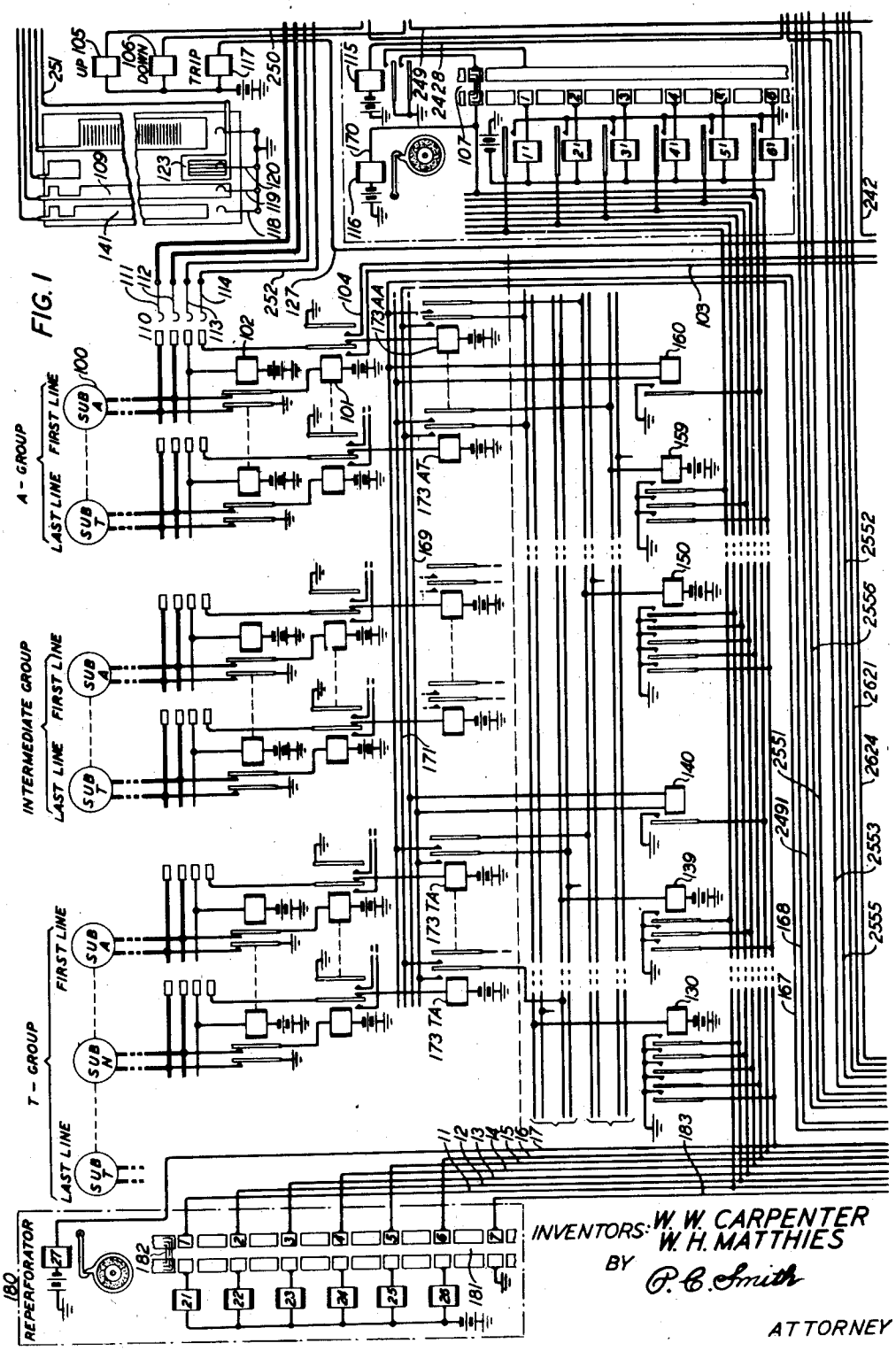
April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

Filed April 28, 1934 43 Sheets-Sheet 1



April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

Filed April 28, 1934 43 Sheets-Sheet 2

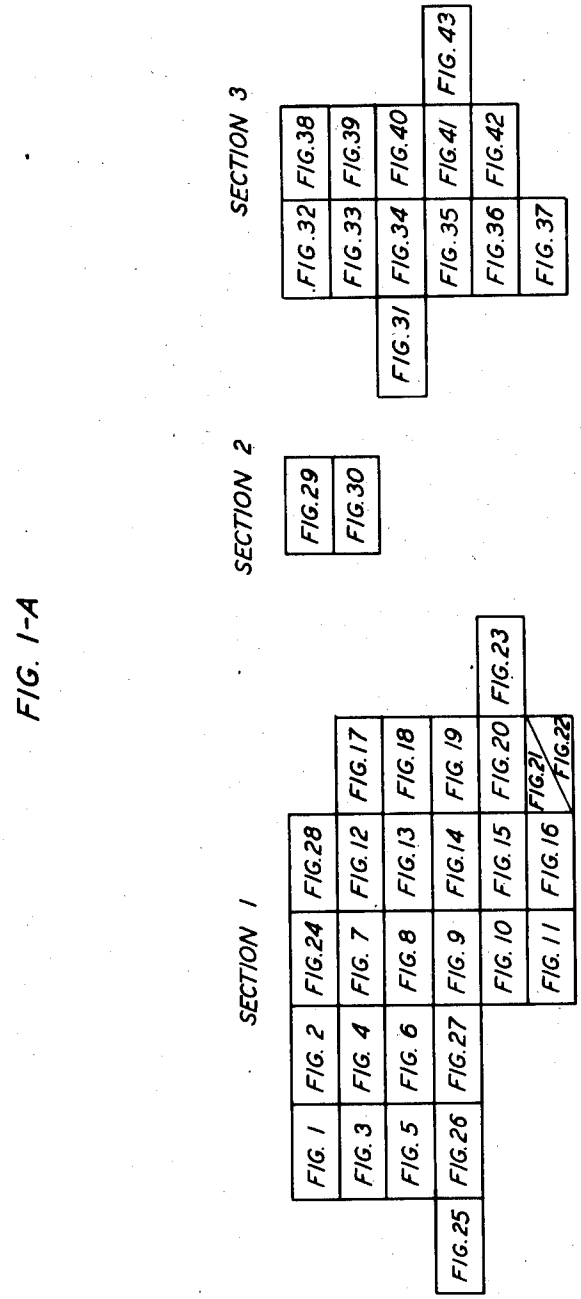


FIG. 1-A

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

BY P. C. Smith

ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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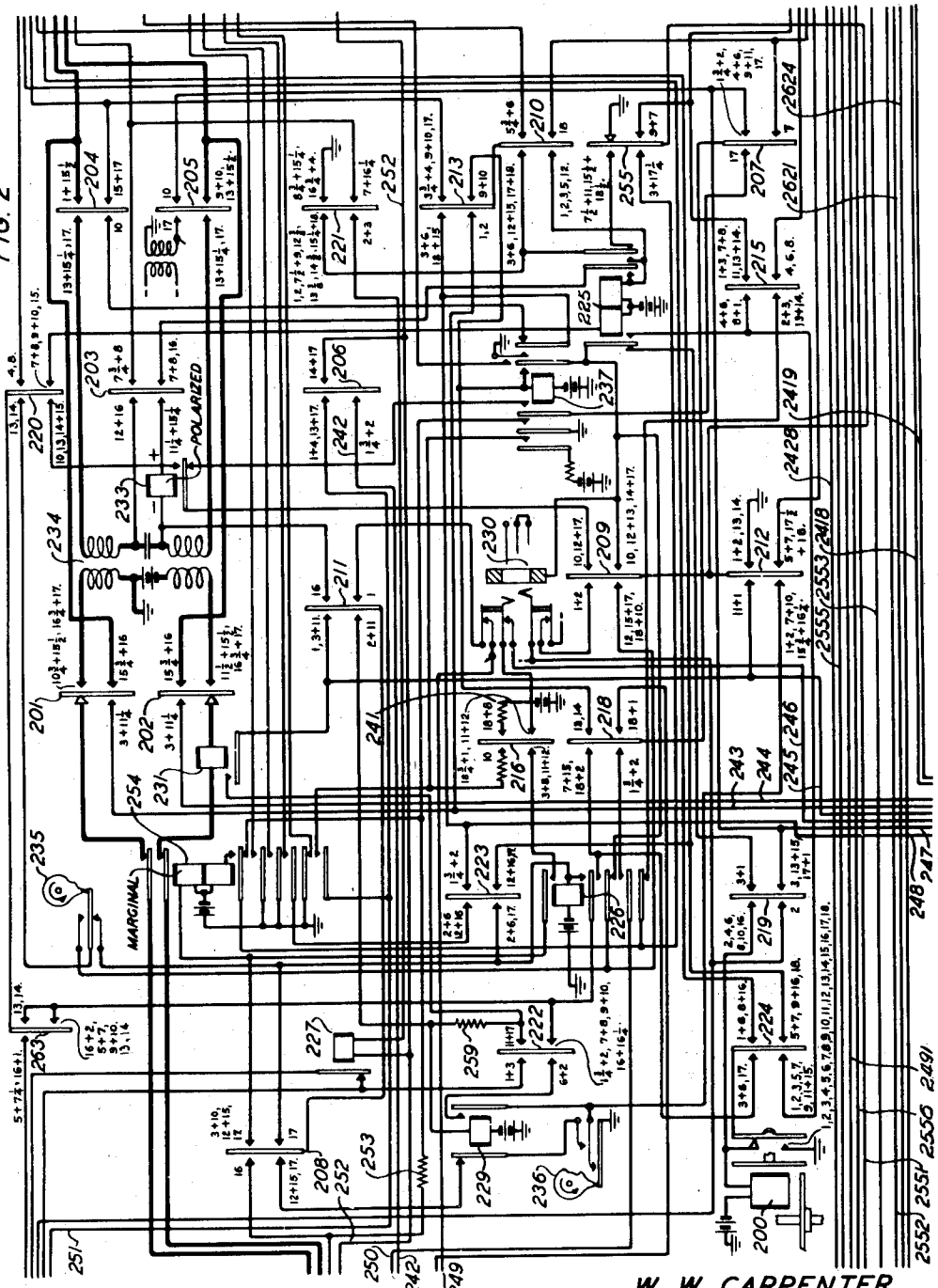
FIG. 2



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

ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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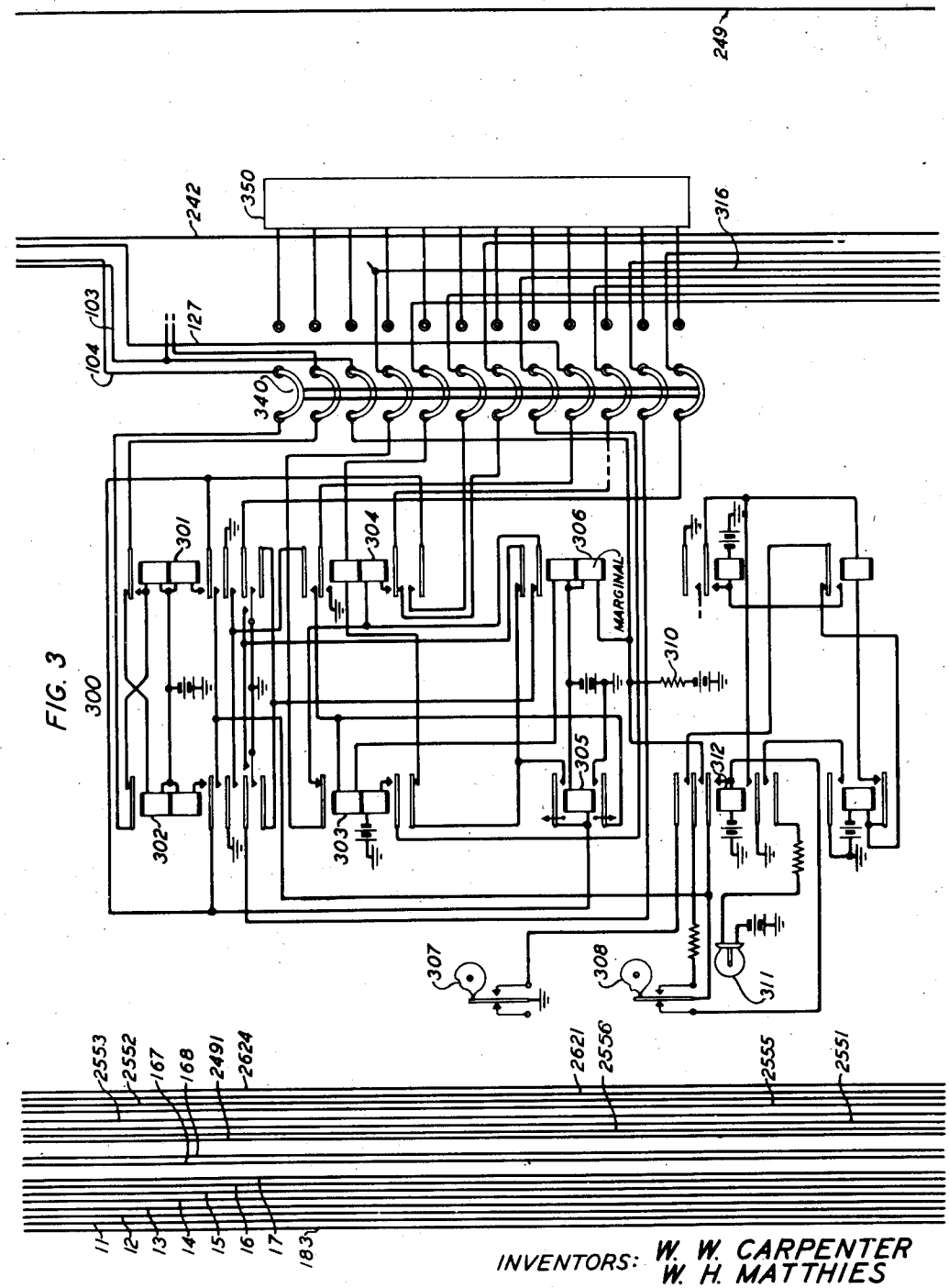

FIG. 3

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

BY P. C. Smith

ATTORNEY

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TELEPHONE SYSTEM

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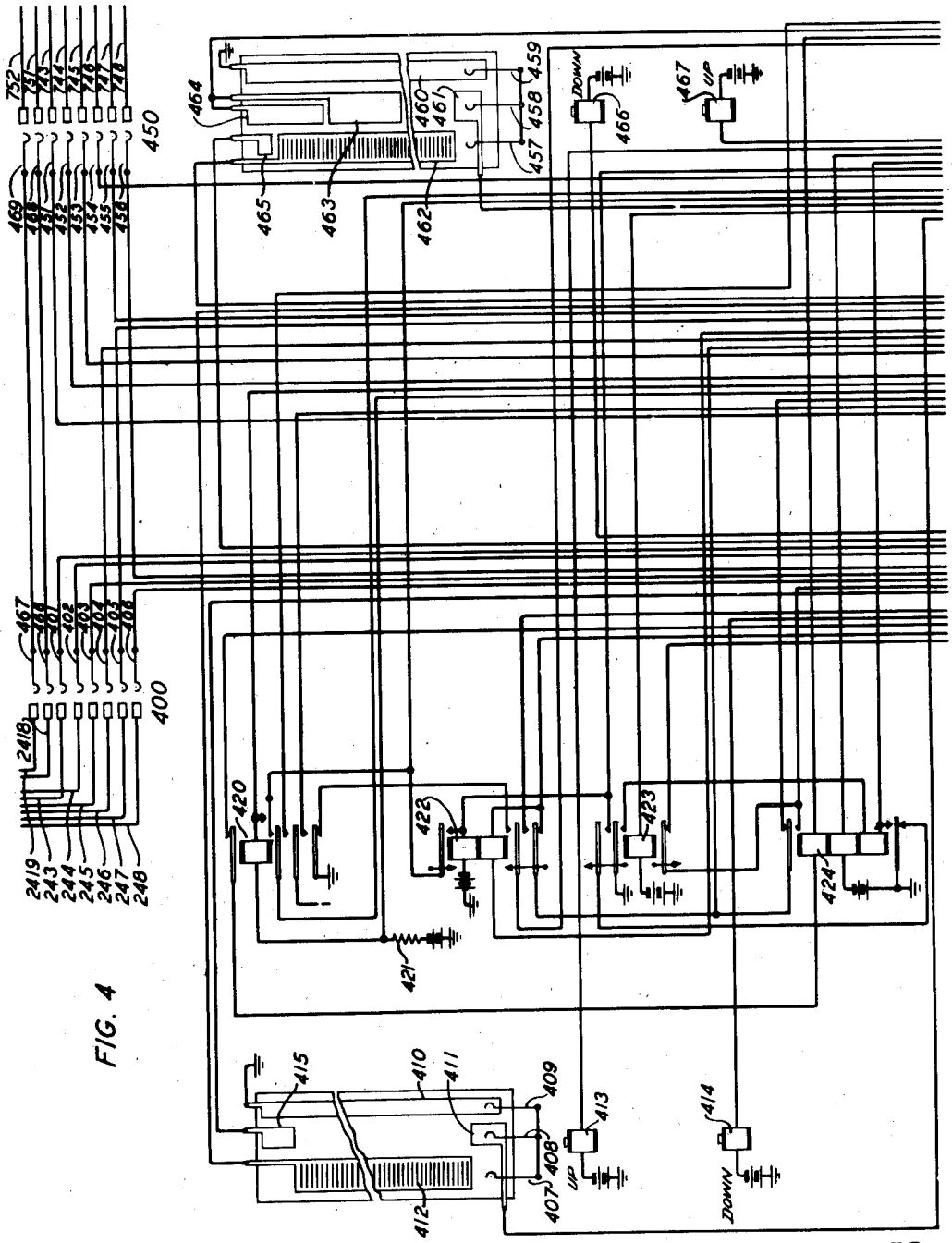

FIG. 4

INVENTORS: W. W. CARPENTER
W. H. MATTHIES
BY P. B. Smith

ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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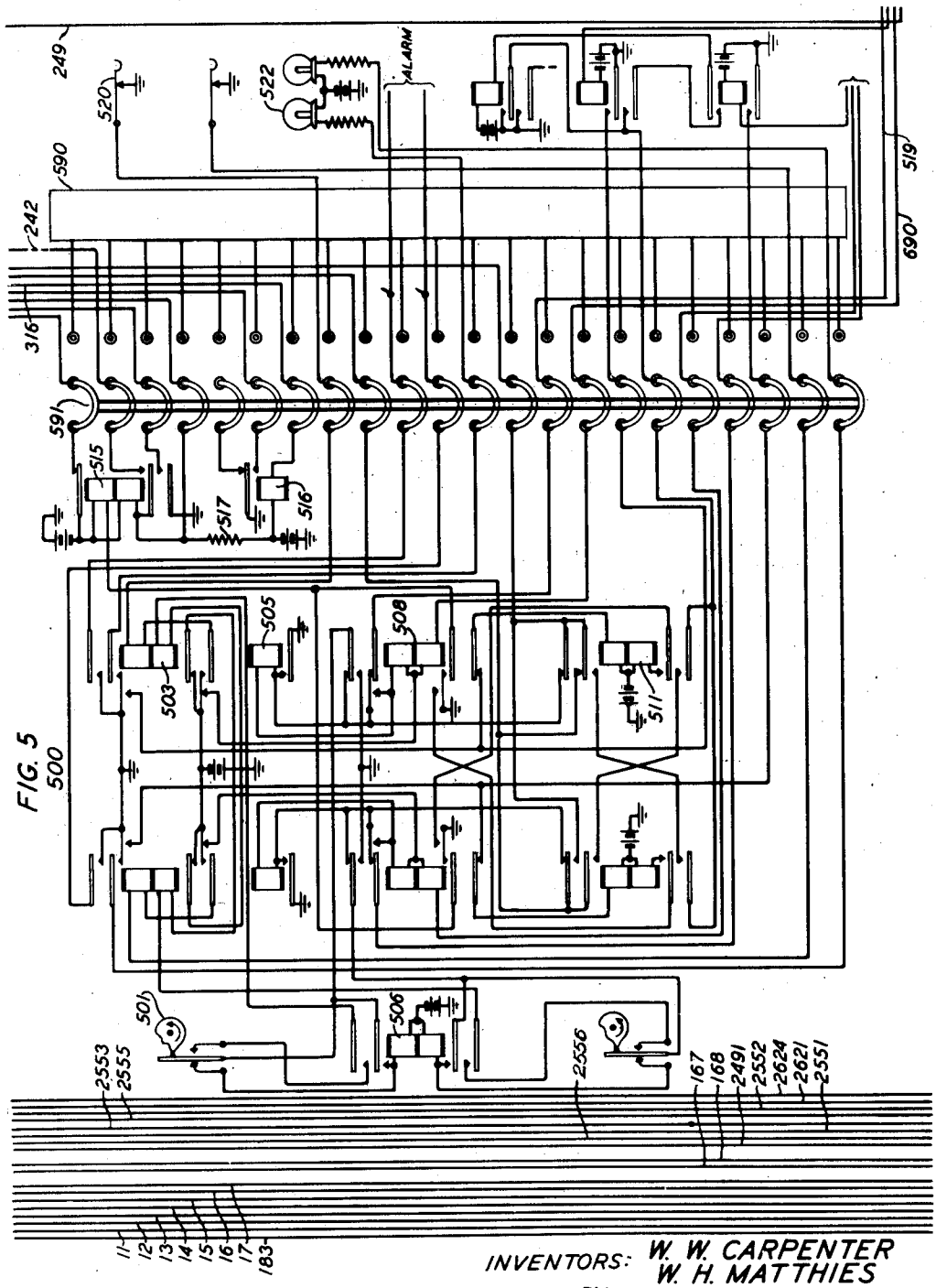

FIG. 5

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

BY P. C. Smith

ATTORNEY

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TELEPHONE SYSTEM

Filed April 28, 1934 43 Sheets-Sheet 7

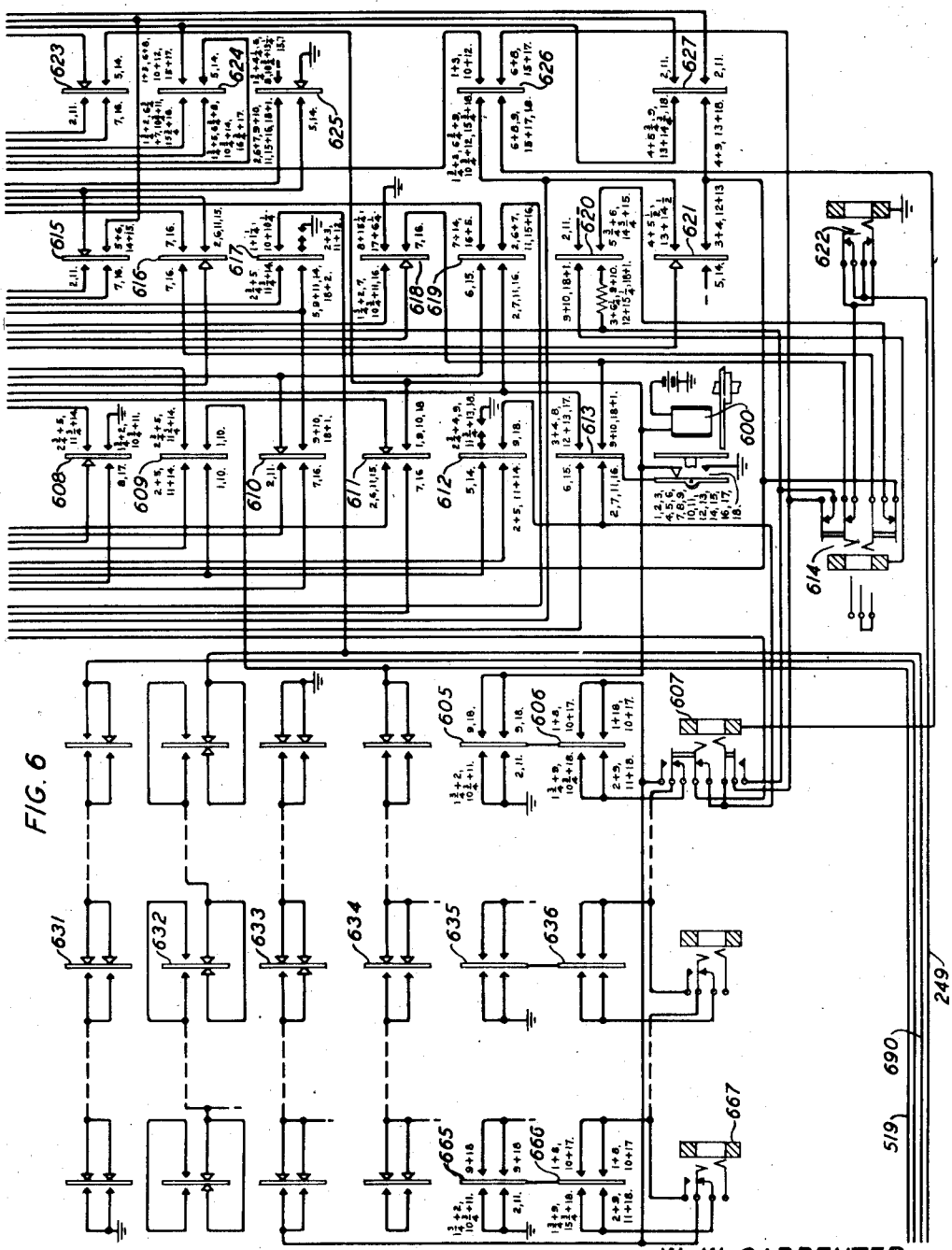

FIG. 6

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

BY P. C. Smith

ATTORNEY

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TELEPHONE SYSTEM

Filed April 28, 1934 43 Sheets-Sheet 8

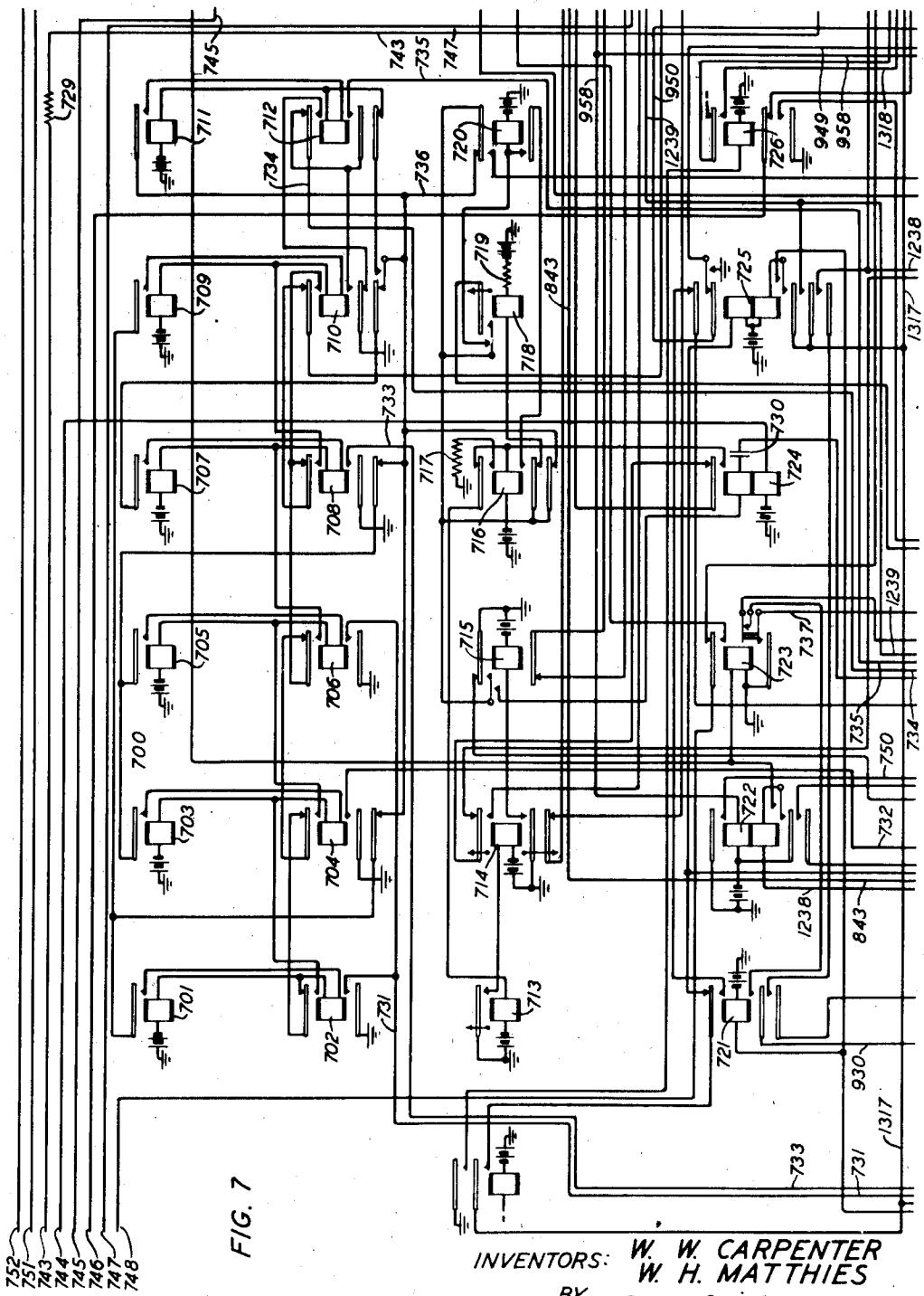

FIG. 7

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

BY G. C. Smith

ATTORNEY

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TELEPHONE SYSTEM

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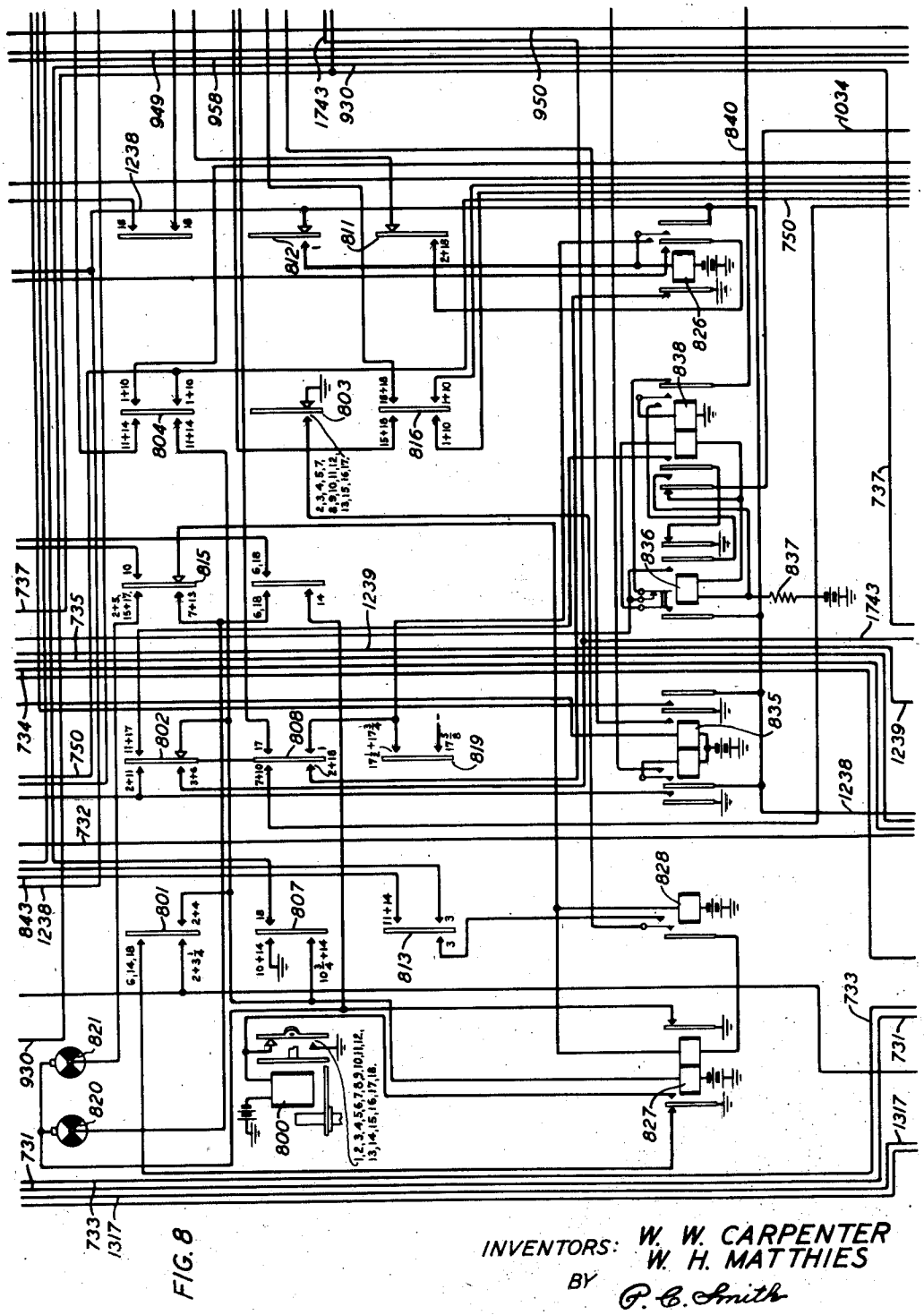

FIG. 8

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

ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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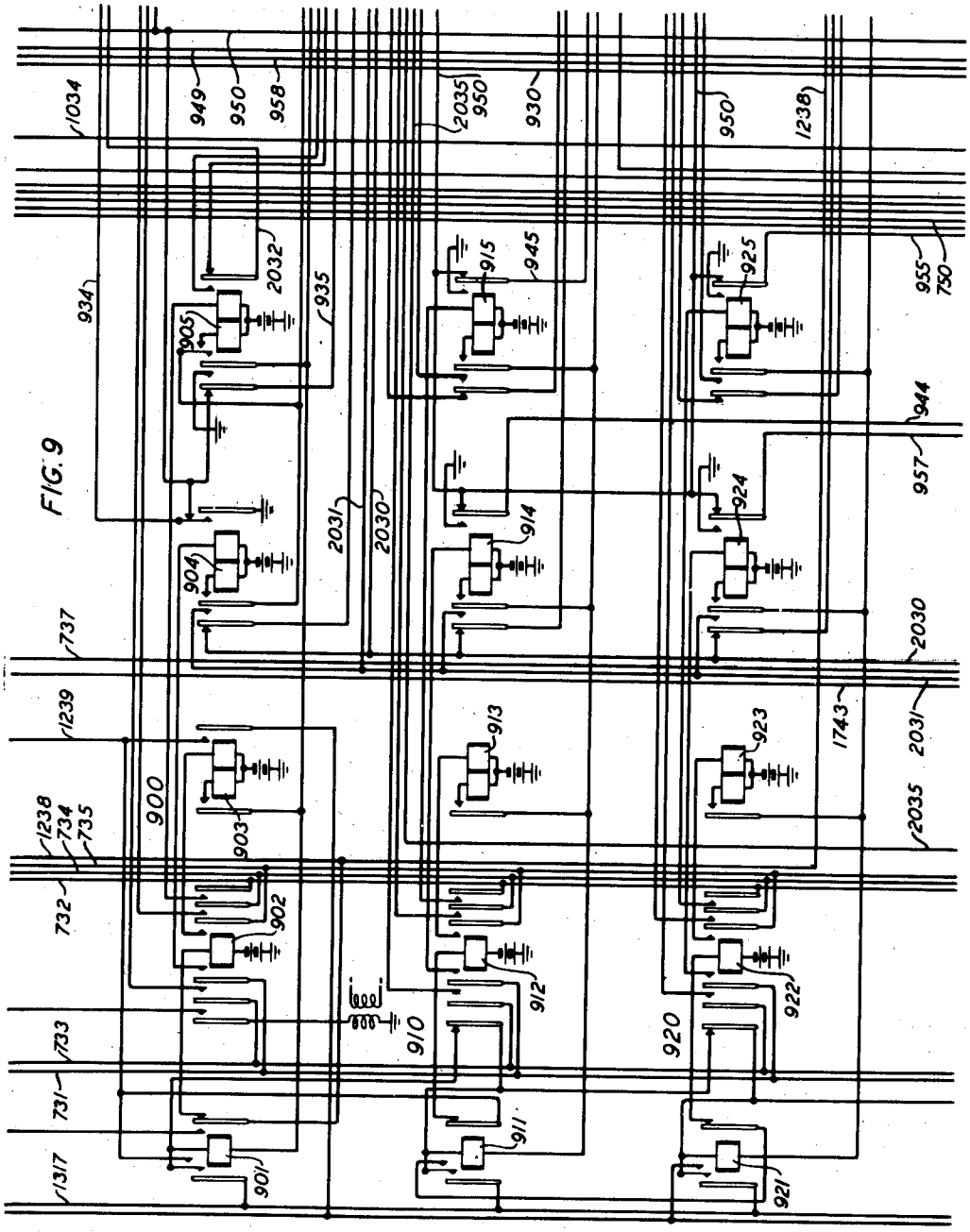

FIG. 9

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

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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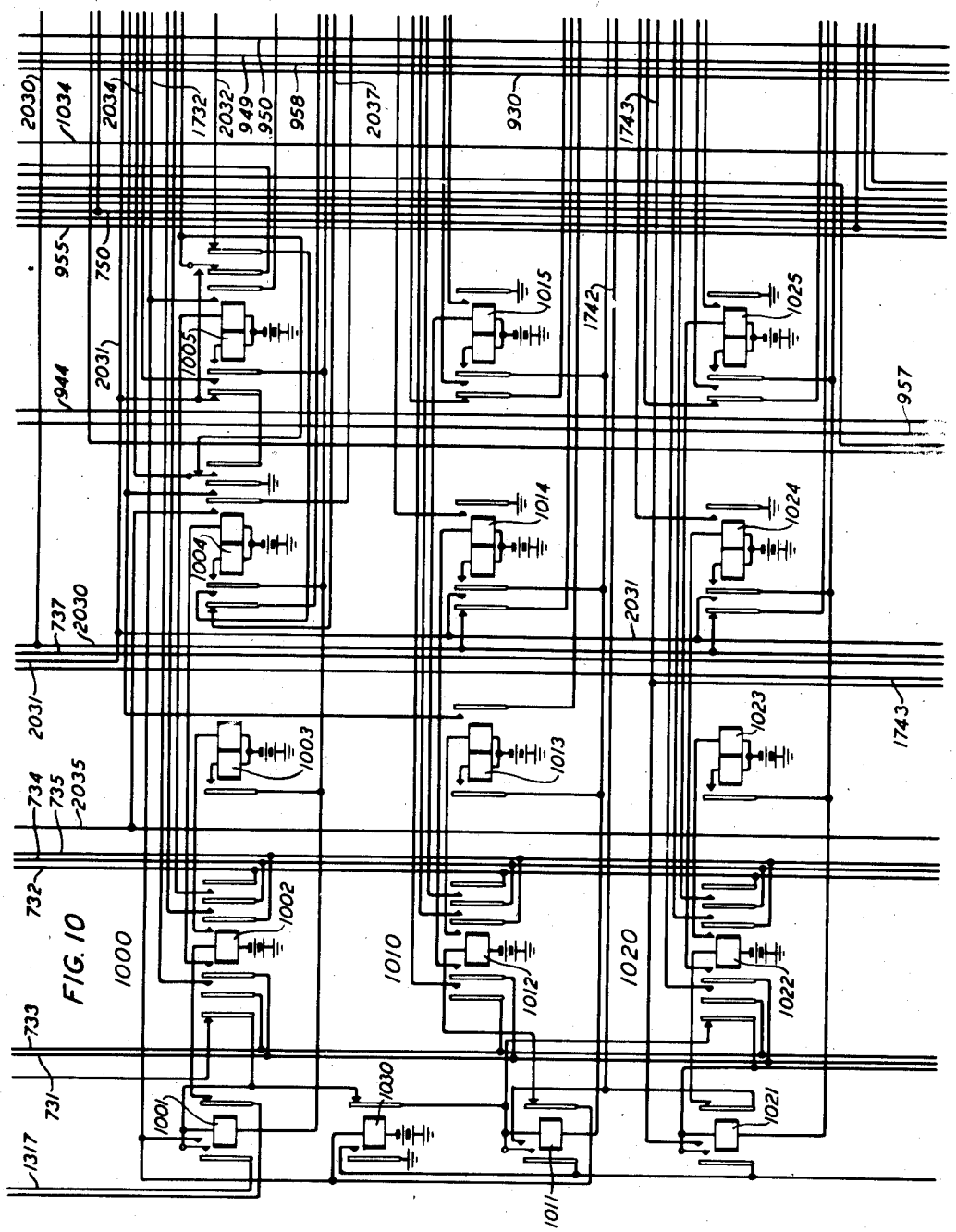

FIG. 10

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

BY P. C. Smith

ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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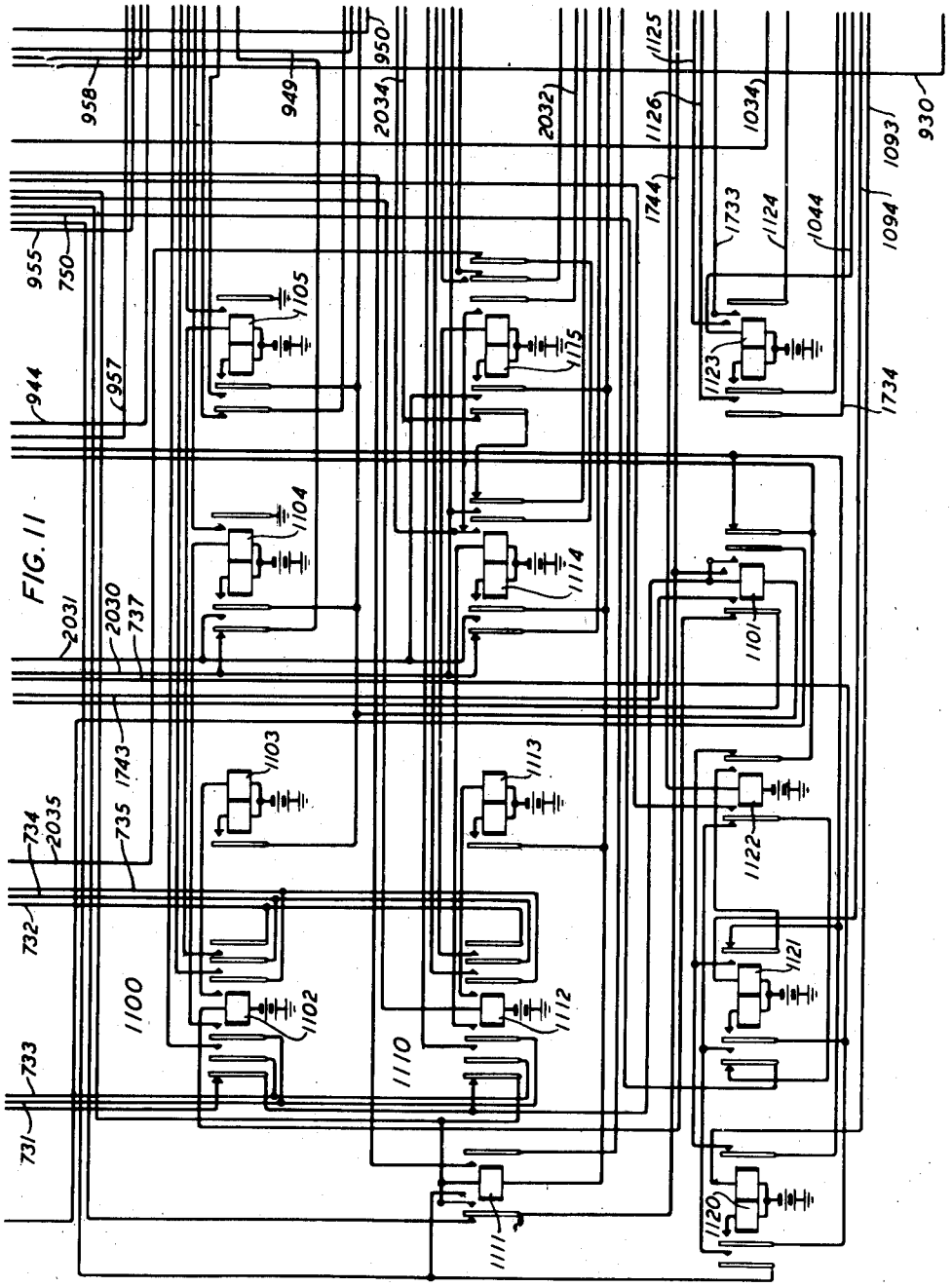


