July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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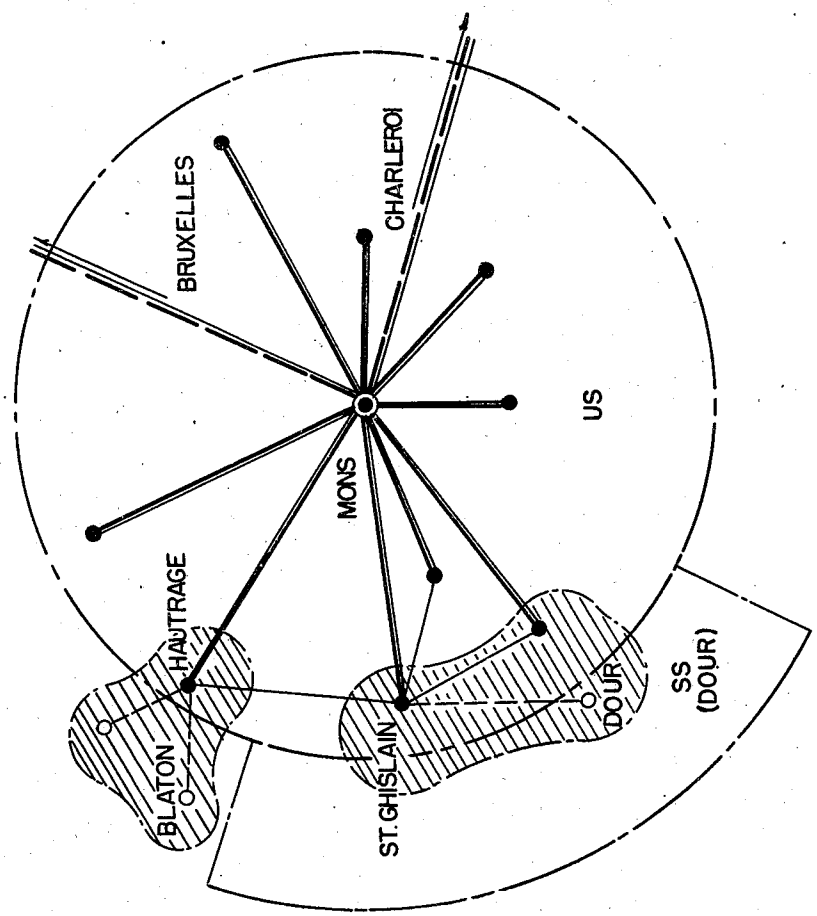


FIG.1

INVENTOR.
JOHN ELLIS OSTLINE

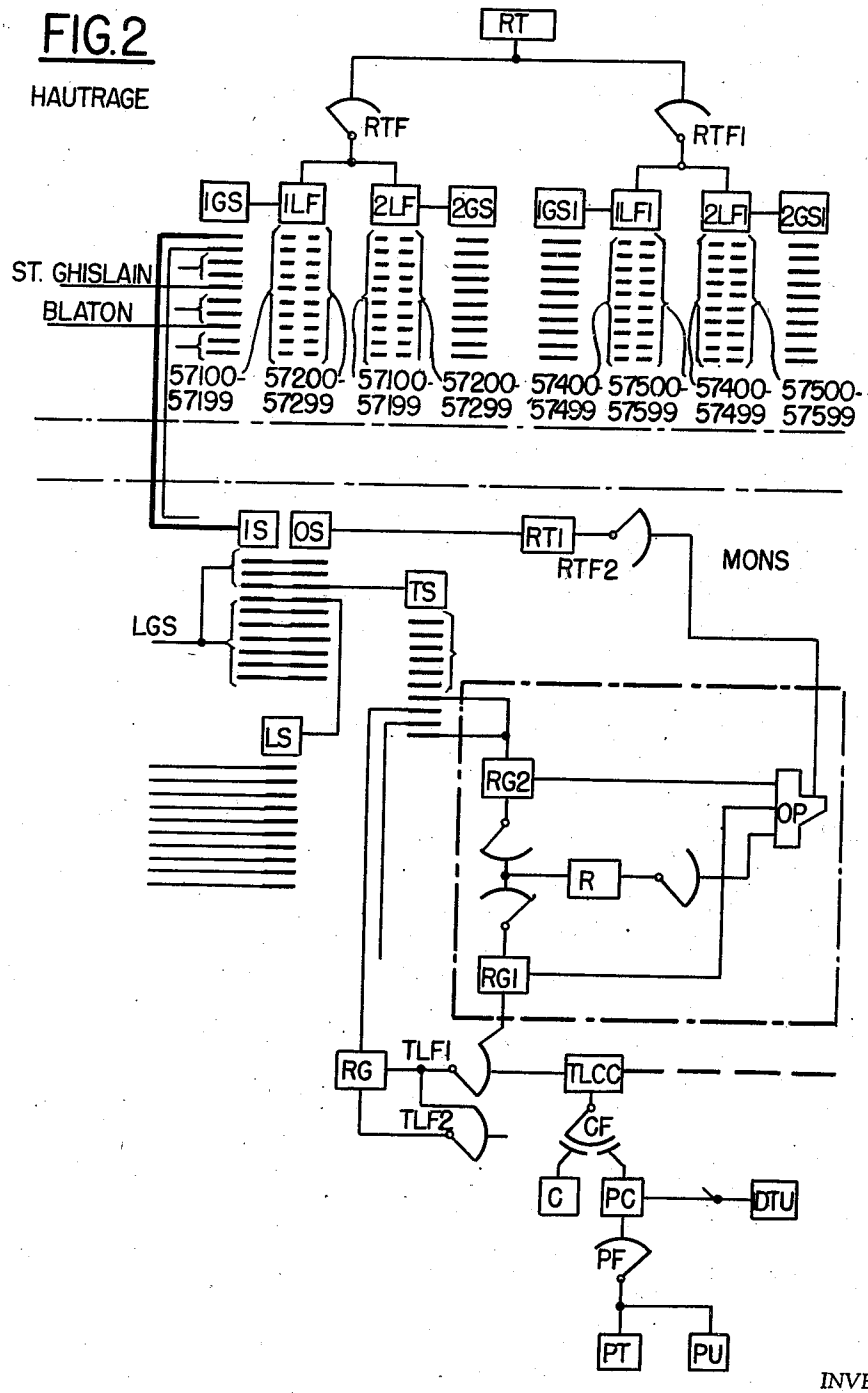
BY Chas. Tu. Caudy.
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 2

FIG.2



INVENTOR.
JOHN ELLIS OSTLINE

BY Chas. Th. Cundy

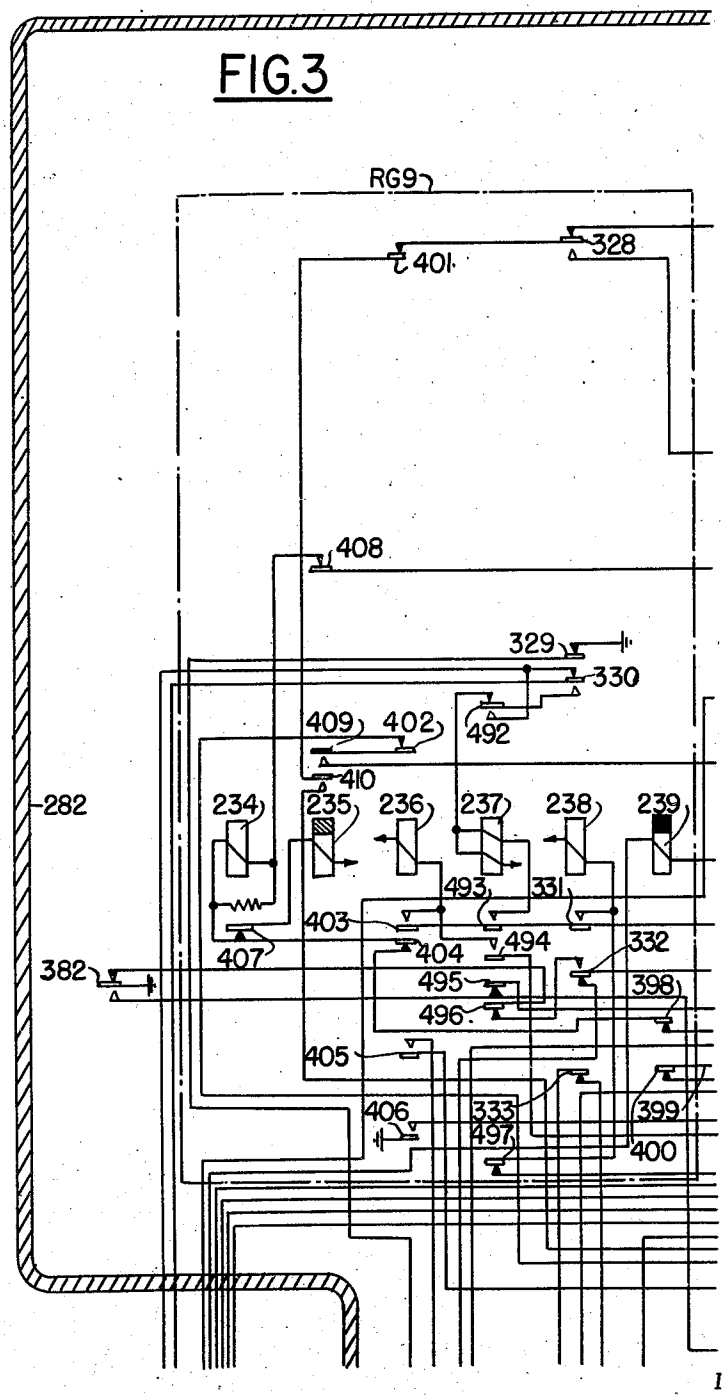
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 3

FIG.3



INVENTOR.
JOHN ELLIS OSTLINE
BY Chas. Tu. Cundy.
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 4

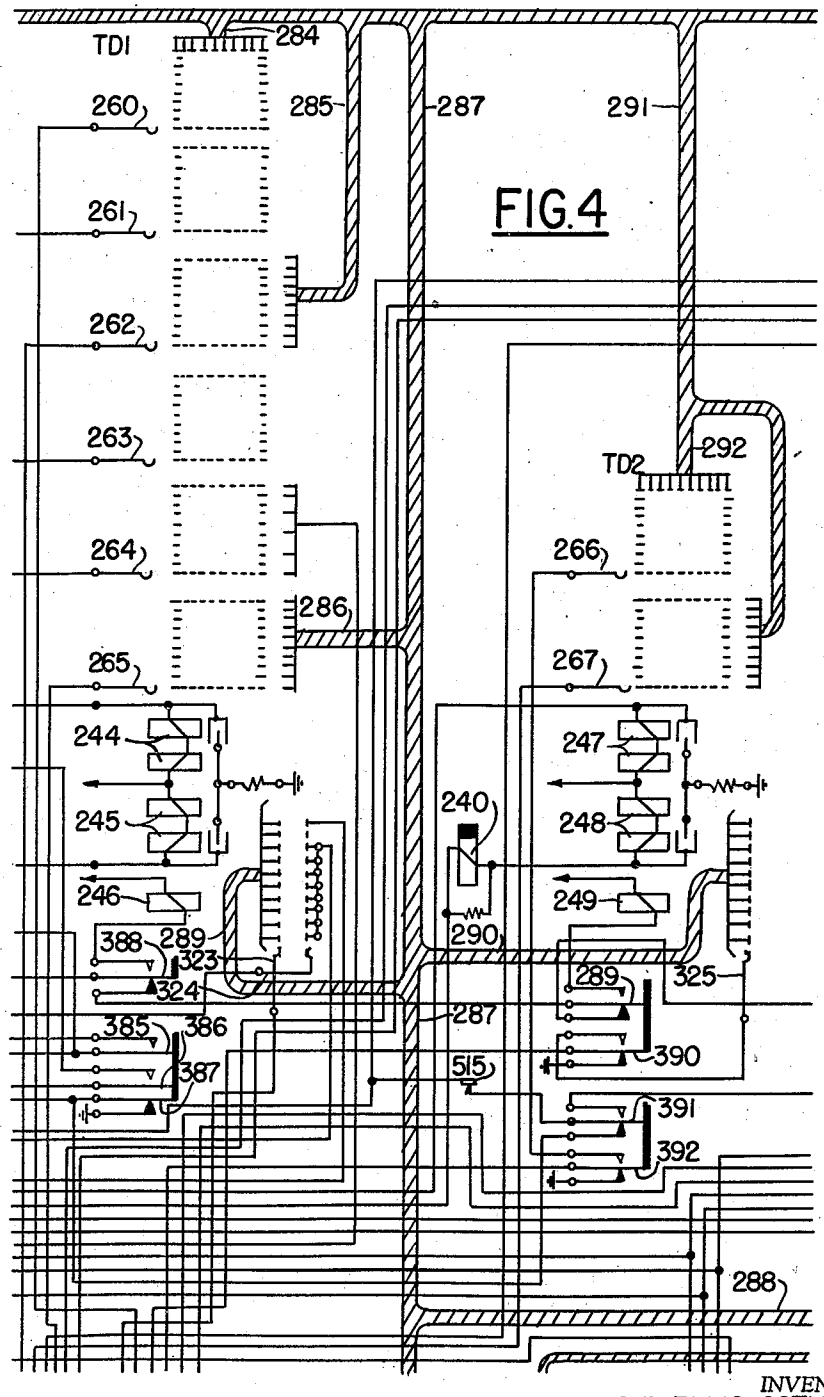


FIG.4

INVENTOR.
JOHN ELLIS OSTLINE

BY Chas. W. Cundy

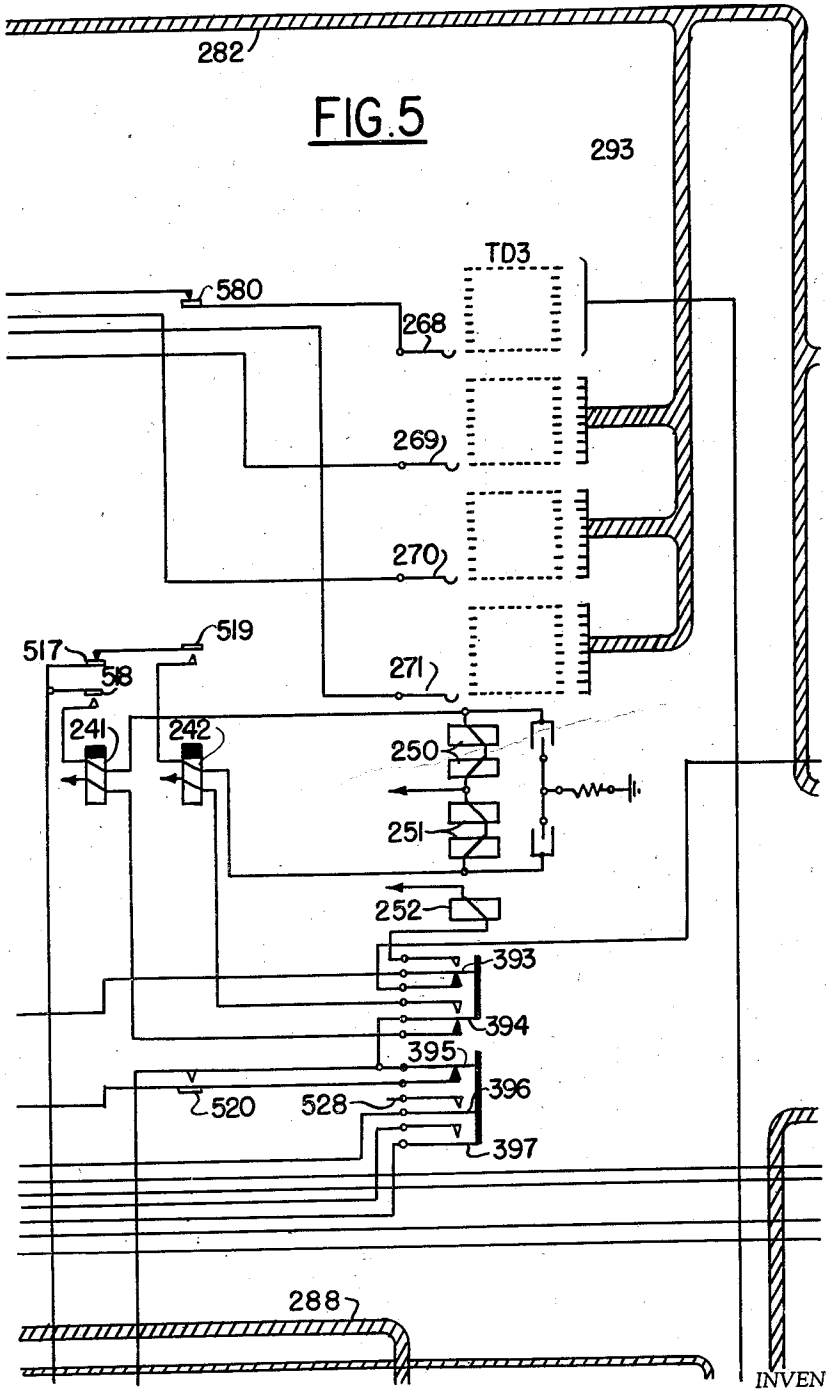
ATTORNEY

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RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG.5



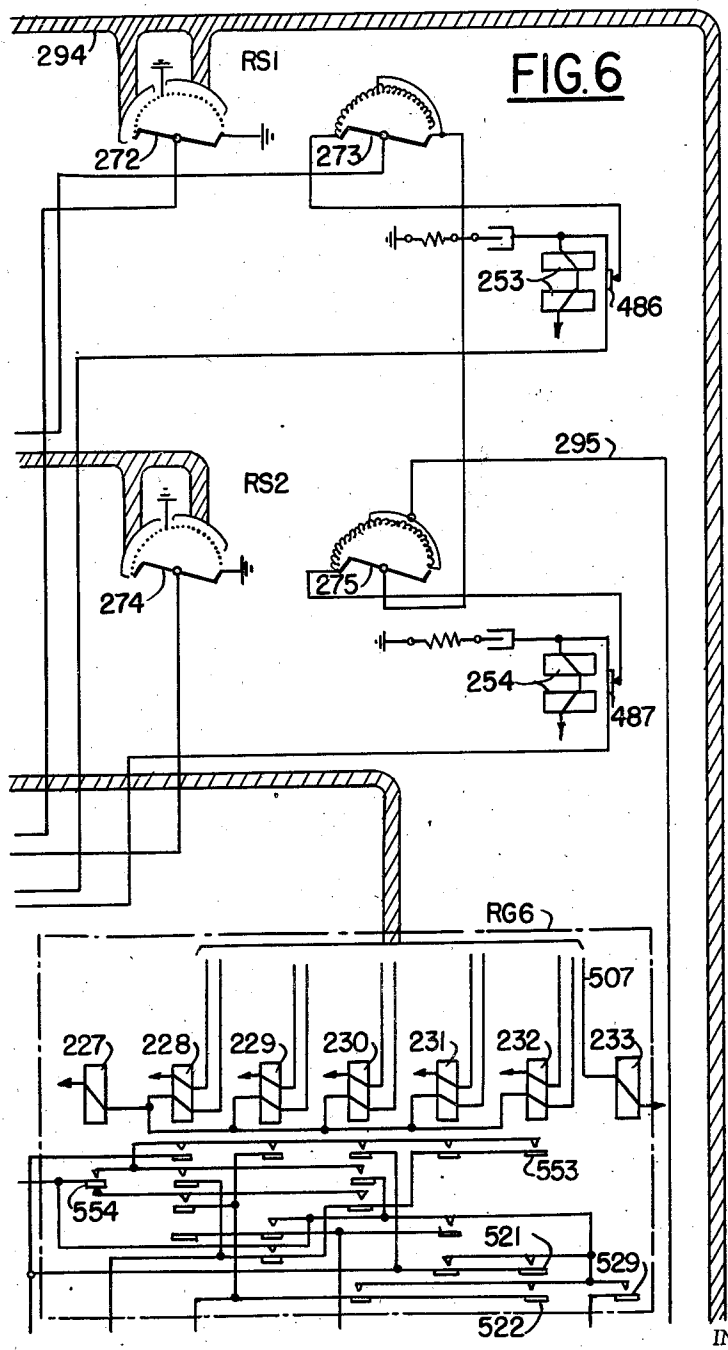
INVENTOR.
JOHN ELLIS OSTLINE
BY Chas. Tu. Cundy
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG. 6



INVENTOR.
JOHN ELLIS OSTLINE

BY Chas. Tu. Candy.

ATTORNEY

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RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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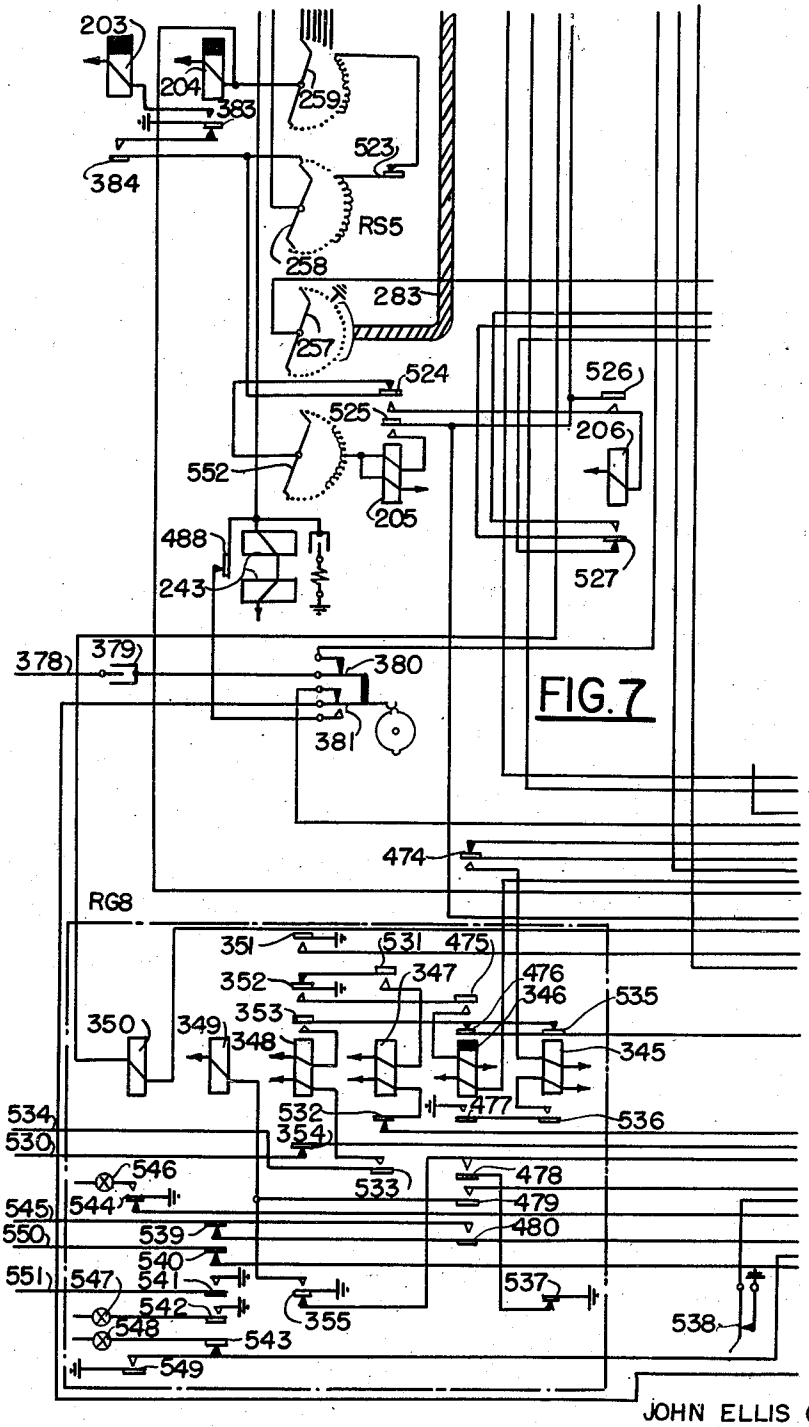


FIG. 7

INVENTOR.
JOHN ELLIS OSTLINE
BY Chas. H. Candy.
ATTORNEY

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RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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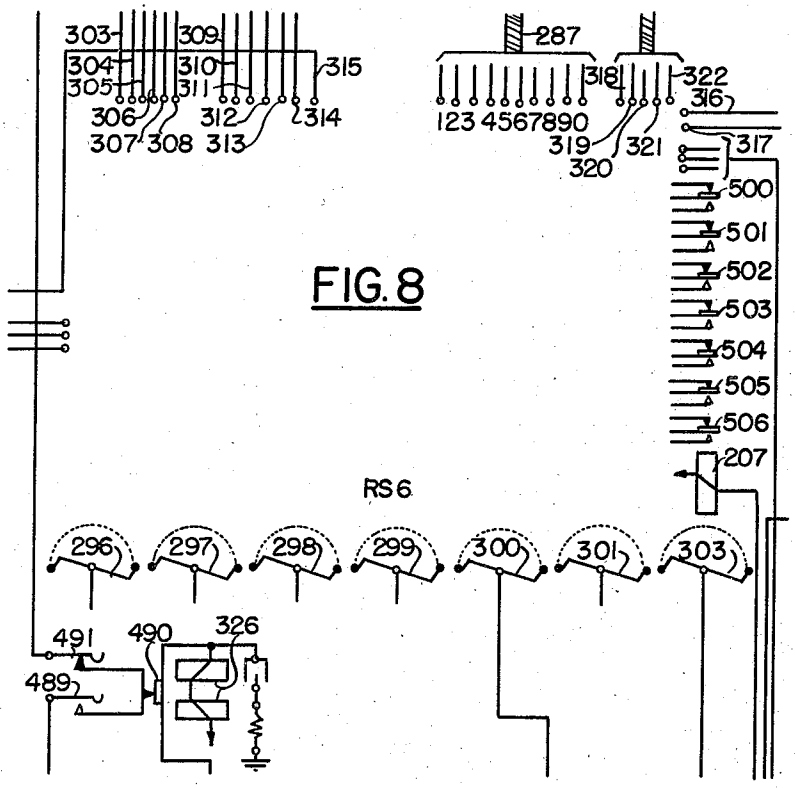


FIG. 8

INVENTOR.
JOHN ELLIS OSTLINE

BY Chas. W. Cundy.

