

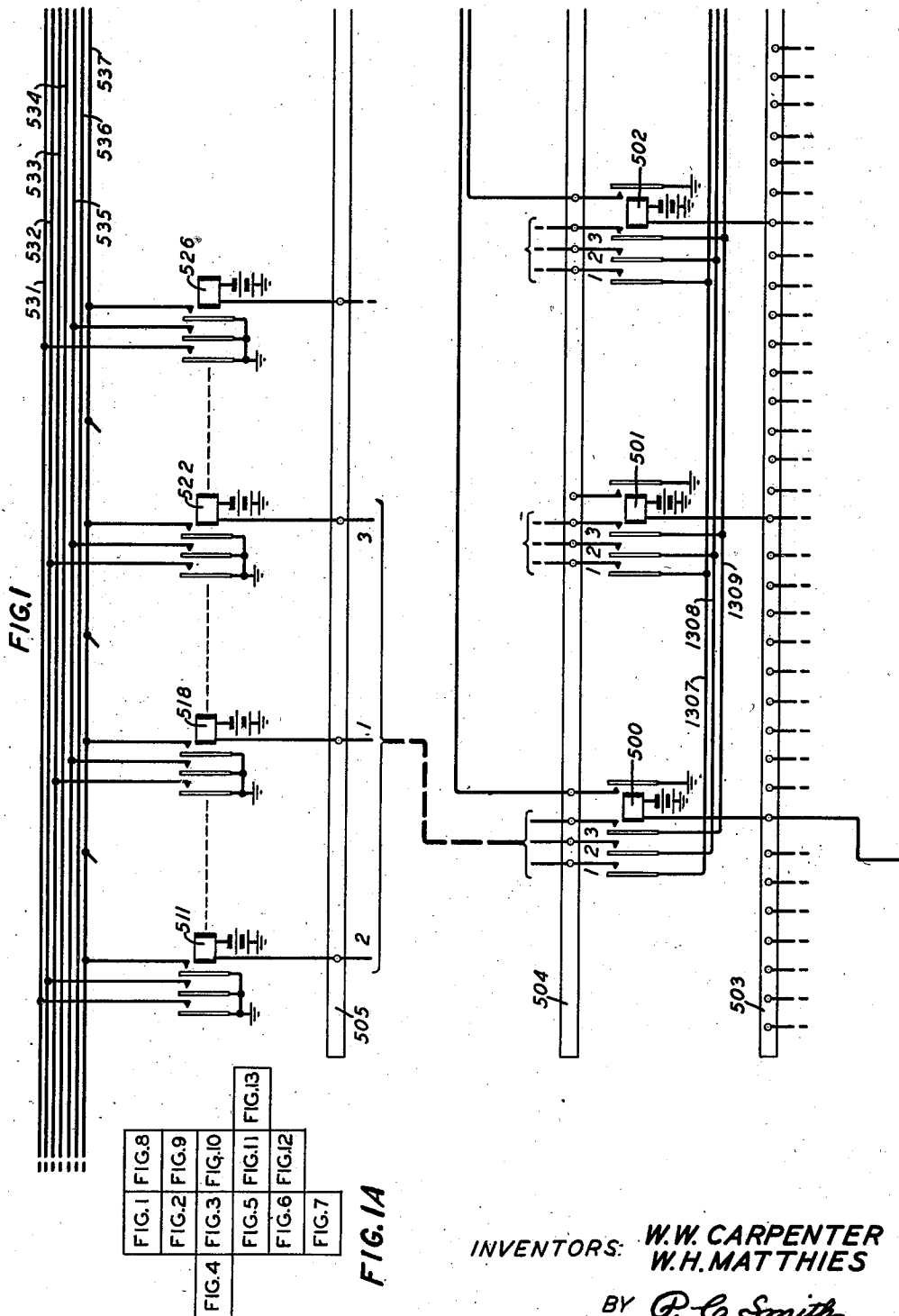
Dec. 30, 1941.

W. W. CARPENTER ET AL

2,268,203

CALCULATING MACHINE

Original Filed April 28, 1934 14 Sheets-Sheet 1



INVENTORS: W. W. CARPENTER  
W. H. MATTHIES

BY *P. C. Smith*  
ATTORNEY

Dec. 30, 1941.

W. W. CARPENTER ET AL

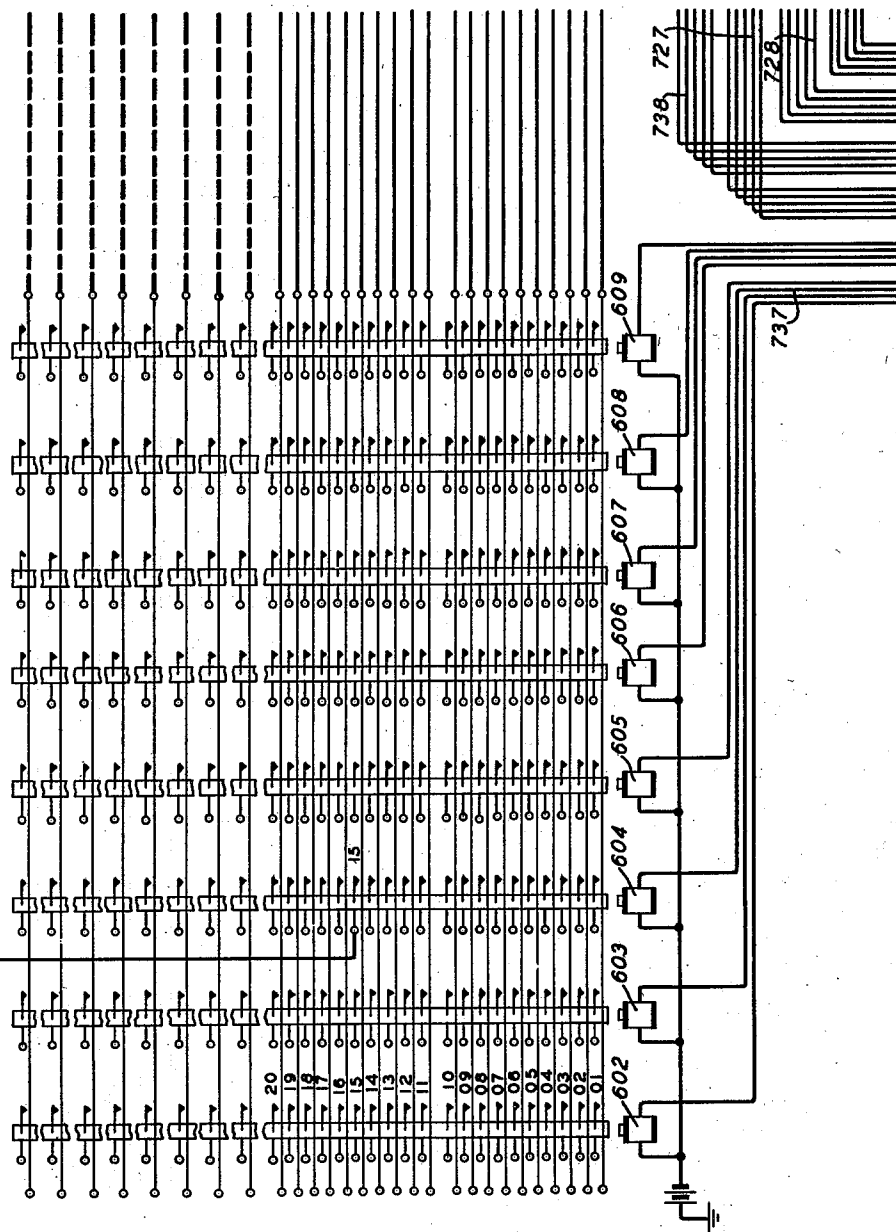
2,268,203

CALCULATING MACHINE

Original Filed April 28, 1934

14 Sheets-Sheet 2

FIG. 2



INVENTORS: W.W. CARPENTER  
W.H. MATTHIES

BY *P. C. Smith*

ATTORNEY

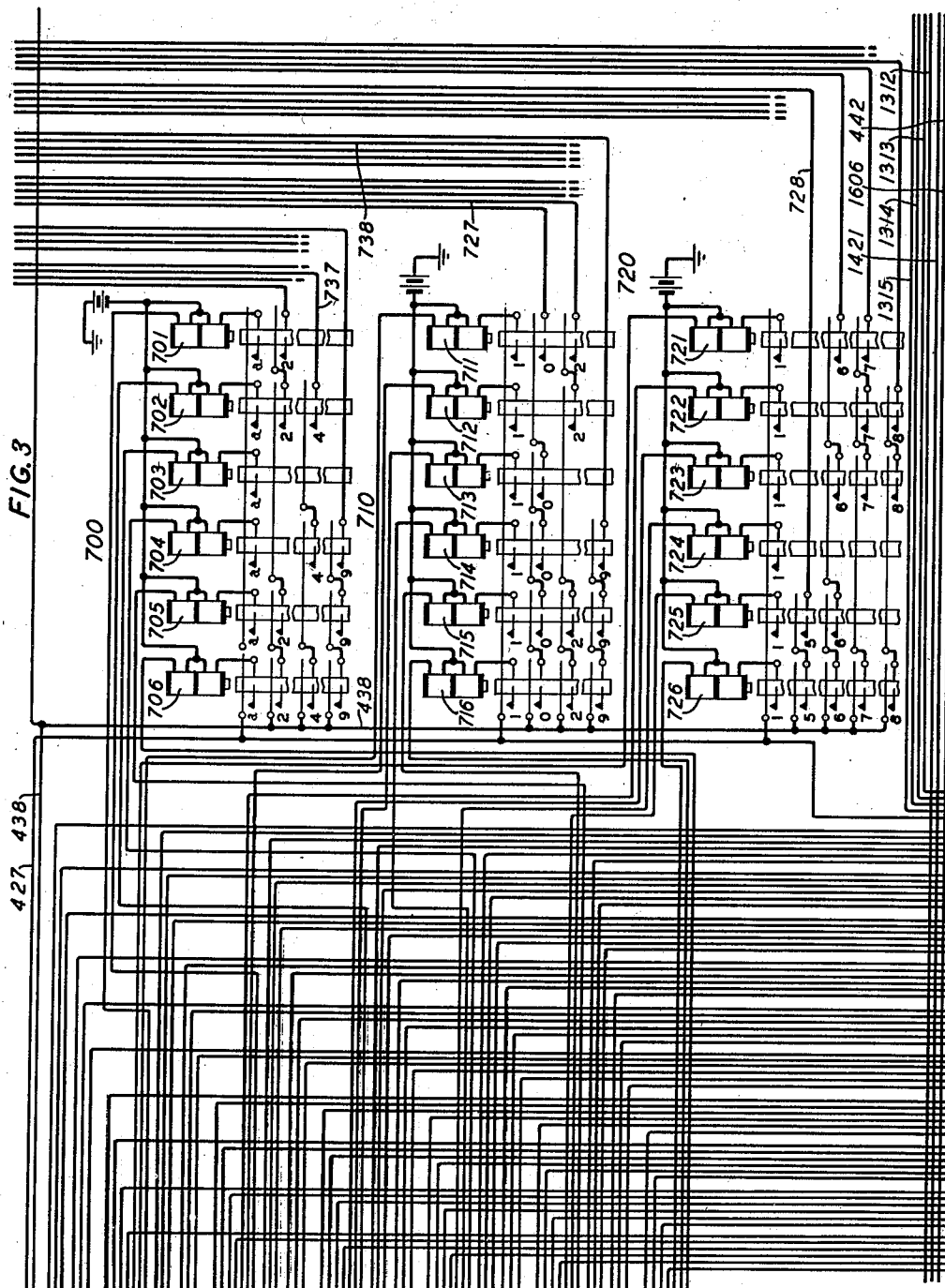
Dec. 30, 1941.

W. W. CARPENTER ET AL

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CALCULATING MACHINE

Original Filed April 28, 1934 14 Sheets-Sheet 3



INVENTORS: W. W. CARPENTER  
W. H. MATTHIES  
BY *P. C. Smith*  
ATTORNEY

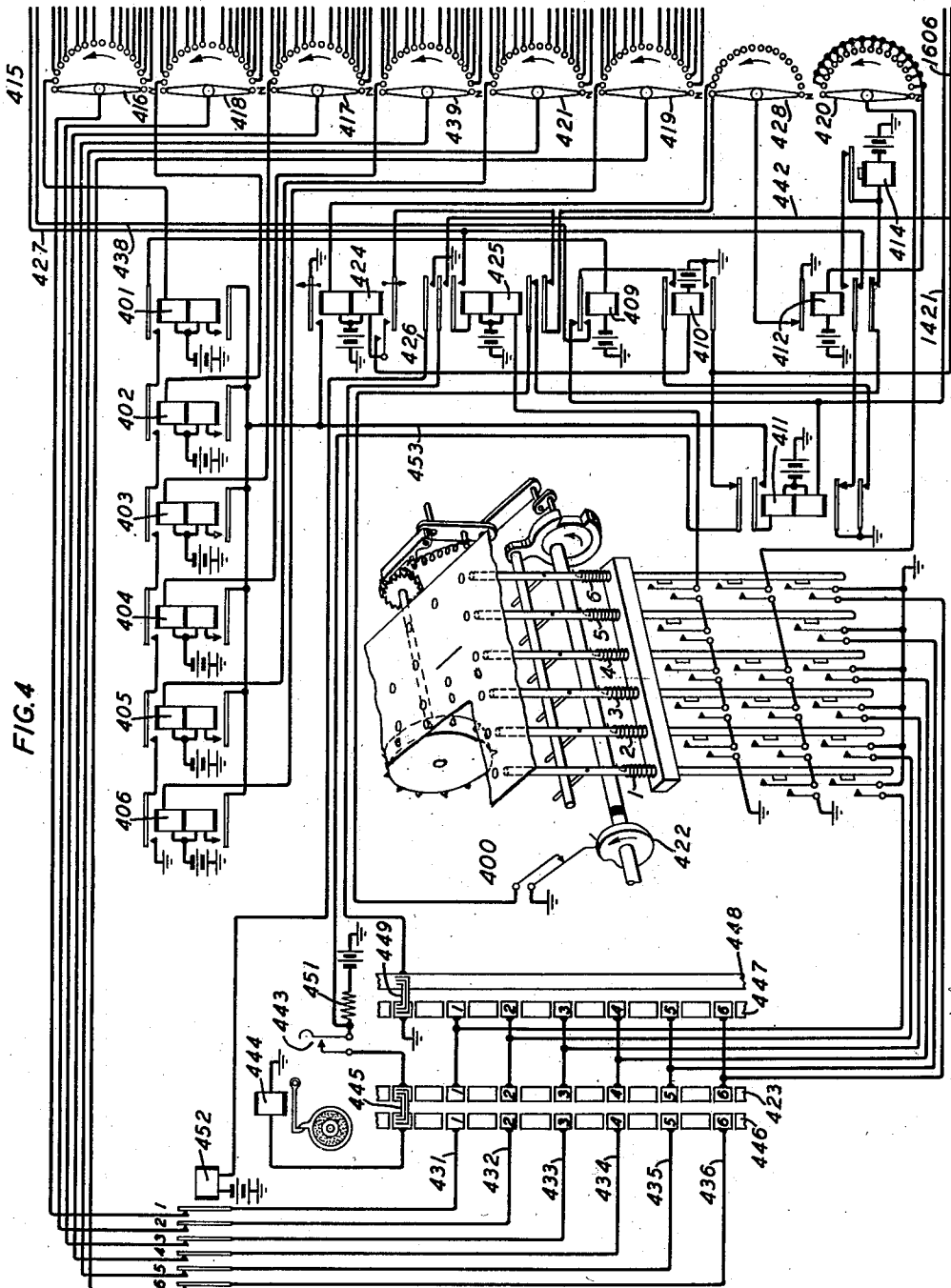
**Dec. 30, 1941.**

W. W. CARPENTER ET AL

**2,268,203**

# CALCULATING MACHINE

Original Filed April 28, 1934      14 Sheets-Sheet 4



INVENTORS: **W.W. CARPENTER**  
**W.H. MATTHIES**

BY *P. C. Smith*  
ATTORNEY

Dec. 30, 1941.

W. W. CARPENTER ET AL

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CALCULATING MACHINE

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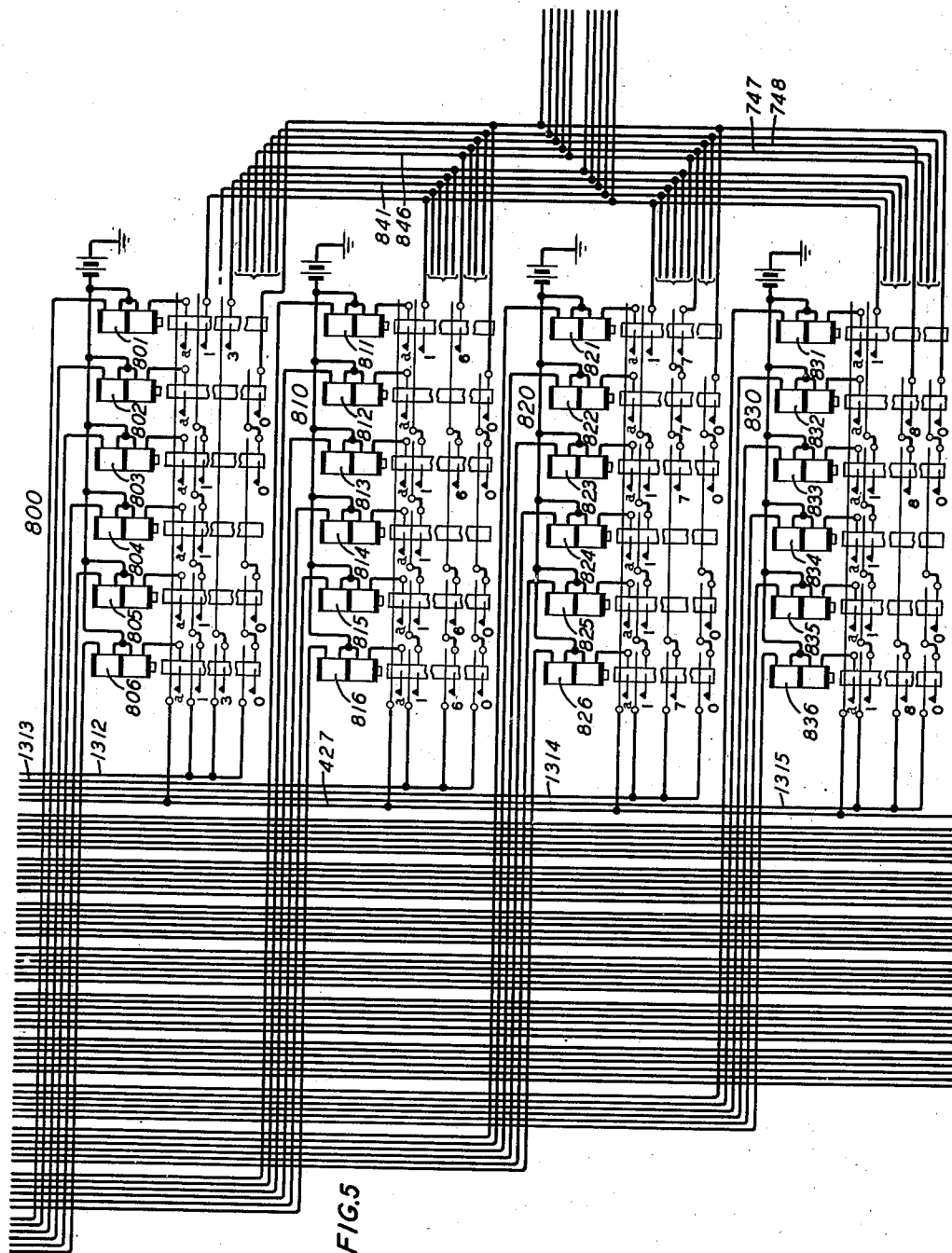


FIG. 5

INVENTORS: W. W. CARPENTER  
W. H. MATTHIES

BY P. C. Smith

ATTORNEY

Dec. 30, 1941.

W. W. CARPENTER ET AL

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Original Filed April 28, 1934

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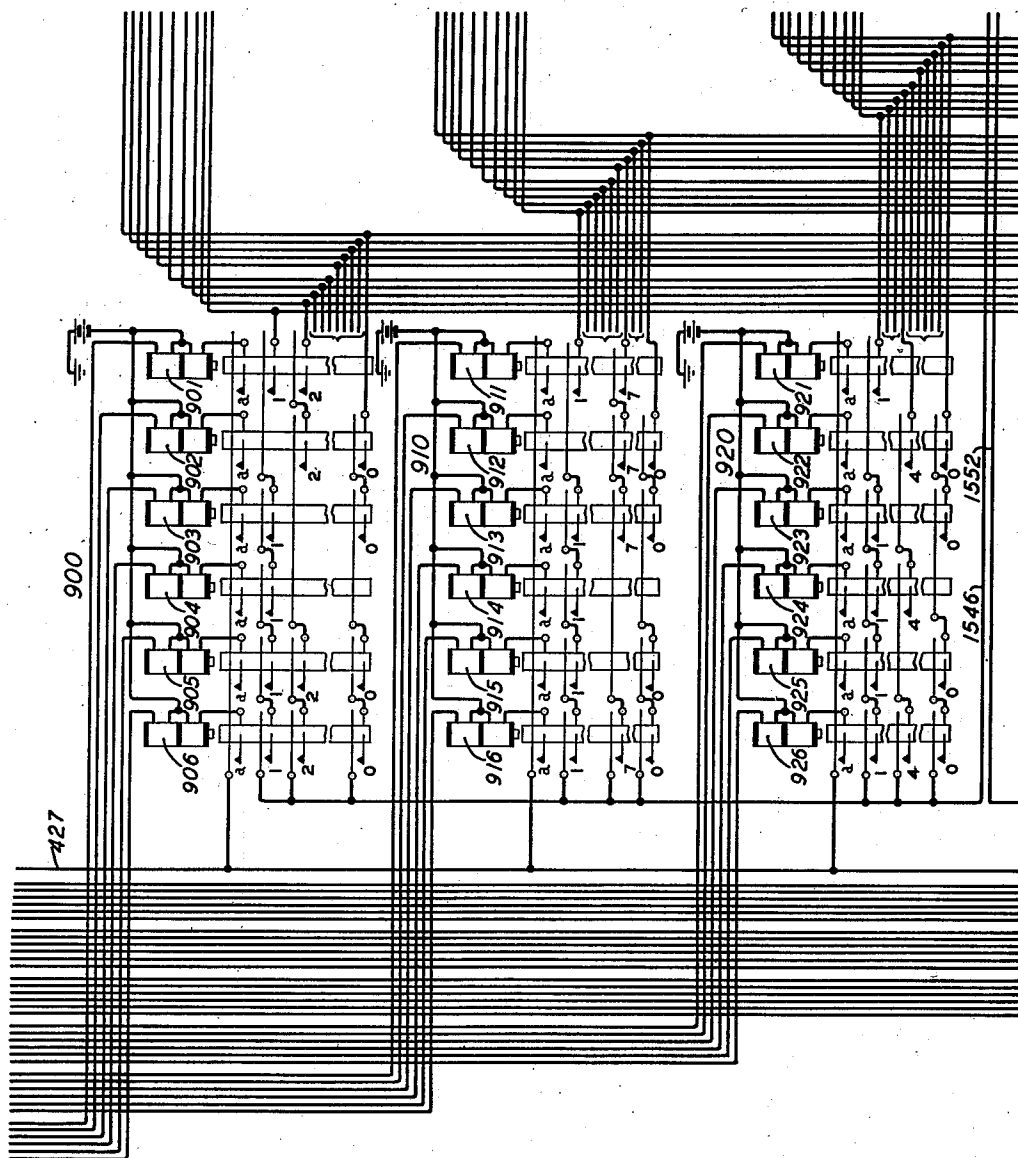


FIG. 6

INVENTORS: W. W. CARPENTER  
W. H. MATTHIES

BY *P. C. Smith*  
ATTORNEY

Dec. 30, 1941.