FIG. 11

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

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

Filed April 28, 1934 43 Sheets-Sheet 13

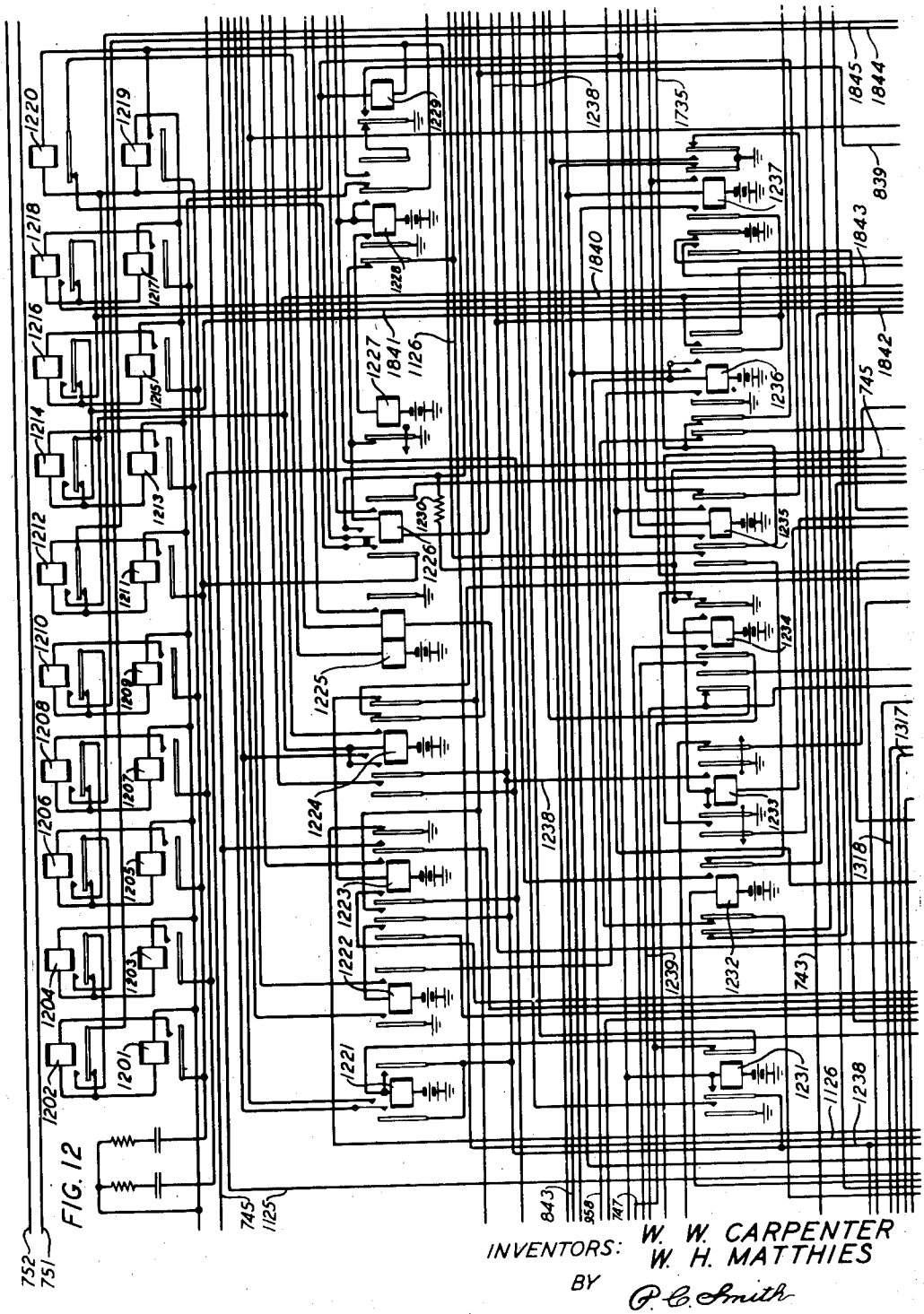


FIG. 12

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

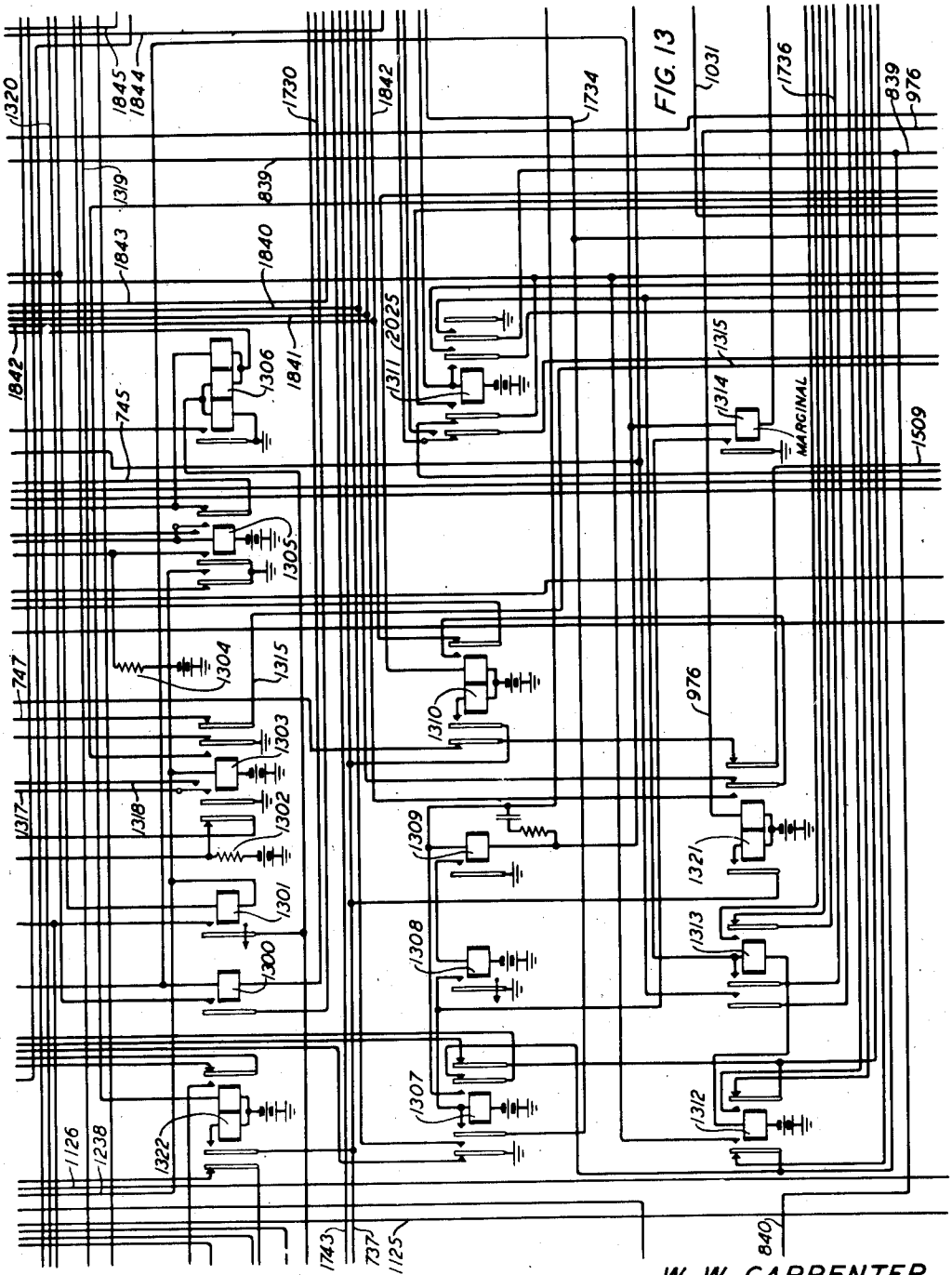
BY P. C. Smith

ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

Filed April 28, 1934 43 Sheets-Sheet 14



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

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

Filed April 28, 1934 43 Sheets-Sheet 15

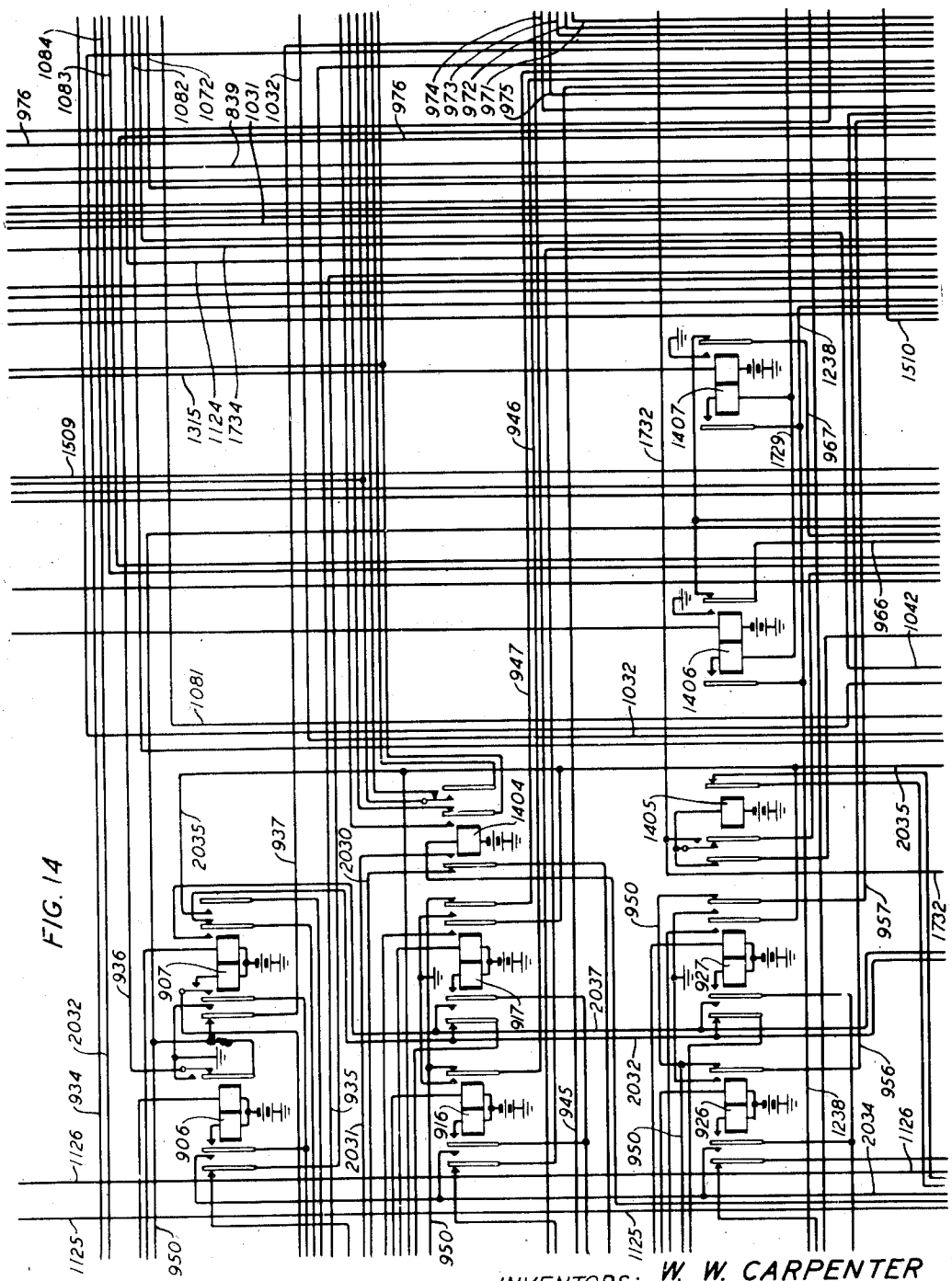


FIG. 14

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

BY P. C. Smith

ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

Filed April 28, 1934 43 Sheets-Sheet 16

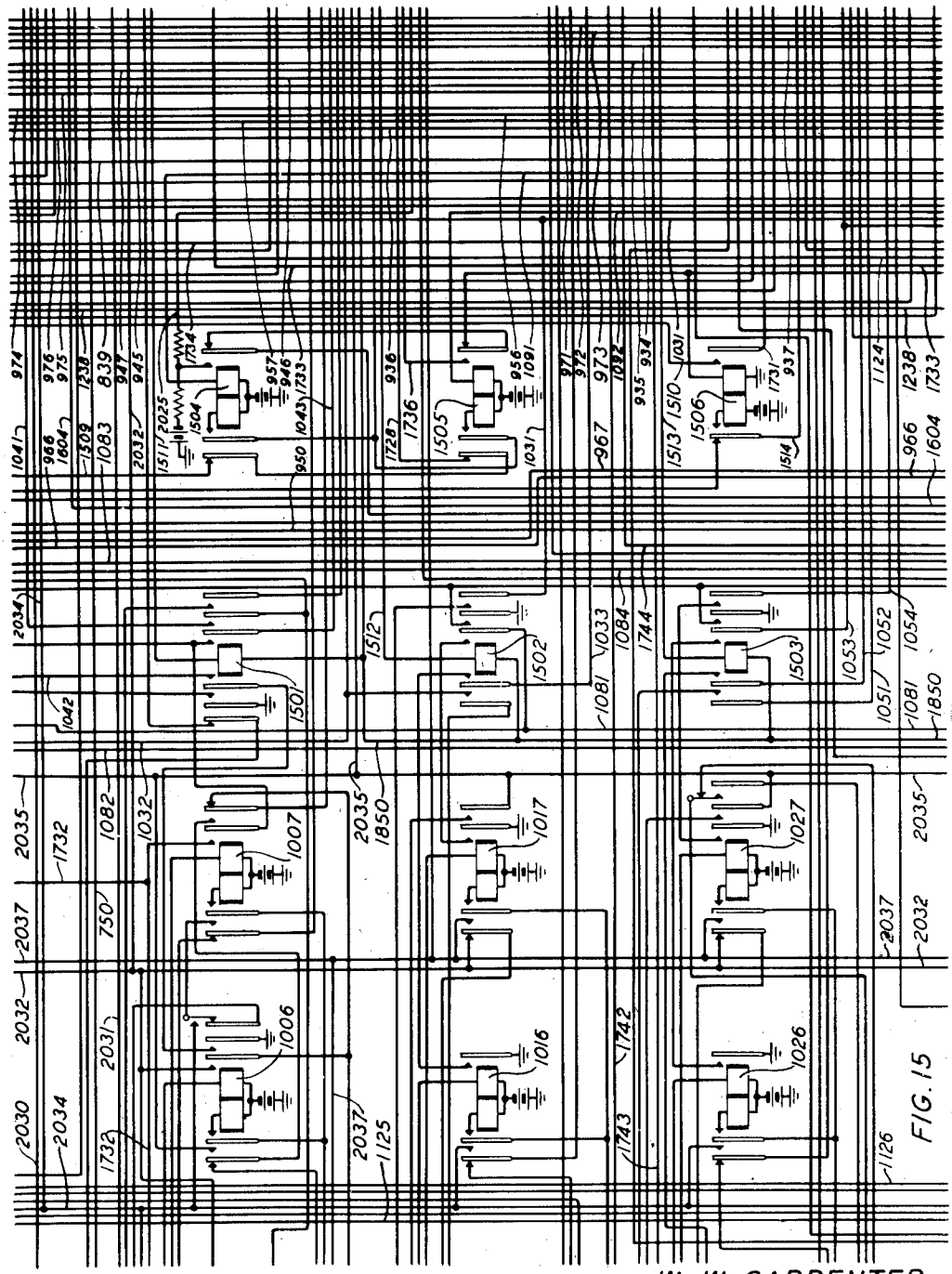


FIG. 15

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

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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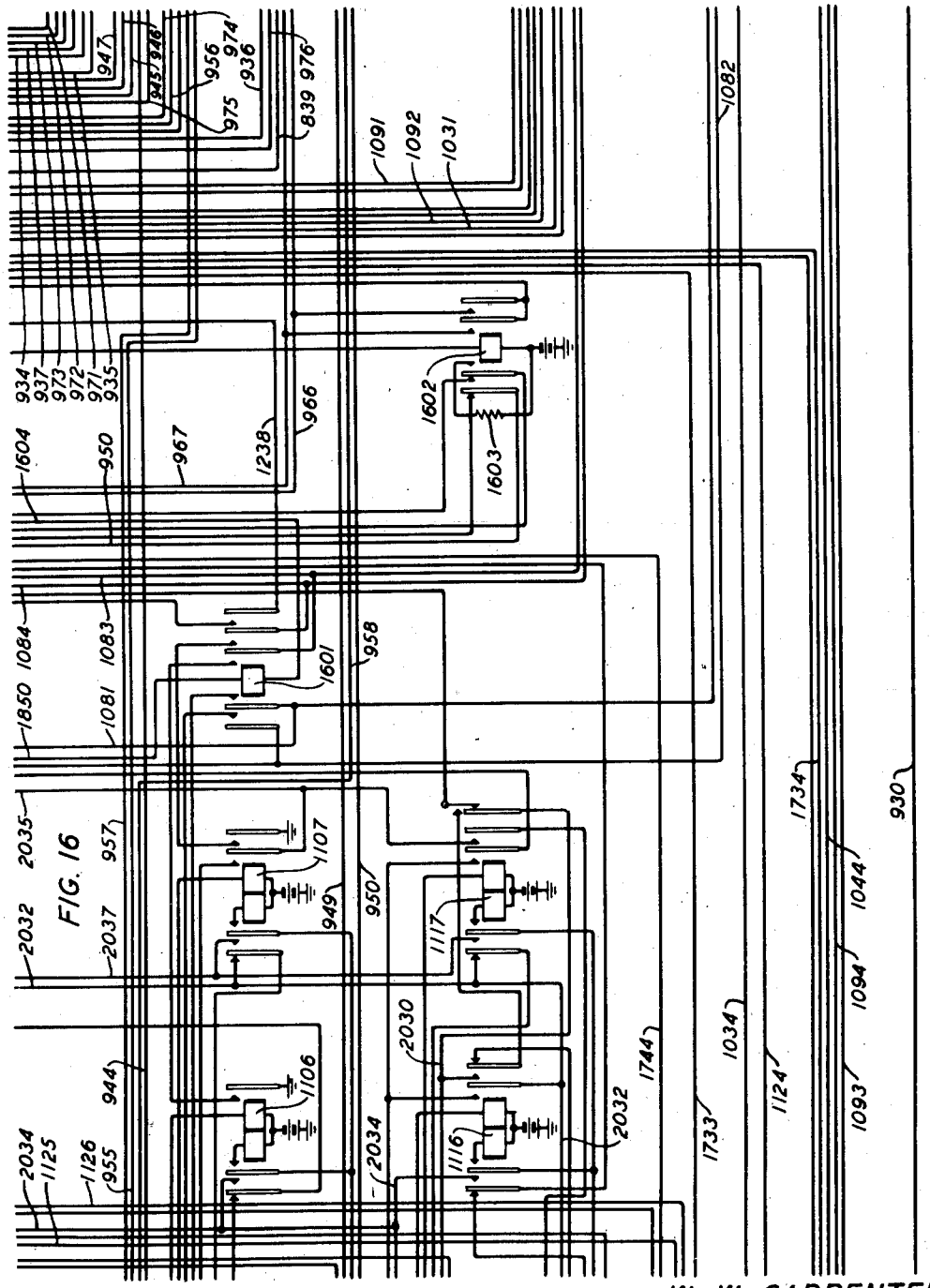

FIG. 16

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

BY P. C. Smith

ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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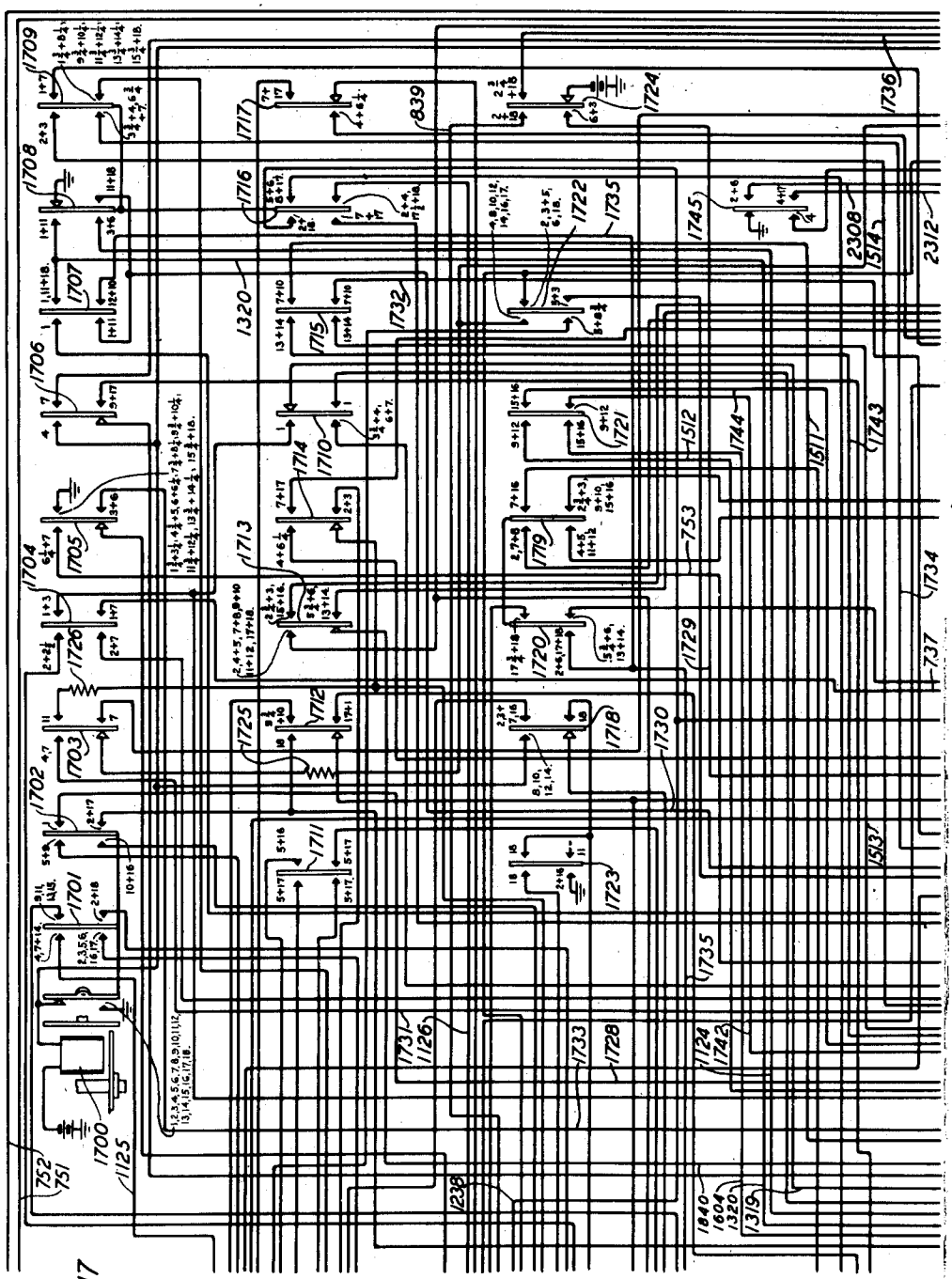

FIG. 17

INVENTORS: W. W. CARPENTER
W. H. MATTHIES
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April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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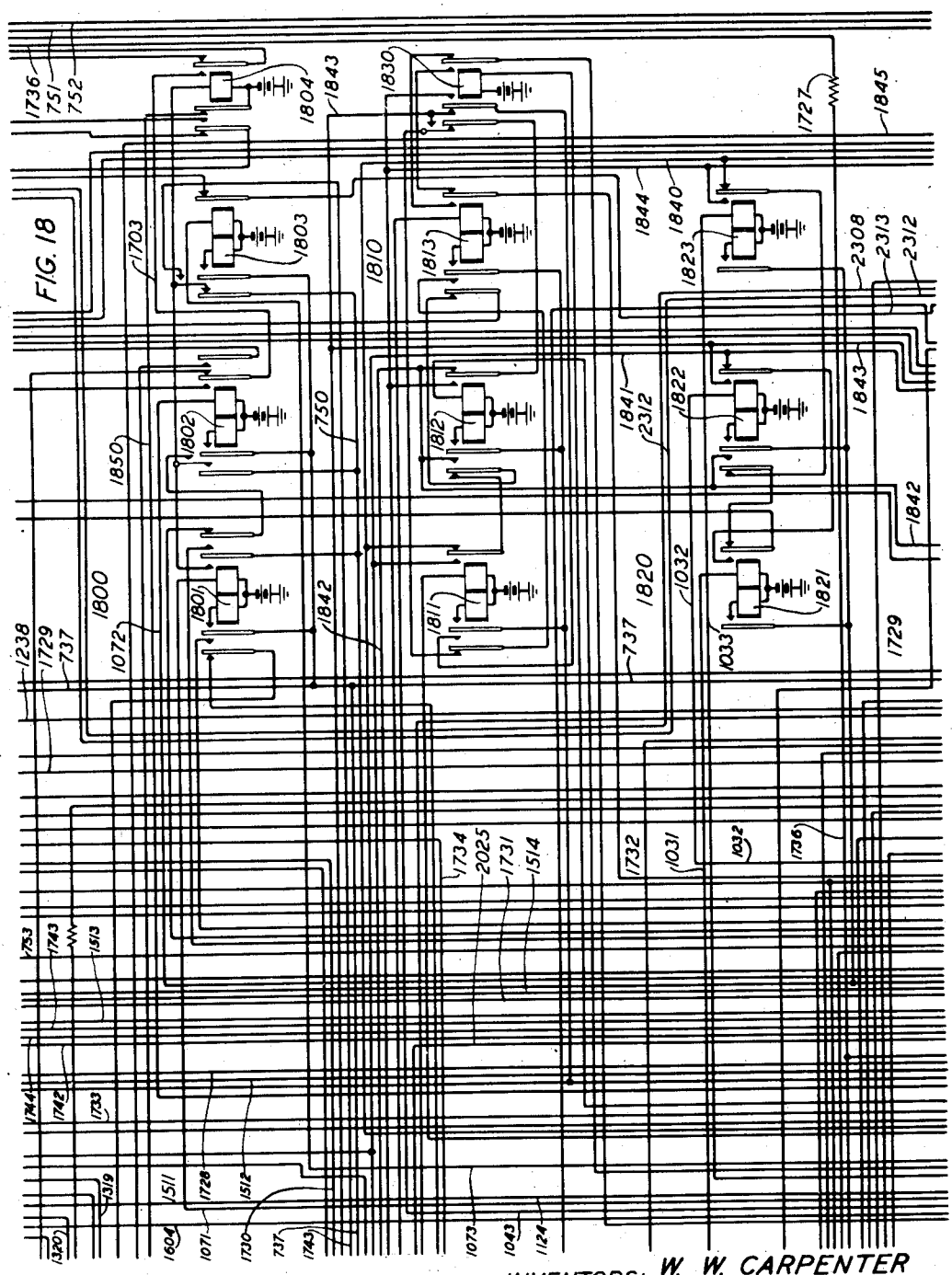

INVENTORS: W. W. CARPENTER
W. H. MATTHIES

BY P. C. Smith

ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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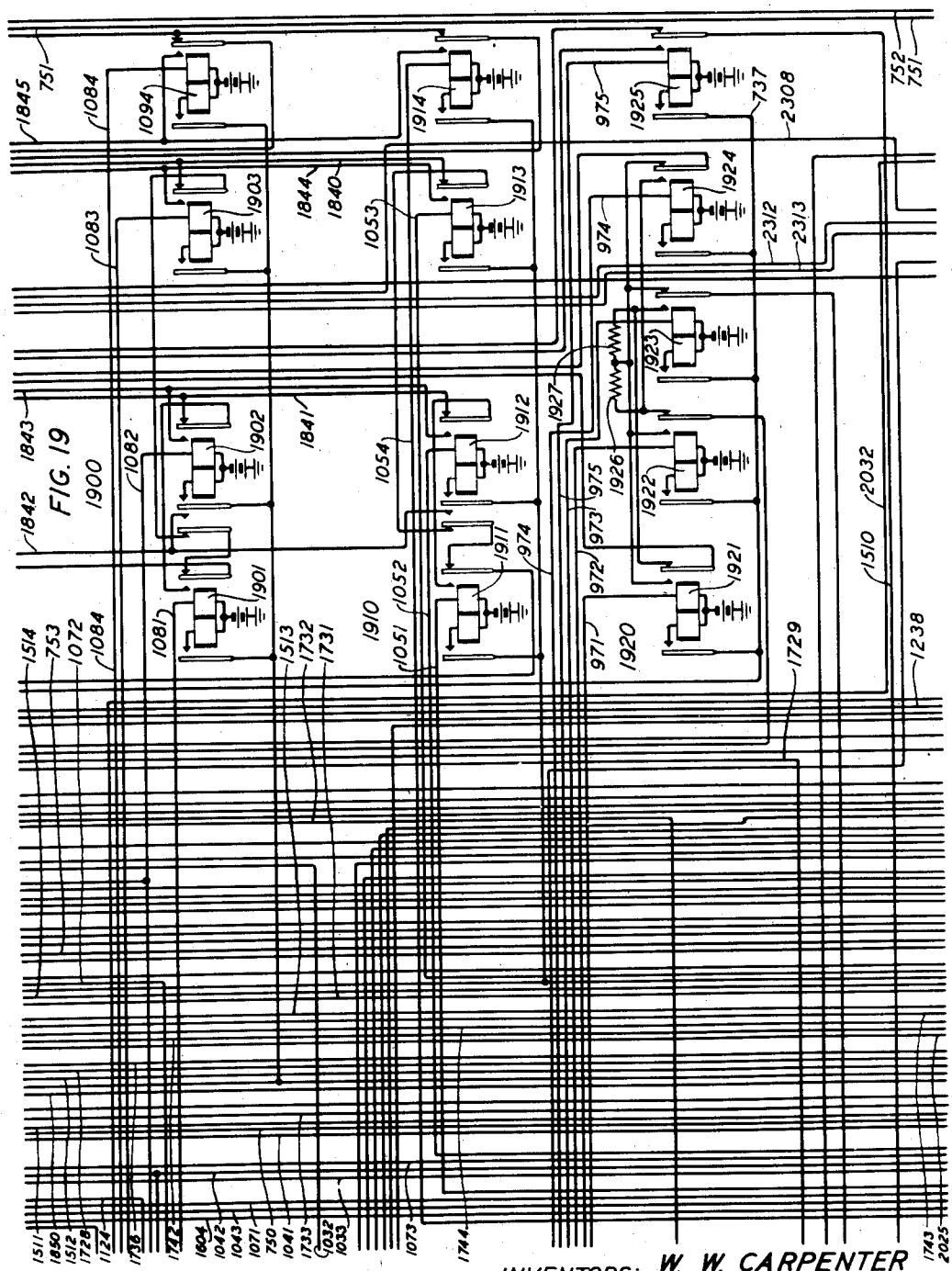

INVENTORS: W. W. CARPENTER
W. H. MATTHIES

BY P. C. Smith

ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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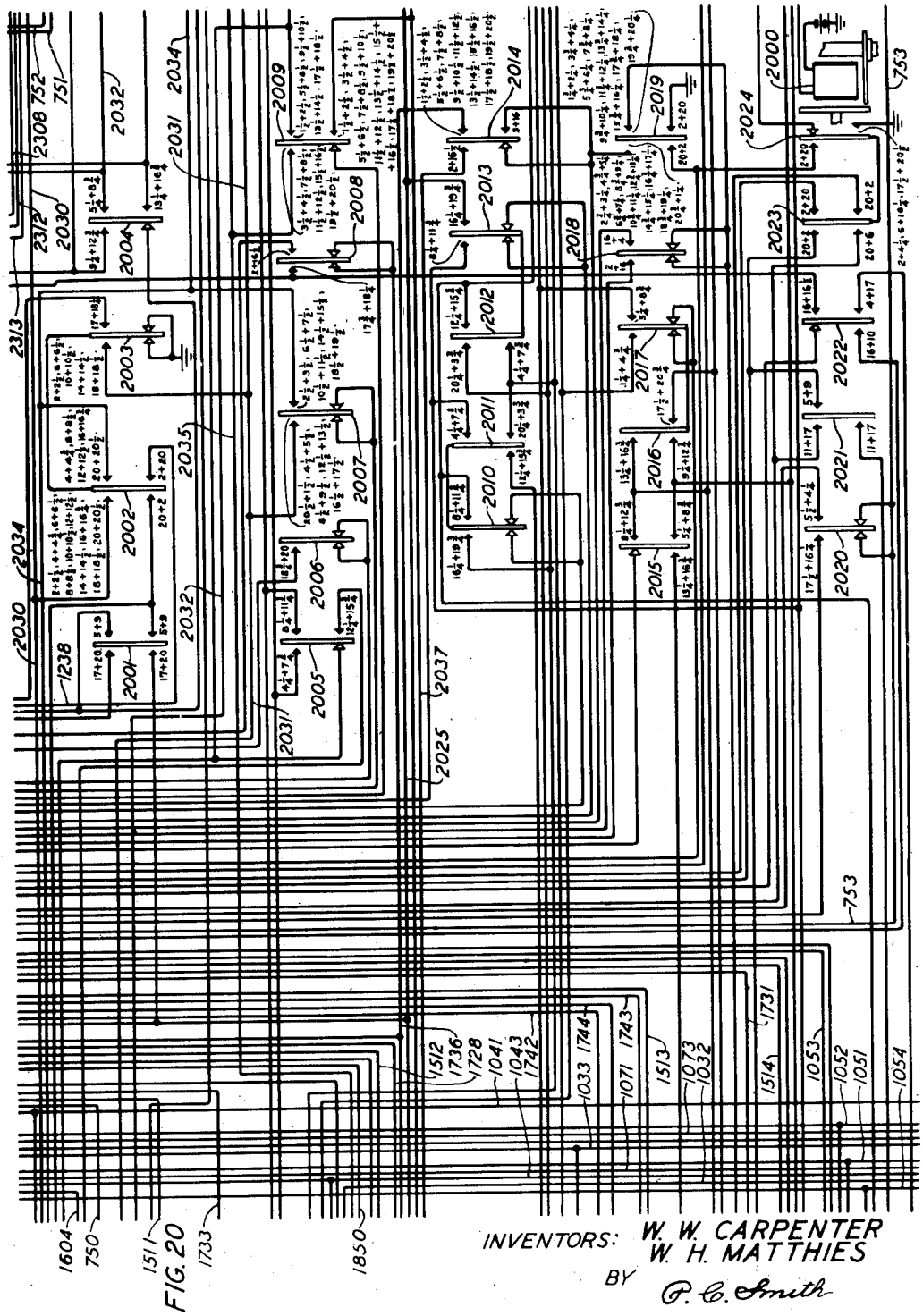

FIG. 20

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

BY P. C. Smith

ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

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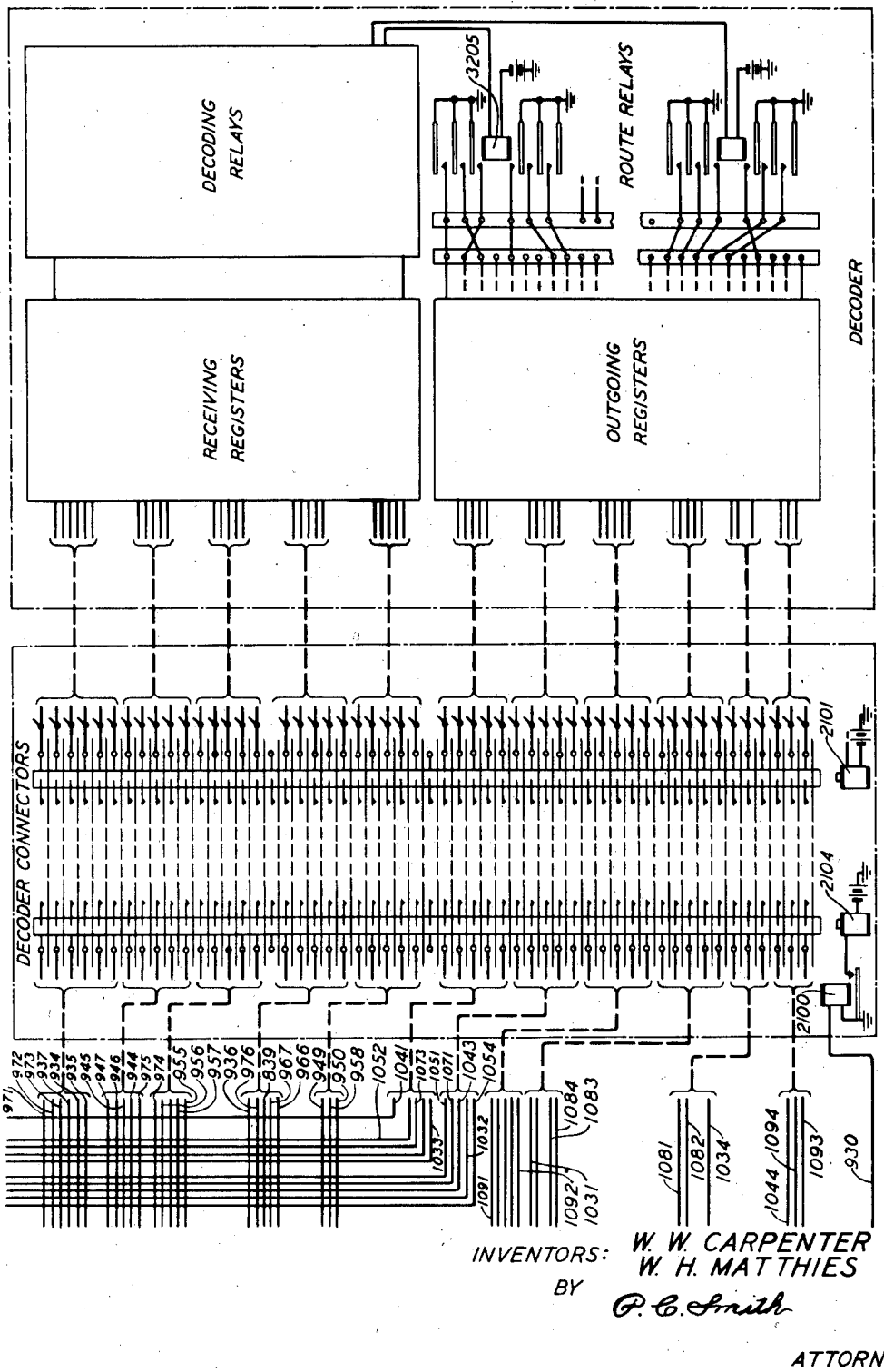

FIG. 22

FIG. 21

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

BY P. C. Smith

ATTORNEY

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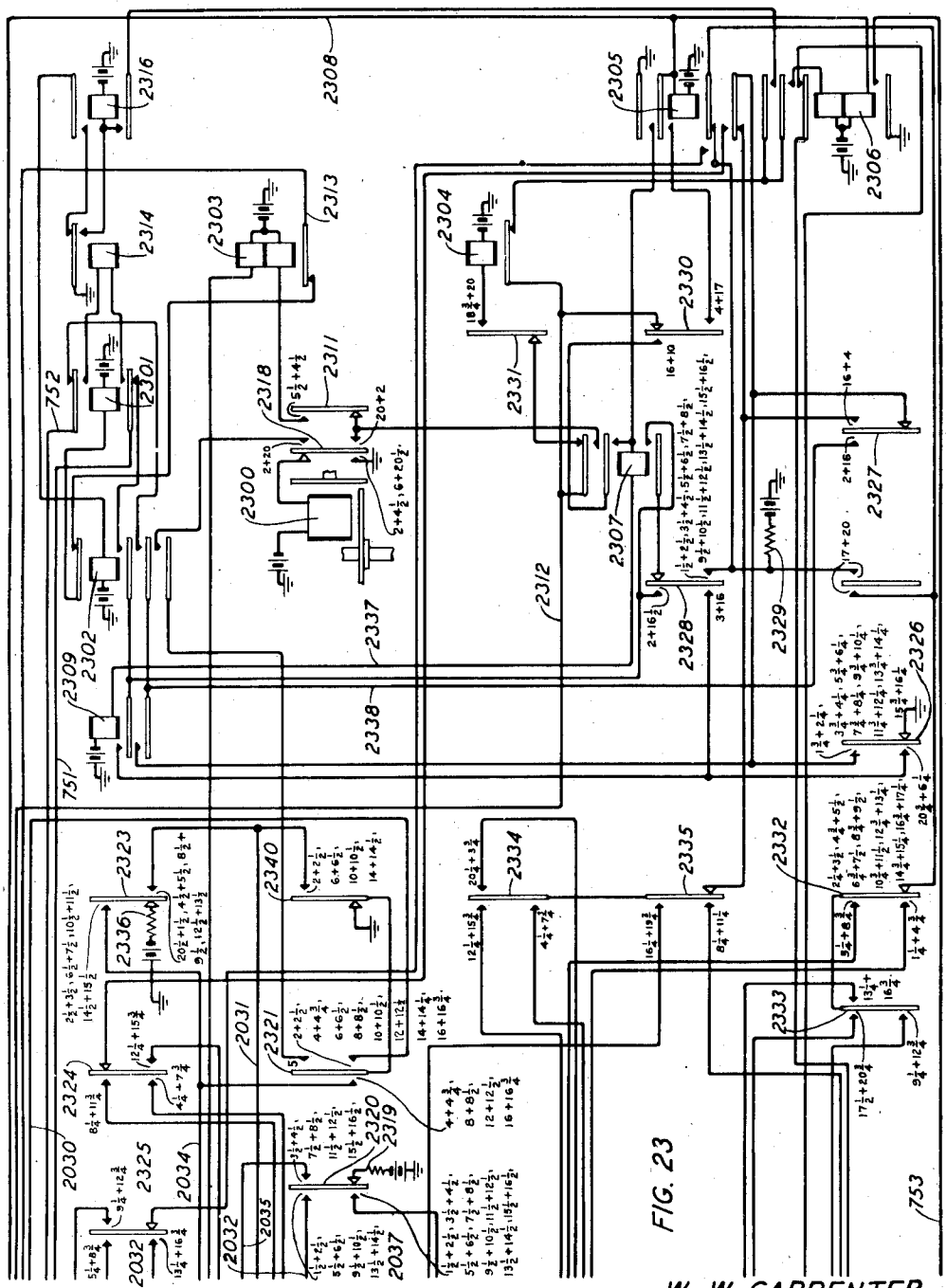

FIG. 23

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

BY P. C. Smith

ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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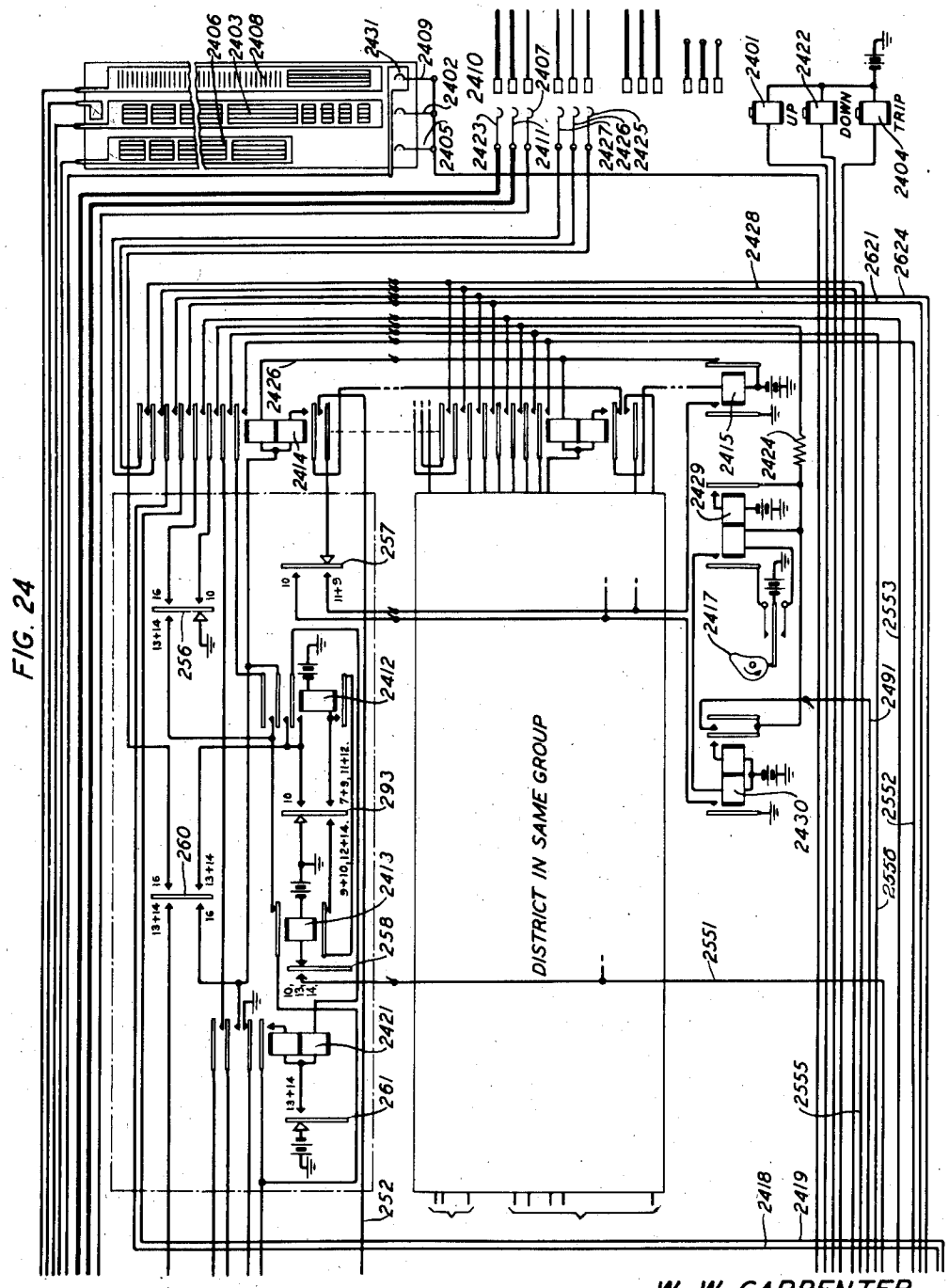

FIG. 24

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

BY P. C. Smith

ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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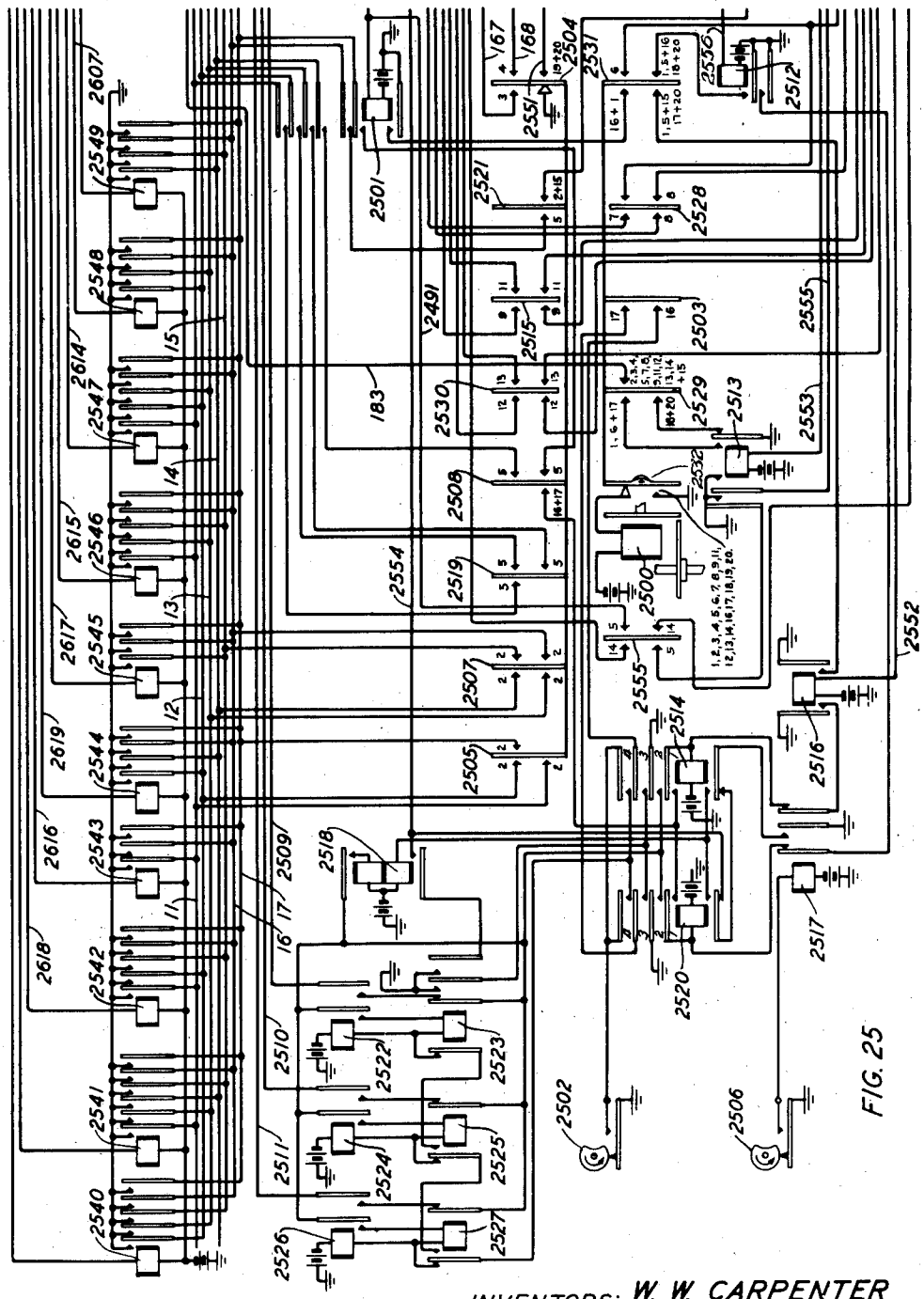

FIG. 25

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

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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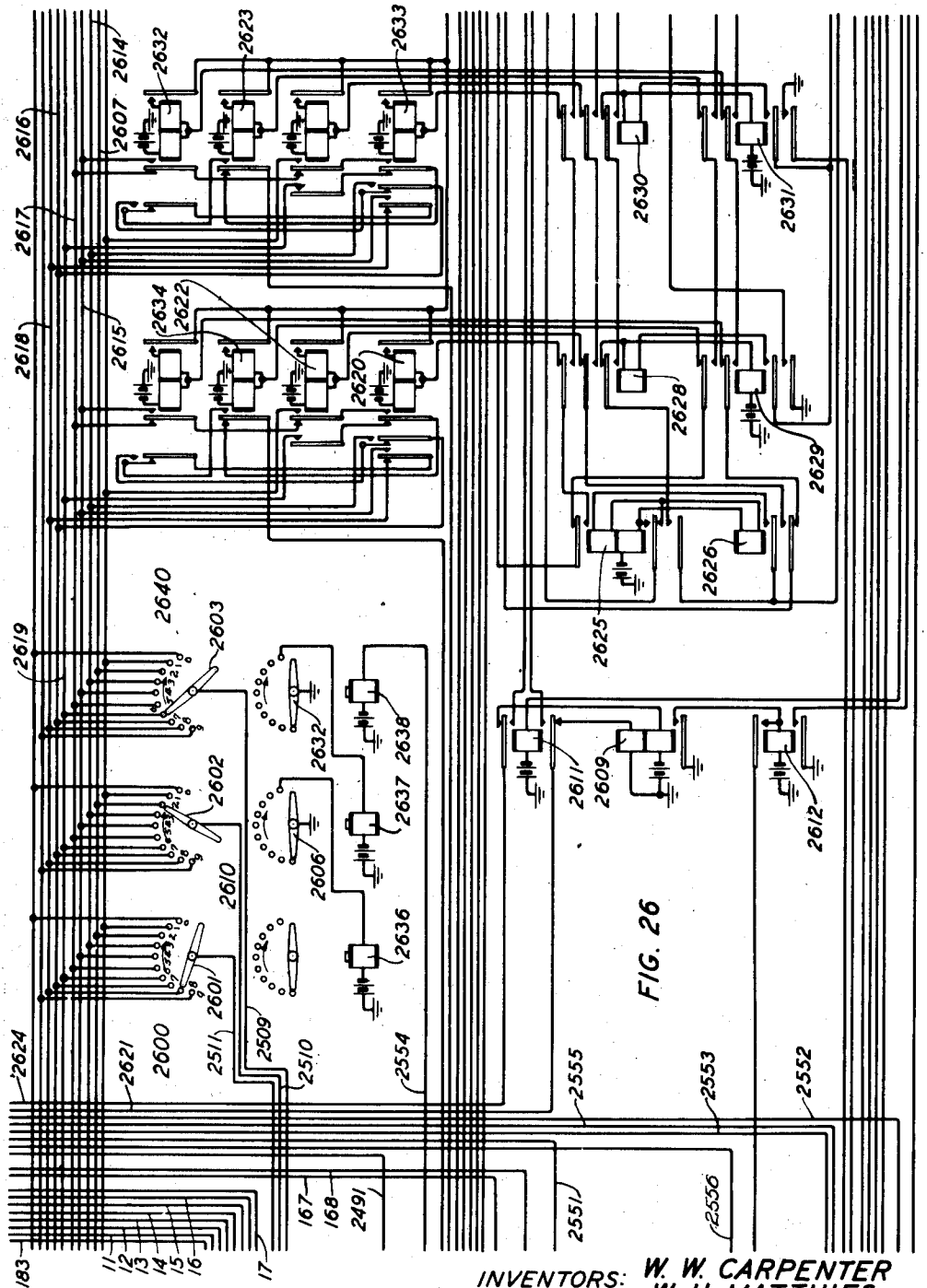

FIG. 26

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

BY P. C. Smith

ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

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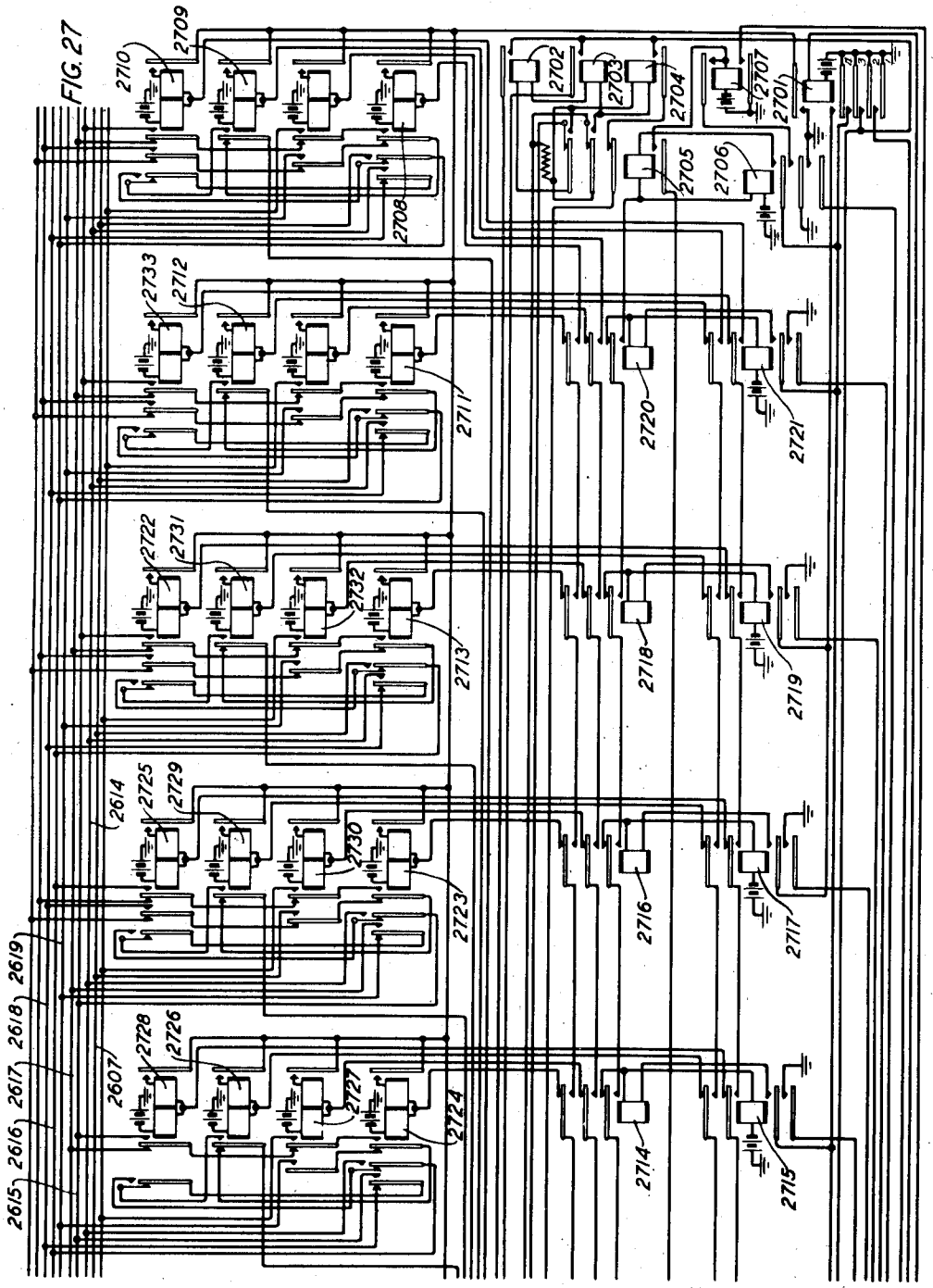
FIG. 27