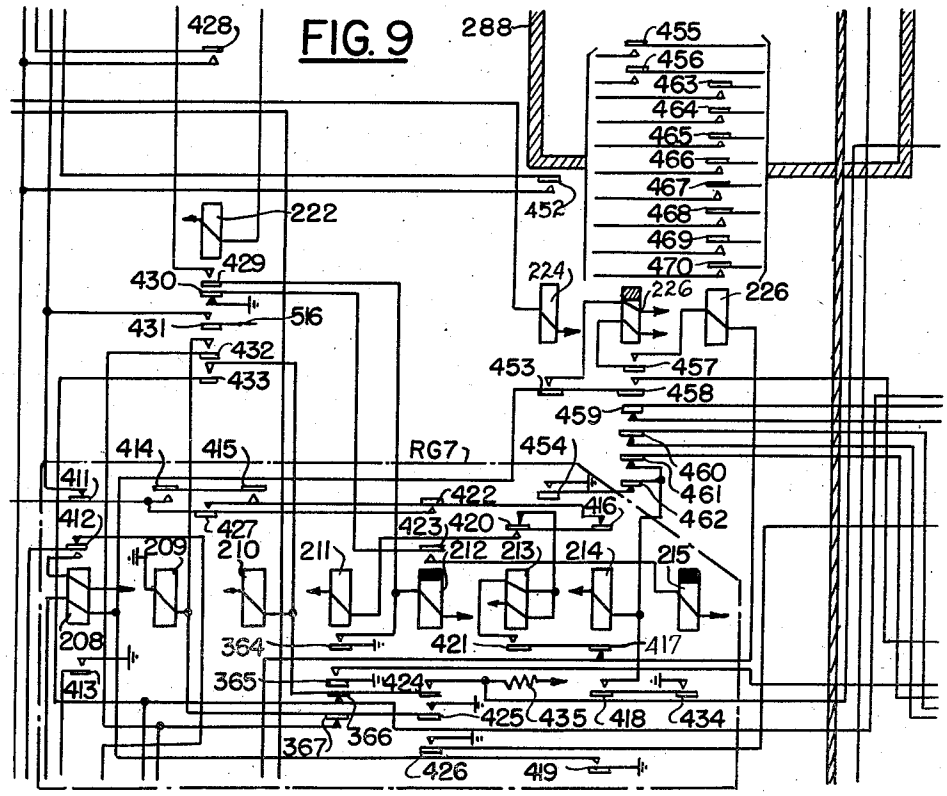
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 9

FIG. 9



INVENTOR.
JOHN ELLIS OSTLINE

BY Chas. Tu. Candy

ATTORNEY

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RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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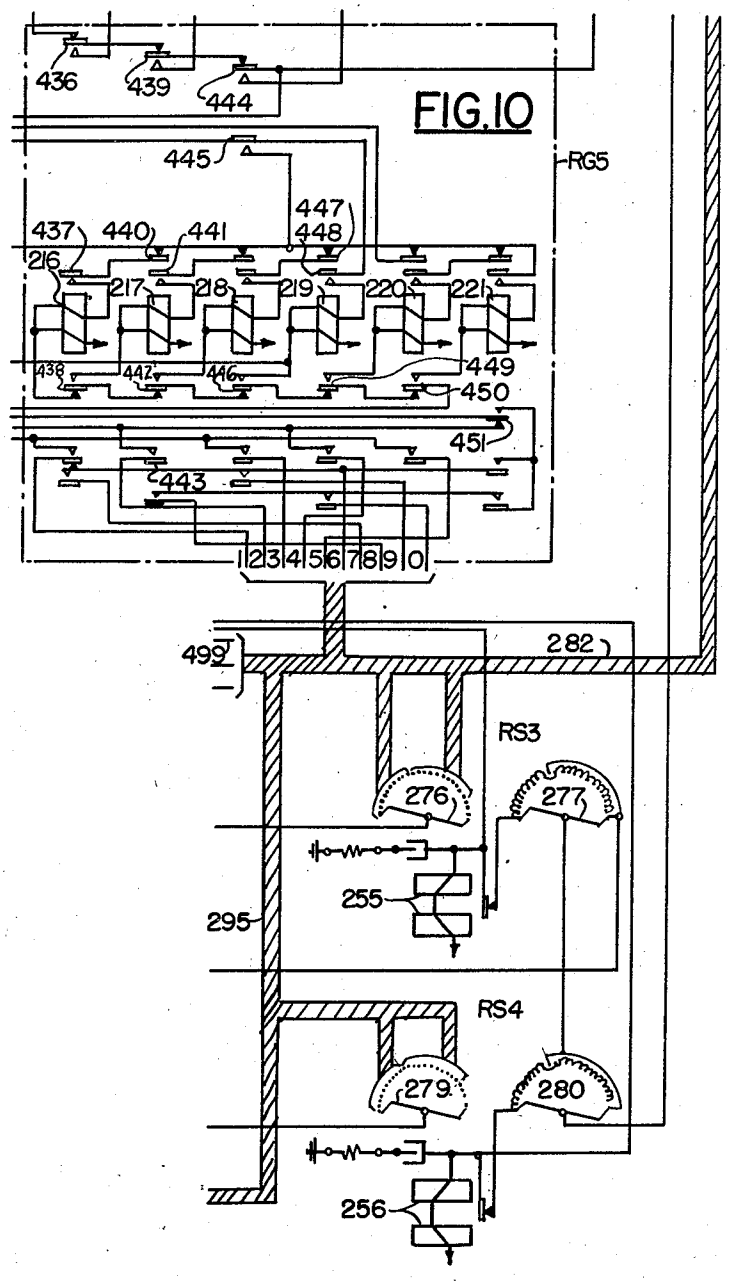


FIG. 10

INVENTOR.
JOHN ELLIS OSTLINE

BY Chas. Tu. Candy

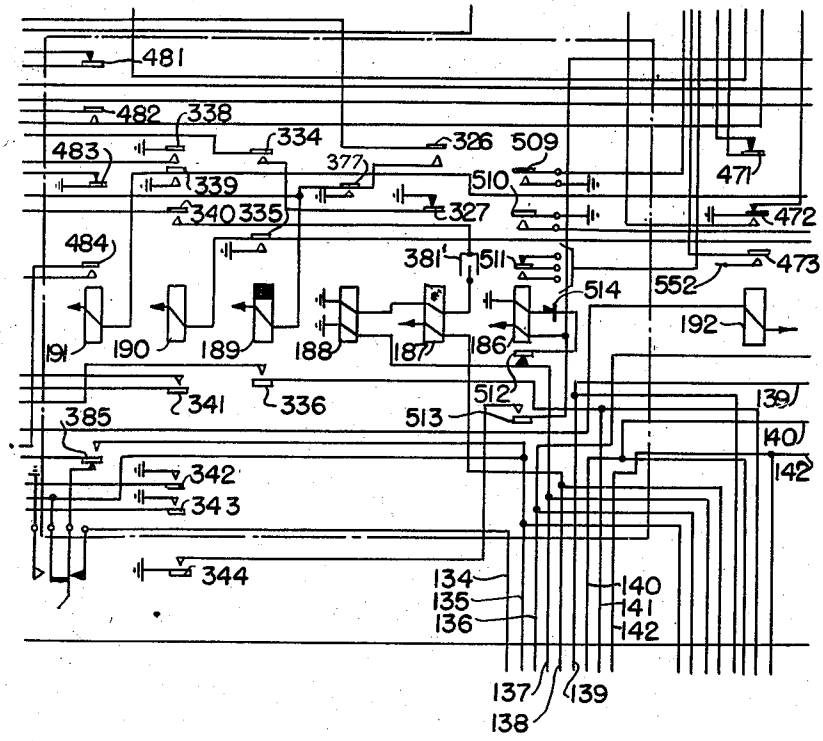
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 11

FIG. 11



INVENTOR.
JOHN ELLIS OSTLINE

BY Chas. Le. Candy.

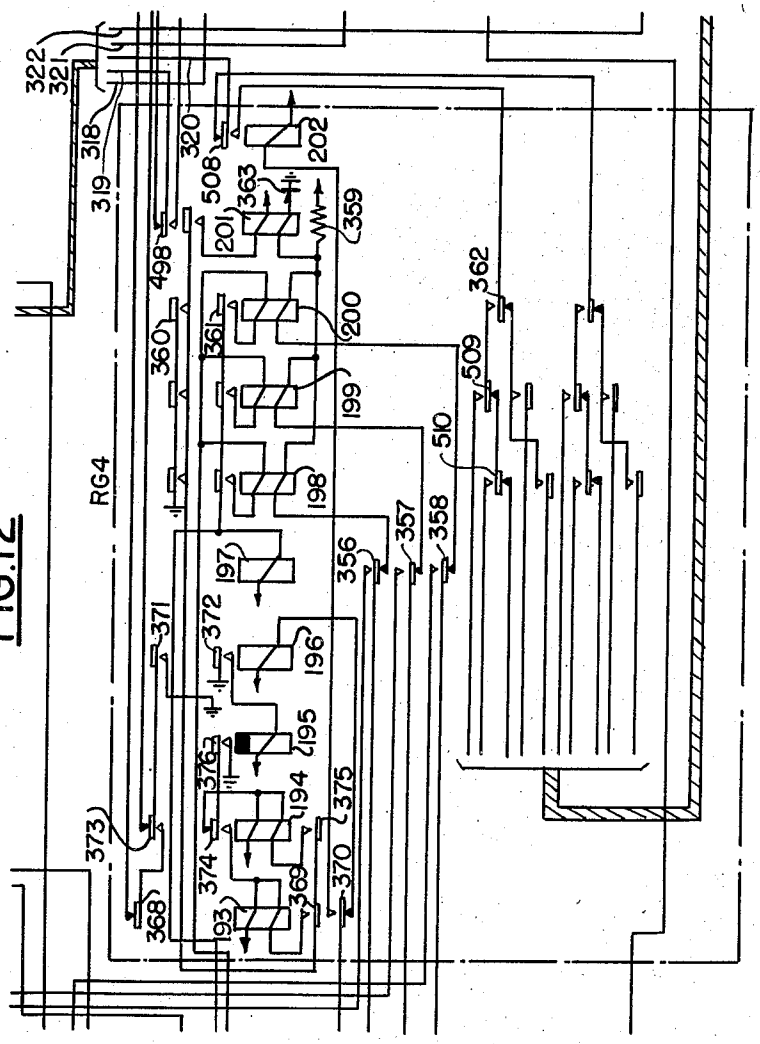
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG.12



INVENTOR.
JOHN ELLIS OSTLINE
BY Chas. Tu. Candy.
ATTORNEY

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RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG.13

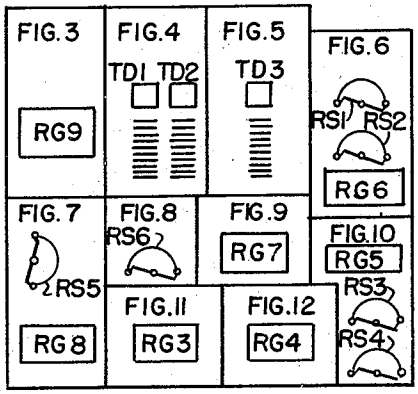


FIG.14

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

FIG.58

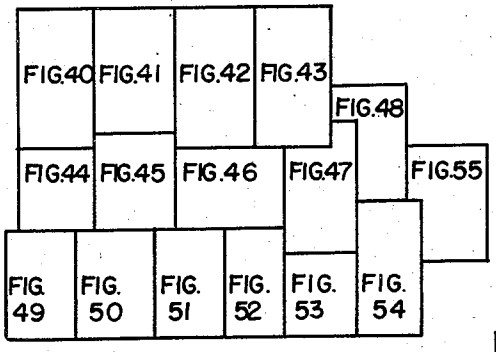
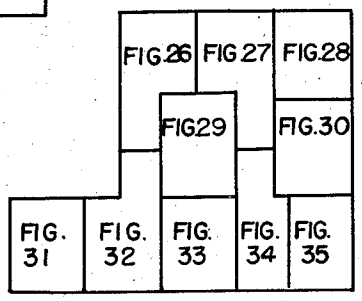


FIG.57



INVENTOR.
JOHN ELLIS OSTLINE
BY Chas. Tu. Candy.
ATTORNEY

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FIG. 15

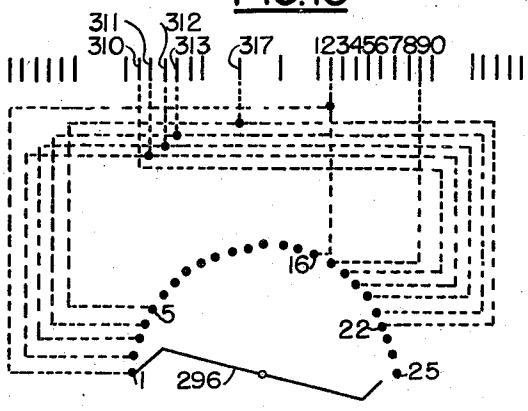


FIG. 16

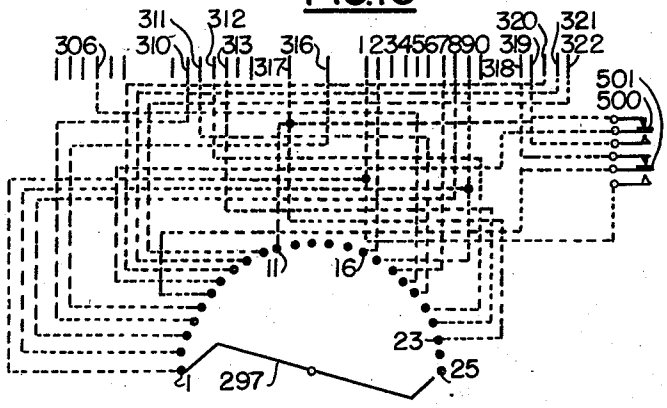
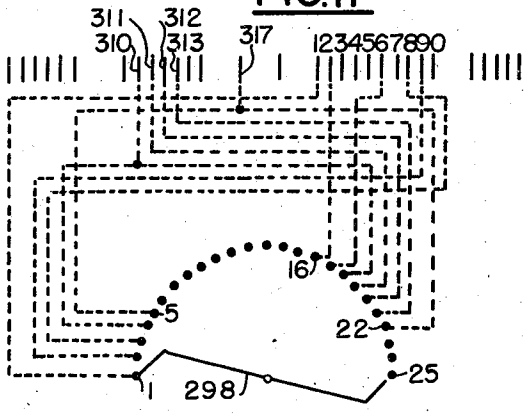


FIG. 17



INVENTOR.
JOHN ELLIS OSTLINE

BY Chas. Tu. Candy.

ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG. 18

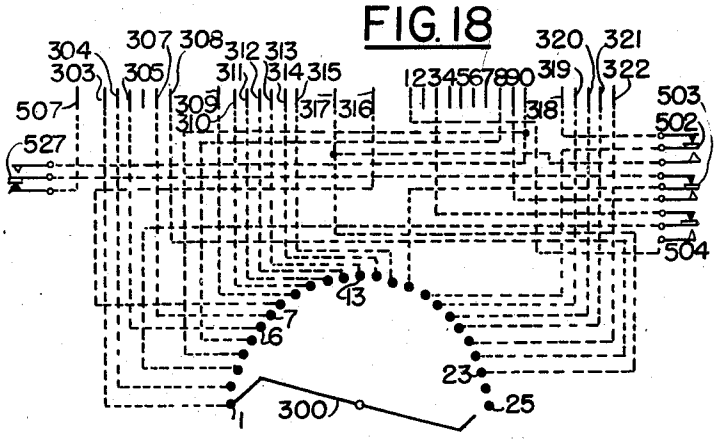


FIG. 19

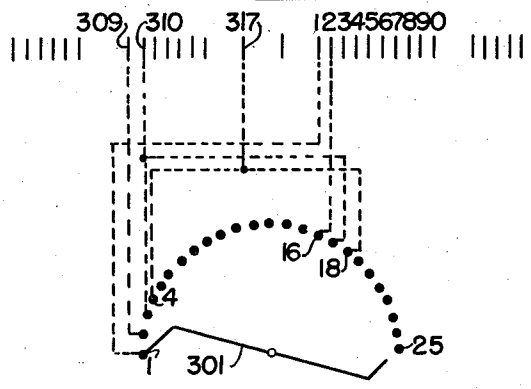
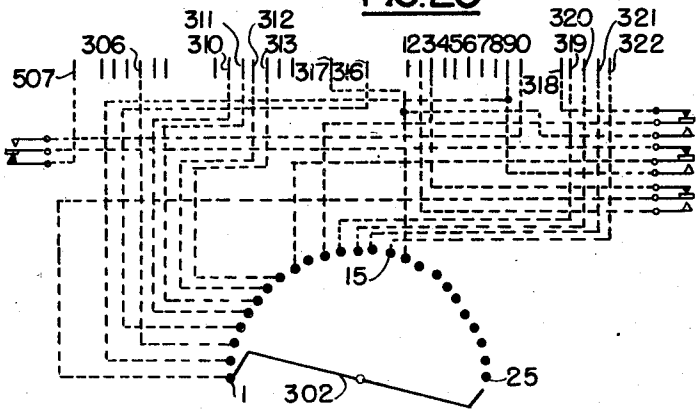


FIG. 20



INVENTOR.
JOHN ELLIS OSTLINE

BY Chas. Tw. Cundy

ATTORNEY

FIG. 21

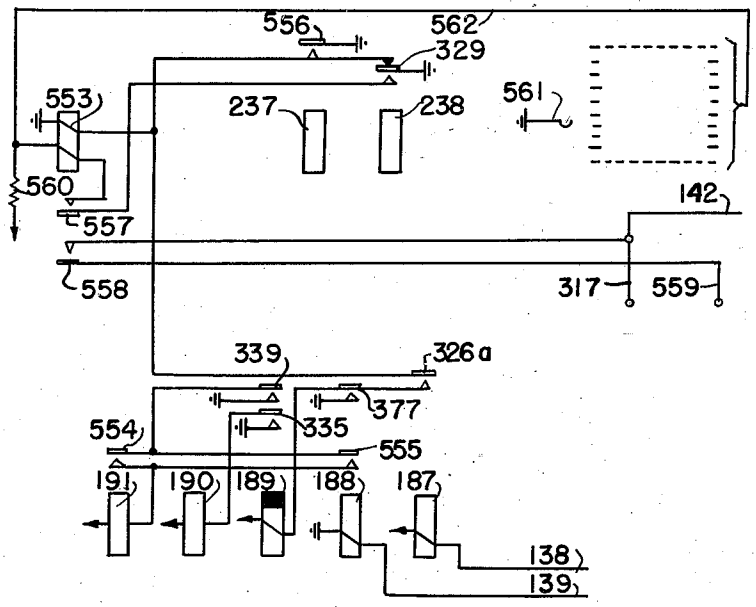


FIG. 56

CALLING 57109	
CALLED 08743123	
DATE 23/12	HOUR 16:10
RATE 0.80	DURATION 09
TOTAL COST 2.40	

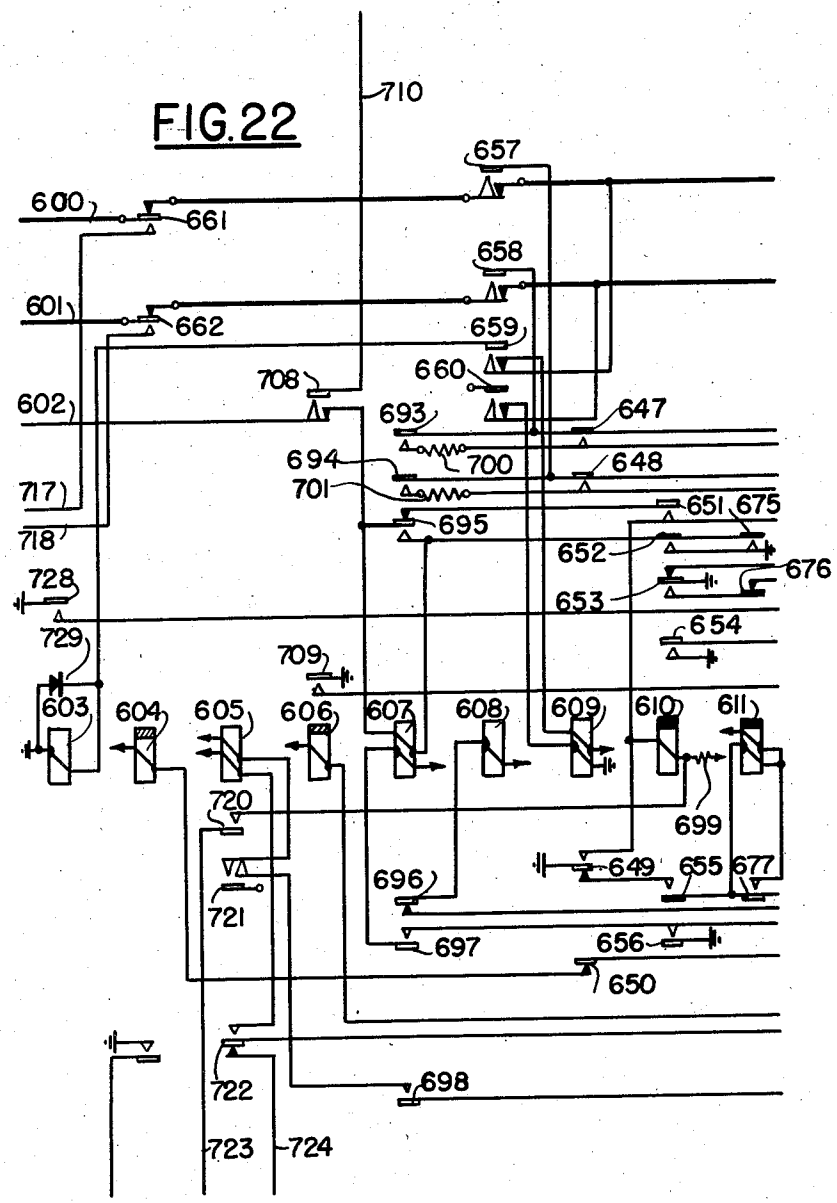
INVENTOR.
JOHN ELLIS OSTLINE
BY Chas. Tu. Candy
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG.22



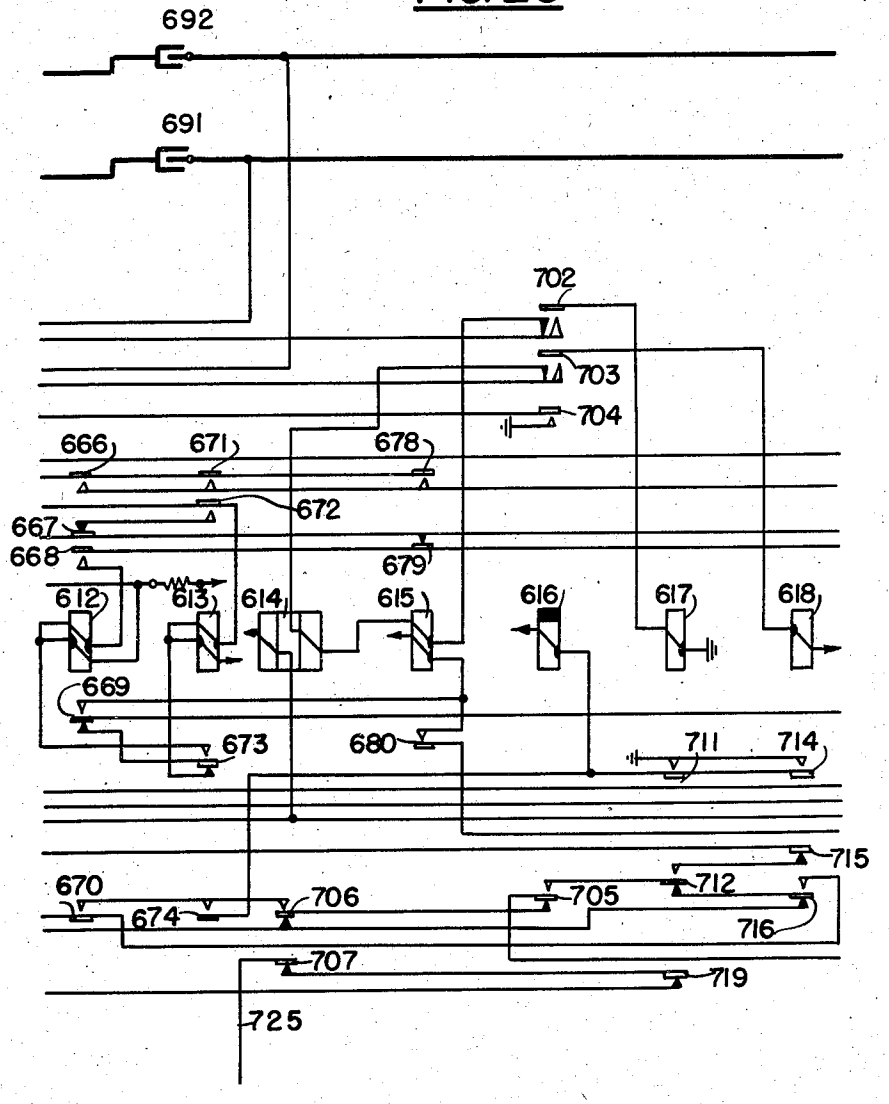
INVENTOR.
JOHN ELLIS OSTLINE
BY Chas. Tu. Candy.
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG. 23



INVENTOR.
JOHN ELLIS OSTLINE

BY Chas. L. Candy

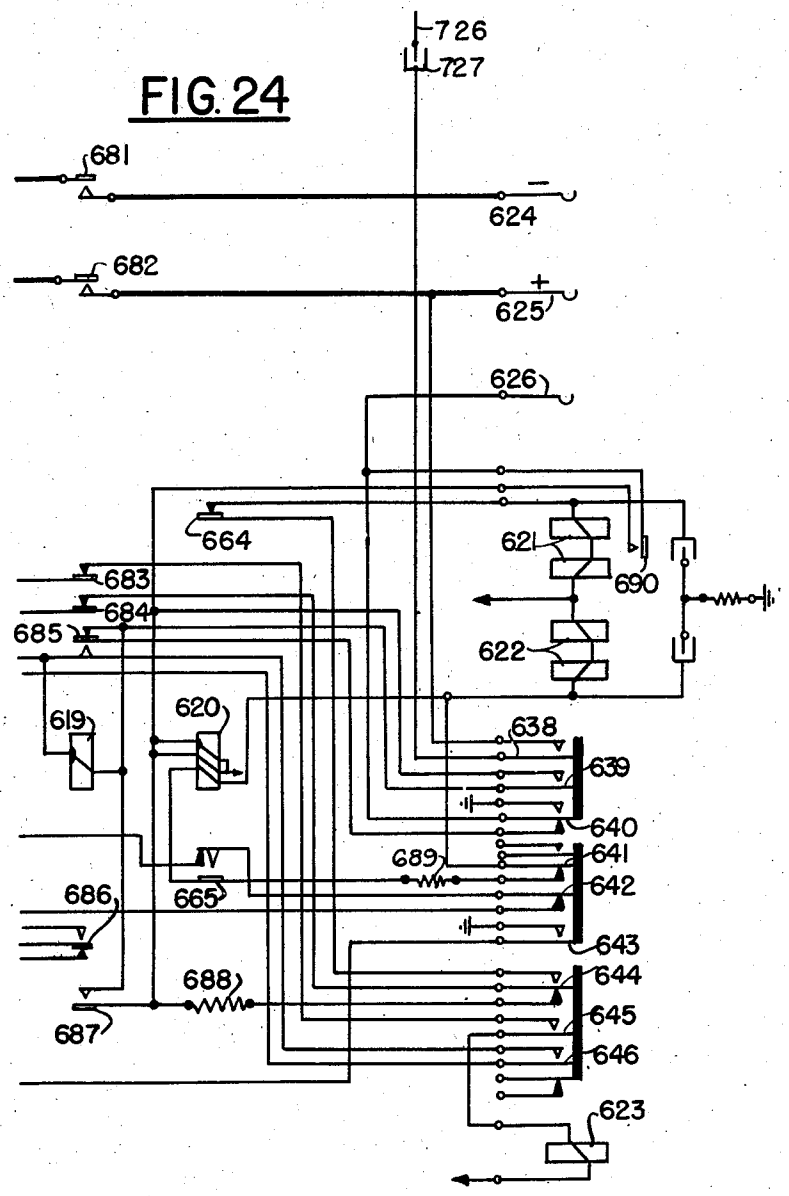
ATTORNEY

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RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG. 24



INVENTOR.
JOHN ELLIS OSTLINE

BY Chas. Tu. Candy

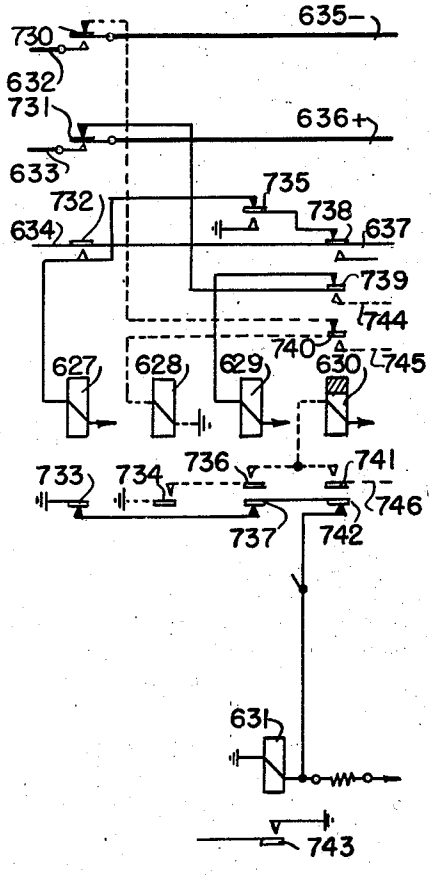
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG. 25



INVENTOR.
JOHN ELLIS OSTLINE
BY Chas. Tu. Candy
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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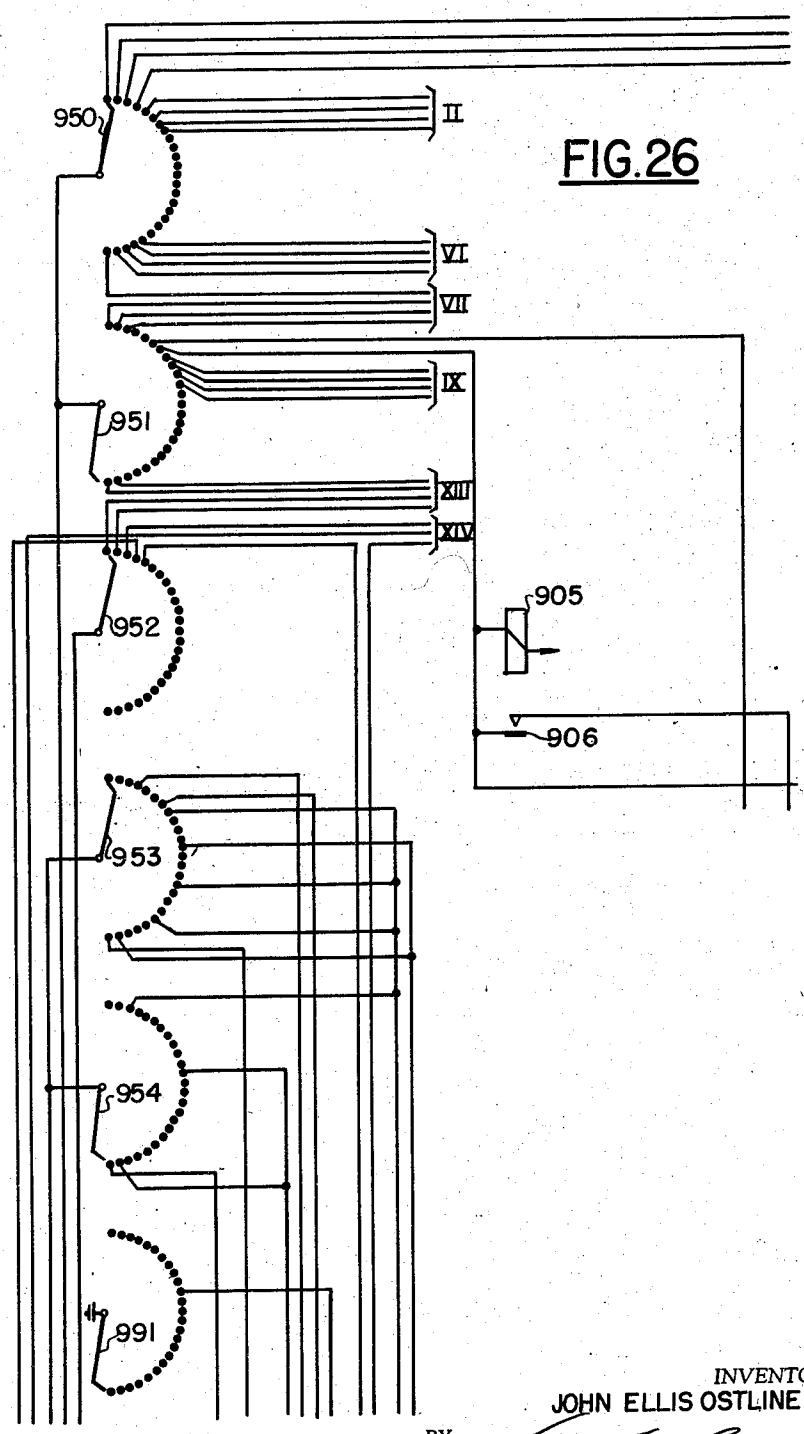