W. W. CARPENTER ET AL

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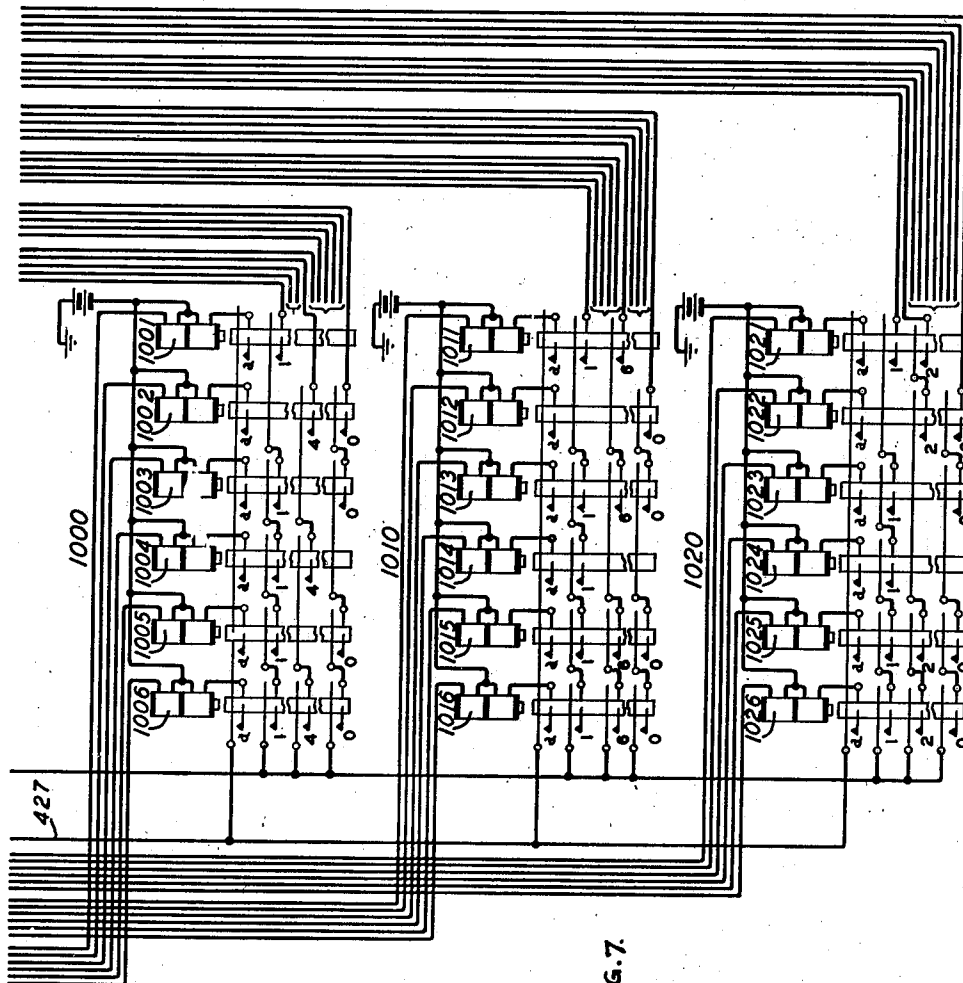


FIG. 7.

| PERF. CODE | 1 | 2 | 3 | 4 | 5 | 6 |
|------------|---|---|---|---|---|---|
| 1          |   |   |   |   |   |   |
| 2          |   |   |   |   |   |   |
| 3          |   |   |   |   |   |   |
| 4          |   |   |   |   |   |   |
| 5          |   |   |   |   |   |   |
| 6          |   |   |   |   |   |   |
| 7          |   |   |   |   |   |   |
| 8          |   |   |   |   |   |   |
| 9          |   |   |   |   |   |   |
| 10         |   |   |   |   |   |   |
| 11         |   |   |   |   |   |   |
| 12         |   |   |   |   |   |   |
| 13         |   |   |   |   |   |   |
| 14         |   |   |   |   |   |   |
| 15         |   |   |   |   |   |   |
| 16         |   |   |   |   |   |   |
| 17         |   |   |   |   |   |   |
| 18         |   |   |   |   |   |   |
| 19         |   |   |   |   |   |   |
| 20         |   |   |   |   |   |   |
| 21         |   |   |   |   |   |   |
| 22         |   |   |   |   |   |   |
| 23         |   |   |   |   |   |   |
| 24         |   |   |   |   |   |   |
| 25         |   |   |   |   |   |   |
| 26         |   |   |   |   |   |   |
| 27         |   |   |   |   |   |   |
| 28         |   |   |   |   |   |   |
| 29         |   |   |   |   |   |   |
| 30         |   |   |   |   |   |   |
| 31         |   |   |   |   |   |   |
| 32         |   |   |   |   |   |   |
| 33         |   |   |   |   |   |   |
| 34         |   |   |   |   |   |   |
| 35         |   |   |   |   |   |   |
| 36         |   |   |   |   |   |   |
| 37         |   |   |   |   |   |   |
| 38         |   |   |   |   |   |   |
| 39         |   |   |   |   |   |   |
| 40         |   |   |   |   |   |   |
| 41         |   |   |   |   |   |   |
| 42         |   |   |   |   |   |   |
| 43         |   |   |   |   |   |   |
| 44         |   |   |   |   |   |   |
| 45         |   |   |   |   |   |   |
| 46         |   |   |   |   |   |   |
| 47         |   |   |   |   |   |   |
| 48         |   |   |   |   |   |   |

FIG. 14.

INVENTORS: W. W. CARPENTER  
W. H. MATTHIES

BY P. C. Smith  
ATTORNEY

Dec. 30, 1941.

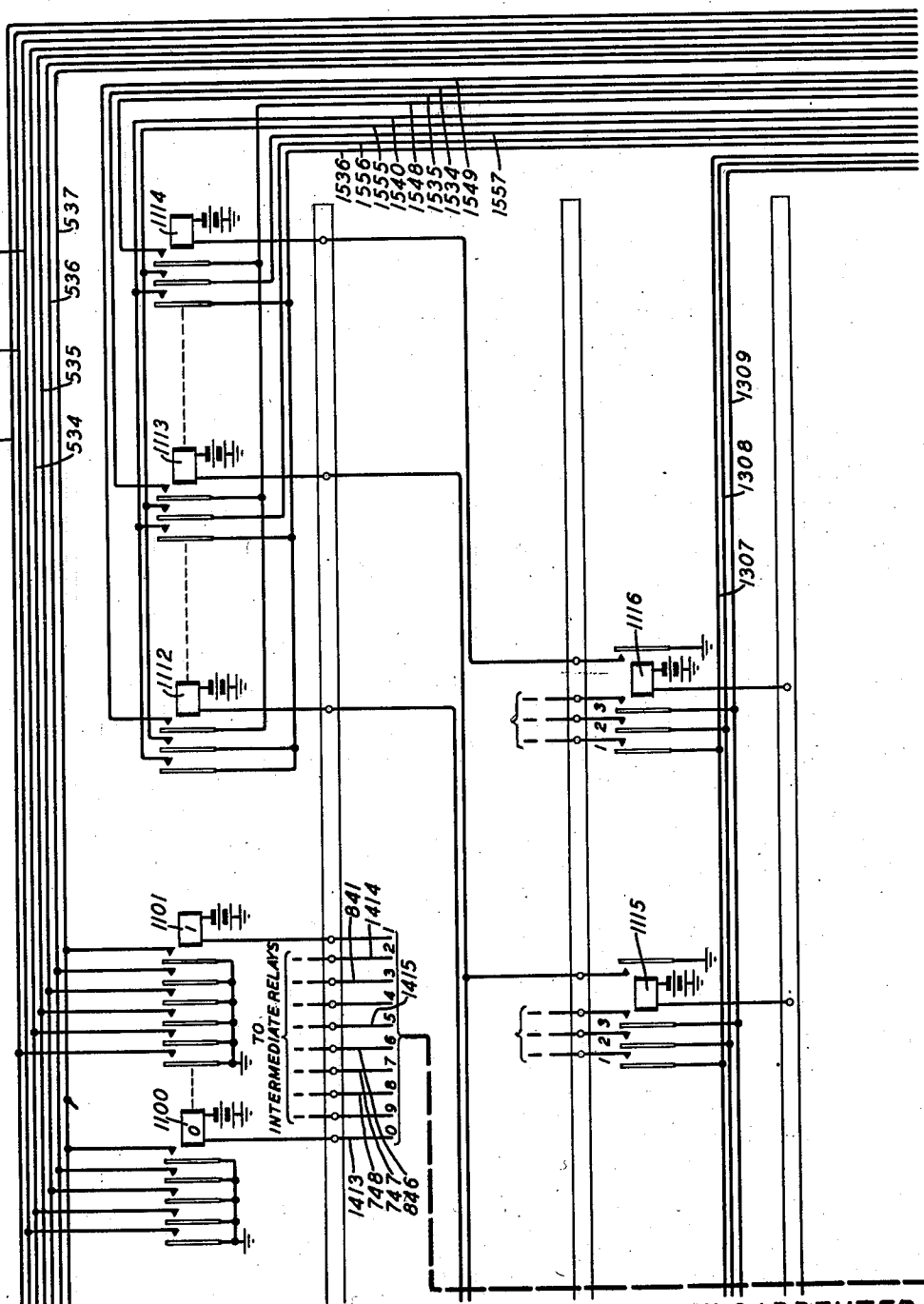
W. W. CARPENTER ET AL

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CALCULATING MACHINE

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FIG. 8



INVENTORS: W.W. CARPENTER  
W.H. MATTHIES

BY P. C. Smith  
ATTORNEY

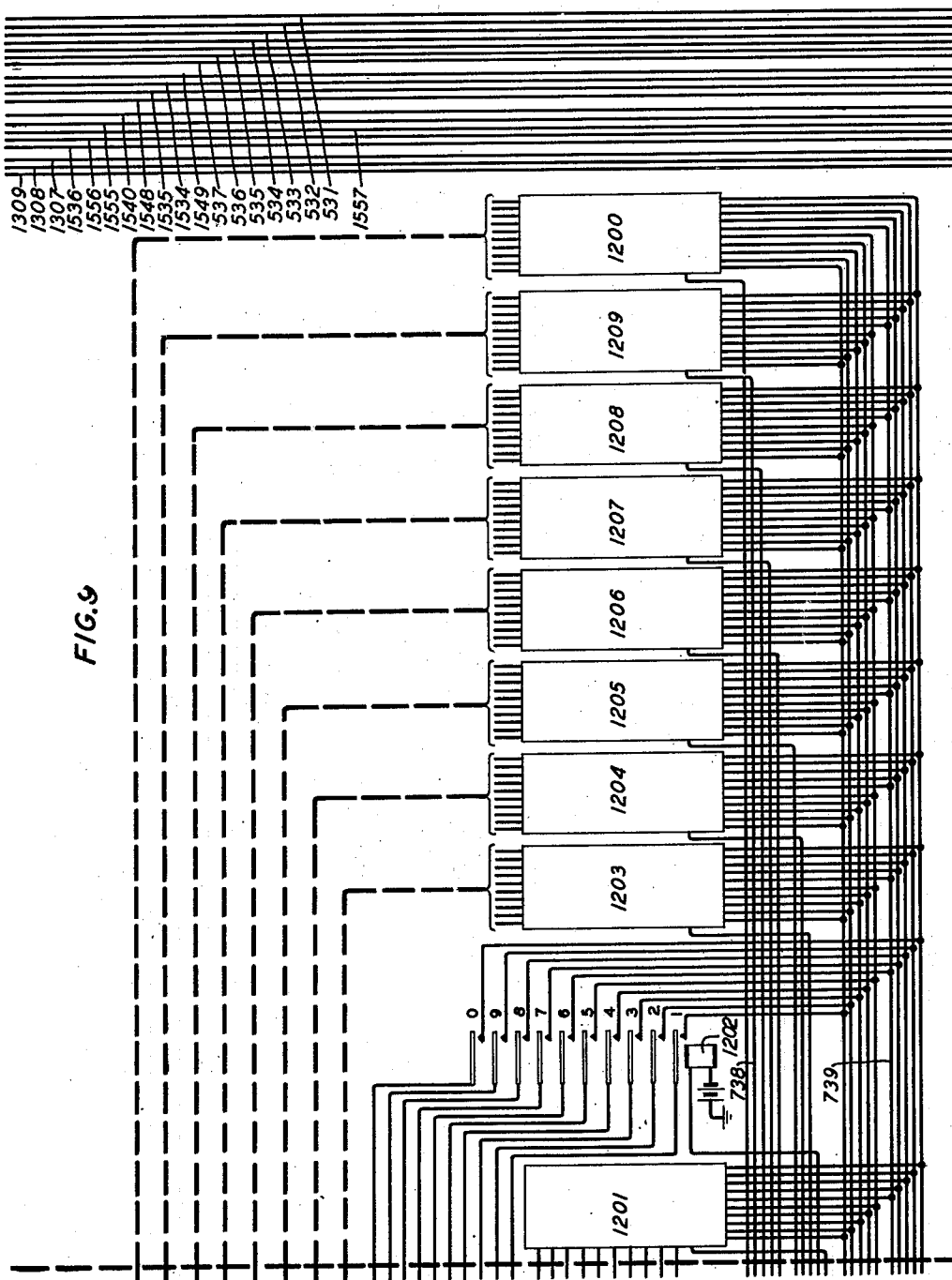
Dec. 30, 1941.

W. W. CARPENTER ET AL

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CALCULATING MACHINE

Original Filed April 28, 1934 14 Sheets-Sheet 9



INVENTORS: W. W. CARPENTER  
W. H. MATTHIES

BY *P. C. Smith*  
ATTORNEY

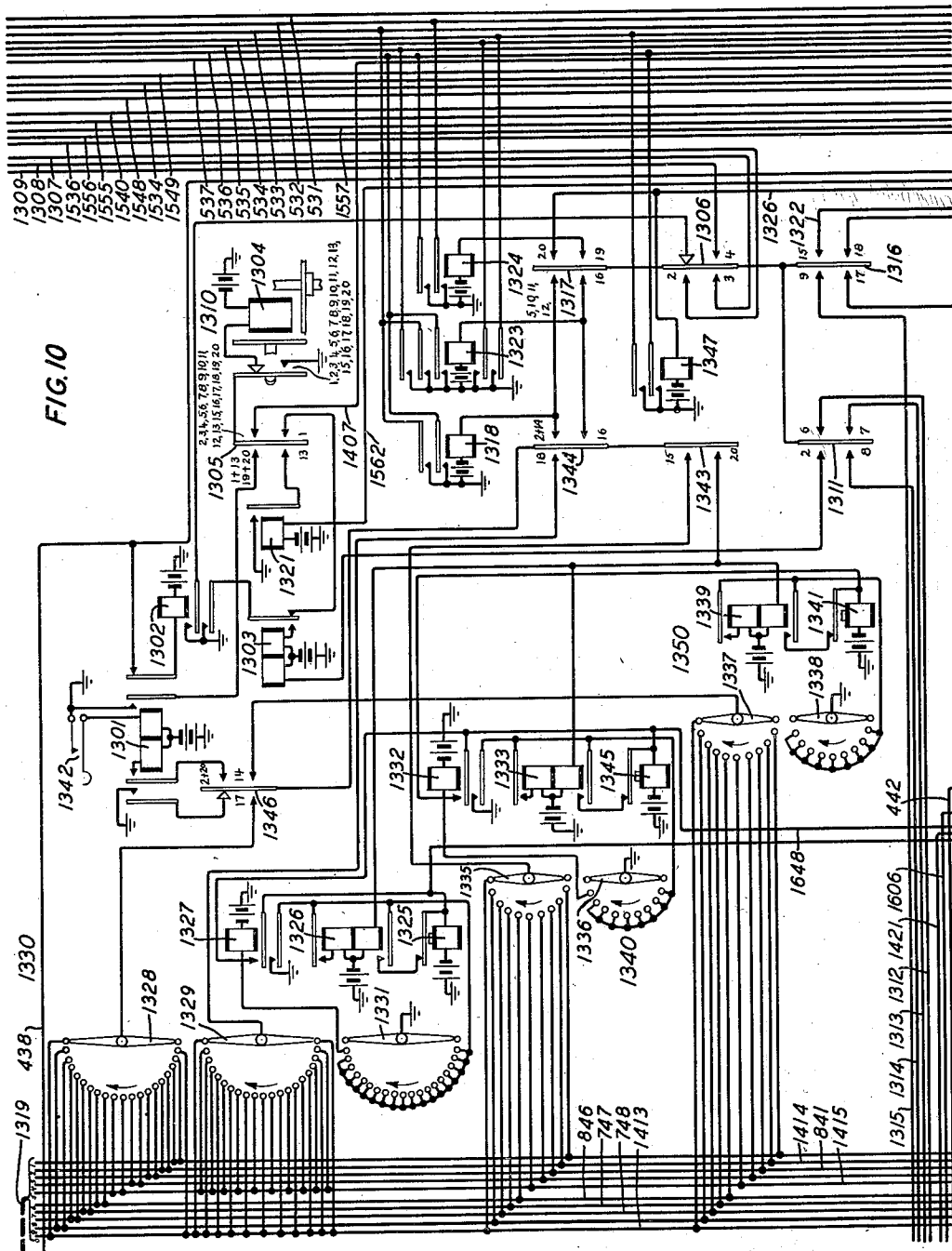
Dec. 30, 1941.

W. W. CARPENTER ET AL

2,268,203

CALCULATING MACHINE

Original Filed April 28, 1934 14 Sheets-Sheet 10



INVENTORS: W. W. CARPENTER  
W. H. MATTHIES

BY P. C. Smith  
ATTORNEY

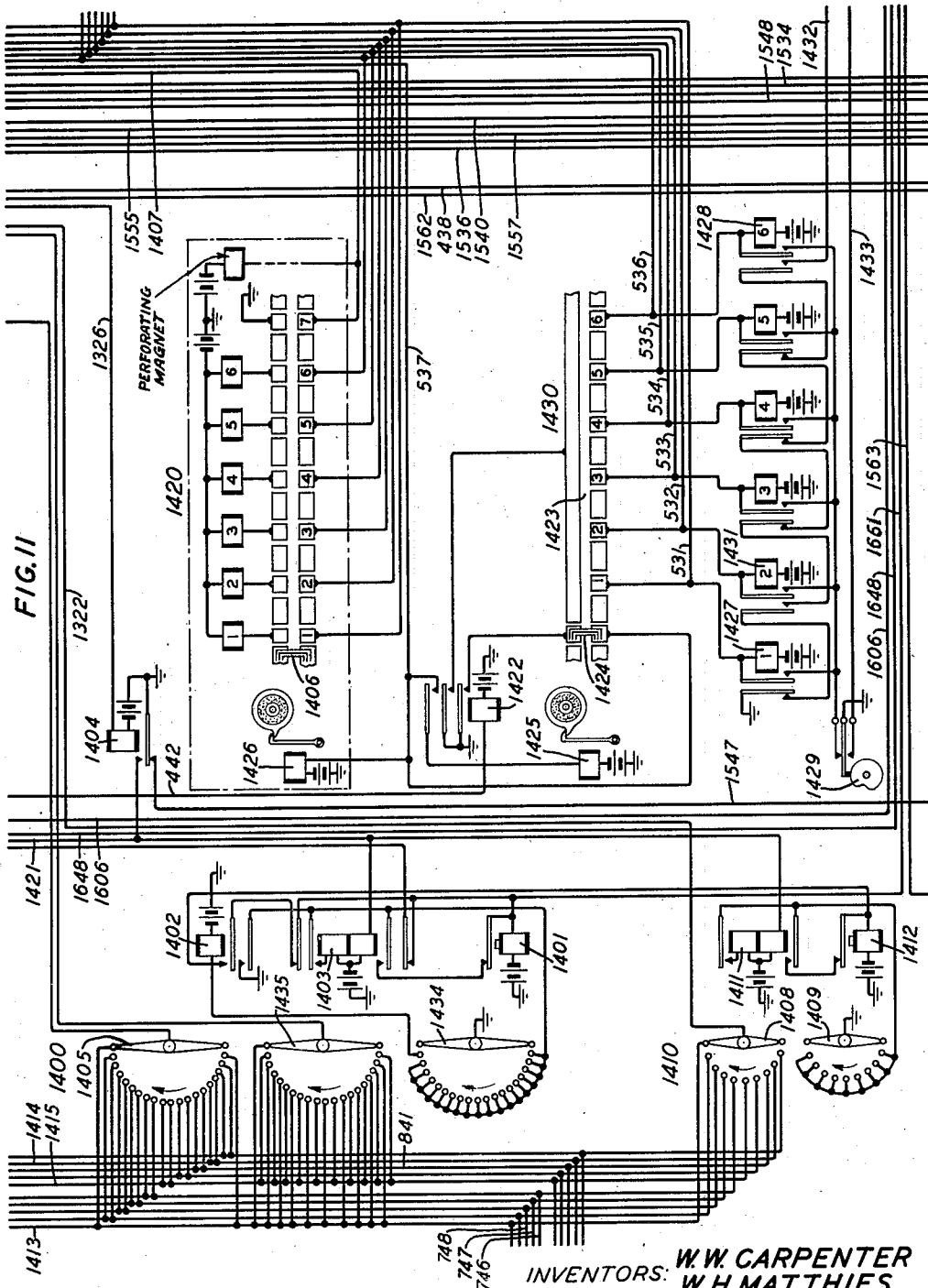
Dec. 30, 1941.

W. W. CARPENTER ET AL

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CALCULATING MACHINE

Original Filed April 28, 1934 14 Sheets-Sheet 11



INVENTORS: W. W. CARPENTER  
W. H. MATTHIES

BY P. C. Smith  
ATTORNEY

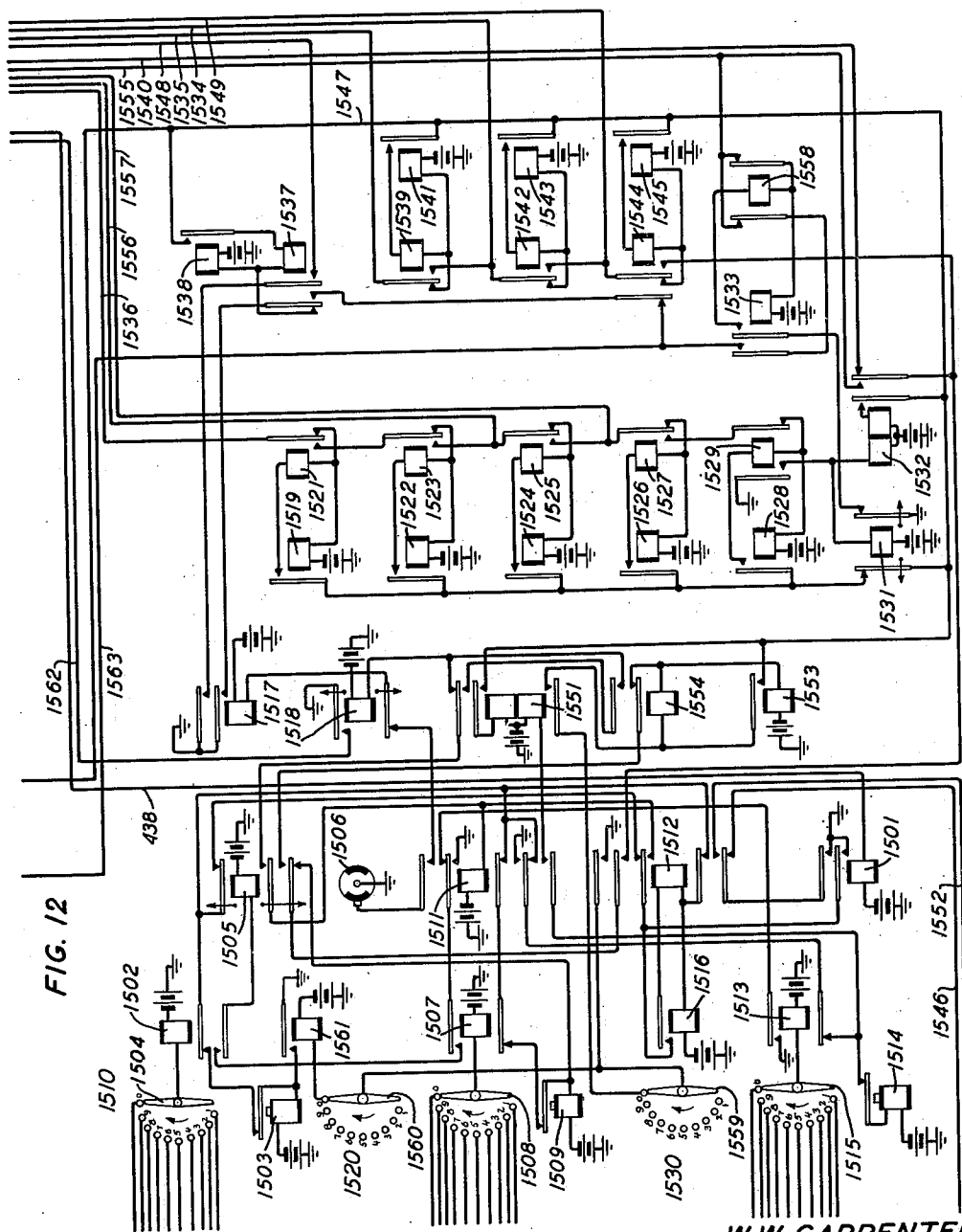
Dec. 30, 1941.