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

BY P. C. Smith

ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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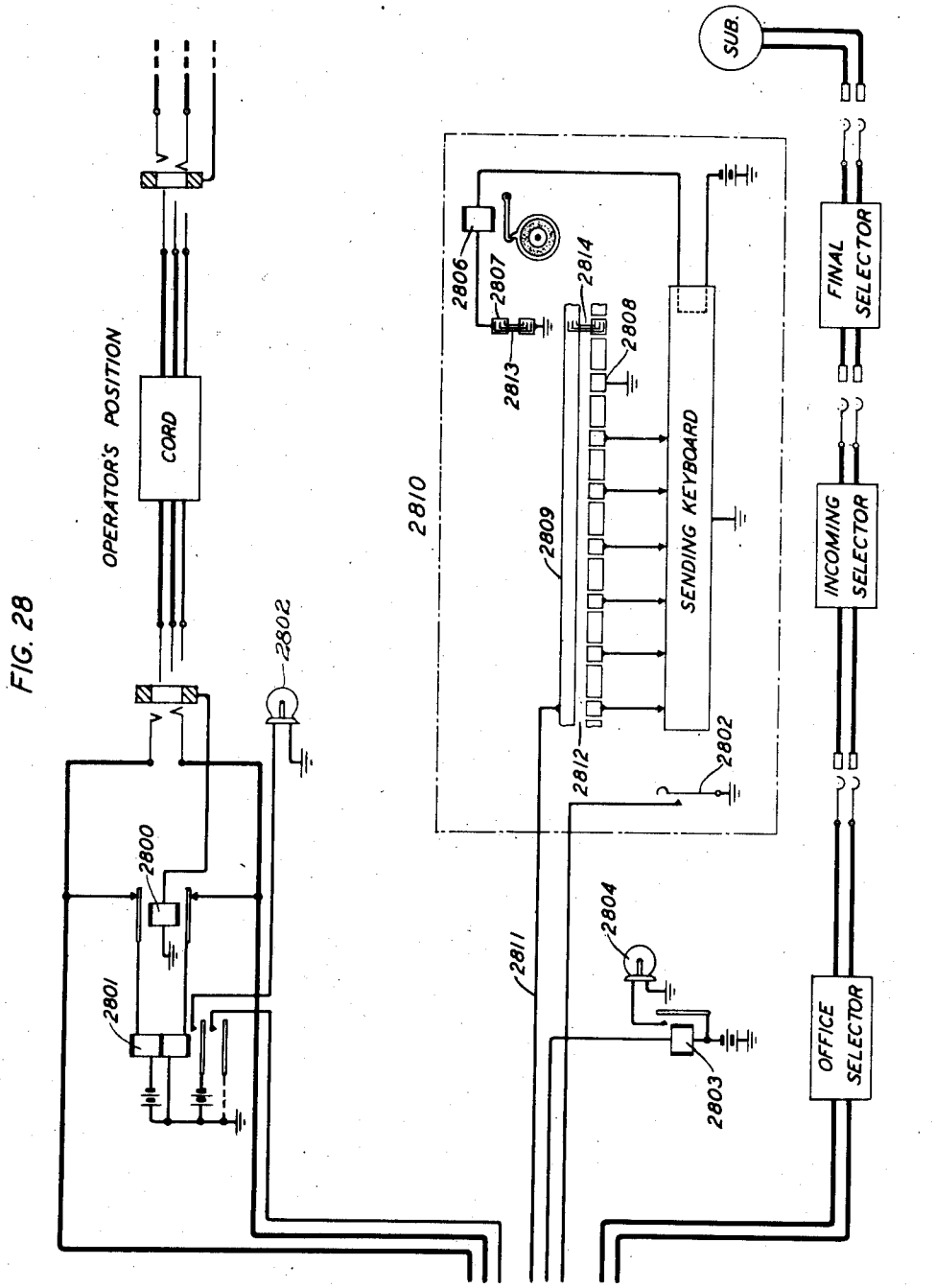

FIG. 28

INVENTORS: W. W. CARPENTER
W. H. MATTHIES
BY P. B. Smith
ATTORNEY

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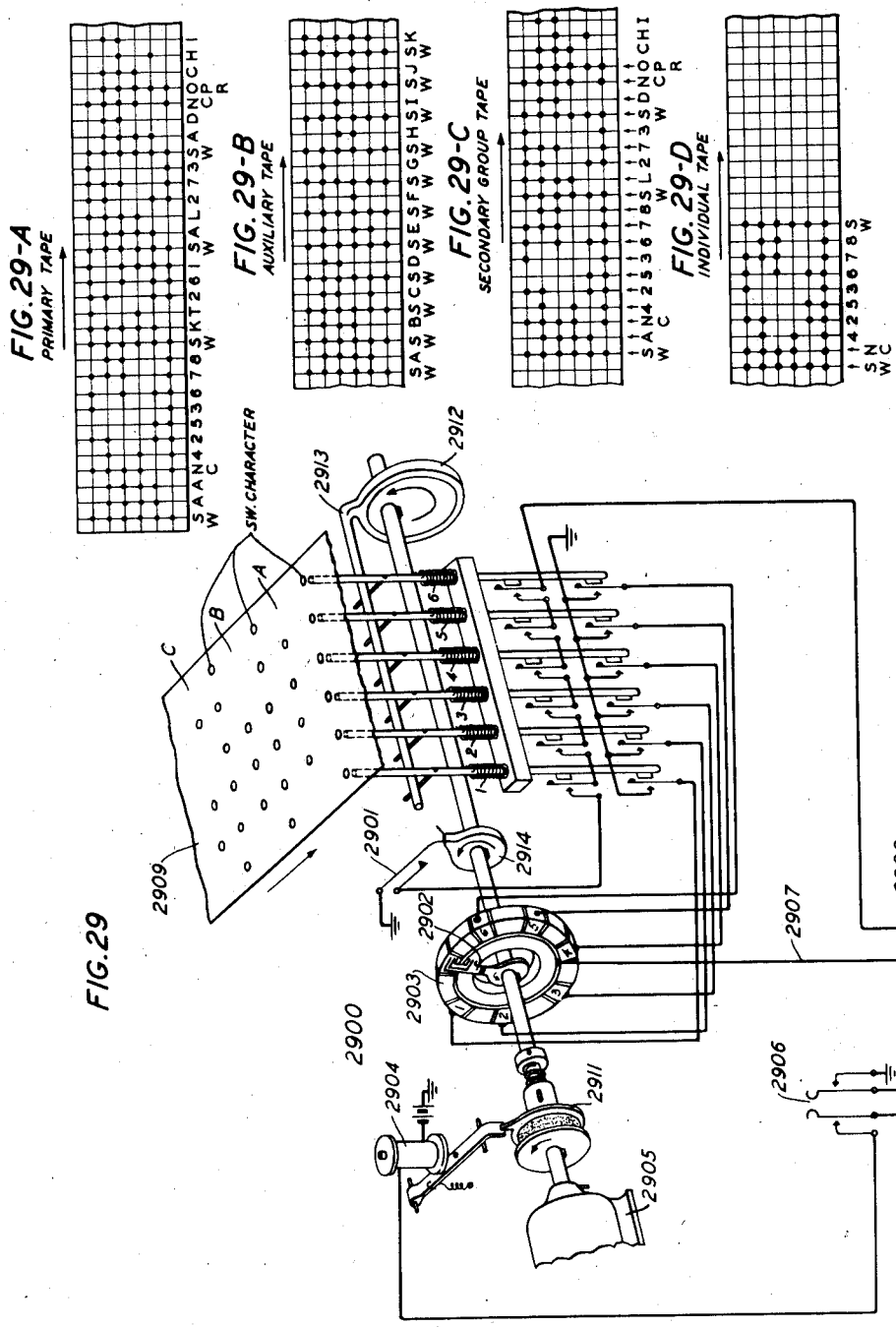

FIG. 29

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

BY P. C. Smith

ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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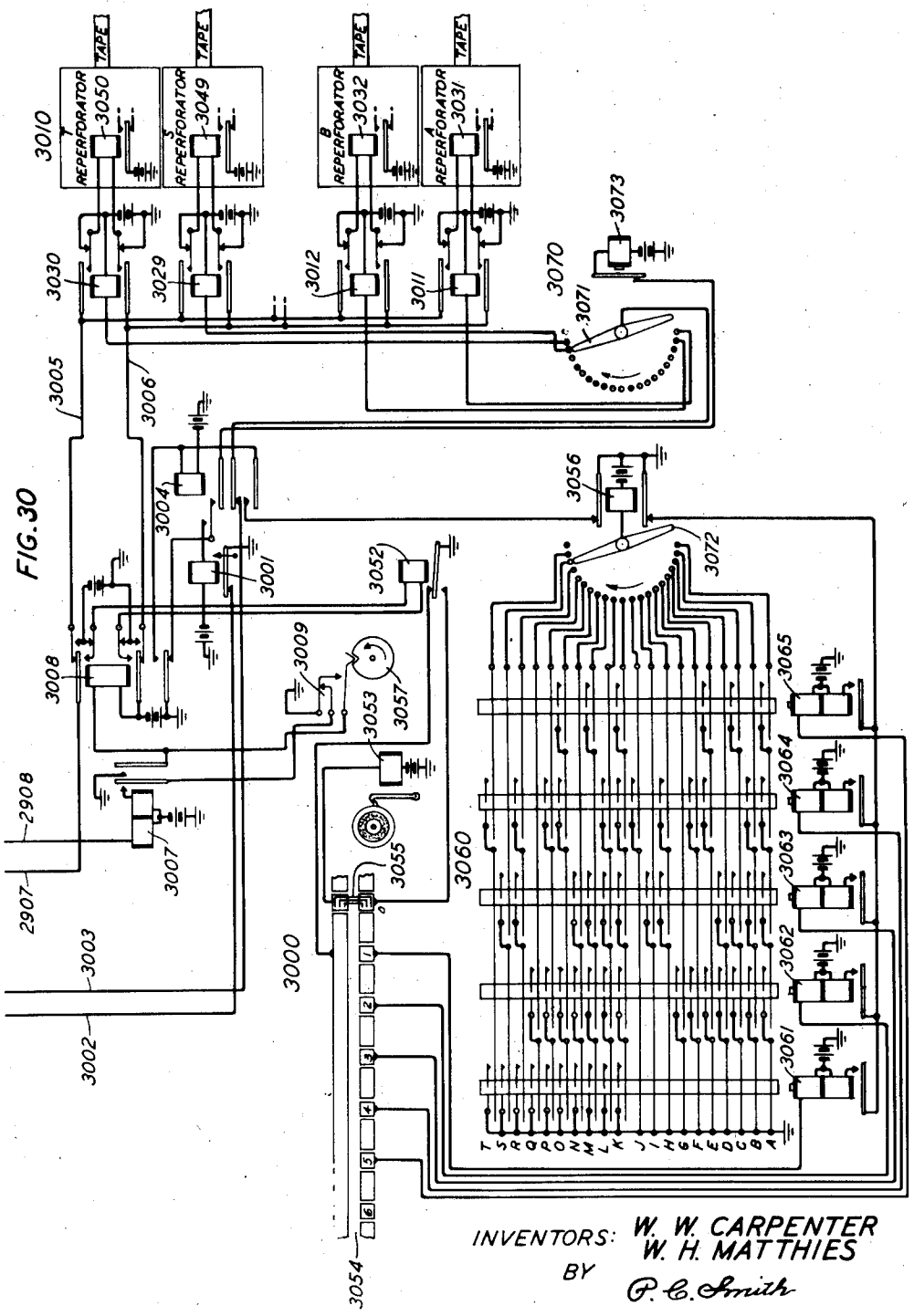

FIG. 30

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

BY P. C. Smith

ATTORNEY

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TELEPHONE SYSTEM

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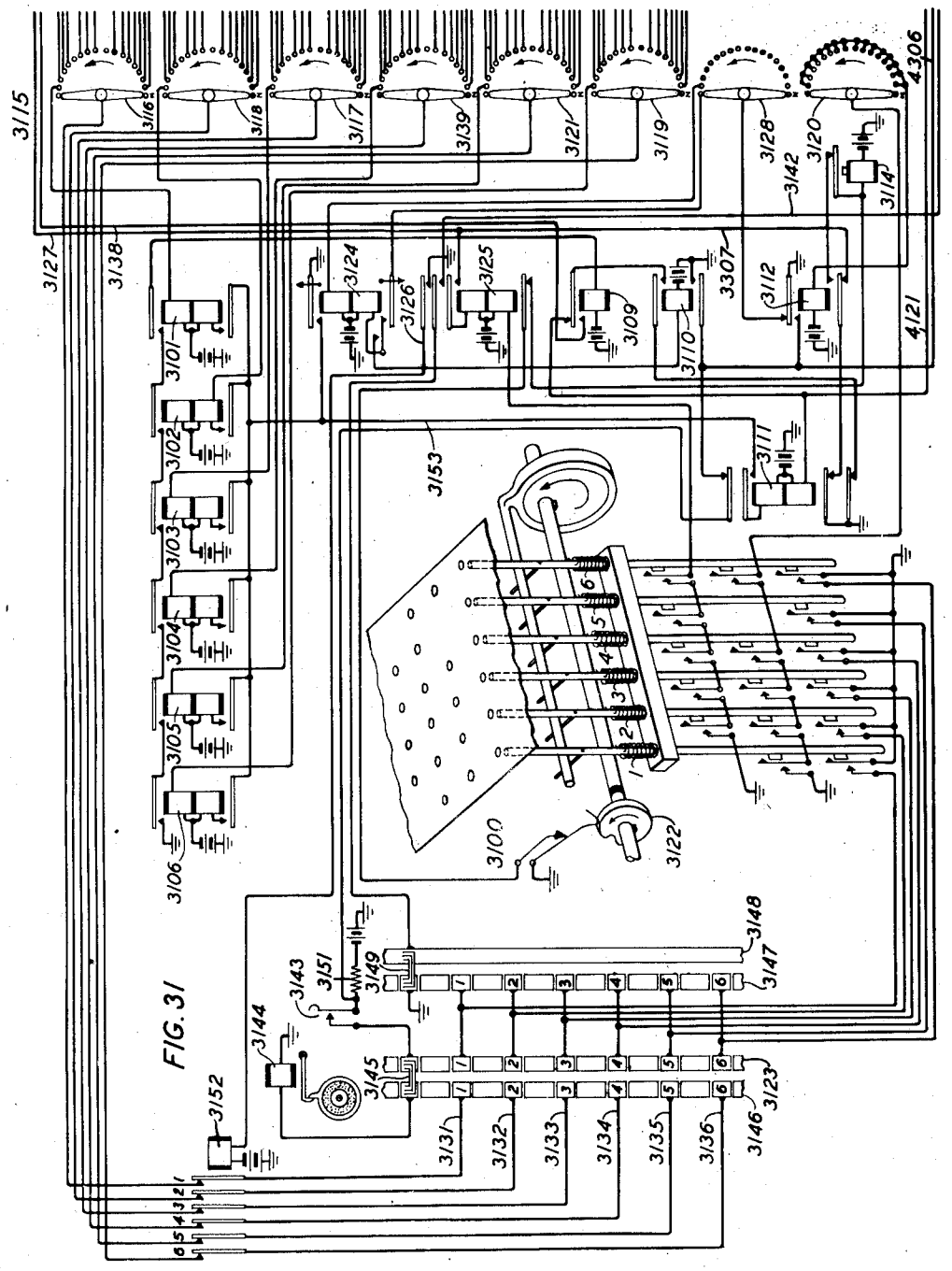

INVENTORS: W. W. CARPENTER
W. H. MATTHIES
BY P. C. Smith
ATTORNEY

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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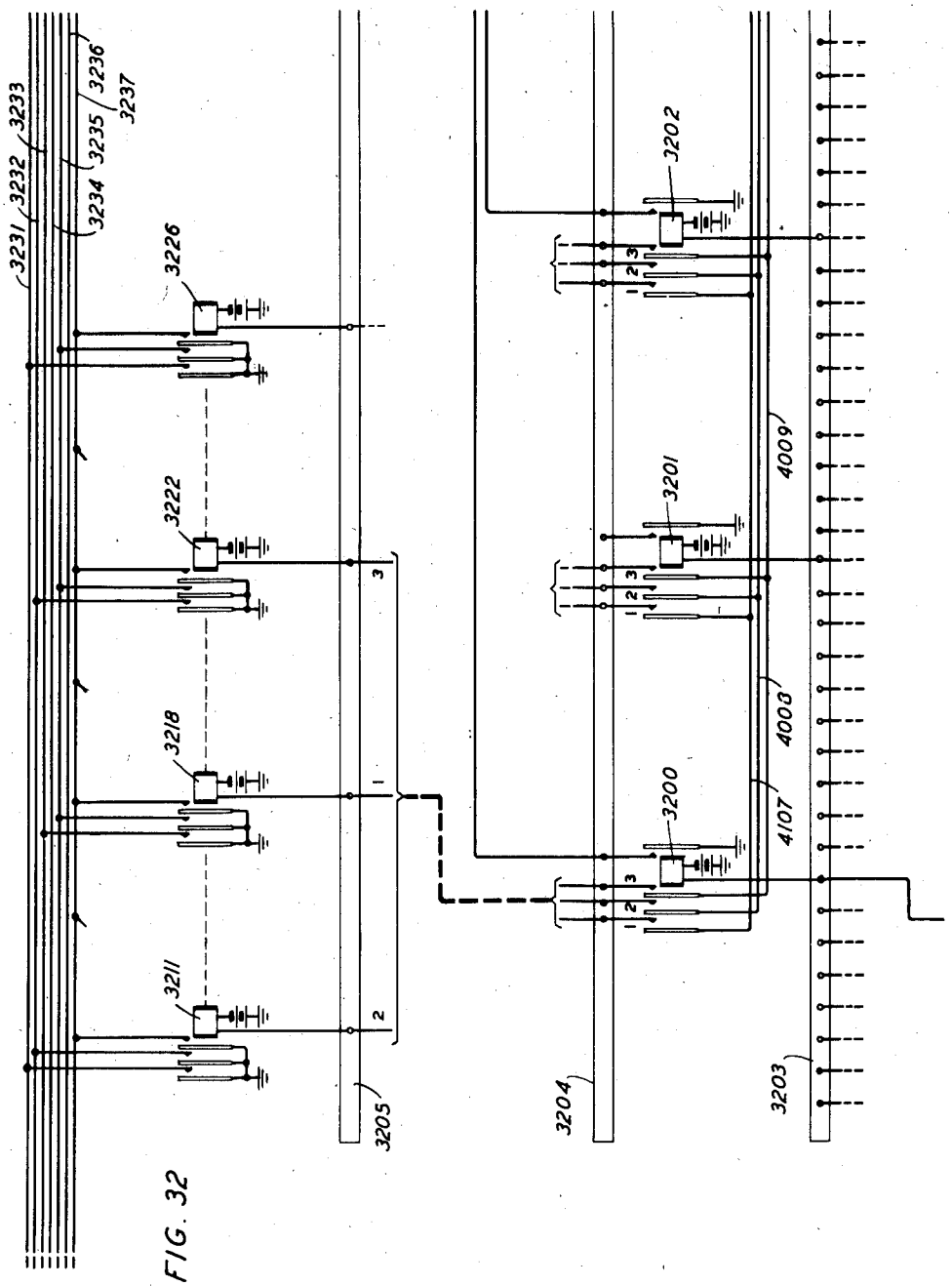

FIG. 32

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

BY P. C. Smith

ATTORNEY

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TELEPHONE SYSTEM

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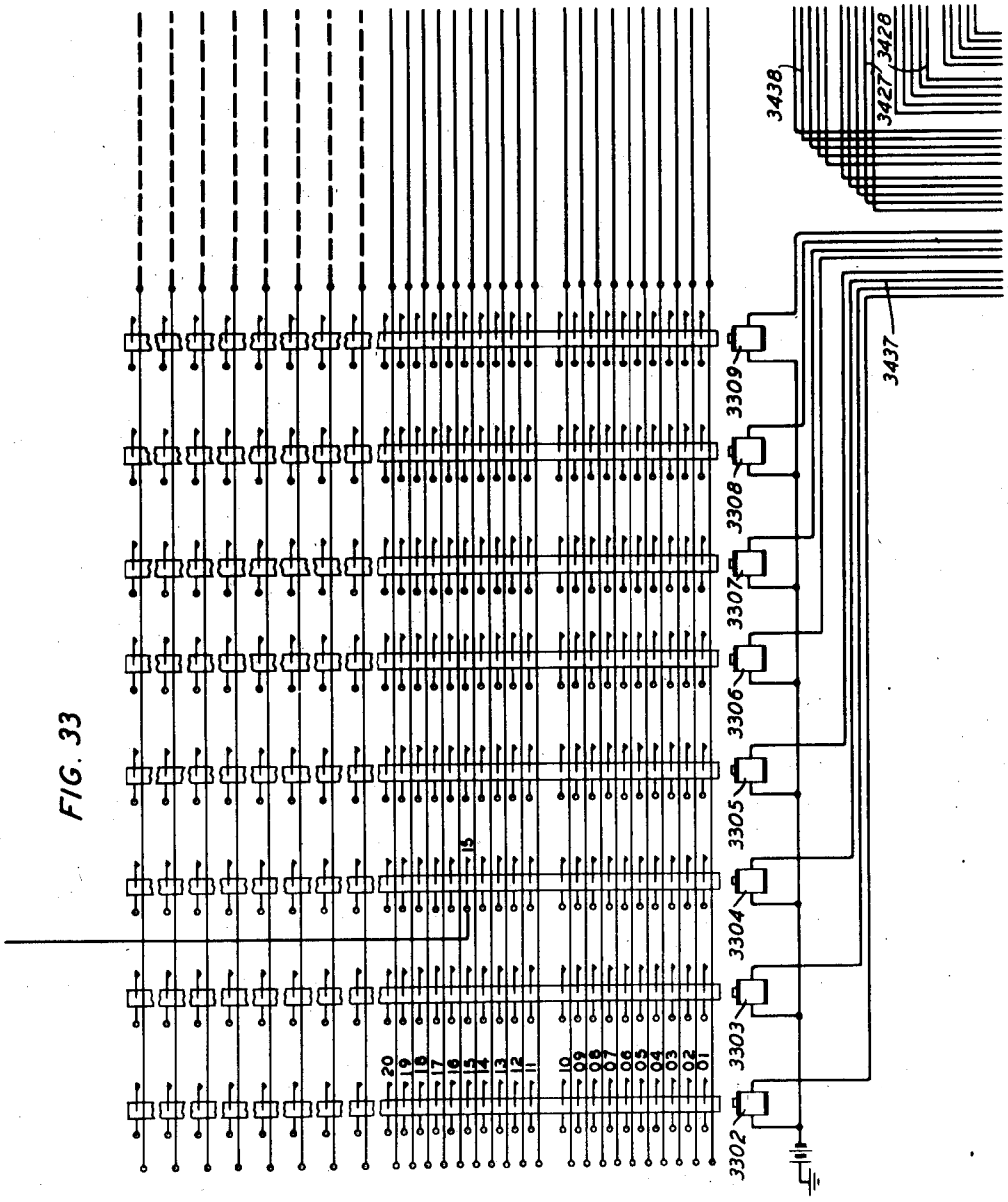

FIG. 33

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

April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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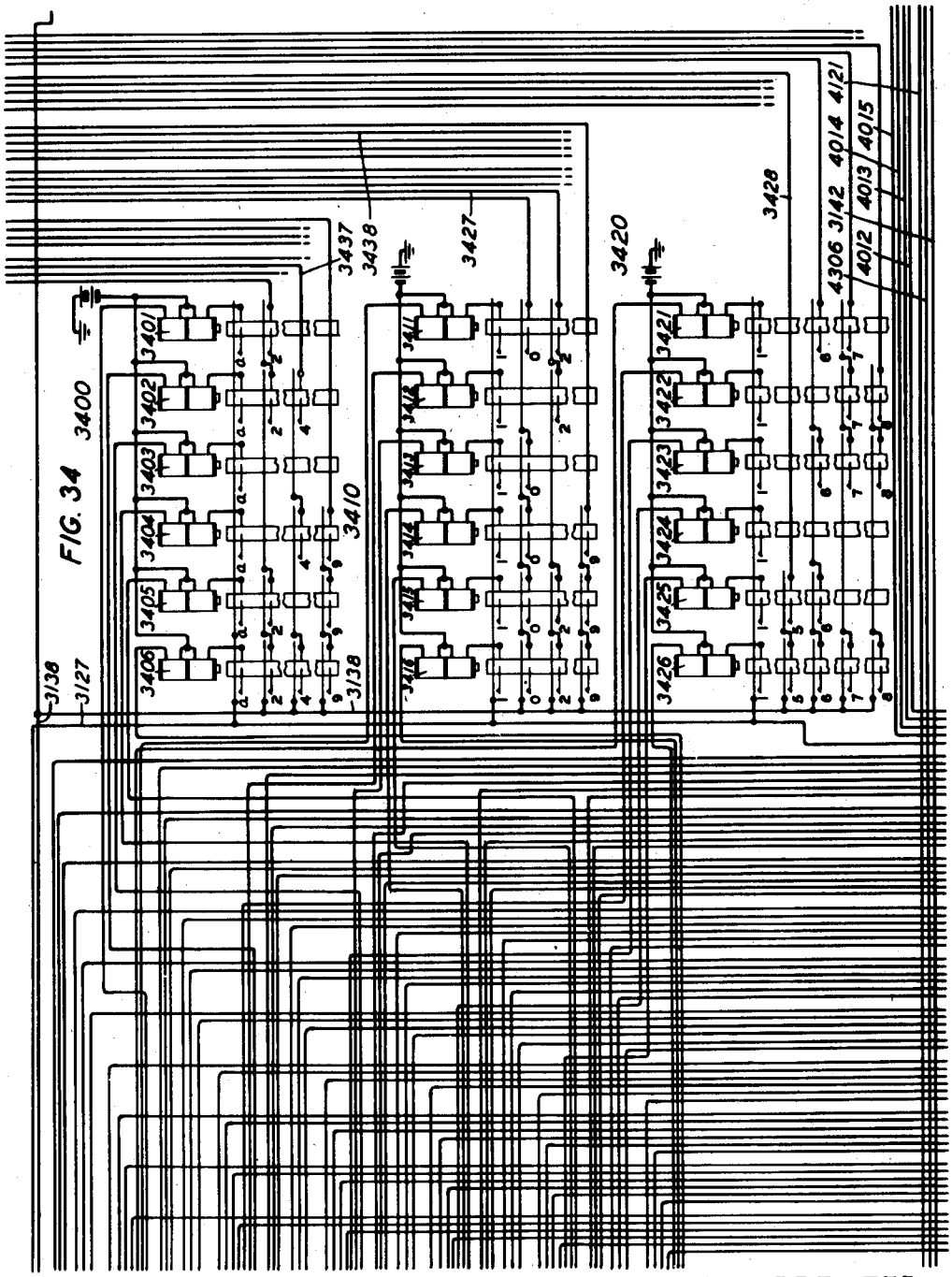

FIG. 34

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

BY P. C. Smith

ATTORNEY

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TELEPHONE SYSTEM

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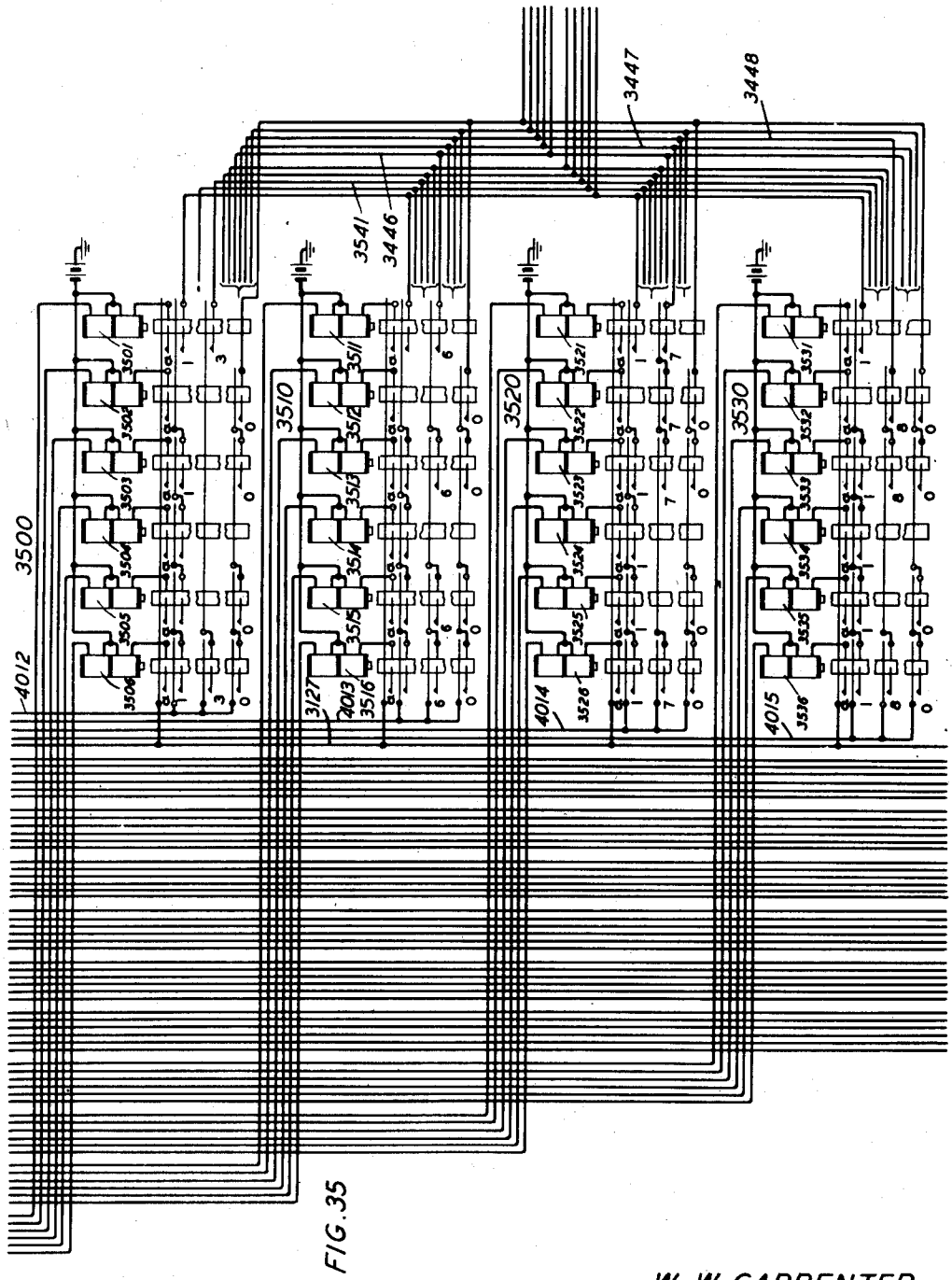

FIG. 35

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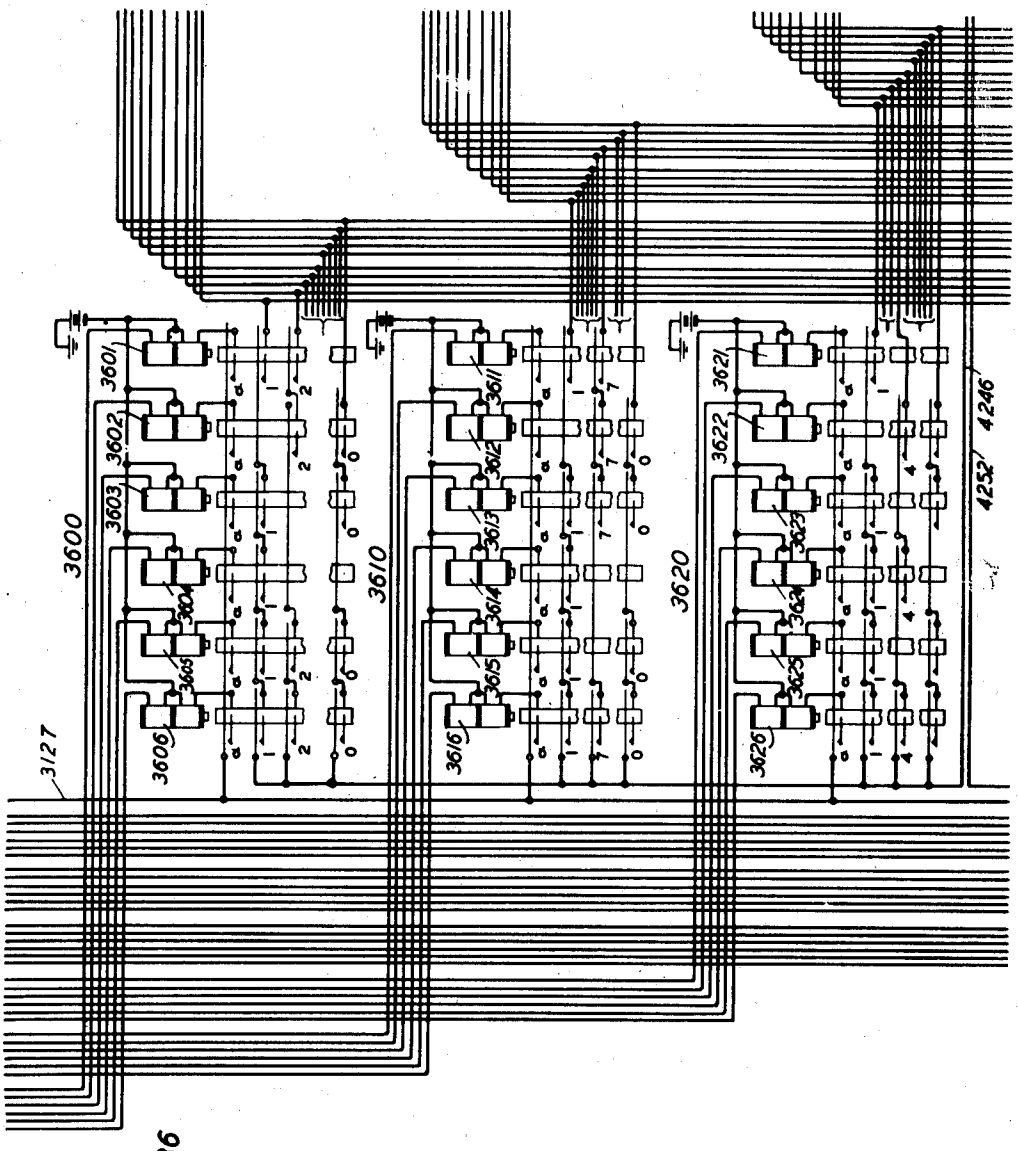

FIG. 36

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

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TELEPHONE SYSTEM

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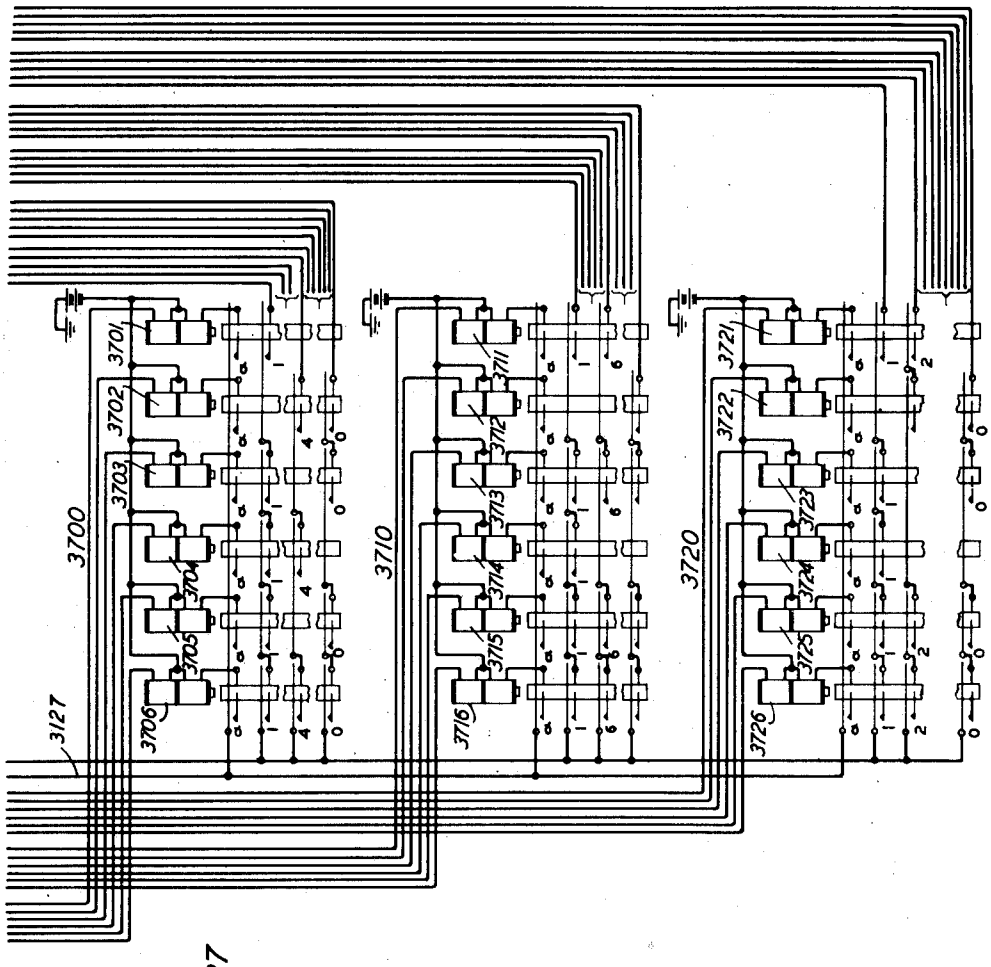

FIG. 37

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

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April 5, 1938. W. W. CARPENTER ET AL 2,112,951

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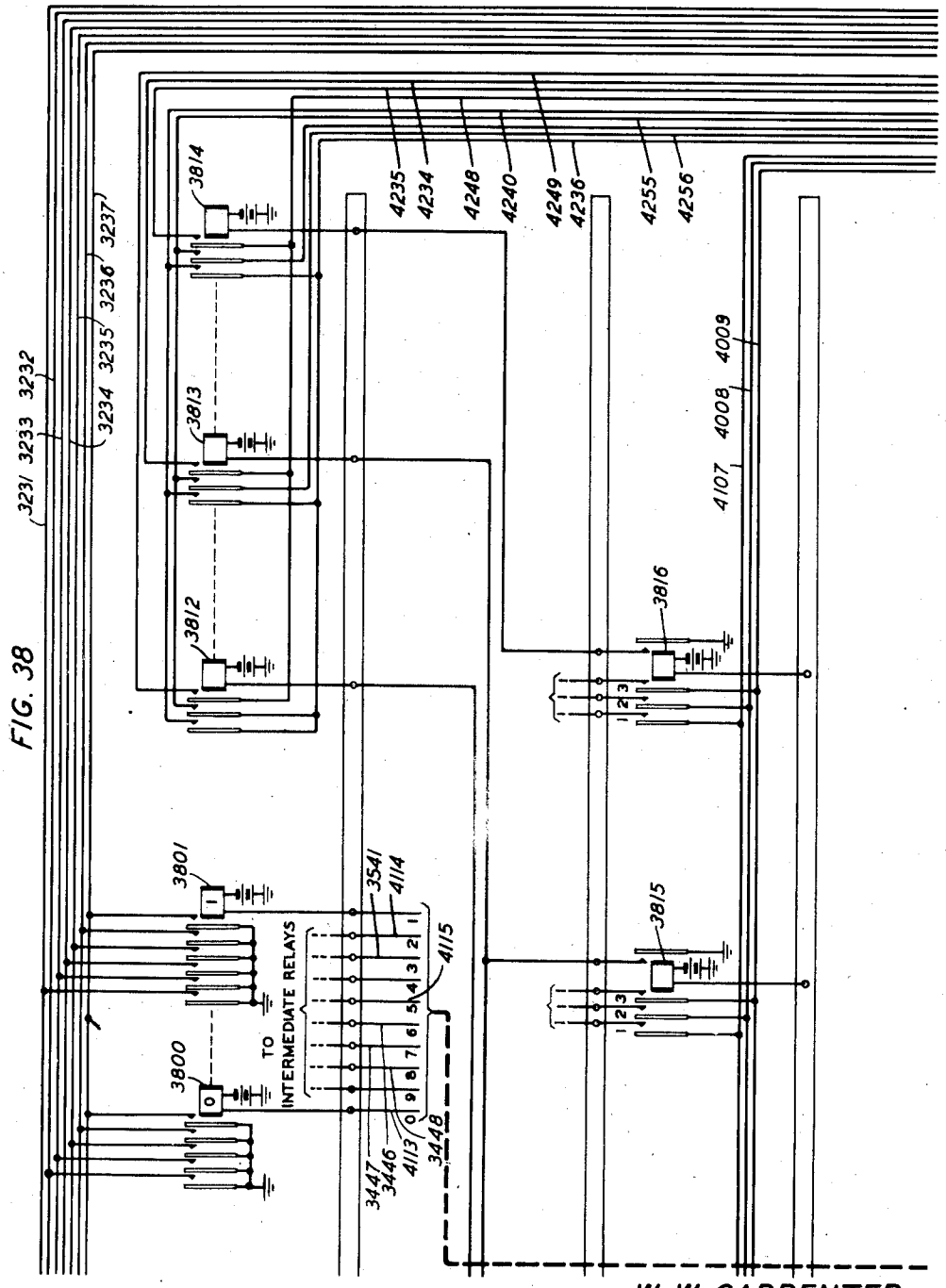

FIG. 38

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

BY P. C. Smith

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TELEPHONE SYSTEM

Filed April 28, 1934 43 Sheets-Sheet 39

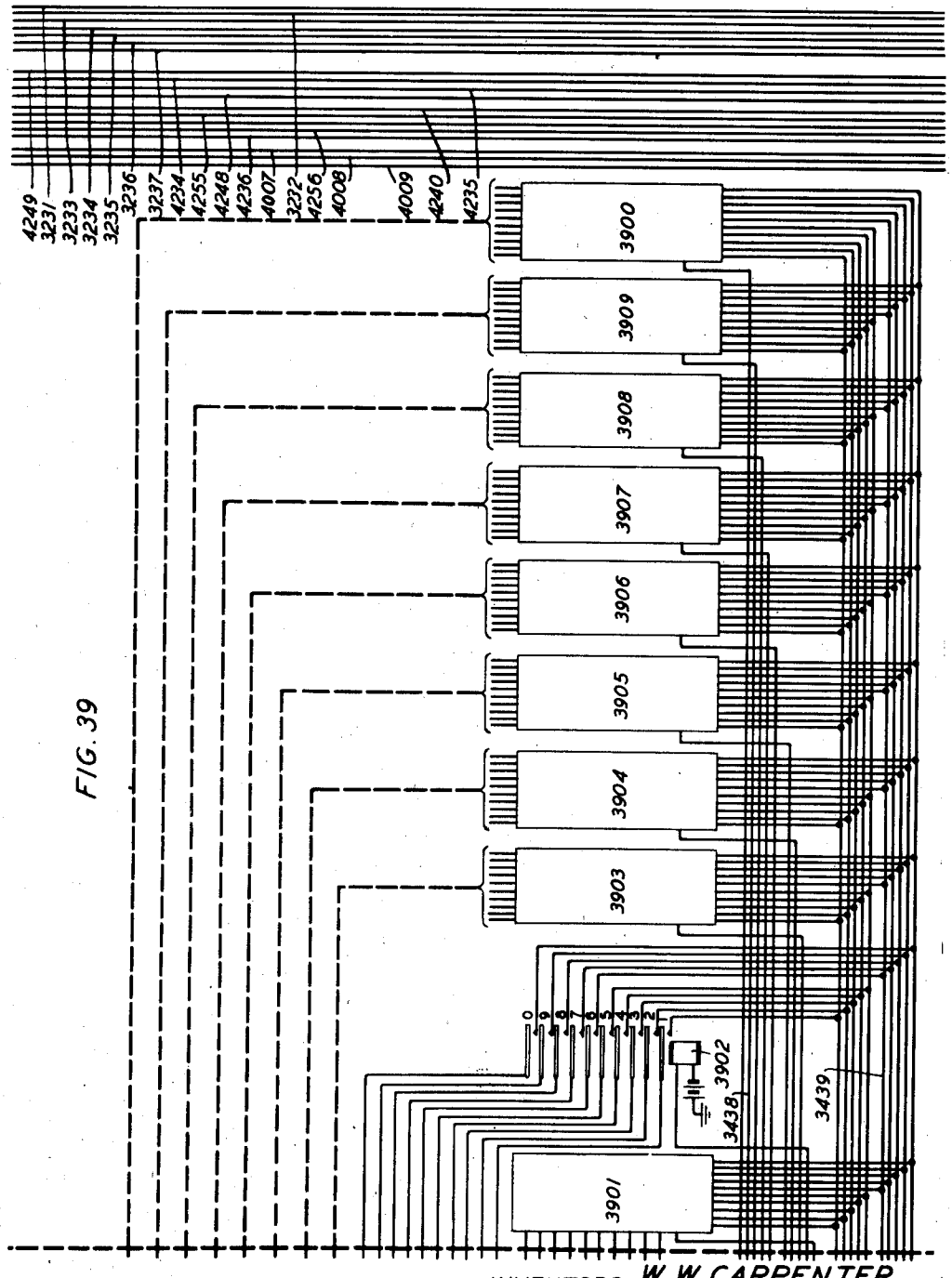

FIG. 39

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

BY P. C. Smith

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April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

Filed April 28, 1934 43 Sheets-Sheet 40

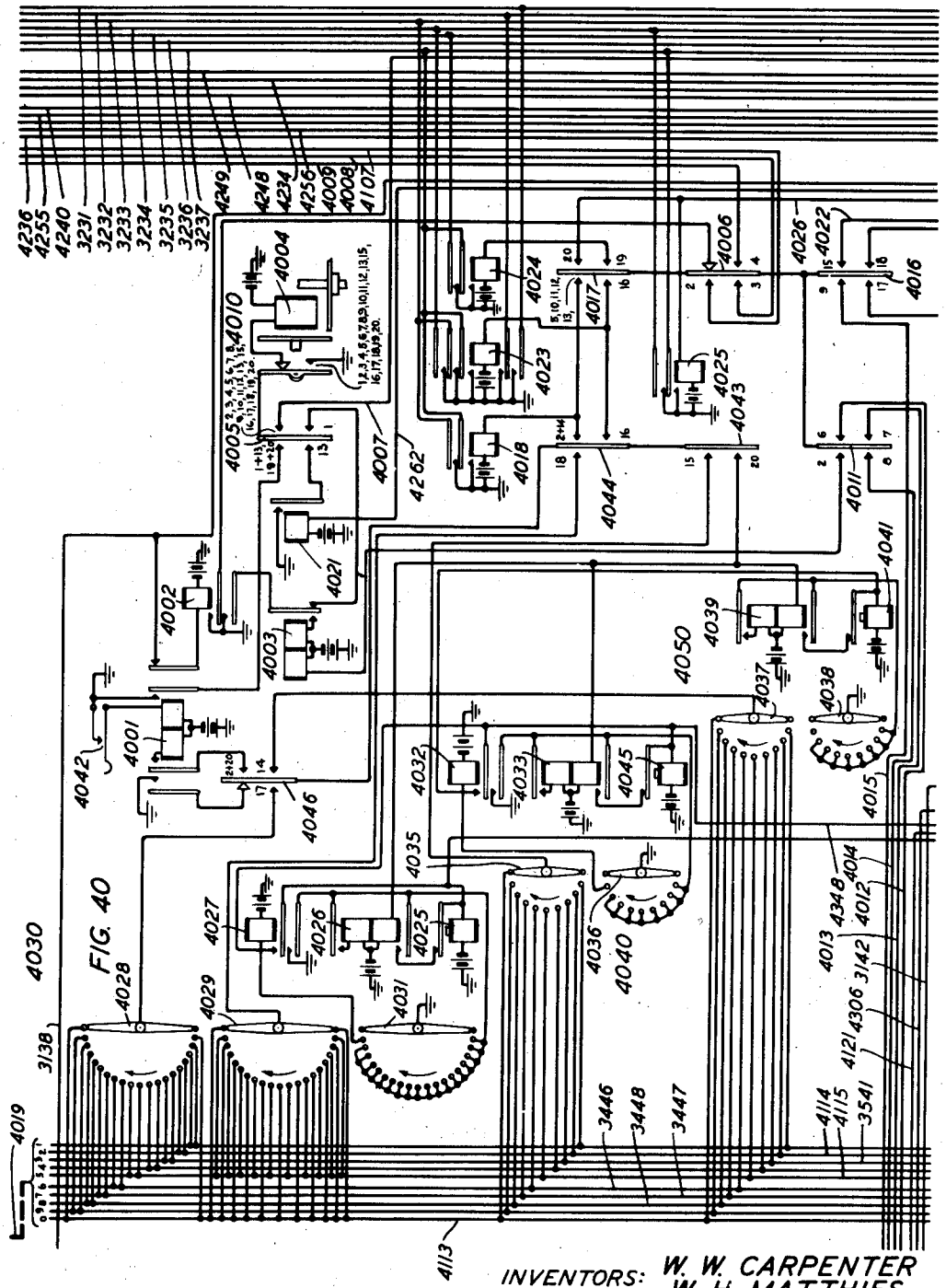

FIG. 40

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April 5, 1938. W. W. CARPENTER ET AL 2,112,951