FIG.26

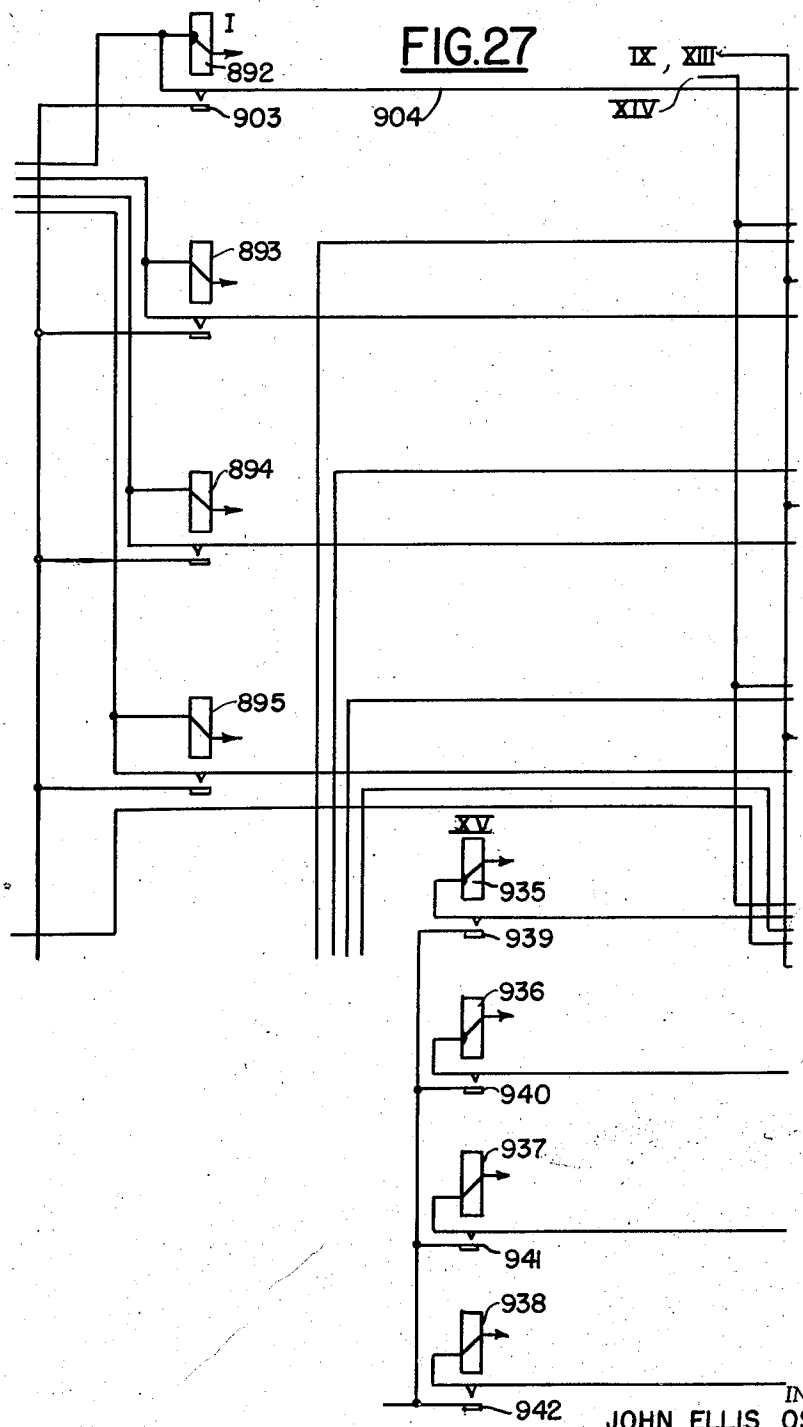
INVENTOR.
JOHN ELLIS OSTLINE
BY Chas. Tu. Candy
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG.27



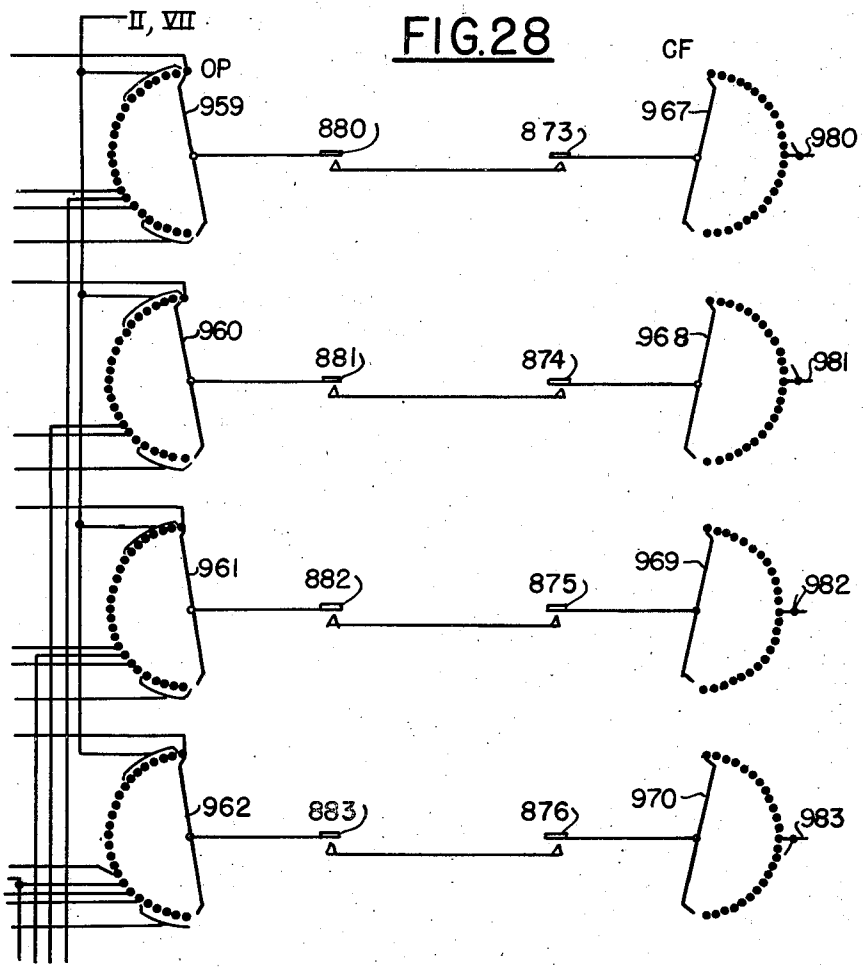
INVENTOR.
JOHN ELLIS OSTLINE
BY Chas. Tu. Candy
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG.28



INVENTOR.
JOHN ELLIS OSTLINE

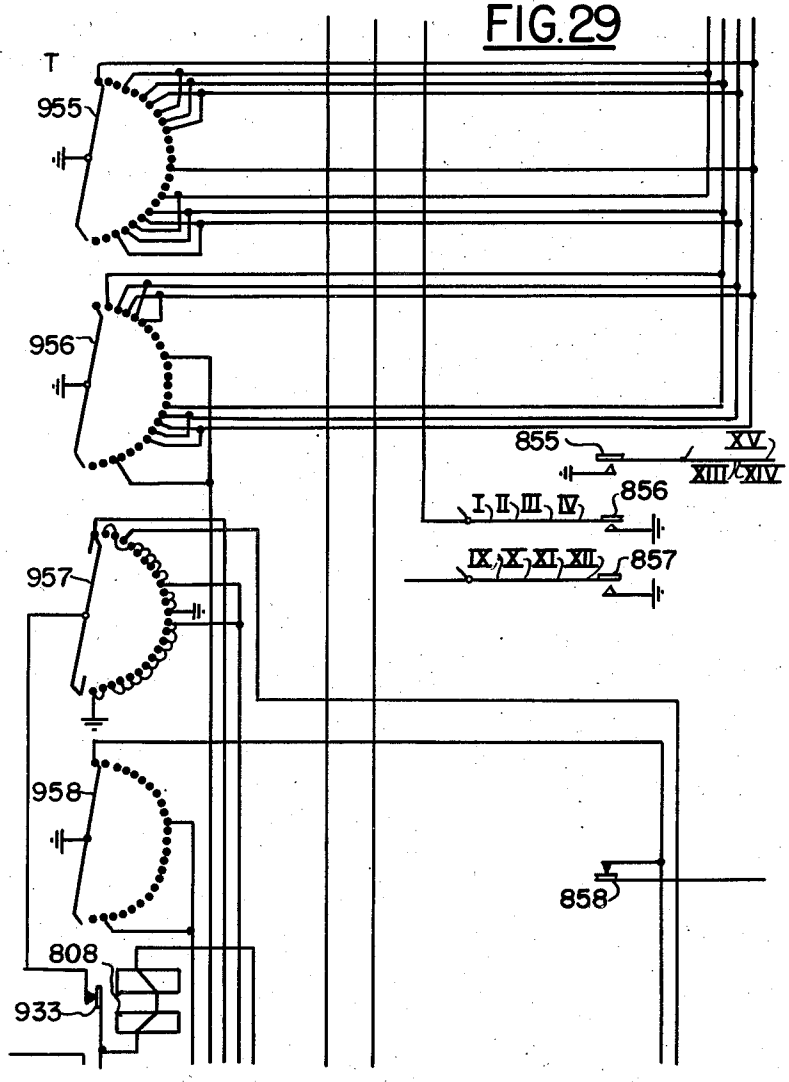
BY Chas. Tr. Candy.
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG. 29



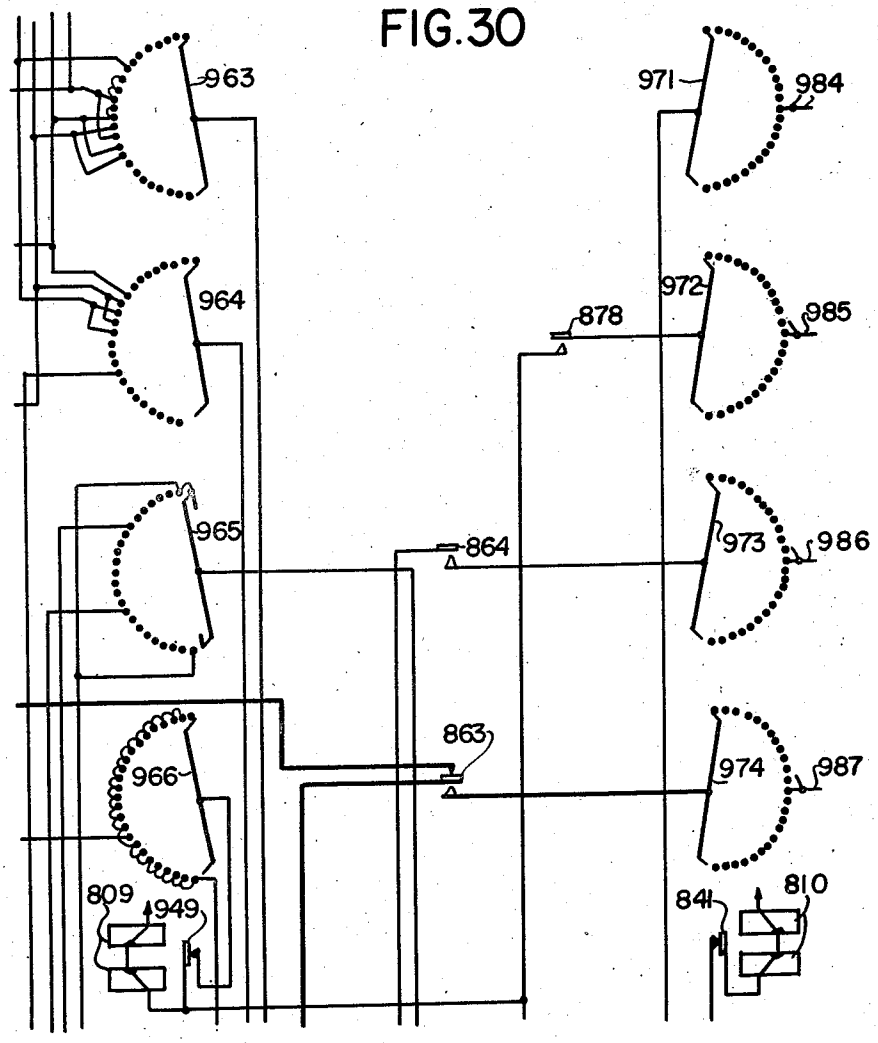
INVENTOR.
JOHN ELLIS OSTLINE
BY Chas. L. Candy
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG.30



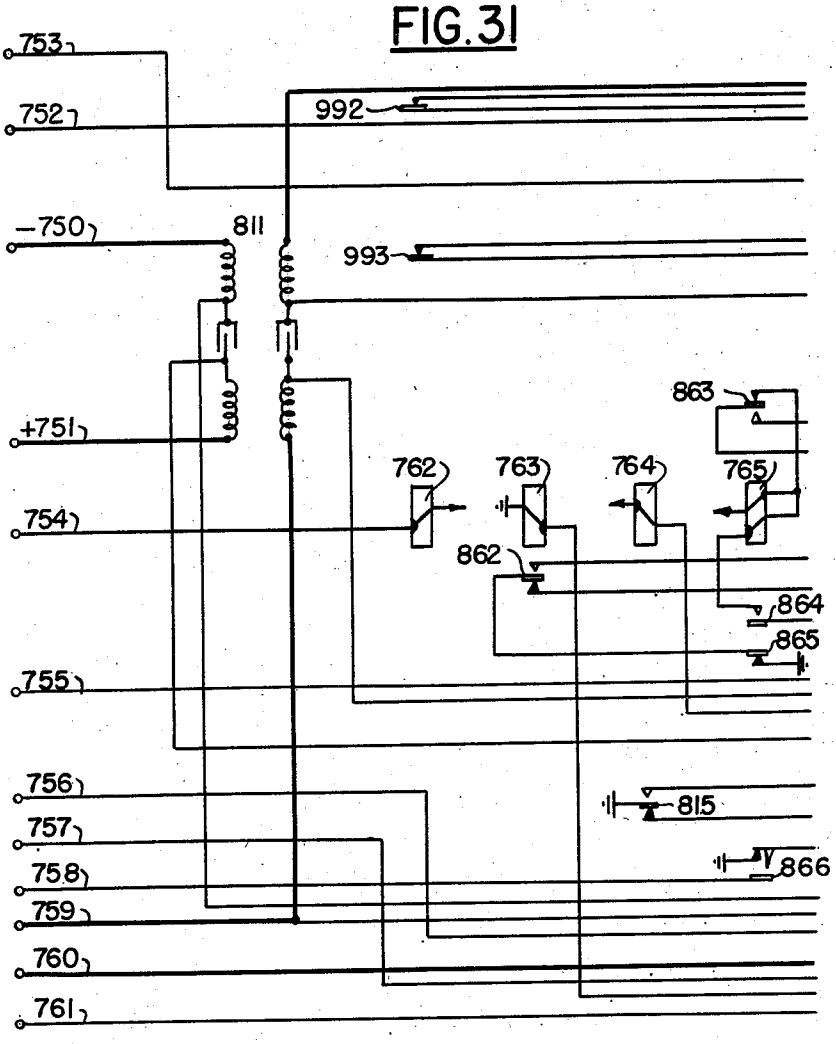
INVENTOR.
JOHN ELLIS OSTLINE
BY Chas. H. Causey.
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG. 31



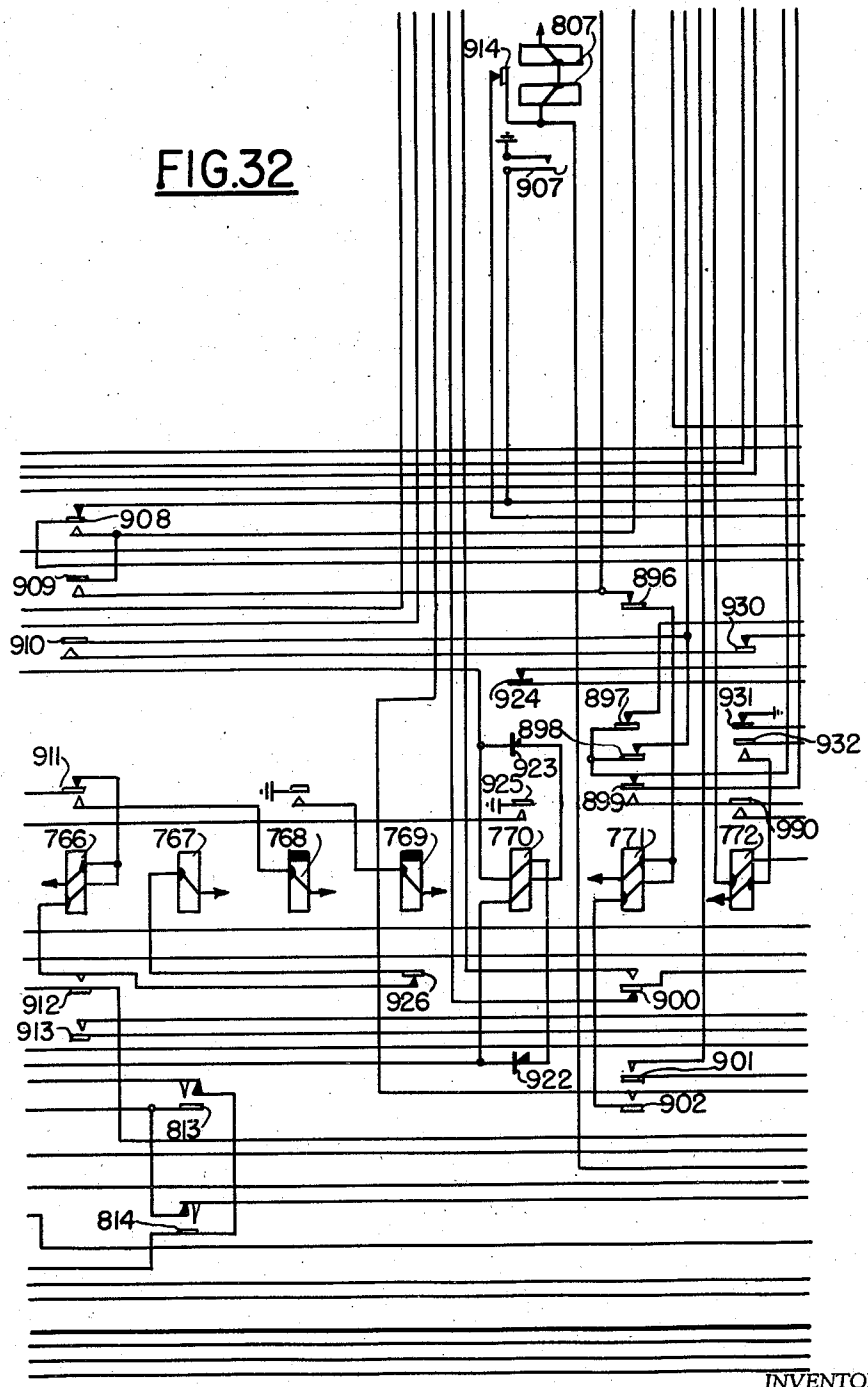
INVENTOR.
JOHN ELLIS OSTLINE
BY Chas. Tr. Candy.
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG.32



INVENTOR.
JOHN ELLIS OSTLINE

BY Chas. Tu. Cundy

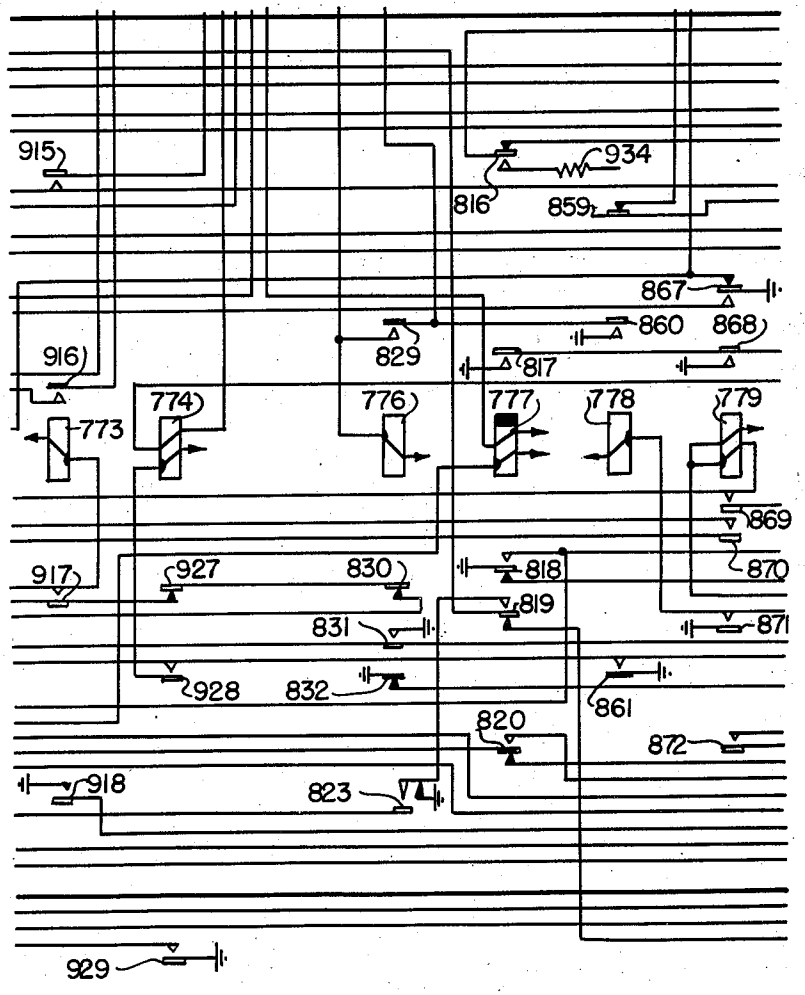
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG.33



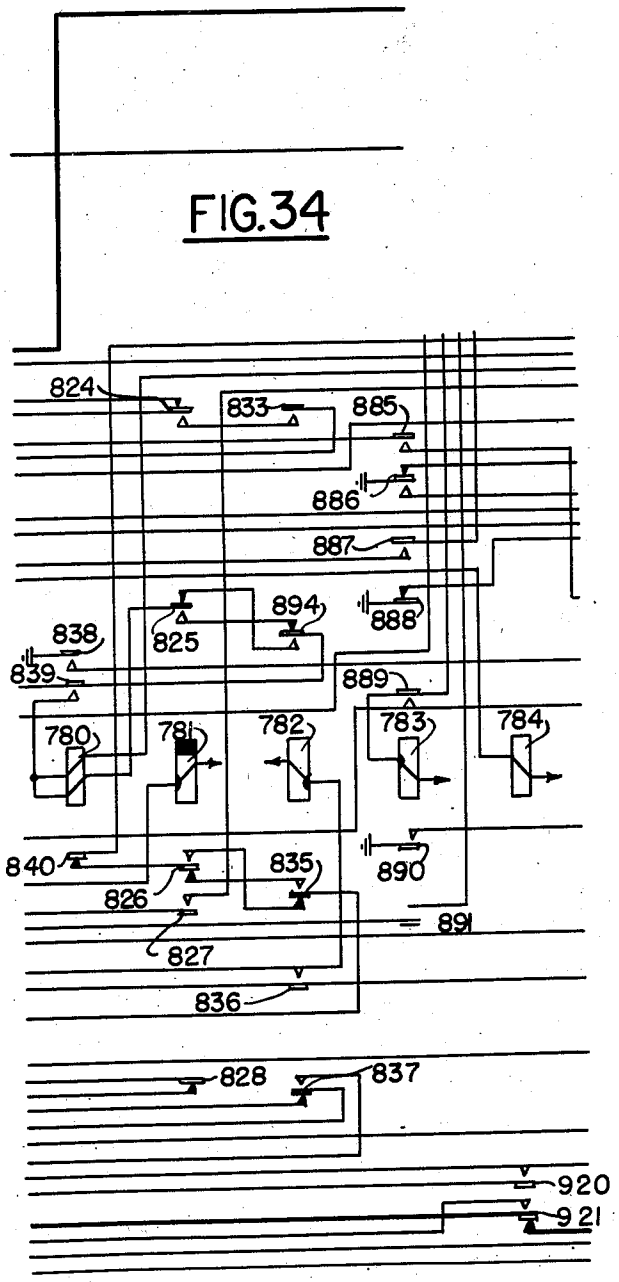
INVENTOR.
JOHN ELLIS OSTLINE
BY Chas. Tu. Landy
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG.34



INVENTOR.
JOHN ELLIS OSTLINE

BY Chas. Tu. Candy.
ATTORNEY

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RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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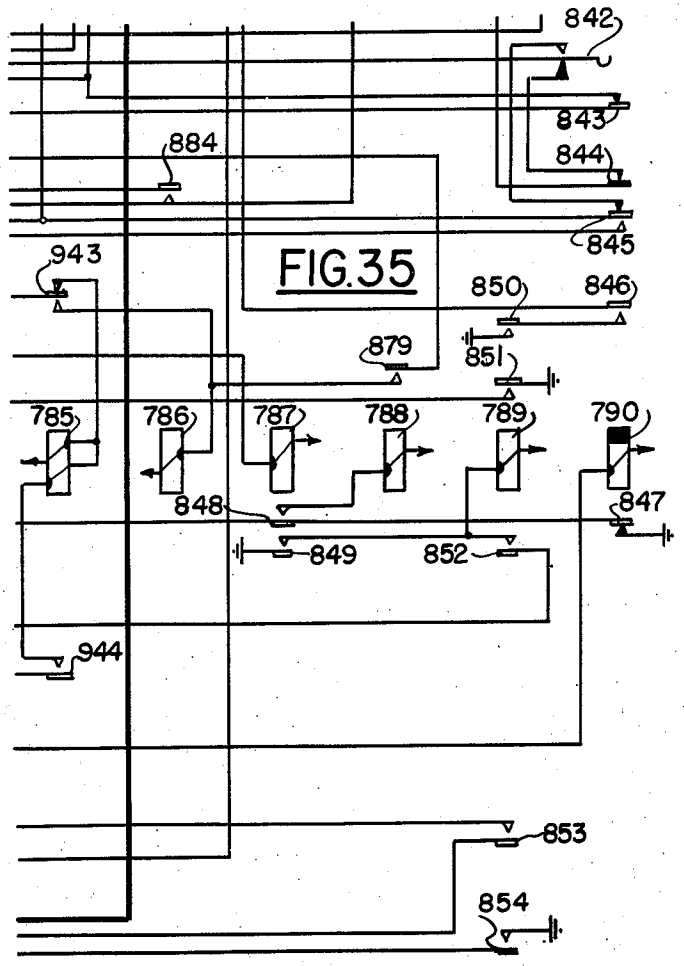


FIG.35

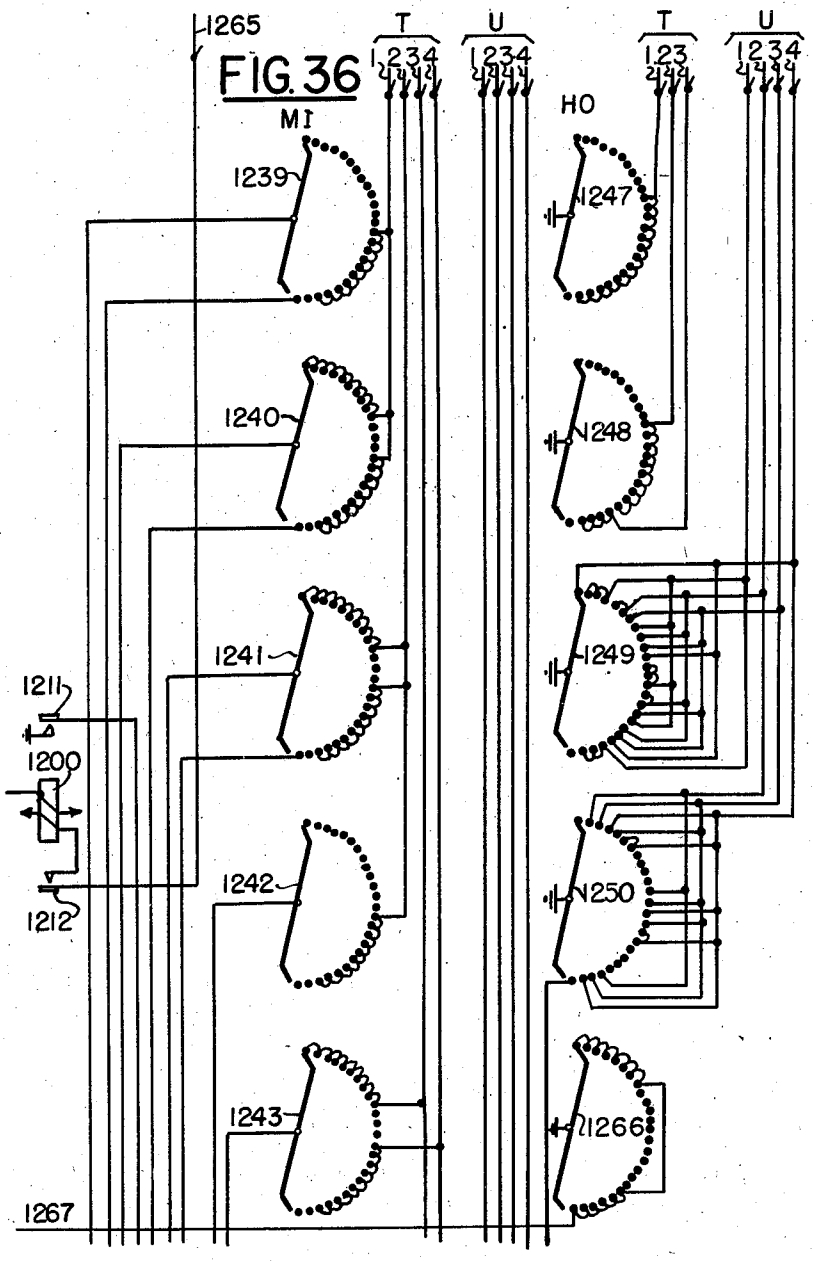
INVENTOR.
JOHN ELLIS OSTLINE
BY Chas. Tu. Candy.
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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FIG. 36