W. W. CARPENTER ET AL

2,268,203

CALCULATING MACHINE

Original Filed April 28, 1934 14 Sheets-Sheet 12



W. W. CARPENTER  
INVENTORS: W. H. MATTHIES

BY P. C. Smith  
ATTORNEY

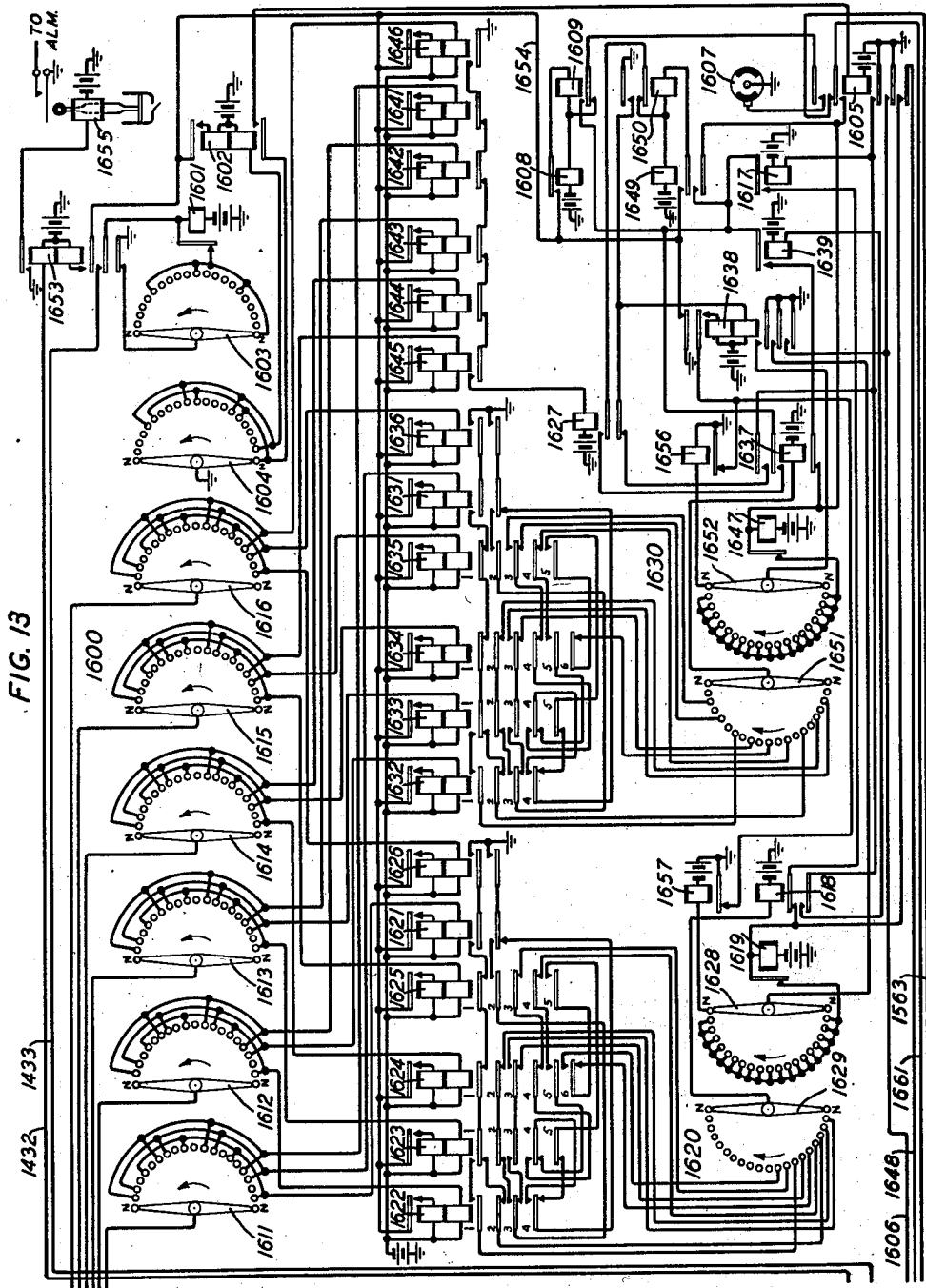
Dec. 30, 1941.

W. W. CARPENTER ET AL

2,268,203

CALCULATING MACHINE

Original Filed April 28, 1934 14 Sheets-Sheet 13



INVENTORS: W. W. CARPENTER  
W. H. MATTHIES

BY P. C. Smith  
ATTORNEY

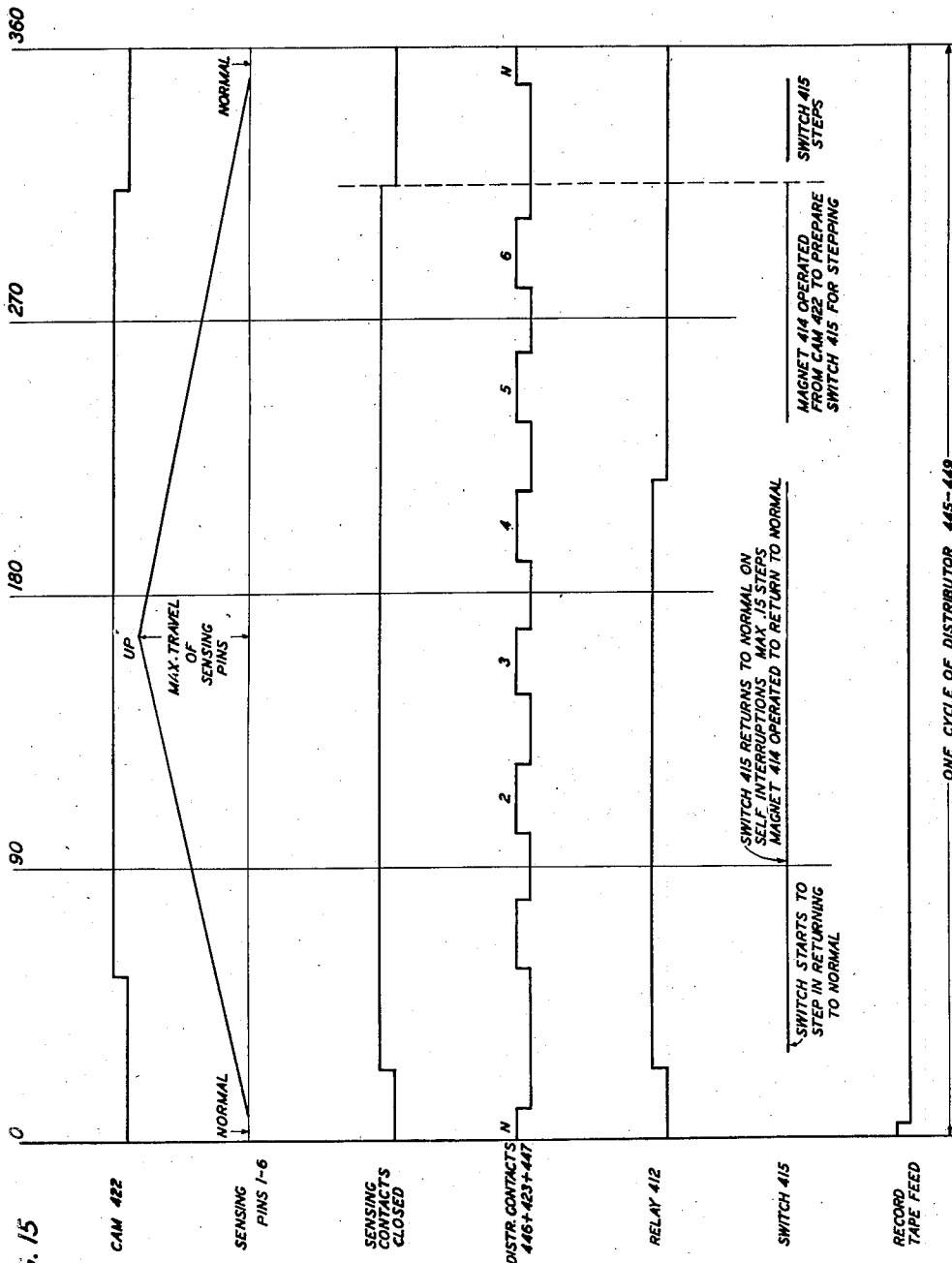
Dec. 30, 1941.

W. W. CARPENTER ET AL

2,268,203

CALCULATING MACHINE

Original Filed April 28, 1934 14 Sheets-Sheet 14



INVENTORS

W. W. CARPENTER  
W. H. MATTHIES

BY

P. C. Smith

ATTORNEY

## UNITED STATES PATENT OFFICE

2,268,203

## CALCULATING MACHINE

Warren W. Carpenter, Garden City, N. Y., and  
William H. Matthies, Hackensack, N. J., assign-  
ors to Bell Telephone Laboratories, Incorporated,  
New York, N. Y., a corporation of New  
York

Original application April 28, 1934, Serial No.  
722,890, now Patent No. 2,112,951, dated April  
5, 1938. Divided and this application Novem-  
ber 6, 1937, Serial No. 173,144

9 Claims. (Cl. 235—61.10)

This invention relates to a calculating machine and more particularly to one designed to produce a computed and translated record from another record which contains notations of connections and conversation times relating to calls completed from a subscriber's line in a telephone system. Specifically, this application is a division of our Patent 2,112,951 issued April 5, 1938, which discloses the entire invention. The purpose of the present application is to more particularly describe and claim that part of the invention which has to do with the means and the method for producing a translated and computed record for each line from another record and containing thereon necessary entries for call charging purposes such as, for example, calling and called line numbers and start and finish times of conversations, all of which were entered on said record at the time that the several connections were being established and terminated. The ultimate purpose of producing such a translated and computed record is, of course, to utilize it to operate well-known tabulating printers to produce the subscriber's monthly bill.

At the present time it is well known that on some classes of subscribers' lines of a telephone system such as, for example, individual message rate lines, charges for telephone service are usually made by operating a message register meter associated with the calling line regardless of whether the telephone system of which said line forms a part is manual, semi-automatic or automatic, and that said meter is operated when the called subscriber removes his receiver from the switchhook in response to the call.

Furthermore, recent advances in the telephone art make it possible, in automatic systems, for the calling subscriber to dial directly the office and number of a wanted subscriber who happens to be located in that section of the toll area which is immediately contiguous to the local area and for which the charge for the connection is a multiple of the base charge for a local call, strictly so-called. For such a connection, the meter of the calling line is operated a number of times for the initial charge period when said charge is a multiple of the standard local rate and also a number of times thereafter for each period of overtime consumed depending upon the multiple of the local standard rate which is charged for each overtime unit. At the end of each month, or whatever the billing interval may happen to be, a reading of the line meter is taken, and by subtracting this reading from

the previous reading, the total number of charges accumulated for the billing interval is determined. This total charge, then, not only contains all the charges for local calls that have been made from the line but also the equivalent, in terms of the standard local rate, of charges for all calls completed therefrom to the immediate toll area and for which the subscriber is to be billed in bulk; that is, billed for the entire service in terms of the local charge rate without differentiating between local and toll calls.

This method of billing subscribers, while practically satisfactory for local calls and for such toll calls as can be billed in bulk, is impractical of application where the equipment of the telephone plant can be extended to permit subscribers to dial directly other subscribers who are located in the more remote toll areas. As is well known, toll and long distance calls are timed and ticketed by a recording operator whose function is to record on a ticket the number of the calling line, the destination of the call and the duration of the conversation so that, when the monthly bill is prepared for the line, the entries on the toll tickets are included in the bill as separate items thereon.

As is well known, the operation of timing and ticketing involves considerable delays at the recording position while the handling of tickets slows up the efficiency of the commercial departments of an operating company to the point where the gains from mechanical switching are canceled to an appreciable extent.

The invention is intended to overcome this obstacle by the use of a centralized recording mechanism which is adapted to register on a permanent record the identity of all local and toll calls, the former automatically where the subscriber can dial the wanted station directly, and the latter manually by the recording operator whose only duty in this respect is to depress a number of keys appropriate to the designation of the call destination and to the charge to be made therefor. More specifically, the invention, as adapted and applied to a telephone plant, involves a system of apparatus and cooperating circuits by which all local calls dialed by the subscriber and all toll calls completed by an operator are recorded upon a tape or other suitable medium in such a manner that the tape may be subsequently used for automatically operating a printing tabulating mechanism to make the subscriber's monthly bill therefrom.

The advantages of the invention are manifest. First of all, it eliminates line meters and the

attendant necessity of reading them; secondly, it places toll call recording on a more efficient basis by freeing the operator from the duty of writing out toll tickets, and thirdly, it preserves a record of all calls as made by the subscriber, thereby eliminating all possibilities of misunderstanding between the subscriber and the operating company. In other words, the value of our invention as applied to telephone billing practices, lies in the fact that it broadens the potential scope of mechanical switching and in the fact that it reduces the cost of operating the clerical branch of the telephone plant.

In the parent patent above referred to, the particular embodiment of our invention as applied to a telephone system, is described and illustrated with reference to a telephone system of the well-known panel type in which the calling subscriber establishes a connection with a called subscriber over panel type switching selectors although no limitation of our invention to any particular type of apparatus or any specific system is intended therein, the invention being readily adaptable by any one skilled in the art to any well-known apparatus used for establishing telephone connections.

The general principle upon which the invention operates is the making, upon a suitable medium, of a record of each call made by a calling line of a group by means of a recording equipment common to the group. This record includes an identifying designation of the calling line, the code of the called office, the number of the called subscriber, and the start and finishing time of the connection.

The recording equipment consists, in general, of a suitable recording apparatus that cooperates with a recording register which, at the appropriate moment, is operatively connected with a calling line extension. This register is used for recording the called office code, the called line number, and the start and finishing time of any particular connection.

For registration purposes one recording equipment is conveniently allotted to one group of subscribers who are, in turn, served by a particular group of switching trunks or, in the case where the lines terminate on line finder frames, to a group of lines on one line finder frame and served by a correlated group of line finder district selectors. However, should it be found that a single recording unit for a line finder group undesirably increases the holding time of the line finder district selectors serving the group, two or more such recording units may be used for the group, each unit serving a proportionately smaller number of lines.

A register circuit is provided for recording the various items required for billing the call and to further control the operation of the recording equipment. This register circuit comprises a pulsing relay which responds to code impulses transmitted from a sender, a group of registering relays or their equivalent for recording the dialed office code and the number of the called subscriber, a timing device, other registers responsive to this timing device at the instant when conversation ensues between the called and calling subscriber over the established connection, and still other registers which respond to said timing device at the time the conversation between the two subscribers is completed.

For the purpose of illustrating the invention both in the parent patent above referred to and in the present divisional application thereof, use

is made of a recording apparatus of the perforator type common in printing telegraph systems which comprises a suitable number of punch magnets for perforating transversely across a tape of suitable size the codes of various items. Other recording apparatus such as that which is responsive to the setting of suitable light valves might be equally well used. The invention, however, is not limited to any particular type of recording apparatus, and the one herein shown and described is, therefore, only typically illustrative and not exclusive of the many equivalent mechanisms well known and available which could be used within the scope of the present invention.

In general, the invention, when applied to a telephone system, operates as follows: When the subscriber removes his receiver from the switch-hook, a line finder district selector and a controlling device, such as a register sender, become connected to the subscriber's line in the well-known manner. The subscriber, upon receiving dial tone, dials the called subscriber's office code and number. These are registered in the sender for the purpose of controlling the proper setting of the various switching selectors between the calling and the called line. When the sender has responded to the series of pulses which make up the code of the called office and the called number, the register circuit above mentioned, or tape register as it designated in the parent patent, is connected to the line finder district selector and placed in a responsive condition to code pulses subsequently to be transmitted to it from the sender. That is to say, when the called office code and called office number have been registered in the sender, it becomes necessary to make a record of this code and number on the tape that will contain the record of the completed call. To do this, the tape register is operatively connected to the sender and a pulse code for each of the letters and each of the digits dialed by the subscriber is transmitted to the tape register and recorded therein. A tape perforator is now operatively associated with the tape register and a group of translating relays intermediate the register circuit and the perforator is brought into play to translate the pulse codes into six-digit perforating codes for perforation upon the tape. However, in advance of perforating the called office code and number in terms of six-digit codes, it becomes necessary to perforate one or more of three special codes indicative of either one of three other notations. The first code is termed a "switching" character code, the second a "new call" character code, and a third a "calling line" character code, this last to identify the calling line in the group of lines to which the registers and perforator are common. The reason for the use of the three special character codes will become apparent later on in the detailed description of the invention but it is plain at the present time that some means must be used to identify the relationship between the calling line and the succeeding called office code and number to which the line is establishing a connection.

If the call is a toll call which must be routed through an operator's position, the recording operator, instead of making the usual ticket for the call, now causes the regular ticket information to be punched upon the recording tape by depressing suitable keys on a teletype transmitter located at her position. In this case, however, the city or town to which the call is to be

completed as well as the called office code and

number therein and the charge for the call in terms of dollars and cents will be punched by the operator on her key-set and subsequently recorded on the tape through printer pulses transmitted to an auxiliary responsive device in the tape register which, in turn, causes the operation of the translating relays to record the information on the tape in the same code that is used for recording the notations of local calls.

After the codes of the called office and number have been perforated on the tape, the tape register and the associated tape perforator are disconnected from the line, ready to be used by some other calling line in the group over which, at this time, the called office and number of another connection may have been completely dialed. Thus it is seen that the tape perforator and associated tape register are not held continuously to one line until the connection is established and conversation completed thereover, but are associated only momentarily with any line in the group at the time the line and its associated equipment have enough of a record to be punched on the tape. The recording equipment, therefore, is used "discontinuously" by all lines in the group to which it has access. It now becomes evident why, prior to punching the called office code and number or any other notation relating to a particular call, it is necessary to perforate an identifying character code which indicates the calling line from which the office code and number were dialed, and why it is necessary to punch a further character code to indicate whether the record which follows relates to a new call started by another line or is merely a succeeding notation of a call made by a previous line for which other notations have already been recorded upon the tape. For reasons which will appear hereinafter should the call be a toll call, that is, one which is to be completed through an operator's position, it will also be necessary to record another character in advance of any information to indicate that what follows is part of the record of a toll call and not of a local call.

When the connection to the called subscriber's line is completed and the called subscriber answers, an occurrence which marks the instant from which conversation time is to be measured, the tape register is once more connected to the district selector whereupon, under the control of a timing device, this instant is registered by setting the position of each of three switches, the first of which by its position marks a particular ten minute interval, the second a particular minute interval and the third a particular tenth of a minute interval. The positioned switches in the tape register are now operatively associated with the translating relays for the purpose of translating said record in terms of the six-digit code used for punching each of the separate designations on the tape, and with the translating relays set in accordance with the position of the switches, the perforator is again operated to punch, first the usual switching character, second the identifying code of the calling line and, third, each of the separate codes indicating the three separate notations of the starting time as marked by the positions of the three switches. The tape register and the perforator are then again disconnected from the line. If at this time another line has started a call and the extension of said line has advanced to the point where the called office and number have been registered in a sender, the tape register as well

as the perforator are connected to this other line to record the information. But in this case, as already noted, the record belonging to this other line is not confused with the preceding record which belongs to the first line because the usual switching character code and the code designating a new call intervenes between the record for the first line and the record for the second. Or if, again, the new call should be a toll call and therefore is to be completed through an operator's position, then whatever information the operator may desire to record on the tape is preceded by the switching character followed by the code indicating a toll call which is then followed by whatever information the operator may have punched on the teletype transmitter associated with her position.

When the conversation starting time has been recorded on the tape, the tape register and the perforator are again disconnected from the line, but when the conversation is terminated and the called subscriber has restored his receiver, the tape register and associated perforator are again connected to the district selector in order that the finishing time of the conversation may then be recorded on the same group of registers and in the same three separate designations as the starting time, preceded, as always, by the switching character code and by the calling line identification code.

Thus the "primary" tape record made for a group of lines contains a series of disconnected code notations which relate to calls initiated from the lines in said group. The next step in our invention is to take this tape and produce from it one tape for each line containing thereon all of the notations belonging to the calls made by the line, with the notations arranged sequentially in the order in which they would have been entered on the tape had they been recorded chronologically in the normal process of establishing the call without interruption for recording the notations of other calls initiated by other lines in the group. That is to say, the order of the notations would be the calling office and number, the starting time and finishing times of the connection, followed by the called office and number and the starting and finishing time of the next call if this next call happens to be a local call, or of the city, office and number and the toll charges if it happens to be a toll call, subject however to the condition that each of these groups of notations would be preceded and followed by the usual switching character code and by the new call code or by the code of an operator's call whichever the case might be.

The equipment for making an individual tape for each line from the primary tape is completely disclosed in our parent Patent 2,112,951, above mentioned, and it is sufficient to note for the purpose of the present invention that said equipment is adapted to produce an individual tape for each line which contains, in chronological order, all the recorded notations for each local and toll call, each group of notations being preceded by a code which denotes whether such a call is local or toll.

It will be observed that the individual tape contains the necessary items from which the charge for each call may be computed inasmuch as the tape contains the record of the calling line, the called office code and the starting and finishing time of each connection. Such computations, however, require a separate operation because calls are charged for at different rates

depending upon the distance of the connection and the duration of the conversation. Besides this, local calls must be added together and separated from toll calls which are also added together and the two included as parts of the same bill. In our invention, this requires the production from the individual tape of a "computed" or final tape for each line, and the running of this final tape through tabulating printers which add up the local calls, print the total charge therefor and further print, on the same or separate bill form, the charge and history of each toll call together with the total for all toll calls.

In order to achieve this next step, the individual tape is passed through the organization of circuits herein called the computer from which is produced a final tape for each line that contains for each call the directory abbreviation of the called office, the number of the called line and the computed charge in dollars and cents to be assessed for the call. In the case of the record of a toll connection included on the individual tape, the computer functions merely to transfer this record on the final tape inasmuch as all of the information in the form to be printed on the bill is already contained on the individual tape.

The more essential elements of the computer comprise a perforator and an impulse receiver, usually of the type common in telegraph systems, a group of registers for recording the called office and number of a local connection thereon, another group of registers for recording the start and finishing time of a connection, a translator for translating the time of a connection and the called office name into a charge based upon standard charge units, and a group of adding registers which integrate the charges as the individual tape advances from one call to the next. After the record of the last call has passed through the computer, the total sum recorded in the adding registers is perforated on the final tape, which tape is then passed through an ordinary page printer adapted to respond to the perforations thereon for printing the final bill.

As said before, the present application is directed specifically to the computer. For the purpose of completely describing their equipment and operation, attention is directed to the following drawings in which

Figs. 1 to 13 inclusive, when arranged as shown in Fig. 1A, disclose in schematic fashion the apparatus and circuits of the invention.

Fig. 14 shows the perforator code used on the individual tape prepared by the mechanism disclosed in Patent 2,112,951 above mentioned;

Fig. 15 is a timing chart showing the operating sequence of the sensing pins of the mechanism 400 relative to one complete cycle of the distributor 445-449, the operation of switch 415 and relays 412 and 422, all of said apparatus being shown in Fig. 4. The raised lines in the chart indicate the operated condition of the apparatus designated except for the lines relating to switch 415 wherein each line represents the movement of the switch or the operation of its driving magnet 414 as indicated by the legend.

#### *Local call record*

The production of the primary tape for the main group of lines and the individual tapes from said primary tape has already been given in connection with the brief description of the invention as a whole above outlined, and reference is made to the above-named patents for

a more comprehensive understanding thereof. For the purpose of describing those elements of the invention which are intended to be covered by the present application, we may start by assuming that the primary tape has been produced for a certain group of lines, that it contains the perforated codes of each of the separate notations that relate to each of the calls made from each of said lines, recorded thereon separately at the time a particular function for a particular call is completed by any one of the lines in the group, and that from this primary tape, a tape for each line has been produced which contains thereon all code entries relating to calls completed from that line.

The next step in the operation of the invention is to take the individual tape and pass it through a computer which will make up the final tape that will operate an ordinary page printer or similar device for printing the bill. This final tape will contain the code of the called office and number of each call, the charge in money units for the call and, as a final entry, the total charge of all the completed calls recorded on the tape.