TELEPHONE SYSTEM

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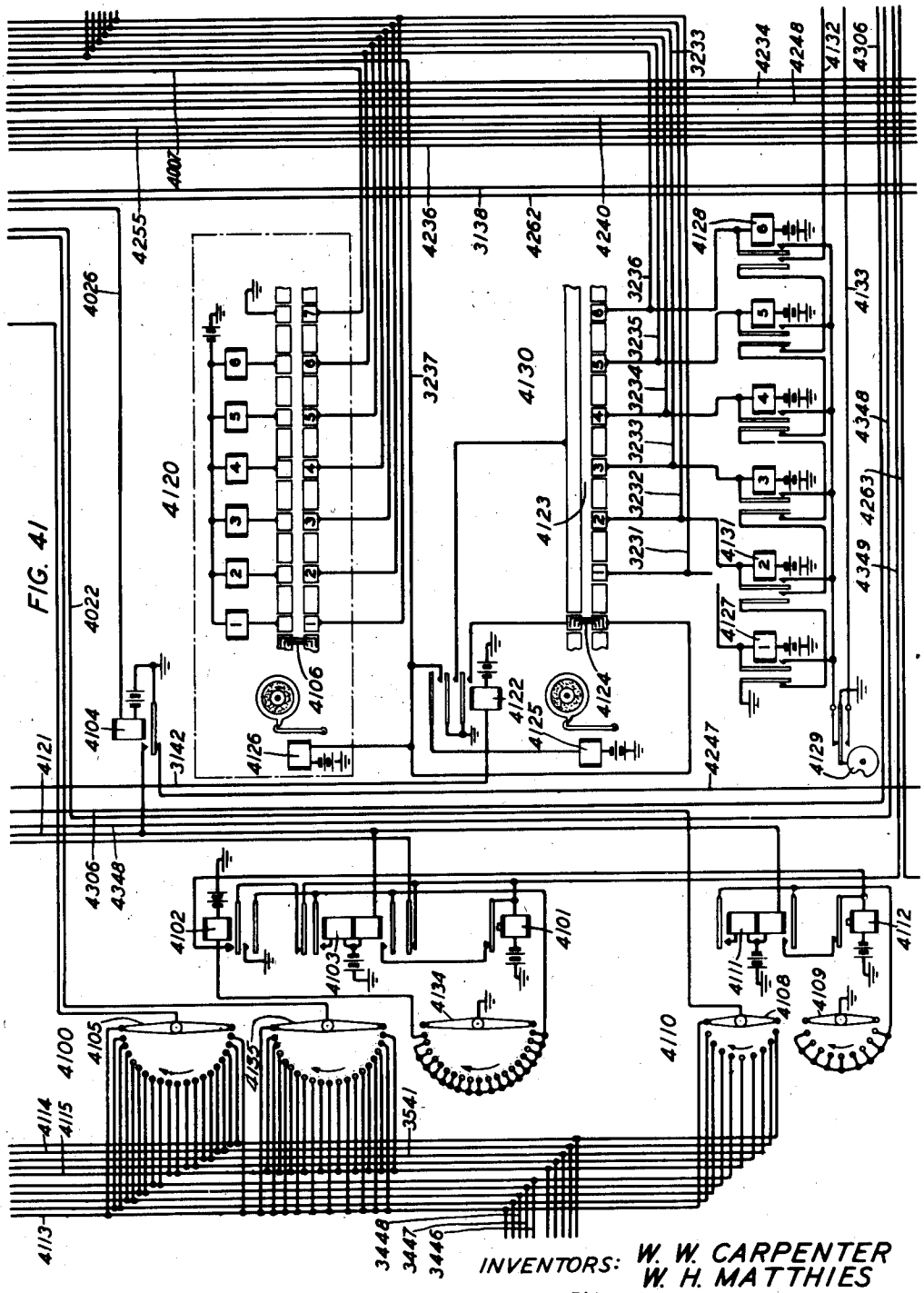

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TELEPHONE SYSTEM

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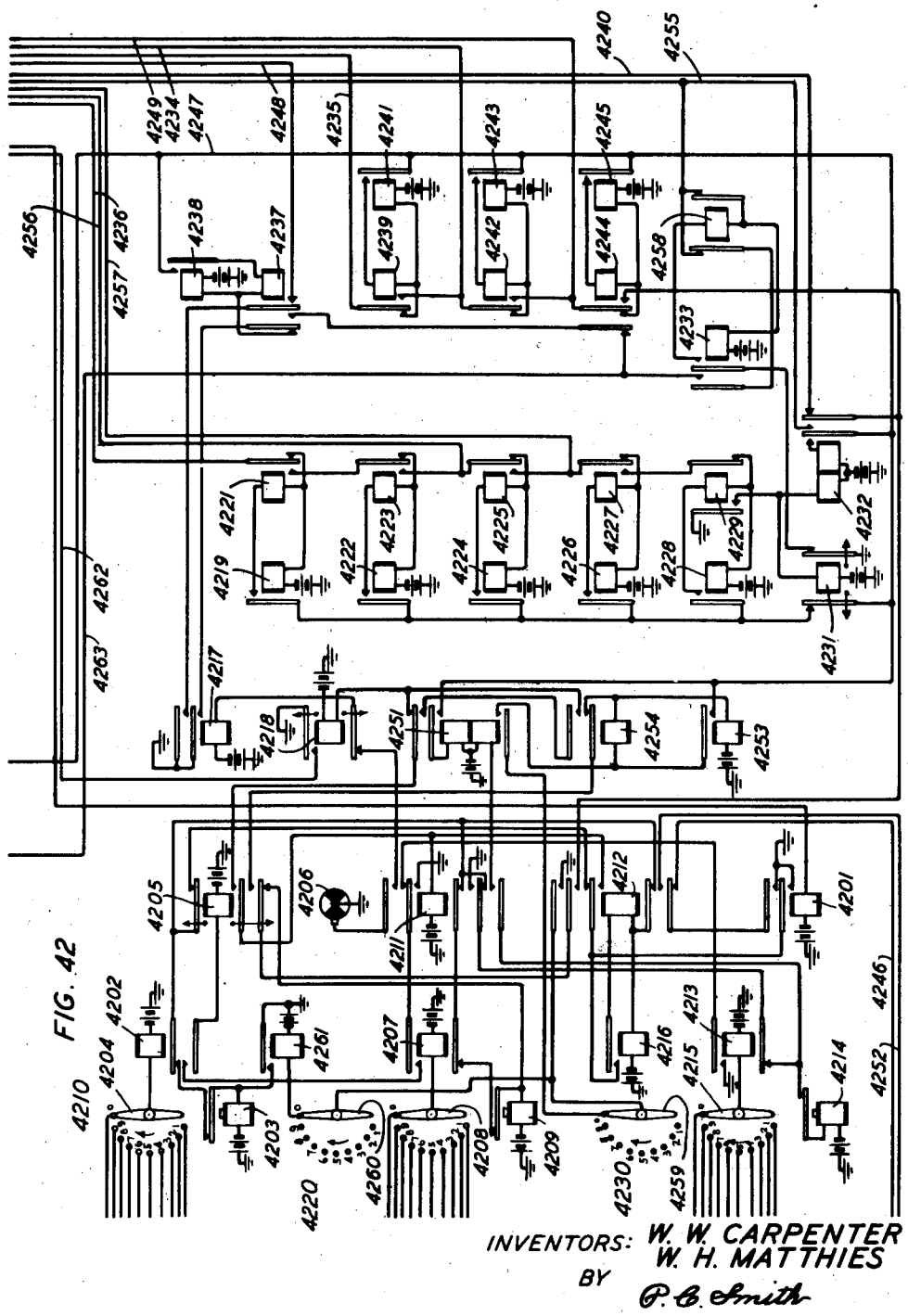

FIG. 42

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TELEPHONE SYSTEM

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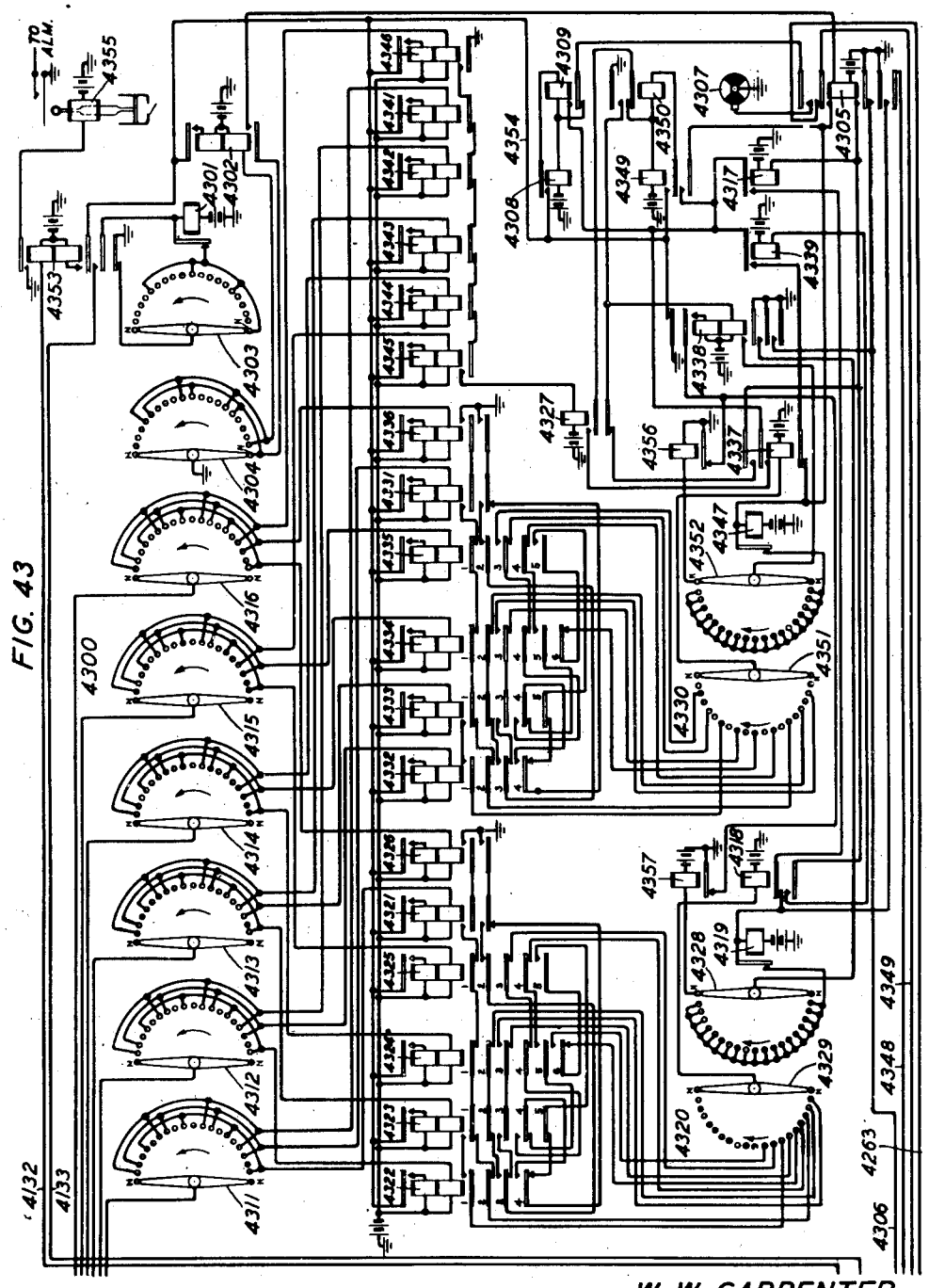

FIG. 43

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2,112,951

TELEPHONE SYSTEM

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Application April 28, 1934, Serial No. 722,890

23 Claims. (Cl. 179—7.1)

This invention relates to telephone systems and more particularly to an automatic billing system embodying the means and the method whereby the various completed calls chargeable to different lines over a stated billing period are automatically recorded, classified and computed and finally printed upon records individual to each of said several lines. In its preferred embodiment the invention has been developed with respect to means for handling the charge accounts of the subscribers of a telephone exchange; but generally speaking, its flexibility makes it possible to adapt and apply it to all large groups of similar commercial transactions which run over stated billing periods. Applied to a telephone system, therefore, the invention covers automatic means for timing, recording and billing all telephone calls made by the subscribers of a telephone office within a stated billing period.

At the present time it is well known that charges for telephone service on some classes of subscribers' lines such as, for example, individual message rate lines, are usually made by operating a message register meter associated with the calling subscriber's line regardless of whether the telephone system of which the calling 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 as evidence of a completed connection.

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 strictly local call. For such a connection, the meter of the calling subscriber is operated a plurality of times for the initial charge period when the charge is a multiple of the standard local rate and also a number of times thereafter for each period of overtime depending on what multiple of the local standard rate is charged for each overtime interval. At the end of each month, or whatever period is used for billing purposes, the reading of each subscriber's line meter is taken. By subtracting the reading of the previous billing period from that of the period then terminated, the total number of charges accumulated over the period is determined. This total charge not only comprises the separate charges for local calls but also the equivalent, in the standard local rate, of charges for all calls completed in the immediate toll area and for which the subscriber is billed in bulk; that is, without an itemized identification of such toll calls to accompany the monthly bill.

This method of billing subscribers, while practically satisfactory for local calls and for such toll calls as can be billed in bulk, is impractical for use where the equipment of the telephone plant can be extended to permit subscribers to dial directly those called lines which 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 preserve on a toll ticket a record of the designation of the calling line, the destination of the call and the duration of the conversation, so that when the monthly bill for the subscriber is made, the entries on toll tickets are entered as separate items thereon. As is well known, timing and ticketing involves considerable delays at the recording position while the handling of tickets further slows up the efficiency of the commercial departments of an operating company the effect of which tends to cancel to some extent the proficiency of mechanical switching.

The invention is intended to overcome this obstacle. It is further intended to avoid the necessity of meter reading for local charges by the use of a centralized recording mechanism capable of registering the identity of all local and toll calls, the former automatically in those cases 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 indicative of the call destination and the charge to be made therefor. The invention further provides automatic equipment by which monthly bills for all local and all toll charges can be made up for each line from records made by said registering device and other devices responsive to said records and containing the record of all calls made by the line over the billing period.

The advantages of the invention are manifest. First of all it eliminates all necessities of having meters at the subscribers' lines; secondly, it places call recording on a more efficient basis by freeing the operator from the necessity of making out tickets, and thirdly it preserves a record of the history of all calls as made by the subscriber at the time and immediately after a connection is established, thereby eliminating all possibilities of misunderstanding between the subscriber and the operating company, the former frequently

complaining of being charged for calls which he alleges he did not make. In other words the superiority of our invention, as applied to telephone billing practices, is to be found in its possibility of broadening the potential scope of the use of the automatic telephone equipment and of reducing the cost of operating the clerical branch of the telephone plant. The present invention, therefore, in its adaptation and application to a telephone plant, has for its broad object a system of apparatus and cooperating circuits whereby 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 subsequently be used as the basis for automatically operating a printing tabulating mechanism for making the subscriber's monthly bill.

A particular embodiment of our invention, in its application to a telephone system, is illustrated in connection with the well known panel automatic telephone system in which the calling subscriber establishes a connection with a called subscriber over panel type switching selectors, although we do not wish to be understood as limiting our invention to any particular type of apparatus or any specific system, the invention being readily adaptable by anyone 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, on 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. Ordinarily most of the information is required for the proper identification of charges which are to be allocated to the particular calling line, but in the case of toll calls where an itemized history of the call is furnished with the bill, such information must also be transcribed as part of the bill, in which event it must likewise be recorded.

The recording equipment consists, in general, of a suitable recording apparatus which cooperates with a recording register that may, at the necessary time, become operatively connected with a calling line extension. This register is used for registering 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 a line-finder is provided, to a group of lines terminating on one line-finder frame and served by a correlated group of line-finder district selectors. Should it be found, however, that a single recording unit for this group undesirably increases the holding time of the line-finder, two or more such recording units for each line-finder group may be used, each unit serving a proportionately smaller group of lines.

A register circuit is provided to receive the information to be recorded and to further control the operation of the recording equipment. It comprises a pulsing relay that responds to code impulses which may be transmitted from a sender, a group of registering relays or their equivalents 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, the recording apparatus herein used is a perforator of the type commonly used in printing telegraph systems and comprises a suitable number of punch magnets depending upon the code system employed for recording the various items of information by perforating holes transversely across a tape of suitable size. Other recording apparatus such as, for example, those which are responsive to the setting of suitable light valves, might be equally well used. The invention, however, as described and claimed hereinafter, 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, works as follows: When the subscriber removes his receiver from the switchhook, a line-finder 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, which are registered in the sender for the purpose of controlling the proper setting of the various switching selectors between the calling line and the called subscriber. When the sender has responded to the series of impulses designating the code of the called office and the called number, the register circuit above mentioned or tape register as it is hereinafter called, is connected to the line-finder district selector and placed in a responsive condition to code impulses 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 information on the tape that will contain the record of the call completed from the calling line. To do this, the tape register is operatively connected to the sender and an impulse code for each of the letters and digits dialed by the subscriber and recorded in the sender is now transmitted in the form of code impulses to the tape register where they are recorded on auxiliary registers for subsequent recording on the tape. When the record is completely registered, the tape perforator is operatively associated with the tape register. Through a group of translating relays intermediate between the register and the perforator the impulse code is translated into a six-digit perforating code. In this manner, the called office code and the called subscriber's number are perforated in a series of positions on the tape. However, in advance of perforating the called office code and number it becomes necessary to perforate a special code indicative of either of three other notations, the first of which we have designated as a "switching" character, the second as a "new call" character and a third as a code which identifies the particular line in the group of lines to which the registers and perforator are common. The reason for the use of a switching character and a new call character will become apparent later on in the detailed description of the invention, but it is plain that some means must be

used to identify the calling line correlated to the succeeding code of the called office and number to which said calling line is endeavoring to establish a connection.

If the call, instead of being a local one and hence completed by automatic means, is the usual toll call which must be completed by way of an operator's position, the recording operator, instead of making the usual ticket for the call, now causes the regular ticket information to be transcribed on the tape in the same way as it would be transcribed for a local call. In this case, however, the city or town to which the call is to be completed as well as the office code and number therein and the charge for the call in terms of dollars and cents will be recorded by the operator on a teletype transmitter associated with her position. Printer pulses are then transmitted to an auxiliary responsive equipment 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 as that used for recording the notations of local calls.

In the case of the local connection, however, when the tape register has finished the operation of causing the called office code and number to be perforated on the tape, the register and the associated tape perforator are disconnected from the line, ready to be used by any other calling line of the group which may have at this time completed the dialing of the called office and number of its own particular connection. Thus it is seen that the perforator and associated tape register are not held continuously to one line until the completion of the connection and the termination of conversation but are only momentarily associated with any line in the group at the time such a line and its associated equipment has enough of a record which may be recorded on the tape. The recording equipment, therefore, is used discontinuously by all lines in the group to which said recording equipment has access. It now becomes evident why, prior to punching the code of the called office name and number, or any other notation relating to a particular call, it becomes necessary to perforate an identifying character which designates the particular calling line from which the office code and name has been dialed and also another character which indicates whether what follows is the start of a new call by another line or merely a succeeding notation of a call made by a previous line for which other notations have already been recorded upon the tape. Should the call be a toll call, that is, one whose completion takes place through an operator's position, it also becomes necessary for reasons which will appear hereinafter to record another character in advance of any information to indicate that what follows relates to a toll call and not to a local call.

After the recording equipment has caused the perforation of the code and number subsequent to the perforation of the switching character and the calling line identification code, said recording equipment is disconnected from the line. The connection to the called subscriber's line is then completed in the usual way and when the called subscriber answers, which event marks the instant when conversation time is to be measured, the tape register is again connected to the district selector whereupon, under the control of a timing device, a record of the starting time of the conversation is made on the tape. This time is registered in terms of three separate digits, the first relating to a ten-minute interval, the second to a minute interval and the third to a tenth of a minute interval, the record of the starting time being made in terms of the position of certain switches which record each of these time intervals. The tape register is 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 setting of the translating relays the perforator is again caused to be operated for recording, first the usual switching character, secondly the identification code of the calling line and, thirdly, each of the separate codes indicating the three separate notations of the starting time. The tape register and 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 been advanced to the point where the called office and number have been registered in the 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 belonging to the first line because the usual switching character and the code designating a new call intervenes between the record of the first line and the record of the second line. Or if, again, the new call should be one which is to be completed by way of the operator's position, then whatever information the operator may wish to have recorded on the tape is preceded by the switching character and the code indicating a call completed through an operator's position which is later followed by whatever information in code form the operator has typed on the transmitting mechanism associated with her position.

When the conversation starting time has been recorded on the tape, the tape register and perforator are again disconnected from the line. 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 and the finishing time of the conversation is then recorded on the same group of registers and in the same three separate designations, preceded, as always, by the switching character and by the calling line identification code.

Thus the primary tape, that is, the tape record which is made for a group of lines, contains a series of disconnected notations relating to calls initiated from the lines in said group. The next step in our invention is to make from the primary tape a series of individual tapes for each one of the lines and containing thereon all of the notations relating to calls made by each of the lines and in the order in which said notations would be entered on the tape in the sequence in which said information would have been recorded in the normal completion of the call, that is to say, the called office and number, the starting time and the finishing time of a connection, followed by another called office and called number and the starting time and finishing time of another connection if such other connection happens to be a local call, or of the city, office and number and the total toll charges should it be a toll call. Each of these notations, however, is contained between two of the usual switching characters and by the code of the new call or by the code of an operator's call whichever the case may be.

The equipment for making a series of individual tapes from the primary tape comprises what is herein called a tape subdivider and consists of a telegraph distributor of a type well known in the telegraph art, a register and a number of reperforating machines equal to the number of subgroups into which, for convenience, the main group of lines may be subdivided. For instance, if, as is the case in line-finder arrangements, the lines are arranged in groups of four hundred lines and further subdivided into subgroups of twenty lines each, there will be twenty reperforating machines associated with one distributor. Hence, when the primary tape is passed through the distributor a system of circuits responds to a part of the code notation of the calling line identification code for selecting the particular reperforator assigned to the subgroup in which the calling line belongs. After the selection of the proper reperforator, the tape is then advanced to succeeding code perforations each of which causes a series of impulses to be transmitted to the selected reperforator and to cause the reperforator to punch all the codes therein which come in succession up to, but not including, the identification code of the next calling line. When the tape has advanced to the identification code of the next calling line, another reperforator is selected in accordance with the subgroup in which said line belongs, and if said line also belongs in the subgroup of the preceding line the same reperforator will, of course, be chosen after which the codes of all the succeeding notations will be perforated, each of said group of perforations, however, being preceded by the perforation of a code indicating a part of the calling line designation so that each tape record made by the reperforator will be identified with the particular line to which the notation belongs.

The primary tape is thus run its entire length through the distributor and, as a result, twenty separate tapes are made. Each of these tapes or group tapes as they are hereinafter called, are not individual to particular subscribers but they are tape records which contain all of the call notations belonging to lines of a particular subgroup. Hence in order to make an individual tape for each subscriber it now becomes necessary to make an individual tape for each subscriber from each of the twenty group tapes. In order to do this, each group tape is now run through the distributor and since the arrangement of each line in the subgroup is the same as the arrangement of each subgroup with respect to the entire group, the secondary reperforator may be used to make a tape for each line within the subgroup. Hence as the group tape is run through the distributor, that portion of the calling line identification code which was perforated on the group tape now causes the selection of a particular reperforator whose numerical, or alphabetical, designation is the same as that of the line within the subgroup itself. When the reperforator is selected, the code notations which follow thereafter on the group tape are then recorded on a third or individual tape; each group of notations, of course, being preceded and succeeded by the usual switching character.

Thus from a main tape record four hundred individual tape records are made, one for each subscriber, and each contains the perforated code of each local call followed by the starting and finishing time of said call, or the perforated code of an operator's call followed by the name of the city, office and town and number of the called subscriber and the money charge for the particular toll call.

The individual tape is now passed through an organization of circuits herein called the computer for the purpose of making a final tape for each subscriber's line, said final tape containing for each call recorded on the individual tape the directory abbreviation of 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 the toll connection contained 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 computer, in its more important essentials, comprises 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 calculator for translating the time of a connection and the called office name into a charge for the connection in terms of standard charge units, and a group of adding registers for integrating all the charges as the individual tape advances from one call to the next. After the last call has passed through the computer, the total sum recorded in the adding registers is perforated on the final tape.

This final tape is then passed through an ordinary page printer adapted to respond to the perforations thereon. These perforations are in groups, each relating to a particular call and comprise the codes of all the items which have to appear in the bill and in the order in which they are to appear; that is, the called office and name and the charge. Between each group of codes is perforated the code for raising and shifting the printer carriage and in response to which the carriage is carried back to the starting position and the bill forms is advanced one space. The operation of printing is then repeated with the next group of codes until all groups are exhausted. The last group of codes are those of the total charge and are caused to be printed underneath the other figures.

The following description has been arranged in three separate sections as a matter of convenience to conform with the arrangement of the drawing: namely, (1) the preparation of the primary tape, (2) the preparation of the individual tape for each line, (3) the preparation of the final tape from the individual tape, and the printing of the bill therefrom.

The invention, therefore, will be described in the same order:

Section 1

The circuits and apparatus for the preparation of the primary tape are disclosed in Figs. 1 to 26, inclusive, arranged as shown in Section 1 of Fig. 1A. The circuits and apparatus comprehended within this section comprise the following:

Fig. 1 shows subscriber line groups; the line-finder end of the line-finder district selector, the line identification register, and the primary tape perforating apparatus, schematically shown;

Figs. 2 and 24, taken together, disclose the remainder of the line-finder district selector;

Figs. 3 to 6, inclusive, show the line start, trip and link circuits for controlling the operative association of a line-finder district selector to a

calling line and the operative association of said selector with a sender;

Figs. 7 to 20 and Fig. 23 disclose the register sender;

Figs. 21 and 22 show schematically the decoder-connector and decoder, the latter being at the appropriate time operatively associated with the sender; and

Figs. 25, 26 and 27 show the tape register circuit.

Consider, first, a local call. Subscriber's line 100 is a line in a group of twenty lines of twenty similar groups for one line-finder frame. The particular group containing the line in question is designated, for the purpose of identification as described hereinafter, as the first or A group while the last or twentieth group is designated as the T-group. Each of the lines in all the groups terminate on the bank of a line-finder frame 110 to which the line-finder district selectors have access in the known manner. In the disclosure of this invention, a line-finder district selector shown in Figs. 1, 2 and 24 comprises two mechanically moving elements operatively associated together, one element being used for finding and connecting with the terminals of a calling line, as shown by the arrangement of the line-finder brushes and terminals at 110, and the other, usually termed the district selector, being used as the first switching element for extending the calling line to other offices or to some line in the same office, as indicated by the brushes of said selector in relation with the selector bank terminals at 2410. In the disclosure of the preferred embodiment of the invention, the well known panel type telephone system is used, but only for the purpose of illustrating the means by which the principles of the invention can be adapted by any one skilled in the art to any type of automatic or semi-automatic telephone switching equipment, the invention being broadly independent of any telephone system or of any particular type of apparatus used therein. For this reason, the line-finder district selector shown in Figs. 1, 2 and 24 is, in general, similar to the panel line-finder district selector disclosed in Figs. 1 and 35 of the telephone system disclosed in Patent No. 1,862,549, granted to R. Raymond and W. J. Scully, dated June 14, 1932, excepting for the fact that the district elevator is modified to carry two sets of brushes, an upper set consisting of brushes 2423, 2411 and 2407 and a lower set consisting of brushes 2425, 2426 and 2427. When the connection is to be extended over trunk groups terminating in local mechanical or manual offices, only the upper set is used. When the connection is to be extended over a trunk group terminating at an operator's position for purposes of toll or long distance connections, both sets of brushes are used, the lower set being used in this case to connect the district selector with the telegraph transmitter 2810 as more particularly described hereinafter.

Likewise, the trip, start and link circuits shown in Figs. 3, 4, 5 and 6, respectively, correspond to the same circuits in the same numbered figures of the above mentioned patent. The sender, decoder and decoder connector which are shown in Figs. 7 to 21, inclusive, of the drawings are also substantially identical with the corresponding parts of the above mentioned patent except for such modifications, especially in the sender, as have been found desirable and as described hereinafter, for adapting the invention to the panel telephone system disclosed and described in said patent. The decoder connector and decoder, schematically shown together at Fig. 21, are the control and translating circuits cooperating with the sender and are also fully described in the above mentioned patent. The operation of all these circuits, in relation to the invention, is believed to have been fully covered in the description following hereinafter, but for such other descriptive matter as relates to such other phases of their operation not touching the invention, reference is made to the above mentioned patent for a more complete description thereof.

Initiation of connection

Assuming, therefore, that subscriber 100 initiates a local call, then the removal of the receiver from the switchhook (not shown) closes a circuit from battery through the winding of line relay 101, inner back contact of cut-off relay 102, through the substation apparatus, outer back contact of relay 102, to ground. Relay 101 operates and connects ground to conductor 104 extending to trip circuit 300 and connects the line-finder terminal to which brush 114 has access to conductor 103, thus initiating the operation of the trip, start and link circuits and the associated line finder.

The trip circuit 300, shown in Fig. 3, is one of ten similar circuits serving a group of four hundred subscribers' lines appearing in one line-finder frame as shown in Fig. 1. The purpose of the circuit is to trip the proper set of brushes on the line-finder that hunts for the calling line and to insure, further, that calls are served in order and one at a time. The gang switch 340 serves to connect the trip circuit with the line and with the start circuit 500 and permits the rapid transfer of the line to the emergency trip circuit 350 should trouble arise.

The start circuit 500 is common to ten trip circuits and serves to bring about the association of calling subscribers' lines with district selectors and senders without interference. The gang switch 591 which connects the start circuit 500 with the trip circuit 300 and the link circuit in Figs. 4 and 6 also serves to transfer these circuits into connection with the emergency start circuit 590 in case of trouble.

The link circuit, shown in Figs. 4 and 6, is one of a group of link circuits serving half of the group of four hundred subscribers' lines. When normal the link circuit associates itself with an idle district selector and advances to a sub-allotted position. The link circuits are arranged in a chain and when one link circuit is taken for use the next is advanced to an allotted position. Therefore, only one link circuit is ready for use at a time. The link circuit serves to connect a calling line to a line-finder district selector circuit and the latter with a sender for the purpose of recording the number of the wanted line and for otherwise controlling the establishment of the connection.

The connection of ground to conductor 104, which is common to a group of twenty lines, completes a circuit through switch 340, back contact of relay 302, upper winding of relay 301 to battery. Relay 301 connects ground over its lowermost front contact, inner contact of relay 306, upper contact of relay 303, switch 340, conductor 316 to gang switch 591, through the winding of relay 516 of the start circuit 500 to battery. It also closes a circuit from ground over its next to lower front contact, outer contact of relay 306,

lower back contact of relay 303, upper winding of relay 304, switches 340 and 591, upper back contact of relay 515 to battery. Relay 304 operates and locks in a circuit from ground over the lowermost contact of relay 301, inner back contact of relay 306, lower winding and inner lower front contact of relay 304, over the back contacts of similar relays in other trip circuits to the start circuit 500 and through the lower winding of relay 515 and resistance 517 in parallel to battery.

Relay 515 operates and connects battery through its lower winding and bottom inner contact and through resistance 517 in parallel, switch 591, to conductor 242. With relays 304 and 515 operated, a holding circuit is completed for relay 301 extending from ground at the outer front contact of relay 515, switch 591, switch 340, outer lower front contact of relay 304, inner front contact and lower winding of relay 301 to battery. This circuit also extends in parallel with the lower winding of relay 301 to the winding of relay 305 and battery. Relay 305 operates and locks over its upper front contact, outer back contact of relay 306, next to the lower front contact of relay 301 to ground and thereby closes an additional locking circuit for relay 301. Relay 305 closes a circuit from ground over its lower contact, outer upper front contact of relay 304, middle front contact of relay 301, switch 340, switch 591, outer back contact of relay 511, inner back contact of relay 508, switch 591, conductor 519, lower contacts of cam 609, to brush 406 of the trunk finder 400. This finder has been positioned on the terminals leading to an idle district selector and the district selector sequence switch has been advanced to position 2 in the manner described hereinafter, so that the above traced circuit extends over conductor 248, right upper and left lower contacts of cam 223, winding of relay 226 to battery. Relay 226 operates in this circuit and initiates the operation of line-finder 110 as more completely described hereinafter.

Relay 304 also closes a circuit from battery to trip magnet 117 of line-finder 110 over conductor 127 to ground at its inner front contact. Relay 305 also closes a circuit from battery through the upper winding of relay 306, upper winding of relay 303, lower front contact of relay 305, to ground. Relay 303 operates in this circuit, but relay 306 can not operate in series with relay 303. Relay 303 opens the circuit of relay 515 and that relay releases unless its circuit is maintained at some other trip circuit belonging to this group of lines.

When relay 226 operates as above described, it locks over its bottom inner front contact, right lower and left upper contacts of cam 222, back contacts of relay 227, commutator strip 109, brush 119, to ground. Relay 226 also closes a circuit from battery through the up-drive magnet 105 of the line-finder 110, conductor 250, bottom front contact of relay 226, left contacts of cam 218, bottom middle front contact of relay 226, left lower contact of cam 209, right upper contact of cam 212 to ground. The line-finder 110 is moved upward in search of the calling line under the control of magnet 105. When the line-finder has passed the tripping zone so that the proper brush set has been made operative, brush 120 encounters the conducting part of the commutator strip 123 completing a circuit thereby from ground over brush 120, segment 123, conductor 251, left contacts of cam 206, conductor 242, through a make busy key (not shown), switch 591, and thence over the inner front contact of relay 515 to the winding of relay 515 and resistance 517 in shunt of the winding of relay 304. Relay 304 now releases, in turn releasing trip magnet 117. When brush 120 leaves the segment 123, relay 515 also releases to restore the operating circuit for the relay, such as relay 304, in other trip circuits.

When the line-finder finds the calling line, a circuit is closed from ground over the right upper and left lower contacts of cam 221, winding of relay 227, conductor 252, brush 114 and bank terminal, inner front contact of relay 101, conductor 103, thence to battery through the lower winding of relay 306 and the resistance 310 in parallel. Both relays 227 and 306 operate in the above circuit. Relay 227 opens its back contact and causes the release of relay 226 preparing said relay to perform functions hereinafter noted, while relay 306 opens the locking circuit of relay 305 and the holding circuit of relay 301. The release of relay 305 further opens the energizing circuit of relay 303 and that relay releases unless held locked because relay 515 is held operated from some other trip circuit.

In the start circuit, at the same time that the operation of relay 305 connected ground to conductor 519 to operate relay 226, said ground was also extended over the inner upper back contact of relay 508, through the winding of relay 505, upper winding of relay 508, outer lower back contact of relay 503 to battery. Relay 505 operates in this circuit, locking to ground at its front contact independent of relay 305, but relay 508 does not operate at this time. However, when relay 226 operates to start the line-finder, it also connects ground from the left lower contact of cam 209, next to the inner lower front contact of relay 226, left upper contact of cam 218, right upper contact of cam 207, conductor 247, brush 405, lower left and right upper contacts of cam 617, conductor 690, switch 591, lower winding of relay 508, bottom outer back contact of relay 503, to battery. Relay 508 now operates, short-circuits relay 505, opening the operating circuit of relay 226 and locks to ground at the front contact of relay 305. Relay 508 also closes a circuit through the upper winding of relay 515 at its bottom inner front contacts for holding that relay operated.

When the calling line is found, the operation of relay 227 opens the locking circuit of relay 226 as already described and that relay releases, opening the circuit of the up-drive magnet 105, bringing the line-finder to rest. The release of relay 226 further releases relay 508 completing the restoration of the start circuit 500. Relay 226 released closes a circuit from battery through the winding of cut-off relay 102, brush 113, resistance 253, bottom innermost back contact of relay 254, bottom outer back contact of relay 226, left lower and right upper contacts of cam 215 to ground on the right upper contact of cam 255. Relay 102, in operating, opens the circuit of line relay 101 which, in releasing, disconnects ground from conductor 104, releasing relays 301 and 306 in the start circuit and relay 227 in the district selector, and reconnects relay 173 with the terminal engaged by brush 114. The release of relay 301 completes the restoration of the trip circuit 300 to normal.

When relay 226 operates to start the line-finder it also transmits a signal to the link circuit to start it hunting for a sender. The circuit for this purpose is the same as that used for operating relay 508 as far as brush 405 whence it extends

over the right contacts of cam 618 through the winding of relay 420, resistance 421 to battery. Relay 420 operates and locks over its inner front contacts to ground over the upper left and lower right contacts of cam 625. It also closes a circuit from ground over its lowermost front contact, right contacts of cam 611, winding of magnet 600 to battery, advancing the link sequence switch to position 2 in which position relay 420 releases. In position 2 a circuit is closed from battery through the winding of relay 423, upper right and lower left contacts of cam 619, upper back contact of relay 424, lower left and upper right contacts of cam 618 to ground. Relay 423 operates and prepares relay 424 to test for an idle sender by connecting ground over its inner upper contact to the lower winding of relay 424 which is connected over the left contacts of cam 624 through the middle winding of relay 424 to battery and over the lower left and upper right contacts of cam 624 through the upper winding of relay 424, back contact of relay 420, upper contacts of cam 626 to brush 454. Relay 424 is so wound that this combination of circuits renders it quick to operate when the proper condition is found and quick to release if some other link has just tested the same sender. Relay 423 also closes a circuit from battery through the upper winding of relay 422, upper front contact of relay 423 to ground at the lower back contact of relay 424. Relay 422 in operating completes a circuit from battery through the winding of updrive magnet 467, upper contacts of cam 623, inner lower front contact of relay 422 to ground at the outer lower back contact of relay 420. The sender selector 450 is therefore driven upward under the control of magnet 467.

Idle senders are characterized by the presence of battery through 270-ohms resistance and, assuming that the sender shown is the first idle one to be encountered, a circuit will be closed from battery through resistance 1302, left back contact of relay 1303, lower back contact of relay 726, conductor 746, brush 454, upper contacts of cam 626 to ground through the upper and lower winding of relay 424. Relay 424 operates in this circuit and holds thereover but due to the closure of its lower front contact to ground thereby short-circuiting the lower winding of said relay, the potential on brush 454 is altered so that no other link circuit which may be hunting can stop on this sender. The operation of relay 424 opens the circuit of relay 423 while relay 423 opens that of relay 422, both of said relays releasing. With relay 423 released and relay 424 operated sequence switch 600 is advanced to position 3 in a circuit from battery through the winding of magnet 600, left lower contact of cam 613, contacts of jack 607, back contact of relay 423, upper front contact of relay 424 to ground over the lower left and upper right contacts of cam 618.

While sequence switch 600 was in position 2, a circuit was closed from ground over the left contacts of cam 605, right contacts of cam 606, to the next link circuit in the sequence which is the first one shown, over a contact of jack 667, left contacts of cam 666 and the right contacts of cam 665, to the magnet (not shown) of the sequence switch of that link to advance said link into position 1 in readiness for use. Likewise, with the link sequence switch 600 in position 2, a circuit was closed from ground over the lower right and upper left contacts of cam 608, brush 401, conductor 243, lower left contact of cam 213, lower left contact of cam 210, right winding of relay 225 to battery. Relay 225 operates and locks over its right outer front contact to ground over the top contacts of cam 221. When relay 226 releases after the calling line has been found, a circuit is closed from battery through the winding of sequence switch magnet 200, left lower contact of cam 224, left front contacts of relay 225, lower inner back contact of relay 226, left lower contact of cam 209 to ground. Magnet 200 operates and advances sequence switch 200 to position 3. When sequence switch 200 leaves position 2 relay 225 releases. When sequence switch 200 reaches position 3 the circuit of the cut-off relay 102 is closed to ground over the left lower and right upper contacts of cam 255, holding the cut-off relay operated under the control of relay 254 until the sequence switch leaves position 17¼.

With link sequence switch 600 in position 2¾ conditions are set up in the sender to identify the class of service to which the calling subscriber is entitled. Subscribers, besides being identified in groups of convenient sizes for the purposes of billing identification as more completely described hereinafter, are further grouped into zones in accordance with the rate at which they are to be charged for calls in the different zones of the exchange area. Different zone groups of subscribers are served by different groups of link circuits and the link circuits are provided with means for signaling the sender as to the group to which the calling subscriber belongs. This is done by establishing one of two conditions to the tip side of the fundamental circuit leading to the sender, and one of two conditions on the ring side of the fundamental circuit before the sender functions to make selections. These conditions are either open circuit or direct ground connected to brush 456 over cam 612, or open circuit or ground connected to brush 455 over cam 617. For the purpose of illustrating the principle and operation of the invention it may be assumed that the service to which subscriber 100 is entitled may be identified by an open circuit to brush 456 and ground to brush 455 from whence the circuit may be traced over conductor 747, outer right back contact of relay 1303, conductor 1315, right winding of relay 1407 and to battery. Relay 1407 operates and locks in a circuit from battery over the lower contacts of cam 1724, conductor 1729, through the left winding of relay 1407 to grounded conductor 1238. Relay 1407, when operated, performs functions to be described hereinafter.

With sequence switch 200 in position 3, and sequence switch 600 also in position 3, a circuit is closed from battery through the winding of relay 229, left contacts of cam 211, conductor 245, brush 403, lower right and upper left contacts of cam 621, brush 453, conductor 745, right back contact of relay 1305, outer left contact of relay 1232, middle and left windings of relay 1306, to ground. Relay 229 operates but is ineffective in this position of the selector sequence switch 200.

Relay 1306 also operates in this circuit, in turn operating relay 1234 which closes a circuit from battery through resistance 1304, winding of relay 1233 to ground at the right front contact of relay 1234. Relay 1233 locks to ground at its inner left contact and connects ground to conductor 1238 which carries off-normal ground to all parts of the sender circuit. It also operates relay 1303 which removes battery from conductor 746 to disconnect the idle test condition and connects ground to conductors 1317, 1318 and 1319. It also completes a circuit over conductor

1238 through the winding of relay 1301 to battery at the left back contact of relay 1237 which prepares for the subsequent release of the sender. In addition, the ground on conductor 1238 completes a circuit over the back contact of relay 901, through the winding of relay 902 to battery, operating relay 902 in preparation for the reception of the first digit.

The removal of battery from conductor 746 releases relay 424, which then closes a circuit from battery through the winding of sequence switch magnet 600, upper right contact of cam 613, back contact of relay 424 to ground over the lower left and upper right contacts of cam 618. Sequence switch 600 is advanced to position 5 in this circuit. In position 5 the sender and district selector are connected together over the following circuit: Conductor 243 of the district selector is connected to conductor 743 of the sender over brush 401, upper contacts of cam 608 to brush 451; conductor 244 is connected to conductor 744 over brush 402, upper contacts of cam 609 to brush 452; conductor 247 is connected to conductor 747 over brush 405, left contacts of cam 617 to brush 455; conductor 248 is connected to conductor 748 over brush 406, left contacts of cam 612 to brush 456. The circuit connecting conductor 245 with conductor 745 extends, in position 5 of the link switch from brush 403, left contacts of cam 627, upper winding of relay 424, upper back contact of relay 420, upper contacts of cam 621 to brush 453. Relay 424 does not operate, but the circuit is maintained in preparation for the advance of the link circuit. No circuits are closed over either conductor 246 or conductor 746 at this time.

As soon as sequence switches 200 and 600 reach position 3 the dialing circuit is closed, which may be traced from battery through the lower winding of relay 724, over conductor 744 through the link circuit to conductor 244, left contacts of cam 202, winding of relay 231, upper inner contacts of relay 254, brush 112 and terminal cooperating therewith, subscriber's loop, brush 111 and terminal cooperating therewith, upper outer contact of relay 254, left contacts of cam 201, conductor 243, through the link circuit to conductor 743, resistance 729 to ground at the right outer back contact of relay 1237. Relay 724 operates in this circuit and closes a circuit from battery through the winding of relay 716, front contact of relay 724 to ground at the right inner back contact of relay 1237. Relay 716, in operating, connects ground through resistance 717, to the winding of relay 713 which also operates, in turn operating relays 714 and 715. With relay 715 operated, a circuit is closed from ground over the inner front contact of relay 715, upper winding of relay 724 through condenser 730, outer left front contact of relay 902, to the source of dial tone D. T. A tone is thereby induced in the primary winding of relay 724 from whence it is transmitted to the subscriber's line over the described loop informing him that he may proceed to dial.

Registration of called number in the sender

When the subscriber operates his dial for the first digit, relay 724 releases momentarily as each pulse is received. Relay 716 releases each time that relay 724 releases but is not as quick to operate as relay 724 so that it may or may not reoperate each time that relay 724 does. Relays 713 and 714 on the other hand, are definitely slow to release so that they do not release during the possible short openings of their circuits and relays 713, 714 and 715, therefore, remain operated during the intervals between digits. When relay 724 closes its back contact in response to the first pulse, it connects ground from the inner right back contact of relay 1237 over the upper front contact of relay 714, inner left front contact of relay 1234, over the upper back contacts of relays 710, 708, 706, 704 and 702, to the winding of relay 701 of the primary register 700 and battery. Relay 701 operates, locks through the winding of relay 702, front contact of relay 701, lower back contact of relay 704, conductor 736, back contact of relay 720 to ground at the outer upper front contact of relay 715. The release of relay 716 closes a circuit from battery through resistance 719, winding of relay 718, inner back contact of relay 716 to ground at the outer upper contact of relay 715. Relay 718 is slow to release so that it remains operated even though relay 716 may momentarily break its operating path. At the end of the first impulse relay 724 reoperates and relay 702 operates and locks in the circuit of relay 701. The operation of relay 702 closes a circuit from ground over its lower front contact to conductor 731. With relay 902 operated this completes a circuit over the inner left contact of relay 902 through the right winding of relay 904 of the first secondary register 900 to battery operating that relay.

When the next pulse is received, the circuit controlled by relay 724 extends, as above traced, to the back contact of relay 704 over the front contact of relay 702, the winding of relay 703 to battery. Relay 703 locks through the winding of relay 704, front contact of relay 703, lower back contact of relay 708, to conductor 736. Relay 704 does not operate until the end of the pulse at which time it opens the locking circuit of relays 701 and 702 which release, in turn releasing relay 904. It also closes a circuit from ground over conductor 732 thence over the outer right contacts of relay 902 to the right winding of relay 905 and battery operating that register relay.

The third pulse causes the operation of relays 705 and 706 in turn and relay 706 grounds conductor 731 reoperating relay 904. Relays 705 and 706 lock in parallel with relays 703 and 704 which remain operated so that relay 905 also remains operated. The fourth pulse operates relays 707 and 708, the latter opening the locking circuit of relays 703 to 706, inclusive, and releasing relays 904 and 905. Relay 708 also closes a circuit from ground over conductor 733, the middle left contact of relay 902, to the right winding of relay 906 and battery.

At the fifth pulse, the circuit controlled by relay 724 extends over the front contact of relay 708 to the winding of relay 709. Relay 709 operates, locking through the winding of relay 710, front contact of relay 709, back contact of relay 704 to conductor 736. At the end of the pulse relay 710 operates, opening the locking circuit of relays 707 and 708 thereby releasing relay 906. It also closes a circuit from ground over its inner lower front contact, upper back contact of relay 712, conductor 734, over the middle right contact of relay 902 to the right winding of relay 907 and battery. In addition, it closes a circuit from ground on conductor 735, lower alternate contact of relay 710, lower back con-

tact of relay 712, winding of relay 711 to battery. Relay 711 locks in series with relay 712 over its front contact to conductor 736. Therefore, the locking circuit of relays 711 and 712 is independent of the remaining counting relays. Relay 712 does not operate at this time being shunted by the operating circuit of relay 711.

At the sixth pulse, the circuit controlled by relay 724 extends over the front contact of relay 716, the back contacts of relays 706, 704 and 702 to the winding of relay 701. This relay locks through the winding of relay 702 which operates as before at the termination of the pulse, thereby grounding conductor 731. The seventh pulse operates relays 703 and 704, releasing relays 701 and 702 and grounding conductor 732 in the same manner as for the second pulse. Relay 704 also opens the locking circuit of relays 709 and 710 and these relays release permitting relay 712 to operate in the locking circuit of relay 711. With relay 712 operated, a new circuit is closed for relay 907 over the front contact of relay 712 and a back contact of relay 710 so that relay 907 is held operated. The eighth pulse causes the operation of relays 705 and 706 in the same manner as for the third pulse. Relays 703 and 704 remain operated and conductors 732 and 731 are grounded causing the operation of relays 904 and 905. The ninth pulse causes the operation of relays 707 and 708, releasing relays 703 to 706 as well as relays 904 and 905 and operating relay 906 instead. The tenth pulse reoperates relays 709 and 710 releasing relays 707, 708 and 906. With relay 712 operated, the operation of relay 710 opens the circuit for relay 907 and closes instead a circuit from ground over the inner lower front contact of relay 710, lower front contact of relay 712, conductor 735, inner right contact of relay 902 through the right winding of relay 903 and battery.

When the last pulse of the digit has been received, relays 724 and 716 remain operated for a considerable length of time. The circuit of relay 718 is thereby opened causing this relay to release and a circuit is closed from battery through the winding of relay 720, normal contacts of relay 718 to ground at the front contacts of relay 715. Relay 720 closes a holding circuit for itself under the control of relay 716 which, however, is normal at this time. It also connects ground from the front contact of relay 715, over the top front contact of relay 720, outer left back contacts of relay 1112, 1102, and 1022, back contact of relay 1030, outer left back contacts of relays 1002, 922 and 912 to the winding of relay 901 and thence over the left front contact and the left winding of those relays of secondary register 900 which remain operated at the termination of the pulse, and thence to battery. This provides a locking circuit for the register relays as well as an operating circuit for relay 901. It may be noted, however, that the locking circuit of relay 904 is only closed when either relay 905 or relay 907 is also operated. This prevents the registration of a false preliminary pulse since a single pulse can not lock up the first register. The operation of relay 720 also releases any of the relays of primary register 700 which are operated.