INVENTOR.
JOHN ELLIS OSTLINE

BY Chas. Tu. Candy

ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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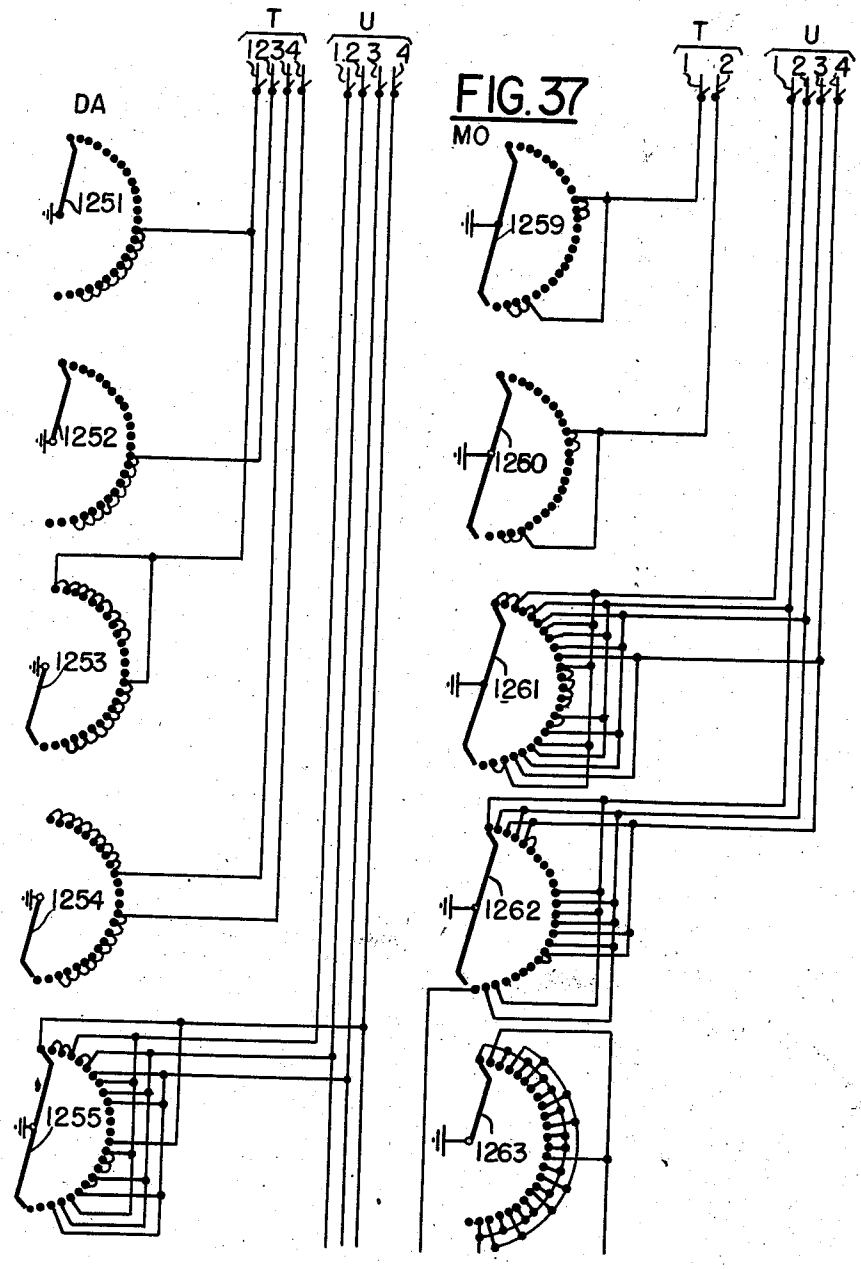


FIG. 37

INVENTOR.
JOHN ELLIS OSTLINE

BY Chas. Tu. Candy.
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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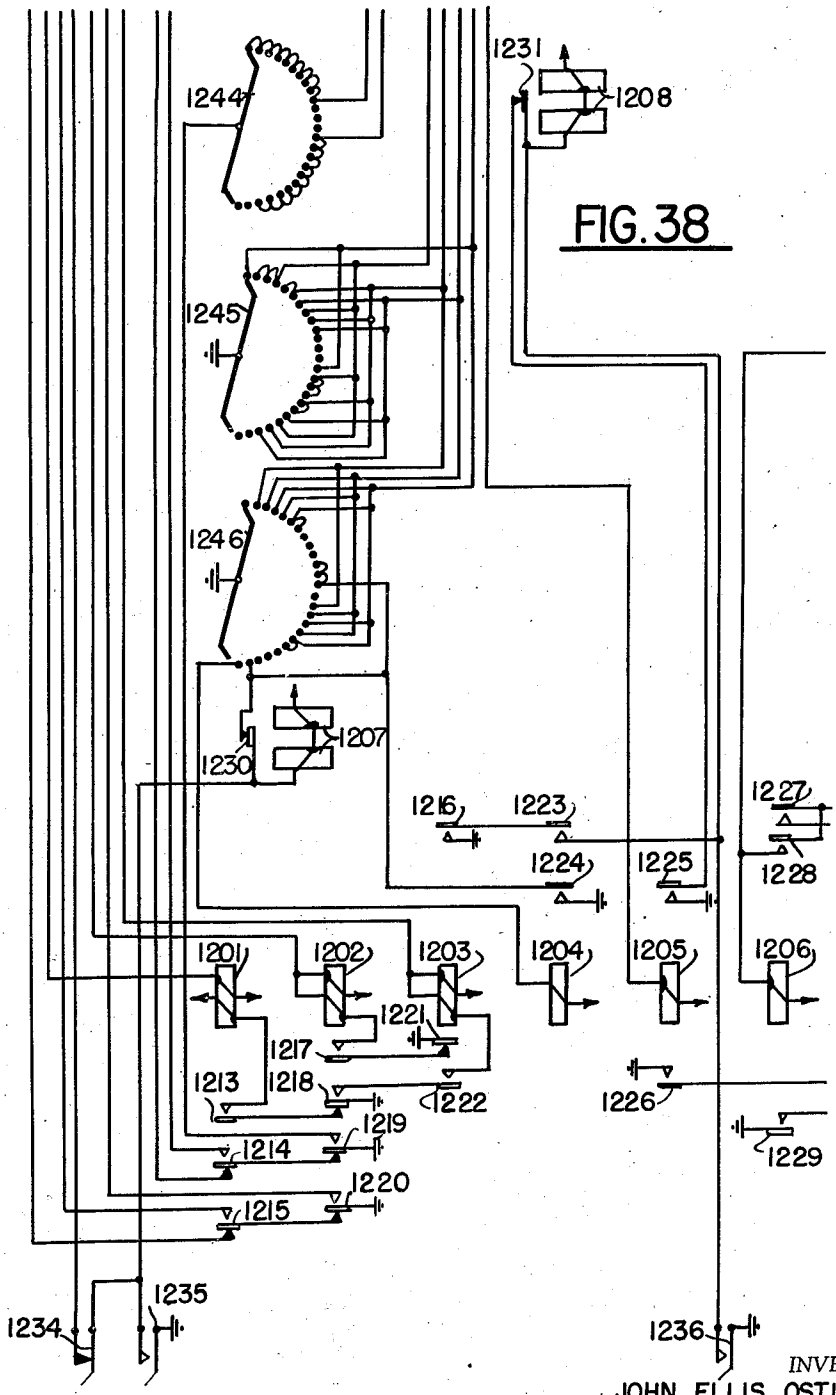


FIG. 38

INVENTOR.
JOHN ELLIS OSTLINE
BY Chas. Tu. Candy.
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 34

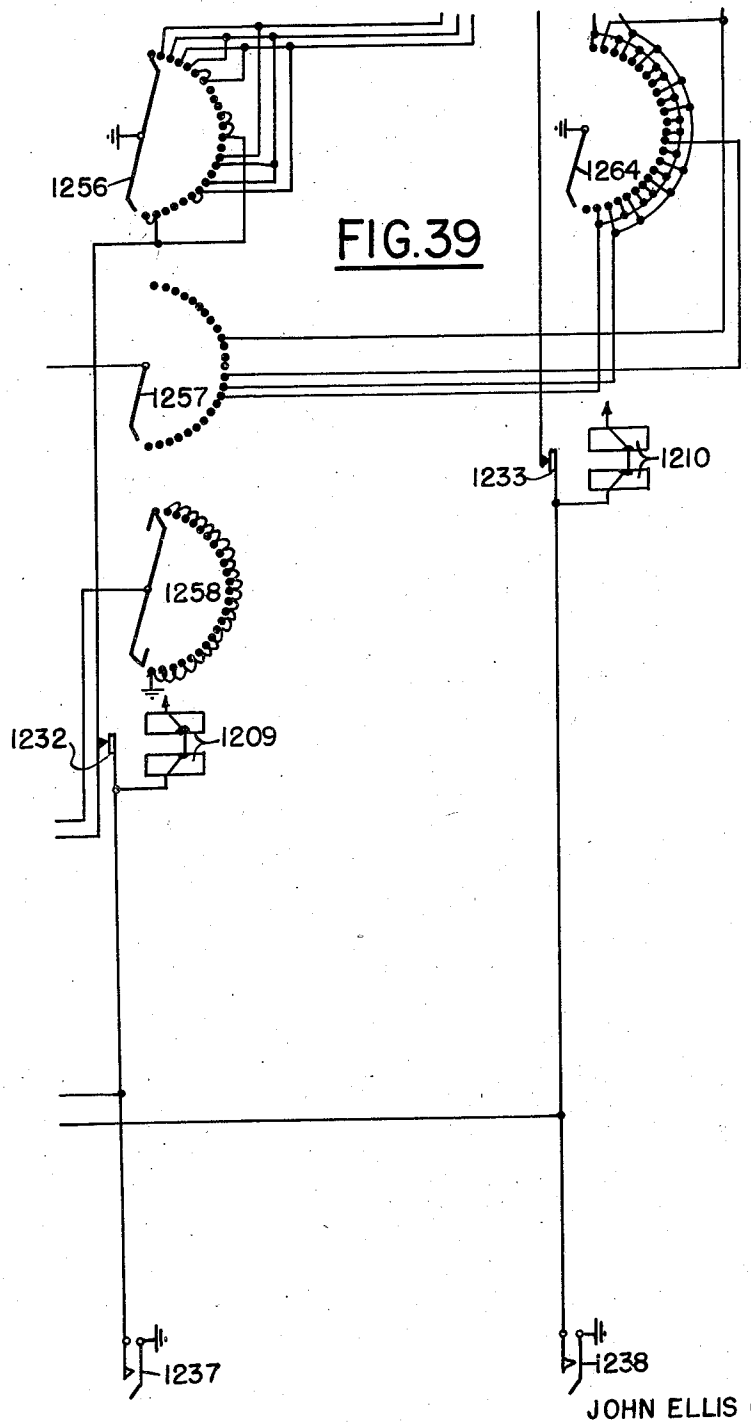


FIG.39

INVENTOR.
JOHN ELLIS OSTLINE

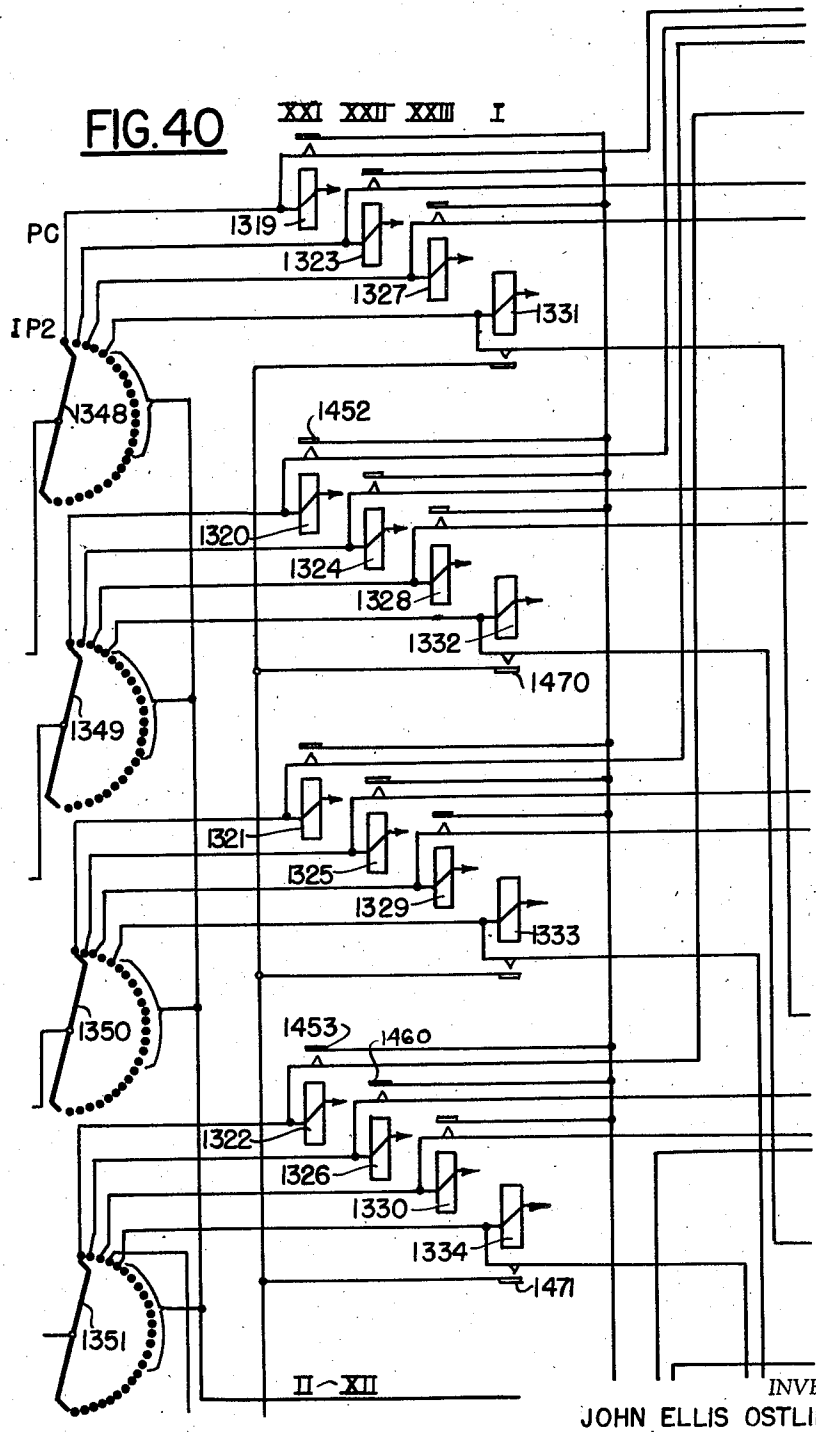
BY Chas. L. Candy
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 35

FIG. 40



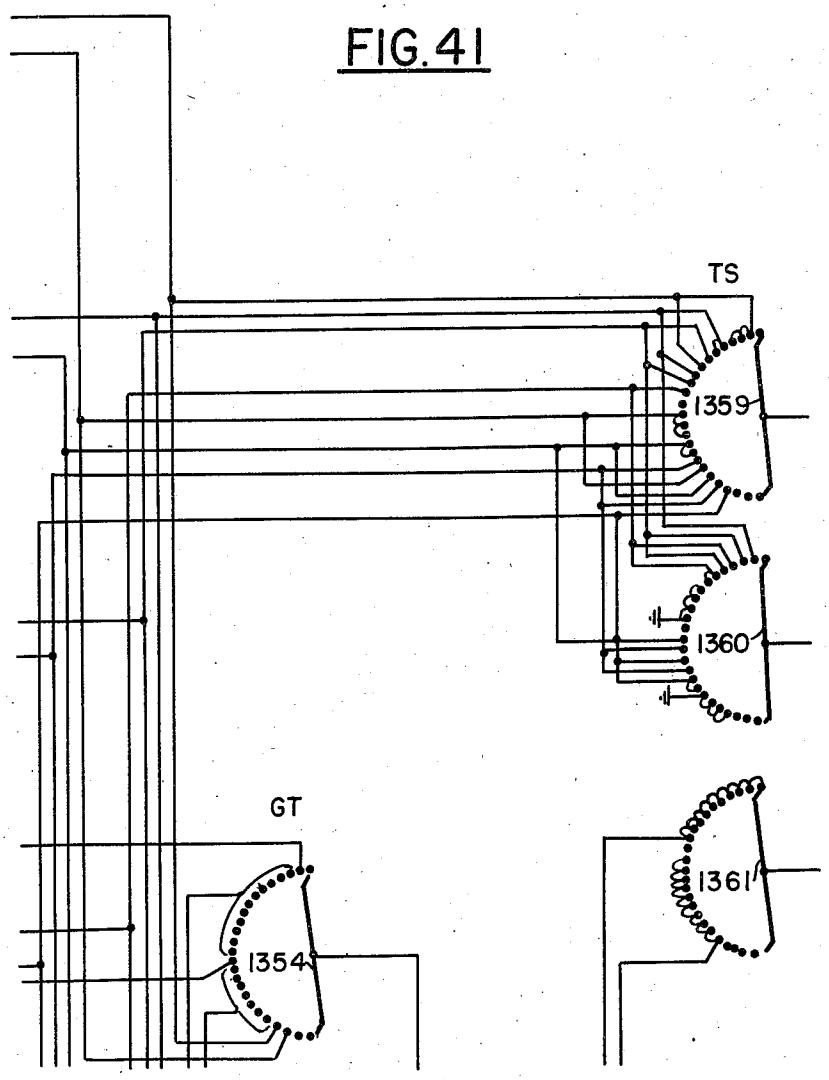
INVENTOR.
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RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 36

FIG. 41



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July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 37

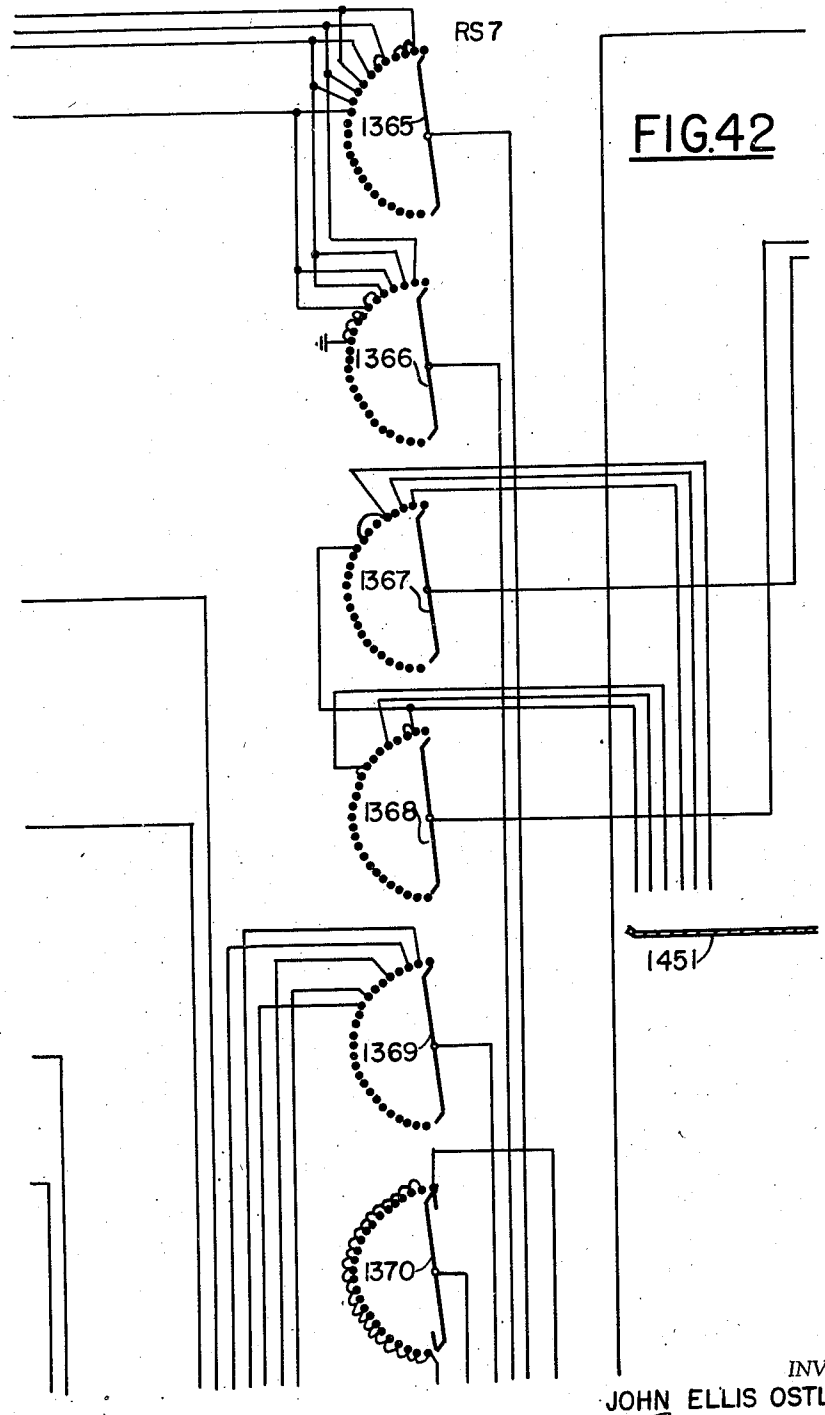


FIG. 42

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RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 38

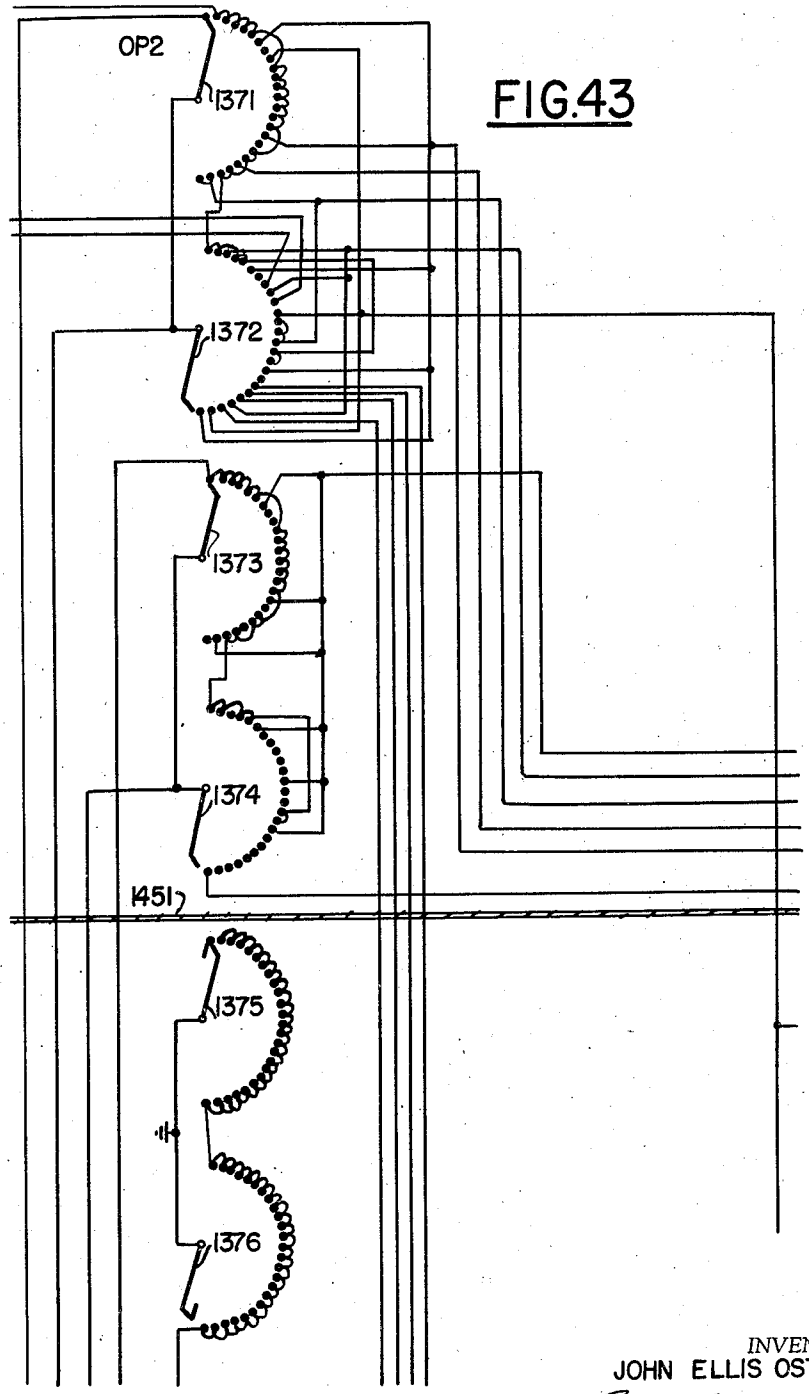


FIG.43

INVENTOR.
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BY Chas. Tu. Candy.