Before considering the detailed description of the computer and the manner in which it operates, it is advisable to have clearly in mind the sequence of entries perforated on the individual tape from which the final tape is to be made. The individual tape contains a switching character code entry followed by an entry which relates to an item of information concerning a completed call followed, in turn, by another switching character which is succeeded again by another entry which likewise relates to the same call. But whereas the primary tape from which all the individual tapes are made contains all of the separate entries for the different calls more or less indiscriminately distributed throughout its length without correlation to the calls to which they pertain, the individual tape for a particular line in any group not only contains the separate entries for all calls made from that line, but has them arranged in the correct succession of time in which such entries would have been made for the particular call if the primary tape had been made continuous for one connection from the instant the call was initiated to the time it was terminated. In other words, while each group of entries on the individual tape is interposed between two switching characters, yet all of the entries within the group are the entries of one call only. For instance, immediately succeeding the first switching character code will be the new call code after which come the entries of the called subscriber's line followed immediately thereafter by the switching character code and then by the entries of the beginning of the conversation time and followed again by another switching character code and then by the entries of the end of the conversation time. Although each of these separate entries may have been separated from each other on the primary tape by other entries appertaining to other calls initiated from other lines in the main group, yet, on the individual tape, they are all assembled together with respect to the call to which they appertain. Hence the individual tape passed through the computer has all entries relating to successive calls disposed on the tape in the order of succession in which these calls were made.

The individual tape is now passed through the sensing mechanism 400 of the computer which is

similar in construction to the senser 200 in our above-mentioned Patent 2,112,951 except for the fact that interrupter 422 the shaft of which operates the tape advancing mechanism and the sensing pins depressing lever is driven by the same shaft which drives distributor brushes 445 and 449 and has a set of contacts which make at the beginning of the distributor brush revolution, that is, in the blank interval immediately preceding segments 1 and remains closed for the entire revolution, that is, until the brushes have cleared segments 6. Distributors 445 and 449 are of the usual rotary types well known in telegraph systems and are typified, for instance, by the disclosure in Patent 1,311,915.

After the tape is inserted in the tape-slot (not shown), locking key 443 is depressed whereupon a circuit for the start magnet 444 is completed which extends from grounded battery, resistance 451, contacts of key 443, distributor brush 445 and the two normal segments of commutators 423 and 446, winding of magnet 444 to ground. Magnet 444 operates, unlatches the distributor brushes which now sweep along the segments of their respective commutators, brush 445 supplying impulse ground to the segments of commutator 446 as the brush comes into contact with the segments of commutator 423 which are grounded in the manner described hereinafter. As the tape advances, the sensing pins 1-6, inclusive, become aligned under the six holes of the first switching character code, pass there-through and, as a result, the six segments of the commutator 423 are grounded by the bottom set of contacts carried on each sensing pins 1-6, inclusive, of the mechanism 400. As the distributor brush 445 rotates along the surface of the commutator, said brush grounds, in succession, the six conductors 431 to 436, inclusive. Commutator brush 449 also receives these pulses and transmits them to commutator bar 448 but inasmuch as this bar is connected to the top middle armature of relay 425 which is normal at this time, the pulses transmitted by brush 449 will have no effect.

For reasons stated hereinafter, the brushes of switch 415, which is of the usual rotary back stroke type typically disclosed in Patent 1,472,465 issued to O. F. Forsberg and R. M. de Vignier on October 30, 1923, may be standing on any set of terminals. Let it be assumed that the switch brushes are resting on the second terminal set; that is, the terminal set immediately succeeding the normal N terminal set. Hence, when the distributor brush 445 reaches segment 1 and grounds conductor 431, a circuit is completed for relay 701 which extends from ground on conductor 431, No. 1 contact set of relay 452, brush 416 and second cooperating terminal, upper winding of relay 701 to grounded battery. Relay 701 operates and locks over its lower winding and No. a contacts, conductor 427, bottom back contacts of relay 412, bottom inner contacts of relay 411, to ground. The grounding of conductor 432, when the distributor brush 445 reaches the second segment, causes a circuit to be completed which traces through the No. 2 contacts of relay 452, brush 418 and second cooperating terminal, upper winding of relay 702, to grounded battery. Relay 702 also operates and locks over its bottom winding and No. a contacts to ground on conductor 427. When the brush 445 reaches the third segment, ground is connected to conductor 433 which is extended over the No. 3 contacts of relay 452, brush 417 and

the second cooperating terminal, upper winding of relay 703 to grounded battery. Relay 703, like relays 701 and 702, operates and locks over its lower winding and No. a contacts to ground on conductor 427. When the distributor brush makes contact with the fourth segment, ground is connected to conductor 434 and a circuit is thereby completed over No. 4 contacts of relay 452, brush 439 and second cooperating terminal, upper winding of relay 704 to grounded battery. Relay 704 likewise operates and locks over its lower winding and No. a contacts to ground on conductor 427. When the distributor brush reaches the fifth segment, ground is connected to conductor 435 and a circuit is completed for relay 705 over the No. 5 contacts of relay 452, brush 421 and second cooperating terminal, upper winding of relay 705 to grounded battery, operating this relay which then locks in a circuit over its lower winding and No. a contacts to ground on conductor 427. Similarly, when the brush makes contact with the sixth segment, ground is connected to conductor 436 and a circuit is thereby completed for relay 706 over the No. 6 contacts of relay 452, through brush 419 and second cooperating terminal, upper winding of relay 706 to grounded battery, operating said relay which then locks in a circuit through its lower winding and No. a contacts to grounded conductor 427.

Hence it is seen that the effect of the first switching character code perforations ahead of the call entries of the first call is to cause the operation of any group of registers shown in Figs. 3 to 7, inclusive, with whose terminals on switch 415 the brushes of said switch may be connected at that time. Interrupter 422, however, closed its contacts at the beginning of the revolution of the distributor brushes so that, at that time, a circuit was completed from ground on said interrupter, inner lower contacts of relay 425, bottom outer contacts of relay 412, winding of switch magnet 414 to grounded battery. The switch magnet operates and breaks its interrupter contacts but since the brushes are advanced on the release, or back stroke, of the switch magnet, the brushes of the switch are held on the terminals with which they are in engagement so long as the magnet circuit is maintained. At the end of the revolution, the contacts of interrupter 422 are opened, the circuit of switch magnet 414 is broken, the magnet releases and the brushes are advanced to the next terminal set. When the brushes have been disconnected from the preceding group of terminals the register relays which had been previously locked up do not release inasmuch as the ground connected to conductor 427 is not disturbed.

The next series of perforations on the individual tape will be those of the new call code which consists of five holes punched transverse the tape, one in each position except the fifth. Therefore when the sensing pins pass through the holes which make up the new call code a circuit is completed from ground on the middle set of contacts of operated sensing pins 1, similar set of contacts of operated sensing pins 2, 3, 4 and 6, off-normal terminals of the terminal bank accessible to brush 420, winding of relay 412 to grounded battery. Relay 412 operates, disconnects ground from conductor 427 causing thereby the release of the register relays previously operated and locked by the switching character code and disconnects the winding of magnet 414 from the contacts of interrupter 422.

In the meanwhile relay 412 closes a self-interrupting circuit for magnet 414 which extends from ground on the bottom inner contacts of relay 411, bottom front contacts of relay 412, interrupter contacts of magnet 414 to grounded battery. The magnet now operates on self-interruptions until brush 420 is advanced to the normal terminal N whereupon relay 412 is released and the switch is stopped from further rotation. Inasmuch as the contacts operated by cam 422 are still closed, magnet 414 is again operated over the previously described circuit, causing the advance of the switch brushes to the first terminal of their respective arc.

Thus it is seen that the effect of the switching character code has been merely to operate and lock a group of registers which are subsequently released while the effect of the new call code is to return switch 415 to the first set of active terminals on the switch arc.

If the brushes of switch 415 are already standing on the normal terminal when the sensing pins pass through the holes of the switching character code the commutator conductors will be grounded as already described, but since the brushes to which each of them is connected are positioned on vacant terminals, no register relays will be operated and the switch will be advanced to the terminals of the first register 700. Further, when the tape has been advanced to the new call code, the previously described operations following in response thereto will take place and the switch will be driven back to the normal terminals.

With the switch 415 in its first position subsequent to the operations of the new call code cycle as above described, the computer is ready to proceed with the next entry on the tape. This entry, it will be remembered, will be, in the case of a local call, the code of the first letter of the called office name. If the call is a local call, the name of the office and the number of the called subscriber will have been recorded on the primary tape and repunched on the individual tape in equivalent number codes. For illustration it may be assumed that the name of the local office is Halifax and that the number of the called subscriber 3678. The office name, however, like the called number, will have been recorded in the code of numerical characters corresponding to the letters. The name Halifax, therefore, will have been recorded in the numerical code 425 the first digit of which is represented by a code that consists of a hole perforated in the second position of the tape, another in the fourth and another in the sixth; that of the second digit by a hole in the first, another in the second, another in the fifth and another in the sixth, while the digit 5 is designated by a code character consisting of a hole in the fifth and a hole in the sixth position of the tape (see Fig. 14). When the distributor start magnet 444 operates to start the next revolution of the distributor brushes, interrupter 422 closes the circuit to the winding of switch magnet 414 over a path previously traced, causing said magnet to operate preparatory to advancing the brushes of the switch to the second terminal set. Hence when the tape has advanced to the position where the sensing pins are aligned under the holes of the code of the character 4, the second, fourth and sixth pins will pass through said holes and close ground to the conductors connecting with commutator segments 2, 4 and 6. Therefore, when the brush 445 rotates one revolution, the ground

on each of the segments is extended at the proper time to conductors 432, 434 and 436 in succession. Ground on conductor 432 closes the circuit of relay 702 as already described causing said relay to operate and lock to conductor 427; ground on conductor 434 causes the circuit of relay 704 to be closed as previously described causing said relay to operate and lock to conductor 427; and the same is true with respect to relay 706 whose circuit is closed by ground over conductor 436, said relay also operating and locking to conductor 427. The code perforations of the digit 4, corresponding to the letter H of the called office name, cause, therefore, the operation and locking of the three above-mentioned relays in the register 700. At the end of the revolution, cam 422 opens its contacts thereby causing the release of magnet 414 which advances the brushes of switch 415 one step to the second set of terminals. At the beginning of the next distributor brush revolution, interrupter 422 again makes its contacts, closing thereby a previously described circuit for switch magnet 414 which operates preparatory to advancing the brushes of the switch 415 to the next or third set of terminals. In the meanwhile the tape has been advanced to the next set of perforations which, in the case assumed, are those of the digit 2 corresponding to the code of the numerical equivalent of the letter A of the called office name. The sensing pins, accordingly, pass through the holes made in positions 1, 2, 5 and 6 of the tape which, in the manner previously described, cause the grounding of conductors 431, 432, 435 and 436 as the distributor brush 445 makes with the correspondingly numbered segments of commutators 446 and 423. With the brushes of switch 415 on the second set of terminals, the grounding of conductor 431 causes a circuit to be closed extending from said ground, No. 1 contacts of relay 452, switch brush 416 and second terminal on its arc, upper winding of relay 711 to grounded battery, causing said relay to operate and lock over its lower winding and No. 1 contact to ground on conductor 427. The ground on conductor 432 causes a circuit to be closed extending from said ground, No. 2 contacts of relay 452, brush 418 and second terminal on the arc, upper winding of relay 712 to grounded battery causing said relay to operate and lock over its bottom winding and No. 1 contact to ground on conductor 427. Ground on conductor 435 likewise causes a circuit to be closed from said ground, No. 5 contacts of relay 452, brush 421 and second terminal on its arc, upper winding of relay 715 to grounded battery. Relay 715 now operates and locks over its bottom winding and No. 1 contact to conductor 427. Lastly, the ground on conductor 436 causes a circuit to be closed over the No. 6 contacts of relay 452, brush 419 and second terminal on its arc, upper winding of relay 716 to grounded battery, causing said relay to operate and then lock over its lower winding and No. 1 contact to ground on conductor 427. Thus the perforations of the code of digit 2 have resulted in the operation and locking of four relays in the group of six relays comprising register 710. At the end of the revolution, cam 422 opens its contacts and magnet 414 releases, advancing the brushes of switch 415 one step to the third set of terminals.

At the beginning of the next revolution of the distributor brushes, interrupter 422 again makes its contact and again closes a previously described circuit to the winding of switch magnet

414 causing said magnet to operate preparatory to advancing the switch brushes to the fourth set of terminals. In the meanwhile the tape has been advanced to the point where the perforations of the code of the next entry, which is that of the numeral corresponding to the third letter of the office name, have become aligned over the sensing pins of the distributor. Since the digit is assumed to be 5 and therefore having perforations in positions 5 and 6 of the tape, the corresponding sensing pins 5 and 6 pass through said holes and cause the grounding of conductors 435 and 436 when the commutator brush 445 comes into contact with commutator segments 5 and 6, respectively. With the switch brushes on terminal 3 of their respective arcs, the grounding of conductor 435 causes a circuit to be closed over the No. 5 contacts of relay 452, brush 421 and third terminal of its arc, upper winding of relay 725 to grounded battery, causing said relay to operate and lock over its lower winding and No. 1 contact to conductor 427. The grounding of conductor 436 further closes a circuit which extends over the No. 6 contacts of relay 452, brush 419 and third terminal of its arc, upper winding of relay 726 to grounded battery, likewise causing said relay to operate and lock over its lower winding and No. 1 contact to ground on conductor 427. Thus the code of the digit 5 has resulted in the operation and locking of two relays in the third register 720 so that registers 700, 710 and 720 now have locked on the relays above mentioned the code of each of the three digits corresponding to the office name of the called subscriber's number. At the end of the revolution cam 422 opens its contacts to release magnet 414 whereupon the brushes of switch 415 are advanced to the fourth set of terminals.

At the beginning of the next distributor brush revolution the interrupter 422 again closes the circuit of magnet 414 preparatory to the advance of the brushes of switch 415 to the fifth set of terminals in the same manner as previously described while the tape is correspondingly advanced to the next entry which, in this case, is a set of perforations corresponding to the code of the thousandths digit of the called subscriber's number. Since the called number of the local connection has been assumed to be 3678, the first set of perforations will be that of the code of the digit 3 which comprise holes perforated in the first and sixth positions of the tape. This causes conductor 431 to be grounded when the commutator brush 445 makes with its first segment, whereupon a circuit is closed from ground on conductor 431, No. 1 contacts of relay 452, brush 416 and the fourth terminal of its arc, upper winding of relay 801 to grounded battery, causing this relay to operate and lock over its lower winding and No. a contacts to ground on conductor 427. When the commutator brush reaches the sixth segment a ground is likewise applied to conductor 436 and a circuit is thereupon completed over the No. 6 contacts of relay 452, brush 419 and fourth terminal of its arc to the upper winding of relay 806 causing said relay to operate over its upper winding and lock over its lower winding and No. a contacts to ground on conductor 427. The switch is now advanced to the fifth set of terminals and the tape is advanced to the next set of perforations in the manner previously described so that, for the perforations of the code of the digit 6, ground is extended to conductors 431, 433, 435 and 436 in succession, causing thereby the operation of relays 811, 813, 75

815 and 816 over circuits similar to those which have just been traced. With the advance of switch 415 to the sixth set of terminals and the tape to the perforations of the code of the digit 7, ground is connected to conductors 431, 432, 433 and 436 which, over the appropriate and easily traceable paths, completes circuits for operating relays 821, 822, 823 and 826 all of which lock to ground on conductor 427.

The switch is next advanced to the seventh set of terminals and the tape to the next set of perforations so that, for the perforations of the code of the units digit 8 ground is extended to conductors 432, 433 and 436 in succession, causing thereby the operation of relays 832, 833 and 836 over circuits similar to those already traced, which relays, upon operating, lock to ground over their lower windings and No. a contacts to ground on conductor 427.

The tape is now advanced to the code of the next entry and switch 415 is advanced to the eighth set of terminals. The code of this next entry is that of the switching character and it will be recalled that ground will be connected to each of the six pulsing conductors in succession. However, switch 415 has been advanced to the eighth set of terminals and inasmuch as these terminals are blank, the pulsing grounds will be ineffective at this time and the switch is advanced to the ninth set of terminals by means of interrupter 422 in the usual manner.

The reason why this "pass-by" position is provided is to make certain that the entries previously recorded are actually the entries of a completed call and not those of an incompleting one. By reference to the parent patent above mentioned, it will be seen that the tape register therein described is connected to the district selector after each registerable item of information is available for registration regardless of whether or not the call is completed. The calling subscriber may disconnect after dialing the called number and said number may be recorded on the primary tape. But if the called number does not form a part of the record of a completed call the entry is valueless and as such should be discarded. If, therefore, the preceding entries which have just been recorded in the registers shown in Figs. 3 and 6, are simply entries of an incompleting call, the next entry after the switching character will be that of the new call designation and will cause the operation of relay 412 as already described and result in the disconnection of ground from conductor 427 to allow the registers to release. The switch is restored to normal, as described, ready for another cycle of operations with the entries which follow the new call code.

Assuming the entries so far made to be those of the completed call described above, the tape is advanced to the code of the next entry and the switch is advanced to the ninth set of terminals. This next entry is the code of the first digit of the three digits which represent the beginning of conversation time. By reference to our above-mentioned parent patent it will be seen that the code of the starting time is divided into three separate designations, the first being a code representing tens of minutes, the second representing from one to ten minutes, and the third the tenths of a minute when the conversation was initiated. Let us suppose that at the time conversation ensues the ten minute switch of the tape register covered by the parent patent above referred to was in position 2, the minute switch

in position 7 and the tenths of a minute switch in position 4. Accordingly, the codes of the digits 2, 7 and 4 are punched on the primary tape and carried over to the individual tape, and the codes of these numbers will then be stored consecutively by the operation of the appropriate relays of registers 900, 910 and 920. Consequently when the brushes of switch 415 advance to the ninth set of terminals and the sensing pins have passed through the set of holes representing the code of the first digit 2, commutator segments 1, 2, 5 and 6 will be grounded, whereupon conductors 431, 432, 435 and 436 will also be grounded. In the course of the distributor brush revolution, the connection of ground to each of these conductors causes the operation of relays 901, 902, 905 and 906 in register 900, the circuit for each of said relays being traced in the same manner as those for previous registrations except that the separate and respective paths are traced through the ninth terminal sets of switch 415. These relays lock over their bottom windings and No. a contacts to ground on conductor 427. Thereafter, switch 415 advances to the tenth set of terminals while the tape is advanced to the next set of perforations which comprises the code perforations of the digit 7. This code consists of holes punched, respectively, in the first, second, third and sixth positions of the tape. On the next revolution of the distributor brush and with each of the switch brushes resting on the tenth terminal of their respective arcs, conductors 431, 432, 433 and 436 are grounded, causing thereby the operation of relays 911, 912, 913, and 916 in register 910. These relays operate over their upper windings and lock over their lower windings and No. a contacts to ground on conductor 427. The tape is then advanced to the next set of perforations which comprises those of the code of the digit 4 and switch 415 is advanced to the eleventh set of terminals. The perforations for the code of the digit 4 consist of a hole in position 2, another in position 4 and another in position 6 of the tape causing thereby, during the revolutions of the distributor brush, the grounding of pulse conductors 432, 434 and 436. With the brushes of switch 415 resting on the eleventh set of terminals, the ground on each of said conductors causes the operation of relays 922, 924 and 926 in register 920. These relays operate over their upper windings and lock over their lower windings and No. a contacts to ground on conductor 427. Thus the starting time of the call as contained on the individual tape is recorded on registers 900, 910 and 920.

Switch 415 is now advanced to position twelve and the tape to the code of the next switching character. All the pulse conductors are now grounded but inasmuch as the twelfth terminal set on switch 415 is vacant, the pulses are ineffective. At the end of the distributor brush revolution, switch 415 is advanced to the thirteenth terminal set by interrupter 422.

In the same way, the finishing time of a conversation is likewise registered in terms of the position of the three switches in the tape register circuit covered by our above-mentioned parent patent. If we suppose that when the conversation is finished these time switches are set on terminals 4, 6 and 2, respectively, then the three entries on the primary tape and carried over on the individual tape will be those of digit 4 for the ten minute switch, digit 6 for the minute switch and digit 2 for the tenths of a minute switch. The successive passage of the tape for every

one of these sets of perforations will then cause the operation of the required combination of relays in registers 1000, 1010 and 1020, respectively. The code of digit 4 will cause the operation and locking of relays 1002, 1004 and 1006 after which switch 415 is advanced to its fourteenth terminal set; the code of digit 6 will cause the operation and locking of relays 1011, 1013, 1015 and 1016 in register 1010 after which switch 415 is advanced to its fifteenth terminal set, while the code of digit 2 causes the operation of relays 1021, 1022, 1025 and 1026 in register 1020 after which the switch is advanced to its sixteenth terminal set. With switch 415 in position 16, a circuit is closed for relay 424 extending from ground on the top back contacts of relay 412, brush 428 and sixteenth terminal on its terminal bank, top winding of relay 424 to grounded battery. Relay 424 operates and connects ground to conductor 453.

With switch 415 on the sixteenth terminal set and the six pulse conductors grounded as a result of the sensing pins passing through the six perforations of the following switching character code, circuits are completed in succession to the top winding of each of the six relays 401 to 406, inclusive. The relays operate and then lock over their respective bottom windings and contacts to ground on the top contacts of relay 424. A circuit is now completed from ground serially through the top contacts of relays 406, 405, 404, 403, 402 and 401, winding of relay 409 to grounded battery. Relay 409 operates, but nothing further happens until interrupter 422 has advanced the tape to the next set of perforations and the brushes of switch 415 have advanced to their seventeenth set of terminals at which time said brushes simultaneously engage their respective normal terminals. During the time that the switch advances from the sixteenth to the seventeenth terminal set, relay 424, being of the "slow-release" type, does not release immediately so that when brush 428 makes with the seventeenth terminal, a locking circuit is furnished for relay 424 which extends from grounded battery through its lower winding and bottom contacts, brush 428 and cooperating terminal to ground on the top contacts of relay 412. A circuit is now completed for relay 410 extending from grounded battery through its winding, bottom contacts of relay 424 to the aforetraced ground on the back contacts of relay 412. Relay 410 operates, connects shunting ground to start magnet 444 over the top back contacts of relay 411 to prevent the distributor commutator brushes from making further revolutions and the sensing mechanism 400 from advancing and, over its top contacts, extends ground on the bottom outer contacts of relay 411, front contacts of relay 409 to conductor 438. This conductor further extends to the commoned contacts of the register relays of Fig. 3, to the winding of relay 1302 by way of the back contacts of relay 1301 and, in parallel therewith, to the winding of relay 1501 to grounded battery, operating both of these relays to perform functions noted hereinafter.

The reason why a check is made for the switching character code following the last code entry of a completed call is to make certain that there is no irregularity in the successive entries on the final tape. The last entry should be followed by a switching character. If it is not and is followed instead, say, by the new call code, then relay 412 will reoperate, connect shunting ground to the start magnet 444 and connect self-

interrupting ground to switch magnet 414, opening the locking circuit to the register relays in Figs. 3 to 7, inclusive, thereby canceling whatever records are locked therein and, upon the release of relay 412 after the switch 415 has cleared the sixteenth terminal set, said switch is advanced to normal in the regular manner to start operations upon the record of a new call. In this manner if, after the registration of a call is complete, the switching character code is not properly received, it may be assumed that the registrations are imperfect and requiring cancellation. On the other hand, if the switching character code check proves satisfactory in the fact that relays 401 to 406 operate, then, when relay 410 operates, the circuit is completed for relays 1302 and 1501, the registration record is preserved and the sensing mechanism 400 prevented from any further advance until the computer has translated the record so registered and entered it in translated form upon the final tape prepared as described hereinafter.

Should the various entries hitherto described, instead of being local call entries were to be toll call entries, then said entries would have been preceded by the perforations of the operator's code. This code is one which has a perforation in every position of the tape except the first so that when the distributor sensing pins pass through five perforations, a circuit is closed extending over the top set of contacts of each of the sensing pins to the lower winding of relay 425. Relay 425 operates and locks over its upper winding and inner contact, bottom back contacts of relay 412 to ground on the bottom inner contacts of relay 411, opens one set of contacts in the circuit of the switch magnet 414 and, over its top outer contacts, completes an obvious circuit for relay 452 which operates and opens the pulse conductors to the various registers. Over its middle upper contacts, relay 425 further extends ground through the normal segment of commutator 447, distributor brush 449, commutator bar 448, middle contact of relay 425, conductor 442, to the winding of the line relay 1422 of distributor 1430, preparatory to receiving impulses set up by the toll entries as more completely described hereinafter.