Relay 901, in operating, locks over its outer left contact to grounded conductor 1317. It also opens the circuit of relay 902, which, in releasing, disconnects the relays of secondary register 900 from primary register 700. In addition, it extends ground from conductor 1317 over its inner left contact, the back contact of relay 911 to the winding of relay 912 to prepare register 910. Assuming, now, that the called subscriber's number is Halifax 3678 which requires the code 425 to be used, relay 906 of register 900 is locked operated, relay 912 is operated as above described and the next operation of the dial brings about the registration of the second digit on register 910. When the last pulse of this digit has been received, the register relay 915 locks in series with relay 911 which in turn locks to conductor 1317, opens the circuit of relay 912 and connects ground from conductor 1317 over its inner front contact and the back contact of relay 921 to the winding of relay 922 to prepare for recording the third digit on register 920 which, in accordance with operations identical with those described above, results in the operation and locking of register relay 927 in series with relay 921, the release of relay 922 and the operation of relay 1002.

Following the registration of the office code the numerical digits are recorded, the thousands digit being recorded on register 1000 which for the thousands digit 3 results in the operation and locking of register relays 1004 and 1005 in series with relay 1001; the hundreds digit being recorded on register 1010 which for the hundreds digit 6 results in the operation and locking of register relays 1014 and 1017 in series with relay 1011; the tens digit being recorded on register 1020 which for the tens digit 7 results in the operation and locking of register relays 1025 and 1027 in series with relay 1021; and the units digit is recorded on 1100, which for the units digit 8 results in the operation and locking of register relays 1104, 1105 and 1107 in series with relay 1101. If the call is one that is to be completed in a manual office where station's digits are employed, this digit will be recorded on register 1110.

Following the registration of the thousands digit, the operation of relay 1001 extends conductor 1317 over its inner left contact of the windings of relays 1012 and 1030 in parallel. Relay 1030 supplies locking ground for registers 1010, 1020 and 1100. Station register 1110 obtains locking ground for its individual relays through relay 1101. The circuit for operating the cut-in relay 1112 of the station registers extends over the lower contacts of cam 816 to the back contact of relay 1111 and the front contact of relay 1101.

The operation of relay 901 following the registration of the first office code digit, closes a circuit from battery through the winding of sequence switch magnet 1700, right upper contact of cam 1702, conductor 1728, left back contact of relays 1505 and 1504, conductor 1509, outer right back contact of relay 1321, left back contact of relay 1310, outer left front contact of relay 1234, conductor 1239, inner left front contact of relay 901 to ground at conductor 1317. Sequence switch 1700 advances to position 2 in this circuit connecting ground over the upper left contact of cam 1716 to conductor 1238 as long as the switch remains out of position 1. At this time a circuit is also closed from battery over the lower right and upper left contacts of cam 1724, winding of relay 1266, contacts of relay 1227 to ground, operating relay 1226 to prepare for the closing of the fundamental circuit. A circuit is further completed for relays 2305 and 2306 in parallel, extending from ground through the top contacts of cam 1745, conductor

2308, winding of relay 2305 to battery and, in parallel therewith, lower winding of relay 2306 to battery. These relays operate, remain in their operated position but perform no particular function at this time.

Decoding office code

When the office code digits have been registered as indicated by the operation of relay 921, a circuit is closed from battery, through the winding of relay 721, inner left front contact of relay 921 to grounded conductor 1317. Relay 721 operates and initiates the operation of the decoder connector, which is schematically shown in Fig. 21, by completing a circuit from battery over the lower right and upper left contacts of cam 1724, conductor 839, conductor 840, right back contact of relay 838, left back contact of relay 836, lower back contact of relay 723, inner lower front contact of relay 721 to conductor 930. Battery on this conductor is supplied to the winding of relay 2100 which is individual to this sender in the decoder connector.

The decoder connector comprises the complete circuit shown in Figs. 21 to 24, inclusive, of the Raymond-Scully patent mentioned above. It is the medium for connecting together at the proper time a sender and a decoder and comprises, essentially a plurality of connecting channels, each accommodating a group of senders, the size of said group being determined by traffic conditions. Accessibility by a sender to its connecting channel as a means of establishing connection with a decoder is made through a multi-contact relay having an appropriate number of contacts, while the connection of a decoder to any channel is likewise made through a multi-contact relay. With this difference, however, that while a sender can be connected with a decoder through its connecting channel only and is therefore provided with a multi-contact relay only in that channel, the decoder must have accessibility to each of the senders in every connecting channel. The decoder, therefore, is provided with a connecting multi-contact relay in every channel. The circuits for operating the decoder connector are arranged so as to prevent interference between senders simultaneously seeking a decoder and to make each decoder a first choice in certain channels. Since the connector channel comprises no part of our invention and is simply a connecting medium between the sender and the decoder, it has not been thought necessary to encumber this specification with a complete description of its further arrangement and operation, it being thought sufficient to refer to said Raymond-Scully patent for a complete description. Suffice it to say that the operation of relay 2100 results in the operation of multi-contact relay 2104 which connects the appropriate sender conductors to the channel wires and further results in the selection of an idle decoder through the operation of its multi-contact relay 2101 on the same channel, all in accordance with the circuit operations described in the above mentioned patent to Raymond-Scully.

The decoder itself, shown schematically in Fig. 22, is a device for translating the dialed office code into the operation of a relay in the decoder which is individual to the code. This relay when operated, causes the operation of a group of registers in the sender which are adapted to set a train of selectors into the proper and respective positions for extending the calling line to the telephone office of the wanted line. This translating device may be of any character and may be located anywhere. That is, it may be an independent entity, as it is for the type of sender herein used, or it may be an integral part of the sender where the number of codes to be translated does not justify the use of an independent translator. However, for the purposes of illustrating the present embodiment of the invention, a sender was chosen which is capable of recording a large number of codes and hence requires a corresponding number of translations. For this purpose a separate translator or decoder is used, such as the one disclosed in the said Raymond-Scully patent and shown in Figs. 25 to 34, inclusive, therein. At the proper time, that is, when a code has been dialed into the sender and that code is to be translated into the setting of means for controlling the proper selection of a trunk leading in the wanted direction, the decoder is connected to the sender through the medium of a sender connector as above indicated.

Briefly, the specific embodiment of the decoder disclosed in the above mentioned patent comprises a set of Receiving Registers for recording the dialed code as received from the sender, a set of Decoding Relays selectively operated in accordance with the setting of the Receiving Registers, a group of Route Relays one of which is operated for each call as determined by the translation of the dial code through the selective operation of the decoding relays, and a set of Outgoing Registers electrically interconnected with all of the route relays for transmitting back into the sender the "translation" as determined by the route relay operated by the receiving registers.

The decoder, or any equivalent translating device, is not a part of this invention and the various registers mentioned above, therefore, are but schematically shown in Fig. 22. This specification is limited to the description of the operation of such parts of the decoder as are necessary to a complete understanding of the invention, referring again to the above Raymond-Scully patent for a more complete and detailed description thereof.

As soon as relays 2101 and 2104 are operated, the receiving registers in the decoder are ready to receive from the sender a record of the dialed code as registered on the operated relays of registers 900, 910 and 920. Since the office register code consists of digits 4—2—5, relays 906, 915 and 927 have been operated in each of the above registers, respectively. The following circuit paths therefore will be closed: From ground, right front contact of relay 906, conductor 936, through the decoder connector to a completing circuit in the receiving register of the decoder to record the digit 4; from ground at the right front contact of relay 915, conductor 945, through the decoder connector to another completing circuit in the receiving register to record the second digit 2; from ground at the right outer front contact of relay 927, conductor 957, through the decoder connector to another completing circuit in the receiving registers of the decoder to record the third digit 5.

It will be remembered that relay 1407 was operated from the link circuit to identify the class of service to which the calling line 100 is entitled. Relay 1407 now closes a circuit from ground over its right front contact, conductor 967, through the decoder connector to another completing cir-

cuit in the decoder for recording the class of service to which the subscriber is entitled.

Setting sender control registers from decoder

Now, in accordance with the operation described for the decoder in the above mentioned Raymond-Scully patent, after the code and class of service records have been set up in the appropriate receiving registers, circuits are closed thereby through the decoding relays to decode this registration and results in the operation of a route relay corresponding to the code. For the purpose of illustration it will be assumed that this route relay is relay **3205**. As already indicated, the contacts of all the route relays are cross-connected through a terminal rack to the appropriate windings of a group of outgoing registers which, in accordance with the particular route relay operated, operates in different combinations for grounding conductors which connect with the selection registers of the sender, shown in Figs. 18 and 19. These registers are designated **1800**, **1810**, **1820**, **1900**, **1910** and **1920**. The relays in each selection register are operated in the appropriate combination called for by the combination of outgoing registers responding to route relay **3205**, and each of the selection registers sets up the necessary circuit conditions to guide and position the train of selectors for extending the calling subscriber's line to the office of the called subscriber's line. Since the manner in which these registers are operated is no part of this invention, and may be easily obtained from the above mentioned Raymond-Scully patent, it will be assumed for the purposes of future operation that the following relays are operated in each selection register by the outgoing registers in the decoder which responded to the operation of route relay **3205**:

Selection register	Relays operated
1810	1812
1900	1901, 1902
1910	1912, 1914
1920	1924, 1925
	1310, 1321—local zone

It will be observed that two of the operated relays of the selection register, namely, relays **1310** and **1321** are, for convenience, located on Fig. 13 of the drawings. Relays **1120**, **1121**, **1123**, **1322** and **1504** are also parts of the selection register and are located in different figures for reasons of convenience but are not operated in the combination required for the proper disposition of the call under consideration, that is, the call to the office was coded **425**.

When all of the registers are operated and the decoder has made appropriate tests to determine that only the proper registers have responded to the circuits closed by the outgoing registers in the decoder, a circuit is closed from ground in the decoder, conductor **958**, upper winding of relay **722**, to battery. Relay **722** operates and closes a locking circuit for itself from battery over its inner lower front contact and lower winding to grounded conductor **1238**. Relay **722** also connects relay **723** to battery in parallel with its lower winding. Relay **723**, at its upper contact, prepares the fundamental circuit for making selections and, at its lower contact, connects ground to conductor **737** to provide a locking circuit for stations delay relays **1120** and **1121**, talking selection relays **1310** and **1321**, two-wire office relay **1322**, class register relays **1801**, **1802** and **1803**, and the compensating resistance register relays **1921** to **1925**, all of which comprise parts of the sender selection register. In addition, this ground extends over the right contacts of cam **1704** in positions 1 to 3 of sequence switch **1700** to form the locking circuit for the district brush register relays **1811** to **1813**, the district group route registers **1901** to **1904** and the zone relays **1504** and **1505**, while it further extends said ground over the lower contacts of cam **1704** in positions 2 to 7 of sequence switch **1700** to form the locking circuit for the office brush register relays **1821** to **1823**, office group register relays **1911** to **1914** and the skip office relay **1123**.

In addition, relay **723** disconnects battery from start conductor **930** which causes the sender connector relay **2100** in the decoder connector to release. This relay, in turn releases multi-contact relays **2101** and **2104** thereby completely disconnecting the sender from the decoder, while other circuits are responsive in the decoder as described in Raymond-Scully patent, to restore the decoder to normal.

Recapitulating the operation in the sender which results from the connection thereof with the decoder, and assuming the calling subscriber's line is to be extended to a panel type office in the local zone, the following relays have been operated in the selection register of the sender as a result of the code translation by the decoder; relay **1924** to indicate that a short trunk needs considerable compensating resistance in the fundamental loop for positioning the various selectors; relay **1925** to indicate that marginal trunk guard relay **1314** is to be used; no relays of class register **1800** have been operated, which fact indicates, by circuits controlled through their back contacts, that a full mechanical type call is to be established; relay **1812** to indicate that the third district brush is to be selected; relays **1310** and **1321** to indicate that the district selector is to be advanced to the second talking position, that is, that the call is to be completed in the local area; relays **1901** and **1902** to indicate the selection of the fourth group of office selectors; no relays of the office brush register **1820** being operated to indicate the selection of the first or zero brush; relays **1912** and **1914** to indicate the selection of the eighth group of trunks outgoing from the office selector; and relays **1120** and **1121** to indicate that the call is to an office employing neither stations digits nor five digit numbers. In the meanwhile, with switch **1700** in position 2, the previously traced circuit is closed for relays **2305** and **2306** in parallel and these relays operate, relay **2306** locking over its upper winding and inner upper front contact, back contact of relay **2304** to ground over conductor **2312**. Relay **2305** closes a circuit from ground through its upper outer contacts, winding of relay **2307**, winding of relay **2309** to battery. Both of these relays operate, but all of the relays so far operated perform no useful function at this time, their operation being merely in advance of the function they perform subsequent to district group selection as described hereinafter.

District brush selection

When relay **723** operates to release the decoder, the fundamental circuit is completed for making district brush selection. The circuit for this purpose may be traced as follows: From battery through the right winding of relay **225**, left lower contact of cam **210**, left upper contact of

cam 213, conductor 248, brush 406, through the link to conductor 748 as already described, upper front contact of relay 723, right contacts of cam 1722, winding of relay 1300, right winding of relay 1225, back contact of relay 1220, inner left contact of relay 1226, resistance 1230, left back contact of relay 1506, conductor 1514, upper left contact of cam 1709, upper right contact of cam 1708 to ground. Relay 225 operates in this circuit, locking over its right outer front contact and the left upper contact of cam 210 to the fundamental circuit as traced. Relay 225 closes a circuit from battery through the winding of sequence switch magnet 200, left lower contact of cam 224, left front contact of relay 225, middle back contact of relay 226, left lower contact of cam 209 to ground, advancing sequence switch 200 to position 4. In this position the operating circuit of relay 225 is open but the relay remains operated over its locking circuit. Relay 225 also closes a circuit from battery through the winding of up-drive magnet 2401 of district selector 2410, right lower and left upper contacts of cam 215, left front contact of relay 225 to ground as above traced. Magnet 2401 causes the district selector to move upwards in a brush selecting movement. In this movement it closes a circuit from ground over the right contacts of cam 255, brush 2402, commutator strip 2403, upper right contact of cam 213, to the fundamental circuit, closing a substitute locking circuit for relay 225 and shunting relay 1300. This circuit is closed each time that brush 2402 encounters a conducting segment of the commutator strip and is opened each time that it passes over an insulating segment.

Relay 1300 also operates in the fundamental circuit but the direction of current flow is such that relay 1225 does not. The operation of relay 1300 closes a circuit from ground over the top contacts of cam 1708, conductor 1320, front contact of relay 1300, conductor 1730, lower contacts of cam 1707, conductor 1735, left contact of cam 1720, left upper contact of cam 1719, left back contact of relay 1813, outer left front contact of relay 1812, conductor 1842, back contact of relay 1216, winding of relay 1215, inner lower front contact of relay 722, to battery. Relay 1215 operates in this circuit and locks through the winding of relay 1216, front contact of relay 1215, outer left contact of relay 1226, lower right contact of cam 1709, right upper contact of cam 1708 to ground. Relay 1216 can not operate at this time, however, because its winding is shunted by the operating circuit of relay 1215. When commutator brush 2402 makes contact with the first conducting segment of strip 2403, it closes the shunt around the winding of relay 1300 and said relay releases thereby permitting relay 1216 to operate. When brush 2402 again reaches an insulating segment, relay 1300 reoperates and the circuit closed over its contacts is extended over the front contacts of relay 1216, back contacts of relay 1218, winding of relay 1217 to battery. Relay 1217 operates and locks through the winding of relay 1218 and its own front contact, right back contact of relay 1220, lower left and upper right contacts of cam 1705 to ground, but relay 1218 does not operate until brush 2404 reaches the next conducting segment. When brush 2402 leaves this segment relay 1300 reoperates and the circuit is extended over the front contact of relay 1218, conductor 1840, left contacts of cam 1713 to the winding of relay 1219 and battery. When brush 2402 reaches the third conducting segment, shunting relay 1300 for the third time, relays 1220 and 1229 operate in the locking circuit of relay 1218.

The operation of relay 1220 opens the fundamental circuit releasing both relays 1300 and 225. The release of relay 225 opens the circuit of up-drive magnet 2401 and brings the selector to rest in position to select the third set of brushes. It also closes a circuit from battery through the winding of sequence switch magnet 200, upper contacts of cam 218, left back contacts of relay 225, middle back contacts of relay 226, left lower contact of cam 209 to ground advancing sequence switch 200 to position 5. In this position a circuit is closed from battery through the winding of trip magnet 2404, right lower contact of cam 212 to ground on the right upper contact of cam 255, rotating the trip rod to trip the selected set of brushes when the selector next moves upward.

When relay 1229 operates as previously described, it closes a circuit from battery through the winding of relay 1228, right upper and left lower contacts of cam 1718, right back contact of relay 1235, front contact of relay 1229 to ground. Relay 1228 locks over its inner right contact to ground over the lower left and upper right contacts of cam 1705 and closes an obvious circuit for relay 1227. When both relays 1228 and 1227 operate the circuit of relay 1226 is opened and this relay releases. The operation of relay 1228 opens the locking circuit for the odd pairs of counting relays, while the release of relay 1226 opens the locking circuit for the even pairs of counting relays including that of relays 1219, 1220 and 1229. The release of relay 1229 closes the circuit from ground over its back contact, outer right front contact of relay 1228, lower left contact of cam 1701, winding of sequence switch magnet 1700 to battery, advancing sequence switch 1700 to position 3. As soon as sequence switch 1700 leaves position 2 the locking circuit of relay 1228 is opened at the right upper contact of cam 1705 and this relay releases. When relay 1228 recloses its back contact, relay 1226 reoperates in a circuit from ground on right lower contact of cam 1716, conductor 1126, left back contacts of relay 1228, winding of relay 1226, to battery through the left upper and right lower contacts of cam 1724.

District group selection

The release of relay 1228, the reoperation of relay 1226 and the advance of sequence switch 1700 to position 3 causes a reclosure of the fundamental circuit. Relays 225 and 1300 again operate, relay 225 advancing sequence switch 200 to position 6 in which position relay 225 is locked to the fundamental circuit over a previously described path, the up-drive magnet is again operated under the control of relay 225 and an intermittent circuit prepared from ground as above traced to brush 2405, commutator strip 2406, upper contacts of cam 210, to the winding of relay 225 and in shunt of the winding of relay 1300. As the district selector moves upward in its group selecting movement, this circuit is intermittently closed, releasing relay 1300 in the manner above described. With sequence switch 1700 in position 3, the counting relay circuit extends from ground over the contact of relay 1300 to conductor 1735 as above traced and thence over the right lower contact of cam 1719, right front contact of relay 1901, right front contact of relay 1902, conductor 1843, back contact of

relay 1214, winding of relay 1213 to battery. The counting relays function to count four closures of the intermittent circuit and then the operation of relay 1220 opens the fundamental circuit. Relay 225 releases bringing the district selector to rest with the brushes engaging the first trunk in the fourth group. It also advances sequence switch 200 to position 7 in the manner above described.

Trunk hunting by district selector

With sequence switch 200 in position 7, relay 225 is reoperated over a circuit which may be traced from battery through the left winding of relay 225, right lower contact of cam 220, left upper contact of cam 263, commutator segment 141 of the line-finder, brush 118 to ground. Relay 225 operates in this circuit and advances sequence switch 200 out of position 7 and into position 8. When sequence switch 200 reaches position 7½, the testing circuit for the first outgoing trunk is closed over the sleeve of that trunk, sleeve brush 2407, right lower and left upper contacts of cam 221, right outer front contact of relay 225, right winding of relay 225 to battery. Therefore, if the first outgoing trunk is busy, as indicated by ground connected to a sleeve terminal, relay 225 is held operated. Updrive magnet 2401 is again operated and the selector moves upward in search of an idle trunk. Relay 225 is held operated between trunks in a circuit through its left winding, right contacts of cam 220, commutator strip 2408, brush 2409, top contacts of cam 215, left front contact of relay 225, bottom inner back contact of relay 226, left lower contact of cam 209 to ground.

When an idle trunk is found and the brushes are properly centered, relay 225 releases, advancing sequence switch 200 to position 9. In position 9 relay 225 is operated in a circuit from battery through its left winding, right lower contact of cam 220, right contact of cam 263, bottom contacts of cam 222, front contact of relay 229, left lower contact of cam 212 to ground on cam 255. Relay 225 operates and advances sequence switch 200 to position 10 in which position relay 225 is held operated under the control of relay 229. In this position the tip of the fundamental circuit is extended from conductor 248, right outer back contact of relay 237, left lower and right upper contacts of cam 204, to brush 2423 and thence to the tip conductor of the office selector. The ring of the fundamental circuit is extended from conductor 247, right contacts of cam 205, and brush 2411 to the ring conductor of the office selector. At the office selector, the tip and ring conductors extend to battery and ground, respectively, as hereinafter described but not shown.

In the sender, the operation of relays 1220 and 1229 perform the same function as above described, advancing sequence switch 1700 into position 4. With sequence switch 1700 in position 4, a circuit is closed from battery through the winding of relay 1602, lower left and upper right contacts of cam 1710 to grounded conductor 1319. Relay 1602 in operating, with neither relay 1504 nor relay 1505 operated, closes a circuit from battery through resistance 1603, inner left front contact of relay 1602, right back contacts of relays 1504 and 1505, right winding of relay 1506 to ground. With relay 1506 operated, the circuit for testing the office selector is closed. This circuit extends from battery in the office selector (not shown) over the fundamental circuit to conductor 748 as previously traced, upper front contact of relay 723, left back contact of relay 1804, through resistance 1725, left contacts of cam 1703, conductor 1731, right front contact of relay 1506, conductor 1510, right front contact of relay 1925, winding of relay 1314, right winding of relay 1225, back contact of relay 1220, inner left contact of relay 1226, bottom contacts of cam 1717, back contact of relay 1921, through resistances 1927 and 1926, back contact of relay 1922, left contacts of cam 1714, back contact of relay 1231 to conductor 747 and then to ground in the office selector. If the circuit is properly completed at that point, relay 1314 operates but relay 1225 does not. The presence of resistance 1725 also prevents the premature operation of the control relay of the office selector. Relay 1314 closes an obvious circuit for relay 1307 which locks to ground over conductors 1734 and the lower left contact of cam 1709. Relay 1307 closes a circuit from ground at its left front contact, left contacts of cam 1706, through the winding of sequence switch magnet 1700 advancing the switch to position 5. As soon as the switch leaves position 4 the locking circuit of relay 1307 is opened. The advance from position 4 also opens the testing circuit and, as soon as position 5 is reached, the fundamental circuit is closed from conductor 748 to the upper right contact of cam 1722, lower right contact of that cam, through the winding of relay 1300 to the back contact of relay 1220 and thence as traced for the testing circuit to the fundamental ring conductor 747. During the time that office test is being made, that is, with sequence switch 1700 in position 4 a circuit is closed for the magnet of switch 2300 extending from battery through its winding, upper left and lower right contacts of cam 2318, upper front contacts of relay 2307, conductor 2312, to ground through the lower right and upper left contacts of cam 1745. The sequence switch magnet operates and advances switch 2300 to position 5. Also, another circuit is closed for relay 2301 extending from battery through its winding, back contact of relay 2302, back contact of relay 2303, conductor 2313, back contact of relay 1803, left contacts of cam 1745 to ground. Relay 2301 operates and connects the winding of relay 2314 to conductors 751 and 752 in preparation of a circuit for relay 2314 at the time when the tape recorder circuit, shown in Figs. 25 to 27, inclusive, is ready to receive a record of the called number, as more completely described hereinafter. With switch 2300 in position 5, relay 2305 is locked over its inner upper front contact and the right contacts of cam 2330 to ground on conductor 2312.

Seizure of tape register

In the meanwhile when sequence 200 reaches position 7 a circuit is closed for operating relay 2412 extending from battery through the winding of said relay, right lower and left upper contacts of cam 293 to ground. Relay 2412 operates and prepares a locking circuit over its bottom contacts, bottom contacts of relay 2413, left contacts of cam 293 when switch 200 reaches position 9, to ground. Relay 2412 remains so locked through position 10 of sequence switch 200 so that when the switch reaches position 10, a circuit is completed for relay 2414 extending from ground through the top contacts of cam 293, top middle contacts of relay 2412, upper winding of relay 2414, common conductor 2426, back contacts of relay 2415 to battery. Relay 2414 operates and

locks over its lower winding and bottom inner front contact through the bottom inner back contact of a similar relay 2414 in every other district selector of the group serving the same line-finder frame, winding of relay 2415 to battery. Relay 2415 operates in this locking circuit and opens the operating circuit of all relays 2414 in each of the districts of the group so that none of these other relays may operate so long as one relay in the group is operated.

Now a relay 2414 is provided in each district whereby, upon its operation, the district is connected to a common tape register circuit, such as that shown in Figs. 25 to 27, inclusive, there being one such circuit for each group of district selectors serving one line-finder frame containing four hundred subscribers' lines. The locking circuit of each of the relays is controlled through a preference lockout path running through the back contacts of each of the relays in each of the district selectors of the group in order to make certain that only one district at a time is connected to the common tape register circuit. When, therefore, relay 2414 has operated and switch 200 has advanced to position 10, a circuit is closed from battery through the bottom contacts of interrupter 2417, left winding of relay 2429, resistance 2424, No. 3 contact-set of relay 2414, lower contacts of cam 256 to ground. Relay 2429 operates and a circuit is thereby completed over its right winding to ground through cam 256 so that when interrupter 2417 breaks its bottom contact, relay 2429 will hold over its locking circuit. When, after a brief interval of time, interrupter 2417 makes its top contact, a circuit is completed from battery, top contacts of said interrupter, left contacts of relay 2429, left winding of relay 2430 to battery. Relay 2430 operates and closes a locking circuit over its right winding and right inner front contact to the holding circuit of relay 2429. Relay 2430 operated closes a circuit from ground on its left contact, over a conductor which extends in parallel to the upper left contact of cam 257 in each district of the group, upper top left and right contacts of cam 257 of the district whose relay 2414 has been operated and locked, bottom outer contact of relay 2414, conductor 252, brush 114 and cooperating terminal on line-finder frame 110, right inner back contact of line relay 101, winding of relay 173—AA to battery. Relay 173—AA operates and closes through the identifying circuit of the particular subscriber's line as more particularly described hereinafter.

The reason for delaying the closure of the circuit to relay 173—AA until relays 2429 and 2430 have operated through the timing interrupter 2417 is to make sure that the district is not really in tell-tale position or simply rotating through position 10 on its way to normal.

With the district sequence switch in position 10 and relay 2414 operated and locked, said district is connected with the common tape register for registering thereon: first, the identifying characters of the calling subscriber's line and, secondly, the number of the called line.

Recording the new call identification

With reference to the calling line character identification, Fig. 1 shows the manner in which subscribers' lines are divided into groups for this purpose. This figure shows the division of the entire main group of four hundred lines on a line-finder frame into twenty minor subgroups of twenty lines each, making twenty subgroups in all, each group being identified by one letter of the alphabet, the first group by the letter A and the last or twentieth group by the letter T. Each line in each group has an identifying relay, like relay 173, connected through the back contact of its associated line relay as, for instance, relay 101. Now, when one registering apparatus is to be used for recording all calls made by the lines on a line-finder frame of the panel type that normally accommodates a main group of four hundred lines, said lines can be subdivided into twenty subgroups of twenty lines each, as done in this instance. However, if the number of calls originating from so large a group is excessive, it may be found that the use of one registering apparatus for the entire group will unduly add to the holding time of the district selector since each of said selectors will be held in position 10 until it will have become connected to the register for registering the calling and called line numbers of a connection in the process of being established. Hence while it was thought desirable to illustrate this part of the invention by the use of one register with one line-finder frame, the invention should not be construed to be so limited as the number of registers that may be used and the necessary subdivision of a main group of lines into the required number of subgroups that can be made are both purely a function of the number of calls which may be originated from said frame and the amount of delay permissible for the district selector. Consequently in the present embodiment of the invention, the main group of four hundred lines is divided into twenty subgroups of twenty lines each, all used in connection with one register. Each of the lines in each of the subgroups is assigned an identifying letter marks its position in its own subgroup, the first line in all subgroups being identified by the capital letter A and the last or twentieth line in each subgroup being identified by the capital letter T. From which it follows that any line in the main group is completely identified by (1) a letter marking the subgroup in which the line belongs and (2) by another letter marking the particular position of the line within the subgroup itself. Thus the first line in the first subgroup would be designated by the letters AA and the last line by the letters AT. In the same way the first line in the last subgroup would be marked by the letters TA and the last line by the letters TT. Intermediate subgroups and lines therein are marked accordingly.

The identification of each of the lines in the main group of four hundred lines on a line-finder frame is accomplished by perforating on a tape or other impressible medium associated with the perforator 180, a punch code of an appropriate number of units for each of the two separate characters which mark a line. For this purpose an identification circuit is provided for the main group of four hundred lines comprising a group of ten relays 130 to 139, inclusive, and an auxiliary relay 140 for the code of each of the identifying letters of the twenty subgroups, and another group of ten relays 150 to 159, inclusive, and an auxiliary relay 160 for the code of each of the identifying letters of each of the twenty lines in each of the subgroups. Each of the ten relays in each group marks a particular letter up to and including the letter J. For all letters from K to T, inclusive, the same relays are operated

as were operated for the preceding tenth letters except for the fact that the auxiliary relay 146 or 166 is operated in addition. Thus for the subscriber whose group is marked by the letter A, relay 130 is operated as described hereinafter, but for a subscriber in group K, relay 130 and relay 140 are operated. In the same way the first subscriber in any group is marked by the letter A and hence by relay 150, whereas the eleventh subscriber in any group and marked by the letter K would be marked by the operation of relays 150 and 160. In the same way for all other groups and all other subscribers, each group and subscriber beyond the tenth would be marked by the same relay that marks the group or subscriber in the first ten plus the auxiliary relay. Hence one of the armatures of each of the line identifying relays 173—AA, etc. is connected to the winding of that relay in the first group 130 to 139 assigned to the letter marking the subgroup of the line and the other armature is connected to the winding of that relay in the second group of relays 150 to 159 assigned to the letter marking the line itself.

Obviously any system of codes will do depending on the type of tape punching apparatus used and the type of registering circuit cooperating therewith. For instance, it is possible to use a registering circuit comprising two groups of twenty relays each, one relay for each identifying character of the subgroup and one relay for each identifying character of the line. Also, it would be possible to use specially constructed tape punching apparatus to operate in conjunction with such a register. However neither appears desirable or necessary. The preferred embodiment of the invention as herein disclosed and described makes use of standard tape punching apparatus of the "printer" type commonly used in printing telegraph systems such as, for instance, the commercial tape perforator disclosed in Patent 1,309,745 to L. M. Potts and granted July 15, 1919 and modified to operate with a six-unit code instead of a five-unit code. This perforator comprises, in part, six punch magnets 21 to 26, inclusive and a start magnet 27, the first mentioned six magnets operating during six equal impulse periods generated by a distributor 182 as it revolves into contact with each of the segments to which the conductors 11 to 16, inclusive, are connected. Since the perforator, as such, forms no part of the invention except as an element thereof in combination with other elements, and is a well known piece of commercial apparatus, it is not thought necessary to encumber this specification with any further description thereof. The code used, both in the registration of the line identifying character as well as for the registration of other items relating to the complete identification of completed calls, whether local or toll, is the so called "six-unit" code shown in the following table:

Printer code for use with automatic billing system

	Opr. code	Line des. etc.	1	2	3	4	5	6
1		K	X	X	X	X	X	
2	K	L	X	X	X	X		
3	Q	M	X	X	X		X	
4	U	N	X	X	X			
5		O	X	X		X	X	
6	J	P	X	X		X		
7	W		X	X			X	
8	A	Q	X	X				
9	X		X		X	X	X	

	Opr. code	Line des. etc.	1	2	3	4	5	6
10	F	R	X		X	X		
11	Y		X		X		X	
12	S	S	X		X			
13	B		X			X	X	
14	D	T	X			X		
15	Z		X				X	
16	E		X					
17	V	A		X	X	X	X	
18	C	B		X	X	X		
19	P	C		X	X		X	
20	I	D		X	X			
21	G	E		X		X	X	
22	R	F		X		X		
23	L			X			X	
24	Line feed	G		X				
25	M				X	X	X	
26	N	H			X	X		
27	H				X		X	
28	Space	I			X			
29	O					X	X	
30	Carriage return	J				X		
31	T						X	
32		Sw. char	X	X	X	X	X	X
33		New call	X	X	X	X		X
34	7		X	X	X			X
35	2		X	X			X	X
36	1		X		X	X	X	X
37	6		X		X		X	X
38	Blank		X			X	X	X
39	—		X			X		X
40	3		X					X
41		Operator		X	X	X	X	X
42	0			X	X		X	X
43	8			X	X			X
44	4			X		X		X
45	'			X				X
46	Period				X	X	X	X
47	9					X	X	X
48	5						X	X

In adapting the use of the above code to the invention, six conductors are used; namely, 11 to 16 as shown therein and a starting conductor 17, not shown in the table. Each of these conductors are connected to the winding of a correspondingly numbered punch magnet in the perforator 180; conductor No. 17 being connected to the winding of the starting magnet. When the circuit of each of these conductors is closed in the combination required by the code of the character to be registered, the magnets operate in the well known manner and record the code of the character by punch, dot or other means well known to the printing telegraph art.

Referring to the above code table, it will be observed that there is one column headed "Line Des. Etc." and another column headed "Opr. Code". Under the first column is to be found the twenty alphabetical characters used for subgroup and line designation together with three additional characters designated as "Sw. Char." as an abbreviation for "switching character", another designated "new call" and yet another "operator". The use made of the last three codes will be described later on, but for the present it is sufficient to note that each character is represented by a particular combination of six conductors as indicated by the x under the number of the conductor and that the codes for said alphabetical characters will be used for line identification characters only.

The other column, designated "Opr. Code" contains such characters as are likely to be used by a toll or long distance operator in registering the complete record of a toll or long distance call for billing purposes. Each of these characters likewise has its own code made up of a combination of from one to six conductors and, when grounded or circuits are otherwise completed thereover, will cause the responsive telegraphic perforating apparatus 180 or other equivalent device to record the code of the corresponding character. These characters, however, will be used also for record-

ing local call information except the calling line characters.

Returning, now, to the description of the line identification circuit and apparatus shown in Fig. 1, the winding of each of the six punch magnets is arranged to be extended through distributor 182 to a conductor common to the two groups of relays 130 to 140, inclusive, and 150 to 160, inclusive; conductor 11 being connectable to magnet 21, conductor 12 to magnet 22, etc., conductor 17, the starting conductor, is connected to starting magnet 27. These conductors 11 to 17, inclusive, may also be extended to the magnet coils in the telegraph printing mechanism 170 shown in Fig. 1 and to the windings of register relays of the tape register circuit shown in Fig. 25. The reason for each of these separate connections will become apparent when the operation of their respective circuits is described.

It must not be supposed that the specific arrangement of line grouping as outlined above is intended to limit the scope of this part of our invention to the example herein described and disclosed. The example illustrated simply typifies the gist of this part of our invention which is an arrangement of apparatus and controlling circuits for transmitting a group of signals to the tape perforator for identifying the calling line. Obviously the recording apparatus is necessarily dependent on the grouping arrangement of the lines, the character of the telephone system of which they form a part and the kind of identifying characters to be recorded or transmitted. Therefore while the subscriber identifying circuits and apparatus shown in Fig. 1 are merely typical and illustrative of one suited to a panel telephone system with a known arrangement and subdivision of lines, any identifying characters and the means of transmitting the same that is best adapted to the character of the telephone system to which the invention is applied is to be understood as coming within the scope of our invention.

Referring, now, to the detailed operation of the line identifying circuit, let it be supposed that subscriber 100 is the first line in the first subgroup. Since, according to the code adopted, each of the twenty subgroups of lines is identified by a letter character and each of the twenty lines therein is also identified by a letter character, the complete line terminal designation of line 100 will be AA. Accordingly, the inner contact of relay 173—AA is connected to conductor 167 while the outer contact is connected to conductor 168. Now the inner armature of relay 173—AA is connected to one of ten conductors, each of which is connected to the winding of one of the ten relays 130 to 139 of the group register. Since the subgroup containing the calling line is assumed to be the first or subgroup A, said armature is connected to the conductor which is connected to the winding of the first relay, that is, relay 130. Also, there are ten other conductors each of which connects with the winding of one of the ten relays 150 to 159 comprising the signaling circuit of the line terminal itself. Since it has been assumed that the calling line is the first in the group and, therefore, designated by the character A, the outer armature of relay 173—AA is connected to that conductor of the second group of conductors which in turn is connected with the first relay of the subgroup, that is, relay 150. If the line in question is within another subgroup say, for instance, the last or twentieth group identified by the letter T, and in an intermediate position within this group, for example, the fourteenth and hence marked by the letter N, then the inner contact of relay 173—TN of said line would be connected to conductor 169 while the armature making with said contact would be extended to the conductor which is connected to the winding of relay 139, and then the outer contact of relay 173—TN would be connected to conductor 171 while the armature making therewith would be connected to the conductor extending to the winding of relay 153 (not shown). This line, then, would have the combined group and line characters of TN. In the same way, the contacts and armatures of all other relays 173 would be connected to the appropriate conductors in the two groups of ten conductors of the group and line registers while their cooperating contacts would be connected to conductor 167 or 169 and 168 or 171, respectively, depending on whether or not the group or line had a character lower than 10 or higher than 10.

The line identifying circuit being thus prepared, now waits before closing the circuits of relays 130 and 150 for printing the line code character until a "switching character" is printed ahead of it as more clearly described hereinafter.

In the meanwhile, at the time the district selector advanced to position 10 and caused thereby the operation of relay 2430, a circuit was closed for relay 2501 extending from ground through the lower contacts of cam 256, the No. 3 contact-set of relay 2414, resistance 2424, right outer contact of relay 2430, conductor 2491, winding of relay 2501 to battery. Relay 2501 operates and closes a circuit from ground over its bottom contact, left upper contact of cam 2531, upper contact of cam 2532, winding of switch magnet 2500 to battery. Magnet 2500 operates and advances the switch to position 2.

Now in the recording and billing system of this invention, the various items of information relating to a particular call are registered on the recording tape at different periods in accordance with the time when such information is available. Since the tape perforating mechanism 180 and the tape register shown in Figs. 25 to 27, inclusive, are both common to a main group of four hundred lines, serious loss of time would be incurred if the tape perforator and the register were to be tied up with one line from the instant that the called number is registered in the sender until the connection is completed. The tape perforator and the register, therefore, are connected to a calling line or the extension thereof for a succession of intervals during each of which some one item of information available for registration and relating to the call is first recorded in the register and then punched on the tape. In between said intervals the tape perforator and register are available to any other calling line in the main group for which this apparatus is common for the purpose of registering and punching whatever items of information relating to this other call. That is, the register may be at first connected to a calling line extension at that stage of the connection when the only items of information are the calling line identification number and the called line number, as in the example under consideration. As explained hereinafter, the tape perforator and the register will remain operatively connected to the line and its extension only for the time interval necessary to punch the code of the letters or the numbers which

make up these two items of information. Thereafter the tape perforator and register will be disconnected from the calling line even though the connection is still partly set up, said tape perforator and register being then available to any other calling line in the main group at any stage of the connection for registering and punching the item of information available at that stage.

For instance, the tape perforator and register, after disconnection from a calling line for which the calling line and called line number have been obtained and punched, may become connected to another calling line in the group at the instant when the connection on this latter line has been completely established and talking is to commence thereover; and this for the purpose of obtaining a record of the time when conversation ensues, such record again being punched on the tape. Thereafter the tape perforator and register are free again for attachment to other lines, as for instance, some line for which the called line number has been dialed and the district selector advanced to position 10; or again to some other line on which conversation has just terminated and the record of the time of such completion must be obtained and punched on the tape.

Thus the tape associated with the perforator **180** will contain a series of entries relating to calls originated from the main group of lines, but each of the successive entries will not necessarily relate to a call from the same line but may relate to different calls from different lines, the entries having to do with one call being interspersed with entries having to do with other calls.

Obviously, each entry must be distinguished from all the others in order that, finally, all entries relating to a call from one line and other entries relating to succeeding calls from the same line may be grouped together and separated from the entries relating to calls from each of the different lines. This distinction is carried out first by perforating ahead of any item of information "switching character" which controls the operation of other apparatus that assembles all items relating to calls made from a subgroup of lines and later from one line in the subgroup, secondly, by perforating the code of the calling line identifying characters, and thirdly by then perforating the code of another character which indicates whether the entry which follows thereafter is an item of information for a new call or an old call for which other entries have already been made.

To revert, now, to the call under consideration and remembering that the register is operatively connected to the calling line extension after the called line number has been registered in the sender and the line indication registers have been partially prepared to transmit into the perforator the code of the two characters marking the calling line, it becomes necessary to record the code of the switching character ahead of the code of the line indication and, later, the code of the character indicating a new call. By referring to the table of codes, it is seen that the code of the switching character is a six-unit code; that is, it calls for circuits to be completed over each one of the six conductors **11** to **16**, inclusive, extending to the punch magnets 21 to 26 of the tape recorder **180** while the new call character is a five-unit code which calls for circuits to be completed over conductors **11**, **12**, **13**, **14** and **16**, and in both instances, of course, a circuit for the starting magnet 27 over conductor **17**. Consequently when switch **2500** reaches position 2, ground is connected to conductors **11** to **16**, inclusive, from ground on cam **2504**, contacts of cam **2505**, to conductors **11** and **12**, respectively, contacts of cam **2507** to conductors **13**, **14**, **15** and **16**, respectively. The grounding of these conductors connects ground to the six separate right-hand segments 1 to 6, inclusive, of commutator **181**, the windings of the separate punch magnets 21 to 26, inclusive, being connected to corresponding left-hand segments of the commutator. At the same time another circuit is completed from ground over the right contact of cam **2505**, conductor **17**, winding of start magnet 27 of the tape perforator to battery. The operation of the start magnet releases the distributor clutch and the motor (not shown), causes the said distributor **182** to make one revolution during which contact is made with each of the grounded segments 1 to 6, inclusive, and circuits are successively completed thereby with the winding of each of the punch magnets. As each magnet operates, it punches a hole transverse the tape in the position on the tape fixed by the tape feed (not shown) in relation to the position of the separate magnets. Since the entire six segments of the commutator are grounded, the six magnets will be operated in succession and six holes are punched across the face of the tape as the code of the switching character. When the distributor **182** engages segment 7, a circuit is closed from ground over conductor **183**, the upper right contact of cam **2529**, winding of magnet **2500** to battery. Said magnet operates and advances the switch to position 3. As it revolves out of position 2, the circuit of the printer start magnet 27 is opened causing said magnet to release and reengage the start latch of the distributor clutch to prevent said distributor from making a second revolution while, at the same time, ground is disconnected from the commutator segments in preparation for the next code. With switch **2500** in position 3, a circuit is closed from ground over the left contacts of cam **2504**, conductor **167**, inner contact of relay **173**—AA, winding of relay **130** to battery. Relay **130** operates and closes all of its contacts to ground thereby closing the circuit of the start magnet of the perforator and also grounding commutator segments 2, 3, 4 and 5 to cause the operation of the four corresponding magnets 22, 23, 24 and 25 in the tape perforator which, in accordance with said code, causes a combination of punches to be recorded which designates the letter A of the calling line subgroup. When distributor **182** again engages segment 7, the previously traced circuit is closed to advance switch **2500** into position 4. As the switch revolves out of position 3, the circuit for relay **130** is broken at the left contacts of cam **2504** and relay **130** releases, thereby releasing the start magnet 27 and removing ground from the commutator segments as already described. When the switch reaches position 4 another circuit is closed from ground on the right upper contact of cam **2504**, conductor **168**, outer contact of relay **173**—AA, winding of relay **150** to battery. Relay **150** operates and grounds the same four conductors and the start conductor as were grounded by relay **130** since the code of the character to be perforated in this case is that of the first subscriber within the subgroup and identified by the letter A. The perforator now functions as before in punching the four properly spaced holes for the second letter A and advances sequence switch **2500** into position 5. As the switch leaves position 4, the circuit of relay **150** is opened, ground is removed from the commutator segments and the start magnet is re-

leased, thereby causing the perforator to come to rest preparatory to punching the next code.

Having recorded the designation of the calling subgroup and the designation of the calling line therein, the next code to be perforated is that relating to the status of the call. Since the call going through is a new call, the code of the "new call" designation is perforated. This code, as already explained, calls for the grounding of conductor 11, 12, 13, 14 and 16. Consequently when switch 2500 reaches position 5, ground is connected through the contacts of cam 2519, and the number 1, 2 and 3 contact-sets of relays 2501, to conductors 11, 12 and 13, respectively; ground is further connected through the right contacts of cam 2508 and contact-sets 4 and 6 of relay 2501 to conductors 14 and 17 respectively, and ground is connected through the left lower contact of cam 2521, No. 2 contact-set of relay 2501 to conductor 16. The perforator now operates as described to punch the code of the new call designation, to advance switch 2500 into position 6 and to restore when switch 2500 has passed beyond position 5 at the time that the circuit of the start magnet is opened.

After the code of the new call designation has been punched and switch 2500 has advanced to position 6, the next item of information to be recorded on the tape is the called office and the called line number. It will be observed that this information is recorded in the sender on registers 900 to 1110, and before it can be recorded on the tape it must be transmitted to the registers of the tape register.

Transfer of registration of called line office and number to tape register

As soon as the sender is ready, which is to say, as soon as the district selections are completed and the district switch 200 is in position 10, a circuit is closed for relay 2609 extending from battery through its lower winding, top back contact of relay 2611, conductor 2624, No. 6 contact-set of relay 2414, conductor 2418, brush 466, brush 468 and cooperating terminal, conductor 751, bottom front contact of relay 2301, winding of relay 2314, top front contact of relay 2301, conductor 752, brush 469 and cooperating terminal, brush 467 and cooperating terminal, conductor 2419, No. 5 contact-set of relay 2414, conductor 2621, bottom contact of relay 2611, upper winding of relay 2609, to ground. Relays 2609 and 2314 both operate, the latter operating relay 2316 over an obvious circuit. Relay 2316 locks over the top upper contact of relay 2306, back contact of relay 2304 to ground on conductor 2312. Relay 2609 operated, closes an obvious circuit for relay 2612 which also operates and locks to ground on cam 2521. Relay 2612, over its lower contact closes a circuit to the winding of relay 2701 which operates and closes ground over its several contacts to a number of holding conductors for the purpose of holding a number of register relays which are to be operated as described hereinafter. Over its bottom outer contact relay 2701 further closes an obvious circuit for relay 2611 which operates and performs two functions, namely, first to disconnect the circuit of relay 2609 which hitherto has been in series with relay 2314 and, second, to connect conductors 2621 and 2624 over its front contacts and the top outer back contacts of relay 2705 to the windings in series of the impulse responding relays 2702, 2703 and 2704 which are now connected over the loop to the sender and in series with relay 2314. Relay 2314 now releases and closes a circuit from ground on its back contact, top contact of relay 2316, winding of relay 2302 to battery. Relay 2302 operates, opens the circuit of relay 2301 which releases and further connects conductors 2337 and 2338 over the inner front contacts of relay 2302 and the back contacts of relay 2301 to conductors 751 and 752, respectively. A circuit is now closed from ground at cam 2340, upper contact of cam 2321, lower contact of relay 2302, upper contacts of cam 2318 to the winding of magnet 2300. The magnet operates and revolves the switch through one revolution during which a series of impulses are transmitted over conductors 751 and 752 in accordance with the registration of the called subscriber's office code as recorded on the registers of the sender.

The designation of the called office and number is transmitted to the tape recorder register in the form of a well known impulse code which is used in transmitting numerical designations from automatic offices to manual offices in the completion of a call from one office to another and is known in the telephone art as the "call indicator" pulse code. The details of the particular code for each letter and number as hitherto used can be obtained from a detailed description of it contained in Patent No. 1,438,743 to E. H. Clark, granted December 12, 1922. Only such part of said code will herein be described as will be actually used in transmitting the impulse code of the number dialed and recorded in the sender which has been assumed to be Halifax 3678.

The call indicator code consists of light positive impulses and light or heavy negative impulses under the control of the registers containing the record of the called number. The light positive impulses are generated over the impulse loop by connecting ground to the ring conductor and battery through a high resistance to the tip conductor of said loop while the light negative impulses are generated by connecting ground to the tip conductor and ground through a high resistance to the ring conductor, the heavy negative impulses being generated by connecting battery through a low resistance in parallel with battery through a high resistance to the ring conductor. Now, according to the code described in the above mentioned patent to Clark, the impulse code for each of the letters and numbers, the designation of which is to be transmitted and recorded in the tape recorder is as follows:

H	4	blank	light negative	positive	light negative
A	2	blank	heavy negative	blank	light negative
L	5	blank	light negative	blank	heavy negative
	3	positive	light negative	blank	heavy negative
	6	positive	light negative	blank	heavy negative
	7	blank	heavy negative	blank	heavy negative
	8	positive	heavy negative	blank	heavy negative

Hence, when the impulser switch 2300 is in position 5, the sender is ready to transmit into the tape recorder register the impulse code of the called office and number to which impulses relays 2702, 2703 and 2704 will respond depending upon whether the impulses are heavy negative, light positive or light negative, respectively.