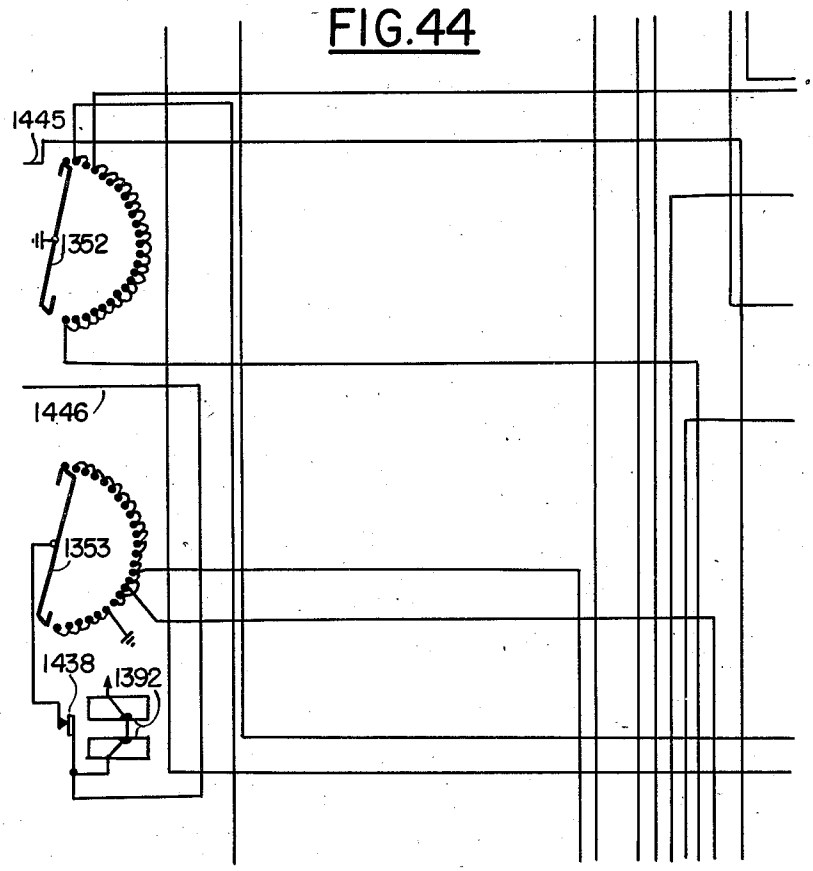
ATTORNEY

July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 39

FIG.44



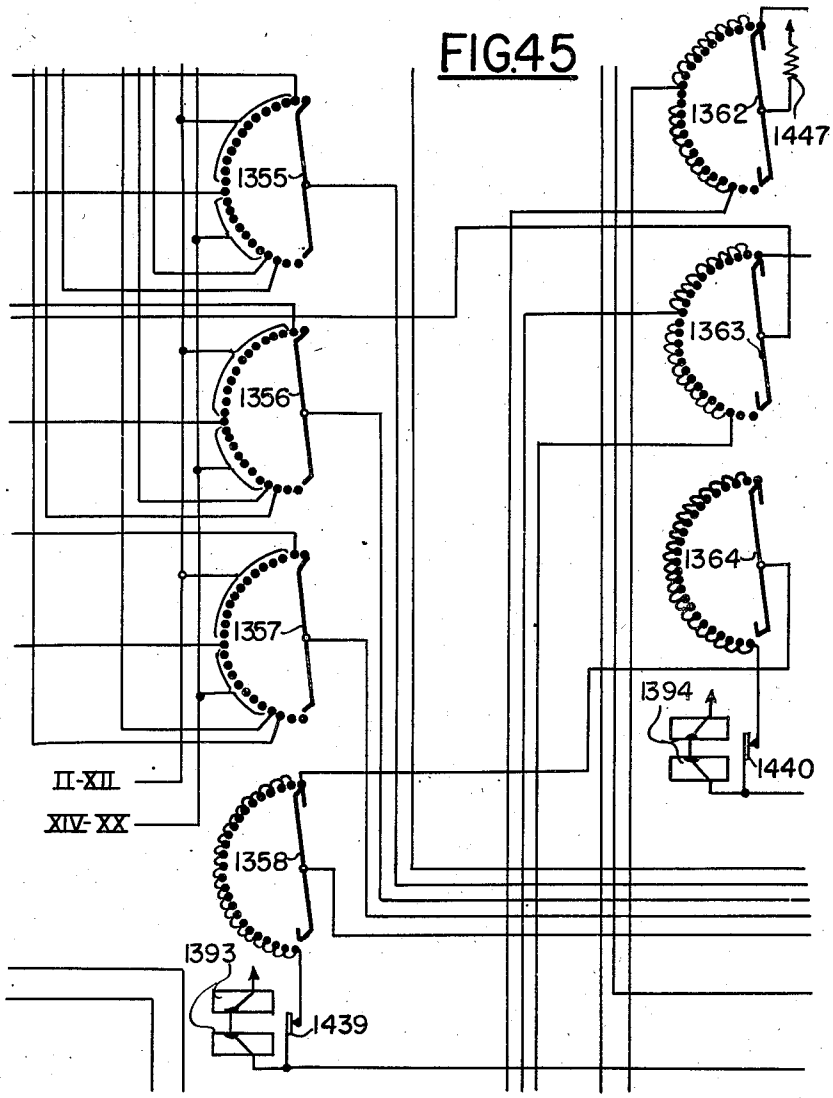
INVENTOR.
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RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 40

FIG.45



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July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 41

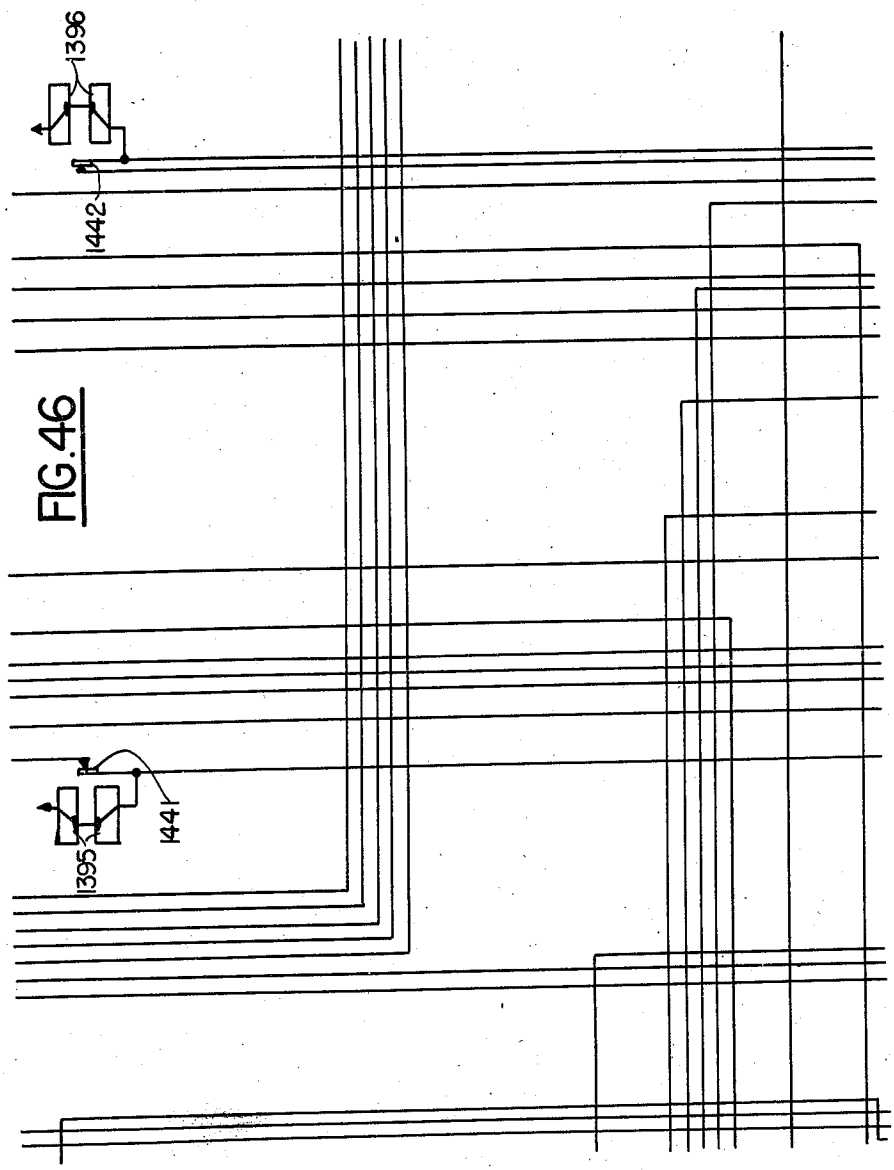


FIG. 46

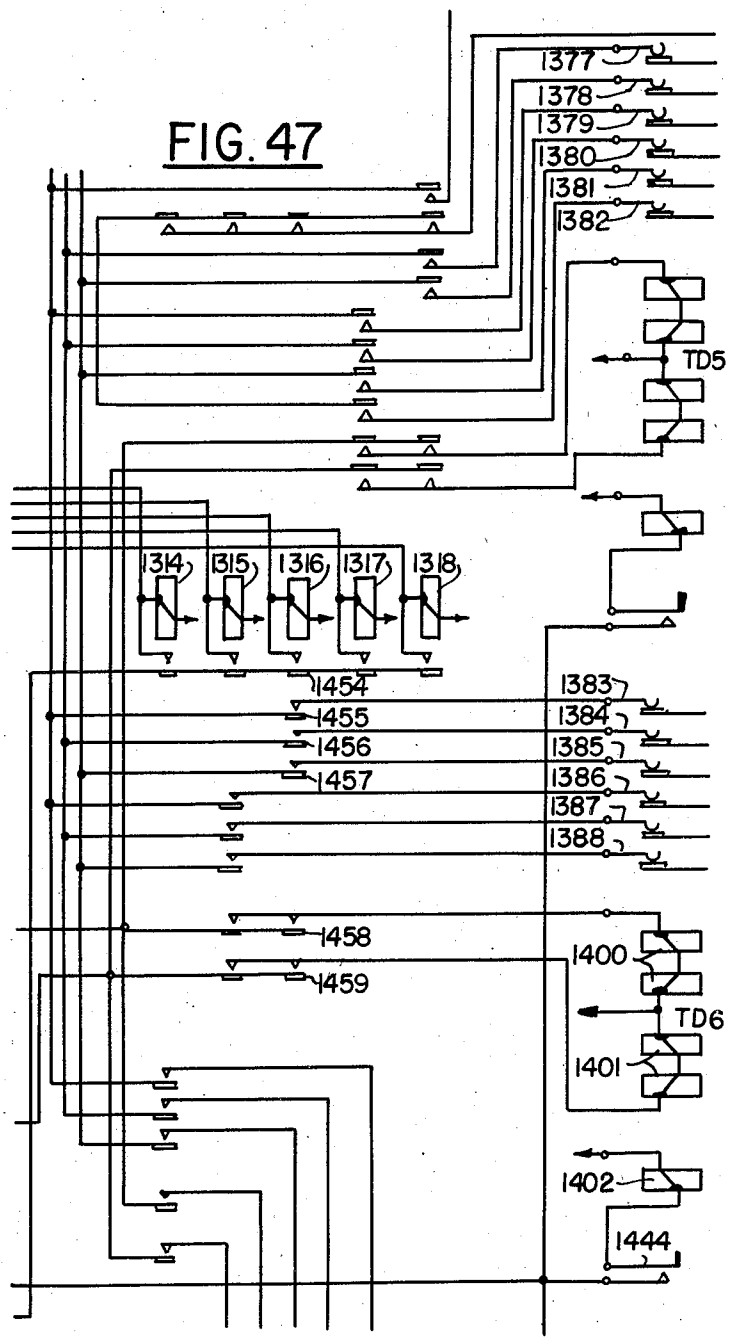
INVENTOR.
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July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 42

FIG. 47



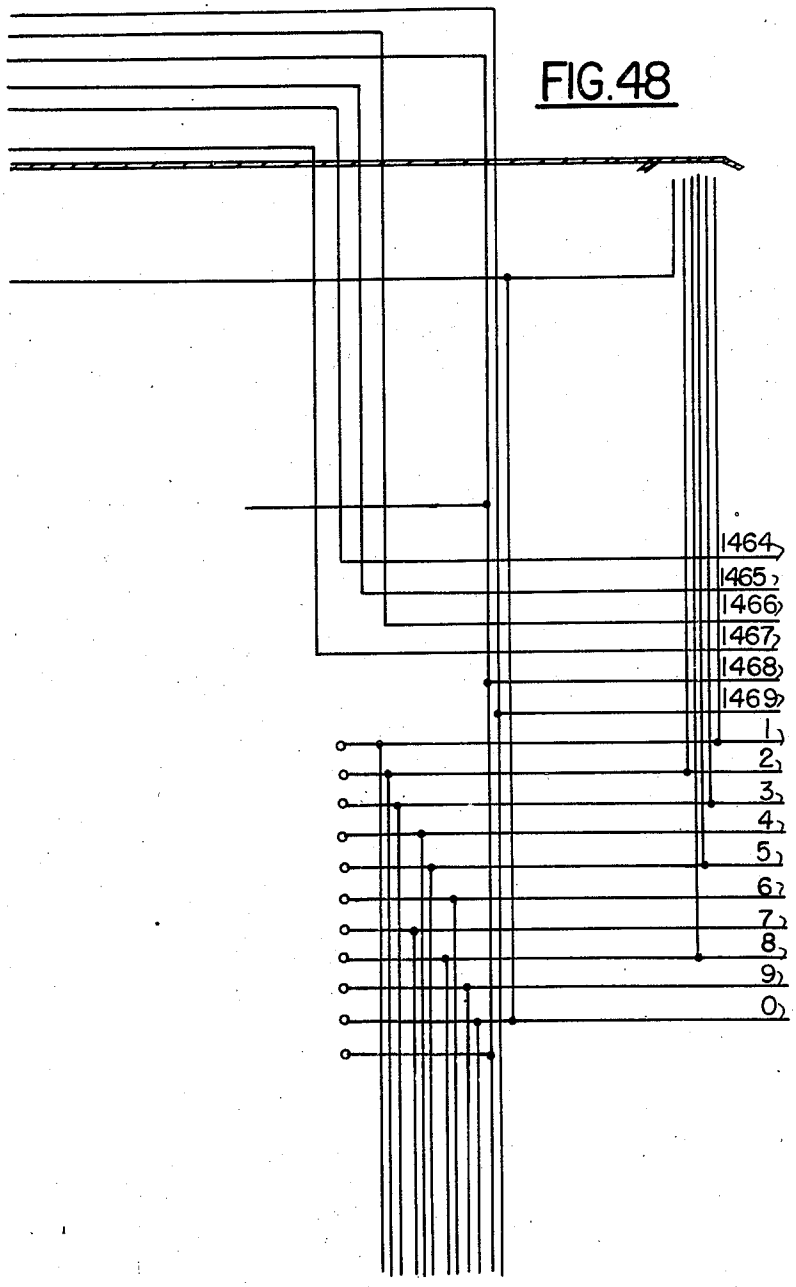
INVENTOR.
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July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 43

FIG. 48



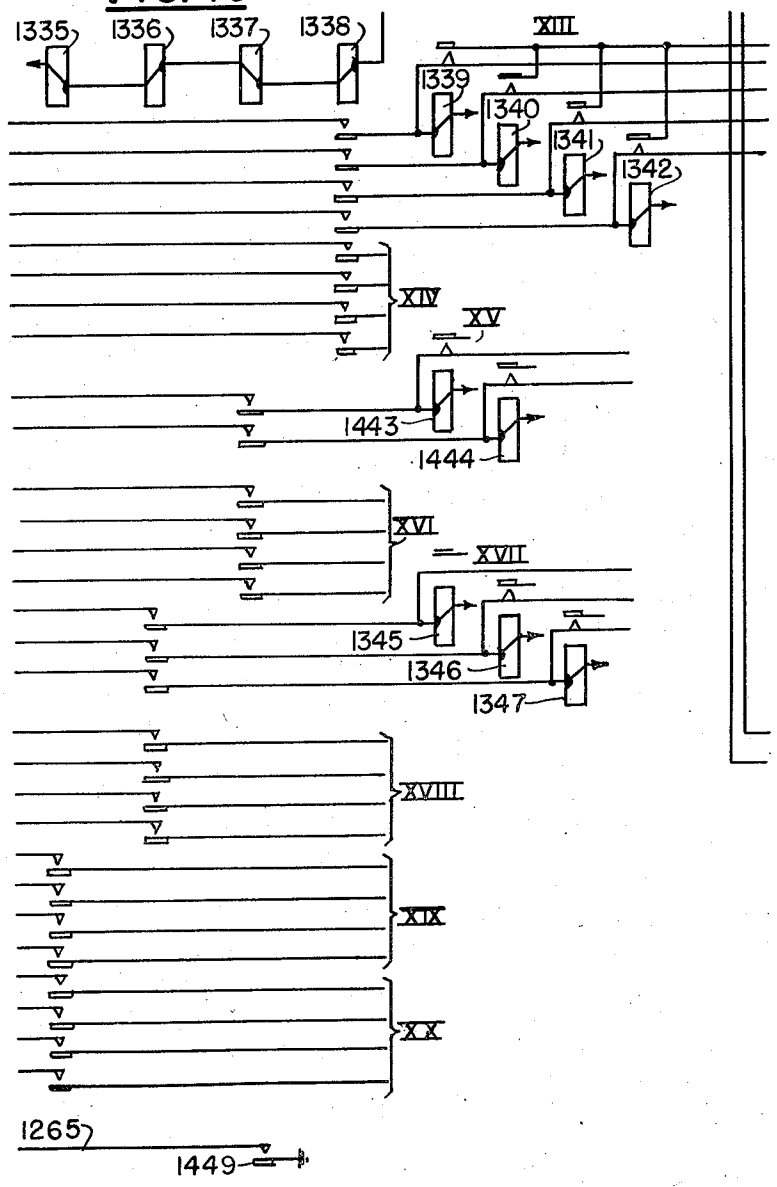
INVENTOR.
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July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 44

FIG. 49



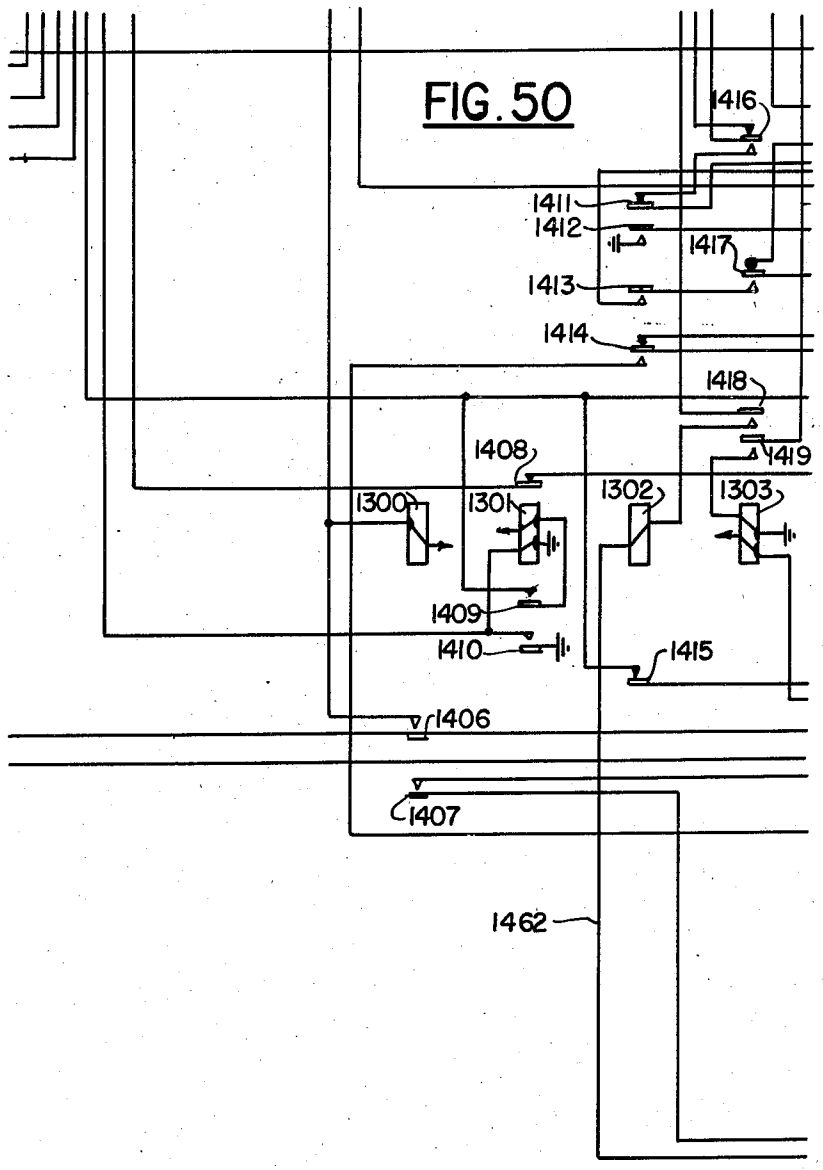
INVENTOR.
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July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 45

FIG. 50

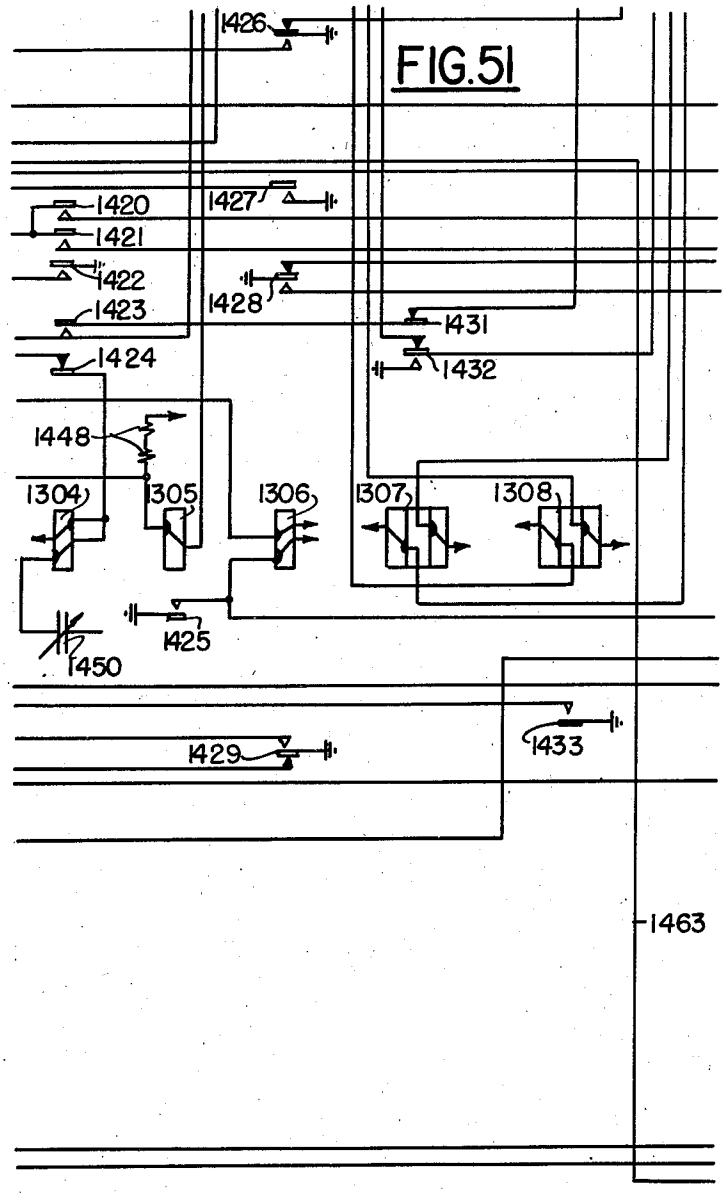


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RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 46



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July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 47

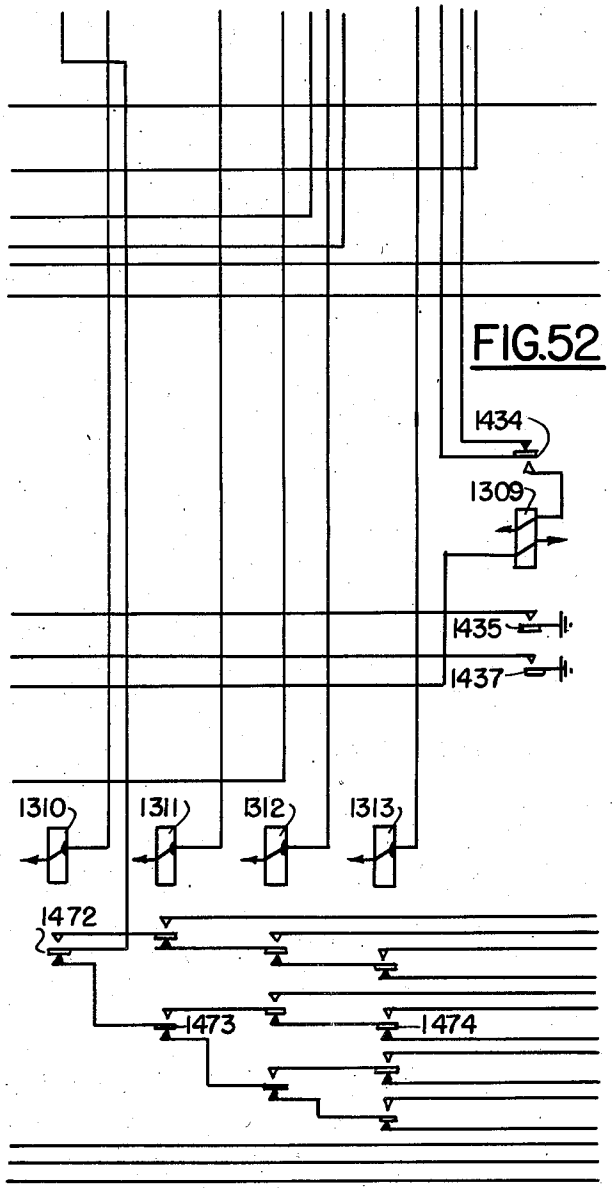


FIG.52

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RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 48

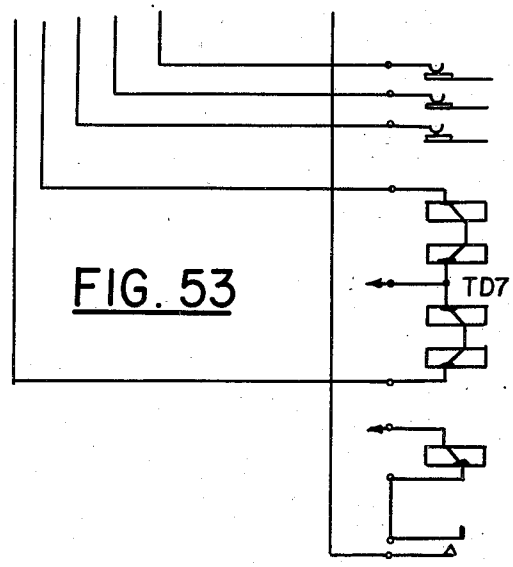


FIG. 53

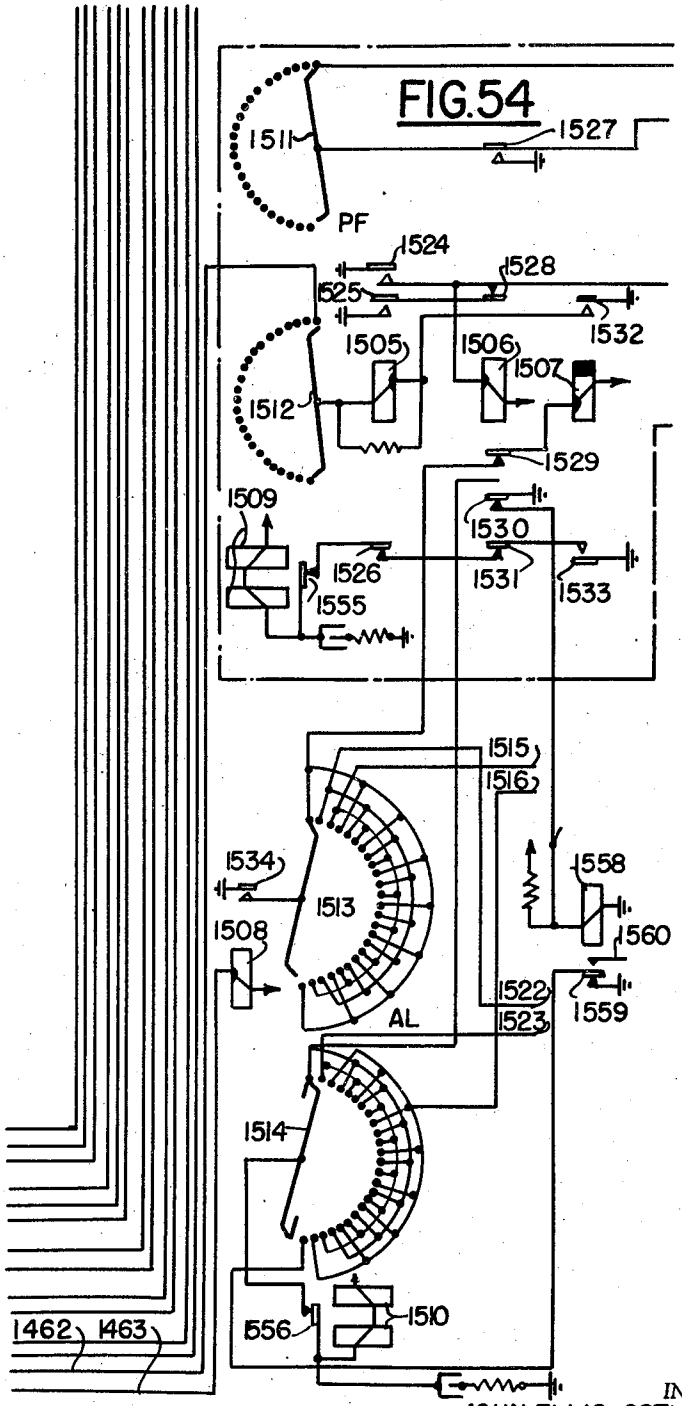
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RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 49

FIG.54



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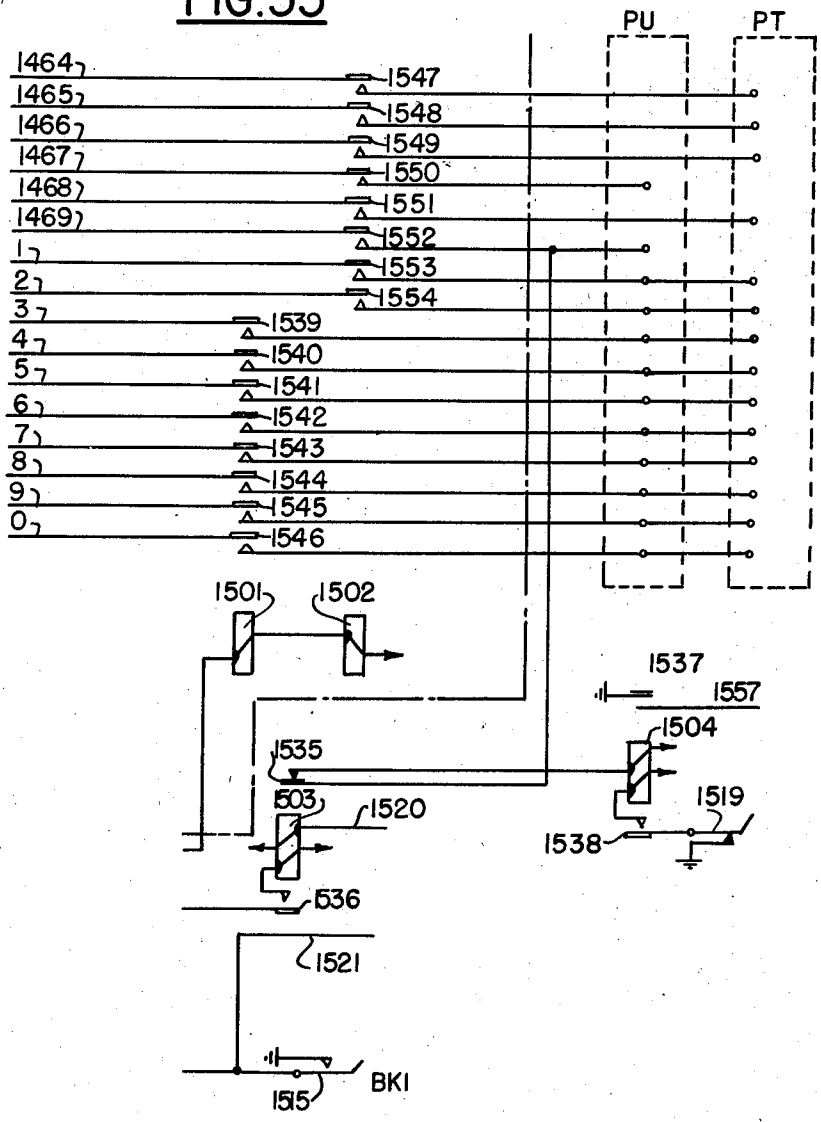
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July 13, 1948. J. E. OSTLINE 2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

Original Filed June 12, 1939 50 Sheets-Sheet 50

FIG.55



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Patented July 13, 1948 2,445,000

UNITED STATES PATENT OFFICE

2,445,000

RATE-BASED RESTRICTED SERVICE TELEPHONE SYSTEM

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

Original application June 12, 1939, Serial No. 278,728, now Patent No. 2,373,908, dated April 17, 1945. Divided and this application June 18, 1942, Serial No. 447,500. In Great Britain June 14, 1938

8 Claims. (Cl. 179—18)

1

The present invention concerns improvements in or relating to telephone systems and in particular concerns novel arrangements connected with the determination of the charge for a connection, especially, although not exclusively, for connections between exchanges or networks normally linked by manual switching means where the charge is assessed by an operator and which connections are in future to be linked by automatic switching means. The present application is a division of my co-pending application Serial No. 278,728, filed June 12, 1939, now Patent No. 2,373,908, issued April 17, 1945.

