In a telephone system, a register, means for collecting certain items of record information pertaining to a telephone connection including the identification of the calling line involved in the connection and for storing the collected items in said register, and means for recording in spaces provided on a preformed ticket individual to the connection the items stored in said register, whereby each item is recorded in a corresponding space provided therefor on the ticket.

11. In a telephone system, a plurality of registers, means for collecting certain items of record information pertaining to a plurality of telephone connections including the identifications of the calling lines respectively involved in the connections and for storing the collected items in corresponding ones of said registers, whereby all the collected items pertaining to a given telephone connection are stored in a given register, a recorder, means for selectively asso-

ciating said recorder with said registers, and means controlled when said recorder is associated with a given register for causing said recorder to record in spaces provided on a preformed ticket individual to a corresponding given telephone connection the items stored in said given register, whereby each item is recorded in a corresponding space provided therefor on the ticket individual to the given connection.

12. In a telephone system, a register, means for collecting certain items of record information pertaining to a telephone connection including the identification of the calling line involved in the connection and for storing the collected items in said register, means for printing in spaces disposed adjacent preprinted identifications provided on a preformed ticket individual to the connection the items stored in said register, whereby each item is printed in a space disposed adjacent a corresponding identification provided on the ticket.

13. In a telephone system, a register, means for collecting certain items of record information pertaining to a telephone connection including the identification of the calling line involved in the connection and for storing the collected items in said register, means including a printer for printing in spaces provided on a preformed ticket individual to the connection the items stored in said registers, whereby each item is printed in a corresponding space provided therefor on the ticket, said printer comprising ticket feeding mechanism cooperating with said ticket in order positively to insure that a given item is printed in a corresponding space provided on the ticket.

14. In a telephone system, a plurality of lines, switching apparatus for setting up connections between said lines, means for establishing charges individual to the connections, first mechanism for producing records individual to the connections and including the charges individual thereto, and second mechanism for producing a record common to the connections and including the charges individual thereto.

15. In a telephone system, a plurality of lines, switching apparatus for setting up connections between said lines, means for establishing charges individual to the connections, first mechanism for producing records individual to the connections and including both the identifications of the calling lines involved in the connections and the charges individual thereto, and second mechanism for producing a record common to the connections and including both the identifications of the calling lines involved in the connections and the charges individual thereto.

16. In a telephone system, a plurality of lines, switching apparatus for setting up connections between said lines, means for establishing charges individual to the connections, first mechanism operative to produce records individual to the connections and including the identifications of the calling lines and the called lines involved in the connections and the charges individual thereto, and second mechanism for producing a record common to the connections and including the identifications of the calling lines and the called lines involved in the connections and the charges individual thereto.

17. In a telephone system, a plurality of lines,

switching apparatus for setting up connections between said lines, means for establishing charges individual to the connections, first mechanism operative to produce records individual to the connections, second mechanism operative to produce a record common to the connections, and means controlled upon the termination of a given connection for operating both said first mechanism and said second mechanism, thereby to cause each of said mechanisms to make a record applicable to said given connection.

18. In a telephone system, a register, means for collecting certain items of record information pertaining to a telephone connection and for storing the collected items in said register, first and second printers, and means for operating said first printer and said second printer substantially simultaneously in accordance with the items stored in said register, said first printer being operative to print the items in appropriate spaces on a detachable ticket in a form suitable for a subscriber, said second printer being operative to print the items on a continuous strip in a form suitable for a permanent record.

19. In a telephone system, a plurality of lines, switching apparatus for setting up connections between said lines, means for establishing charges individual to the connections, a mechanism comprising a first recorder and a second recorder, and means for progressively associating, said mechanism with connections, thereby to cause said first recorder to produce a plurality of records individual to the connections and to cause said second recorder to produce a record common to the connections.

20. In a telephone system, a plurality of lines, switching apparatus for setting up connections between said lines, means for establishing charges individual to the connections, recording mechanism comprising a first recorder and a second recorder, and means operative in response to the termination of a number of connections for progressively associating said mechanism therewith, thereby to cause said first recorder to be operated repeatedly to produce individual records of the charges for the individual connections and to cause said second recorder to be operated repeatedly to produce a common record of the charges for the individual connections.

21. In a telephone system, a plurality of lines, switching apparatus for setting up connections between said lines, means for establishing charges individual to the connections, recording mechanisms each comprising a first recorder for producing a record individual to a connection and including the charge individual thereto and a second recorder for producing a record common to a number of connections and including the charges individual thereto, an allotter for preselecting idle mechanisms for use, means operative in response to the termination of a given connection for associating a preselected one of said mechanisms therewith, and means operative in response to the association of said one mechanism with said given connection for operating the first recorder and the second recorder thereof.

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