The first code impulse of the letter H, as shown above, is blank. The second impulse is light negative and is transmitted during the time that switch 2300 is revolving through positions 5¾ to 6¼. At this time, therefore, a circuit is completed from battery through the high resistance 2329, right lower and left upper contacts of cam 2328, conductor 2337, inner contact of relay 2302, bottom back contacts of relay 2301, conductor 751 and previously described loop includ-

ing relays 2702, 2703 and 2704, back over conductor 752, top back contact of relay 2301, middle contacts of relay 2302, conductor 2338, upper left and right lower contacts of cam 2327, left upper and right lower contacts of cam 2326 to ground. Since, as already stated, this impulse is light negative, relay 2704 responds while relays 2702 and 2703 remain unoperated. Relay 2704, in operating, closes a circuit extending from ground on the No. 3 contact-set of relay 2701, contacts of relay 2704, inner back contact of relay 2705, bottom inner back contacts of relay 2625, winding of relay 2626, lower winding of relay 2625, to battery. Relay 2626 operates and closes a short-circuiting path to the upper winding of relay 2625 through its inner bottom contact and ground on relay 2701 whereby relay 2625 remains unoperated. Now so long as the impulse circuit above traced remains in effect, the impulsing circuit of the tape recorder register also remains as above described, that is, with relay 2704 operated, relay 2226 operated and relay 2625 short-circuited. As the impulser switch, however, passes beyond position 6¼, the above described impulsing circuit is opened as a result of which relay 2704 releases, the short circuit around the upper winding of relay 2625 is removed and this relay now operates in series with relay 2626, both relays now holding over a circuit extending from battery through the lower winding of relay 2625, winding of relay 2626, upper winding of relay 2625, inner contacts of relay 2626 to ground. A circuit is now completed for relay 2629 extending from battery through the winding of said relay, inner back contact of relay 2628, bottom outer contact of relay 2625 to ground. Relay 2629 operates and establishes a locking circuit through the winding of relay 2628, bottom inner contacts of relay 2629, No. 2 contact-set of relay 2701 to ground. Relay 2628 does not operate at this time, however, due to the operating ground for relay 2629 short-circuiting its winding through the inner back contact. As the impulser circuit advances to position 6¾, the impulsing circuit is again closed for the transmission of the third impulse of the impulse code of the first office letter. This impulse, as noted above, is a positive pulse and the impulsing circuit, therefore, is closed from battery through high resistance 2336, left contacts of cam 2323, conductor 2034, left outer front contact of relay 906, left lower and top outer contacts of cam 2324, bottom outer front contact of relay 2305, right lower and left upper contacts of cam 2327, middle contacts of relay 2302, top back contact of relay 2301, conductor 752 and loop including relays 2702, 2703 and 2704, back over conductor 751, bottom back contacts of relay 2301, inner front contact of relay 2302, inner contacts of relay 2309, bottom contacts of cam 2326, to ground. Relay 2703 operates in this circuit and closes a path extending from ground on the No. 3 contact-set of relay 2701, contacts of relay 2703, bottom outer front contact of relay 2626, middle back contacts of relay 2628, left winding of register relay 2622, to battery. Relay 2622 operates and locks over its windings in series and front contact to ground on the top front contact of relay 2701. When the impulser switch has advanced beyond position 7¼ the above impulsing circuit is opened and relay 2703 releases. The last impulse of the code for the first digit of the office code is a light negative impulse. Therefore, as soon as the sequence switch has advanced to position 7¾, the circuit previously traced when the switch was in position 5¾ will again be reclosed and cause thereby the operation of relay 2704. Relay 2704 now operates and closes a ground from the No. 3 contact-set of relay 2701, contacts of relay 2704, inner back contacts of relay 2705 to the bottom inner front contact of relay 2625, shunting relay 2626 and holding relay 2625 locally on said ground. As the switch passes position 8¼, the above impulse circuit is opened and relay 2704 releases, thereby causing the release of relay 2625 and the removal of the short circuit around the winding of relay 2628 which now operates in series with relay 2629.

The code of the second digit is a blank impulse, a heavy negative impulse, a blank impulse and a light negative impulse, all of said impulses being transmitted in positions 9 to 12, inclusive, of the sequence switch. Consequently, when switch 2300 advances to position 8¾ the blank impulse is transmitted, which means, of course, that the loop previously described is open. As the switch advances to position 9¾ the loop is closed for the transmission of the heavy negative impulse and this circuit is as follows: Ground through the right lower and left upper contacts of cam 2326, outer contacts of relay 2309, middle contacts of relay 2302, top back contacts of relay 2301, conductor 752, over the previously described loop including the pulsing relays, back over conductor 751, lower back contact of relay 2301, inner front contact of relay 2302, inner contact of relay 2309, bottom contacts of cam 2328, high resistance 2329, to battery. It will be observed that this is the impulse circuit for the light negative impulse and consequently would only cause the operation of relay 2704 as previously described. At the same time, however, another circuit is closed in parallel with it extending from battery through low resistance 2319, right lower and left upper contacts of cam 2320, conductor 2032, left back contact of relay 917, left outer front contact of relay 915, right contacts of cam 2325, bottom inner front contact of relay 2305, resistance 2329 to battery. Now resistance 2319 is a very low resistance and when placed in parallel with resistance 2329, causes a current flow through the impulsing loop which is sufficient to cause the operation of relays 2704 and 2702. Relay 2704 in operating causes a circuit to be closed from ground on the No. 3 contact-set of relay 2701, contact of relay 2704, inner contact of relay 2705, bottom inner back contact of relay 2625, winding of relay 2626, lower winding of relay 2625 to battery. Relay 2626 operates as before and short-circuits relay 2625 while relay 2702, in operating, closes another circuit extending from ground through its contacts, top back contact of relay 2625, top outer front contact of relay 2629, top outer back contact of relay 2631, left winding of relay 2623, to battery. Relay 2623 operates and locks over its windings in series and front contact to ground on the top front contacts of relay 2701. When the impulser switch has advanced beyond position 10¼, the above impulsing circuit is opened causing thereby a release of relays 2702 and 2704. The release of relay 2704 causes the operation of relay 2625 in series with relay 2626 as previously described which, in turn, causes an operating circuit for relay 2631 to be closed extending from battery through its winding, top inner back contact of relay 2630, top inner front contact of relay 2628, bottom outer front contact of relay 2626 to ground on the No. 3 contact-set of relay

2701. Relay 2631 operates and locks in series with the winding of relay 2630 to ground through the bottom inner contacts of relay 2631, relay 2630 being short-circuited in the meanwhile by ground on its top inner back contact. As the switch advances through positions 10¾ to 11¼, no impulse is sent. The fourth impulse is a light negative impulse and is transmitted from positions 11¾ to 12¼ of impulser switch 2300 over a previously described circuit except for the different positions of the switch. As before, relay 2704 operates and closes a previously described circuit for shunting relay 2626 which thereupon releases, relay 2625 holding over a local circuit to ground through the contacts of relay 2704. As the switch passes position 12¼ the impulse circuit is opened, relay 2704 is released whereupon relay 2625 is released and the short circuit is removed from relay 2630 which now operates in series with relay 2631 to ground on the No. 3 contact-set of relay 2601.

The next group of impulses is that which is to be transmitted for the third digit of the office code and consists of a blank impulse, light negative impulse, a blank impulse and a heavy negative impulse. These impulses are transmitted as switch 2300 passes through positions 13 to 16, inclusive. Accordingly, when the switch advances from position 12¾ through position 13¼ the blank impulse is transmitted which, of course, means that the impulse circuit is open. The next impulse transmitted between position 13¾ and 14¼ is a light negative pulse. The previously traced impulse circuit for a light negative impulse including resistance 2329 and the impulse relays in the tape recorder circuit is again effective causing thereby the operation of relay 2704 which, in turn, closes a circuit previously traced from ground through its contacts and bottom inner back contacts of relay 2625 to operate relay 2626. The next impulse is a blank impulse and is transmitted from position 14¾ to position 15¼ and causes the release of relay 2704 and the operation of relay 2625 in series with relay 2626 as previously described. A circuit is now closed for relay 2715 extending from battery through its winding, top inner back contact of relay 2714, top inner front contacts of relays 2630 and 2628, bottom outer front contact of relay 2625 to ground. Relay 2715 operates and closes a locking circuit through the winding of relay 2714. Relay 2714 does not operate at this time due to the short-circuiting ground on its inner back contacts. The last impulse in this series is a heavy negative impulse and is transmitted between positions 15¾ to 16¼. As soon as switch 2300 reaches position 15¾ the impulse circuit for the light negative impulse is closed as previously described. In addition thereto a parallel circuit is closed from battery through low resistance 2319, right contacts of cam 2320, conductor 2035, right inner front contact of relay 927, left back contact of relay 925, lower contacts of cam 2325, lower inner front contact of relay 2305, resistance 2329, to battery. The current flowing through the impulse circuit by virtue of these two resistances in parallel is sufficient to operate relays 2702 and 2704 as previously described. Relay 2704 in operating now causes the release of relay 2626 while relay 2702, in operating, closes a circuit from ground through its front contact, top front contact of relay 2625, top outer front contacts of relays 2628 and 2630, top outer back contact of relay 2714, left winding of relay 2724 to battery. Relay 2724 operates and locks over its winding in series and front contact to ground on the top contact of relay 2701. When the switch passes position 16¼ the above impulsing circuit is opened whereupon relays 2702 and 2704 release, the latter, in releasing, causing the release of relay 2625 and which, upon releasing, opens the short circuit around relay 2714 causing it to operate in series with relay 2715.

The impulse code for each of the three letters or digits of the called office code has now been transmitted and has resulted in the operation and locking of relays 2622, 2623 and 2724 in the tape register circuit. The next group of impulses to be transmitted are those relating to the four digits of the called subscriber's number. In this connection, if the called subscriber's number involved a station's digit, the impulses of this station's letter would be transmitted in positions 17¼ to 20¼, inclusive, of the first revolution of the impulse switch 2300. However, the assumed number does not contain a station's digit, and the impulse codes are only those of the thousands, hundreds, tens and units digits of the called number. For this reason the stations impulse cuttings have been omitted at the switch cams and the switch registers eliminated in Fig. 27. Should it be desirable, however, to include the stations digit then the impulse cuttings and necessary registers may be easily added.

In the meanwhile, when switch 2300 has advanced past position 17, the locking circuit of relay 2305 is opened at cam 2330 whereupon this relay will release provided sequence switch 1700 has passed beyond position 6, thus opening the initial operating circuit of relay 2305. It is to be noted in this connection that following the completion of district selections and office trunk test, office selections are made as hereinafter described, following which sequence switch 1700 advances into position 7. Relays 2307 and 2309 remain operated after the release of relay 2305 over a locking circuit extending over the inner top contact of relay 2307, the upper contacts of cam 2330 to ground on conductor 2312. When switch 2300 reaches position 1 a circuit is closed from ground through the bottom right contact of cam 1745, conductor 2312, top outer front contacts of relay 2307, contacts of cam 2318, winding of sequence switch magnet 2300 to battery. The magnet operates and advances the switch out of position 1 and into position 2 of its second revolution whereupon, in position 2, another circuit is closed through the left contacts of cam 2318 to revolve said switch out of position 4 and into position 5. In position 5 the previously traced circuit from ground on cam 2321 is thereafter operative to keep the switch advancing through another revolution until it reaches position 1 again.

It will be recalled that the called subscriber's number has been assumed to be 3678 and that the impulse code for the thousands digit 3 comprises a positive, a light negative, a blank and a heavy negative impulse. Consequently when the switch has advanced to position 20¾ the impulse circuit is closed as follows: From battery through resistance 2336, lower contacts of cam 2323, conductor 2031, right middle front contact of relay 1005, left outer back contact of relay 1007, right contact of cam 2334, right contact of cam 2335, lower back contact of relay 2305, lower right and upper left contacts of cam 2327, middle contacts of relay 2302, top back contact of relay 2301, conductor 752 over the

previously described loop including the impulsing relays in the tape register circuit, conductor 751, bottom back contact of relay 2301, inner front contact of relay 2302, left contacts of cam 2328, to ground through the bottom contacts of cam 2326. Relay 2703 operates in this circuit and closes a circuit extending from ground through its contacts, outer back contact of relay 2626, inner front contacts of relays 2629, 2631 and 2715, inner back contact of relay 2717, left winding of relay 2725 to battery. Relay 2725 operates and locks over a circuit through its windings in series and front contact to ground on the top contact of relay 2701. The next impulse is a light negative impulse and is transmitted during the time that sequence switch 2300 is passing through positions 1¾ to 2¼. During this time the previously traced impulse circuit for the light negative impulse is closed but in the aforesaid positions of the switch, causing thereby the operation of relay 2704. Relay 2704 in operating closes a previously traced ground to the back contact of relay 2625 and therefrom through the winding of relay 2626 as previously described, causing said relay to operate. The next impulse is a blank impulse and, of course, the impulse circuit is open between positions 2¾ to 3¼. During this time relay 2704 releases, causing relay 2625 to operate and lock in series with relay 2626 as already described. A circuit is now closed for relay 2717 extending from battery through its winding, inner back contact of 2718, inner front contacts of relays 2714, 2630, 2628 in succession, bottom outer front contacts of relay 2625 to ground. Relay 2717 operates and closes a locking circuit through the winding of relay 2716, bottom inner contacts of relay 2717 to ground on the No. 1 contact-set of relay 2701. Relay 2716 however, does not operate at this time as it is short-circuited by the operating ground for relay 2717 at its inner back contact. The next impulse, a heavy negative impulse, is transmitted in positions 3¾ to 4¼. Therefore, in addition to the closure of the previously described impulse circuit for the light negative impulse a parallel circuit is closed thereto from battery through resistance 2319, right contacts of cam 2320, conductor 2035, right inner contact of relay 1004, right outer back contact of relay 1007, bottom contacts of cam 2332, bottom inner contacts of relay 2305, to resistance 2329. Relays 2702 and 2704 now operate as before, the latter closing a circuit to release relay 2626 and to hold relay 2625 while the former closes a circuit from ground through its front contact, top front contact of relay 2625, top outer front contacts of relays 2628, 2630 and 2714, top outer back contact of relay 2716 to the left-hand winding of relay 2723 to battery. Relay 2723 operates and locks in a circuit over its windings in series and front contact to ground on the top front contact of relay 2701. At the end of the impulse, that is, after the switch has revolved beyond position 4¼, the above impulse circuit is opened causing thereby the release of relays 2702 and 2704, the latter, on releasing, causing the release of relay 2625 and the consequent operation of relay 2716 in series with relay 2617.

The next group of impulses to be transmitted is that of the digit 6 and consists of a positive impulse, a light impulse, a blank impulse and a heavy negative impulse. Each of these impulses will be transmitted, respectively, as the switch passes through positions 5 to 8. Consequently when the switch reaches position 4¾, the impulse circuit is again closed as follows to transmit a positive impulse: Battery through resistance 2336, bottom contacts of cam 2323, conductor 2031, left outer front contact of relay 1014, left back contact of relay 1016, bottom contact of cam 2334, right contact of cam 2335, bottom back contacts of relay 2305, right lower and left upper contacts of cam 2327, conductor 2338, middle contacts of relay 2302, top back contacts of relay 2301, conductor 752, over the pulsing loop back to conductor 751, bottom back contacts of relay 2301, inner contacts of relay 2302, left contacts of cam 2328, to ground through the bottom contacts of cam 2326. Relay 2703 operates in the above circuit and closes a circuit extending from ground through its front contact, the outer back contact of relay 2626, inner front contacts of relays 2629, 2631, 2715 and 2717, top inner back contact of relay 2719, left winding of relay 2722 to battery. Relay 2722 operates and then locks over its windings in series and front contact to ground on the top inner contacts of relay 2701. As the impulser switch passes beyond position 5¼ the above traced impulse circuit is opened causing thereby the release of relay 2703. The next impulse is a light negative impulse and is transmitted between positions 5¾ and 6¼ and causes the operation of relay 2704 as previously described. The operation of relay 2704 causes the operation of relay 2626 as previously described. At the termination of the impulse, when the switch has passed position 6¼, relay 2704 releases causing the operation of relay 2625 in series with relay 2626. A circuit is now closed for relay 2719 extending from battery through its winding, inner back contact of relay 2718, inner front contacts of relays 2716, 2714, 2630 and 2628 in succession, bottom outer contacts of relay 2625 to ground. Relay 2719 operates and closes a locking circuit through the winding of relay 2718 to ground on the No. 1 contact set of relay 2701. Relay 2718 does not operate at this time as it is short-circuited by the operating ground of relay 2719 at its inner back contacts. The next impulse is a blank impulse and is transmitted between positions 6¾ to 7¼. The impulse circuit is opened during this time. The next and last impulse of this group is a heavy negative impulse and is transmitted during the time that switch 2300 is passing positions 7¾ to 8¼. In addition to the usual impulse circuit for the light negative pulse there is closed in this position another circuit in parallel therewith extending from battery through resistance 2319, right contacts of cam 2320, conductor 2035, right outer front contact of relay 1017, left outer back contact of relay 1015, left upper and right lower contacts of cam 2332, bottom inner back contact of relay 2305, resistance 2329 to battery. Relays 2702 and 2704 operate in the above traced circuit, the latter causing the shunting of relay 2626 and the holding of relay 2625 while the latter closes another circuit extending from ground through its front contact, top front contact of relay 2625, top outer front contacts of relays 2628, 2630, 2714 and 2716, top outer back contact of relay 2718, left winding of relay 2713 to battery. Relay 2713 operates over its left winding and locks through both of its windings in series and front contact to ground on the top front contact of relay 2701. When the switch has passed beyond position 8¼, the above mentioned impulse circuit is opened causing thereby the release of relays 2702 and 2704. When relay 2604 releases, relay 2625 also re-

leases, in turn causing the operation of relay 2718 in series with relay 2719.

The next group of impulses is that of the tens digit or 7. The code of this digit, as above mentioned, consists of a blank, heavy negative impulse, a blank, another heavy negative impulse. Therefore when the switch has reached position 8¾ the first of these impulses will be transmitted which, of course, being a blank impulse, means that the above mentioned impulse circuit will be open. When the switch has advanced to position 9¾ the second impulse will be transmitted and the impulse circuit already traced for the light negative pulse will be closed, but in the position last mentioned. Another circuit is closed in parallel therewith extending from battery through resistance 2319, through the lower contacts of cam 2320, conductor 2037, left outer front contacts of relay 1027, left outer front contacts of relay 1025, lower left contact of cam 2333, right lower contact of cam 2332, bottom inner back contact of relay 2305, to resistance 2329. This circuit causes the operation of relays 2702 and 2704 as before, the latter causing the operation of relay 2626 while the former closes a circuit extending from ground through its contacts, top back contacts of relay 2625, top outer front contacts of relays 2629, 2631, 2715, 2717 and 2719, top outer back contacts of relay 2721, left winding of relay 2712 to battery. Relay 2712 operates over its left winding and locks through both of its windings in series and front contact to ground on the top contacts of relay 2701. At the termination of the impulse, after the switch has passed position 10¼, the impulse circuit is opened thereby causing the release of relays 2702 and 2704. The release of relay 2604 removes the short-circuit around 2625 which latter relay now operates. A circuit is now closed for relay 2721 extending from battery through its winding, top inner back contact of relay 2720, top inner front contacts of relays 2718, 2716, 2714, 2630, 2628, bottom outer front contact of relay 2625 to ground. Relay 2721 operates and closes a locking circuit through the winding of relay 2720 and bottom inner front contacts to ground. Relay 2720 is prevented from operating at this time due to the short-circuiting ground at its top inner back contact. The next impulse is a blank impulse and, of course, during the time that the switch is passing through positions 10¾ to 11¼ the above traced impulse circuit is open. The last impulse is a heavy negative impulse and is transmitted during the time that the switch is passing through positions 11¾ to 12¼. Hence as soon as the switch reaches position 11¾, the impulse circuit for the light negative impulse is closed as before and, at the same time, another circuit is closed in parallel therewith extending from battery through resistance 2319, lower contacts of cam 2320, conductor 2037, left outer front contact of relay 1027, left outer front contact of relay 1025, bottom contacts of cam 2333, right lower contact of cam 2332, bottom inner back contacts of relay 2305, resistance 2329 to battery. This heavy negative impulse circuit again causes the operation of relays 2702 and 2704, the latter causing the release of relay 2626 and the holding 2625, while the former closes another circuit extending from ground through its front contact, top front contact of relay 2625, top outer front contacts of relays 2628, 2630, 2714, 2716, 2718, top outer back contact of relay 2720 to the left winding of relay 2711 to battery. Relay 2711 operates and locks over its windings in series and front contact to the top contact of relay 2701. At the termination of the impulse, when switch 2300 reaches position 12¼, the above traced impulse circuit is opened thereby causing the release of relays 2702 and 2704, the latter releasing relay 2625 and causing, in turn, the operation of relay 2720 in series with relay 2721.

The next and last group of impulses is that for the units digit 8 and consists of a light positive impulse, a heavy negative impulse, a blank, and a heavy negative impulse. These impulses are transmitted from positions 13 to 16 inclusive of the switch. Consequently when the switch reaches position 12¾, a circuit is closed from battery through resistance 2336, bottom contacts of cam 2323, conductor 2031, left outer front contact of relay 1104, left outer back contact of relay 1106, upper left contact of cam 2334, right contact of cam 2335, bottom outer back contact of relay 2305, lower right and upper left contacts of cam 2327, middle contact of relay 2302, top back contact of relay 2301, conductor 752 over the previously described loop including the impulsing relays in the register circuit back to conductor 751, bottom back contact of relay 2301, inner front contact of relay 2302, left contacts of cam 2328, to ground through the lower contacts of cam 2326. Relay 2703 operates in the above circuit and causes a circuit to be closed from ground through its contacts, outer back contact of relay 2626, top inner front contacts of relays 2629, 2631, 2715, 2717, 2719 and 2721, left winding of relay 2710 to battery. Relay 2710 operates over its left winding and locks over both of its windings in series and front contact to ground on the top front contact of relay 2701. When the switch has passed position 13¼ the above traced impulse circuit is first short-circuited and then reversed for the following impulse which is negative and causes among other things, the release of relay 2703. The next impulse is heavy negative and is transmitted as the switch passes from position 13¼ to 14¼ inclusive. Consequently when the switch advances to position 13¾ the above traced impulse circuit for the light negative impulse is again closed and in parallel therewith another circuit is closed from battery through resistance 2319, bottom contacts of cam 2320, conductor 2037, left outer front contact of relay 1107, left outer front contact of relay 1105, right contact of cam 2333, right lower contact of cam 2332, bottom inner back contact of relay 2305, to resistance 2329. Relays 2702 and 2704 again operate as before, the latter causing the operation of relay 2626 and the former closing a circuit from ground through its front contact, top back contact of relay 2625, top outer front contacts of relays 2629, 2631, 2715, 2717, 2719 and 2721 to the left winding of relay 2709 to battery. Relay 2709 operates over its left winding and locks over both of its windings in series and front contact to ground on the top front contact of relay 2701. At the termination of the impulse, as switch 2300 leaves position 14¼, relays 2702 and 2704 release, the latter causing the operation of relay 2625 in series with relay 2626 as previously described. When relay 2625 operates a circuit is closed from battery, through the winding of relay 2706, top inner front contacts of relays 2702, 2718, 2716, 2714, 2630, 2628, bottom outer front contact of relay 2625 to ground. Relay 2706 operates and closes a locking circuit through its winding, the winding of relay 2705 and its inner contact, but relay 2705 is short-circuited for the time being.

The next impulse is a blank impulse and is delivered in positions 14¾ to 15¼ of switch 2300 during which time the impulse circuit is open. The next and last impulse is delivered in positions 15¾ to 16¼ and comprises a heavy negative impulse. The impulse circuit now closed is the one which was described immediately above and again causes the operation of relays 2702 and 2704. The operation of relay 2704 causes the release of relay 2626 in the described manner, holding relay 2625 locally operated while relay 2702 closes circuit from ground through its front contact, top front contacts of relay 2625, top outer front contacts of relays 2628, 2630, 2714, 2716, 2718 and 2720, inclusive, to the left winding of relay 2708 to battery. Relay 2708 now operates and locks over both of its windings in series and front contact to ground on the top contacts of relay 2701. When the switch has passed position 16¼ the above impulse circuit is opened thereby causing the release of relays 2702 and 2704, the latter causing the release of relay 2625 and thereafter the consequent operation of relay 2705 in series with relay 2706.

The entire impulse code has now been transmitted from the sender into the tape recorder register and therein set up on relays 2622, 2623, 2724, 2723, 2725, 2722, 2713, 2711, 2712, 2708, 2709 and 2710 all of which have been operated. As switch 2300 passes beyond position 10 and back into position 1, relays 2307 and 2309 release, after which a circuit is closed from ground on conductor 2312, top outer back contact of relay 2307, contact of cam 2331, winding of relay 2304, to battery. Relay 2304 operates and opens its back contact to release relays 2306, 2316 and 2302. The release of relay 2306 further removes the holding circuit from ground through its bottom front contact, conductor 753, to the left upper contact of cam 1705, thereby opening the holding circuit for relays 1219 and 1220. With the release of relays 1219 and 1220, the sender switch 1700 proceeds to advance and make the remaining fundamental selections as more described in the above mentioned patent to Raymond-Scully.

The tape impulse switch 2300 has now completed its function of transmitting the impulse code of the called subscriber's office and number to the tape register. The switch is now normal, the tape register has recorded within it the called office and number and the sender now proceeds with the numerical selections.

Recording of office code and number of called line by tape perforator

Returning now to the operation of the tape register circuit, at the time when relay 2631 operates, signalizing the reception of all of the impulses of the code of the A digit as well as two impulses of the B digit code, a circuit is closed from ground on its bottom outer contact, right upper contact of cam 2531, through the winding of magnet 2500 to battery, thereby advancing switch 2500 to position 7, in which position the register is ready to ground the proper combination of the perforator conductors for perforating the code of the A digit. It will be remembered that the impulse code of the A digit, that is, for the letter H of the office code or the number 4 of the actual number dialed, resulted in the operation of relay 2622. Consequently with the switch 2500 in position 7, a circuit is closed extending from ground on the bottom contacts of relay 2631, right upper contacts of cam 2528, left back contact of relay 2634, left inner back contact of relay 2620, left outer front contact of relay 2622, conductor 2619, winding of relay 2544 to battery. Relay 2554 operates in this circuit and connects ground to conductors 12, 14, 16 and 17, the first three of which cause the operation of the tape punch magnets 2, 4 and 6 in accordance with the code for the digit 4 as shown in the operator's code of the printer table, while the last closes the circuit of the start magnet 27 for the operation of the perforator. Hence with the operation of relay 2554, the code of the numeral 4 is perforated on the tape. When distributor 182 engages segment 7 a circuit is closed from ground over conductor 183, the upper right contact of cam 2529 and to battery through magnet 2500. Switch 2500 is advanced into position 8.

It will be observed that during the time the register is receiving the impulses of the B digit and part of those of the C digit, switch 2500 remains in position 7 for the perforation of the code of the A digit on the tape. When the switch passes out of position 7 the circuit for relay 2544 is opened at the upper contacts of cam 2528 and said relay releases and disconnects ground from conductors 12, 14, 16 and 17.

After the code of the B digit and two impulses of the code of the C digit are received relay 2715 operates, and with sequence switch 2500 in position 8, a circuit is closed extending from ground on the lower front contact of relay 2715, the lower contacts of cam 2528, left front contact of relay 2623, left outer back contact of relay 2632, left outer back contact of relay 2633, conductor 2618, winding of relay 2542 to battery. Relay 2552 operates and grounds conductors 11, 12, 15, 16, and 17, the first four thus grounded being the appropriate conductors for operating the proper combination of magnets in the tape perforator to punch the code designation of the digit 2 while the grounding of conductor 17 closes a circuit of the start magnet 27 in the usual manner. When distributor 182 engages segment 7, the previously traced circuit is closed to advance switch 2500 into position 9.

While the impulse code of the B digit is thus being registered the impulse code of the C digit 5 and two impulses of the code of the thousands digit 3 are being transmitted from the sender and set upon the C and thousands registers, after which relay 2717 operates as described. When switch 2500 leaves position 8 the circuit of relay 2542 is opened at the lower contacts of cam 2528 causing this relay to release and disconnect ground from the tape perforator conductors. With the switch in position 9 and relay 2724 operated in response to the code of the third office digit, a circuit is closed extending from ground, lower contacts of relay 2717, the left contacts of cam 2515, left back contacts of relay 2726, left inner front contacts of relay 2724, left inner back contacts of relay 2727, left inner back contacts of relay 2728, conductor 2617, winding of relay 2545 to battery. Relay 2545 operates and grounds conductors 15, 16 and 17, the first two thus grounded being the appropriate conductors for operating the proper combination of magnets in the tape perforator to punch the code designation of the digit 5 while the grounding of conductor 17 closes the circuit of the start magnet 27. The magnets of the tape perforator now operate to perforate two holes in the tape in accordance with the code of the digit 5. When distributor 182 engages segment 7, the previously traced circuit is closed to advance switch 2500 into position 11.

After the impulse code of the thousands digit 3

and two impulses of the code of the hundreds digit 6 have been received, relay 2719 operates as described. When switch 2500 advances beyond position 9 the circuit of relay 2545 is opened at the left contacts of cam 2515 causing thereby the release of relay 2545 which, in turn, disconnects ground from tape perforator conductors. With switch 2500 in position 11 and relays 2725 and 2723 operated in response to the impulse code of the thousands digit 3, a circuit is closed from ground over the bottom contacts of relay 2719, through the right contacts of cam 2515, left back contacts of relay 2729, left inner front contacts of relay 2723, left inner back contacts of relay 2730, left inner front contacts of relay 2724, conductor 2616, winding of relay 2543, to battery. Relay 2543 operates and grounds conductors 11 and 16 in accordance with the code of the digit 3 and also grounds conductor 17 to the start magnet 27 thereby causing the punching of two holes in the tape in accordance with the code of the digit 3. When distributor 182 engages segment 7 the previously traced circuit is closed to advance switch 2500 into position 12.

After the tape register has received the impulse code of the hundreds digit 6 and two impulses of the code of the tens digit 7, relay 2721 operates as already described. When switch 2500 advances beyond position 11 the circuit of relay 2543 is opened, thereby disconnecting ground from conductors 11, 16 and 17. In position 12 a circuit is closed from ground over the bottom contacts of relay 2721, the left contacts of cam 2530, back contacts of relay 2731, left inner front contacts of relay 2713, left inner back contacts of relay 2732, left inner front contacts of relay 2722, conductor 2615, winding of relay 2546 to battery. Relay 2546 operates and grounds conductors 11, 13, 15, 16 and 17, the first four in accordance with the code of the digit 6 and the last for the operation of the start magnet 27 of the perforator which result in the perforation of holes in positions 1, 3, 5 and 6 of the tape in conformity with the impulse code of this digit. When distributor 182 engages segment 7, the previously traced circuit is closed to advance switch 2500 into position 13.

After the tape register has received the impulse code of the tens digit 7, and two impulses of the code of the units digit 8, relay 2706 operates as described. When the switch passes beyond position 12 the circuit of relay 2456 is opened at the right lower contact of cam 2515 thereby causing the release of relay 2546 and the consequent removal of ground from the conductors to the tape magnets. In position 13, with relays 2711 and 2712 operated in response to the impulse code of the tens digit 7, a circuit is closed from ground over the lower contacts of relay 2706, the right contacts of cam 2530, left front contact of relay 2712, left outer back contact of relay 2733, left outer front contact of relay 2711, conductor 2614, winding of magnet 2547, to battery. Relay 2547 operates and grounds conductors 11, 12, 13 and 16 in accordance with the impulse code of digit 7 and also grounds conductor 17 to the winding of the start magnet 27, thereby causing the operation of the perforator to punch four holes in the tape in accordance with the code of the digit 7. When distributor 182 engages segment 7, the previously traced circuit is closed to advance switch 2500 into position 14.

When the impulses of the units digit 8 are received, relay 2705 operates as already described and closes a circuit extending from ground on the bottom outer contacts of relay 2629, bottom contacts of relay 2705, winding of relay 2707 to battery which operates and locks through its top contacts to ground on the middle contacts of relay 2706. When switch 2500 passes out of position 13 the circuit of relay 2547 is opened at the right contacts of cam 2530 thereby causing the disconnection of ground from the tape perforator conductors. With the switch in position 14, and relays 2708, 2709 and 2710 operated in response to the impulse code of the digit 8, a circuit is closed extending from ground, bottom contact of relay 2707, the right lower and left upper contacts of cam 2555, left front contact of relay 2709, left outer front contacts of relay 2710, left middle front contacts of relay 2708, conductor 2607, winding of relay 2548, to battery. Relay 2548 operates and grounds conductors 12, 13, 16 and 17 the first three in accordance with the code of the digit 8 and the last for operating the start magnet 27 to cause it to punch the three holes on the tape in the required position for the code. When distributor 182 engages segment 7, the previously traced circuit is closed to advance switch 2500 into position 16.

The entire called subscriber's number has now been recorded in seven separate rows of punches transverse the tape. As the switch 2500 advances beyond position 15, the locking circuit of relay 2612 is removed, causing said relay to release and open the circuit of relay 2701. Relay 2701 releases, opens its contacts and removes ground from all the locking conductors which have held the various register and control relays in the tape register circuit in an operated position. These relays now release. With the release of relay 2701 the circuit of relay 2611 is likewise opened, causing said relay to restore to normal and again connect relay 2609 across the pulsing conductors. But inasmuch as these conductors are now opened at the tape impulser circuit since, with the advance of switch 1700 beyond position 4, relay 2301 can not operate, there is no circuit to reoperate relay 2609.

In position 16 of switch 2500 a circuit is closed extending from ground through the bottom contacts of relay 2501, left upper contacts of cam 2531, cam 2532, winding of magnet 2500 to battery. Magnet 2500 operates and advances the switch beyond 16 to its normal position thereby restoring the entire tape register to normal.

However, when switch 2500 reaches position 19, a circuit is closed from ground through the bottom contacts of cam 2504, conductor 2551, contacts of cam 258, winding of relay 2413 to battery. Relay 2413 operates and opens its contacts through the bottom set of which it unlocks relay 2412. The release of relay 2412 now unlocks relay 2414 which releases, opens the circuit of relays 2415, 2429 and 2430. With the release of relay 2414, the connection between the district selector and the tape register is opened, causing the release of relay 2501 and the removal of the starting circuit for switch magnet 2500.

It will be observed that the tape register circuit is connected to the district only for the time necessary to record on the tape whatever item of information is available for registration at the time the connection between the two circuits is made. Although the calling line has not yet been completely extended to that of the called subscriber's line, the tape register is dismissed for the interval during which the sender is occupied in completely establishing the call. During this interval, the tape register circuit is free for

connection with other district selectors in various stages of establishing connections and which at this time may have items of information which may be available for perforation on the tape with respect to calls originated over said districts.

The tape register circuit is now in a position to be seized by some other district regardless of the character of the information which it may have ready for registration and perforation. If it is a new call, then, after its seizure consequent operation of relay 2501 and the transmission thereafter of the switching character code, the calling line character identification codes and the new call code, it proceeds to advance to position 5 in readiness to receive from the sender and then transmit to the perforator the series of impulse codes of the called number as already described. However, the fact that relay 2501 always reoperates on a new call and thereafter causes the transmission of the new call code indicates that the codes which follow subsequently, that is, the called number codes, bear no relation to other codes which may have been perforated previously on the tape and that the information which follows up to the perforation of the next switching character belongs to a call which has no relation to any other previous call. Consequently, when switch has advanced beyond position 5 and into position 6, the register proceeds with operations already described for recording and punching the code of the called number of the connection relating to the next district with which the tape register is operatively associated.

The tape register, of course, will have other functions to perform in connection with the measurement of conversation time and also in connection with operators' calls. But since these functions will be better understood when illustrated with respect to the call here being traced, the description of this portion of the tape register operation will be postponed until the connection between the two subscribers has been completely established and conversation between them begins.

Setting office selector

The operations in making office selection are similar to those already described for making district selections. The counting relay circuit for making office brush selection may be traced from ground over the front contact of relay 1300 to conductor 1735, left contact of cam 1720, lower left contact of cam 1719, back contact of relay 1821, left back contact of relay 1822, right back contact of relay 1823 to conductor 1840, left contacts of cam 1713, to the winding of relay 1219 and battery. Therefore, a single revertive impulse from the office selector satisfies the recorded condition of the sender and the first office brush set is selected. Relays 1220, 1229, 1228, 1227 and 1226 operate as previously described to advance sequence switch 1700 to position 6 where office group selection is made. In this position, the reoperation of relay 1226 awaits the release of relay 1227, which is slow to release. The fundamental circuit is the same as that for office brush selection but the counting relay circuit extends over the right lower contact of cam 1720, right back contact of relay 1911, outer left front contact of relay 1912 to conductor 1842, back contact of relay 1216, winding of relay 1215 to battery. Two revertive impulses, therefore, cause the operation of relays 1215 to 1218. With relay 1218 operated the circuit now extends over conductor 1840, bottom contacts of cam 1713, right front contact of relay 1914, conductor 1845, the back contact of relay 1202, winding of relay 1201 to battery. The following five revertive impulses cause the operation of relays 1201 to 1210, inclusive, and the operation of relay 1210 extends the counting circuit to the winding of relay 1219 so that the eighth revertive impulse causes the operation of relays 1220 and 1219, resulting in the opening of the fundamental circuit and the advance of sequence switch 1700 to position 7 where a test is made of the selected trunk outgoing to the incoming selector at the wanted office.

Until the impulser switch 2300 has completed sending code impulses to the tape register, ground is connected over conductor 753, the left contacts of cam 1705, the inner right front contact and winding of relay 1228, thus holding relays 1228 and 1227 operated, relay 1227 holding the circuit of relay 1226 open. Relay 1226 being released, holds the fundamental circuit open to prevent trunk test from being made. As soon, however, as switch 2300 completes the transmission of code impulses and relay 2306 releases, the locking circuit of relay 1228 is opened, in turn releasing relay 1227 and permitting relay 1226 to reoperate and close the fundamental circuit.

As soon as sequence switch 1700 left position 3, after district brush selection, the locking circuit for the relays of registers 1810 and 1900 was opened at the right upper contact of cam 1704 and relays 1901, 1902 and 1812 released. When sequence switch 1700 reaches position 7 a circuit is closed extending from battery over the inner left back contact of relay 1804, conductor 1850, through the winding of relay 1501, conductor 1511, right contacts of cam 1715, conductor 1732 and thence over the inner left front contact of relay 1001 to grounded conductor 1317. Therefore, relay 1501 can not operate until the thousands digit has been recorded as indicated by the operation of relay 1001. Relay 1501, in operating, connects the thousands register 1000 to the district brush register 1810 which now becomes the incoming brush register. Relay 1930 is now included in this register. Since the thousands digit of the called subscriber has been assumed to be 3, relays 1004 and 1005 of register 1000 have been operated as previously described and a circuit is now closed extending from ground over the middle right contacts of relay 1004, outer right front contact of relay 1501, winding of relay 1830 to battery. A second circuit is also closed extending from ground on conductor 1732, inner right contact of relay 1005, middle right contact of relay 1501, conductor 1041, right winding of relay 1811 to battery.

In position 7 of sequence switch 1700, trunk test of the distant (or local) incoming selector is made and the trunk test circuit is the same as that traced in position 4 of switch 1700 for the office selector except that the quantity of compensating resistance included in the trunk test circuit is now controlled by relays 1923 and 1924 and the circuit, therefore, extends from the upper right contact of cam 1714 to the upper right contact of cam 1717 by way of the right front contact of relay 1924, resistance 1926 and the right back contact of relay 1923 so as to include only resistance 1926 instead of both resistances 1927 and 1926. Relays 1602 and 1506 are again operated in positions 6 and 7 to complete the testing circuit as previously traced. As before, the completion of the circuit at the incoming selector permits the operation of relay 1314, in

turn operating relay 1307 which locks to ground through the left lower contact of cam 1709 as long as sequence switch 1700 is in position 7. Relay 1307 closes a circuit extending from ground through its outer left contact, left lower and right upper contacts of cam 1706, right back contact of relay 1304 to the winding of sequence switch 1700 advancing sequence switch from position 7 to position 8. The advance of sequence switch 1700 opens the locking circuit of relay 1307 which releases. It also opens the locking circuit for the relays of registers 1820 and 1910 at the lower contact of cam 1704 causing the register relays 1912 and 1914 to release.

Incoming selections

In position 8, incoming brush selection takes places in a manner similar to the other selections, the fundamental circuit extending as for office selections except that resistance 1926 is included alone in the fundamental circuit. The counting relay circuit for this selection extends from ground through the contact of relay 1300 to conductor 1735, inner left back contact of relay 1236, upper contacts of cam 1719, left back contact of relay 1813, left back contact of relay 1812, right front contact of relay 1811 to conductor 1841, back contact of relay 1216, and thence to the winding of relay 1217. Two revertive pulses are received and the second brush set of the incoming selector is chosen, at which time relays 1216, 1217, 1219, 1220 and 1229 will have operated.

The operation of relay 1229 closes a circuit extending from ground over its front contact, right back contact of relay 1235, left contacts of cam 1718, winding of sequence switch magnet 1700 to battery, advancing the sequence switch to position 9. In position 9 a circuit is closed from battery over the back contact of relay 1804, conductor 1850, winding of relay 1502, conductor 1512, left upper and right lower contacts of cam 1721, conductor 1742, inner left front contact of relay 1911, to ground at the front contact of relay 1930. Incoming group selection is now made under the joint control of the thousands and hundreds registers 1900 and 1910 and, therefore, can be made only after the hundreds digit has been recorded as indicated by the operation of relay 1911. With relay 1502 operated, a circuit is closed from ground over the middle right front contact of relay 1502, upper right contact of cam 1701, to the winding of sequence switch magnet 1700, advancing the sequence switch to position 10 in preparation for making incoming group selection. Relay 1502 also connects the hundreds register 1910 with office brush register 1820 which now becomes the final brush register and with relay 1901 the district group register 900 now becomes the incoming group register. Under the assumption that the called subscriber's called number contains the hundred's digit 6, relays 1914 and 1917 are to be operated. A circuit is now closed extending from ground at the right contact of relay 1914, outer right front contact of relay 1502, conductor 1031, right winding of relay 1821 to battery. A circuit is also closed from ground over the right inner contact of relay 1917, inner right contact of relay 1502, conductor 1081, right winding of relay 1901 to battery. Since relay 1830 was operated, a circuit is closed extending from ground through the left middle contacts of relay 1501, right front contacts of relay 1830, right back contacts of relay 1813, right winding of relay 1902 to battery.

With the sequence switch 1700 in position 10, the fundamental circuit is established for incoming group selection and is the same as that for incoming brush selection. The counting relay circuit extends as for incoming brush selection to the right lower contact of cam 1719, and thence over right front contact of relay 1901, right front contact of relay 1902, conductor 1843, back contact of relay 1214 to the winding of relay 1213 and battery. Therefore, four revertive impulses are required to satisfy the sender and the fourth group of final selectors is selected. The incoming selector hunts for an idle final selector in the usual manner and extends the fundamental circuit to the line relay of the final selector. The operation of relay 1229 advances sequence switch 1700 to position 11. When sequence switch 1700 leaves position 10, relay 1501 releases since its circuit is opened at the right upper contact of cam 1715. With the release of relay 1501, the relays of register 1810 release.

Final selections

In position 11 of switch 1700 the fundamental tip is connected to the fundamental ring to dissipate any charge due to cable capacity which may have accumulated on the cable before starting final selections. The circuit for this purpose extends from conductor 748 to the back contact of relay 1804, through resistance 1725, left lower and right upper contacts of cam 1703, resistance 1726, right back contact of relay 1231 to conductor 747. Since relay 1502 is operated, sequence switch 1700 is immediately advanced to position 12 in a circuit extending from ground on the right middle contacts of relay 1502, right upper contact of cam 1701, winding of magnet 1700 to battery. The fundamental circuit is now reclosed for final brush selection. The counting relay circuit for final brush selection extends from ground over the right contacts of cam 1708, conductor 1730, front contact of relay 1300, conductor 1320, right contacts of cam 1707, conductor 1735, inner left back contact of relay 1236, upper right and lower left contacts of cam 1719, front contact of relay 1821, back contact of relay 1822, conductor 1841, to the winding of relay 1217 so that the second brush set of the final selector is taken for use. As before, the operation of relay 1229 advances sequence switch 1700 to position 13. The advance of the sequence switch releases relay 1502 and the relays of registers 1820 and 1900.

In position 13 a circuit is closed extending from battery over the back contact of relay 1804, conductor 1850, through the winding of relay 1503, conductor 1513, left contacts of cam 1715, conductor 1743, inner front contact of relay 1021 to ground at the front contact of relay 1030. Relay 1503 operates and connects the tens register 1020 with the relays of register 1910 which now becomes the final tens register. Since relays 1025 and 1027 are operated for the tens digit 7, circuits are closed from ground over the right contact of relay 1025, inner left contact of relay 1503, conductor 1052, winding of relay 1912 to battery, and from ground over the inner right contact of relay 1027, outer right contact of relay 1503, conductor 1054, winding of relay 1914, to battery. Relay 1503 also connects ground to the winding of magnet 1700 advancing the sequence switch to position 14 in which position final tens selection is made. The counting relay circuit for final tens selection may be traced over the contact of relay 1300 to conductor 1735, inner left back contact of relay 1236, upper right

contact of cam 1719, lower right contact of cam 1720, back contact of relay 1911, left front contact of relay 1912, conductor 1842, back contact of relay 1216, winding of relay 1215 to battery. Two revertive impulses operate relays 1215 to 1218 when the circuit is extended over the front contact of relay 1218, conductor 1840, bottom contacts of cam 1713, front contacts of relay 1914, conductor 1845, back contact of relay 1202, winding of relay 1201 to battery. Five more impulses operate relays 1201 to 1210, inclusive, when the circuit is extended to relay 1219. Therefore, eight revertive impulses are necessary to satisfy the setting of the sender. The operation of relay 1229 advances sequence switch 1700 to position 15, releasing relay 1503 and relays 1912 and 1914 of register 1910.

In position 15 a circuit is closed extending from battery over the left inner back contacts of relay 1804, conductor 1850, the winding of relay 1601, conductor 1604, left lower and right upper contacts of cam 1721, conductor 1744, inner right front contact of relay 1101, to ground at the front contact of relay 1030. Therefore, relay 1601 can only operate after the units digit has been completely recorded. Relay 1601 connects the units register 1100 with the relays of registers 1900, which now serve as the final units register. Since the units digit has been assumed to be 8, relays 1104, 1105 and 1107 will have been operated. Consequently, circuits are closed from ground over the right contact of relay 1104, inner left contact of relay 1601, conductor 1881, winding of relay 1901 to battery; from ground over the right contact of relay 1105, outer left contact of relay 1601, conductor 1882, winding of relay 1902 to battery, and from ground over the outer right front contact of relay 1107, middle right contact of relay 1601, conductor 1884, right winding of relay 1904 to battery. Relay 1601 also closes a circuit from ground on conductor 1238, right outer contacts of relay 1601, outer right contact over the upper right contact of cam 1701, through the winding of sequence switch magnet 1700, advancing the sequence switch to position 16 in which position the fundamental circuit is reestablished for making final units selection. With relays 1901 and 1902 operated, the counting relay circuit extends from the contacts of relay 1300 to conductor 1735 as previously traced, left middle back contacts of relay 1236, right contacts of cam 1719, front contact of relay 1901, front contact of relay 1902, conductor 1843, back contact of relay 1214, winding of relay 1213 to battery. Three revertive impulses operate relays 1213 to 1218 when the circuit is extended over front contact of relay 1218, conductor 1840, upper right contact of cam 1713, front contact of relay 1904, conductor 1845 to the winding of relay 1201. Five more revertive impulses result in the operation of relays 1201 to 1210, inclusive, while the ninth revertive impulse operates relays 1219, 1220 and 1229. In position 16 of sequence switch 1700, the operation of relay 1229 causes the operation of relay 1228 in a circuit extending from ground on the front contacts of relay 1229, back contacts of relay 1235, left lower and right upper contacts of cam 1716, winding of relay 1228 to battery. Relay 1228 operates and closes a circuit for relay 1227 which also operates to release relay 1226. The counting relays now release as previously described. With relay 1229 released and relay 1228 operated, sequence switch 1700 is advanced to position 17 releasing relay 1601 and relays 1901, 1902 and 1904 of register 1900. In position 17 the fundamental circuit is reestablished for receiving reversed battery from the incoming selector as soon as relay 1226 reoperates following the reclosure of the back contact of relay 1227.

After the wanted line has been found, the incoming selector is advanced to a position in which reverse battery is connected to the fundamental circuit. Therefore, relays 1300 and 1225 are both operated at this time. Relay 1225, in operating, closes a circuit extending from ground at its contact, left contacts of cam 1711, through the left winding of relay 1225 to battery holding the relay operated. It also closes a circuit over the lower contacts of cam 1711, winding of relay 1235 to battery. With relay 1235 operated, the operation of relay 1300 closes a circuit extending from ground over its front contact to conductor 1735 as previously traced, inner left front contact of relay 1235, winding of relays 1218, 1220 and 1229 to battery on the winding of relay 1219. Relay 1219 operates and locks as before described but relays 1220 and 1229 remain short-circuited from ground on cam 1716 and right upper contact thereof, right back contacts of relay 1232, left outer contacts of relay 1235 to the other side of the windings of relays 1220 and 1229 in parallel. A relay in the incoming selector also operates over the fundamental circuit and advances the incoming selector to a position where the reverse battery is removed, at which time the fundamental circuit is opened. Relay 1300 releases and the short circuit is removed from relays 1220 and 1229 allowing both of these relays to operate in series with relay 1219. Relay 1225 is locked, holding relay 1235 operated. Relay 1229 closes a circuit from ground over its front contact, right front contact of relay 1235, winding of relay 1231 to battery. Relay 1231 operates, locking over its inner left contact to grounded conductor 1238. Relay 1231 opens the fundamental ring conductor at its right contact. Relay 1229 also closes a circuit from ground at its front contact, over the right front contact of relay 1235, lower contacts of cam 1712, top contacts of cam 816 of switch 800 which has been advanced to position 15, as described in the above mentioned patent to Raymond-Scully, winding of relay 1232 to battery. Relay 1232, in operating, closes a circuit from battery through the winding of relay 1228, right front contact of relay 1232, upper right contact of cam 1716 to ground. Relay 1228 locks over the left lower and upper right contacts of cam 1705, inner right front contact and winding of relay 1228 to battery. It further operates relay 1227 and releases relays 1226, 1219, 1220 and 1229. When relay 1229 releases it closes a circuit extending from ground over its back contact, front contact of relay 1228, cam 1701 to magnet 1700, advancing the sequence switch to position 18. Relays 1225 and 1235 now release, relay 1231 remaining locked and holding relay 1232 operated. Relay 1228 also releases, reclosing the circuit of relay 1226 over the right lower contact of cam 1716 to ground.