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

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

Exchanges within an extended network may be linked up either by incorporating them in the same designation plan which is employed for every exchange in the network while provided special facilities for separately charging and routing such calls, or if it is not convenient to incorporate such exchanges in the same designation plan either because the exchanges are more conveniently situated for inclusion in a different network having its own designation plan or for any other reason, such as the fact that the inclusion of certain exchanges would necessitate a modification of the designation plan proposed or in operation, then such exchanges and subscribers connected thereto would be designated according to a different plan.

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

For the purpose of setting up calls between exchanges operating on different designation plans,

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

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

One of the objects of the invention is to determine the charge for a connection and manner of charging locally in accordance with its destination and irrespective of the route over which it is set up.

Another object of the invention is to provide a highly flexible scheme whereby calls which can alone be permitted to be set up by certain subscribers or under certain conditions are controlled independent of the route over which the call is set up.

According to one feature of the invention calls may be set up automatically between exchanges over local routes or over inter-zone routes dependent upon the location of the exchanges, and in which charges for a connection are made dependent upon the distance between the originating and destination exchanges, while the manner of charging is made dependent upon the route over which the connection is set up.

According to a further feature of the invention

charge rate determining means are associated with the originating exchange and assess the rate of charging for connections to exchanges within the zone as well as to exchanges outside the zone in which the originating exchange is located and determine the manner in which the charge is to be made.

According to a further feature of the invention a charge to an exchange outside the zone of the calling party is determined jointly by a plurality of devices adapted to be set independently in accordance with the zone and in accordance with the exchange in the zone of the wanted party respectively, so that the charge for the call can be dependent upon the distance between the calling and called subscribers' exchanges and independent of the route over which the call is set up.

A future feature of the invention is an arrangement whereby in a telephone system calls set up by a calling party may be metered in different ways according to their destination, as determined by registering means taken into use on the initiation of a call, one of which ways of metering consists of automatically recording particulars including the calling party's number and the charge for the call; for instance, if the called party's exchange is located in the same urban area of a zone as the calling party's exchange then metering may be effected in well-known manner by operating the calling subscriber's meter, one or more times for each completed chargeable connection. If the called party's exchange is located in the same zone but in a suburban area, instead of an urban area, or where the charging rate is greater than that allowed for by the usual metering methods, the metering may be effected by printing a ticket with the charge for the call printed thereon. If the called party's exchange is in a different zone from the calling party then the metering may be effected by printing a ticket even if the charging rate is no greater than that allowed for by the usual metering methods.

A further feature of the invention relates to arrangements by which certain subscribers or certain lines under certain conditions may be prevented from setting up calls in which the charge rate is more than a predetermined amount; for instance, two adjacent exchanges may be so situated that one is within one zone and another within the other zone, but they are so near together that the charge rate is the lowest or unit rate, and therefore while it may be convenient from the point of view of the telephone administration to set up such calls over lines connecting different zones it is not expedient that such connections should be prevented. When it is borne in mind that a calling party without such preventing means would be enabled to set up quite expensive calls it is desirable to ensure that only calls of a low rate should be set up without special permission.

A further feature therefore relates to an arrangement for determining whether a telephone connection can be set up by a calling party or not, comprising a plurality of independent means responsive to calling party control, each adapted to determine whether the calling party control corresponds to part of a subscriber's number or not, and charge rate assessing means adapted to be variably operated in accordance with the setting of said first means to determine according to its setting whether a call is to be completed or not; for instance, the means responsive to calling party control would be two directional switches for registering respectively the zone and exchange of the wanted party, and the charge rate assessing means could be conveniently a further switch which is set under the joint control of the two registers mentioned to determine the charge rate for the call, and if the charge rate is greater than a predetermined amount to prevent the call.

Another feature of the invention is an arrangement incorporating separate zone and exchange determining means for preventing calls being set up to exchanges for which the charge is greater than a predetermined charge, while permitting calls being set up to other exchanges over routes passing through said first exchanges for which the charge is equal to or less than said predetermined charge.

Actually in the arrangement to be hereinafter described, the predetermined charge is the unit rate, but it is quite clear that with little modification the predetermined charge might be made double unit rate or any other selected minimum charge. Similarly it has been assumed that only charges for a unit rate should be metered on the subscriber's individual meter whereas actually of course any known arrangements could be used which would operate the subscriber's meter a variable number of times, and only the higher charge rates need be ticketed. On the other hand it may be desirable to eliminate the subscriber's individual meters altogether in which case all calls would be then ticketed. It may be desirable to have lines which are normally free to set up connections to any party, for instance, by the proprietor of a premises, but to provide arrangements to prevent visitors to the premises setting up calls for which the charge rate exceeds a predetermined amount, and accordingly a further feature of the invention is an arrangement for controlling the setting up of a call in which manually operated means are adapted to render effective the prevention of the completion of a call when the destination of the call is such that the charge rate therefor exceeds a predetermined amount.

Another feature of the present invention concerns the introduction of automatic recording equipment for certain calls inside a zone, while other calls are recorded on subscribers' individual meters. When it is borne in mind that one of the restrictions on the size of the zone, and probably a most important one in view of the recent developments in long distance dialling and employment of repeaters, is that all exchanges of a zone are such that they can be metered by one or more pulses on a subscriber's meter depending upon the distance between such exchanges, as all calls recorded on a subscriber's meter can only be charged in accordance with the meter reading without reference to individual calls, it becomes desirable to limit the charging rate for calls which are metered in this manner and according, therefore, to this feature of the invention the size of a zone can be such as to include within its area exchanges the cost of calls to which for other exchanges in the zone is greater than a predetermined amount by providing automatic recording equipment suitably disposed as to be taken into use whenever calls are set up, the charge for which exceeds said predetermined amount. It will be understood that where such calls extend over a common trunk line over which calls of less than the predetermined amount are also extended provision may be made for automatically recording the latter calls also.

Another feature of the invention concerns the provision of means whereby the transmission of particulars of a call for charging purposes are transmitted or not in accordance with the relative positions of the originating and destination exchanges in the same zone.

A further feature of the invention concerns an arrangement in which the charge rate for a connection is assessed at one stage in the setting up of a connection which charge rate is subsequently transmitted to a position reached at a different stage of a connection and where particulars of the connection are collected.

A further feature of the invention concerns an arrangement whereby calls outside the zone of the calling party are adapted to be automatically recorded by transmitting the zone, exchange and number of the wanted party to the recording position, calls inside the zone of the calling party are adapted to be automatically recorded if the connection extends over a junction line having a recording position associated therewith to which only a part of a subscriber's designation requires to be transmitted and calls inside the zone of the calling party not extending over a junction line having a recording position associated therewith which are adapted to be metered on the subscriber's individual meter.

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

In the drawings:

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

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

Figs. 3–12 illustrate the register translator for use at other than the central exchange. These figures should be arranged as shown in Fig. 13 to give the complete circuit.

Fig. 14 shows a table indicating the manner in which digits are transmitted in code.

Figs. 15–20 show the cross connections extending between the banks of the route control switch RSS which forms part of the register translator, to various conductors shown adjacent the banks thereof in Fig. 8.

Fig. 21 shows in brief a modification to the register translator circuits for dealing with the barred service facility.

Figs. 22–24 show the circuits of the first group selector.

Fig. 25 shows a junction line circuit.

Figs. 26–35 show a toll line control circuit located at a central exchange which serves to store all the information transmitted from the register translator, and to time the duration of the call. These figures should be arranged as shown in Fig. 57 to give the complete circuit.

Figs. 36–39 show the circuits of the date and time unit.

Figs. 40–53 and part of Fig. 54 show a printer controller which receives from the toll line control circuit the rate at which the call is to be charged, the duration of the call, the calling and called party's number in order to transfer this information together with the date and time at which the call was made to a printer unit. These figures should be arranged as shown in Fig. 58 to give the complete circuit.

Part of Fig. 54 and Fig. 55 show the circuits of the printer unit.

Fig. 56 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 invention will be described with reference to the Belgian telephone network since the circuits illustrated were designed for use therein. It will be appreciated however that the principles upon which the invention is based are of general application and are in no way limited to the specific arrangements which are about to be described.

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

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

The determination of the charge which is to be made for a call is effected in accordance with the straight-line distance between the exchanges and in this particular example, a call between any two exchanges within the urban area is considered to be a unit rate call. The same applies to certain calls from exchanges within the urban area to exchanges in the suburban area. Thus for example, calls from St. Ghislain to Dour are to be considered as unit rate calls and for this reason the area which covers these exchanges is shown shaded in Fig. 1. Calls between other urban exchanges and Dour, however, are considered as multi-rate calls.

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

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

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

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

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

As an example, subscribers in the Mons exchange which has an ultimate capacity of 8000 lines have numbers which will begin with the digit 2 followed by one of the digits 1 to 6 and 9 to 0; Hautrage subscribers having an ultimate capacity of 600 lines have numbers which will begin with the digits 57 and Dour with an ultimate capacity of 1200 lines have numbers which will begin with the digit 6 followed by the digit 1 or 2. Finally St. Ghislain with an ultimate capacity of 3000 will begin with the digit 3 followed by the digit 1, 2 or 3. It will be of advantage at this point to describe in general the setting up of the various possible connections between the exchanges in the Mons zone. In the first place all connections from Hautrage, with the possible exception of direct calls to St. Ghislain, will eventually pass through the Mons central exchange although in the meantime provision may be made for direct calls to other nearby exchanges such as Blaton. Connections to other exchanges of the zone are trunked through Mons.

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

It is also to be noted that on calls from an exchange which is still manual such as Dour the operator is provided with the necessary equipment to set up the various calls automatically,

the type of metering employed being based on the considerations mentioned above.

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

The determination at the originating exchange of the rate at which the call is to be charged is of advantage in connection with determining whether the call is allowable or not. The public may be allowed the use of the telephone for setting up unit rate calls. With the complete automatisation of the telephone network however if this privilege is continued, a member of the public would normally be able to set up a toll call. Accordingly it is arranged to provide a push button, the operation of which so alters the circuit of the instrument for instance by placing an earth on the mid-point of the ringer windings that if it is determined by the equipment at the local exchange that the call is a "barred" call, e. g., a multi-rate call, the call is prevented from being set up and a tone is returned to the calling party. Where, however, the call is a unit rate call then even though, as in the case of a call from Hautrage to Blaton when the latter is automatic, the connection extends over toll or interzone lines and may involve the use of repeaters, it can be set up.

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

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

Each first group selector at Hautrage has ac-

cess over levels 1, 2, 4, 5, 7 and 8 to local final selectors; over level 3 to junction lines extending to Blaton; over level 6 to junction lines extending to St. Ghislain; over level 9 to "poor" grade junction lines to Mons and over level 0 to "good" grade junction lines to Mons.

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

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

With this general description reference will now be made to the detailed circuits of which Figures 3–25 represent equipment located at Hautrage exchange while Figs. 26–55 represent equipment located at Mons central exchange. The equipment illustrated in Figs. 3–14, 15–17, 18–20, 22–35 is the same as the equipment illustrated in Figs. 7–18, 19–21, 23–25, 27–40 in my co-pending application Serial No. 278,727, filed June 12, 1939, now Patent No. 2,369,071, Feb. 6, 1945, and the equipment illustrated in Figs. 26–56 is the same as the equipment illustrated in Figs. 1–31 of my co-pending application Serial No. 278,729, filed June 12, 1939, now Patent No. 2,272,475, Feb. 10, 1942.

It will therefore be assumed in the foregoing description that the line finder and register translator finder have been operated to the extent of seizing an idle register translator RT full details of which operation are to be found in my co-pending application Serial No. 278,727, filed June 12, 1939.

EXTENSION OF IMPULSING CIRCUIT TO REGISTER TRANSLATOR

The subscriber's loop circuit is extended into the register translator as follows: earth, lower winding of relay 138, conductor 137 (Fig. 11), subscriber's loop, conductor 138, lower winding of relay 187 to battery. Relay 188 operates over this loop circuit and at armature 377 provides an alternative earth for relay 139. In addition dial tone is now transmitted from the dial tone source 378 (Fig. 7), condenser 379, cam contacts 380 in their resting position, armatures 333, 340, condenser 331', winding of relays 187 and 188 to earth and thence over the loop circuit by induction into the second windings of the relays. The calling party now dials the required number.

GENERAL DESCRIPTION OF REGISTER TRANSLATOR

These circuits are shown in Figs. 3 to 12 which should be arranged as indicated in Fig. 13. In Fig. 13 the components of the circuits are indicated briefly in order that a clear picture is obtained of the essential elements. The circuits comprise three two-directional switches TD1, TD2, (Fig. 4), TD3 (Fig. 5), rotary switches RS1, RS2 (Fig. 6), RS3, RS4, (Fig. 10) RS5 (Fig. 7) and RS6 (Fig. 8) together with various relay groups which are indicated by the references RG3 (Fig. 11), RG4 (Fig. 12), RG5 (Fig. 10), RG6 (Fig. 6), RG7 (Fig. 9), RG8 (Fig. 7) and RG9 (Fig. 3). The called party's number is recorded on the switches TD1, TD2, RS1, RS2 and RS5, the latter also acting as a distributor switch for routing the incoming digits to the appropriate switches. Switch TD3 is a combining switch for determining the kind of junction and the rate at which the call is to be charged. The calling party's number as described in my co-pending application Serial No. 278,727, filed June 12, 1939, is recorded on the relay group RG4 and the switches RS3 and RS4. In addition the switch RS6 serves to control the transmission of routing digits and any additional information which is desirable in view of the destination of the call. For this purpose according to the destination of the call as determined by the registration of the called party's number a particular wiper of the switch RS6 is selected and the contacts over which this wiper moves are cross-connected to the various groups of conductors shown adjacent the banks in such a manner as to control the transmission of the necessary digits for setting up the particular call. Impulse transmission from the register translator is effected by the relay group RG7, the number of impulses which are to be transmitted in each train being controlled by markings extended either directly or indirectly over the various switch banks to a group of ten control conductors indicated generally by the cable 282 with its various branches. These conductors extend from the relay group RG5 and are multipled to the various switch

banks in the register translator as indicated by the cabled conductor and are connected directly to certain contacts in the banks of the switch RS6. In certain circumstances coded impulses are transmitted by the register translator in which case the relay group RG5 is adapted to act in conjunction with the relay group RG6 due to the operation of relays 224, 225 and 226. Finally a relay group RG8 is provided for the purpose of giving alarms and supervisory signals in certain circumstances to be discussed later.

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

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

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

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

Consideration will now be given to the registration of called numbers the first digit of which is 0 thereby indicating that the call is for a special service. In connection with the term "special service," it is to be understood that this term includes calls to an operator, calls for services such as the speaking clock and also toll or inter-zone calls. In setting up toll or inter-zone calls it is necessary for the calling party to dial 8 digits while for the other services, three are sufficient. In all cases, however, the switch TD1 which will be raised to the 10th level is released that is to say the first digit in all cases is absorbed but a circuit operation which will be pointed out in detail hereafter takes place an effect of which is that wiper 263 instead of wiper 261 is employed for determining which wiper of the switch RS6 is to be employed. The 2nd and 3rd digits are then registered by the vertical and rotary movement respectively of the switch TD1 the 4th and 5th by the vertical and rotary movement respectively of the switch TD2, the 6th by the operation of the switch RS1, the 7th by the operation of the switch RS2 and the 8th by the operation of the switch RS5. In addition the switch TD3 is set automatically in dependence upon the position of the wipers of the switch TD1 as regards the vertical movement and as regards its rotary movement in accordance with the position of the wipers of the switch TD2. The switch TD3 may thus be said to take up a position which is the resultant of the first four digits registered in the register translator. The purpose of the switch TD3 is to enable one or more routing digits to be transmitted from the register translator and also one or more digits which are indicative of the "tariff" or rate at which the call is to be charged.

The control of digit transmission from the register translator is again effected by the route control switch RS6 as it steps from contact to contact and as in the case of a local call the first digit retransmitted by the register translator is effective in indicating the manner in which the charge for the call is to be recorded. Following this a series of digits is transmitted which is effective in setting the switches in the Mons central exchange in order that the call is routed towards the desired terminating exchange. Next follows what may be termed a class digit the purpose of which will be explained in detail later.

When these routing digits and the call digit have been transmitted the called party's number and the calling party's number is transmitted to equipment located at the outgoing toll line in the main exchange in the form of coded impulses. The change in transmission from the decimal basis to a code basis is effected by a cross-connection extending from the appropriate contact in the selected bank of the switch RS6 to the conductor 316. This causes the operation of the relays 224, 225 and 226, to enable co-operation to take place between the relay groups RG5 and RG6. Finally after these coded impulses have been transmitted the "tariff" digit is transmitted in accordance with the position of wiper 271 of the switch TD3. After the transmission of the "tariff" digit the next contact of the route control switch is cross-connected to conductor 317 to cause the release of the register-translator and register-translator finder RTF.

DETAILED DESCRIPTION OF REGISTER TRANSLATOR

It will be sufficient for the purpose of this invention to describe the following four examples of kinds of calls:

1. Local call with individual metering.
2. Call to an operator with manual ticketing.
3. Call outside the zone with automatic ticketing.
4. Call to a suburban exchange.

Local Call

Reception of dialed digits

A detailed description will now be given of the operation of the register translator and for this purpose it will be assumed that the calling subscriber wishes to set up a connection to a subscriber in his own exchange, that is to say in the Hautrage exchange. In my co-pending application Serial No. 278,727, filed June 12, 1939, there appears a more detailed description of the register translator. It will be remembered that upon registration of the calling party's number and the transmission of dial tone back to the calling subscriber over the windings of relays 187 and 188 (Fig. 11), the lower windings of these relays were energized over the calling subscriber's loop. As point out above all subscribers connected to the Hautrage exchange will have for the first two digits in their call number the digits 5 and 7. Consequently the first two digits dialled by the calling subscriber will be 5 and 7.

When the first break occurs in the calling subscribers line circuit relays 187 and 188 will release and at armature 327 a circuit is closed as follows: earth, armatures 327, 334, winding of relay 204 to battery. A branch of this circuit also extends over wiper 259 of the switch RS5 in position 1, winding of the vertical magnet 244 of the two-directional switch TD1 to battery. Relay 204 at contact 383 closes an obvious circuit for relay 203, both these relays being slow-to-release so that they are maintained operated during the reception of the impulse train. The first digit dialled by the calling party is thus registered by the vertical movement of the switch TD1. At the end of the first impulse train relay 204 releases after a short-period and at contact 383 opens the circuit of relay 203. During the release period of the relay 203, however, a circuit is closed over earth, armatures 383, 384, contact 1 and wiper 258 of the switch RS5, armature 330, winding of magnet 243 of the switch RS5 to battery. The magnet of the switch RS5 is, therefore, energized for the duration of the release period of relay 203 after the wipers of the switch RS5 are stepped on to their second position whereby the impulsing circuit is extended over relay 239 to the rotary magnet 245 of the switch TD1. Relay 239 is a slow-to-release relay and is maintained operated for the duration of the impulse train. The third, fourth and fifth digits will be registered by the operation of the vertical magnet 247 and the rotary magnet 248 of the switch TD2 and the magnet 253 of the switch RS1 respectively, the relay 240 remaining operated during the reception of the fourth digit. It will of course be understood that the switch RS5 is advanced one step as each digit is received so that at the termination of the fifth digit the wipers of the switch will be in their sixth position.

IMPULSE TRANSMISSION FROM REGISTER TRANSLATOR ON DECIMAL BASIS

Digit transmission from the register translator takes place as soon as the second digit has been registered and is controlled by the release of relay 239 at the end of the second digit. On the release of relay 239 a circuit is completed from earth at armature 338 of relay 190 (Fig. 11) rotary off-normal springs 385 of the switch TD1 in their operated position, armatures 398, 404, 407, winding of relay 235 to battery. Relay 235 operates armature 409 and this completes the following circuit: impulsing conductor 399 extending from an impulsing machine, armature 400, rotary off-normal springs 386 of the switch TD1 in their operated position, armatures 409, 402, 411 (Fig. 9), 414, 415, 416, 420, lower winding of relay 213 to battery. On the reception of the first impulse from the impulsing machine relay 213 operates over its first step and closes armature 421 and energizes fully at the end of the impulse. On energizing fully relay 213 at armature 420 opens its original energizing circuit at its resting contact and at its operated contact transfers the impulsing conductor to the winding of relay 211. The succeeding impulses, therefore, cause the synchronous operation of relay 211 which at armatures 366 and 367 repeats the impulses to the first group selector by opening the circuit extending from relays 209 and 210 to the impulse responding relay in the group selector. Further at armature 364 relay 211 closes an obvious circuit for relay 212. Relay 212 is a slow-to-release relay and is thus maintained operated during the period that relay 211 is being impulsed. At armature 423 relay 212 closes a circuit from earth at armature 430 of relay 222, armature 423, winding of relay 215 to battery. At armature 424 and 425 the relay 212 replaces the battery and earth connections normally supplied by relays 210 and 209 by battery over a resistance 435 and a direct earth to improve the impulsing circuit to the group selector. Relays 209 and 210 release during impulse transmission but a shunt circuit is provided across armatures 414 and 415 which shunt circuit extends over armature 422 of relay 212. The impulses transmitted by relay 211 to the group selector are repeated at armature 365 to the group of counting relays RG5.

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

OPERATION OF COUNTING RELAY GROUP RG5 ON DECIMAL BASIS

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

ROUTE CONTROL SWITCH RS6

Consideration will now be given to the arrangements for determining the particular digits which are to be transmitted by the register translator. As stated above this is determined by cross-connections extending between the contacts of the route control switch RS6 and the various conductors and contacts grouped adjacent the banks. Typical examples are shown of the cross-connections in Figs. 15–20 and in this connection it should be pointed out that in general each wiper of the switch may be used for controlling the setting up of two types of connection. Thus for example wiper 296, Fig. 8, cross-connected as shown in Fig. 15, controls the setting up of local calls i. e. calls to Hautrage subscribers and also calls to Mons subscribers. An exception to this occurs on eight-digit calls where it is necessary to employ the whole of one bank.

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

For an understanding of the case under consideration reference will be made to Fig. 15, which shows the cross-connections made from wiper 296 of the switch RS6. It should be pointed out that the selection of the appropriate wiper of the switch RS6 is effected by the position taken up by wipers 261 and 263 of the switch TD1, according to the type of connection required. Connections are taken from contacts in the banks associated with these wipers to the appropriate wipers of the route control switch RS6 which are thus connected up in dependence upon the first two digits recorded in the register translator.

As pointed out above the first digit transmitted determines the type of metering which is to be employed and in this case since the metering will be effected by the calling party's meter in the usual way, the digit 2 will be transmitted. Since this will always be the case on a local call the first contact associated with wiper 296 will be connected directly to conductor 2 of the conductors 1–10, since the call is local no routing digits are transmitted and further since Hautrage has less than 1000 lines, three digits only need be retransmitted. Hence the 2nd, 3rd and 4th contacts are cross-connected to the wipers of the switches TD2 and RS1 the position of which represent the 3rd, 4th and 5th digits dialled i. e. wipers 325, 266 and 272.

In detail, when wiper 296 of switch RS6 is on the first contact, earth at armature 472 of relay 192 (Fig. 11) is extended over armature 412 and its resting contact, armatures 471, 410 (Fig. 3), 401, 328, wiper 261 on contact (5, 7), wiper 296 of switch RS6 on contact 1, cross-connection to conductor 2 and thence as described above in connection with the operation of the counting relay group RG5 (Fig. 10). When relay 214 is operated at the end of the transmission of digit 2, it completes the following circuit: earth at contact 419, lower winding of relay 208, winding of magnet 326 of switch RS6 to battery. The magnet 326 is

maintained energized until the release of relay 214 when its circuit is opened and it deenergizes to step the wipers of the switch on to contact 2. Relay 208 operates over the energizing circuit of the switch magnet and at contact 411 disconnects the impulsing conductor from relays 213 and 211 until the switch has stepped.

Contact 2 associated with wiper 296 of switch RS6 is cross-connected to one of the group of conductors 309 to 315 which are connected to the various wipers of the switches whose positions represent the digits dialled by the calling party. In the present case contact 2 is connected to conductor 311 and thence to vertical wiper 325 of switch TD2 over vertical off normal springs 390. Assume the number of the required subscriber is 57, 146. Then wiper 325 is in engagement with contact 1 of the vertical bank and thence to conductor 1 of the conductors 1–10 of the cable 290. Hence the digit 1 will be transmitted from the register translator to the group selector IGS (Fig. 2). The group selector then hunts over the first level for an idle final selector (not shown). Wiper 295 of the switch RS6 is now rotated on to the 3rd contact which is cross-connected to conductor 312 connected to wiper 266 of the switch TD2. As a result of this cross-connection conductor 4 will be earthed and the digit 4 (the tens digit) will be transmitted to the final selector (not shown). Lastly contact 4 associated with wiper 296 of the switch RS6 is cross connected to conductor 313 connected to wiper 272 of the switch RS1 and consequently the final digit transmitted is 6. Digit transmission is now completed and wiper 296 of switch RS6 is stepped to contact 5 which is cross-connected to conductor 317. A circuit is now closed from the earthed wiper 296 of switch RS6, conductor 317, armature 474 and resting contact (Fig. 7), armature 358 to conductor 142 leading to the register translator finder.

RELEASE OF REGISTER TRANSLATOR

When the register translator is disconnected from the register translator finder as previously described above relays 209 and 210 (Fig. 9) release together with relays 187 and 188 (Fig. 11). The release of the latter two relays opens the circuit for relay 189 and during the release period of this relay a circuit is closed from earth at armature 327 over armature 334, winding of relay 204 (Fig. 7) to battery. Relay 204 causes the operation of relay 203 and when relay 189 releases and the above traced circuit is opened a pulse is transmitted during the release time of relay 203 to magnet 243 of the switch RS5. Switch RS5 is thus stepped on to contact 7. Relay 189 in releasing opens the circuit of relay 190 which releases and opens the circuit of relay 191. Relay 191 in releasing at armature 483 closes a circuit as follows: earth, armature 483, winding of relay 350, armature 332, operated vertical off-normal springs 388 of the switch TD1 in their operated position, release magnet 246 to battery. The release magnet 246 is thus energized and the switch TD1 restored to normal. Rotary off-normal contacts 385 are thus opened and relay 235 de-energizes, thereby disconnecting earth from wiper 261 of the switch TD1. Further the restoration of the vertical off-normal contacts 388 extends the earth connection previously traced, to the release magnet 249 of the switch TD2 over operated vertical off-normal springs 389. The switch TD2 is thus restored to normal and the earth connection is again extended over vertical off-normal springs 389 of the switch TD2 in their resting position, vertical off-normal springs 393 of the switch TD3 in their resting position, wiper 273, bank contact and multipling associated with this wiper, interrupter springs 486, magnet 253 of the switch RS1 to battery. Switch RS1 is thus rotated to the 11th contact whereupon the above energizing circuit is further extended over wiper 275 and conductor 295 in turn to magnets 254, 255, 256 and 243 to step switches RS2, RS3 and RS4 to their 11th or 25th contacts and to restore switch RS5 to normal. On the restoration of switch RS5, the circuit is further extended over off-normal springs 381 and their resting position, armature 431 of relay 191, off normal contacts 489 of the switch RS6, interrupter contacts 490, winding of magnet 326 to battery. The switch RS6 is thus returned to normal in which position the off-normal springs 489 are opened and the above-traced circuit is interrupted. The register translator has now been completely released and can be used for a further call.