Confining our attention for the present to those operations of the computer which follow the registration of the called office name and number as well as the start and finish time of a local connection on the registers as already described, the computer will now decode the various information locked in the registers in terms of characters which can be recorded on the final tape for printing purposes. For instance, the called office code which has been recorded in terms of digits, must now be changed to office letters and recorded as such on the final tape so that the office name, as appearing in the telephone directory, will appear on the bill. Further, the conversation time must be changed to money units so that the assessment for the call may be printed in money terms. Hence the subsequent operations of the computer following the record registered in the various registers of Figs. 3 to 7 inclusive have to do, first with translating such items of the record that need translating in terms that can be printed on the bill and causing said items to be recorded in the final tape exactly as they are to be printed, and second to cause such items of the record that require no translation to be copied into the final tape exactly as they are registered.

The first operation in the computer is the selection of a relay which is individual to the called office code. For this purpose a translator is used which is shown schematically in Figs. 2, 5, 8 and 9. This translator comprises a group of multicontact relays 602 to 609, inclusive, the winding of each of which extends to the contacts of the relays in register 700, the winding of relay 602 extending to the proper combination of contacts of the relays in said register which respond to the digit 2 and so on up to and including the winding of relay 609 which extends to the contacts of those relays in said register which respond to the digit 9, there being one such relay for every digit that may be used as the first digit, or letter, of the called office name. In prevailing telephone practice neither the digit 1 nor the digit 0 is used as the equivalent of a first office letter so that, instead of providing ten multicontact relays, one for each possible digit, only eight are provided, one for each digit from 2 to 9, inclusive. Each of these multicontact relays is provided with one hundred pairs of contacts, one contact of each pair being extended, or strapped, to a corresponding contact of a similar pair in each of the other seven relays, each group of ten of said extensions being carried to the corresponding armatures of a relay like relay 1202 shown on Fig. 9. Moreover, since there are one hundred such extensions of the contacts of the multicontact relays divided into ten groups of ten each, there is provided a group of ten relays 1201 to 1200, inclusive, the second of which only, namely, relay 1202, is shown in detail, and to the ten armatures of each of which are extended a group of ten commoned contacts of the multicontact relays. The corresponding "make" contact of each pair of contacts of the relays 1201 to 1200 is commoned to one of ten conductors which, in turn, extends to a contact in one of the relays of register 720. The winding of each relay in the group of relays 1201 to 1200 is connected over a separate conductor to contacts of the register relays in the register 710 and connected thereto in the combination required for operating each of said relays in accordance with the operation of the combination of the relays contained in said register as more clearly described hereinafter.

Each make contact of the multicontact relays 602 to 609, inclusive, is connected, through terminal block 503, to the winding of a code relay which designates the code of a particular office within the called area. Five such representative relays are shown in Figs. 1 and 8 and are designated as 500, 501, 502, 1115 and 1116. One of these relays, namely 500, will be assumed to represent the code relay corresponding to the office code of the office dialed for the call being used to illustrate the operation of the invention, namely the relay which represents the office Halifax. The other relays designate four other offices.

The object in the first operation of the computer, following the registration of the office code in the registers 700, 710 and 720 is to translate the registration of the three digits of the office code, as registered by the operated relays of said registers, into the operation of the code relay individual to the called office which, in this case, is relay 500. Consequently, after the digit 4 has been recorded in register 700 by the operation of relays 702, 704 and 706, a circuit is closed which extends from the ground on conductor 438, No. 4 contacts of relays 706, 704 and 702, conductor

737, winding of relay 604 to grounded battery. Relay 604 operates and closes through its one hundred make contacts to the common conductors of the multicontact relay group.

The operation of relays 711, 712, 715 and 716 in response to the code of the digit 2 of the office code now causes a circuit to be closed extending from ground on conductor 438, No. 2 contacts of relays 716, 715, 712 and 711, conductor 727, winding of relay 1202 to grounded battery. Relay 1202 operates and closes through the second group of ten common conductors to the group of conductors extending to the relay contacts of register 720. Therefore, with relays 725 and 726 operated in response to the code of the third digit 5 of the office code, a circuit is closed which extends from ground on conductor 438, No. 5 contacts of relays 726 and 725, conductor 728, No. 5 contact set of relay 1202, No. 15 contact on relay 604, winding of relay 500 to grounded battery. Relay 500 operates and marks thereby the code of the called office.

The code used in recording the various items of information on the tape prepared by the computer is shown in Fig. 14 and is the well-known six-digit telegraph code modified to suit the purposes of the present invention.

Relay 500 and other similar code relays are each provided with four sets of contacts the right armatures of which are connected to ground and the three left armatures of which are extended to cam 1306 of sequence switch 1310 which is of the type disclosed in Patent 1,127,808 issued to J. N. Reynolds and C. F. Baldwin on February 9, 1915. The make contacts of the above-mentioned armatures are extended to various terminals on terminal block 504 as more particularly described hereinafter.

With reference to the sequence switch disclosed in the above-mentioned Patent 1,127,808 and herein used as a circuit permutator, the numbers adjacent to the various contacts and associated cams indicate that said contacts electrically engage their respective cams one-quarter of a position before and disengage them one-quarter of a position after the one indicated. Thus if a 2 is shown adjacent a contact and cam, it means that the contact makes electrical engagement with the cam from position  $1\frac{3}{4}$  through position  $2\frac{1}{4}$ . Further, if two numbers are shown connected with a plus sign as, for instance, 2+20, it means that the contact makes continuous electrical engagement from position  $1\frac{3}{4}$  to position  $20\frac{1}{4}$ , inclusive. The numbers for the "centering cam" shown immediately to the left of the drive magnet 1310, on the other hand, indicate that the contact is not in electrical engagement with the cam beginning one-quarter of a position before and ending one-quarter of a position after the one indicated. Thus a legend 3 on the centering cam indicates that the contact is not in electrical engagement with the cam from position  $2\frac{3}{4}$  to position  $3\frac{1}{4}$ . When a position is omitted entirely on the centering cam, it means that the contact engages the cam three-quarters of a position before the centering cam of the position omitted and continues in engagement with the cam three-quarters of a position beyond the center line; in other words, the commutation is continuous. Thus a legend 3, 5 means that the contact is out of electrical engagement between positions  $2\frac{3}{4}$  and  $3\frac{1}{4}$ , in electrical engagement between  $3\frac{1}{4}$  and  $4\frac{3}{4}$  and out of electrical engagement between  $4\frac{3}{4}$  and

514. The reason for the alternation in the indications between cuttings on the commutation cams and those on the centering cam of the switch is the fact that a circuit completed to the magnet through any of the contacts and a commutation cam position is closed one-quarter of a position before through one-quarter of a position after the center line of the position indicated so that there would be no advance of a full position by the switch unless an intermediate drive circuit is provided for operating the magnet between positions. This intermediate drive circuit is provided by the contact associated with the lower surface of the centering cam located immediately to the left of the magnet 1310 and, in the description of the circuits which follows, the various circuits for magnet 1310 are traced only as far as cam 1305, it being understood that the remainder of the circuit path through the cam on the left of magnet is the same for all circuits.

To the terminals of another cross-connecting block, namely cross-connecting block 505, are connected the windings of three groups of relays. The first group comprises a relay for each letter of the alphabet and of which relays 511, 518, 522 and 526 are examples of such relays; the next group of relays consists of ten relays, namely relays 1100 to 1101, inclusive, only relays 1100 and 1101 being disclosed, one for each of ten digits, and a third group of three relays or more, namely, relays 1112 to 1114, inclusive, each relay in said last group representing a calling zone the area of which includes offices having definite initial and overtime rates which are different in either or both respects from those of other zone areas. Each relay in each of the first two groups carries a full complement of contact sets sufficient for the requisite six-digit code combination called for by the code of each of the letters and each of the numbers represented by said relays. The armatures of these relays are all grounded and the corresponding contacts are connected in the proper combination, to the six conductors 531 to 537, inclusive, which extend through commutator segments to the magnets of the perforator 1420, the function of which is described hereinafter.

The contacts of relay 500 and those of other code relays which make with the commoned armatures of all code relays that are extended to cam 1306, are cross-connected from block 504 to block 505, that is, the left outer contact No. 1 is extended to the winding of the alphabetical relay of the first letter of the office name, the left middle contact No. 2 to the winding of the alphabetical relay of the second letter and the third or inner contact No. 3 to the winding of the relay designating the third or last letter of the office name. Should the last digit of the office code be designated by a number instead of a letter, then the third contact would be cross-connected to the winding of one of the relays 1100—1101 depending upon the digit. For instance, if the office Halifax is listed in the telephone directory as HAL, contact No. 1 would be cross-connected to the winding of relay designating the letter H, that is, relay 518; contact No. 2 would be cross-connected to the winding of relay 511 designating the letter A, while contact No. 3 would be cross-connected to the winding of relay 522 designating the letter L. On the other hand if, as is now the case in large metropolitan areas employing three-digit codes, it be-

comes necessary to abbreviate the letter designation of an office name into two letters and a digit for the purpose of expressing the last digit of the office code numerically so that more than one office may have the same name, then contact No. 3, instead of being connected to the winding of relay 522 would be cross-connected to the winding of any one of the relays in the group 1100-1101 so that the translation would be HA-1, HA-2, HA-3, etc., in accordance with the designation of the called office in the telephone directory. The right contact of relay 500 is cross-connected to the winding of relay 1112 or 1113 or 1114 depending upon the particular zone in which the office Halifax is located with respect to the calling office.

The code relay 500, when operated, marks certain definite information with respect to that code which is to be used subsequently for printing the office name on the subscriber's bill in accordance with the directory listing and also marks the rate of charge to be made for any particular call completed in the zone which contains the called office. Consequently, when relay 500 operates in the manner described, and assuming that the office designated by said relay is listed in the telephone directory as HAL and, also, that said office is located in zone 1, that is, the zone designated by relay 1112, then the operation of relay 500 partially prepares the circuit for each of the following relays; namely, relays 511, 518 and 522 and completes an obvious circuit for relay 1112.

In the meanwhile with ground connected to conductor 438, relays 1302 and 1501 have operated as already described. Relay 1302 closes a circuit which extends from ground over its bottom outer contacts, back contacts of relay 1303, right lower contact of cam 1305, winding of magnet 1304 of switch 1310, to grounded battery. The magnet operates and rotates the switch 1310 out of position 1 and into position 2. In position 2 a circuit is completed extending from ground on the inner contacts of relay 1302, upper right contact of cam 1306, left upper contact of cam 1311, left winding of relay 1303, to grounded battery, operating said relay which now locks in a circuit over its right winding and front contact to ground on the outer contacts of relay 1302. Relay 1303, by breaking its back contact, opens the starting circuit of magnet 1304. Another circuit is also closed extending from ground over the inner contacts of relay 1302, upper contacts of cam 1306, conductor 1307, No. 1 contacts of relay 500, jumper conductor between blocks 504 and 505, winding of relay 518, to grounded battery. Relay 518 now operates and grounds perforator conductors 533, 535 and 537. Each of the first two conductors extends to a segment of a commutator associated with tape reperforator 1420 while conductor 537 is connected to the winding of the start magnet 1426 of said perforator. This reperforator may be of any suitable type as, for instance, that described in Patent 1,194,365 but modified as shown in Fig. 11 for adaptation to our invention by the addition of two additional segments on the commutator engaged by brush 1406, to adapt the reperforator to a six-digit code and to provide circuit means for advancing the circuit after each perforation. The perforator shown in the above patent is basic to a type of commercial reperforator contemplated for use in this invention. While shown only schematically, reference to said patent will identify all its essential parts.

Thus, 78 constitutes the segments of the distributor; 79 is the brush which corresponds to the brush 1406; magnets 54-58 are the setting magnets which correspond to the magnets 1-6, while magnet 18 is the punch magnet which is referred to in the present application and shown in the drawing of Fig. 11 as the "perforating magnet." The locking and releasing circuits of the reperforator are completely self-contained and need no auxiliary facilities outside of the mechanism itself to initiate their operation at the beginning or ending of each cycle of action. In our invention, no use is made of the line relay 74 of the reperforator since this relay is utilized to receive pulses from a distant point. The pulses are, in our invention, received directly upon the segments 1, 2, 3, 4, 5 and 6 of the reperforator over conductors connected thereto and extending to the contacts of the code and zone relays shown in Figs. 1 and 8. As said before, the only modification of the reperforator made for adaptation to our invention is the addition of two additional segments on the commutator engaged by brush 1406 in order to adapt it to a six-digit code and to provide means for advancing the circuit after each perforation. That is, the pulsing conductors extend to commutator segments which have corresponding segments extending to perforating magnets which, when operated on a pulse over a distributor brush bridging the two segments, cause the punch levers associated with the operated magnet to be set to perforate the tape. The operation of these magnets, in response to successive connections between corresponding commutator segments as the distributor brush makes one revolution over the surface of the commutator, sets the perforator mechanism to punch two holes in positions 3 and 5 of the tape associated with said perforator to characterize the letter H of the called office name at the time when brush 1406 connects ground to segment 7. Ground is thereby applied to conductor 1407 for the performance of functions noted hereinafter and, in parallel therewith, to the winding of the perforating magnet, which then operates to cause the tape to be perforated in the positions determined by levers set by the operated setting magnets 1-6, as described in the above-mentioned Patent 1,194,365. When the distributor brush 1406 engages with and connects the seventh commutator segments together, a circuit is closed for the perforating magnet and another circuit is closed for magnet 1304 which extends from ground through brush 1406, conductor 1407, right upper contact of cam 1305, winding of magnet 1304 to grounded battery. The magnet operates and advances the switch to position 3 by which time brush 1406 will have again reached its first segment. As the switch leaves position 2, the circuit of relay 518 is opened, causing said relay to release and disconnect ground from the tape perforator magnets. As the switch advances into position 3, a circuit is completed extending from ground on the upper contacts of relay 1302, through the left lower contact of cam 1306, conductor 1308, No. 2 contacts of relay 500, winding of relay 511, to grounded battery. Relay 511 operates and grounds conductors 531, 532 and 537. The corresponding magnets are now operated in the tape perforator 1420 to punch holes in positions 1 and 2 of the tape which are the code perforations of the letter A. When the distributor brush 1406 again contacts with the seventh segments of the commutator the aforetraced circuits of perforating

magnet and magnet 1304 are again completed, the tape is punched in positions 1 and 2 and the switch is advanced to position 4. As the switch moves past position 3, the circuit of relay 511 is opened at the left lower contact of cam 1306 causing said relay to release and remove ground from the perforator conductors and from the commutator segments to which they are connected. When the switch reaches position 4 the ground on the upper contact of relay 1302 is extended by way of the right lower contact of cam 1306, conductor 1309, No. 3 contacts of relay 500, winding of relay 522, to grounded battery. Relay 522 now operates and grounds conductors 532, 535 and 537 causing thereby the operation of the corresponding magnets in the tape perforator 1420 and the punching of holes in positions 2 and 5 of the tape for the code of the letter L and the consequent advancement of switch 1310 to position 5. As the switch rolls past position 4 the circuit of relay 522 is opened causing this relay to release and remove ground from the perforator conductors and from the corresponding commutator segments in the perforator.

The office code having been perforated, it now becomes necessary to punch on the tape the code of each of the digits of the called subscriber's number. However, since the tape which is now being produced is the one that is to be fed into the printing mechanism to make the bill, the characters to be printed thereon are to be properly spaced on the tape, and it is desirable, therefore, to leave a space on the bill between the office code and called number. This is accomplished by interposing a space character code on the tape after the office code so that a space will be left on the bill between the office code and the number. Hence when the switch 1310 reaches position 5, a circuit is closed which extends from ground on the inner contact of relay 1302, right upper contact of cam 1306, upper left contact of cam 1317, winding of relay 1318, to grounded battery. Relay 1318 operates and grounds conductors 533 and 537, the first of which corresponds to the code of the space character and the second of which is used to complete the circuit of the perforator start magnet 1426. The perforator is now operated, the space character code is punched on the tape and the switch is advanced to position 6. As the switch passes beyond position 5 the circuit of relay 1318 is opened thereby causing this relay to release and open the circuit of the perforator start magnet and disconnect ground from conductor 533, while the perforator advances the tape to the next perforating position in the usual manner. When the switch reaches position 6 a circuit is closed extending from ground on the right upper contact of cam 1306 to the right upper contact of cam 1311, conductor 1312, No. 3 contact set of relay 806 of the thousands register 800, No. 3 contact set of relay 801, conductor 841, bracket line 1319, corresponding conductor 841 in Fig. 5, winding of relay 1103 (not shown) to grounded battery. Relay 1103 operates and grounds conductors 531, 536, and 537, the first two being those required for the code of the digit 3 and the third for operating the start magnet. The perforator now operates to perforate the code of the thousands digit 3 immediately succeeding the code of the space character. When the distributor brush 1406 reaches the last or seventh segment of the commutator, the previously described circuit for switch magnet 1304 is closed and switch 1310 is advanced to position 7. As the switch passes po-

sition 6, ground is disconnected from the path of relay 1103 at the right upper contact of cam 1311 to release said relay and disconnect ground from the perforator conductors.

When the switch reaches position 7, a circuit is closed extending from ground on cam 1311, over the right lower contact thereof, conductor 1313, No. 6 contacts of relays 816, 815, 813 and 811 of the hundreds register 810, conductor 946, bracket line 1319, conductor 846 in Fig. 3, winding of relay 1106 (not shown) to grounded battery. Relay 1106 operates and grounds conductors 531, 533, 535, 536 and 537 for setting the perforator 1420. When the commutator brush of said perforator reaches the seventh segment, the previously traced circuits of perforator magnet and magnet 1304 are closed, the tape is perforated with the code of the digit 6 and the switch is advanced to position 8. As it passes beyond position 7, ground is disconnected from the path of relay 1106 causing said relay to release and disconnect ground from the perforator conductors.

When the switch reaches position 8, ground is extended over the left lower contact of cam 1311, conductor 1314, No. 7 contacts of relays 826, 823, 822, 821 of the tens register 820, conductor 747, bracket line 1319, conductor 747 in Fig. 8, winding of relay 1107 (not shown) to grounded battery. Relay 1107 operates and grounds conductors 531, 532, 533, 536 and 537 causing thereby the operation of associated perforating magnets and the subsequent punching of holes in positions 1, 2, 3 and 6 of the tape for the code of the digit 7 of the called subscriber's number. When the distributor brush 1406 reaches the seventh segment, the previously traced circuit of magnet 1304 is closed, operating said magnet and causing the switch to advance to position 9. When the switch passes position 8 the circuit of relay 1107 is opened at the left lower contact of cam 1311 causing said relay to release and disconnect ground from the perforator conductors.

When the switch reaches position 9, a circuit is completed from ground over the left upper contact of cam 1316, conductor 1315, No. 8 contacts of relays 836, 833 and 832 of the units register 830, conductor 748, bracket line 1319, conductor 748 in Fig. 8, winding of relay 1108 (not shown) to grounded battery. Relay 1108 operates and grounds conductors 532, 533, 536 and 537 causing thereby the operation of associated magnets in the perforator 1420 and the registration of the code of the digit 8 through the punching of holes in positions 2, 3 and 6 of the tape. Concurrently with which the circuit of magnet 1304 is closed and the switch is advanced to position 10. As the switch passes beyond position 9, the circuit of relay 1108 is opened at the left upper contact of cam 1316 causing said relay to release and disconnect ground from the perforator conductors.

The called subscriber's number, having been punched in code form on the tape being produced by reperforator 1420, a space is again interposed between the last digit and the information that follows, that is, the call charge. Therefore, when the switch reaches position 10 a previously traced circuit for relay 1318 is again closed, operating said relay and grounding conductors 537 and 533 for operating the magnet of the perforator to punch the code of the space character. At the end of the distributor brush revolution, the aforetraced circuit of magnet 1304 is again closed and the switch advanced to posi-

tion 11. As it passes beyond position 10, the circuit of relay 1318 is opened and ground is disconnected from the perforator conductors. In positions 11 and 12 space characters are punched in each of those positions in the manner already described, for the purpose of advancing the printer carriage to the right and to the proper position for printing the charge characters on the bill form.

In position 13, the switch 1310 awaits the registration of the call charge which is evidenced by the operation of relay 1321. This registration is made as follows:

At the time ground was applied to conductor 438, relay 1501 was operated as already described. This relay, in operating, connects ground to its outer contact, bottom outer back contacts of relay 1512, to conductor 1546. This conductor now supplies ground to the contacts of the relays in registers 900, 910 and 920, and these registers, it will be recalled, contain locked therein the registration of the starting time of a conversation in terms of three digits which, for the local call under illustration, have been assumed to be 274. On its inner contacts relay 1501 closes a circuit which extends over the top inner back contact of relay 1512, top contacts of relay 1505, inner back contacts of relay 1502, interrupter contacts and winding of magnet 1503 of rotary switch 1510 which is of the type shown in the above-mentioned Patent 1,472,465, to grounded battery. Magnet 1503 operates and advances its brush 1504 over the terminals of its arc to which are connected the ten conductors from registers 900 to 1000, the conductor connecting with the No. 1 contacts of the relays in registers 900 and 1000 being connected to the first terminal, the conductor extending to the zero contacts of said relays being connected to the last terminal while the intermediate conductors are distributed among the remaining terminals in the proper numerical order.

Since the digit 2, representing the first digit of the start conversation time, resulted in the operation and locking of relays 901, 902, 905 and 906 in register 900, then the ground on conductor 1546 will be extended over the No. 2 contacts of said relays to the second terminal of the arc of switch 1510. Hence when brush 1504 has reached the second terminal of its arc, a circuit is completed to the winding of relay 1502. Relay 1502 operates, opens the circuit of switch magnet 1503 and, over its outer contacts, closes one set of contacts in the circuit path of relay 1505. The switch brush is now connected with the second terminal on the arc. At the same time that a circuit is closed for switch magnet 1503, three other circuits are closed as follows: (1) ground on the inner contacts of relay 1501, top inner back contacts of relay 1512, top contacts of relay 1505, bottom inner back contacts of relay 1511, bottom contacts of relay 1507, interrupter contacts and winding of magnet 1509 of rotary switch 1520 to grounded battery; (2) ground as traced to the bottom inner contacts of relay 1511, bottom middle back contacts of said relay, bottom contacts of relay 1513, interrupter contacts and winding of magnet 1514 of rotary switch 1530 to grounded battery; (3) ground as traced to the contacts of relay 1511, in parallel thereto over the bottom inner back contacts of relay 1512, winding of relay 1516 to grounded battery. Magnet 1509 of switch 1520 operates and steps its brushes over the terminals of their cooperating arcs until brush 1508 reaches a

grounded terminal whereupon an obvious circuit for relay 1507 is completed. The conductors connected to each of the several terminals of the arc associated with brush 1508 extend to the contacts of the relays in registers 910 and 1010, that is, to the two registers which record the second digit, respectively, of the start and finish time of the conversation. Inasmuch as the second digit of the start conversation time has been assumed to be 7, resulting in the operation and locking of relays 911, 912, 913 and 916, the ground on conductor 1546 is extended through the No. 7 contacts of said relays to the seventh terminal in the arc of switch 1520 accessible to brush 1508. Hence when the switch has advanced brush 1508 to the seventh terminal, a circuit is completed over said brush, winding of relay 1507 to grounded battery. Relay 1507 operates, opens the circuit of magnet 1509, prevents the switch from taking any further steps and closes another contact-set in the circuit path of relay 1505.

In the same way, magnet 1514 of switch 1530 steps its brushes over successive terminals of their respective arcs until brush 1515 makes contact with a grounded terminal, whereupon a circuit is completed for relay 1513. The conductors connected to each of the several terminals of the arc associated with brush 1515 extend to the contacts of the relays in registers 920 and 1020, that is, to the two registers which record the third digit, respectively, of the start and finish time of the conversation. Inasmuch as the third digit of the start conversation time has been assumed to be 4, resulting in the operation of relays 922, 924 and 926, the ground on conductor 1546 is further extended through the No. 4 contacts of said relays to the fourth terminal in the arc of switch 1530 accessible to brush 1515. Hence when the switch has advanced brush 1515 to the fourth terminal of its arc, a circuit is completed over said brush, winding of relay 1513 to grounded battery. Relay 1513 operates, opens the circuit of magnet 1514 to prevent the switch from taking any further steps and completes a circuit extending from ground on its top contacts, top inner back contacts of relay 1511, top contacts of relay 1507, bottom contacts of relay 1502, winding of relay 1505 to grounded battery. Relay 1505 operates to perform functions noted hereinafter.