The operation of relay 1232 opens the shunt around the high resistance winding of relay 1306, including this resistance in the circuit of relay 229 at the district selector. Relay 229 can not remain operated in series with this resistance and therefore releases, in turn releasing relay 225 which advances sequence switch 200 from position 10 to position 11. In position 11 a circuit is closed for relay 2412 extending from battery through the winding of said relay, right lower and left upper contacts of cam 293 to ground. Relay

2412 operates and locks over its lower contact, lower contacts of relay 2413, left contacts of cam 203 to ground. Relay 2412 in operating, partially prepares a circuit to reseize the tape register as more completely described hereinafter. A circuit is now provided extending from ground on the right contact of cam 255, right lower contact of cam 209, left back contacts of relay 225, top contacts of cam 219, winding of sequence switch magnet 200 to battery. The magnet operates and advances the switch to position 12. Before the switch leaves position 11, however, a circuit is also closed from ground on the right upper contact of cam 255, left upper contact of cam 212, left contacts of cam 211, winding of relay 229 to battery. Also, in position 11 ground is applied to conductor 245 through the left upper contact to cam 212 to conductor 245 for advancing the sender, as described hereinafter, before battery through relay 229 is disconnected from said conductor.

Now if the calling subscriber still has the receiver off the switchhook, relay 231 is held operated in the dialing circuit previously traced and a second circuit is closed for relay 229 through resistance 259, front contact of relay 231, left upper contact of cam 217, to ground on the right upper contact of cam 255 over which it is held operated through position 17 of the sequence switch 200 under the control of the calling subscriber. A circuit is also closed from ground over the right contacts of cam 255 top contacts of cam 215, left lower contact of cam 224, winding of switch magnet 200 to battery, operating said magnet and advancing switch 200 to position 12. When the sequence switch leaves position 11, relay 229 is disconnected from conductor 245.

In the sender the disconnection of battery from conductor 245 opens the circuit of relay 1306 which releases, in turn releasing relay 1234. With relay 1234 released, a circuit is closed from ground over its outer right back contact, left contact of relay 1233, winding of relay 1305 to battery. Relay 1305 operates and locks over its outer right front contact to conductor 745 which is now grounded through the left upper contact of cam 212. It also connects ground through its left inner contact in shunt of battery through resistance 1304 so that relay 1233 also releases.

Talking selection

With relay 1234 released, the circuit for making talking selection is completed as follows: Battery through the right winding of relay 225, left lower contact of cam 210, left upper contact of cam 213, conductor 248, through the link circuit to conductor 748, front contact of relay 723, right contacts of cam 1722, winding of relay 1300, right winding of relay 1225, back contact of relay 1220, front contact of relay 1226, resistance 1230, inner right back contact of relay 1234 to ground. Relay 1300 closes a counting relay circuit from ground as previously traced to the left contact of cam 1720, right upper contact of said cam, right inner back contact of relay 1224, front contact of relay 1310, front contact of relay 1321, conductor 1841, lower back contact of relay 1218, winding of relay 1217 to battery. Relay 225, in operating, closes a circuit from battery through the winding of sequence switch magnet 200, left lower contact of cam 224, left front contact of relay 225, right lower contact of cam 209, to ground on the right upper contact of cam 255. As sequence switch 200 advances out of position 12 through positions 12⅜ and 13⅜ ground is connected over the upper contacts of cam 221, left upper contact of cam 210 left upper contact of cam 213, to conductor 248 in shunt of the winding of relay 1300. Relay 1300 releases twice thereby permitting relays 1217, 1218, 1219, 1220 and 1229 to operate. Relay 1220 opens the operating circuit for relay 225 which now releases, holding sequence switch 200 in position 14 in which a charge is made.

When sequence switch 200 advanced beyond position 11¼ the dialing circuit was opened at cams 201 and 202, and in position 11½ the calling subscriber's talking circuit is completed from ground through the upper left winding of repeating coil 234, upper contacts of cam 201, top outer contact of relay 254, brush 111 and cooperating terminal, subscriber's loop, brush 112 and cooperating terminal, top inner contact of relay 254, winding of relay 231, bottom contacts of cam 202, left lower winding of repeating coil 234 to battery. The cutting between the left upper and right lower contacts of cam 202 overlaps sufficiently to prevent the release of relay 231. The opening of the dialing circuit releases relay 724 which, in turn, releases relays 716, 713, 714 and 715.

The operation of relay 1229 as described, closes a circuit extending from ground over the front contact of relay 1229, back contact of relay 1235, bottom contacts of cam 1718, winding of relay 1237 to battery. As an emergency means of clearing out the link and sender in case relay 1229 fails to operate relay 1237, as for instance, on an abandoned call or the failure of the sender to count impulses in talking selection, the latter relay is operated over the fundamental ring conductor 247 when the district reaches position 18 over a circuit extending from ground on cam 255, bottom left and contact of cam 209, middle bottom contacts of relay 226, left back contact of relay 225, right contacts of cam 219, conductor 247, through the link circuit to conductor 747, left back contacts of relay 1234, top contacts of cam 1723, winding of relay 1237 to battery. The operation of relay 1237 opens the circuit of relay 1301, connects battery through the resistance 1302 over the inner right front contact of relay 1305 to conductor 745. The connection of battery to conductor 745 reverses the direction of current flow through the upper winding of relay 424 so that the relay now operates, closing a circuit from ground over its lower front contact, lower contacts of cam 624, upper winding of relay 422 to battery. Relay 422 operates and locks in a circuit from battery through its upper winding and upper front contact to ground over the lower contacts of cam 625. Relay 422 further closes a circuit from ground at the lower back contact of relay 426, inner lower front contact of relay 422, right contacts of cam 623 to the winding of sequence switch magnet 600 and battery, advancing sequence switch 600 to position 6. In this position conductors 743, 744, 746, 747 and 748 are all disconnected from the corresponding conductors of the district selector, the connection of conductor 745 being maintained at the top contacts of cam 621 until the sequence switch moves out of position 5½, at which time relay 424 releases. In position 6, the locking circuit of relay 422 is held closed if the sender selector is within predetermined distance of the top of its bank. This is determined by the use of commutator segments 463 and 464. Segment 464 extends over

the top ten terminals and segment 463 over the next ten terminals, so that, according as segment 463 alone or both 463 and 464 are used, the locking circuit of relay 422 is maintained over the right contact of cam 615 if the sender selector is engaging one of the top ten or one of the top twenty terminals. With relay 422 held operated in position 6, a circuit is closed from battery through resistance 421, winding of relay 420, upper left and lower right contacts of cam 618, outer lower front contact of relay 422, lower left and upper right contacts of cam 618 to ground. Relay 420 closes a circuit from battery through the winding of down-drive magnet 466, upper contacts of cam 611, lowermost front contact of relay 420 to ground. The sender selector is thereby driven to its lowermost position where a circuit is closed from ground over commutator strip 460, brushes 459 and 458, commutator segment 461, lower contacts of cam 616 to resistance 421 in shunt of the winding of relay 420, releasing that relay and opening the circuit of the down-drive magnet 466, leaving the sender selector in the lowermost position ready to hunt for another sender. As soon as brush 458 leaves segments 464 and 463, relay 422 releases. If the sender selector is engaged in any set of terminals below the eightieth, relay 422 releases when switch 600 leaves position 5½ and the sender selector remains in engagement with the set of terminals last used.

When relay 422 falls back, the magnet of sequence switch 600 is energized over the upper left contact of cam 613, lower back contact of relay 422, lower left and upper right contacts of cam 618 to ground advancing sequence switch 600 to position 7. In this position, the link is ready to associate itself with another idle district. When a district is ready for association with a link circuit, its sequence switch is advanced to position 1 and a circuit is closed similar to that traceable from ground over the upper contacts of cam 212, left upper and right lower contacts of cam 211, contacts of jack 230, conductor 249, contacts of jack 622, contacts of jack 614, lower contacts of cam 618, upper back contact of relay 424, lower left and upper right contacts of cam 618 through the winding of relay 423 to battery. Relay 423 operates and closes a circuit from battery through the upper winding of relay 422 to ground on the back contacts of relay 424 and also closes a circuit from battery through the middle winding of relay 424, left contacts of cam 624, lower winding of relay 424, to ground at the front contact of relay 423. At the same time, a circuit is closed from ground at the inner upper front contacts of relay 423, through the lower winding of relay 424, lower left and upper right contacts of cam 624, upper winding of relay 424, back contact of relay 420, upper left and lower right contacts of cam 626, contacts of jack 614 to brush 464 to test for a district selector at the waiting link condition. With relay 422 operated, the circuit of the up-drive magnet 413 of the district finder is closed in a path extending over the lower left and upper right contacts of cam 623, inner lower front contact of relay 422 to ground at the lower back contact of relay 420. In position 1 of the district selector sequence switch 280, battery through a predetermined resistance is connected to the terminal to which brush 464 has access over a circuit similar to that traceable from battery, through resistance 241, right contacts of cam 216, contacts of jack 230 and conductor 246. When the district finder reaches a set of terminals marked in this manner relay 424 operates, releasing relay 422 and thus opening the circuit of up-drive magnet 413.

If the district finder 400 reaches the top of its bank without finding a district ready for association with the link, a circuit is closed from ground over commutator strip 410, brushes 409 and 408, commutator segment 415, lower left and upper right contacts of cam 610, winding of relay 420, resistance 421 to battery. Relay 420 operates and locks over its inner lower contacts and upper left and lower right contacts of cam 625. The district finder is restored to normal in this circuit since a circuit for the down-drive magnet 414 is now closed extending from ground on the bottom outer front contacts of relay 420, left right and left lower contacts of cam 611, winding of magnet 414 to battery. Relay 420 also opens the testing circuit extending to brush 464 to prevent the false operation of relay 424. When the finder has reached normal, ground is connected over segments 410 and 411, and brushes 408 and 409, upper right and lower left contacts of cam 616, through resistance 421, shunting and releasing relay 420 which restores the testing circuit as well as the circuit of up-drive magnet 413 after which the hunt for a district selector continues.

When a district is found standing in position 1, relay 424 operates, opening the circuit of relay 423 which now releases and closes a circuit extending from battery through sequence switch magnet 600, lower left contact of cam 613, contacts of jack 607, lower back contact of relay 423, upper front contact of relay 424, lower contacts of cam 618, contact of jack 614, contact of jack 622 to ground over conductor 249. Sequence switch 600 is advanced to position 8 in this circuit. In this position relay 424 remains locked under the control of battery from the district selector. In position 8 a circuit is closed extending from ground over the upper right and lower left contacts of cam 618, upper front contact of relay 424, left contacts of cam 608, brush 401, to the tip conductor of the district selector engaged by finder 400 when the circuit is similar to that traceable over conductor 243, lower left contact of cam 213, lower left contact of cam 210, right winding of relay 225 to battery. This relay operates and locks over its right outer front contact and top contacts of cam 221 to ground and advances sequence switch 200 to position 2. As the sequence switch leaves position 1, relay 225 releases and the sequence switch comes to rest in position 2. The advance of switch 200 out of position 1 disconnects battery from conductor 246 thus permitting relay 424 to release and close a circuit from battery through sequence switch magnet 600, upper right contact of cam 613, back contact of relay 424, lower left and upper right contacts of cam 618 to ground, advancing the sequence switch to position 9. The link remains in this position until the link next to it in the chain has been taken for use and advanced to position 2. Assuming that the link represented by cams 631 to 636, inclusive, is the next link, then, when this link reaches position 2, a circuit is closed extending from ground over the left contacts of cam 635, right contacts of cam 636, contacts of jack 607, left contacts of cam 606, right contacts of cam 605 to the winding of sequence switch magnet 600, advancing the sequence switch to position 10 which is the equivalent of position 1 and making this link ready for use in connection

with the next incoming call in this group of lines.

Returning now to the sender, the disconnection by the link of the conductors extending to the district selector results in the release of relay 1305. When relay 1305 releases, as well as relay 714 as above described, a circuit is closed from battery through the winding of sequence switch magnet 1700, lower right contact of cam 1701, lower back contacts of relay 714, back contacts of relay 1233, back contacts of relay 1305 to ground. Sequence switch 1700 advances in this circuit to position 1 thereby disconnecting battery at cam 1724 from the various conductors associated therewith, and disconnecting ground at cam 1716 from conductor 1238, which in turn releases relay 1303. With sequence switch 1700 in position 1, a circuit is closed for returning sequence switch 2000 to position 1 if it should be off-normal. The disconnection of ground from conductor 1238 releases relay 826 which controls the time measure switch 800, thereby closing a circuit from ground at its back contact, lower left contact of cam 808, lower right contact of cam 802, left winding of relay 827 to battery. Relay 827 closes a circuit for advancing sequence switch 800 which is maintained until sequence switch 800 reaches position 1 at which time relay 827 also releases and brings the time measure switch to rest, thereby restoring all parts of the sender to normal including the switch TM.

In the district selector, when the sequence switch 200 comes to rest in the talking position selector, that is, in positionn 14, the outgoing end of the talking circuit is established from tip brush 2423, top contacts of cam 204, right upper winding of repeating coil 234, left contacts of cam 203, winding of relay 233, right lower winding of repeating coil 234, bottom contacts of cam 205, to the ring brush 2411.

Sequence switch 800 and the apparatus of Fig. 8 serve to time the various stages of the operation of the sender and to control the restoration thereof if it fails to function properly. It will be remembered that when ground was connected to conductor 1238, relay 826 operated over contacts of cam 812 and locked to conductor 1238 independent of cam 812. Relay 826 closes a circuit extending from grounded conductor 1238 over the middle contact of relay 826, lower right contact of cam 808, lower right contact of cam 802, to the left winding of relay 827 and battery. Relay 827 operates, connecting ground to the winding of sequence switch magnet 800, advancing the sequence switch from position 1. In position 2, relay 827 releases and the sequence switch comes to rest. In position 2 the timing operation is started. An interval of twenty-seven to fifty-seven seconds is measured by interrupter 821 in positions 2 and 3 for the registration of the first digit. On the first closure of the interrupter, after the switch reaches position 2, a circuit is closed for relay 828 extending from battery through the winding of said relay, left lower and right upper contacts of cam 815, interrupter 821, ground on the right contacts of relay 827. Relay 828 operates and closes a locking circuit through the right winding of relay 827 but this relay does not operate at this time due to ground from interrupter 821 being connected to the other side of its winding. When the interrupter gets to an insulating segment, the shunt is removed causing relay 827 to operate in series with relay 828 and close an obvious circuit to the winding of switch magnet 800, advancing the switch to position 3.

If a call progresses normally, the operation of relay 901 to indicate that the first digit has been dialed, closes a circuit from battery, through the left winding of relay 827, lower contacts of cam 801, right front contact of relay 901 to grounded conductor 1238. Relay 827 advances sequence switch 800 to position 4 and releases. When the units digit has been recorded, a circuit is closed from battery through the left winding of relay 827, bottom contacts of cam 802, conductor 1743, left front contact of relay 1101, inner left front contact of relay 1021 to ground at the left contact of relay 1030. If the call has been for an operator, reached by dialing either zero, or a three-digit code as described hereinafter, relay 1803 will have been operated from the decoder and the circuit above traced will extend from the lower contact of cam 802, conductor 1743, over the inner left front contact of relay 1803 to grounded conductor 750. Relay 827 advances switch 800 to position 7 when either of these circuits is closed.

The units digit having been dialed in the time allowed, then if there is any reason to expect that a station's or a fifth digit will be dialed, an interval of about four seconds is measured by interrupter 820 in positions 7 to 10. The operation of advancing switch 800 through these positions is the same as above described. When the switch is advanced by position 10 the operating path of relay 1112 is opened at the right lower contact of cam 816 thus preventing any registration, false or otherwise, on the station's register relays 1110 afterwards. If another digit is dialed before the switch advances to position 10, the operation of relay 1111 operates relay 827 over a circuit extending from battery through the left winding of said relay, right lower contacts of cam 802, left upper contacts of cam 808, inner left contacts of relay 1111 to ground as previously traced.

Should the dialing of the fifth numerical or station's digit start while the switch is in position 10, the release of relay 716 and the operation of relay 718 extends ground over the bottom contacts of relay 716, front contacts of relay 718, right contacts of cam 815, winding of relay 828 to battery, operating this relay and connecting ground to one side of the winding of relay 827 so that, on the opening of interrupter 820, relay 827 will not operate to advance the switch. When relay 720 reoperates after the completion of the dial pulses, ground is connected over the top front contacts of relay 720, left contacts of relay 1111 to the winding of relay 827 as previously traced, causing said relay to operate and close the circuit of magnet 800 to advance the switch to position 11.

A local circuit for relay 827 is now closed between positions 11 to 14, inclusive, extending from ground on the left contacts of cam 807, left winding of relay 827 to battery operating said relay which, in turn, closes a circuit for magnet 800, operating said magnet and advancing the switch to position 15.

From position 15 onward, intervals are measured by interrupter 821 for the sender to complete its work and be released. For any call routed through a distant office selector, the interval is measured in positions 15, 16 and 17 and varies from sixty to ninety seconds. For any other call, the interval is from thirty to sixty seconds except that on calls to a distant man-

ual office requiring the transmission of the impulse codes of the wanted number, if position 17 is not reached before trunk test is completed, switch 800 is turned through position 17 to allow an extra thirty seconds for the operator to assign the trunk.

On the first cycle of interrupter 821, after the switch reaches position 15, relays 827 and 828 operate in the described manner and advance switch 800 to position 16. On the second cycle it is advanced to position 17. If the call is to be completed to a mechanical office and through a two-wire office selector, then relays 1223 and 1322 are both normal, whereupon a circuit is completed for relay 827 extending from ground through the right back contacts of relay 1223, left back contacts of relay 1322, right upper contact of cam 808 and thence as previously traced to the left winding of relay 827, causing thereby the advance of the switch to position 18. If either of them is operated, relays 827 and 828 operate on the third cycle of the interrupter and advance the switch to position 18. The switch stops in 18 and a flashing lamp signal (not shown) is given to the monitor operator to indicate that the sender has not cleared out in the prescribed time.

Such, in brief, is the description of the operation of the time measure switch 800. The operation of relays 835, 836 and 838 which function upon operating irregularities of the sender is herein omitted for brevity together with circuits and apparatus for making coin test when the sender is used to extend connections originating from coin lines. These operations are amply described in the Raymond-Scully patent mentioned above and since they do not form a part of this invention, reference is made thereto for more extended descriptions.

Recording response of called subscriber

In the meantime, the incoming selector connects ringing current in the known manner to the called subscriber's line and when that subscriber responds, the current flowing through relay 233 is reversed so that relay 233 operates and closes a circuit extending from ground on the right upper contact of cam 255, right upper contact of cam 209, front contact of relay 233, left contacts of cam 220, bottom contact of interrupter 235, winding of relay 226, to battery. Relay 226 operates and locks over its bottom inner contact, right contact of cam 263, left lower contact of cam 220, front contacts of relay 233 to ground. When the interrupter 235 closes its top contact a circuit is closed from battery through the winding of relay 237, top contacts of cam 218, bottom middle front contacts of relay 226, top contacts of interrupter 235, to a previously traced ground. Relay 237 operates and locks to ground through its right inner contact, right lower contact of cam 209 to ground. The operation of relay 237 is the signal to the district, after the interval measured by the interrupter 235 to allow for line disturbance, that the called subscriber has answered and indicates the instance from which the conversation period is to be measured. Consequently, after the operation of relay 237 it becomes necessary for the district selector again to become connected to the tape register circuit and associated tape recorder. Therefore, as soon as relay 237 operates, relay 2412 having been operated and locked as already described, a circuit is closed from ground on the right middle front contact of relay 237, left upper and right lower contacts of cam 260, top middle contacts of relay 2412, upper winding of relay 2414, back contacts of relay 2415 to battery. At the same time a parallel circuit is closed over the top inner contacts of relay 2412, lower winding of relay 2421, contacts of cam 261 to battery. Both relays operate, relay 2421 locking up in a circuit over its top winding and inner contact to the bottom outer back contact of relay 254 which is normal, while relay 2414 locks over its bottom winding and inner lower contact to the winding of relay 2415 to battery if, at this time, its locking circuit is not cut off at the back contacts of any other relay 2414 of a district selector in the group connected to the common tape register, in which event the district waits until the previous district has discharged, whereupon relay 2414 locks and relay 2415 operates as previously described. The operation of relays 2414 and 2415 now closes a circuit extending from ground on the front contact of relay 2415, lower contacts of cam 257, bottom outer contact of relay 2414, conductor 252, brush 114 and cooperating contact, inner back contact of relay 101, winding of relay 173—AA to battery. Relay 173—AA operates in preparation for perforating the calling line indication characters in advance of the code perforations of the starting time of the conversation as more completely described hereinafter.

The operation of relay 2414 again reconnects the district to the tape register and causes thereby the operation of relay 2516 in said recorder over a circuit extending from battery through the winding of relay 2516, conductor 2552, No. 1 contact-set of relay 2414, top outer contacts of relay 2412, left contacts of cam 256 to ground. Relay 2516 operates and closes a circuit for relay 2514 extending from ground over its left contacts, back contact of relay 2517 if not operated by interrupter 2506, winding of relay 2514, to battery. Relay 2516 also closes another circuit extending from ground over its right contacts, left lower contact of cam 2531, cam 2532, winding of magnet 2500 to battery. Magnet 2500 operates and advances the switch from position 1 to position 2 when the circuit is interrupted at cam 2531 causing said switch to rest in said position. When the switch reaches position 2, however, the seven punch magnet conductors 1 to 7, inclusive, are grounded, as already described when the tape register was first connected to the perforator and to the sender for recording the called line number, and the code of the "switching character" is perforated on the tape in advance of anything else. When distributor 182 of the perforator engages segment 7, the previously traced circuit is closed over the right contact of cam 2529 for advancing switch 2500 into position 3. When the switch reaches position 3 ground is connected to conductor 167 and since relay 173—AA is now operated again, as already described, the previously traced circuits for the calling line subgroup identification registers in Fig. 1 are closed causing thereby the punching of the line subgroup character code immediately after that of the switching character code. The distributor 182 again closes the circuit over the right contact of cam 2529 advancing switch 2500 into position 4. Conductor 168 is now grounded and the previously traced circuits for the registers of Fig. 1 identifying the particular line in the subgroup are closed, causing thereby the punching of the remainder of the line identification code. Distributor 182 again closes the circuit

over the right contact of cam 2529 for advancing switch 2500 into position 5. In this way, the line designation character codes are used to identify the codes which follow recorded thereon as belonging to the line with other codes which may have been recorded previously in connection with the same line. As the switch passes into position 5 the circuit previously traced from the right contacts of relay 2516, over the lower left contact of cam 2531 is again effective to advance switch 2500 into position 16. When the sequence switch 2500 reaches position 16, the tape register is ready to record upon the tape the start of the conversation time. This is done as follows:

It will be observed from Fig. 25 that the circuit of relay 2517 is constantly interrupted over an operating circuit from interrupter 2506 which makes its contact every six seconds. When the tape register circuit is disconnected from any district, the operation of relay 2517 causes a circuit to be closed extending from ground on its middle contact, bottom contacts of relay 2514, bottom back contact of relay 2520, conductor 2554, winding of rotary magnet 2638 of the stepping switch 2640 to battery. This switch is of the well known step-by-step type structure used in machine switching telephony and comprises two arcs with separate cooperating brushes 2603 and 2632. Every six seconds therefore, magnet 2638 operates and advances the brushes one terminal. Since the switch takes but one step every six seconds it is clear that the brushes, in advancing from one terminal to the next, count off one-tenth of a minute. But since, due to the construction of the switch arcs but ten terminals are provided therein, it is also evident that when the brushes have taken ten steps or made one complete circuit of the arc, sixty seconds or one minute will have been counted off. Hence at the end of the minute, and on the next closure of the relay 2517 thereafter, that is, when brush 2603 is in contact with the tenth terminal of the arc, a circuit is closed for rotary magnet 2638 in the usual way but another circuit is also closed extending from ground on the brush 2632 and cooperating contact, to the winding of rotary magnet 2637 of switch 2610. This switch is of similar construction to switch 2640 and, at the termination of the interrupter pulse, will have advanced its brushes 2602 and 2606 one terminal while, at the same time, the release of magnet 2638 causes the brushes of the associated switch 2640 to make contact again with the first terminal of their respective arcs. Thus for every half revolution of the brushes of switch 2640, a rotation of whose brushes over the entire arc measures one minute, causes the minute switch 2610 to advance its brushes one terminal and thereby register one minute. Since the minute switch 2610 also has ten terminals on each of its arcs, a complete rotation of its brushes around their respective arcs is equivalent to measuring ten minutes. After the ten-minute interval has terminated and the brushes of switch 2610 are again on their tenth terminal, with the brushes of switch 2640 also on their normal terminal, the next closure of relay 2517 causes the operation of magnet 2638 as already described, and another circuit is also closed for switch magnet 2637 as already described, while the fact that switch brush 2606 of switch 2610 is resting on its normal terminal causes another circuit to be closed extending from ground on brush 2606 and cooperating terminal, winding of rotary magnet 2636 of switch 2600 to battery. Switch 2600 is similar in construction to switches 2610 and 2640, has two arcs of ten terminals each with cooperating brushes and advances the brushes one terminal over their respective arcs for every half revolution of the brushes 2602 and 2606 of switch 2610. These three switches comprise the timing register and, together, are capable of measuring of one hundred and eleven minutes, one hundred minutes being recorded by switch 2600, ten minutes by switch 2610 and one minute by switch 2640. These timing operations continue regardless of whether the tape register circuit is being engaged or idle so that, at the moment of its seizure for recording the start of conversation time, each of the brushes of each of the above switches will be on some one terminal of their respective arcs and the beginning of the conversation will be recorded in terms of the particular terminals on which brushes 2605, 2602 and 2601 will be standing at the time the tape register is connected to the district selector.

Consequently when the tape register circuit is seized by the operation of relay 2516, which indicates that the beginning of conversation time is to be recorded for some district selector, then, at the instant when relay 2517 is normal, a circuit is closed from ground on the left contacts of relay 2516, outer contacts of relay 2517, to the winding of relay 2514 to battery. Relay 2514 operates and locks over its No. 1 contact-set to ground through the left contacts of cam 2508. With relay 2514 operated a circuit is now closed extending from ground on the interrupter contact 2502, which contacts are closed for two-tenths of a second and open for three-tenths of a second, No. 4 contact-set of relay 2514, back contacts of relay 2527, winding of relay 2526 to battery. Relay 2526 operates and closes a locking circuit for itself through the winding of relay 2527, inner contacts of relay 2526 to ground on the No. 2 contact-set of relay 2514; relay 2527 not operating in the meanwhile as it is short-circuited by said ground and also by the ground which causes the operation of relay 2526. With relay 2526 operated, a circuit path is now partially prepared extending from ground on the No. 2 contact-set of relay 2514, right contact of relay 2527, outer contact of relay 2526, conductor 2511, to brush 2601 of the ten-minute switch 2600. Now, depending upon the terminal upon which brush 2601 is resting at the time the above path is closed, the circuit will be completed to the winding of one of the relays 2540 to 2549, inclusive, since each one of the conductors extending to a winding of one of these relays is multiplied to a corresponding terminal on the arcs of switches 2600, 2610 and 2640 with which brushes 2601, 2602 and 2603, respectively, engage; the winding of relay 2540 being connected to terminals 0 that of relay 2541 to terminals 1, etc. up to and including the winding of relay 2549 which is connected to terminals 9. For instance, if at the time the path to brush 2601 is completed, said brush is resting on terminal No. 2 of the arc of ten-minute switch 2600, then the circuit is completed to the winding of relay 2542, to battery. Relay 2542 operates and grounds conductors 11, 12, 15, 16 and 17 of the perforator, the first four being the appropriate combinations for the code of the digit 2 and the last for the operation of the start magnet 27. The code of the digit 2 is thus punched on the tape immediately following that of the calling line characters. This indicates that at the time conversation was started on the call originated by the

calling line bearing the calling line character immediatey ahead of the code perforations of the digit 2 the ten-minute switch 2600 had each of its brushes connected to terminal 2 of its respective arc. When interrupter 2502 opens its contact at the end of the two-tenths of a second interval the short-circuit around relay 2527 is removed and this relay now operates in series with relay 2526, locking to ground on the No. 2 contact-set of relay 2514 and opening the circuit of relay 2542 which, on releasing, disconnects ground from conductors 11, 12, 15, 16 and 17.

In the meanwhile it will be remembered that interrupter 2506 operates once every six seconds and, at the time the tape register is connected to the district it may be anywhere in its cycle of operation. It is important, however, that during the interval when the beginning of conversation time is being recorded on the tape, any pulse count from interrupter 2506 is preserved since, with relay 2514 operated, the circuit to magnet 2638 is opened and no movement of the switches can take place to record that count. The reason for keeping an accurate notation of all pulse counts is due to the fact that interrupter 2506 is used for measuring the interval between the beginning and end of conversations for all districts in the group for which the tape register is common. Should a pulse count equivalent to a tenth of a minute be lost, therefore, during any registration, then succeeding registrations of the termination of conversation time would be in error by a tenth of a minute. Consequently if the tape register is connected to a district when the contacts of interrupter 2506 are open, then should they close during the interval of registration and cause the operation of relay 2517, a circuit will be closed extending from ground on the middle contacts of relay 2517, bottom front contacts of relay 2514, lower winding of relay 2518, to battery. Relay 2518 operates and locks in a circuit over its upper winding and contacts to ground on the No. 2 contact-set of relay 2514. The way in which relay 2518, when operated as described, preserves the pulse count is described hereinafter.

At the next closure of interrupter 2502 a circuit is again closed extending from ground on said interrupter contacts, No. 4 contact-set of relay 2514, left front contact of relay 2524 to battery. Relay 2524 operates and closes a locking circuit for itself through the winding of relay 2525, inner contacts of relay 2524, to ground on the No. 2 contact-set of relay 2514; relay 2525 being held short-circuited in the meanwhile by ground through the contacts of relay 2524 and also by the ground through its own left back contacts. A path is now prepared extending from ground on the No. 2 contact-set of relay 2514, right contacts of relay 2525, outer contacts of relay 2524, conductor 2518 to brush 2602 and cooperating terminal of the minute switch 2610. Depending on the terminal on which brush 2602 is resting at the time the above path is closed, the circuit is further extended to the winding of any one of the relays 2540 to 2549, inclusive. If, for example, the brush is resting on terminal No. 7 then the circuit is completed through the winding of relay 2547 to battery. Relay 2547 operates and grounds the conductors 11, 12, 13, 16 and 17 to operate the magnets of the perforator for punching the code of the digit 7. When interrupter 2502 opens its contacts at the end of the two-tenths of a second interval the short circuit around relay 2525 is removed and this relay now operates in series with relay 2524 in the circuit above described. The circuit for relay 2547 is opened and the tape perforator magnets are released in preparation for punching the code of the next digit.

At the next closure of the interrupter 2502 a circuit is closed extending from contacts on said interrupter, No. 4 contact-set of relay 2514, left front contacts of relays 2527 and 2525, left back contacts of relay 2523, winding of relay 2522 to battery. Relay 2522 now operates and closes a locking circuit for itself through the winding of relay 2523, inner contact of relay 2522 to ground on the No. 2 contact-set of relay 2514, relay 2523 being short-circuited in the meanwhile by said ground and also by the ground which operated relay 2522. With the operation of relay 2522, a path is closed extending from ground on the No. 2 contact-set of relay 2514, right back contacts of relay 2523, outer contacts of relay 2522, conductor 2509, to brush 2603. Depending upon the terminal upon which said brush rests at the time the above path is closed, the circuit is completed to the winding of any one of the relays 2540 to 2549, inclusive. If, for instance, the brush is resting on the fourth terminal, the circuit is extended to the winding of relay 2544 to battery. Relay 2544 operates and grounds conductors 12, 14, 16 and 17 of the tape perforator which now operates and causes the punching on the tape of the code of the digit 4. When interrupter 2502 opens its contacts the circuit of relay 2544 is opened and the ground to the tape perforator magnet conductors is disconnected thereby, releasing said magnets in preparation for succeeding functions. The tape, therefore, has had recorded thereon the codes of the number 274 immediately following the codes of the calling line characters as an indication that the conversation time has started at the time when the tens switch 2600 was at position 2, the minute switch 2610 at position 7 and the tenths of a minute switch 2640 at position 4. This information is later utilized to compute the total conversation time as more particularly described hereinafter.

When relay 2523 operates, which is the signal that the three digits comprising the notation of the start of the conversation time have duly been recorded, a circuit is closed extending from ground on the right outer contacts of relay 2523, bottom contacts of relay 2518, conductor 2554, winding of magnet 2638 to battery, causing switch 2640 to operate and advance its brushes 2603 and 2632 one terminal in registration of the one pulse count which occurred during the registration period as above described. Another circuit is also closed extending from ground on the middle contacts of relay 2523, No. 3 contact-set of relay 2514, left lower contact of cam 2503, winding of sequence switch magnet 2500 to battery. Magnet 2500 operates and advances the switch to position 17. In position 17 a circuit is closed extending from ground on the right contacts of relay 2516, left lower contacts of cam 2531, winding of sequence switch magnet 2500 to battery. The switch magnet operates over this circuit and causes the switch to be driven back to position 1. As the switch revolves through positions 19 and 20 a circuit is closed extending from ground through the bottom contacts of cam 2504, conductor 2551, contact of cam 250, winding of relay 2413 to battery. Relay 2413 operates and, by opening its bottom contacts, causes the release of relay 2412. Relay 2412, in releasing,

opens the circuit of relay 2414 which, it will be recalled, is locked up in series with relay 2415. The release of relay 2414 opens the circuit of relay 2516 which releases and restores the tape register circuit to normal in readiness for connection with any other district which may be in a position to have information recorded therein. With the release of relay 2516 and with switch 2500 past position 17 the locking circuit of relay 2514 is now opened, causing this relay to release, in turn releasing the counting relays 2522 to 2527, inclusive, and also relay 2518. With the tape register normal, the timing relay 2517 continues to be responsive to the periodic closures of interrupter 2502.

At the end of the conversation, when the called subscriber restores his receiver to the switchhook, the direction of the current flowing through relay 233 is reversed and the relay releases, in turn releasing relay 226. When the calling subscriber restores his receiver, relay 231 releases, in turn releasing relay 229. With relay 229 released, a circuit is closed extending from ground over interrupter 236, back contact of relay 229, left lower and right upper contacts of cam 208, top winding of relay 254 to battery. Relay 254 operates and locks through its lower winding and bottom inner contact to ground over the left lower and right upper contacts of cam 255, relay 2421 not releasing in the meanwhile due to a supplementary holding path over the top back contact of relay 2413 to ground on the left contacts of cam 256. Relay 254 further disconnects the tip and ring conductors of the line-finder district selector trunk from the tip and ring brushes of the line-finder but ground through resistance 253 is still connected to brush 113 through the left middle contact of relay 237.

In positions 13 and 14 of sequence switch 200 and after relay 254 has operated, a circuit is closed extending from ground on the No. 3 contact-set of relay 254, middle contact of relay 2421, top winding of relay 2414, back contact of relay 2415 to battery. Relay 2414 now operates and locks in series with relay 2415 and reconnects the district selector to the tape register circuit if no other district is connected to it at this time. With the reclosure of the contacts of relay 2414 a circuit is now closed extending ground on the No. 2 contact-set of relay 254, upper contacts of relay 2421, No. 2 contact-set of relay 2414, conductor 2556, winding of relay 2512 to battery. Relay 2512 operates and over its inner contacts closes a circuit extending from ground, right lower contact of cam 2531, winding of switch 2500, to battery. Switch magnet 2500 operates and causes the switch to advance from position 1 to position 2. When the switch reaches position 2 the code of the switching character is punched on the tape by the perforator as already described, and then advances through positions 3 and 4 in the manner previously described for perforating the codes of the calling line characters also as previously described. When switch 2500 reaches position 5 it is advanced into position 17 over the circuit controlled by relay 2512.

The reason for recording the switching character and calling line characters at this time is, of course, the same as for recording them in advance of the registration of the called line code and the start conversation time code, that is, in order to identify the code of the information which follows with the information relating to this call already perforated upon the tape since between the last item of information so punched and that to be punched presently, the codes of various items of information belonging to calls from other lines in the group may intervene.

As soon as relay 2517 is in its normal position, a circuit is closed from ground on the outer contacts of relay 2512, inner contacts of relay 2517, winding of relay 2520 to battery. Relay 2520 operates and locks over its top inner contact to ground through the left contact of cam 2508. As soon as interrupter 2502 closes its contacts a circuit is then closed extending from ground over said contacts, No. 4 contact-set of relay 2520 to a previously traced circuit for relay 2526. Relay 2526 now operates and extends ground from the No. 2 contact-set of relay 2520 to brush 2601 as previously described in connection with the registration of the start of the conversation time. Depending, now, upon the terminal to which brush 2601 is connected, the circuit is completed to one of the relays 2540 to 2549, inclusive, as previously described. The operation of the particular relay then grounds the appropriate combination of conductors to the perforator and causes the punching of the code of the number of the terminal on which brush 2601 is connected at this time. When interrupter 2502 opens its contacts, relay 2523 operates as previously described, opening the circuit of the relay of the groups 2540 to 2549, causing the release of the operated perforator magnets.

In the same way, on the second closure of the interrupter 2502, a circuit is completed for relay 2524 and the ground is then extended to brush 2602 over a previously described path, and from brush 2602 the circuit is completed to one of the relays 2540 to 2549, inclusive, depending upon the terminal to which brush 2602 is connected. The operation of one of said relays grounds conductors connected to the windings of the tape perforator magnets to cause thereby the punching of the code of the digit number of the terminal upon which brush 2602 is resting. When interrupter 2502 opens its contacts, relay 2525 operates and opens the circuit of the relay of the groups 2540 to 2549 as previously described, causing the operated perforator magnets to release.

On the third closure of interrupter 2502 a previously described circuit is closed for relay 2522 which, upon operating, causes ground to be extended over a previously traced path to brush 2603. Depending upon the terminal to which said brush is connected at this time, said ground is extended to one of the relays 2540 to 2549, inclusive, and the operation of the particular relay again causes the grounding of the conductors in the combination called for by the code of the digit of the terminal to which said brush is connected, whereupon the perforator operates as described to punch said code. When the interrupter opens its contacts, relay 2523 operates as previously described and opens the circuit of the relay in the group 2540 to 2549, causing the release of the operated tape perforator magnets. It also closes a circuit extending from ground on its inner front contact, No. 3 contact-set of relay 2520, left upper contact of cam 2503, winding of sequence switch magnet 2500 to battery, causing the switch to be advanced out of position 17 into position 18. In position 18 the previously traced circuit through the bottom inner contacts of relay 2512 and the lower right contacts of cam 2531 causes the switch to be advanced to position 1. As the switch passes through positions 19 and 20 a previously described circuit through the bottom contacts of cam 2504 causes the operation of re-

lay 2413 in the district which, upon operating, causes the release of relay 2421. Relay 2421, in releasing, opens the circuit of relay 2414, the release of which causes the disconnection of the district from the tape register and the release of relay 2512 therein.

The finish of the conversation time is, like the start of the conversation time, recorded on the tape by codes indicative of the position of each of the registers 2600, 2610 and 2640 which are in continual operation under the control of interrupter 2506. The manner in which both records are used for obtaining the conversation time of the call is described hereinafter in connection with the description of the computor.

The release of relay 2421 now causes a circuit to be closed extending from ground on its back contact, No. 4 contact-set of relay 256, left upper and right lower contacts of cam 223, right lower contacts of cam 224, winding of magnet 200 to battery. Magnet 200 operates and advances the switch to position 17. As the sequence switch passes through positions 15 to 17, the locking circuit of relay 237 is held closed through the right lower contact of cam 209. In position 17 a circuit is closed extending from ground on interrupter contact 236, left contacts of relay 229, bottom contacts of cam 208, winding of relay 226 to battery. Relay 226 operates and locks over its bottom inner contact, contacts of cam 263, commutator segment 141, brush 118 to ground. With relay 226 operated, a circuit is closed extending from ground on the left bottom contact of cam 209, bottom next to inner contacts of relay 226, top left contact of cam 224, winding of switch 200 to battery thereby causing the switch to advance from position 17 to position 18. In position 18 a circuit for the down-drive magnet 2422 of the district selector is closed extending from battery through the winding of said magnet, right lower and left upper contacts of cam 210, right outer back contact of relay 225, top contacts of cam 221 to ground. The operation of the down-drive magnet now causes the restoration of the two sets of district selector brushes to normal. In position 18 another circuit is closed for restoring the line-finder elevator to normal. The circuit extends from battery through the winding of the down-drive magnet 106, right lower and left upper contacts of cam 218, next to the inner contact of relay 226, lower left contact of cam 209 to ground. When the line-finder elevator restores to normal, brush 118 leaves commutator segment 141 thereby removing ground from the holding circuit of relay 226 causing it to release and, in turn, opening the circuit of the down-drive magnet 106 causing said magnet to release also. When magnet 2422 has returned the district elevator to normal, ground on brush 2409 now becomes connected to commutator segment 2431 and a circuit is thereupon closed extending from said segment, right lower contact of cam 224, winding of sequence switch magnet 200 to battery causing said switch to be restored to position 1. In position 1, battery through 270 ohms is again connected to the conductor 244 which leads to the link circuit as an indication of an idle condition and as already described.

Recording data for a toll call

Having described the formation of the perforated tape record for a call between two local subscribers, the formation of a similar tape record for a toll or long distance call which has to be established through the intervention of an operator at the toll or the recording position will now be described.

In the case of a long distance call to be made by a calling subscriber in a full mechanical office, the subscriber is usually instructed to dial a special code which, for a three-digit area, comprises a three-digit code. This code is registered in the sender in the usual way and is later translated by the decoder. As a result of the translation, the sender guides the district selector to a group of trunks extending to the recording position from which it selects an idle trunk. The operation of the sender with respect to receiving the impulses of the "long distance" code on the impulse register 700 and recording them on the impulse registers 900, 910 and 920 is the same as previously described for the dialing of the three-digit office code of an office located in the local area except that, in the case of an operator's class of call, no thousands, hundreds, tens and units digits are dialed. These operations, therefore, need not be described again. The operator's code is transferred to the decoder in the same manner as the office code digits of a local call and results in the translation of said code into the operation of a route relay which, in turn, causes the operation of a number of relays in the selection registers of the sender with which to control the selection of the proper brush in the district selector and the proper group of trunks in the district frame extending to the recording position from which the call is to be routed. In addition, the decoder also causes the operation of relay 1803 which in turn causes the operation of relay 1804. The operation of relay 1803 permits the trunk test to be made immediately without waiting for additional digits. The trunk test further causes the operation of relays 1309, 1308 and 1307 in the same manner previously described for a local call. However, relay 1307 now closes a circuit extending from ground at its left outer front contacts, left lower and upper right contacts of cam 1706, right front contact of relay 1804, back contact of relay 1802, winding of relay 1221 to battery. Relay 1221 operates and locks to grounded conductor 1238 and extends ground over its inner left contact, upper left contact of cam 1702 to the winding of sequence switch magnet 1700 and battery, advancing the sequence switch to position 10. As the sequence switch passes through position 9¾, a circuit is closed extending from battery through the winding of relay 1231, left lower and right upper contacts of cam 1712, outer left front contact of relay 1221 to grounded conductor 1238 operating relay 1231 which also locks to conductor 1238. Relay 1231 advances sequence switch 1700 to position 17 in which position relay 1232 is operated as previously described, in turn operating relay 1228 and advancing sequence switch 1700 to position 18. In this position talking selection takes place. Since this call is for an operator, neither relay 1310 nor 1321 will have been operated and the circuit controlled by relay 1300 at this time is as previously traced to the lower left contact of cam 1720, upper right contact of cam 1720, right inner back contact of relay 1224, right back contact of relay 1310, back contact of relay 1216 to the winding of relay 1215 and battery. Sequence switch 200, in advancing from position 12, closes ground in shunt of the winding of relay 1300 in positions 12⅜, 13⅜, and 14⅜ whereupon the circuit of relays 1300 and 225 is opened and sequence switch 200 is brought to rest in position 15. In this position, the incoming and outgoing

ends of the talking circuit extend as previously described to repeating coil 234, the outgoing end including the winding of polarized supervisory relay 233, but is now further extended over tip brush 2423, top back contact of relay 2800, top winding of relay 2801 of the operator's trunk to battery. On the ring side the circuit is completed through ring brush 2411, bottom contacts of relay 2800, lower winding of relay 2801 to ground. Relay 2801 operates in this circuit, but relay 233 does not. Relay 2801 now closes an obvious circuit for lamp 2802 which lights to apprise the operator that a call is waiting and further connects ground to sleeve brush 2407 to hold the district selector.

The operator, on noting the signal, answers the call by inserting the calling end of a toll cord into the trunk jack, causing the operation of cut-off relay 2800 which disconnects relay 2801 from the trunk conductors and supplies reverse talking battery to the trunk (not shown), all in the well known manner. Relay 233 now operates, closing a circuit which extends from ground over the upper right contact of cam 209, front contact of relay 233, bottom contacts of cam 220, left winding of relay 225 to battery. Relay 225 operates, closing a circuit extending from battery through the winding of sequence switch magnet 200, left lower contact of cam 224, left front contact of relay 225, right lower contact of cam 209 to ground. Sequence switch 200 is advanced to position 16 and relay 225 releases. In position 16, the talking circuit extends from tip brush 111 of the line-finder 110, top outer back contacts of relay 254, upper left and lower right contacts of cam 201 to the tip brush 2423 of the district selector, and from the ring brush 112 of the line-finder, top inner back contacts of relay 254, winding of relay 231 lower left and upper right contacts of cam 202, to the ring brush 2411 of the district selector. Battery and ground are supplied from the operator's cord so that relay 231 is held operated, in turn holding relay 229 operated. The release of the sender takes place as for other calls. Since relay 233 is not operated in positions 13 or 14, relay 237 can not operate and no charge is made.

From this point on the call is completed to the wanted subscriber in the toll or long distance area by inserting the calling end of the cord into the jack of the trunk going in the wanted direction. Since the establishment of this part of the connection is no part of the invention it is omitted for the sake of brevity. The operator further makes note of all items relating to billing information, such as the name of the city, the called office and number therein and, during the period of conversation, times the call. When the call is completed and the operator receives the disconnect signal she proceeds to record the billing information on the telegraph keyboard 2810 located at her position.

This keyboard is the ordinary telegraph typewriter equipped with a number of keys, one per character, the depression of any one of which grounds certain commutator segments in accordance with the code called for by the character of the key depressed and further closes the circuit of the start magnet 2806 for rotating the distributors 2813 and 2814 about the surface of the commutator 2812. The distributor 2814, as it advances, closes an impulse circuit whenever it comes into contact with a grounded segment, all in accordance with standard printing telegraph practice. Since the code used with this invention comprises a six-unit code, the six conductors from the segments to the individual keys are so wired that the depression of each key grounds the conductors in the required combination as called for by this code, as exemplified in the code table hereinbefore given.

As soon as the operator has received the disconnect signal and is ready to transfer the call record to the primary tape, key 2802 is depressed. A circuit is now completed extending from ground on said key, sleeve brush 2425 of the lower group of brushes on the district selector, right upper and left lower contacts of cam 260, upper winding of relay 2414, back contacts of relay 2415 to battery. If no other district at this time has its relay 2414 locked to the winding of relay 2415, the above circuit is completed in which relay 2414 operates and is later locked through the winding of relay 2415 which now operates as already described. The operation of relay 2414 closes a previously described circuit for relay 173—AA operating said relay and further connecting the district selector with the tape register circuit after which a circuit is completed extending from ground through the left lower and right upper contacts of cam 256, No. 4 contact-set of relay 2414, conductor 2553, winding of relay 2513 to battery. Relay 2513 operates and closes a circuit extending from ground through its right front contacts, left upper contact of cam 2529, winding of sequence magnet 2500 to battery causing said switch to advance from position 1 to position 2. As the switch advances through position 2 all of the conductors 1 to 7, inclusive, are grounded to cause the perforator 180 to operate and punch the switching character as already described. When distributor 182 of the perforator engages segment 7, the previously traced circuit is closed over the right contact of cam 2529 for advancing switch 2500 into position 3. With switch 2500 in position 3, and assuming that the toll call has been originated by the same subscriber's line 100 which has been considered for a local call and whose line identifying relay 173—AA has been operated, the line registers now reoperate as previously described to punch the one code which designates the calling line character subgroup. Switch 2500 is then advanced to position 4 and a second code is punched which designates the position of the line in the subgroup. Switch 2500 is then advanced into position 5. When switch 2500 reaches position 5, a circuit is closed extending from ground through the left outer contacts of relay 2513, lower left and upper right contacts of cam 2555, winding of relay 2501 to battery. Relay 2501 now closes its upper group of contacts and connects ground to conductors 11, 12, 13, 14, 16 and 17 causing thereby the operation of the perforator 182 to punch the code of the new call designation after which the switch 2500 is advanced into position 6. As the switch passes out of position 5, the circuit of relay 2501 is opened, ground is disconnected from the conductors 11, 12, 13, 14, 16 and 17 and the perforator is restored to normal. From position 6, switch 2500 is advanced into position 18 over the circuit traced from the right contact of relay 2513 and the upper left contact of cam 2529. When the switch reaches position 18, a circuit is closed extending from ground on the left inner contacts of relay 2513, conductor 2555, No. 8 contact-set of relay 2414, ring brush 2426 of the second group of brushes of the district selector, winding of relay 2803 to battery, operat-

ing this relay which then closes a local circuit to light lamp 2804. The lighting of the lamp is a signal to the operator to write up the call information on the telegraph key board. And it will be noted that the signal is furnished only after the codes of the switching character, the calling line character and the new call designation have been punched on the tape for this call.

The operator now proceeds to depress the keyboard keys in the order called for by the notations on the call ticket which may involve the name of a city, the called office in that city, the called number therein and the cost of the call in dollars and fraction thereof. It is not necessary to make an additional record of the calling number since that is already recorded in the form of the calling line characters.