CALLS THE FIRST DIGIT OF WHICH IS 0

Operation on All Calls

When the first digit dialled by the calling party is the digit 0 the switch TD1 will be raised to the 10th level whereupon a circuit is closed during the energized period of relay 204 from earth at armature 382 of relay 204 and its operated contact (Fig. 3) armature 495, vertical wiper 324, tenth vertical bank contact, armature 497, winding of relay 238 to battery. Relay 238 operates and locks over armature 331 to earth at armature 338 (Fig. 11). Relay 238 in operating at contact 339 opens the circuit to magnet 243 of switch RS5 in order to prevent this switch stepping its wipers from the first to the second contact. Further at armature 332 relay 238 closes the following circuit for the release magnet 246 of the switch TD1: earth at armature 382 and its resting contact (Fig. 3), armatures 496 and 332, vertical off-normal springs 388 and their operated contacts, winding of release magnet 246 to battery. The switch TD1 is thereby restored to normal. In addition relay 238 at armature 330 closes a circuit during the release period of relay 203 as follows: earth at armature 383, armature 384, contact 1 and wiper 258 of switch RS5, armatures 330, 492, lower winding of relay 237 to battery. Relay 237 operates and locks over both windings in series with armature 493 and at armature 492 and its operated contact prepares a circuit for the magnet 243 of the switch RS5.

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

Operation on Individual Calls

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

Three Digit Calls

Three digit calls may again be subdivided into those for which the second digit is "0" and those for which the second digit is other than "0". In the first subdivision are included calls to an operator (call number 001 for a toll operator and 004 for an international operator) and calls for cer-

tain services (call numbers 005–008 inclusive). In the second are included for instance calls for the speaking clock (call numbers 091 and 092).

SECOND DIGIT "0"

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

With regard to the digits which are to be re-transmitted, in this case the call will be metered by an operator in the usual way. Consequently the first digit re-transmitted from the register translator will be the digit "1" and for this purpose, referring to Fig. 16, contact **1** associated with wiper **297** of the switch RS6 is cross-connected to conductor **1** of the control conductors. The second digit transmitted will serve to position the first group selector on to a "poor" grade junction line extending to the Mons exchange at which the operators are located, and for this purpose the second contact associated with wiper **297** is connected to conductor **9** in the similar way as for a call to Mons described above.

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

The 5th contact associated with wiper **297** of the switch RS6 is cross-connected to conductor **316** and the earth extended to this conductor causes the operation of relay **224**. Relay **224** at armature **454** closes a circuit over: earth, armatures **454**, **462**, winding of relay **214** to battery. Relay **214** at contact **419** closes an energizing circuit for magnet **326** as described above. Further earth at contact **419** is also extended over armature **453** of relay **224** to the upper winding of relay **225**. Relay **225** is slow-to-energize and first closes a locking circuit over its X armature **457** in series with the winding of relay **226** from earth at contact **339** (Fig. 11). When relay **225** operates fully it opens at armature **462** the circuit for relay **214** which releases and at armature **419** opens the energizing circuit of magnet **326** whereby the wipers of switch RS6 are stepped on to the next i. e. the 6th contacts. Relay **226** operates in the above locking circuit and relays **225** and **226** by their operation cause the counting relays RG5 to co-operate with the counting relays RG6 to enable the remaining digits transmitted by the register translator to be in coded form.

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

It will be noted on referring to Fig. 16 that contacts **6** and **7** associated with wiper **297** of the switch RS6 are extended over armatures **501** and **500** of relay **207** in the resting position to conductors **318** and **319** while contacts **8**, **9** and **10** are connected directly to conductors **320**, **321** and **322** respectively. With regard to conductors **318** and **319** these are permanently connected, the first with conductor **5** of conductors **1–10** and the second with conductor **7** of conductors **1–10** over armature **498** of relay **201** and its resting contact and conductor **499** to conductor **7** of the control conductors. This as explained previously is always the same since the ultimate capacity of Hautrage exchange is only 600 lines and hence the 10,000 and 1,000 numbers of all the subscribers lines are the same. With wiper **297** of the switch RS6 on contact **6** therefore earth is extended from conductor **318** to conductor **5** of the control conductors and thence through cable **282**, cable **287**, cable **288**, armature **465** of relay **226**, winding of relay **232** of the relay group RG6 to battery. Relay **232** operates and causes the digit 5 to be transmitted in coded form. Similarly when wiper **297** steps on to contact **7** earth is extended over a similar circuit, contact **467** of relay **226**, windings of relays **229** and **227** in series to battery. These relays operate to cause the transmission of the digit 7 in coded form. Conductor **320** is connected over the operated armature **508** of relay **202** to operated armature **362** of relay **200**, armatures **509**, **510** in their rest position to conductor **1** of the control conductors in accordance with the hundreds digit of the calling party's number (57109) and thence over cable **295**, cable **282** to the winding of the appropriate relays of the group RG6 as described above. Conductors **321** and **322** are connected to wipers **276** and **279** respectively of switches RS3 and RS4 and thence over cable **282** as described above to the appropriate relays of the group RG6. It will thus be understood that as wiper **297** of the switch RS6 steps from the 6th to the 10th contact the calling party's number will be transmitted in code over the junction line to the Mons central exchange. At the termination of digit transmission wiper **297** will be stepped on to the 11th contact which is cross-connected to conductor **317**

to cause the release of the register translator as described above.

The above description deals with calls of which the number is 001 and 004. As pointed out previously however arrangements are provided for dealing with other services and calls if any for these services also have the digits "00" for the first two digits. Since however the metering of these calls is effected by an operator it has been found simpler to deal with these calls over a different wiper of the switch RS6. The third digit of these calls may be any of the digits 5 to 8 and consequently a connection is made from contacts 5 to 8 of the 10th level of the bank associated with wiper 263 of the switch TD1 to wiper 298 (Fig. 17) of the switch RS6. Further the first part of the bank is employed for the calls and hence no connection is made from the contact on which wiper 264 of the switch TD1 is standing to magnet 326.

Referring now to Fig. 17 which shows the cross-connections for a call of this type, it will be noted that contact 1 is cross-connected to conductor 1 of the control conductors so that the first digit transmitted will be the digit "1" indicating that metering is to be effected by an operator. The next two contacts are cross-connected to conductors 9 and 8 respectively of the control conductors in order to secure the necessary routing of the connection as far as the switch TS at the Mons exchange. Contact 4 is cross-connected to conductor 310 which is directly connected to wiper 260 of the switch TD1 in order that the third digit dialled by the calling party is retransmitted without translation to raise the switch TS to the appropriate level. Finally contact 5 is cross-connected to conductor 317 to cause the release of the register-translator.

Eight Digit Calls

Straight forward connection

If the second digit is 1–8 it indicates that the call is for an exchange in another zone. In this case when the second digit has been registered by the vertical movement of the switch TD1 and relay 204 has released, a circuit is closed as follows: earth at armature 382 and its resting contact (Fig. 3), operated contact and armature 495 of relay 237, vertical wiper 324, the bank contact to which this wiper has been raised, armature 494 of relay 237, winding of relay 236 to battery. Relay 236 operates and locks at armature 403 in parallel with relays 237 and 238. Relay 236 at armature 404 opens the circuit of relay 235 in order to prevent the register translator from commencing digit transmission. The fourth and fifth digits dialled by the calling party are registered by the vertical and rotary movements of the switch TD2 and the sixth by the operation of the switch RS1 as previously described. At the termination of the reception of the sixth digit, the wipers of the switch RS5 are stepped on to the 6th contacts and the seventh series of impulses are thus repeated to magnet 254 of the switch RS2. The wipers of the switch RS5 are now stepped on to the 7th contacts and the eighth digit dialled is repeated at contacts 327 of relay 187 (Fig. 11) to the magnet 243 of the switch RS5 as follows: earth, armatures 327, 334, wiper 259 of switch RS5 on contact 7, armature 523 of relay 205, contact 7 and wiper 258, armatures 330, 492 in their operated positions winding of magnet 243 to battery. The eighth and last digit is thus registered on the switch RS5.

As pointed out above in a call for an exchange of another zone the switch TD3 is automatically set as regards its vertical movement in accordance with the resultant of the first two digits recorded in the register translator and as regards its rotary movement in accordance with the third and fourth digits registered in the register translator. Relay 236 prepares the circuit for operating the switch TD3 which circuit is completed as follows on the registration of the fourth digit: earth at armature 406 of relay 236, armature 515 of relay 240, rotary off-normal springs 391 and their operated contacts, rotary off-normal springs 395 of the switch TD3 and their resting contacts, vertical off-normal springs 394 and their resting contacts, winding of relay 241 to battery. Relay 222 (Fig. 9) is also operated in parallel with relay 241. Relay 222 at armature 431 connects the impulsing conductor 516 extending from an impulsing machine to relay 213, the circuit extending as follows: impulsing conductor 516, armature 431, contact and armature 411, armature 427 and its operated contact, armatures 416, 420, winding of relay 213 to battery. Relay 213 operates as previously described and at armature 420 and its operated contact extends the impulsing conductor to relay 211. Relay 211 operates and completes an impulsing circuit extending from earth at armature 364, armature 429 of relay 222, armature 518 and its operated contact, winding of relay 241, winding of vertical magnet 250 of the switch TD3 to battery. Relay 211 and the magnet 250 are thus operated in synchronism. It will be noted that relay 222 at armatures 432 and 433 completes a shunt circuit across armatures 367 and 366 of relay 211 to prevent any impulses being transmitted to the first group selector. Further relay 222 at armature 428 extends earth to wiper 300 of the switch RS6 over which wiper the setting up of the connection is controlled. This circuit extends as follows: earth at armature 472 of relay 192 (Fig. 11), armatures 412, 471, 428, 405 to wiper 300.

The determination as to the number of steps to be taken by the switch TD3 is effected over wiper 262 of the switch TD1. Referring to Fig. 18 it will be noted that contact 1 associated with wiper 300 of the switch RS6 is cross-connected to conductor 303 which is directly connected with wiper 262. Contacts associated with wiper 262 are connected to appropriate ones of the 10 conductors 1–10 and according, therefore, to the conductor which is connected to the particular contact on which wiper 262 is resting so the switch TD3 will make this number of vertical steps, the control being exerted over cable 285 and cable 282 through the counting relays RG5 in a precisely similar manner to that described in connection with the digit transmission on a decimal basis from the register translator. Thus relay 214 (Fig. 9) will operate when the switch TD3 has made the required number of steps and at armature 419 will close the circuit of magnet 326 to step wiper 300 on to the second contact. The original circuit of relay 241 is interrupted when the switch TD3 is moved off-normal, but this relay is maintained operated until the end of the vertical movement by the impulses transmitted over its upper winding to the vertical magnet 250. When the switch TD3 moves off-normal, however, the original energizing circuit for relay 241 is extended to the lower winding of relay 242 over vertical off-normal springs 394 in their operated position. Relay 242 operates and at contact 519 prepares the impulsing circuit for the rotary mag-

net 251. When relay 241 releases at the end of the vertical movement this impulsing circuit is completed over armature 517 of relay 241 and the switch TD3 is rotated over the level upon which it has been set. The rotary movement of the switch TD3 is determined by the position of the wiper 267 of the switch TD2. The contacts associated with this wiper are connected to the appropriate ones of the conductors 1–10 and the rotary movement of the switch TD3 is controlled in a similar manner to that of the vertical movement, contact 2 associated with wiper 300 of the switch RS6 being cross-connected to conductor 304 and thence to wiper 267. Relay 242 at armature 520 serves to maintain the circuit of relay 222 during the rotary movement, the original circuit being opened at rotary off-normal springs 395. At the termination of the rotary movement of the switch TD3, the wipers of switch RS6 are stepped on to the 3rd contact and relay 22 releases.

The release of relay 222 causes at armature 431 the disconnection of the impulsing conductor 516 from relay 211. A further impulsing conductor 528 is, however, connected for the purpose of digit transmission from the register translator over rotary off-normal springs 396 of the switch TD3 in their operated position (Fig. 5) to armature 411 of relay 208. It is to be noted that the circuit over which earth is extended to wiper 300 is opened at armature 428 on the release of relay 222. The circuit is however maintained over rotary off-normal springs 397 which close on the first rotary step of the switch TD3 to shunt armature 428. Impulse transmission now commences from the register translator and the first digit is controlled by wiper 300 of the switch RS6 in position 3. Referring again to Fig. 18 it will be seen that contact 3 is cross-connected over armature 504 and its resting contact to conductor 3 of the control conductors since the determination of the charge for the call will be effected automatically. Following the transmission of this digit the next four digits transmitted, control the routing of the connection to and through the Mons central exchange. Thus contact 4 is cross-connected to conductor 0 of the 10 control conductors to step the first group selector 1GS to the 10th level where it selects an idle junction line of "good" grade to the Mons central exchange. As previously pointed out the next digit will be the digit 8 in order to step the incoming selector IS of the Mons exchange to the 8th level. The incoming selector hunts over this level to find an idle special services selector TS. Calls to other zones are routed over levels 2 and 3 of this selector according as to whether the call is to proceed over the Brussels central exchange or over the Charleroi central exchange. Consequently the next digit will be variable so that contact 6 associated with wiper 300 will be cross-connected to conductor 305 which is directly connected to wiper 269 of the switch TD3. The position taken up by this wiper serves to control over the control conductors the transmission either of the digit 2 or the digit 3 in accordance with the destination of the call whereby the special services selector TS to the Mons exchange is raised to the second or third level whereupon it hunts for an idle relay group RG. The next digit to be retransmitted determines whether a "good" or "poor" grade junction line extending from the Mons central exchange shall be taken into use. As pointed out previously this depends on the destination exchange and also as to whether repeaters are to be used in the connection. Assuming that a "good" grade junction is to be employed as determined by wiper 270, the transmission of the next digit will cause the toll line circuit finder TLF1 to start hunting for an idle toll line control circuit TLCC. The routing of the call through Mons exchange is now completed and the remaining digits are transmitted to Mons in code. Consequently contact 8 associated with wiper 300 is cross-connected to conductor 316 to cause circuit operations to take place as described previously with result in the transmission of coded impulses. The next seven contacts i. e. contacts 9 to 15 associated with wiper 300 are cross-connected respectively to conductors 309 to 315 inclusive which are directly connected with the vertical and rotary wipers 323 and 260 of the switch TD1, the vertical and rotary wipers 325 and 266 of the switch TD2 and the wipers 272, 274 and 257 of the switches RS1, RS2 and RS5 on which the second to the 8th digits dialled by the calling party are stored. Of these digits the first two indicate the zone and the second two the destination exchange in that zone while the remaining impulses indicate the number of the called subscriber. The transmission of these digits only takes place in response to a signal from the toll line control circuit TLCC. The digit control when wiper 300 is on contact 16 is only employed in certain circumstances which will be described later and on a normal call no digit is transmitted. Contact 16 is, therefore, cross-connected over armature 503 of relay 207 and its resting contact, armature 527 of relay 206 and its resting contact to conductor 507 (Fig. 6). Earth extended over wiper 300 therefore causes the energization of relay 233 which at armature 529 closes a circuit which causes wiper 300 to be stepped on to contact 17 without any digit being transmitted. This circuit will be traced in detail later. The remaining digits to be transmitted from the register translator represent the calling party's number and the rate at which the call is to be charged. The transmission of the digits representing the calling party's number takes place as described previously except that the cross-connection between contact 17 and conductor 318 which controls the transmission of the 10,000 digit of the called subscriber's number is extended over contact 502 and its resting contact, the purpose of which cross-connection will be explained later. Finally when the calling party's number has been transmitted wiper 300 is stepped on to contact 22 which is connected to conductor 308 which is directly connected to wiper 271 of the switch TD3. This is for the purpose of transmitting a digit which is indicative of the rate at which the call is to be charged and it will be appreciated from what has been stated above that this digit will be dependent upon the zone to which the connection is to be extended and the destination exchange in that zone. Finally contact 23 is cross-connected to conductor 317 to cause the release of the register-translator as previously described.

An alternative method of operation on calls of which the first digit is "0" is to allow the first group selector to be set on to an idle "good" grade junction line to Mons while the digit "0" is being absorbed in the register-translator. The digit indicating the type of metering which is to be employed is transmitted to the first group selector subsequently. This method of operation considerably reduces the holding time of the junction. The necessary alterations to effect this modifica-

tion are slight and will be readily apparent to those skilled in the art.

VARIATION IN THE CROSS-CONNECTING FIELD WHEN PRICE OF CALL REQUIRED

Ficilities are provided whereby on multi-rate calls the calling party can be informed if he so desires of the total cost of the call. For this purpose he is instructed to dial an additional digit after dialling the call number. This additional digit has the following effect.

When the 8th digit has been received by the register-translator, the following circuit is always closed during the release period of relay **204**: earth at armature **383** (Fig. 7), armatures **384**, **524**, wiper **552** and bank commoning lower winding of relay **205** to battery. Relay **205** partially operates in this circuit and closes its X armature **525** both windings being energized in series to earth at armature **338** (Fig. 11) when relay **203** releases and at armatures **524** a circuit is prepared for relay **206**. If now a further digit is dialled, the individual impulses will have no effect but at the end of the train the following circuit is closed also during the release period of relay **204**: earth at armature **383**, armatures **384**, **524** and its operated contact, winding of relay **206** to battery. Relay **206** in operating at armature **526** completes a holding circuit for itself to earth at armature **338** and at armature **527** alters the cross-connection extending from contact **16** associated with wiper **300** (Fig. 18).

Referring now to Fig. 18 it will be seen that contact **16** is normally cross-connected over armature **503** of relay **207** and its resting contact, armature **527** and its resting ccntact to conductor **597** extending to relay **233** (Fig. 6). As previously described this connection serves to step the switch RS6 on to contact **17** without the transmission of any coded digit from the register-translator. With relay **206** operated however the cross-connection extends over armature **527** and its operated contact to conductor O of the control conductors. The digit "0" is thus transmitted in code and transmission of this digit causes an indication such as an asterisk or other suitable sign to be printed on the ticket so that at the end of conversation the calling party is rung and given the total cost of the connection. It can also operate a warning signal to call the attention of an attendant.

It is pointed out that any digit can be employed for obtaining this facility since the number of impulses transmitted is not of importance. It has however been found preferable to employ the digit "0" for this purpose.

VARIATION WHEN CALLS ARE SET UP FROM MANUAL OPERATOR

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

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

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

With regard to wiper **300** it will be remembered that contact **3** is normally cross-connected over armature **504** and its resting contact to conductor **3** of the control conductors to cause the transmission of the digit which gives an indication in the first group selector of the type of metering which is to be employed. Since the call is metered by the manual operator when a connection is being set up from a manual exchange, the operation of relay **207** causes the cross-connection from contact **3** to be extended over armature **504** and its operated contact to conductor **1** whereby the digit 1 is transmitted from the register-translator. Further contact **16** which is normally cross-connected to armature **527** would now be cross-connected over armature **503** and its operated contact to conductor **9** of the control conductors, to cause the transmission of the digit **9** thereby giving an indication that the connection is being set up by a manual operator. Further contact **17** which is normally cross-connected over armature **502** and its resting contact to conductor **318** to cause the transmission of the 10,000 digit of the calling party's number is now cross-connected over armature **502** and its operated contact to conductor **317** to cause the release of the register-translator.

It is possible to arrange that the "special" digit is employed only in the case where the subscriber requires the cost of the call to be communicated to him. It will be understood that if the call originates from a manual exchange, the call is metered in the usual way by the originating operator and hence no rate digit will be transmitted.

This involves a loss of time since the route control switch RS6 has still to step over this contact. Now there will normally be five rate digits with a possibility of a sixth when Blaton is converted to automatic working and by referring to Fig. 14 it will be seen that six digits can be transmitted without employing the fourth impulse of the cycle. Hence by employing the digit "0" for instance as a manual indication it can be transmitted as an alternative to the rate digit with a consequent saving of time.

CODED IMPULSE TRANSMISSION FROM REGISTER-TRANSLATOR

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

When coded impulses are to be transmitted, each digit is represented by the cyclic operation of four of the counting relays of the group RG5. Normally the sequential operation of these four relays would involve the transmission of four impulses to the first group selector but owing to the opertaion of relays **225** and **226** the effect now is to cause certain of these impulses to be suppressed as regards their transmission over the positive conductor, those transmitted over the negative conductor being in all cases unaffected. The code adopted is indicated in Fig. 14 where the numerals in the vertical column on the left hand side represent the digit and the numerals in the top row represent the impulses of the cycle. Thus if the digit 5 is to be transmitted, the 1st and 3d impulses of the cycle will be suppressed, the 2d and 4th being transmitted and so on for other digits.

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

Assume the digit "5" is to be transmitted. Then earth is extended over conductor **5** as previously described to cause the energization of relay **232**. Relay **232** then closes the following circuit: battery, resistance **435** (Fig. 9), armature **521** of relay **232**, armature **436** of relay **216**, armatures **439**, **444** to the contact associated with armature **366**. Thus when armature **366** is opened when relay **211** responds to the first impulse, no impulse is transmitted over the positive conductor due to the shunt circuit traced above. Relay **216** responds to the first impulse however and on the termination thereof opens the shunt circuit at contact **436**. The next impulse is therefore transmitted over the positive conductor and at the end of this impulse relay **217** operates fully and again closes the shunt circuit across the contact of armature **366**. This shunt circuit extends as traced above except that it passes over armature **522** of relay **232** and armature **439** in its operated position instead of over armature **521** of relay **232** and armatures **436** and **439**. The fourth impulse is transmitted over the positive conductor and at the termination of this impulse relay **219** operates fully and locks over its own armature **448** and armature **445** of relay **218**. Relay **219** at armature **447** opens the circuit of relay **218** which releases and at armature **445** opens the circuit of relay **219** which also releases. On the release of relay **219** the four relays **216**, **217**, **218** and **219** are now all de-energized and the transmission of the next digit can take place. It will of course be understood that the transmission of digits other than the digit "5" will take place in a manner similar to that described above although the detailed circuits will differ in order that the correct impulses as indicated in Fig. 14 may be suppressed. For instance for the digit "0" relay **232** will be energized over its lower winding in series with relay **227**. The shunting circuit for the first and third impulse is the same as described in connection with the transmission of digit 5 and the shunting circuit for the second impulses thus extends over armatures **554** and **553** to armature **436** so that the first, second and third impulses are suppressed.

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

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

BARRED CALL FACILITY

As mentioned previously the register-translator is provided with arrangements whereby it can be determined whether a call set up by a particular subscriber is allowable or not. This facility is of considerable importance where a telephone instrument is available to the public who could otherwise set up quite expensive calls without paying the appropriate fee. On a fully automatic system this privilege may possibly be abused in that the public may endeavor to set up calls to which they are not entitled. The circuits of the register-translator are, therefore, arranged in one embodiment so that a calling party is unable to set up from such an instrument calls prefixed by the digit "0." To enable the necessary discrimination to be effected at the register-translator between ordinary subscribers and subscribers having limited facilities it is arranged that in the latter case an earth is connected to the positive conductor extending to the register translator. It will be remembered that when the calling party's loop is extended to the register translator, relays **187** and **188** are operated and a circuit is completed for relay **189** over armature **326a** of relay **187** to earth at armature **329** of relay **238** (Fig. 3). An additional circuit is also provided for relay **189** at armature **377** of relay **188**. When, however, earth is connected to the calling party's loop, relay **188** is not operated and relay **189** is then held solely from earth at armature **329**. If, however, the first digit operated is "0," relay **238** is operated and earth is thus re-

moved at armature 329 from relay 189 with the result that this relay releases followed by the relays 190 and 191 to cause the release of the register translator as described above.

It is, however, at times permissible for certain calls to be set up the first digit of which is "0." This will be the case for instance for a call to the speaking clock or for a call from Hautrage to Blaton when the latter is fully automatic and it is, therefore, desirable for the register translator to perform a further discriminatory function to distinguish between allowed and barred calls commencing with the digit "0." Reference should now be made to Fig. 21 which shows the essential arrangements for carrying this into effect. It should be pointed out that the same relays and armatures are given the same references in Fig. 21 and Figs. 3 to 12. Referring now to Fig. 21 when a call comes in from a subscriber having limited facilities, relay 187 only operates and causes the sequential operation of relays 189 and 190. When the first digit, that is the digit "0," is registered by the vertical movement of the switch TD1, relay 238 is operated followed shortly after by the operation of relay 237. During the period between the operation of relays 238 and 237, relay 553 is operated over armature 326a of relay 187 to battery over the winding of relay 189. Relay 189 remains energized. Relay 553 closes a locking circuit for itself from earth, armatures 329, 557, lower winding of relay 553 to battery, over the resistance 560. Relay 553 at armature 558 connects the terminal 559 which is arranged in the cross-connecting field of the rotary switch RS6, to conductor 142.

Conductor 559 is cross-connected to contact 3 associated with wiper 300 of the switch RS6 and consequently the register translator and the register translator finder are restored to normal and a tone is transmitted to the calling subscriber. It will be understood that the addition of the cross-connection to terminal 559 is in addition to the connections shown in Fig. 18. Thus contact 3 will be cross-connected to terminal 559 while contact 4 will be cross-connected to conductor 3 of the 10 control conductors. All the other cross-connections will be similarly advanced by one contact.

In the case of a call from an unrestricted subscriber, relay 188 operates together with relay 187 and causes the sequential operation of relays 189, 190, and 191, the energizing circuit of the latter relay extending over armature 555 while the locking circuit extends over armature 554. Relay 553 cannot now operate since it is short-circuited by earth at armature 377 and the connection is set up as previously described.

Calls commencing with the digit "0" and which are regarded as local are however, allowed to the restricted subscriber and the wiper 561 of the switch TD3 which represent these calls are strapped together and a connection is taken over conductor 562 to the junction point of the lower winding of relay 553 and the resistance 560. On a call of this nature therefore, relay 553 operates and locks as before but the locking circuit over the lower winding is short-circuited by earth over wiper 561 when the switch TD3 has been set. Relay 553 is thus released and the call may be set up as previously described.

With regard to the arrangements for connecting earth to the positive conductor where the barred call service is required this may be either permanent or temporary. In the former case an addition may be made to the dial switch of the telephone instrument so that when the digit "0" is dialled as the first digit the earth connection is effected due to the rotation of the finger hold plate or it can be made under the control of a push-button which may be remote from the telephone instrument. The latter arrangement enables the barred call facility to be employed or not as desired.

OTHER CALLS

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

CALLS TO SUBURBAN EXCHANGE

As explained previously there is at present a direct junction between St. Ghislain and Dour and calls from Hautrage to Dour are extended through St. Ghislain. Now Dour is in a suburban area within the Mons zone and hence a call thereto from Hautrage is a multi-rate call. At the moment, therefore, the call is metered by the operator dealing with incoming calls at Dour. The cross-connections for setting up a call to Dour extend from contacts 1–4 associated with wiper 301 of the switch RS6 and referring to Fig. 19 it will be seen that contact 1 is cross-connected to conductor 1 of the control conductors while contact 2 is cross-connected to conductor 309 to cause the transmission of the first digit dialled in order to route the call to St. Ghislain. This is satisfactory as long as it is arranged that the junction lines to St. Ghislain are connected on a level corresponding to the first digit of the Dour numbers. Contact 3 is cross-connected to conductor 310 in order to secure the transmission of the second digit dialled by the calling party. This digit is repeated through St. Ghislain to Dour to extend the connection to an operator's position at Dour. The remainder of the call is thus set up manually and consequently conductor 4 is cross-connected to conductor 317 to cause the release of the register translator.

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

With regard to the operation of the register translator, it will be understood that although a call to Dour is a multi-rate call, it differs from multi-rate calls to exchanges in other zones in that a five figure number will be dialled instead of an eight figure number. Since, however, once

the dialled digits have been registered in the register translator the further operation is controlled by the route control switch RS6, the circuits of the register translator will not have to be altered but the modifications will occur in the cross connections extending from the contacts associated with wiper 301 of the switch RS6.

Rate determination will be limited to the choice between two rates while with regard to the controlling circuits and ticket-printing equipment it will be appreciated that in general they will be similar to those employed on a call to an exchange in another zone. The requisite information will be transmitted to the Mons exchange in coded form since this results in a saving of time and a converter will be employed for converting the coded digits into decimal routing digits. No non-decimal impulse trains will be required however since repeaters will not be employed and "poor" grade junction lines may be used. The routing digits may be transmitted in the form of alternating current impulses or if direct current impulsing is to be employed, regeneration may be made use of. At the end of conversation the various items will be transferred to the printer-controller as for other calls with the exception that the star indication may not be employed.

An example of the cross-connections which would serve for setting up a call to Dour when the latter is automatic is shown in Fig. 20. It should, however, be understood that this particular example is somewhat tentative and may involve alteration when the route which the call follows in the Mons exchange has been finally decided. Wiper 302 in Fig. 20 represents an alternative to wiper 301 of switch RS6 and can be substituted therefor when the change takes place.

Referring now to Fig. 20 it will be noted that contact 1 associated with wiper 302 is cross-connected to conductor 3 of the control conductors to cause the transmission of the digit 3 to indicate that the call is to be metered by ticket-printing equipment. Contact 2 is connected to conductor 9 of the control conductors whereby the first group selector 1GS (Fig. 2) is raised to the ninth level to select a "poor" grade junction line to Mons. Contact 3 is cross-connected to conductor 306 which in turn is connected to wiper 265. The contact on which wiper 265 is resting is connected to the appropriate control conductor to cause the transmission of the appropriate routing digit to Mons. This is the only routing digit transmitted to Mons and hence in this particular example the junction lines to Dour are directly accessible over the switch 1S. Contact 4 is cross-connected to conductor 316 to enable the remaining digits to be transmitted in code. The remaining contacts are cross-connected in a manner similar to that for a toll call to another zone as shown in Fig. 18 the rate digit being transmitted between the calling and called party's number.

DETAILED DESCRIPTION OF FIRST GROUP SELECTOR

Reference will now be made to Figs. 22, 23 and 24 which show the circuits of the first group selector 1GS and to Fig. 25 which shows a junction line circuit accessible to the wipers of the first group selector.