In the meanwhile when relay 1516 operated, it closed a locking circuit through the winding of relay 1512, contacts of relay 1516 to ground on the inner contacts of relay 1501. Relay 1512, however, is prevented from operating at this time by the connection of ground to the other side of its winding through its own bottom inner back contacts, top contacts of relay 1505, top inner back contacts of relay 1512 to ground on the inner contacts of relay 1501.

Thus until switches 1510, 1520 and 1530 take settings which correspond to each of the digits of the start conversation time, relay 1516 is operated and relay 1512 is short-circuited. When the setting is completed, as evidenced by the operation of relay 1505, the short circuit around the winding of relay 1512 is removed causing said relay to operate and lock in series with relay 1516. Should the brushes of any or all of the switches be resting on arc terminals immediately grounded by the extension of ground on conductor 1546 through the operated contacts of the relays in the start conversation registers 900 to 920, inclusive, then the particular cut-in

relays effected; that is, relay 1502 or 1507 or 1513, or all of them, will be immediately operated and the particular switch magnet whose circuit is opened by the operation of the relay will thereby be prevented from taking any steps. Another circuit is now completed extending from ground on the inner contacts of relay 1501, top inner front contact of relay 1512, winding of relay 1511, to grounded battery, causing said relay to operate. Although the operating circuit of relay 1505 is now opened at the top inner contacts of relay 1511, yet the relay will not release since, by relay 1511 making its top inner front contact, a holding circuit is now provided for relay 1505, said relay being sufficiently slow in releasing so as to not break its contacts in the interval of transition from one circuit to another.

When relay 1512 operates, ground is disconnected from conductor 1546 and, through the bottom outer front contacts of said relay, ground is connected to conductor 1552 which, in turn, extends to the commoned contacts of all relays in the finish conversation registers 1000, 1010 and 1020. The removal of ground from conductor 1546 opens the circuits of relays 1502, 1507 and 1513 which now release causing, in turn, the release of relay 1505. The ground on conductor 1552 now extends by way of the operated relays in registers 1000, 1010 and 1020 to one of the terminals in each of the switches 1510, 1520 and 1530. Since the finish conversation time for the call has been assumed to be represented by digits 4, 6 and 2, terminal 4 will be grounded in the arc of switch 1510, terminal 6 in that of switch 1520 and terminal 2 in that of switch 1530. If any of the terminals grounded are the same as those previously grounded for the start of the conversation time, any of the relays 1502, 1507 and 1513 will, of course, operate. This, however, produces no effect at the present time except in the case of relay 1513 in which, if it operates immediately upon the connection of ground over conductor 1552 to the contact of the arc to which brush 1515 is engaged, the operation of relay 1551 is prevented as explained hereinafter. On the other hand, if at the time relay 1511 operates and the self-interrupting circuit for magnet 1514 is established, relay 1513 has not operated, a circuit is completed for relay 1551 which extends from grounded battery through the lower winding of said relay, bottom outer contacts of relay 1511, back contacts of relay 1513 to ground on the bottom next to the inner contacts of relay 1511. Relay 1551 operates and locks in a circuit over its upper winding and inner front contacts, conductor 1547 to ground on the bottom contacts of relay 1404.

The purpose of operating relay 1551 if switch 1530 takes a step between the start and finish conversation time is to indicate the fact that if tenths of a minute have been consumed as a part of the conversation time, then an additional minute has to be added to the total conversation time for charging purposes since conversation time is usually charged for in terms of minute units or "fractions thereof."

After the operation of relay 1511, a circuit is closed extending from interrupter 1506 (which may be driven by any suitable means at the speed required for the performance of the functions described below), top outer contacts of relay 1511, bottom contacts of relay 1518, winding of relay 1517, to grounded battery. At the closure of the interrupter and the consequent operation of relay 1517, interrupter relays 1538 and 1537

operate, the former on the closure of the interrupter over a circuit extending from ground on the inner contacts of relay 1517, outer back contacts of relay 1537, winding of relay 1538 to grounded battery. Relay 1538 operates and closes a locking circuit for itself through the winding of relay 1537 and its own contacts to ground on conductor 1547. Relay 1537, however, does not operate at this time since it is short-circuited by the operating ground for relay 1538. However, as soon as the interrupter opens its contacts, relay 1517 releases and relay 1537 operates in the above locking circuit.

It will be recalled that the office Halifax, marked by relay 500, was assumed to be located in zone 1 which meant, of course, the operation of relay 1112 at the time relay 500 operated.

In this disclosure "zone 1" is assumed to mean that calls completed to any office within the zone will be charged for at the rate of five cents for the first five minutes of conversation period and five cents thereafter for each additional five minutes or fraction thereof. Consequently, on the next closure of the interrupter 1506 and the subsequent operation of relay 1517, a circuit is closed which extends from ground on the outer contacts of relay 1517, inner front contacts of relay 1537, conductor 1548, inner contacts of relay 1112, conductor 1549, left inner back contacts of relay 1544, winding of relay 1545 to grounded battery. If the office Halifax had been located in zone 2, which means that twice the unit charge prevails for the initial period of conversation and a unit charge for three minutes of overtime, then the right contact of relay 500 would have been cross-connected to the winding of relay 1113 and the above circuit would have been traced from ground on conductor 1548, inner contacts of relay 1113, conductor 1534, back contacts of relay 1542, winding of relay 1543 to grounded battery. If, on the other hand, the office had been located in zone 3 wherein the initial charge is three times the unit charge for an initial conversation period of five minutes and a unit charge for two minutes of overtime or fraction thereof, the contact of relay 500 would have been extended to the winding of relay 1114 in which event the above circuit would then be completed over the inner contacts of relay 1114, conductor 1535, back contacts of relay 1539, winding of relay 1541, to grounded battery. In the event that the office is in zone 3 and relays 1539 and 1541 are operated on the first set of interruptions, the next closure of the interrupter will cause a circuit to be completed for relay 1543 which extends from ground on conductor 1535 as already traced thereto, front contacts of relay 1539, back contacts of relay 1542, winding of relay 1543 to battery. Relay 1543 operates and locks itself through the winding of relay 1542 to ground on conductor 1547; said last-mentioned relay, however, remaining short-circuited until the insulating period of the interrupter is reached, at which time said relay operates and extends conductor 1535 to the armature of relay 1544. On the succeeding closure of the interrupter, the circuit is completed to the winding of relay 1545 which operates and locks through the winding of relay 1544 to ground on conductor 1547, said last-mentioned relay, however, remaining short-circuited until the insulating period of the interrupter is reached, at which time said relay operates to perform functions noted hereinafter. Should the office be in zone 2 and relays 1542 and 1543 are operated on

the first set of pulse interruptions, then the next set of pulse interruptions will cause the operation and locking of relays 1544 and 1545 in the manner described. Assuming, however, that the called office is in zone 1, then, when relay 1545 operates, it closes a locking circuit for itself extending from ground on conductor 1547, contacts of relay 1545, winding of relay 1544, winding of relay 1545 to grounded battery. Relay 1544, however, is maintained short-circuited by the operating ground for relay 1545 so that as long as the interrupter is on the grounded segment, relay 1545 remains operated and relay 1544 remains short-circuited.

In the meanwhile and before relay 1517 releases, another circuit is completed which extends from ground on the inner contacts of relay 1517, outer front contacts of relay 1537, left outer back contacts of relay 1544, conductor 1563, upper back contact of relay 1605, conductor 1649, winding of switch magnet 1401 of switch 1400 to grounded battery and in parallel therewith over the lower back contact of relay 1403 to grounded battery through the winding of magnet 1325 of the totalizing switch 1330. The magnets 1401 and 1325 operate, and since the switches are of the back stroke type disclosed in the above-mentioned Patent 1,472,465, prepare the brushes 1405, 1435 and 1434 of switch 1400 and brushes 1328, 1329 and 1331 of switch 1330 to advance on the release of the magnets, the brushes being on their normal resting contacts at the time the above circuit is closed. Hence, when the interrupter engages an insulating segment and relay 1517 releases, the switch magnets release, advancing their respective brushes one step over each of their separate cooperating arcs while relay 1544 operates and locks in series with relay 1545.

The advance of the brushes of switches 1400 and 1330 one terminal on their respective arcs marks one charge unit for the call which, at this time, is merely the charge for the initial period of conversation and is registered in advance of marking the actual time consumed as recorded by the difference in setting of switches 1510, 1520 and 1530 in response to the setting of the start and finish time of conversation registers.

If the office Halifax had been located in zone 2 for which two charges are made for an initial period, switches 1400 and 1330 would be made to take two steps because two make and break cycles of the interrupter 1506 would be taking place in the time taken to operate the two counting relay sets 1542—1543 and 1544—1545. In the same way, if the office had been located in zone 3 for which three unit charges are made for the initial period and for which the circuit for the previously mentioned counting relays is completed over conductor 1535 as described, switches 1400 and 1330 would be made to take three steps because three interrupter cycles of the interrupter 1506 would be taking place in the time taken to operate the three counting relay sets 1539—1541; 1542—1543 and 1544—1545.

When relay 1544 operates and relay 1517 re-operates on the next closure of the interrupter, ground on conductor 1548 is now traced as before to conductor 1549, front contacts of relay 1544, top middle front contact of relay 1512, bottom outer back contact of relay 1505, winding of stepping magnet 1509 to grounded battery, operating said magnet and preparing brushes 1508 and 1560 to take a step. At the same time a parallel circuit is completed extending from

ground on conductor 1549, front contacts of relay 1544, outer back contacts of relay 1532, conductor 1540, outer contacts of relay 1112, conductor 1536, back contacts of relay 1521, winding of relay 1519 to grounded battery, causing relay 1519 to operate and establish a locking circuit for itself through the winding of relay 1521, contacts of relay 1519, left contacts of relay 1531, to ground on conductor 1547. Relay 1521 does not operate at this time due to the operating ground for relay 1519 being connected to the battery side of its winding. When the interrupter 1506 advances to an insulating segment and relay 1517 releases, ground is disconnected from conductor 1548, and hence from conductor 1549, thereby causing the operation of relay 1521, which now locks in series with relay 1519, and the release of magnet 1509 which now advances brushes 1508 and 1560 one step.

At the next operation of the interrupter, ground on conductor 1549 again completes the circuit of magnet 1509 while the ground on conductor 1536 is now advanced over the front contacts of relay 1521, back contacts of relay 1523, winding of relay 1522 to grounded battery for the purpose of operating the counting relay set 1522—1523. On the break period of the interrupter relay 1523 operates and magnet 1509 releases advancing the brushes 1508 and 1560 one step.

Thus with each conducting and insulating segment of the interrupter 1506, the minute switch 1520 is advanced one step and one set of counting relays in the group of relays 1519—1529 is operated; the process continuing until brush 1508 is advanced to the grounded terminal marked by the operated register 1010. It will be remembered, however, that switch 1520 was originally set on the seventh terminal of the arc in response to the digit 7 of the minutes setting of the start conversation register 910 and that the terminal grounded by the minutes setting of the minutes finish conversation register 1010 is 6. This means that the switch brushes have to take nine steps before they can be advanced to the sixth terminal on their arcs. Consequently when, after the third cycle of interrupter operations, brushes 1508 and 1560 have been advanced to their respective zero terminals, a circuit is completed which extends from ground on the top outer contacts of relay 1512, brush 1560 and cooperating terminal, winding of relay 1561 to battery. Relay 1561 operates and closes an obvious circuit for switch magnet 1503 of the ten-minute switch 1510. When the interrupter makes with its insulating segment and the brushes of switch 1520 are advanced to the first terminals, relay 1561 is released, causing thereby the release of magnet 1503 and the advance of switch 1510 to the next or No. 3 set of terminals.

In the meanwhile, and at the time the brushes of switch 1520 have advanced to their second terminal and the interrupter has made five cycles of operation beginning with the cycle which first operated magnet 1509, the five sets of counting relays 1521 to 1529, inclusive, have been operated. These five steps are equivalent to the period of conversation for which one charge has already been made as previously described.

It will be noted, however, that in the call being illustrated, the start conversation digits are assumed to be 274 and the finish conversation digits 462 which give a total of nineteen minutes of conversation time as completely described in the parent patent above-mentioned. Since, however,

a charge for the first five minutes has been made in advance by the operation of switches 1400 and 1330 at the time the circuit of their respective magnets was closed through the back contacts of relay 1544 and the release of said switches when relay 1544 operated, it now becomes necessary to make three other additional charges and count off fourteen more minutes, each charge being made in advance of the counting.

At the end of the fifth cycle of operation and release of relay 471, the brushes of switch 1520 will be resting on their respective second terminals, and relays 1528 and 1529 will have been operated. With the operation of relay 1529 a parallel circuit is closed for relays 1531 and 1532.

Relay 1532 locks in a circuit over its right winding and inner front contact to ground on conductor 1547 while the operation of relay 1531 unlocks the counting relay group 1519-1529 causing these relays to release. The release of relay 1529 releases relay 1531 which, in turn, re-establishes the locking ground for the counting relay group 1519-1529.

In the meanwhile, the operation of relay 1532 causes a set of contacts in the circuit of relay 1533 to be closed at its outer front contact. If, now, overtime is to be charged as is evidenced by the fact that the brushes of switch 1520 have not yet been stepped to the terminal marked by the register 1010, the interrupter ground paths remain undisturbed and the circuit of relay 1533 is completed on the first ground pulse which marks the beginning of the overtime count. This circuit is completed from ground on conductor 1549, left inner contacts of relay 1544, outer front contacts of relay 1532, conductor 1555, right back contacts of relay 1558, winding of relay 1533 to grounded battery thereby causing this relay to operate and close a path for relay 1558 over its inner contacts to ground on the right contacts of relay 1531. Relay 1558 does not operate at this time since it is shunted on the other side of its winding by ground on conductor 1555.

Over its outer contacts relay 1533 closes the operating circuit of magnets 1401 and 1325, which circuit extends from ground on conductor 1555, left contacts of relay 1558, outer contacts of relay 1533, conductor 1563, top inner back contacts of relay 1605, conductor 1649, winding of magnets 1401 and 1325 to grounded battery. The magnets operate and prepare to advance their brushes 1405, 1435, and 1434 and 1328, 1329 and 1331 one step.

In the meanwhile the interrupter ground extending to conductor 1536 via conductor 1548, inner contacts of relay 1112, conductor 1549, left inner front contacts of relay 1544, outer front contacts of relay 1532, conductor 1555, middle contacts of relay 1112 to conductor 1536, and has again been effective in operating the counting relay 1519 while that on conductor 1549 has likewise been effective in operating magnet 1509 over a previously described path so that, when relay 1517 releases in response to interrupter 1506 making with an insulating segment, the following operations take place: (1) relay 1558 operates in series with relay 1533 and opens the circuit of magnets 1401 and 1325 which now advance their brushes one step to register another charge; (2) relay 1521 operates and locks in series with relay 1519 over a previously described circuit; and (3) magnet 1509 releases and advances its brushes to the third set of terminals.

Thus on the first pulse count of the overtime period, the proper charge is made on the switch

1400 and on the totalizing switch 1330, the first set of counting relays in the group 1519-1529 is operated and switch 1520 is advanced one step. From this point on the circuit reoperates to count off five pulses for an additional five-minute period. When, however, brush 1508 reaches terminal 6, a circuit is completed for relay 1507 which extends from ground on conductor 1552, through the No. 6 contacts of the operated relays of register 1010 (relays 1011, 1013, 1015 and 1016, which have responded to the tens digit 6 of the finish conversation time), terminal 6 and brush 1508, winding of relay 1507, to grounded battery. Relay 1507 operates and closes a set of contacts in the path of the winding of relay 1505. Switch magnet 1509, however, is not prevented from further stepping since the circuit of the magnet is, at this time, independent of relay 1507. When this switch reaches terminal 7 and relay 1531 operates in response to the operation of the last set of counting relays 1528-1529, the counting relays are released and relays 1533 and 1558 are likewise released. Relay 1532, however, remains locked to ground on conductor 1547.

The charge made for overtime is not necessarily the same as the initial charge either for the same elapsed period or for any fraction thereof. For the local zone, the most prevalent practice is to charge for overtime on the same basis as the initial charge, that is, one unit charge for the first five minutes of conversation and one unit charge thereafter for each additional five minutes or fraction thereof. The computer herein disclosed and described is arranged for charging on this basis. Relay 1112 is the local zone relay whose operation marks the fact that the initial charge should be one unit for five minutes by virtue of having caused the operation of counting relays 1544 and 1545 and that the overtime shall be charged on the basis of one unit charge for every five minutes thereafter by virtue of reclosing the path to counting relays 1519 and 1521 after the first charge to count off additional increments of five minutes thereafter. The overtime charge for the two other zones, that is, the zones marked by relays 1113 and 1114 is made on the basis of charging one unit for three or two minutes of overtime where the initial charge is two units for the first five minutes and three units for the first five minutes, respectively. Thus an office located in the second zone would be marked by the operation of relay 1113 and a call to this office would be charged for on the basis of two charge units for the first five minutes and one charge unit for every three minutes of conversation thereafter. Accordingly, the operation of relay 1113 would cause the operation of counting relays 1542-1543 and 1544-1545. On the first set of pulses that cause the operation of counting relays 1542 and 1543, a previously traced circuit from the inner contacts of relay 1517 through the back contacts of relay 1544, causes the operation of switch magnets 1401 and 1325, advancing the brushes of said switches and recording one charge. On the next set of interruptions which cause the operation of counting relays 1544 and 1545, the same circuit to switch magnets 1401 and 1325 is again completed and the switches, by advancing their brushes to the next set of terminals, register the second charge. Thereafter, the charging switch 1400 and the totalizing switch 1330 will advance under the control of relay 1533 as already described except that the number of counting relays operated prior to the closure of the circuit for relay 1532 and

that of relay 1533 depends, of course, on the number of minutes which constitute the overtime period. In the case of the zone marked by relay 1113, the overtime period is assumed to be three minutes. Consequently the ground on conductor 1555 is carried through the middle set of contacts of relay 1113, through conductor 1556 to the back contact of relay 1525 which, on pulses from interrupter 1506 and consequent operations of relay 1517, causes the operation of the three sets of counting relays 1524—1525, 1525—1527; and 1528—1529.

In the same way charges are made for the offices in zone 3 which are all marked by zone relay 1114. The charges for the offices in this zone are made on the basis of three charge units for the first five minutes and one charge unit for every two minutes thereafter. The operated condition of relay 1114 causes the operation of the three successive sets of counting relays 1539—1541; 1542—1543 and 1544—1545 with three successive operations of the charging switch 1400 and the totalizing switch 1330. Ground on conductor 1555 is, in this case, carried through the middle contacts of relay 1114 to conductor 1557 which extends to the back contact of relay 1527 causing thereby the operation of the two sets of counting relays 1526—1527 and 1528—1529 and the consequent operation of the charging switch 1400 and the totalizing switch 1330 thereafter to record one charge for each interval of two minutes counted off by the counting relays.

Going back to the charging operations for the local call under consideration and remembering that two charges have been registered by switch 1400 and 1330 for the ten pulses already counted, and further remembering that brush 1508 is connected to terminal 7 at the time the last charge is made, two more additional charges are still to be made for a total conversation time of nineteen minutes. With brush 1508 on terminal 7, the stepping circuit for magnet 1509 and the counting circuit of the counting relay group remain undisturbed so that another full count of five pulses again takes place during which time brush 1508 is advanced to terminal 2, the five sets of counting relays are again energized and another charge is registered in advance of the count on switches 1400 and 1330 in the manner described, thus making a total charge of three units for fifteen minutes of conversation. When, however, brush 1560 has advanced to the zero terminal of its arc (that is, during the third pulse count) the previously described circuit of relay 1561 is again completed, whereupon this relay energizes and completes the circuit of magnet 1503 which, when relay 1561 releases as a result of brush 1560 leaving the zero terminal, advances brush 1504 to terminal 4. Terminal 4, it will be remembered, is the terminal to which the ground on conductor 1552 has been extended by the operated combination of relays in register 1000 so that a circuit is now completed for relay 1532 which operates but performs no function at this time.

In the meanwhile switch 1520 continues to step in response to interrupter relay 1517 until its brushes reach the sixth terminal, at which time all the counting relay pairs up to and including relays 1526—1527 have been operated. Since, however, the ground from conductor 1552 is extended to terminal 6 as already described, relay 1537 operates and a previously traced circuit is now completed for relay 1505, operating said relay and opening the stepping circuit of magnet

1509. It will be remembered, however, that at the time brush 1515 of switch 1530 advanced from terminal 4, grounded by the tenths-of-a-minute start conversation register 920 to terminal 2, grounded by the tenths-of-a-minute finish conversation register 1020, brush 1559 of said switch passes through the zero terminal of its cooperating arc. Since relay 1551 was operated as a result of the movement of brush 1515, then, when brush 1559 made contact with the zero terminal, a circuit was completed for relays 1553 and 1554 extending from grounded battery through the winding of relay 1553, winding of relay 1554, bottom contacts of relay 1551, zero terminal and brush 1559 to ground on the top outer contacts of relay 1512. Both of these relays operate and lock to ground on conductor 1547 through the contacts of relay 1553. Under these circumstances the operation of relay 1505 at the time when relays 1502 and 1507 operate in response to brushes 1504 and 1508 coming to rest on the terminals grounded by the finish conversation registers, causes a circuit to be completed for relay 1518 which extends from grounded battery through the winding of said relay, outer contacts of relay 1554, outer front contacts of relay 1551, bottom inner front contacts of relay 1505, top inner contacts of relay 1512, inner contacts of relay 1501 to ground. Relay 1518 operates and opens the circuit of relay 1517 which is released and placed out of control of interrupter 1506, thereby stopping further pulse counting. On the other hand, if at the time switch 1530 advanced from the start conversation position to the finish conversation position, brush 1559 does not pass through the zero terminal of its cooperating arc, relays 1553 and 1554 do not operate. Consequently at the termination of the pulse count as determined by the operation of relay 1505, there is no circuit for operating relay 1518, relay 1517 will still be responsive to interrupter 1506 and the pulses continued for one more count during which time an additional set of counting relays in the group 1519—1529 will be operated while the circuit which was previously completed to magnet 1509, with relay 1505 down will be now transferred over the bottom outer front contact of relay 1505, inner back contacts of relay 1554, winding of relay 1553 to grounded battery. Relay 1553 will operate and, at the time that interrupter 1506 is on its insulating segment, relay 1554 will also operate and further lock in series with relay 1553. Relay 1518 then operates as before.

The reason for the above operations is to insure correct charges in those cases where the conversation time exceeds chargeable intervals by any fraction of a minute, in which event an additional minute must be added to the total conversation time. For instance, if the total conversation time for a zone 1 call is exactly twenty minutes, four unit charges will be made, each at the beginning of a pulse count of five. In such a case switch 1530 will not advance its brushes between the start and finish conversation registrations and relay 1551 will not have been operated. Therefore at the end of the fourth pulse count, relays 1507 and 1502 will operate as described, in turn operating relay 1505 which completes a circuit for relay 1518 extending from grounded battery through its winding, top outer back contacts of relay 1551, bottom inner contacts of relay 1505 to previously traced ground on the inner contacts of relay 1501. With the operation of relay 1518, relay 1517 is released to

prevent further counting and charging. On the other hand if the total conversation time is twenty and one-tenth minutes, five unit charges will have to be made. In this case, switch 1530 will have been advanced by its brushes one terminal and relay 1551 will have been operated as already described. But at the end of the fourth count pulse counting will not be stopped since, with the operation of relay 1551, the circuit of relay 1518 is not closed until relay 1554 operates after the reception of the first pulse count of another series after the fourth. However, since relay 1533 operates at the beginning of the first pulse count, the circuit of magnets 1401 and 1325 is closed to operate said magnets which, in operating, prepare their respective brushes to advance a step. At the end of the first pulse count, relay 1554 operates to stop further counting and relay 1558 operates to open the circuit of magnets 1401 and 1325 which release and advance their brushes one step to register an additional charge.

The operation of relay 1518 further closes a circuit which extends from ground through its upper contacts, conductor 1562, winding of relay 1321 to grounded battery. Relay 1321 operates and closes a circuit for magnet 1304 which extends from ground on the contacts of said relay, left lower contact of cam 1305, winding of magnet 1304 to grounded battery, operating said magnet and advancing the switch from position 13 to position 15. In this position a circuit is completed extending from ground on the right upper contact of cam 1306, right upper contact of cam 1316, conductor 1322 to brush 1408 of switch 1410. Switch 1410 is termed the "dollar" switch, and if the total charge accumulated on switch 1400 for any one call is less than a dollar, the brushes of switch 1410 will be resting on their zero terminal for reasons that will be pointed out hereinafter. Consequently with brush 1408 on the zero, or top, terminal the circuit is further extended to conductor 1413, bracket line 1319, conductor 1413, winding of relay 1100 to grounded battery. Relay 1100 operates and grounds the perforator conductors in the required combination for causing perforator 1420 to perforate (on the seventh segment of the commutator) the code of the digit 0 on the tape in the manner previously described.

When the distributor brush 1406 of perforator 1420 reaches its last segments, a previously described path is also closed to the right upper contact of cam 1305 and the circuit is now completed thereover to magnet 1304 which, on operating, advances the sequence switch 1310 to position 16. As the switch passes position 15, the circuit of relay 1100 is opened at the right upper contact of cam 1316 and relay 1100 releases in consequence to disconnect ground from the perforator conductors.

After punching the dollar designation it is necessary to perforate the code of the "period" character so that the dollar units of the charge may be separated from the fraction of a dollar. Consequently when the switch 1310 reaches position 16, a circuit is completed for relay 1323 which extends from ground on the right upper contact of cam 1306, left lower contact of cam 1317, winding of relay 1323 to grounded battery. Relay 1323 operates and grounds conductors 533, 534, 535, 536 and 537, the first four being for the code of the period character and the fifth for operating the start magnet 1426 of the perforator 1420. The period code is now perforated in the usual manner and, when the distributor brush 1406

makes with the last segments, a previously described circuit for magnet 1304 is completed through the right upper contact of cam 1305 to advance switch 1310 to position 17. As the switch passes beyond position 16 the circuit of relay 1323 is opened at the left lower contact of cam 1317 causing said relay to release and disconnect ground from the perforator conductors.

With switch 1310 in position 17 and with brushes 1405 and 1435 of the charging switch 1400 on the fourth terminal for a call involving a charge of four charge units or twenty cents if each charge unit is five cents, a circuit is completed from ground on the right upper contact of cam 1306, left lower contact of cam 1316, brush 1405 and fourth cooperating terminal, conductor 1414, bracket line 1319, conductor 1414, winding of relay 1102 (not shown) to grounded battery. Relay 1102 operates and grounds conductors 531, 532, 535, 536 and 537 to the perforator, all in accordance with the code of the digit 2 as previously described. The perforator now causes the code of said digit to be perforated immediately succeeding that of the period character and causes the circuit of magnet 1304 to be closed whereupon switch 1310 is advanced to position 18. As the switch passes beyond position 17 the circuit of relay 1102 is opened at the left lower contact of cam 1316 and said relay releases and disconnects ground from the perforator conductors.

With the switch in position 18, a circuit is completed which extends from ground on the right upper contact of cam 1306, right lower contact of cam 1316, brush 1435 and fourth terminal on the associated arc, conductor 1413, bracket line 1319, conductor 1413 in Fig. 8, winding of relay 1100 to grounded battery. Relay 1100 operates and grounds the perforator conductors required to perforate the digit 0 as already described. When the distributor brush 1406 of the perforator reaches the last segments, a previously described circuit for magnet 1304 is closed through the right upper contact of cam 1305 and switch 1310 is advanced to position 19. As the switch passes beyond position 18, the circuit of relay 1100 is opened at the right lower contact of cam 1316 causing said relay to release and disconnect ground from the perforator conductors.

It will be noted that the terminals of the arc to which brush 1435 has access are divided into two groups. The first group, consisting of the even terminals, are all connected to conductor 1413 for closing the circuit of relay 1100 which, when operated, causes the zero digit to be perforated. The other group, consisting of the odd terminals, are all extended to conductor 1415 which, in Fig. 8, is connected to the winding of relay 1105 (not shown). Relay 1105 when operated grounds conductors 535, 536 and 537 for causing the perforation of the digit 5. The reason for this is that since the charge unit is assumed to be five cents, the total charge for a call is always expressed in increments of five cent units below one dollar, the tens unit of the total charge being expressible in progressive digits from 1 to 9 and controlled by the arc cooperating with brush 1405 while the units digit is expressed either by 0 or by 5. Should the charge for any call amount to one dollar or more, then, when the brushes of switch 1400 have been advanced to the last set of terminals on the ninety-five cent pulse charge, relay 1402 operates. On the succeeding closure of interrupter 1506 when ground is connected to conductor 1563 to register the addi-

tional five-cent charge to make the added charges one dollar, a circuit is completed which extends from ground on said conductor as traced to conductor 1661, top back contacts of relay 1403, inner contacts of relay 1402, winding of magnet 1412 to grounded battery, operating said magnet and preparing the switch 1410 to advance its brushes to the next set of terminals. When the interrupter advances to its insulating segment, the ground is removed, magnet 1412 is released and the brushes are advanced to register the one dollar increment for the call. When switch 1400 has advanced to the normal terminal, relay 1402 is released. Thus every time switch 1400 makes one complete revolution in response to twenty charge units, switch 1410 is advanced one step to register said twenty charge units in terms of one dollar units; the number of such units which can be registered being limited only by the capacity of switch 1410 which, of course, can be extended to any figure desired. The code of the number of dollars to be perforated before the perforation of the period code character, is now controlled through brush 1408 of switch 1410.

In a similar manner if the totalizing switch 1330 has been advanced to the next to the last or ninety-five cents set of terminals, relay 1327 operates from ground over brush 1331 and on the next closure of interrupter 1506 when ground is connected to conductor 1563 to signify the addition of another five cents to make the total of one dollar, a circuit is completed over the lower back contact of relay 1403, inner contact of relay 1327, winding of magnet 1345 to grounded battery, operating said magnet preparatory to advancing the brushes of the dollar totalizing switch 1340. On the next opening of the interrupter 1506, magnet 1345 releases and the brushes of switch 1340 are advanced one step. When switch 1330 has advanced to normal, relay 1327 releases. Thus every time switch 1330 makes one revolution to totalize twenty charge units, switch 1340 is advanced one step to register said twenty units in terms of one dollar units. When the dollar totalizing switch 1340 has advanced to the next to the last or nine-dollar set of terminals, relay 1332 operates over a circuit extending from ground through brush 1336 and on the next closure of the circuit of magnet 1345 for the ten-dollar accumulation, a circuit is completed over the inner contact of relay 1332 from ground on conductor 1648, winding of magnet 1341 to grounded battery, operating said magnet preparatory to advancing the brushes of switch 1350. On the next opening of the circuit of magnet 1345, magnet 1341 releases and switch 1350 is advanced one step. When switch 1340 has advanced to normal, relay 1332 releases. Thus every time switch 1340 makes one revolution to totalize ten dollars in charges, switch 1350 is advanced one step.

Having completed the perforation of the call charge on the tape, it now becomes necessary to perforate thereon the code of each of two other characters, namely, the character required to signal the page printer to advance the bill form to the next line, commonly known as the "line feed," and then another character to return the page printer carriage to the position originally occupied by said carriage for printing the first letter of the office code of the previous call. This character is commonly known as the "carriage return" character. Hence when the switch 1310 is in position 19 a circuit is completed which extends from ground on the right upper contact of

cam 1306, right lower contact of cam 1317, winding of relay 1324 to grounded battery, operating said relay which, in turn, grounds conductors 532 and 537. A perforation in position 2 of the tape is the "line feed" code. When the perforation has been made, switch 1310 is advanced to position 20 over a previously described circuit and, when said switch passes beyond position 19 the circuit of relay 1324 is opened at the right lower contact of cam 1317 whereupon said relay releases and disconnects ground from the perforator conductors.

With the switch in position 20 a circuit is completed extending from ground on the right upper contact of cam 1306, right upper contact of cam 1317, winding of relay 1347 to grounded battery and, in parallel therewith over conductor 1326, winding of relay 1404 to grounded battery. Both relays operate. Relay 1347 grounds conductor 534 and 537 for operating the perforator to punch a hole in position 4 of the tape as the code of the "carriage return" character, while relay 1404 operates to perform functions noted hereinafter. When the distributor brush 1406 of the perforator 1420 has reached the last segments, a previously traced circuit for magnet 1304 is completed and the switch is advanced from position 20 to position 1, its normal position. As it leaves position 20, the circuit of both relays is opened, causing them both to release, relay 1347 disconnecting ground from the perforator conductors.

In the meanwhile the operation of relay 1404 disconnects ground from conductor 1547 as a result of which all counting relay pairs and relays 1532 and 1551 locked thereto are released. Relay 1518, however, does not release when relay 1551 releases because it has slow-releasing characteristics which permit it to remain operated until after relay 1551 has released whereupon a holding circuit is closed for relay 1518 over the top back contacts of relay 1551, bottom inner contacts of relay 1505, top inner contacts of relay 1512 to ground on the inner contacts of relay 1501. Relay 1404 further connects ground to the lower winding of relays 1403 and 1411. Both relays operate. Relay 1403 locks over its top winding and contact to ground on the arc of switch 1400 cooperating with brush 1434 if said brush is on any terminal of its commoned arc. A self-interrupting circuit is now completed for switch magnet 1401 which extends from grounded battery through its winding and interrupter contacts, bottom inner contacts of relay 1403 to ground on brush 1434. Relay 1403, on its bottom outer contacts, further opens the path of magnet 1325 of the totalizing switch 1340 so as to prevent any totalling operations during the time when the charging switches 1400 and 1410 are returning to normal. When brush 1434 reaches the terminal preceding the normal terminal, relay 1402 operates, provides a supplementary locking circuit for relay 1403 thereby preventing its release in the event that relay 1404 has released in the meanwhile, and completes a step circuit for magnet 1401 extending from ground on its outer contacts, bottom inner contacts of relay 1403, interrupter contacts of magnet 1401 to battery. The magnet now operates to restore its brushes to normal thereby causing the release of relay 1402 and the release of relay 1403 since, by this time, relay 1434 will have released. In the meanwhile relay 1411 has operated as already described and locked over its top winding and contacts to brush 1409 of switch

1410 if said switch is off normal, and closes a self-interrupting path for magnet 1412 to the same brush. If the switch is normal, that is, if the charge for the single call is less than a dollar, brush 1409 will be resting on its normal terminal and no self-interrupting circuit is closed for magnet 1412. On the other hand, if the call charge is more than a dollar, the above circuit for magnet 1412 is established and the switch brushes are restored to normal. The totalizing switches remain in the positions to which they have been set.

The operation of relay 1404 further connects ground to conductor 1421 which completes a circuit to the lower winding of relay 411 which locks over its upper winding and contact to ground on the top contact of relay 424. As soon as relay 411 operates, ground is disconnected from conductors 427 and 438 causing the registers in Figs. 3, 5, 6 and 7 and all relays depending upon said grounds to release, and further releases relays 1501 and 1302. Relay 1302 unlocks relay 1303 in preparation for the next call while relay 1501 releases all relays in the computer circuit of Fig. 12 which are locked thereto.

The operation of relay 411 further opens the shunting ground to resistance 451 whereupon the circuit of the distributor magnet 444 is again made operative to advance the distributor brushes 445 and 449 over their respective segments and to advance the tape to the next set of perforations. If the next call is a local call, relay 412 is operated as described, releasing relay 424 which in turn releases relay 411. Relay 411 now reconnects ground to conductors 427 and 438 in preparation for the decoding operations of the code perforations of the next call which, of course, will be the same as those already described.

#### *Toll call record*

The individual tape passing through distributor 400 contains the records of toll calls as well as local ones and since the record of each of the toll calls must likewise appear on the final tape prepared by perforator 1420, its code characters likewise must be decoded into characters that can be printed on the final bill. That is to say, the name of the city, the office and number therein, the total charge for the call and the date on which the call was made have to appear on the bill while the money charges have to be added, besides, on the switches 1330, 1340 and 1350 so as to be included in the total.

Let it be assumed, therefore, that the next call appearing on the individual tape is a long distance call to Chicago, Illinois, and that it was completed to a subscriber therein whose number is Evergreen 3721. The charge for the call may be further assumed to be \$3.75 and that it was made on July 31, 1933. In accordance with the procedure outlined in the above-mentioned parent patent for the establishment of a toll call, the toll operator will depress appropriate keys on the keyboard sender associated with her position to record on the primary tape "Chicago Ill. Evergreen 3721—JL. 31 '33—\$3.75." The order in which these notations are set down is, of course, purely arbitrary and may be changed to suit the routine requirements of any particular operating company.

It will be remembered that each group of notations for a call on the individual tape which is passed through distributor 400 is separated by a switching character code from the succeeding group of notations of the next call, and

that the notation following the switching character code is either that of the "new call" code if the call is local or that of an "operator" if the call is toll or long distance. If the call which follows the local call is another local call, then the alignment of the five holes of the new call code over the five selecting fingers of the sensing mechanism 400 will be effective in advancing the brushes of switch 415 to their respective first terminals as already described. On the other hand, if the next code which follows that of the switching character is the "operator" code, then this code consists of holes punched in positions 2 to 6, inclusive, of the tape. Consequently when sensing pins 2 to 6, inclusive, pass through these holes, a circuit is completed for relay 425 which extends from ground on the upper contacts of selecting finger 2 serially through similar contacts on the succeeding selecting fingers, lower winding of relay 425 to grounded battery. Relay 425 operates, locks in a circuit over its upper winding and upper inner contacts, lower back contacts of relay 412, inner back contacts of relay 411 to ground and unlocks relays 424, 411 and 410. An obvious circuit is now closed for relay 452 from the top outer contacts of relay 425 which is effective in operating this relay and opening the pulse conductors to the brushes of switch 415. At this time and for reasons already advanced, distributor brushes 445 and 449 are in contact with their respective normal segments so that when relay 425 operates, a circuit is completed which extends from ground through brush 449, upper middle contacts of relay 425, conductor 442, winding of relay 1422 of perforator 1430 to grounded battery. Relay 1422 operates and, through its inner contact, extends ground to the normal segment of commutator 1423 to complete a circuit through brush 1424, winding of start magnet 1426 to grounded battery. Over its outer contacts relay 1422 further closes a parallel branch of the same circuit to the winding of start magnet 1425 of distributor 1430 which is of the same general mechanical construction as the distributor of reperforator 1420. Both magnets operate and since the motor which controls the movement of distributor brush 1406 is synchronized with the one which controls the movement of brush 1424, both brushes will reach their first commutating segments at the same time. However, since the motor which is driving brushes 445 and 449 is also synchronized with each of the motors which drive the brushes of commutators 1420 and 1430, brushes 445 and 449 will reach their respective first commutating segments at the same time that brushes 1406 and 1424 will reach theirs.

By this time the individual tape has been advanced to the code of the first letter of the city to which the toll call is completed. If the city happens to be Chicago as we have assumed, then this letter will be "C" the code of which is a hole punched in the second position of the tape, another in the third and another in the fourth. Consequently when the sensing pins 2, 3 and 4 pass through the perforations of this code, ground is connected to the conductors which extend to segments 2, 3 and 4 of commutator 447 so that when brushes 445 and 449 reach their respective second segments (at which time brushes 1406 and 1424 will reach theirs) a circuit is completed from ground on segment 2 of commutator strip 447, brush 449, upper middle contacts of relay 425, conductor 442, winding of

relay 1422 to grounded battery. Relay 1422 operates on this pulse and connects ground through its middle set of contacts to the upper strip of commutator 1423. Since, at this time, brush 1424 is in engagement with segment 2 of this commutator, the circuit is completed to conductor 532, segment 2 and brush 1406 of perforator 1420, punch magnet 2 of said perforator to grounded battery. This magnet now operates to set the corresponding perforator punch to perforate a hole in position 2 of the tape. It will be observed that at the same time that the circuit is completed to magnet 2 a parallel circuit is completed to relay 1431. This relay operates and locks to ground on interrupter 1429 as will be the case with each of the relays in the group 1427—1428, each of which will operate at the time a ground pulse is transmitted over the commutator segments to which they are separately connected. However, for reasons which will shortly appear, these relays will perform no function at this time. When brush 449 has passed beyond segment 2, relay 1422 is released and magnet 2 is likewise released. In the same way when brush 449 reaches segments 3 and 4, respectively, the above circuit for pulse relay 1422 is reclosed and since brush 1424 reaches corresponding segments on its commutator at the same time that brush 449 reaches the correspondingly numbered segment, a circuit is closed, in succession to magnets 3 and 4, respectively, of perforator 1420 which will set their corresponding punches to perforate holes in positions 3 and 4 of the tape. In this manner the code of the letter C on the individual tape is transmitted without change to perforator 1420 and caused thereby to be punched on the final tape.

In the same manner the code of each of the other letters or symbols punched in the original tape is caused to be punched in the final tape. These operations are all identical, each code being transmitted and punched during one revolution of the three sets of commutator brushes above-mentioned. For this reason further description of the punching of the code of all the other symbols is omitted.

When the individual tape is in the position to transmit the code of the dollar sign, two pulses are transmitted, one in position 2 and the other in position 6. While this results in the punching of a hole in position 2 and another in position 6 of the tape, it also results in the operation of relays 1431 and 1428 which further lock over their inner contacts to ground on interrupter 1429. This interrupter is carried on the shaft of distributor brush 1424 and makes its upper contact during the time that brush 1424 is passing over the length of the commutator from the normal segment to segment 6, inclusive, and its lower contact during the travel across the insulating segment extending between segment 6 and the normal segment. Hence when brush 1424 has advanced to segment 6, a circuit is completed from ground on the outer normal contacts of relay 1427, outer make contacts of relay 1431, outer back contacts of the relays connected to segments 3, 4 and 5, outer make contacts of relay 1428, conductor 1432, upper winding of relay 1653 to grounded battery. Relay 1653 operates, closes an obvious circuit to "dash-pot" slow operate alarm relay 1655, locks in a circuit extending from grounded battery through its lower winding and bottom inner contacts, conductor 1654, to ground on the upper outer con-

tacts of relay 1638, disconnects ground from brush 1603 of rotary switch 1600 which is of the type disclosed in the above-mentioned Patent 1,472,465, and closes the path of switch magnet 1601 from grounded battery through its winding, middle contacts of relay 1653, conductor 1433 to the lower contact of interrupter 1429. When brush 1424 is on the insulating segment between commutating segment 6 and the normal segment, the upper contact of interrupter 1429 breaks from the driven contact which now makes with the lower contact thereby releasing relays 1431 and 1428, and further completing the circuit of switch magnet 1601. The magnet now operates preparatory to advancing its brushes on its release. When brush 1424 makes its normal segment the lower contact of interrupter 1429 is opened, the switch magnet is released and the brushes of switch 1600 are advanced to their respective first terminals.

All of the above operations take place, of course, as a result of the individual tape having the punched holes of the dollar sign code aligned over and passed through by the distributor sensing pins of mechanism 400. When this tape is advanced to the punch holes of the next code, that is, the code of the numeral 3 which consists of a hole in position 1 and another in position 6 of the tape, sensing pins 1 and 6 pass through aforesaid holes and cause the sequential grounding of conductors 531 and 536 whereupon corresponding holes are punched on the tape associated with perforator 1420 in the manner described while, at the same time, the grounds on conductors 531 and 536 are extended to brushes 1611 and 1616, respectively, of switch 1600. The ground on conductor 1611 completes a circuit which extends over the first terminal to which it is connected, lower winding of relay 1621 to grounded battery. This relay operates and then locks in a circuit over its upper winding and contact to ground on conductor 1654. In the same way the ground on brush 1616 completes a circuit through the terminal to which it is connected, lower winding to relay 1626 to grounded battery. This relay also operates and locks in a circuit through its upper winding and contacts to ground on conductor 1654. At the same time, relays 1427 and 1428 also operate and lock as brush 1424 makes one revolution, but inasmuch as no circuits are controlled by these relays except in the required combination called for by the code of the dollar sign, that is, relays 1431 and 1428 operated and the remainder unoperated, the operation of the six relays connected to the segments of commutator 1423 in any other combination is ineffective.

While the brushes of switch 1600 are connected to their respective first terminals, a circuit is closed for relay 1602 which extends from ground on brush 1604 and the first terminal of the arc, lower winding of relay 1602 to grounded battery. Relay 1602 operates and then locks in a circuit over its upper winding and contact to ground on conductor 1654. This relay performs no function at this time but is operated in advance to prepare a circuit at a later time for relay 1605 as described hereinafter.

At the end of the revolution of brush 1424 and also of brushes 1406, 445 and 449, interrupter 1429 again closes its lower contact and completes the previously described circuit of magnet 1601 which operates and, when the interrupter opens its contact, releases to advance the brushes of switch 1600 to their second respective terminals.

The individual tape is now advanced to the next set of punchings which is that of a "period" since the operator may be required to punch the period code between the dollar and cents quotation and it is assumed, for purposes of illustration, that it will be so required. The code of the period character comprises holes punched in positions 3, 4, 5 and 6 of the tape and results in the punching of corresponding positions in the final tape being produced by perforator 1420. In this case, however, switch 1600, having been advanced to the second group of terminals which are blank, the period code has no effect on the circuit shown in Fig. 16.

When the individual tape is advanced to the code of the next digit which is that of the digit 7 the sensing pins 1, 2, 3 and 6 are operated, whereupon four pulses are sent as called for by the perforations in these positions, which require conductors 531, 532, 533 and 536 to be grounded in the sequence named. The code of the digit 7 is punched on the tape in the manner described while, as the punch magnets of perforator 1420 are operated, brushes 1611, 1612, 1613 and 1616 are grounded, switch 1600 having been advanced to position 3 in the meanwhile over a circuit path previously traced. Successive circuits are, therefore, completed extending: (1) from ground on brush 1611 and the third terminal of its arc, lower winding of relay 1631 to grounded battery, operating said relay and locking it through its upper winding and contact to ground on conductor 1654; (2) ground on brush 1612 and third terminal of its arc, lower winding of relay 1632 to grounded battery, operating said relay which locks over its upper winding and contact to ground on conductor 1654; (3) ground on brush 1613 and third terminal of its arc, lower winding of relay 1633 to grounded battery, operating said relay which now locks over its upper winding and contact to ground on conductor 1654; (4) ground on brush 1616 and third terminal of its arc, lower winding of relay 1636 to grounded battery, operating said relay which now locks over its upper winding and contact to ground on conductor 1654.

In the same way, when the individual tape is advanced to the code of the third digit, which is that of the code 5, two pulses are sent, one in the fifth pulse position of the various commutators and one in the sixth. Switch 1600, having been advanced to the fourth group of terminals in advance of relay 1422 responding to said pulses, brushes 1615 and 1616 are grounded in the manner described whereupon one circuit is completed from ground on brush 1615 and its fourth terminal, lower winding of relay 1645 to grounded battery causing said relay to operate and lock over its upper winding and contacts to ground on conductor 1654, and another circuit from ground on brush 1616, lower winding of relay 1646 to grounded battery, causing this relay to operate and lock over its upper winding to ground on conductor 1654. These two relays now close a circuit which extends from ground on the lower make contacts of relay 1646, lower back contacts of relays 1641, 1642, 1643, 1644, lower make contacts of relay 1645, winding of relay 1627 to grounded battery. Relay 1627 operates and performs functions which are described hereinafter.

At the end of the revolution of brush 1424, switch 1600 is advanced to the fifth set of terminals whereupon a circuit is completed extend-

ing from ground on brush 1604, lower contacts of relay 1602, winding of relay 1605 to grounded battery. Relay 1605 operates and, through its lower middle contacts, grounds conductor 1606 which extends to the upper back contacts of relay 411 and short-circuits start magnet 444 thereby preventing any further advance of the individual tape.

The toll charge figures having been set on the registers shown in Fig. 13, the operation of circuits is now initiated to pass this registration to the totalizing switches 1330, 1340 and 1350 in order that the toll charges may be included in the total. Hence when relay 1605 operates, the path from interrupter 1607 (which may be driven in any suitable manner at the speed required to perform the functions described below) is closed to the "pick-up" relays 1608 and 1609 so that on the make period of said interrupter a circuit is completed for operating relay 1608 which extends from ground through said interrupter, top outer contacts of relay 1605, back contacts of relay 1609, winding of relay 1608 to grounded battery. Relay 1608 operates and establishes a locking circuit through the winding of relay 1609, contacts of relay 1608, to ground on the top outer contacts of relay 1638. On the open period of the interrupter, relay 1609 operates to perform functions described hereinafter.