When the line finder 1LF switches through on to the calling line, earth as previously explained is extended from the register-translator over the negative conductor 109, to conductor 600 (Fig. 22), armature 661 and its resting contact, make-before-break contacts of armatures 657 and 659, upper winding of relay 609 to battery. Similarly battery is extended over the positive conductor 108 to conductor 601, armature 662 and its resting contact, make-before-break contacts of armatures 658 and 660, lower winding of relay 609 to earth. Relay 609 therefore operates and at armature 649 closes a circuit for relay 610. In addition at armature 647 and 648 relay 609 prepares the impulsing circuit to the outgoing conductors. Relay 610 in operating at armature 652 extends earth over the upper winding of relay 607 to test conductor 602 and conductor 110. The switch is now in a condition to receive impulses from the register-translator.

The first digit transmitted from the register-translator is effective in giving an indication as to the type of metering which is to be employed for the call and does not effect any setting operation of the switch wipers. This digit may be 1, 2 or 3 and on the first impulse, relay 609 releases and closes a circuit over: earth, armature 649 and its resting contact, armature 655 and its operated contact, rotary off-normal springs 642, make-before-break contacts of armature 665, armatures 669, 673, lower winding of relay 613 to battery. Relay 613 is a two-step relay and at this time closes its X armature 672 only. At the termination of the impulse, relay 613 operates fully over: earth, armatures 654 (Fig. 22), 667, 672 to battery over both windings of relay 613 in series. Relay 613 at armature 673 extends the impulse repeating circuit to the lower winding of relay 612. It is also to be noted that relay 611 is energized over both windings in a parallel branch of the impulse repeating circuit and being slow-to-release is maintained operated for the whole of the impulse train.

Assume that the first digit comprises three impulses. Then the second impulse will cause the energization of relay 612 over operated armature 673. Relay 612 is also a two-step relay and operates in a similar manner to relay 613. It looks over its X contacts 668 to earth over armatures 679 and 654 and on operating fully at armature 667 opens the locking circuit of relay 613 which thereupon releases. Finally the third impulse causes the energization of relay 615 over operated armature 669. Relay 615 is a two-step relay and at the end of the impulse locks over its X armature 680, armatures 686, 656, to earth and operates fully. At armature 679 relay 615 opens the locking circuit of relay 612 which releases. Relay 611 also releases at the end of the impulse series and at armature 676 the following circuit is closed for relay 620: earth, armature 653, 676 (Fig. 22), armatures 678, 684, or armature 671 or 666 according to the number of impulses, vertical off-normal springs 644, resistance 688, centre winding of relay 620 to battery. Relay 620 operates and at armature 665 prepares an impulsing circuit to the vertical magnet 622. The second impulse series transmitted from the register translator is repeated at armature 649 of relay 609 over the following circuit: earth, armature 649 (Fig. 22) and its resting contact, armature 655, rotary off-normal springs 642, operated contacts and armature 665, resistance 689, rotary off-normal springs 641 in parallel with the low resistance lower winding of relay 620, winding of magnet 622 to battery. On the first vertical step of the switch the original energizing circuit of relay 620 is opened at vertical off-normal springs 644 but the relay is maintained operated by the

impulses over the lower winding. At the end of the impulse series, relay 620 releases and at armature 664 the following circuit is closed for the rotary magnet 621: earth, armatures 653, 676 (Fig. 22), armatures 678, 684, vertical off-normal springs 644 in their operated position, armature 664, winding of rotary magnet 621 to battery. The rotary magnet energizes and steps the wipers on to the first line in the selected level. Further on energizing the rotary magnet closes contacts 690 thereby completing the following circuit: earth, armature 654 (Fig. 22), winding of relay 619, armature 685, 11th step springs 640, self-interrupting contacts 690 of magnet 621, upper winding of relay 620 to battery. If the line on which the wipers are standing is engaged, earth is fed back over wiper 626 so that relay 619 is short-circuited but relay 620 operates and at armature 664 opens the circuit of the rotary magnet. The rotary magnet thereupon releases and opens contacts 690 whereupon relay 620 releases and again closes the circuit for the rotary magnet. This interaction continues until an idle line is found to which no battery potential is applied. Relay 619 now operates in series with the upper winding of relay 620 and locks over armature 687 in series with the centre and upper windings of relay 620 and at armature 684 opens the energizing circuit of the rotary magnet to prevent any further operation thereof. Further at armature 686 relay 619 opens at its resting contact, the locking circuit of relay 615 if this relay has been operated. Relay 615, having enabled the impulsing circuit to the vertical magnet to be prepared, releases. At its operated contact, armature 686 of relay 619 closes the following circuit for relay 608: earth at armature 656 (Fig. 22), armatures 686, 696, winding of relay 608 to battery. In addition relay 619 at armatures 681 and 682 closes points in the circuit of the outgoing conductors. Relay 608 in operating over the above circuit at armatures 657, 658, 659 and 660 disconnects the conductors 600 and 601 incoming from the register-translator from relay 609 which releases and connects them to the outgoing conductors over a circuit which bypasses the condensers 691 and 692, thereby providing a direct current impulsing circuit from the register translator to the succeeding apparatus. Impulse transmission from the register-translator continues and at the termination thereof, earth is disconnected from conductor 602 whereupon relay 607 which was short-circuited by this earth and the earth extended from armature 652, operates over the following circuit: earth, armature 652, upper winding of relay 607, armatures 695, 651, winding of relay 610 to battery over resistance 699. Relay 607 operates and locks over its X armature 697 to earth at armature 656; at armature 696 relay 607 opens the circuit of relay 608 which releases; at armatures 693 and 694 it closes a loop including resistances 700 and 701 for holding subsequent switches and at armature 695 short-circuits its upper winding to make it slow-to-release. Relay 608 on releasing reconnects the incoming conductors to relay 609 which energizes and at armatures 647 and 648 shunts armatures 693 and 694 together with resistances 700 and 701. This holding circuit extends as follows: negative conductor, wiper 624, armatures 681, 648, make-before-break contacts associated with armature 703, right-hand winding of shunt field relay 614, upper winding of relay 615, make-before-break contacts associated with armature 702, armatures 647, 682 to the positive wiper 625. The left-hand winding of relay 614 was energized on the operation of relay 610 but the relay does not operate at this state and neither does relay 615.

The effect of the operation of relays 612, 613 and 615 in response to the first digit received from the first group selector will now be discussed and it will first be assumed that the connection is to be metered by the calling party's meter in the usual manner i. e. the first digit is "2" and relay 612 is operated. When the called party replies the battery and earth connections are reversed to cause the operation of relay 614. Relay 614 at armature 706 closes the following circuit for relay 606: earth at rotary off-normal springs 643 and their operated contacts (Fig. 24), armatures 705, 706, 670, winding of relay 606 to battery. Relay 606 operates and at armature 708 disconnects the earth from armature 652 which is applied to conductor 602 and connects booster battery thereto over conductor 710. The calling party's meter is thus operated. Further relay 606 at armature 709 short-circuits relay 612 which releases and at armature 670 opens the circuit of relay 606 which also releases. Further operation of the calling party's meter is thus prevented.

When the calling party replaces his receiver at the end of conversation, relay 609 releases followed shortly after by relay 610. Relay 610 at armature 654 opens the circuit for relays 619 and 620 which release and at armature 653 and its resting contact the following circuit is closed for the release magnet 623: earth, armatures 653, 683, vertical off-normal springs 645, winding of release magnet 623 to battery. The switch wipers are thus returned to normal. Further at armature 656 the locking circuits of the various relays are opened and the switch is thus restored to normal.

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

Thus when the calling party replaces his receiver, relay 609 releases but the only effect of this release is to remove at armatures 647 and 648 the short-circuit around armatures 693 and 694 and the high resistances 700 and 701. The current flowing in the loop circuit is thus reduced sufficient to cause the release of the line relay at the operator's position to indicate that the calling party has hung up but insufficient to cause the release of relays 617 and 618. These relays are only released when the operator takes down the connection, for instance by removing the plug from the jack or by the restoration of a

key. The operator is thus in a position to re-ring the calling party if necessary and to do this the negative conductor is opened at the operator's position. Relay 618 then releases and the following circuit is closed: earth at operated rotary off-normal springs 643, armatures 705, 712, 715, 650, winding of relay 604 to battery. Relay 604 operates and at armatures 661 and 662 connects conductors 717 and 718 to conductors 600 and 601 over which conductors ringing current is transmitted to the calling party.

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

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

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

If the group selector is unable to find an idle outlet in the selected level, the wipers are rotated to the 11th step whereupon 11th step springs are operated. At springs 640 and their resting contacts the testing circuit over relay 619 is opened and at their operated contacts earth is applied to wiper 626 to operate an overflow meter; at contact 639 a circuit is closed for relays 619 and 620 in series so that these relays operate to prevent further energization of magnet 621 and finally at contact 638, busy tone is transmitted over conductor 726, condenser 727 to the positive conductor and thence to the calling party. The latter now replaces his receiver and relays 609 and 610 release and the release of the switch takes place as previously described.

Referring to the junction line circuit shown in Fig. 25 it will be seen that when earth is extended over wiper 626 of the 1st group selector on the operation of armature 685 (Fig. 24), relay 627 is operated and at armatures 730 and 731, the wipers of the group selector are extended over conductors 632 and 633, armatures 730 and 731, to the junction line conductors 635 and 636. Relay 627 in addition locks independent of armatures 738 and 735 over contact 732 to earth on wiper 626 of the group selector, this earth providing busy test to other group selectors. Finally at armature 733 the shunting earth is removed from relay 631 which thereupon operates and an armature 743 closes a signal circuit to indicate the busy condition of the junction line.

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

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

Reference will now be made to the circuits which are provided at the Mons exchange. It will be understood however that a number of the switches provided at Mons are of standard construction and arrangement and a description thereof apart from the general description already given with respect to Fig. 2 is unnecessary for an understanding of the invention. A detailed description will therefore be given only of the toll line control circuit TLCC, the printer-controller PC, the date and time unit DTU and the printer units PT and PU. The register translator or converter C with the associated finder switch CF is described in detail in my co-pending application Serial No. 278,727, filed June 12, 1939.

DETAILED DESCRIPTION OF TOLL LINE CONTROL CIRCUIT

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

When a connection is extended to the toll line control circuit earth potential is extended over conductor **750** (Fig. 31), 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. 30). This circuit extends as follows: earth, armature **832** (Fig. 33), 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. 33), armatures **834, 825** in its operated position both windings of relay **780** in series. Relay **780** is thus short-circuited and does not operate so that the wipers of the switch CF are rotated until they reach an idle converter. When this occurs relay **780** operates from earth at armature **817** as traced above over wiper **971** and conductor **984** to battery in the converter. Relay **780** in operating at armature **840** opens the energizing circuit to the magnet **810**; at armature **839** closes a locking circuit for itself independent of relays **781** and **782** and at armature **838** closes an obvious circuit for relay **787**. Relay **787** in operating at armature **848** closes a circuit for relay **788** to earth at armature **847** and at armature **849** closes a circuit for relay **789**. Relay **788** in operating at armature **879** closes a circuit from earth at armature **886** (Fig. 34) for relay **786** which operates. The operation of relays **786** and **788** causes wiper **959** to **962** of the switch OP to be connected to wipers **967** to **970** of the switch CF over the pairs of contacts **880, 873; 881, 874; 882, 875**; and **883, 876**. Further relay **787** at armatures **863** and **864** connects wipers **974** and **973** 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. 33) and at armature **853** connects relay **763** (Fig. 31) to the positive conductor **751** over make-before-break contacts of armature **814** and the lower primary winding of transformer **811**. Relay **763** operates on its connection to conductor **751** and at armature **862** extends earth from armature **865**, windings of relay **779** to battery. Further its connections to this conductor serves as an indication in the register-translator that the toll line control circuit is ready to receive impulses therefrom. Relay **779** operates and locks over armature **869** to earth at armature **851** (Fig. 35). Relay **779** in operating at armature **871** closes an alternative circuit for relay **778** independent of relay **787** and **789**.

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

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

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

A detailed description will now be given of the reception of the first digit which by way of example will be assumed to be the digit 1. Referring to Fig. 14 it will be seen that 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-energize. Relay **764** at armature **815** and its

resting contact closes the following circuit: earth, armature 815 and its resting contact, armature 820 and its operated contact, armature 837, winding of magnet 807 of switch IP to battery. Magnet 807 energizes but since it operates on the reverse-drive principle the wipers are not stepped at this time. It will be noted that at armature 815 and its operated contact the circuit for relay 777 is opened but this relay is sufficiently slow-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. 29) of relay 778 (Fig. 33). 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 relays 763 and 764 reoperate 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. 33), wiper 953 of switch IP on contact 4, armatures 898, 897, winding of magnet 809 of the switch OP to battery. A branch of this circuit also extends over contact 878 of relay 788, wiper 972 of the switch CF to the converter.

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

The second digit is stored on group II of the counting relays. These relays are not shown but are connected to contacts 5 to 8 associated with wiper 950 as shown by the bracketed conductors II. Further on the 4th impulse of the second digit the wipers of the switch OP are stepped from position 2 to position 3 by earth connected to wiper 953 on contact 8, armature 897 and then as previously traced. The third digit is stored on group III of the counting relays connected to contacts 9 to 12 associated with wiper 950 while the wipers of the switch OP 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 conductors marked II–VII and by the bracketed contacts 2–7 associated with wipers 959 to 962.

The next digit to be received is the special digit. On a normal toll call set up by a subscriber, as pointed out in the description of the register-translator, no "special" digit is transmitted and hence no impulses are transmitted over the positive conductor so that the wipers of the switch IP are stepped over four contacts without any impulses being repeated over the wipers of the switch. If the call although being for an exchange in another zone is to be considered as a unit rate call e. g. a call from Hautrage to Blaton when the latter is automatic, or if the call is set up by an operator at a manual exchange e. g. a call from Hautrage to Blaton when the latter is manual, the special digit "9" is transmitted the effect of which is to prevent a ticket being printed. Thus when this digit is received, which consists of a positive pulse on the third impulse only of the series an earth is connected to wiper 951 in position 6 to cause the operation of relay 776. Relay 776 operates and locks over armature 829 to earth at armature 860; at armature 832 removes earth from the contact associated with armature 840 in order to prevent the finder switch CF, on the release of the converter, from hunting for an idle printer-controller; at armature 831 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, armature 902, both windings of relay 771 in series to battery. At armature 900 relay 771 prepares the circuit for extending earth over wiper 952 instead of wipers 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. 26), armatures 908, 833, 824, interrupter contacts 914, windings of magnet 807 to battery. The wipers of the switch IP are rotated into the position shown when springs 907 open to interrupt the energizing circuit for the magnet. Further at armature 837 relay 782 disconnects magnet 807 from the resting contact associated with armature 815 and connects it to armature 918.

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

The converter completes its operation, and then battery is removed from wiper 971 to cause the release of relay 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 energizes to operate its X armature 912 and close a circuit for relay 767 over armature 926 to earth at armature 818. Relay 767 in operating provides supervision at armatures 813 and 814 by reversing the battery feed to the calling party. On the termination of the signal, relay 766 energizes fully and at armature 913 relay 766 initiates the timing of the call.

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

The first 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 energizes and at the

end of the pulse releases to step the wipers of the switch IP on to contact 2. The switch IP is therefore caused to take one step every 5 seconds for the duration of the conversation. On the reception of the fourth pulse when wiper 953 is on contact 4, the following circuit is closed: earth at armature 861, wiper 953 on contact 4, armatures 910, 930, contact 1 and wiper 957 of the switch T, interrupter contacts 933, windings of magnet 808 upper low resistance winding of relay 777 to battery. The magnet energizes and at its interrupter contacts opens the above-traced circuit whereupon the magnet releases to step the wipers on to contact 2. In addition when wiper 953 is moved on to contact 5 at the end of the fourth pulse a further point is opened in the energizing circuit for magnet 808. With wiper 957 on contact 2 however a further circuit is closed for magnet 808 as follows: earth at armature 931 (Fig. 32), bank multipling and wiper 957, interrupter contacts 933, windings of magnet 808 upper winding of relay 777 to battery. The wipers of the switch T are now stepped on to contact 4 where the energizing circuit for the magnet is opened. The switch T now remains in this position until three minutes have elapsed and wiper 991 is on contact 11 when earth is extended over the upper winding of relay 772, contact 4 and wiper 957, interrupter contacts 933 windings of magnet 808 upper winding of relay 777 to battery. Relay 772 is a high resistance relay and operates over this circuit although the magnet does not. Relay 772 locks over its lower winding and armature 932 to earth at armature 867 and at armature 930 and 931 opens points in the first two energizing circuits traced above for magnet 808. Further stepping of the switch T is now under the control of the switch IP and it is arranged that the switch T makes one step every minute which elapses. Thus on each reception of the 12th pulse with wiper 953 of the switch IP on contact 12 or 24, the following circuit is closed: earth at armature 861 (Fig. 33), 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 and wipers 950, 952 and 953 are stepped on to contact 1.

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

Timing is stopped by the termination of conversation, when the calling party replaces his receiver, and relays 763 and 764 release. Relay 764 at armature 815 opens the circuit for relay 777. Relay 777 in releasing slowly at armature 819 and its operating contact removes earth from conductor 752 but this earth is replaced at its resting contact from armature 854 (Fig. 35) and finally at armature 818 relay 777 opens the circuit of relays 781, 765 and 766. During the release period of relay 781 however a circuit is closed from earth at armature 818 of relay 777, armature 827, wiper 963 and bank contact as determined by the number of 10 minute intervals, winding of one of the relays 935 to 938 to battery. A parallel branch of this circuit extends over armatures 843 and 816 to wiper 964 and bank contact to a winding of another of the same relays. The operation of a combination of relays 935 to 938 in accordance with the digit to be stored will be apparent from Fig. 14 if the references 1, 2, 3 or 4 in the upper horizontal row are replaced by the references 938, 937, 936 and 935 respectively. Thus if the call lasts for less than 10 minutes, the switch OP will not have been stepped and thus will remain on contact 8. On the release of relay 777 therefore relay 935 is operated over wiper 963 but no relay is operated over wiper 964 in accordance with the table. Relay 935 locks over armature 939 to earth at armature 855 (Fig. 29). This earth is also extended over the contact associated with armature 939 to contact 18 associated with wiper 962. If

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

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

The circuit for extending earth to wipers 963 and 964 is opened at armature 827 when relay 781 finally releases. In addition relay 781 at armature 828 closes the following circuit for relay 790; earth at armature 815, armatures 820, 828, 872, winding of relay 790 to battery; at armature 824 closes a self-interrupting circuit for magnet 807 to earth at off-normal springs 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 energizing circuit for magnet 809 of the switch OP over wiper 966 to earth at armature 888. The switch OP is thus stepped to position 17 unless it is already at this position. A circuit is now closed for relay 783 as follows: earth, armatures 850, 846 (Fig. 35), 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. 33), 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. 33), armature 834 and its operated contact, armature 825 and its resting contact, both windings of relay 780 in series, cam springs 842 in their operated position, contact and armature 844, wiper 971. A busy printer-controller is indicated by earth which is extended over wiper 971 to shunt relay 780 while an idle printer-controller is indicated by battery which operates relay 780. Relay 780 in operating locks over its upper winding and armature 839; at armature 840, relay 780 opens the energizing circuit for the magnet 810 and at armature 838 closes before a circuit for relay 787 which operates followed by relay 788 which is operated from earth at armature 890 (Fig. 34).

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 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. 34) to magnet 809 of the switch OP and also over wiper 972 of the switch CF to the printer controller. On the reception of the second pulse relay 786 operates to energize magnet 809 and at armatures 880 to 883 connects wipers 959 to 962 to wipers 967 to 970 over armatures 873 to 876 of relay 788; it will be noted that contacts 17 associated with wipers 959, 961 and 962 of the switch OP are connected to counting relay group XIV (not shown) on which the "rate" digit is stored. The charging rates are so devised that the rate digit may be any one of five digits and hence three relays only of the group XIV are employed. Earth is thus extended from armature 855 (Fig. 29) of relay 778 (Fig. 33) over the locking contacts of the operated counting relays, contacts 17 in the banks of wipers 959, 961 or 962, armatures 880, 882, or 883, armatures 873, 875 or 876, wipers 967, 969 or 970 of the switch CF to the printer-controller. At the termination of the second pulse, relay 786 releases and the wipers of the switch OP are stepped on to the 18th contacts. Contacts 18 of wipers 959 to 962 are connected to the contacts associated with the locking armatures of the relays in group XV on which the number of 10-minute periods are stored. This information is transmitted to the printer-controller in a similar manner as that described for the "rate" digit. With the switch OP on contacts 19, connections are completed from wipers 955 and 956 of the switch T in order to transfer the minute periods to the printer-controller. Contact 20 associated with wiper 962 is connected to the locking circuit of relay 905 so that a circuit is now completed to the printer-controller if the calling party requires the cost of the connection. Contacts 21—25 of the switch OP are connected to counting relay groups IX to XIII to transfer the calling party's number to the printer-controller. The wipers of the switch OP are now stepped on to contact 1 and continue to step on to contact 8 under the control of relay 786 during which time the called party's number which is stored on counting relay groups I to VII is transferred to the printer-controller.

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

All the necessary information has now been stored in the printer-controller and the toll line control circuit may be released. When wiper 965 of switch OP reaches contact 8 a circuit is completed from earth at armature 850 (Fig. 35), 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 re-

leases; at armature 871 opens the circuit of relay 778 which releases and one point in the locking circuit for relay 789 and at armature 872 opens the circuit of relay 790 which releases slowly.

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

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

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

Relays 778 in releasing at armatures 855, 856, 857 (Fig. 29) 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. 33), 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 digits 1 and 2 represent charging rates of 5 and 3 francs respectively and it is arranged that during the call the rate in both cases is reduced to 1 fr. 80 centimes. This is effected by an earth which is extended from the date and time unit in a manner to be explained later, to conductor 754 to cause the operation of relay 762. It should be explained that digits 1 and 2 cause the operation of the first and second and the first and third relays respectively of the appropriate relay group. It will be noted however that contacts 4 and 5 associated with wiper 952 of the switch IP (Fig. 26) are connected to the windings of the storage relays over armatures 993 and 992 respectively. Consequently with relay 762 operated, the first only of the counting relays is operated in response to the reception of rate digit 1 or 2. Now the operation of the first relay of the group represents the digit 7 which is equivalent to a rate of 1 fr. 80 centimes. A conversion of the rate has thus taken place.

DETAILED DESCRIPTION OF DATE AND TIME UNIT

The date and time unit (Figs. 36–39) 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 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 0 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. 14. 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 multipling, interrupter contacts 1230, windings of magnet 1207 to battery. Contacts 11, 12 and 13 associated with wiper 1246 are multipled 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 13 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 in accordance with the table of Fig. 14. 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 1245 and 1246 are multipled 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 energizing 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 40th 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 addtiion 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 60th 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 energized. 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 de-energizes 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 in accordance with the table given in Fig. 14. After the 10th hour or at the end of the hour during which the digit 9 has been registered, 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 energizing 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-energizes 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 groups 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 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 groups 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 multipling, 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 multipling; at armature 1229 closes an energizing 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 energizing and locking circuits of relay 1206 are opened. The relay releases and at armature 1229 opens the circuit for magnet 1210 which de-energizes 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 steppped 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. 31) and when earthed serves to operate relay 762 with the results previously described.

DETAILED DESCRIPTION OF PRINTER-CONTROLLER

When the printer-controller (Figs. 40–54) is seized from a toll line control circuit, earth is extended from wiper 971 of the toll line control circuit (Fig. 30) 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 and 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; digits rerepresenting the duration of the call; digit 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. 28) of the toll line control circuit and it will be understood that as the 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. 28), 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 for 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, armatures 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
4	1.20
7	1.80
8	0.80

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 relays 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. 51), 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 energizes when both its windings are energized 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 energizing 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 energizing the vertical magnet 1401 extends as follows on the next energization of relay 1304: earth at armature 1422 (Fig. 51), armature 1417, wiper 1361 of the switch TS on contact 1, bank multipling, armature 1459, windings of magnet 1401 to battery. The magnet 1401 energizes 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 energizes and at the termination of the pulse de-energizes 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. 51) 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 energizes and at armature 1433 closes a circuit for relay 1303 which energizes 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, tank multipling 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 energize and step 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. 54) as will be described later. Further the operation of relay 1303 causes battery to be extended over resistance 1447 (Fig. 45), wiper 1362 on contact 21, armature 1418, winding of relay 1302 to conductor 1462 to cause the printer-controller finder switch PF (Fig. 54) 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 energizing 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 groups 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, armatures 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. 55) which take the form of electric typewriters are employed, one of which PT prints a ticket in the manner shown in Fig. 56 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 energizes and on the release of relay 1304 de-energizes to step the wipers of switch GT on to contact 2. In addition the following circuit is also closed when relay 1304 energizes: earth at armature 1422, armatures 1417, 1413, winding of magnet 1396 to battery. Magnet 1396 energizes and on the release of relay 1304 de-energizes 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. 51), 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 1473 and 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 typewriter 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 energizing 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 relays 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 0 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 consecutively 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 mechanism 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 RS7 and the centime portion by the position of wiper 1368 of the switch RS7 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 franc 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 9, 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 multipled 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 1320 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 contact 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 1519. 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.

What is claimed is:

1. In a telephone system, a plurality of lines including both restricted and unrestricted lines, register equipment controllable over any of said calling lines during the extension of a connection to establish different charge rates for connections extended therefrom in accordance with the distances between calling and called lines, switching apparatus, and means controllable by said equipment for operating said switching apparatus to set up connections from calling unrestricted lines regardless of the charge rates established therefor by said equipment and for positively preventing operation of said switching apparatus to set up connections from different calling restricted lines in the event the charge rates established therefor by said equipment exceed a predetermined rate.

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

switching apparatus for setting up connections between said lines, means operated during the extension of connections for establishing different charge rates for connections in accordance with distances between calling and called lines, means controllable to prevent the completion of certain connections in the event that the charge rates established therefor by said means exceed a predetermined amount, said last-mentioned means selectively controlled over the calling line involved in the connection for preventing or permitting the completion of said connection.

3. In a telephone system, a calling line, a plurality of called lines, switching apparatus for setting up connections between said calling line and said called lines, means operated during the extension of connections for establishing different charge rates for said connections in accordance with distances between calling and called lines, normally effective means for preventing the completion of certain connections only in the event that the charge rates established therefor by said first means exceed a predetermined amount, and means controlled from a station on said calling line for selectively rendering ineffective said last-mentioned means, whereby connections may be completed whether or not said charge rates therefore exceed said predetermined amount.

4. In a telephone system, a plurality of lines including both restricted and unrestricted lines, register equipment controllable over any of said calling lines during the extension of a connection to establish different charge rates for connections extended therefrom in accordance with the distances between calling and called lines, switching apparatus, means controllable by said equipment for operating said switching apparatus to set up connections from calling unrestricted lines regardless of the charge rates established therefor by said equipment, and additional means controllable by said equipment for positively preventing operation of said switching apparatus to set up connections from calling restricted lines in the event the charge rates established therefor by said equipment exceed a predetermined rate and for returning a characteristic signal over said calling restricted lines.

5. In a telephone system, a plurality of lines including both restricted and unrestricted lines, register equipment controllable over any of said calling lines during the extension of a connection to establish different charge rates for connections extended therefrom in accordance with the distances between calling and called lines, switching apparatus, means controllable by said equipment for operating said switching apparatus to set up connections from calling unrestricted lines regardless of the charge rates established therefor by said equipment, and additional means controllable by said equipment for positively preventing operation of said switching apparatus to set up connections from calling restricted lines in the event the charge rates established therefor by said equipment exceed a predetermined rate and for releasing said equipment for further use.

6. In a telephone system, a plurality of zones, a plurality of exchanges in each of said zones, a plurality of subscriber lines in each of said exchanges, switching apparatus for setting up connection between said lines, means controllable over a calling line for registering digits dialled by a calling subscriber representing a zone of a called subscriber's line, means controllable over a calling line for registering digits representing the exchange of the called subscriber line, means jointly controlled by said zone registering means and said exchange registering means for establishing a charge rate for a connection, and means controllable at times over a calling subscriber line for preventing operation of said switching apparatus to set up a connection between a calling line in one zone and a called line in another zone if the charge rate for said connection exceeds a predetermined amount.

7. In a telephone system, a plurality of exchanges, a plurality of non-restricted lines in each of said exchanges, a plurality of restricted lines in each of said exchanges, switching apparatus operative to set up connections between said lines, register means controllable from a calling line for registering the number of a called line and for thereafter selectively operating said switching apparatus, means in said register means controlled in accordance with the different exchanges involved in a connection for establishing correspondingly different charge rates therefor, means operative under control of said charge rate establishing means for preventing said registering means from operating said switching apparatus to set up connections from calling restricted lines in the event the charge rate therefor exceeds a predetermined amount, said last mentioned means rendered ineffective when said register means is operated responsive to calls originating from said non-restricted lines, whereby all connections therefrom may be set up regardless of the amount of the established charge rate therefor.

8. In a telephone system, a plurality of exchanges, a plurality of restricted lines and a plurality of non-restricted lines in each of said exchanges, switching apparatus operative to set up connections between said lines, control means common to said apparatus selectively operated over any calling one of said lines, means operated responsive to the operation of said control means for establishing charge rates for connections, means operated responsive to said operation of said control means for operating said switching apparatus to set up connections from calling non-restricted lines to all other lines and for operating said switching apparatus to set up connections from calling restricted lines in one exchange to all other lines in the same exchange and for preventing the operation of said switching apparatus by said control means to set up connections from calling restricted lines in one exchange to called lines in another exchange when certain charges are established by said control means.

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