In the meanwhile relay 1605 closes an obvious circuit for relay 1617 which operates. When, therefore, interrupter 1607 again closes its contacts after relays 1608 and 1609 have operated, a circuit is closed which extends from ground through said interrupter, front contacts of relay 1605, front contacts of relay 1609, contacts of relay 1617, back contacts of relay 1618, winding of magnet 1619 of switch 1620 to grounded battery and, in parallel therewith over the back contact of relay 1618, bottom outer front contacts of relay 1605, conductor 1648, winding of magnet 1345 to grounded battery. Magnets 1619 and 1345 operate and prepare to advance their respective brushes one step. When the interrupter 1607 opens its contacts, magnets 1619 and 1345 release and advance their brushes. On each succeeding pulse the brushes are advanced to successive terminals in their arcs in the same manner as described. Thus with each pulse from the interrupter the two switches are advanced one terminal for each pulse. Switch 1340, being the dollar totalizing switch, will add by its advance, as many dollars to its previous registration as it takes steps, and the operation will be stopped only when brush 1629 of switch 1620 becomes connected to the terminal on its arc which marks the digit representing the number of dollars charged for the call as explained hereinafter.

It will be recalled that the code of the first digit of the toll charge, that is, the digit 3, was registered on the group of relays 1621 to 1626, inclusive, and that the code of the digit 3 caused the operation of relays 1621 and 1626. Hence a ground is caused to be extended to the third terminal of the arc accessible to brush 1629 over the inner contacts of relays 1626 and 1621, No. 1 back contacts of relays 1625, 1624 and 1623 and the No. 2 back contact of relay 1622 to said third terminal. Therefore after the third pulse, and with brushes 1628 and 1629 on their respective third terminals, a circuit is completed extending from ground on brush 1629, winding of relay 1618

to grounded battery, operating said relay, opening the circuits of magnets 1619 and 1345 and closing a circuit for relay 1639 which extends from ground on the bottom inner contacts of relay 1605, outer contacts of relay 1618, winding of relay 1639 to grounded battery. Relay 1639 operates and closes a path from the interrupter 1601 to the winding of magnet 1647 of switch 1630 and also, in parallel over conductor 1661 to magnet 1401 of switch 1400. On the next ground pulse of interrupter 1607, a circuit is, therefore, completed for magnets 1647 and 1401 which extends from ground through said interrupter to outer contacts of relay 1605, front contacts of relay 1609, contacts of relay 1639, bottom contacts of relay 1637, winding of magnet 1647 to grounded battery and, in parallel therewith through the top inner contacts of relay 1605, conductor 1661, winding of magnet 1401, to battery and, in parallel therewith over the lower back contact of relay 1403, winding of magnet 1325 to grounded battery. The magnets now operate and prepare to advance their brushes one step for each pulse interruption. Switch 1330, however, is the totalizing switch that, for each step, adds one standard charge unit or five cents to the previous total. Hence each step now taken in response to the interrupter pulse will add five cents to the total charge, the stepping operations continuing until the circuit is opened, which occurs at the time that brush 1651 of switch 1630 comes into contact with the terminal of its arc which marks the tenths of a dollar to be charged for the call, as explained hereinafter.

Now the tenths of a dollar charge has been assumed to be represented by the digit 7 the code of which has caused the operation of relays 1631, 1632, 1633 and 1636 as already described. Consequently, a ground is extended to the fourteenth terminal of the arc accessible to brush 1651 which traces through the inner contacts of relay 1636, inner contacts of relay 1631, No. 1 contacts of relays 1635 and 1634, No. 1 front contacts of relay 1633, and No. 1 contacts of relay 1632 to the fourteenth terminal of the arc accessible to brush 1651 so that, after switch 1630 has taken fourteen steps and switch 1330 has likewise taken fourteen steps and added seventy cents thereby to the total, a circuit is completed for relay 1637 which extends from ground on brush 1651, winding of relay 1637 to grounded battery. Relay 1637 operates and opens the circuit of magnets 1325 and 1647 thereby preventing them from further operation and, through its upper inner contacts, completes a circuit for relay 1649 if relay 1627 has operated in response to the last digit of the charge being a five. Under these circumstances it becomes necessary to step the totalizing switch 1330 another step to register an additional five cents and this is done by means of relays 1649 and 1650. Therefore when relay 1637 operates, the interrupter circuit on the next ground pulse is completed as before to the front contacts of relay 1609, top inner contacts of relay 1637, inner contacts of relay 1627, inner back contacts of relay 1650, winding of relay 1649 to grounded battery. Relay 1649 operates, establishes a locking circuit through the winding of relay 1650 and its own inner contact to ground on the top outer contacts of relay 1638 and, through its outer contacts, extends the interrupter ground to conductor 1661 to operate magnet 1325 as before described. At the end of the interrupter ground period, ground is removed from conductor 1661 allowing said magnet to

release and advance its brushes one terminal to register a unit charge, while relay 1650 now operates in series with relay 1649.

If the last digit had been a zero, the relay 1627 would not have been operated and, upon the operation of relay 1637, a circuit would have been completed for relay 1638 which would extend from ground on the bottom inner contacts of relay 1605, top outer contacts of relay 1637, normal contacts of relay 1627, lower winding of relay 1638 to grounded battery. Relay 1638 now locks over its upper winding and inner contacts to ground on the normal contacts of relays 1656 and 1657. When the digit is a five, the operation of relay 1638 is postponed until the additional pulse, controlled by relays 1649 and 1650, is transmitted over conductor 1658.

When, therefore, relay 1650 operates, an obvious circuit is closed for relay 1638 which now locks as described. On its upper contact, relay 1638 removes ground from conductor 1654 and thereby causes the release of all relays locked thereto. Through its bottom inner contacts, it connects ground to brush 1652 and through its bottom middle contacts to brush 1628. Since all of the terminals of the arcs to which each of these brushes are commoned, except the normal terminals, are connected to the interrupter contacts of magnets 1647 and 1619, respectively, a self-interrupting circuit is provided for each of these magnets by which the brushes of each of the switches are driven to the last terminals, whereupon a circuit is closed for relay 1657 extending from ground on brush 1628 and a circuit is also closed for relay 1656 extending from ground on brush 1652. These relays now operate and open the locking circuit of relay 1638 which releases and restores the entire circuit to normal. During the time that relay 1638 is operated, a supplementary ground is connected to conductor 1606 to hold distributor 400 until the circuit of Fig. 13 has restored to normal, ground having been removed from said conductor by the release of relay 1605 following the release of relay 1602 upon the disconnection of ground from conductor 1654.

Relay 1655 is a slow-acting relay of any suitable construction having its time of operation adjusted to the time taken to perform the circuit operations described above, that is, from the time that ground is first applied to conductor 1432 to the time that relay 1638 releases. Should the circuit fail to function in the time prescribed, the operation of relay 1655 will cause any suitable alarm circuit to be closed for the purpose of calling attention to the failure.

When ground is removed from conductor 1606, the short circuit is removed from start magnet 444 and the individual tape is now caused to be advanced for the translation and the computation of the codes in each of the succeeding calls, local or toll, each of said translations, together with the money charge, being repunched on the final tape by perforator 1420, while the money charges are successively integrated on the totalizing switches 1330, 1340 and 1350.

When the individual tape is completely run through, it becomes necessary to punch the code of the total accrued charges on the final tape, said charges being those indicated by the position of switches 1330, 1340 and 1350. In order to punch the code of the total charge, key 1342 is operated and closes an obvious circuit for relay 1301 which operates and closes a locking circuit through its left winding, left inner contacts,

upper contacts of cam 1346, left outer contacts of relay 1301 to ground. This relay, on operating, opens the circuit of relay 1302 and completes a circuit to the winding of magnet 1304 extending from ground, right inner contacts of relay 1301, left upper contacts of cam 1305, winding of magnet 1304 to grounded battery. Magnet 1304 operates and advances switch 1310 to position 14.

In position 14 ground is connected from the left outer contacts of relay 1301, left upper and right lower contacts of cam 1346 to brush 1337 of switch 1350. Now, depending upon the particular terminal to which the brush 1337 has been advanced by the successive charge integrations, a circuit will be completed to any one of the digit relays 1100—1101 depending upon the terminal to which said brush is connected. The relay will then operate and cause the punching of the code on the tape associated with perforator 1420 in the manner described, which code represents the number of tens of dollars of the total charge. When the code is punched, switch 1310 is advanced by the connection of ground to conductor 1407 in the described manner to position 15 in which ground is then extended to brush 1335 of the dollars switch 1340 over the left outer contacts of relay 1301, left upper contact of cam 1346, upper contact of cam 1343 to brush 1335. In this case also the circuit is completed once again to the winding of one of the relays in the group 1100—1100 depending upon the terminal to which brush 1335 has been advanced by the successive additions of dollar charges. The relay operates and causes the punching of the code of the digit designated by the relay operated, after which switch 1310 is advanced to position 16 by the connection of ground to conductor 1407.

In this position a circuit is completed for the "period" code relay 1323 which extends from grounded battery through its winding, lower contact of cam 1344 to ground on the contacts of relay 1301. Relay 1323 operates and causes the punching of the period code to separate the dollars from the tenths of a dollar and the cents. After the code is punched, switch 1310 is advanced to position 17 in which position ground is connected to brush 1328 of switch 1330 by way of the left outer contacts of relay 1301 and left contacts of cam 1346. Switch 1330 is the tenths of a dollar switch with brush 1328 controlling the tenths and brush 1329 controlling the units of the dollar designation. Accordingly, when ground is applied to brush 1328, a circuit is completed to one of the digit-designating relays in the relay group 1100—1100 depending on the terminal to which the brush is connected. The relay operates and causes the punching of the corresponding code on the tape immediately succeeding that of the period code, after which the switch 1310 is advanced to position 18 in the manner described. In this position ground is now applied to the units brush 1329 over a path which extends from ground on the left outer contacts of relay 1301, left upper contact of cam 1346, left contact of cam 1344 to brush 1329. In this case, brush 1329 resting on a terminal corresponding to that on which brush 1328 is resting, completes a circuit either to the winding of relay 1100 if the total charges makes the units digit 0 or to relay 1105 if it makes the units digit five whereupon the code of 0 or 5 is punched on the tape after which the switch is advanced to position 19 in the usual manner.

In position 19 the circuit for magnet 1304 is again completed from ground on the right inner contacts of relay 1301 through cam 1305 and switch 1310 returns to normal. In the interval during which it is advancing through these positions, a circuit is completed for relays 1339, 1333 and 1326 extending from ground at the left outer contact of relay 1301, upper left contact of cam 1346, the lower contact of cam 1343 to the lower windings in parallel of each of the relays mentioned. These relays operate, lock over their respective upper windings and upper contacts to ground on brushes 1338, 1336 and 1331, respectively, and close the following circuits: (1) ground on brush 1331 and terminal engaged thereby, bottom contacts of relay 1326, interrupter contacts of magnet 1325, winding of said magnet 1325, to battery. Switch magnet 1325 operates under self-interruptions in this circuit until it reaches terminal 19 at which time the circuit is opened. However, an obvious circuit is closed through this terminal for relay 1327 which, in operating, supplies an additional locking circuit for relay 1326 and closes a stepping circuit for switch magnet 1325 extending from ground on its outer contacts, lower contacts of relay 1326, interrupter contacts of magnet 1325, winding of said magnet 1325 to battery, causing the magnet to take one step which restores brushes 1328, 1329 and 1331 to normal; (2) ground on brush 1336 and terminal engaged thereby, bottom contacts of relay 1333, interrupter contacts of magnet 1345, winding of said magnet 1345 to battery. This magnet now operates under self-interruptions in this circuit and causes brushes 1335 and 1336 to be driven to their respective ninth terminals, in which position the drive circuit is opened. However, an obvious circuit is completed for relay 1332 from the ground supplied through the brush 1336 and this relay, in operating, completes a supplementary locking circuit for relay 1333 and closes another stepping circuit for magnet 1345 which extends from ground on its lower contacts, bottom contacts of relay 1333, interrupter contacts of magnet 1345, winding of said magnet 1345 to battery. Magnet 1345 operates and drives brushes 1335 and 1336 to normal; (3) ground on brush 1338 and terminal engaged thereby, bottom contacts of relay 1339, interrupter contacts of magnet 1341, winding of said magnet 1341, to battery. The magnet operates on self-interruptions and restores the switch to normal. Thus the totalizing switches are restored to normal and when this takes place, relays 1327 and 1332 are released. The locking circuits for relays 1326, 1333 and 1339 which depend upon the switches which they respectively control being off-normal are thus opened and these relays restore. The totalizing switches are now normal in preparation for the adding operation to be performed on the tape of another subscriber's line.

After the final tape for a line is completed; that is, the tape made by perforator 1420, said tape is passed through the ordinary page printer in extensive commercial use which, in response to the codes represented by the various punched hole sets, will type on a standard bill form the various characters and numbers designated by the codes.

No need is felt to further lengthen this description by an amplification of the operation of the printer since this is a well-known piece of commercial apparatus such as typified, for in-

stance, by Patent Re. 18,208 to E. R. Wheeler dated September 22, 1931.

What is claimed is:

1. A computer adapted to produce a tape record in response to the sensing of another tape record containing thereon a plurality of groups of perforations for each completed call and uncompleted connection from a telephone line, said plurality of groups of perforations including a group of perforations for each of the called offices, a group of perforations for each of the called line numbers, a group of perforations for the starting time of a conversation and a group of perforations for the finish time of a conversation, comprising means for sensing said other tape record and for producing a group of impulses characteristic of the group of perforations sensed, a storing register for each group of perforations, distributing means operative in advance of each operation of said sensing means for causing the register correlated to the group of perforations to be sensed to be set by the group of impulses produced in response to the sensing of said group of perforations, means responsive to the sensing of a group of perforations indicating that the preceding groups of perforations relate to an uncompleted connection for resetting said registers, an office decoding device responsive to the storage register set in response to the group of perforations relating to a called office, a time decoding device responsive to the storing registers set in response to the groups of perforations relating to the start and finish times of conversation, a monetary charge device, a totalling register, means responsive to said office decoding device and said time decoding device for operating said monetary charge device and said totalling register to cause a change in the setting thereof corresponding to a charge for the call, a tape perforator and a tape associated therewith, a group of conductors extending between said office decoding device, the storing registers settable in accordance with the sensing of the group of perforations for the called line number, said monetary charge device, said totalling register and said tape perforator, a progress switch having a plurality of commutating positions, means responsive to the sensing of a plurality of groups of perforations for a completed connection for operating said progress switch through all its commutating positions, circuits completed in succession through certain of the commutating positions of said switch and over one or more conductors of said group of conductors extending between said office decoding device, said line number storing registers, said monetary charge device and said tape perforator for operating said tape perforator to produce a plurality of groups of perforations on the tape associated therewith in accordance with the setting of said office decoding device, said line number registers and said monetary charge device whereby said plurality of groups of perforations denote a translated designation of the call and the money charge therefor, and manually controllable means for causing circuits to be completed through certain other commutating positions of said switch between said totalling register and said tape perforator over one or more conductors of said group of conductors whereby said tape perforator is operated to produce a group of perforations denoting the money equivalent of the total charges for all calls as determined by the setting of said totalling register.

2. In a telephone system adapted for auto-

matic call recording, a computer therefor adapted to produce a tape record for a subscriber's line in response to the sensing of another tape record which contains a plurality of groups of perforations for each telephone connection completed from said line, each plurality of groups of perforations including a group of perforations relating to the called office, a group of perforations relating to the start of conversation time and another group of perforations relating to the finish of conversation time, comprising means for sensing said other tape record, storing registers settable in response to the sensing of each of said groups of perforations, means jointly controlled by each of said storing registers for computing the monetary units assessable for a connection, a monetary charge register controlled by said computing means for registering the monetary units assessable for the connection indicated by each plurality of groups of perforations sensed, an accumulating register jointly operative with said monetary charge register, a tape perforator, means operative upon each setting of said storing registers for operatively associating said tape perforator in succession with the called office storing register and with said monetary charge register for producing a plurality of groups of perforations for each call that includes a group of perforations denoting the called office and another group of perforations which denote the monetary charge assessable for a call, and manually controllable means for causing said last mentioned means to operatively associate said tape perforator with said accumulating register for producing a group of perforations denoting the total monetary charge units for all calls as determined by the setting of said accumulating register.

3. A computer adapted to produce a tape record in response to the sensing of another tape record containing thereon a plurality of notations for each connection completed from a telephone line, each of said plurality of notations including a notation that designates the called office of a connection, comprising means for sensing said other record, a storage register settable in response to the sensing of the called office notation by said sensing means, a decoding device including a called office relay for each called office, a common group of relays wired to the contacts of all of said called office relays in a predetermined order for translating each called office into a predetermined code of letters and numerals, means responsive to the setting of said storage register for operating said decoding device and the called office relay therein which corresponds to the called office notation sensed by said sensing means, a tape perforator, a group of conductors extending from the contacts of said common group of relays to said tape perforator, a progress switch having a plurality of commutating positions, means rendered operative after the setting of said storage register for operating said progress switch through all of its commutating positions, circuit means closed through the contacts of said operated called office relay and the different commutating positions of said switch for operating in succession each of the relays of said common group of relays accessible through said contacts, and circuits closed between the contacts of said operated relays of said common group of relays and said tape perforator over said common group of conductors for causing said tape perforator to operate and produce in succession a group of

perforations characteristic of the letters and numerals of the called office designation as determined by said operated relays of said common group of relays.

4. A computer adapted to produce a tape record in response to the sensing of another tape record containing thereon a plurality of groups of perforations for each call completed from a telephone line, each of said plurality of groups of perforations including a group that designates the called office of the connection, another group that designates the start of conversation time and yet another group that designates the finish of conversation time, comprising means for sensing said other record, a storing register for each group of perforations, distributing means responsive to the sensing of a group of perforations for causing the storing register correlated to said group of perforations to be set in accordance with the sensing thereof, an office decoding device including a called office relay for each called office, a zone relay for each zone into which one or more called offices may be divided, each zone relay being operatively responsive to the operation of any called office relay included in the zone designated by said zone relay, a common group of relays wired to the contacts of all of said called office relays in a predetermined order for translating the called office denoted by each of said called office relays into a predetermined designation of letters and numerals, a time-decoding device settable in accordance with the setting of storing registers responsive to the sensing of the start of conversation time group of perforations and the finish of conversation time group of perforations, said time-decoding device including a first plurality of counting means adapted to count intervals of elapsed time and a second plurality of counting means jointly controlled by said first plurality of counting means and an operated zone relay for counting the number of charge units chargeable for a connection to a called office in the zone determined by said operated zone relay, charging switches, a plurality of numerical relays connected to the arcs of said charging switches, a tape perforator and a tape associated therewith, a group of conductors extending between the contacts of said common group of relays, the contacts of said numerical relays and said tape perforator, a progress switch having a plurality of commutating positions, circuits rendered operative after the setting of all said storage registers for causing said office decoding device and the called office relay therein to be operated under the control of the setting of those registers which are set in response to the called office perforations, whereby the locally controlled zone relay is operated, means also operated after setting of said storage registers for initiating the operation of said progress switch, circuits completed through certain successive commutating positions of said switch and through the contacts of said operated called office relay for operating the relays of said common group of relays wired thereto, circuits successively completed by said operated relays over one or more of said common group of conductors for operating said tape perforator to punch on its associated tape a group of perforations characteristic of each letter or numeral designated by each of said operated relays, means controlled by said tape perforator at the end of each punching operation for advancing said progress switch to its next commutating position, means operative subse-

quent to the last punching operation of said tape perforator in response to said operated relays for operating a number of counting means in said second plurality of counting means as determined by the operated zone relay and for operating in succession a number of counting means in said first plurality of counting means as determined by the operation of the number of counting means in said second plurality of counting means and the setting of said time-decoding device, an interrupter circuit completed through the last to be operated one of said counting means in said second plurality of counting means for operating one or more of said charging switches as many times as the number of operated counting means in said second plurality of counting means, circuits completed through certain other successive commutating positions of said progress switch and through the arcs of said charging switches over one or more conductors of said common group of conductors for operating in succession one or more of said numerical relays in said plurality of numerical relays in accordance with the setting of said switches, and circuits completed successively by said operated numerical relays over one or more conductors of said common group of conductors for operating said tape perforator to punch on its associated tape a group of perforations characteristic of each of the digits designated by each of said operated relays in said plurality of numerical relays, whereby said groups of perforations are characteristic of the charge for the call whose plurality of groups of perforations on said other record have been sensed by said sensing means.

5. A computer according to claim 4 which includes a plurality of accumulating switches having the arcs thereof connected to said numerical relays and settable in parallel with said charging switches, manually controllable means for completing circuits in succession through commutating positions of said progress switch to a plurality of said numerical relays in accordance with the setting of said accumulating switches, and circuits completed successively by said operated numerical relays over one or more conductors of said group of conductors for operating said tape perforator to punch on its associated tape a group of perforations characteristic of each of the digits designated by each of said operated numerical relays whereby said groups of perforations are characteristic of the total charges for all calls whose perforations on said other record have been sensed by said sensing means.

6. A computer adapted to produce a tape record in response to another tape record containing thereon a plurality of groups of notations for each call completed from a telephone line, each of said plurality of groups of notations including a group of notations designating the called office and groups of notations designating the start and finish times of conversation for each call, comprising means for sensing said other record, means responsive to the sensing of said group of notations that designates a called office for determining the number of unit charges for a standard period of conversation, means responsive to the sensing of said groups of notations that designate the start and finish times of conversation for translating said groups of notations into the elapsed time interval for the call, means responsive to the last two mentioned means for translating said time interval into one or more standard time units for an initial con-

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versation period and into a plurality of overtime units each chargeable as one time unit, a translator for changing standard time units into equivalent monetary units, means for operating said translator a number of times equal to the number of charge units as determined by said time and called office notation responsive means, and means responsive to the setting of said translator for making a permanent record of the total charge in monetary units.

7. A computer adapted to produce a tape record in response to the sensing of another tape record containing thereon a plurality of groups of notations for each call completed from a telephone line, each of said plurality of groups of notations including a group of notations that designates the called office and groups of notations that designate the start and finish times of conversation for each call, comprising means for sensing said other tape record, a first translating means responsive to the sensing of a group of notations designating the called office for determining the charge rate for the call in terms of standard charge units, a second translating means responsive to the sensing of said groups of notations that designate the start and finish times of the call for determining the elapsed time thereof, a translator for changing said charge units into monetary units, a tape recorder having a tape, means responsive to the operation of said first and second translating means for operating said translator a number of times equal to the total number of charge units for the time of the call, and means responsive to the setting of said translator for operating said tape recorder to record on said tape the monetary charges for said total number of charge units.

8. A computer adapted to produce a tape record from another tape record which contains thereon a plurality of notations for each call completed from a telephone line, each of said plurality of notations comprising a notation designating a called office, a notation designating the start of conversation and another notation designating the finish of conversation for each call, comprising means for sensing said other tape record, a tape recorder having a tape, a first translating means responsive to the sensing of said called office notation for determining the charge rate for the call in charge units, a second translating means responsive to the sensing of said start and finish times notations for determining the elapsed time for the call, a translator for changing the charge units into

monetary units, means responsive to the operation of said first and second translating means for operating said translator a number of times equal to the number of charge units for the time of the call, means responsive to the setting of said translator for operating said tape recorder to record on said tape the equivalent monetary units of said unit charges, adding means in said translator responsive to the operation of said first and second translating means for adding up the charges for all calls, and manually controllable means for causing said tape recorder to be operated under the control of said adding means to record on said tape the monetary equivalent of the total charges for all calls.

9. A computer adapted to produce a translated record from another record which contains thereon a plurality of groups of notations for each call completed from a telephone line, each of said plurality of groups of notations comprising groups of notations designating the called office and the called line number therein, and groups of notations designating the starting and finishing times of conversation for each call, comprising means for sensing said other record, a tape recorder having a tape, a decoding device settable in response to the sensing of said group of notations designating the called office for translating said group of notations into the directory designation of said called office, means responsive to the setting of said decoding devices for operating said tape recorder to record on said tape the directory designation of the called office and the called line number therein, means responsive to the setting of said decoding device and to the sensing of said groups of notations designating the start and finish times of the call for determining the charge for the call in standard charge units, money charge translating means responsive to the last mentioned means for translating said standard charge units into equivalent monetary charge units, means responsive to said money charge translating means for operating said tape recorder to record on said tape notations representing said monetary charge units, means settable in parallel with said money charge translating means for accumulating the monetary charge units for all calls, and manually controllable means for causing said tape recorder to be operated under the control of said settable means to record on said tape the monetary equivalent of the total charges for all calls.

WARREN W. CARPENTER.  
WILLIAM H. MATTHIES.