Let it be assumed that the calling line is extended to the city of Chicago and to a subscriber therein identified by the exchange and number Dearborn 6927 and that the charge for the call is $8.75. The information may be recorded in any order required by the practices of the operating company but, for simplicity, it may be assumed that the name of the city will be transmitted first, the exchange next, the number thereafter and the cost last. The name of the city may be recorded either in toto, or by abbreviation. If it is assumed that the entire name is to be recorded then the operator will depress the required keys of transmitter 2810 in the order of succession necessitated by the letters C—H—I—C—A—G—O. On the depression of the key for the letter C, segments 2, 3 and 4 of commutator 2812 are grounded in accordance with the code of the letter C and the circuit of the start magnet 2806 is closed in the known manner. The operation of the start magnet unlatches the distributors 2813 and 2814 which now revolve around the commutator drum. As soon as distributor 2813 leaves the first segments 2807 the circuit of the magnet 2806 is opened so that when both distributors reach their normal position, the distributor 2813 is again latched to arrest any further rotation. When the distributor 2814 reaches segment 2808, the circuit of relay 115 of the receiver 170 is closed from ground through the segment 2808 and distributor 2814, continuous segment 2809, conductor 2811, tip brush 2427 of the lower pair of brushes on the district selector, No. 7 contact-set of relay 2414, conductor 2428, winding of relay 115 to battery. Relay 115 operates and closes the circuit of start magnet 116 of the receiver 170 from ground over its outer contacts, the normal segments of the receiver commutator through the winding of magnet 116 to battery. Start magnet 116, on operating releases the distributor 107 and causes it to make one revolution around the face of the associated commutator. The ground through the outer contacts of relay 115 is further extended over conductor 17 through winding of magnet 27 of the perforator 180 causing said magnet to operate which, in turn, unlatches its own distributor 182 for one revolution around its commutator. As soon as distributor 2814 of transmitter 2810 leaves segment 2808, relay 115 releases and with distributor 107 now off normal, magnets 116 and 27 release and the receiver 170 and perforator 180 will therefore stop after distributors 107 and 182 have made one revolution. The separate motors which drive the distributors of the transmitter 2810 of the receiver 170 and of the perforator 180 are all in synchronism so that said distributors all reach corresponding segments at the same time. Hence, when the distributor 2814 of the transmitter 2810 has reached segment 2, the distributor 107 of receiver 170 has likewise reached segment 2 and so will the distributor 182 of the perforator 180. But inasmuch as segment 2 of the transmitter is grounded by the depression of the key for the letter C, a circuit is completed extending from ground on segment 2 to conductor 2428 as previously traced, winding of relay 115 to battery. Relay 115 operates and through its inner front contact extends ground through segment 2, winding of relay 2' to battery. Relay 2' operates and connects ground to conductor 12 extending to the perforator 180 and since, at this time, distributor 182 of said perforator is likewise in engagement with its segment 2, a circuit is completed for magnet 22 which controls the perforating punch in the second punch position on the tape. When the brush of the transmitter has passed segment 2, the circuit of relay 115 is opened, thereby removing ground from the front contact of said relay. In the same way, as the brush of the transmitter connects with segments 3 and 4, the above circuit is closed again, relay 115 is reoperated twice and conductors 13 and 14 extending to the perforator are grounded. Thus the code of the letter C is transmitted from the recording position and perforated in the primary tape.

It is not believed necessary to describe the sending of the code impulses of each of the other characters. It is the same as that already described for the letter C so that the tape will have a code punched thereon for each character of the information "Chicago Dearborn 6927 $8.75", which comprises all of the information necessary for billing purposes. Any other information which is thought desirable may, of course, also be included.

When the operator has finished transmitting the above data, key 2802 is released whereupon relay 2414 is released, thereby releasing the connection between the tape register and the position and between said position and receiver 170. The release of relay 2414 opens the circuit of relay 2513 which, upon releasing, opens the circuit of relay 2803 at the position to extinguish lamp 2804 and further closes a circuit extending from ground on the right back contacts of relay 2513, left lower contact of cam 2529, winding of sequence switch 2500 to battery causing the switch to advance from position 18 to position 1 thereby restoring the register to normal.

Section 2.—The preparation of the individual tape: Figs. 29 and 30

The primary tape record, the making of which has just been described, contains a series of perforated entries in the form of codes representing certain characters, each series preceded by the code of the switching character. These code entries are notations relating to completed or partially completed calls originated from a main group of calling lines to which the perforator and tape register are common, and completed (or not completed, as the case may be) within the local area or to the toll or long distance area. It now becomes necessary to break down this primary tape into a series of individual tape records, one for each subscriber's line, and containing thereon all code entries relating to calls completed from that line. Since it has been assumed that the main group of lines consists of

four hundred subscribers' lines, it is clear that the primary tape will have to be resolved into four hundred separate individual tape records.

In order to do this, use is made of the apparatus and circuit arrangement shown in Figs. 29 and 30 which is known as the tape subdivider. The equipment consists of a telegraph distributor unit designated 2900 which is capable for responding to tape punches and setting up telegraph impulses in response thereto such as are used in printing telegraph systems, a printing distributor, also of the type used in printing telegraph systems and designated as 3000, a group of twenty separate reperforators A to T, of a well-known construction designated 3010, a register circuit 3060, and a switch 3070 by means of which a series of connections can be made between the distributor unit 2900 and each of the twenty reperforators.

The distributor unit 2900 and the printing distributor 3000 are well known telegraph pieces of apparatus and are not described herein except insofar as such equipment has been modified for operation with the present invention, while each of the reperforators A to T is similar to the tape perforator 100 except for the fact that the usual normally operated line relay is provided to respond to a blank pulse for starting purposes by a closure of its back contact, and to line pulses over its front contact as is the standard practice in start-stop printing telegraph systems.

With the above equipment and cooperating circuit arrangement, the primary tape record can be resolved, first, into a series of twenty secondary group tapes, one for each subgroup of lines as divided on the line-finder frame for identification purposes and, secondly, into an individual tape for each line by running each of the separate secondary tapes through the distributor unit 2900. Hence if each of the twenty secondary tapes is run through the distributor 2900, four hundred individual tapes, one for each line, will be produced.

It is necessary to bear clearly in mind that the object of breaking down the primary tape record into a tape record for each line is to assemble on each of said individual line tapes the record of all entries appertaining to all calls originated from said line. It will be recalled that each entry on the primary tape is preceded by a switching character, that is, a character whose code is designated by the perforation of six holes transverse the tape. For a purpose made clear by the description proceeding hereinafter, before the primary tape is run through the distributor unit 2900, an auxiliary tape containing twenty switching characters and twenty alphabetical codes from A to T, each switching character being succeeded by one of the twenty alphabetical characters, is run through the distributor ahead of the main tape. Such a tape is shown in Fig. 29—B. It has as its first perforation the switching character code of six perforations transverse the tape; the second entry is the code of the letter A of the line subgroup designation codes, the third is that of the switching character, the fourth the code of the letter B, and so on up to and including the code of the letter T.

As soon as the auxiliary tape is placed in the tape receiving slot (not shown) of the distributor unit 2900 and the unit is made ready for operation by closing the circuit of the motor 2905, a key 2906 is operated by means of which a circuit is closed extending from ground on the contacts of relay 3001, conductor 3002, left contacts of key 2906, winding of magnet 2904, to battery. Magnet 2904 operates and unlatches the clutch plate 2911 to cause the distributor shaft to be rotated by the motor, during which time distributor brush 2902, keyed to the shaft, sweeps over the commutator segments of commutator 2903 and makes contact with each of them. The shaft also carries cam 2914 and 2912, the latter having an extension rod 2913 for depressing the selecting fingers of the distributor away from the record tape. As soon as the auxiliary tape has traveled to the point where the selecting fingers are coincidental with the code holes of the first switching character, all the fingers pass through the holes and close two sets of contacts carried on the lower extremity of each of the finger rods. A contact in each set of the lower pair is connected to a commutator segment corresponding to the number of the finger while the mates of said contacts are grounded. That is to say, the normally open contact on the lower contact-set of finger 1 is extended to commutator segment 1, that of finger No. 2 to segment No. 2 and so on up to and including that of finger No. 6 which is extended to segment No. 6.

The upper set of contacts on each of the fingers are connected in a series chain from interrupter 2901 over conductor 2908 to the left winding of relay 3007 for the purpose of operating the relay at the end of one shaft revolution, the contacts of the interrupter 2901 being closed at that time.

In the meanwhile, as the time key 2906 is operated, ground is connected from its right contact, over conductor 3003, the back contacts of relay 3004 to the brush 3071 of switch 3070. Now switch 3070 is a well known switch structure of the back stroke type and is provided with two brushes 3071 and 3072 and two cooperating terminal arcs consisting of twenty-one terminals each. Each of twenty terminals on the bank cooperating with brush 3071 is extended to the winding of a relay associated with one of the reperforators in the group 3010, terminal No. 1 being connected to the winding of relay 3011 of reperforator A, terminal No. 2 to the winding of relay 3012 reperforator B and so on up to and including the twentieth terminal which is connected to the winding of relay 3030 associated with reperforator T. The terminals of the arc accessible to brush 3072 are, in turn, extended to the common conductors of the group of relays 3061 to 3065, inclusive, said relays comprising the register 3060; the first terminal being connected to the first or lowest conductor and the twentieth to the uppermost. Now, depending upon the terminal to which brush 3071 is connected at the time ground is connected to conductor 3003 when key 2906 is operated, a circuit will be completed to any one of the twenty relays 3011 to 3030.

Let it be assumed that the switch brushes are resting on the nineteenth set of terminals at the time key 2906 is operated so that a circuit is completed through the winding of relay 3029 to battery. This relay, therefore, now operates and by closing of its contacts, connects the impulser magnet 3049 of reperforator S to the common conductors 3005 and 3006. Therefore, when all of the selecting fingers of distributor 2900 are extended through the six holes of the code of the first switching character in the auxiliary tape and the distributor brush 2902 is making contact with the blank segment of the commutator, the pulsing relay 3049 of reperforator S which, prior to the operation of relay 3029, is held nor-

mally operated from battery supplied over the normal contacts of relay 3029 (as is the case with the pulsing relay in each of the other reperforators) now releases and closes the circuit of the start magnet (not shown) of the reperforator S and causes thereby the rotation of the commutator brush of said reperforator over the associated receiving segments. Since the motor of each of the reperforators is synchronized with motor 2906 of the distributor 2900 in accordance with standard telegraph practice, the commutator brush of reperforator S will reach its first segment at the time distributor brush 2902 reaches segment No. 1. Therefore a circuit is closed extending from ground on the lower contacts of selecting finger No. 1, segment 1 of commutator 2903, distributor brush 2902, inner commutating ring of commutator 2903, conductor 2907, top back contacts of relay 3008, conductor 3005, top contacts of relay 3029, winding of line relay 3049 of reperforator S, bottom contacts of relay 3029, conductor 3006, bottom inner back contacts of relay 3008 to battery. So long as the distributor brush 2902 is in contact with segment 1, the commutator brush of the reperforator is likewise in contact with segment 1 of its commutator, and since the line relay is operated during this time, the front contact of the line relay is extended through the brush and No. 1 segment to close a circuit to the first receiving magnet in the reperforator; the other terminal of said magnet being connected to ground. The receiving magnet operates on the pulse and causes the first tape punch controlled by it to be set for perforating the tape in the well known manner. When the distributor brush 2902 has left segment 1 and is in contact with the insulating segment which separates commutating segment No. 1 from commutating segment No. 2, the circuit of the line relay 3049 is opened and the receiving magnet is released. When the commutator brush has traveled to the point of making contact with commutating segment No. 2, the commutating brush of reperforator S has also advanced to contacting position with commutating segment No. 2 to which the winding of the second receiving magnet is connected. A circuit, therefore, is closed from ground on the lower contacts of selecting finger 2 to commutator segment No. 2 of distributor 2900 and thence as previously traced through the winding of the reperforator line relay 3049, reoperating said relay and causing the operation of the second receiving magnet to set the reperforator to punch a hole in the second position of the tape.

In the same manner, as distributor brush 2902 travels over commutator segments 3, 4, 5 and 6, four other impulses are similarly transmitted to line relay 3049 of reperforator S, thereby causing each of the six receiving magnets in said reperforator to operate and punch six holes across the tape indicative of the switching character.

During the time that the distributor brush 2902 is in contact with the blank segment between commutating segment No. 6 and commutating segment No. 1, interrupter 2901 closes its contacts and causes a circuit to be completed from ground on the interrupter contacts, the upper set of contacts on each of the selecting fingers, conductor 2908, left winding of relay 3007 to battery, operating said relay and causing it to lock over its right winding and inner contacts to the normal contacts of interrupter 3009. Relay 3007 further closes a circuit extending from ground on its outer contact to the winding of relay 3008 to battery. Relay 3008 operates and transfers conductors 3005 and 3006 to a battery and ground supply over its middle contacts to reoperate line relay 3049 of reperforator S and thus prevent the reperforator distributor brush from falsely taking another revolution during the time that relay 3029 is operated. Relay 3008 further closes an obvious circuit for relay 3004 which operates and locks over its own outer contacts to ground on the top contacts of relay 3056 and opens the circuit of relay 3029 which releases. Relay 3029 disconnects the pulsing conductors 3005 and 3006 from the perforator line relay 3049 and supplies local battery and ground to said line relay to maintain its operated position. Relays 3007, 3008 and 3004 are fast operating relays and perform the circuit functions above described before the distributor brush 2902 comes to its resting position on the blank segment, at which time interrupter contacts 2901 are opened and the operating circuit of relay 3007 is opened. Relay 3007 however, does not release because it is locked over its outer winding to interrupter contacts 3009 which are normal at this time. Rod 2913 is also depressed at this time to lower the selecting fingers out of the tape holes and permit the tape advancing mechanism (not shown) to advance the tape to the next group of perforations.

The auxiliary tape is advanced to the next set of holes which, it will be remembered comprises the code of the letter A. Since nothing has happened to disturb the circuit of start magnet 2904, the brush shaft will now make another revolution and the selecting fingers which are coincidental with the holes perforated for the character A, that is fingers 2, 3, 4 and 5 will now pass through them and cause the closure of their associated contacts.

When relay 3008 operated, the circuit which holds the line relay 3052 of the distributor 3000 permanently energized is opened. Relay 3052 releases and completes a circuit for the distributor start magnet 3053 extending from ground over the back contacts of relay 3052, segment 0 of the distributor commutator 3054, distributor brush 3055, winding of start magnet 3053 to battery. The magnet operates, unlatches the distributor brush clutch and causes said distributor brush to revolve into contact with all commutator segments. The motor driving the brush is, of course, in synchronism with the one driving distributor 2900, but segment 0 of commutator 3054 is smaller in length than the blank insulating segment of commutator 2903 so that distributor brush 3055 will reach its commutating segment 1 at the same time that brush 2902 reaches its own commutating segment 1. Therefore, when the brush 2902 makes contact with commutator segment 1 no pulse is transmitted since the ground connected to this segment is controlled by selecting finger 1 which is normal for the code of the letter A. Hence line relay 3052 will remain on its back contact during the time that both distributor brushes are on their respective segments 1. When the distributor brush 2902 reaches segment 2, however, ground is connected to said segment over the lower contacts of selecting finger 2 so that a circuit is completed extending from ground over the lower contacts controlled by said finger, commutator segment No. 2, distributor brush 2903, commutator ring and conductor 2907, top front contacts of relay 3008, winding of line relay 3052, inner front contacts of relay 3008 to battery.

Relay 3052 operates and closes a circuit extending from ground over its front contacts, continuous segment of commutator 3054, distributor brush 3055, segment 2, top winding of relay 3062 to battery, operating this relay which then locks in a circuit over its bottom winding and contact to ground on the bottom contacts of relay 3056. In the same way impulses are transmitted when brush 2902 is making contact with the third, fourth and fifth segments of commutator 2903 causing, in turn, the operation of relays 3063, 3064 and 3065, respectively, all of which then lock to ground on the bottom contacts of relay 3056. In the meanwhile, when the shaft carrying distributor brush 3055 started from its position of rest, interrupter 3009 was operated by cam 3057 making its contacts and opening the locking circuit of relay 3007 which now releases. At the same time, however, an auxiliary locking circuit for relay 3008 was closed over the make contacts of this interrupter which does not reclose until the end of the distributor brush cycle. At the end of the cycle, interrupter contacts 3009 restore to normal, opening the circuit of relay 3008 which releases and restores the permanent energizing circuit for relay 3052 which now operates and prevents magnet 3053 from reoperating and starting another cycle.

When relay 3008 releases, a circuit is closed for relay 3001 extending from battery through its winding, top inner contacts of relay 3004 to ground on the bottom outer front contacts of relay 3008, operating said relay and opening the circuit of start magnet 2904 thereby preventing brush 2902 from making another revolution. Distributor brush 2902 is held from advancing any further until the brushes of switch 3070 have been moved to the No. 1 set of terminals as described hereinafter. Hence as soon as relay 3008 releases and relay 3001 operates, a circuit is completed extending from ground on the bottom outer back contact of relay 3008, inner contacts of relay 3004, interrupter contacts of switch magnet 3073, winding of said magnet to battery. Switch magnet 3073 now operates and steps brushes 3072 and 3073 over the successive terminals on their respective arcs until brush 3072 reaches a terminal which has been grounded by the combination of relays 3061 to 3065, inclusive, operated in accordance with the code of the perforated character which succeeds the switching character, which in the case under illustration, is that of the letter A and resulted in the operation of relays 3062 to 3065, inclusive. Hence a circuit is established from ground over the lowest contact-sets of relays 3062, 3063, 3064 and 3065, respectively, the No. 1 terminal on the arc accessible to brush 3072, winding of relay 3056 to battery. Relay 3056 operates, opens its contacts, releases the register relays 3062 to 3065, inclusive, and further releases relay 3004 which, on releasing, opens the circuit of switch magnet 3073 causing the latter to stop, releases relay 3001 which reestablishes the circuit to the start magnet 2904 of distributor 2900. With the release of relay 3004 a circuit is now completed extending from ground on the right contacts of key 2906, conductor 3003, back contacts of relay 3004, brush 3071, the No. 1 terminal on the arc accessible thereto, winding of relay 3011 to battery. Relay 3011 operates, opens the operating circuit of line relay 3031 of reperforator A and connects the winding of said relay to conductors 3005 and 3006. With relay 3008 released, conductor 3005 is connected to conductor 2907 over the top contacts of relay 3008 and conductor 3006 is connected to battery over the inner bottom contacts of relay 3008. With line relay 3011 of reperforator A released, the circuit of the associated reperforator start magnet is closed.

It will be observed that the first switching character ahead of the first letter character was perforated on the tape associated with any one of the twenty reperforators on the terminal of whose switching relay brush 3031 was connected, and that the code of the letter A following the switching character caused the selection of reperforator A. The auxiliary tape is now advanced to the next switching character which is interposed between the code of the previous letter character and the succeeding code of the next letter character or B. Therefore, upon the third revolution of distributor brush 2902, that is, when the selecting fingers have passed through the holes comprising the code of the switching character, the six impulses generated by the connection of ground to the six commutator segments of commutator 2903 are then transmitted over conductor 2907 and top contacts of relay 3008 to the line relay 3031 of reperforator A, causing thereby a perforation of the switching character on the tape associated with said perforator in the manner already described for the perforation of the switching character on the tape of reperforator S.

At the end of the distributor brush cycle, interrupter 2901 again makes its contacts and closes the previously described circuit of relay 3007 while, at the same time, the tape is advanced one notch to the place where the selecting fingers are in position to pass through the tape holes of the next character following the switching character. The operation of the circuit now continues as before; that is, the impulses of the code, which in this case would be those of the letter B with holes perforated in positions 2, 3 and 4 of the tape, will cause the operation and locking of relays 3062, 3063 and 3064 in the same manner as previously described for the code of the letter A. These relays operate and lock as before and switch 3070 is caused to take another step since the terminal on the arc of brush 3072, grounded for the letter B, is the one immediately succeeding that for the letter A. The advance of brush 3072 to the terminal grounded by the operation of relays 3062, 3063 and 3064 causes the operation of relay 3056 and the succeeding operations following thereafter, as already described, whereby reperforator A is disconnected and reperforator B is connected to the pulsing conductor 2907. The tape is next advanced to the next group of holes where the selecting fingers pass through the six holes of the switching character code. The previous operations are now repeated and the switching character code is perforated on the tape associated with reperforator B. In this manner, a switching character code is perforated as the first entry on each of the tapes associated with each of the twenty reperforators A to T, inclusive, except that the tape of the reperforator to which the distributor 2900 was first connected as, for instance, perforator S will have two switching character codes perforated in succession thereon. It will be shown, however, that the entry of two successive switching characters between which no code entry is perforated will in no way influence the proper operation of the circuit.

After the auxiliary tape has been completely run through and a switching character has been thereby perforated on each of the tapes associated with each of the twenty reperforators, the master tape is run through the distributor unit 2000 for the purpose of making twenty separate secondary tapes, one for each subgroup of subscribers, on each of which will be perforated the entries of all calls originated from the lines within the subgroup.

It will be recalled that the primary tape is produced by perforating in advance of all entries relating to a call both the code of the switching character and those of the two letters which identify the subgroup of the calling line and the line itself, except that on the first entry, the code of the "new call" designation or the operator's code is perforated in addition but after the perforation of the switching characters. Following these entries is the code of the particular entry relating either to the series of codes making up the called subscriber's number or toll call information or the code indicating the starting time or the finishing time of a local connection. In any event there are, at least, three entries made upon the primary tape in advance of an entry relating to the details of a call, namely, the switching character, the code of the group letter and the code of the subscriber's identifying letter. Hence, when the primary tape is inserted into the tape slot of the distributor unit 2000, the first group of holes to become coincidental with the selecting fingers will be that of this first switching character which, in accordance with the operations previously described for the auxiliary tape, causes a switching character code to be perforated as an entry on the tape associated with the last reperforator on which the rushes of switch 3070 were left; that is, on the tape of reperforator T. Hence, before any call entry is made on any secondary tape, there will be two tapes that will have two switching characters recorded thereon, in the case under consideration the secondary tapes of reperforators S and T.

The first entry after the switching character is, as already mentioned, the code of the letter indicating the subgroup in which the calling line belongs. Since there are twenty subgroups and each one of them is characterized by some letter from A to T, inclusive, that character may be any one of these twenty letters depending on the subgroup in which the line making the call belongs and to which call the succeeding entries appertain. Therefore, when the primary tape has been advanced to the point where the selecting fingers are coincidental with the holes indicating the code of the subgroup letter, switch 3070 is caused to advance its brushes, in the manner already described, to select the reperforator marked by the operated combination of relays 3061 to 3065 inclusive responding to the letter code impulses received by distributor 3000. The reperforator switching relay in the group of relays 3011 to 3030 inclusive then operates to connect the associated reperforator with the pulsing conductors 3005 and 3006. The tape is then advanced to the next entry which, in this case is the code of a letter marking the position of the calling line within the subgroup, and the code of this letter is now perforated on the tape associated with the reperforator whose switching relay has been operated. If, for instance, the calling line belonged in the nineteenth subgroup and marked by the letter S, relay 3029 will be operated and the code of the letter marking the position of the calling line within the subgroup is then perforated on the tape associated with reperforator S, this entry following the entry of the last switching character previously made by running the auxiliary tape through the distributor unit 2000. If, on the other hand, the line belongs in the first or A group as for instance, line 100 herein used for illustrating the operation of the invention, switching relay 3011 will have been operated, the pulsing conductors 3005 and 3006 will be connected to the line relay 3031 of reperforator A and the code of the calling line character, which would be A for line 100, is then perforated on the tape of reperforator A.

The primary tape is now advanced to the next entry which may be either the code of the new call designation or, if it is an entry relating to a call for which other entries have already been made, may be a series of entries either appertaining to the starting time or the finishing time of a connection. If the entry is the code of the new call designation then the entries which follow the new call entry are those of the called subscriber's number or the "operator" code. For the simplicity of illustration it will be assumed that the next entry is that of the new call designation which is later followed by the entries of the called office and number. Since, therefore, relay 3011 is operated and remains operated, eight pulse groups will be sent from the distributor unit 2000 over conductors 2007 and 3005 through the winding of relay 3031, conductor 3006 to battery, the first of which will be that of the new call designation code while the seven that follow will be those of the called office and number. The line relay 3031 of reperforator A will respond to the pulses and with each distributor cycle of the reperforator will cause the code represented by the pulse combination received during the cycle to be perforated on the secondary tape. Since the called subscriber's number of the call originated by line 100 has been assumed to be Halifax (425) 3678, the secondary tape of reperforator A will then have recorded thereon in succession; (1) one switching character; (2) the code of the letter A; (3) the new call designation code; (4) the three digits of the called office and (5) the four digits of the called number. When all these entries have been made on the secondary tape, the primary tape will have been advanced to the next switching character which has been perforated after the code of the units digit.

In response to the next switching character relay 3007 is operated, the reperforator A is disconnected from the pulsing line conductor 2007 and the register 3060 is prepared to take the setting called for by the code of the subgroup character of the line involved in the succeeding group of entries on the primary tape, whereupon switch 3070 is stepped to select the reperforator called for by the operated combination of relays in the register 3060. It will be assumed that this code is for a call from a line in subgroup K.

The succeeding code character on the primary tape is assumed to be one marking the calling line T within subgroup K and the code of this character is therefore perforated upon the secondary tape associated with the reperforator K (not shown) selected in accordance with the code of the letter K preceding the one now being considered. Following the perforation of the code of the line letter, the primary tape is advanced

and pulses of the code pertaining to whatever entry follows thereafter are transmitted. The next entry on the primary tape may be a new call designation followed by a series of entries identifying the called subscriber's line, or, again, it may be an entry indicating the start of conversation time, or, again, it may be an entry relating to the finish of a conversation. As illustrated in Fig. 29A the three entries on the primary tape following the entry for the code letter T are assumed to indicate the codes for the starting time of a conversation between the line identified by the preceding code letters K and T and a line called thereby. After impulses have been transmitted in accordance with these entries the primary tape is advanced to the next switching character which, of course, is perforated on the same secondary tape, after which the pulsing conductors are switched again to any other reperforator called for by the code character of the next line subgroup. In this way all entries relating to calls originated by the different lines in each subgroup are assembled on one secondary tape for each subgroup, there being one such tape for each subgroup, one such representative tape taking on the appearance shown in Fig. 29—C.

Each of the secondary tapes contains, therefore, code entries of the calling line letter, new call designations, called subscribers' numbers, start and finishing times of connections, offices in different cities and called numbers therein and also the actual toll charge in money units for any particular toll or long distance connection. Each of these entries, or group of entries is, of course, both preceded and followed by the switching character. For a new local call, the first entry following the line designation will be that of the new call designation and for a toll or long distance connection will be the new call designation followed by the operator's code. Each of the tapes is now marked in any suitable manner to distinguish them from each other.

The next step in the process of making an individual tape for each line is to take each secondary tape and run it through the subdivider. Bearing in wind that the secondary tape contains all entries for the twenty lines of a subgroup and also the calling line letter of each line making a call therein it is clear from the operations of the subdivider already described that the first switching character appearing at the head of the tape will be perforated on the tape of the reperforator to which the brushes of switch 3070 are connected at the time pulsing operations begin. The next entry on the secondary tape is the code of the letter of the calling line the effect of which is to set the relays of register 3060 and cause the selection thereby of the similarly lettered reperforator, after which the new call designation (if there is one), the call entries and the switching character are perforated on the tape in succession, one after the other, in the same order as they appeared on the secondary tape. The next entry following the switching character will be the letter code of another line in the same group or the same line just considered. If it is the same line register 3060 will be reset in the same way and switch 3070 will not move. The entries following thereafter will be perforated in succession on the same tape after the switching character and in the same order as they appear on the secondary tape. If it is a different line, then the code of that line will set the register 3060 accordingly and switch 3070 will select the reperforator called for by the line code, after which it will record the succeeding entries and the following switching character; the operation continuing until the entire secondary tape has been advanced through the subdivider.

Thus all the entries on the secondary tape, except the line entries, are dispersed among twenty separate and individual tapes, each of said individual tapes containing all the entries relating to a particular line and in the order in which such entries succeed one another for any particular call, each complete entry being followed by a switching character. In other words, not only are all the entries for one line now entered on a tape individual to that line, but, of necessity, all entries relating to one call are collated together in the sequence called for by the process of setting up and completing that particular call itself, although each complete entry is separated from the next complete entry by the code of the switching character, the last entry on the tape not being followed by the switching character.

Section 3—The computer: Figs. 31 to 43

The next step in the operation of the invention is to take each of the individual tapes thus made and pass it through a computer which will make up the final tape that will be passed through an ordinary page printer or similar device for printing the bill. This 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 operation of the computer, it is advisable to have clearly in mind the sequence of entries perforated on the individual tape of one line and from which the final tape is to be made. The individual tape contains a switching character entry followed by an entry relating to an item of information concerning a completed call followed, in turn, by another switching character which is succeeded again by another entry also relating to the same call. But whereas the primary tape from which the individual tapes are made contained all of the separate entries for separate calls more or less dispersed throughout the tape, the individual tape for a particular subscriber in any group, not only contains the separate entries for all calls made from that line, but contains them 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 will be the new call designation after which come the entries of the called subscriber's line followed immediately thereafter by the code of the switching character and then by the entries of the beginning of the conversation time and followed again by another switching character 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 relating to different calls initiated from different 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 when the individual tape is passed through

the computer, all entries relating to successive calls have been correlated to their respective places on the tape in the succession in which they were made.

The individual tape is now passed through the distributing mechanism 3100 of the computer which is similar in construction to the distributor 2900 except for the fact that interrupter 3122 is driven by the same shaft that drives distributor brushes 3145 and 3149 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.

After the tape is inserted in the tape-slot (not shown), key 3143 is depressed whereupon a circuit for the start magnet 3144 is completed extending from battery, resistance 3151, contacts of key 3143, distributor brush 3145 and the two normal segments of commutators 3123 and 3146, winding of magnet 3144 to ground. Magnet 3144 operates, unlatches the distributor brushes which now traverse along the segments of their respective commutators, brush 3145 supplying impulse ground to the segments of commutator 3146 as the brush comes into contact with the segments of commutator 3123 which are grounded in the manner described hereinafter. As the tape advances, the selecting fingers become coincidental with the six holes of the first switching character as a result of which the six segments of the commutator 3123 are grounded by the bottom set of contacts carried on each selecting finger of the mechanism 3100. As the distributor brush 3145 revolves around the commutator said brush grounds in succession the six conductors 3131 to 3136, inclusive. Commutator brush 3149 also receives these impulses and transmits them to commutator bar 3148 but inasmuch as this bar is connected to the top middle armature of relay 3125 which is normal at this time, the impulses transmitted by brush 3149 will have no effect.

For reasons stated hereinafter, the brushes of switch 3115, which are of the usual rotary back stroke type, 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 3145 reaches segment 1 and grounds conductor 3131, a circuit is completed extending from ground on conductor 3131, No. 1 contact-set of relay 3152, brush 3116 and second cooperating terminal, upper winding of relay 3401 to battery. Relay 3401 operates and locks over its lower winding and No. "a" contacts, conductor 3127, bottom back contacts of relay 3112, bottom inner contacts of relay 3111, to ground. The grounding of conductor 3132 when the distributor brush 3135 reaches the second segment causes a circuit to be completed over the No. 2 contacts of relay 3152, brush 3118 and cooperating terminal which, in this case, is assumed to be the second, upper winding of relay 3402 to battery. Relay 3402 also operates and locks over its bottom winding and No. "a" contacts to ground on conductor 3127. When the brush reaches the third segment, ground is connected to conductor 3133 which is extended over the No. 3 contacts of relay 3152, brush 3117 and the second cooperating terminal, upper winding of relay 3403 to battery. Relay 3403, like relays 3401 and 3402, operates and locks over its lower winding and No. "a" contacts to ground on conductor 3127. When the distributor brush makes contact with the fourth segment ground is connected to conductor 3134 and a circuit is thereby completed over No. 4 contacts of relay 3152, brush 3139 and second cooperating terminal, upper winding of relay 3404, to battery. Relay 3404 likewise operates and locks over its lower winding and No. "a" contacts to ground on conductor 3127. When the distributor brush reaches the fifth segment ground is connected to conductor 3135 and a circuit is completed over the No. 5 contacts of relay 3152, brush 3121 and second cooperating terminal, upper winding of relay 3405 to battery, operating this relay and locking it in a circuit over its lower winding and No. "a" contacts to ground on conductor 3127. Likewise, when the brush makes contact with the sixth segment, ground is connected to conductor 3136 and a circuit is thereby completed to relay 3406 over the No. 6 contacts of relay 3152, through brush 3119 and second cooperating terminal, upper winding of relay 3406 to battery, operating said relay and locking it in a circuit through its lower winding and No. "a" contacts to grounded conductor 3127.

Hence it is seen that the effect of the first switching character perforations ahead of the call entries of the first call is to cause the operation of any group of registers shown in Figs. 34 to 37, inclusive, with whose terminals on switch 3115 the brushes of said switch may be connected at that time. It will be remembered, however, that interrupter 3122 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, bottom contacts of relay 3125, winding of switch magnet 3114 to 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 3122 are opened, the circuit of switch magnet 3114 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.

On the tape, the next series of perforations will be those of the new call designation which, it will be remembered, consists of five holes punched transverse the tape, one in each position except the fifth. Therefore when the selecting fingers pass through these holes a circuit is completed from ground on the middle set of contacts of operated selecting finger 1, similar set of contacts of operated selecting fingers 2, 3, 4 and 6, off-normal contacts of the terminal arc accessible to brush 3120, winding of relay 3112, to battery. Relay 3112 operates, opens ground to conductor 3127 causing thereby the release of the register relays previously operated and locked as the result of the switching character and, over its top contacts connects ground to the other side of resistance 3151, short-circuiting start magnet 3144 and preventing it from operating again at the time brush 3145 reaches its normal segment. In the meanwhile relay 3112 closes a self-interrupting circuit for magnet 3114 extending from ground on the inner contacts of relay 3111, bottom front contacts of relay 3112, interrupter contacts of magnet 3114, to battery. The magnet now operates on self-interruptions

until brush 3120 is advanced to the normal terminal N whereupon relay 3112 is released and the switch is stopped from further rotation. With the release of relay 3112, the short-circuiting ground for start magnet 3152 is removed and this magnet now operates to cause another revolution of brushes 3145 and 3146. Inasmuch as the selecting fingers are still in the holes of the tape designating the new call designation, segments 1, 2, 3, 4 and 6 are grounded while, at the same time, the previously described circuit for magnet 3114 is again closed from the contacts of interrupter 3122, causing said magnet to operate and prepare the advance of the switch brushes. However, due to the fact that at this time the brushes of the switch 3115 are resting on vacant terminals, the consequent grounding of conductors 3131, 3132, 3133, 3134 and 3136 will have no effect.

When the distributor brushes have completed one revolution and the interrupter 3122 opens its contacts at the end thereof, the circuit of magnet 3114 is opened and the brushes of the switch are advanced to the first terminals of their associated arcs.

Thus it is seen that the effect of the switching character has been merely to operate and lock a group of registers which are subsequently released and the effect of the new call character is to return switch 3115 to the first set of active terminals on the switch arc.

If the brushes of switch 3115 are already standing on the normal terminal when the selecting fingers pass through the punches of the switching character, the commutator conductors will be grounded as already described, but inasmuch as 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 3400. Further, when the tape has been advanced to the new call designation character, 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 in its normal position the computer is ready to give effect to the code of 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 connection, the name of the office and the number of the subscriber will have been recorded on the primary tape and repunched on the individual tape in equivalent number codes. In our illustration it has been assumed that the name of the local office is Halifax and the number of the called subscriber 3678. The office name, however, like the called number, has been recorded in the code of numerical characters corresponding to the letters. The name Halifax, therefore, has been recorded in the numerical code 425 the first digit of which is represented by a code comprising 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. When the distributor start magnet 3144 operates to start the next revolution of the distributor brushes, interrupter 3122 closes the circuit to the winding of switch magnet 3114 over a path previously traced, causing said magnet to operate preparatory to advancing its brushes to the second terminal set. Hence when the tape has advanced to the position where the selecting fingers are coincidental with the holes representing the code of the character 4, the second, fourth and sixth fingers will pass through said holes and close ground to the conductors connecting with commutator segments 2, 4 and 6. Therefore, when the brush 3145 rotates one revolution, the ground on each of the segments is extended at the proper time, to conductors 3132, 3134 and 3136 in succession. Ground on conductor 3132 closes the circuit of relay 3402 as already described causing said relay to operate and lock to conductor 3127; ground on conductor 3134 causes the circuit of relay 3404 to be closed as previously described causing said relay to operate and lock to conductor 3127; and the same is true with respect to relay 3406 whose circuit is closed by ground over conductor 3136, said relay also operating and locking to conductor 3127. 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 register 3400. At the end of the revolution, cam 3122 opens its contacts thereby releasing magnet 3114 which advances the brushes of switch 3115 one step to the second set of terminals. At the beginning of the next distributor brush revolution, interrupter 3122 again makes its contacts, closing thereby a previously described circuit for switch magnet 3114 which operates preparatory to advancing the brushes of the switch 3115 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 numerical equivalent of the letter A of the called office name. The selecting fingers, accordingly, pass through the holes made in positions 1, 2, 5 and 6, which, in the manner previously described, cause the grounding of conductors 3131, 3132, 3135 and 3136 as the distributor brush 3145 makes with the correspondingly numbered segments of commutators 3146 and 3123. With the brushes of switch 3115 on the third set of terminals, the grounding of conductor 3131 causes a circuit to be closed extending from said ground, No. 1 contacts of relay 3152, switch brush 3116 and second terminal on its arc, upper winding of relay 3411 to battery, causing said relay to operate and lock over its lower winding and No. 1 contact to ground on conductor 3127. The ground on conductor 3132 causes a circuit to be closed extending from said ground, No. 2 contacts of relay 3152, brush 3118 and second terminal on the arc, upper winding of relay 3412 to battery, causing said relay to operate and lock over its bottom winding and No. 1 contact to ground on conductor 3127. Ground on conductor 3135 likewise causes a circuit to be closed from said ground, No. 5 contacts of relay 3152, brush 3121 and second terminal on its arc, upper winding of relay 3415 to battery. Relay 3415 now operates and locks over its bottom winding and No. 1 contact to conductor 3127. Lastly, the ground on conductor 3136 causes a circuit to be closed over the No. 6 contacts of relay 3152, brush 3119 and second terminal on its arc, upper winding of relay 3416 to battery, causing said relay to operate and then lock over its lower winding and No. 1 contact to ground on conductor 3127. 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 3410.

At the end of the revolution, cam 3122 opens its contacts and magnet 3114 releases advancing the brushes of switch 3115 one step to the third set of terminals.

At the beginning of the next revolution of the distributor brushes, interrupter 3122 again makes its contact and again closes a previously described circuit to the winding of switch magnet 3114 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 coincidental with the selecting fingers 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 selecting fingers 5 and 6 pass through said holes and cause the grounding of conductors 3135 and 3136 when the commutator brush 3145 comes into contact with commutator segments 5 and 6, respectively. With the switch brushes on terminal 4 of their respective arcs, the grounding of conductor 3135 causes a circuit to be closed over the No. 5 contacts of relay 3152, brush 3121 and third terminal of its arc, upper winding of relay 3425 to battery, causing said relay to operate and lock over its lower winding and No. 1 contact to conductor 3127. The grounding of conductor 3136 then closes a circuit extending over the No. 6 contacts of relay 3152, brush 3119 and third terminal of its arc, upper winding of relay 3426 to battery, likewise causing said relay to operate and lock over its lower winding and No. 1 contact to ground on conductor 3127. Thus the code of the digit 5 has resulted in the operation and locking of two relays in the third register 3420 so that registers 3400, 3410 and 3420 have now locked on some of their respective relays 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 3122 opens its contacts to release magnet 3114 which thereupon advances the brushes of switch 3115 to the fourth set of terminals.

At the beginning of the next distributor brush revolution the interrupter 3122 again closes the circuit of magnet 3114 preparatory to the advance of the brushes of switch 3115 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 subscriber's number has been assumed to be 3678, the first set of perforations will be that of the digit 3 and, according to the code, comprises holes perforated in the first and sixth positions of the tape. This causes conductor 3131 to be grounded when the commutator brush 3145 makes with its first segment, whereupon a circuit is closed from ground on conductor 3131, No. 1 contacts of relay 3152, brush 3116 and the fourth terminal of its arc, upper winding of relay 3501 to battery, causing relay 3501 to operate and lock over its lower winding and No. "a" contacts to ground on conductor 3127. When the commutator brush reaches the sixth segment a ground is likewise extended to conductor 3136 and a circuit is thereupon completed over the No. 6 contacts of relay 3152, brush 3119 and fourth terminal of its arc to the upper winding of relay 3506 causing said relay to operate over its upper winding and lock over its lower winding and No. "a" contacts to ground on conductor 3127. 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 3131, 3133, 3135 and 3136 in succession, causing thereby the operation of relays 3511, 3513, 3515 and 3516 over circuits similar to those which have been previously traced. With the advance of switch 3115 to the sixth set of terminals and the tape to the perforations of the code of the digit 7 ground is connected to conductors 3131, 3132, 3133 and 3136 which, over the appropriate paths, completes circuits for operating relays 3521, 3522, 3523 and 3526 all of which lock to ground on conductor 3127.

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 3132, 3133 and 3136 in succession, causing thereby the operation of relays 3532, 3533 and 3536 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 3127.

The tape is now advanced to the code of the next entry and the switch to the eighth set of terminals. The code of the next entry is that of the switching character and, it will be recalled, ground will be connected to each of the six pulsing conductors in succession. However, switch 3115 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 3122 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 incompleted one. It will be remembered that the tape register is connected to the district selector after each registerable item of information is available for registration regardless of whether the call is completed or not. The calling subscriber may disconnect after dialing the called number and said number may be recorded on the primary tape. But if it does not form a part of the record of a completed call the entry is valueless and must be discarded. If, therefore, the preceding entries which have just been recorded in the registers shown in Figs. 34 and 35, are simply entries of an incompleted call, the next entry after the switching character will be that of the new call designation and will cause the operation of relay 3112 as already described and result in the disconnection of ground from conductor 3127 and allow the registers to release. The switch is restored to normal, as described in preparation to begin another cycle of operations with the entries following the new call designation.

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 representing the beginning of conversation time. It will be recalled 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 inclusive and the third the tenths of a minute. Each of these registrations, as contained on the individual tape, will be recorded successively on the relays of registers 3600, 3610 and 3620. It will further be remembered that, for the call initiated by line 100, the positions of the time switches 2600, 2610 and 2640 in the tape register circuit were, at the time conversation began, 2, 7 and 4; that is, the tens switch 2600 was in position 2, the minute switch 2610 in position 7 and the tenths of a minute switch 2640 in position 4. Consequently when the brushes of switch 3115 advance to the ninth set of terminals and the selecting fingers 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 3131, 3132, 3135 and 3136 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 3601, 3602, 3605 and 3606 in register 3600, the circuit for each of said relays being traced in the same manner as those for previous registers except that the separate and respective paths are traced through the ninth terminal sets of switch 3115. These relays lock over their bottom windings and No. "a" contacts to ground on conductor 3127. Thereafter switch 3115 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 a hole 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 3131, 3132, 3133 and 3136 are grounded, causing thereby the operation of relays 3611, 3612, 3613 and 3616 in register 3610. These relays operate over their upper windings and lock over their lower windings and No. "a" contacts to ground on conductor 3127. The tape is then advanced to the next set of perforations which comprises those of the code of the digit 4 and switch 3115 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 revolution of the distributor brush, the grounding of pulse conductors 3132, 3134 and 3136. With the brushes of switch 3115 resting on the eleventh terminal set, the ground on each said conductors causes the operation of relays 3622, 3624 and 3626 in register 3620. These relays operate over their upper windings and lock over their lower windings and No. "a" contacts to ground on conductor 3127. Thus the starting time of the call as contained on the individual tape is recorded on registers 3600, 3610 and 3620.

Switch 3115 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 3115 is vacant, the pulses are ineffective. At the end of the distributor brush revolution, switch 3115 is advanced to the thirteenth terminal set by interrupter 3122.

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. If it is assumed that at the time the conversation is finished the time switches 2600, 2610 and 2640 in the tape register are set on terminals 4, 6 and 2, respectively, then the following three entries on the individual tape will be those of digit 4 for the tens 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 3700, 3710 and 3720, respectively. The code of digit 4 will cause the operation and locking of relays 3702, 3704, and 3706 after which switch 3115 is advanced to its fourteenth terminal set; the code of digit 6 will cause the operation and locking of relays 3711, 3713, 3715 and 3716 in register 3710 after which switch 3115 is advanced to its fifteenth terminal set, while the code of digit 2 causes the operation of relays 3721, 3722, 3725 and 3726 in register 3720 after which the switch is advanced to its sixteenth terminal set. With the switch in position 16, a circuit is closed for relay 3124 extending from ground on the top back contacts of relay 3112, brush 3128 and sixteenth terminal on its arc, top winding of relay 3124 to battery. Relay 3124 operates and connects ground to conductor 3153.

After the last entry has been recorded on register 3720 the tape is advanced to the next switching character. With switch 3115 on the sixteenth terminal set and the six pulse conductors grounded as a result of the selecting fingers passing through the six perforations of the switching character code, circuits are completed in succession to the top winding of each of the six relays 3101 to 3106, inclusive. The relays operate and then lock over their respective bottom windings and contacts to ground on the top contacts of relay 3124. A circuit is now completed from ground on the top contacts of relay 3106, through the series contacts of relays 3105 to 3101, inclusive, winding of relay 3109 to battery. Relay 3109 operates but nothing further happens until interrupter 3122 has advanced the tape to the next set of perforations and switch 3115 has advanced to the seventeenth set of terminals. During the time that the switch advances from the sixteenth to the seventeenth terminal set, relay 3124 does not release due to the fact that it is "slow-release" so that when brush 3128 makes with the seventeenth terminal, a locking circuit is furnished for relay 3124 extending from battery through its lower winding, bottom contacts of said relay, brush 3128 and cooperating terminal to ground on the top contacts of relay 3112. A circuit is now completed for relay 3110 extending from battery through its winding, bottom contacts of relay 3124 to the aforetraced ground on the back contacts of relay 3112. Relay 3110 operates, connects shunting ground to start magnet 3144 over the top back contacts of relay 3111 to prevent the distributor commutator brushes from taking any further revolutions and, over its top contacts, extends ground on the bottom outer contacts of relay 3111, front contacts of relay 3109 to conductor 3138. This conductor further extends to the commoned contacts of the register relays of Fig. 34, to the winding of relay 4002 by way of the back contacts of relay 4001 and, in parallel therewith to the winding of relay 4201 to battery, operating both of these relays to perform functions noted hereinafter.

The reason why a check is made for the switching character following the last code entry of a completed call is to make certain that there is no irregularity in the successive entries on the tape. The last entry should be followed by a switching

character. If it is not and is followed instead, say, by the new call designation, then relay 3112 will reoperate, connect shunting ground to the start magnet 3144 and connect self-interrupting ground to switch magnet 3114, opening the locking circuit to the register relays in Figs. 34 to 37, inclusive, thereby canceling whatever records are locked therein and, upon the release of relay 3112 after the switch has cleared the sixteenth terminal set, said switch is advanced to normal in the regular way to start with the record of a new call. In this manner if the switching character is not properly received after the registration of a call is complete it is assumed that the registrations are imperfect and all of them are canceled for that call. If however, upon the switching character check, relays 3101 to 3106, inclusive, operate then, when relay 3110 operates, the circuit is completed for relays 4002 and 4201, the registration record is preserved and the distributor 3100 prevented from any further advance until the computer has translated the record 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 be toll call entries, then said entries would have been preceded by the perforations of the operator's code. This character, it will be remembered, is one having a perforation in every position of the tape except the first so that when the distributor selecting fingers pass through five perforations, a circuit is closed extending over the top set of contacts of each of the selecting fingers to the lower winding of relay 3125. Relay 3125 operates and locks over its upper winding and inner contact, bottom back contacts of relay 3112 to ground on the bottom inner contacts of relay 3111, opens one set of contacts in the circuit of the switch magnet 3114 and, over its top outer contacts, completes an obvious circuit for relay 3152. This relay operates and opens the pulse conductors to the various registers. Over its middle upper contacts, relay 3125 further extends ground through the normal segment of commutator 3147, distributor brush 3149, commutator bar 3148, middle contacts of relay 3125, conductor 3142, to the winding of the line relay 4122 of distributor 4130, 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 has to 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 having been recorded in terms of digits, has to be translated in terms of office letters and recorded as such on the final tape so that the office name, as appearing in the telephone directory, may be printed on the bill. Further, the conversation time has to be translated in terms of money units so that the assessment for the call may be printed in terms of the charge for the call. Hence the subsequent operations of the computer following the record registered in the various registers of Figs. 34 to 37 inclusive have to do, first with translating such items of the record that need translating in terms that are to 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 marking relay individual to the called office code. For this purpose a translator is used which is shown schematically in Figs. 32, 33 and 38 and 39. This translator comprises a group of multi-contact relays 3202 to 3209, inclusive, the winding of each of which extends to the contacts of the relays in register 3400, the winding of relay 3202 extending to the proper combination of contacts of the relays in said register responding to the digit 2 and so on up to and including the winding of relay 3209 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 prevalent 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 multi-contact relays, one for each possible digit, only eight are provided, one for each digit from 2 to 9, inclusive. Each of these multi-contact relays contains 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 eight relays, each group of ten of said extensions being carried to the corresponding armatures of a relay like relay 3902 shown on Fig. 39. 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 3900 to 3909, inclusive, the second of which only, namely, relay 3902, is shown in detail, and to the ten armatures of each of which are extended a group of ten commoned contacts of the multi-contact relays. The corresponding "make" contact of each pair of contacts of the relays 3900 to 3909 are commoned to one of ten conductors which, in turn, extend to the contacts of the relays of register 3420. The winding of each relay in the group of relays 3900 to 3909 is connected over a separate conductor to contacts of the register relays in the register 3410 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 multi-contact relays 3202 to 3209, inclusive, is connected, through terminal block 3203, 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. 32 and 38 and are designated as 3200, 3201, 3202, 3315 and 3316. One of these relays, namely 3200, will be assumed to represent the code relay corresponding to the office code of the office dialed in the illustration, 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 3400, 3410 and 3420 is to translate the three-digit registration of the office code, as registered by the operated relays of said registers, into the operation of the code relay designating the called office which, in this case, is relay 3200. Consequently, after the digit 4 has been recorded in register 3400 and relays 3402, 3404 and 3406 have been operated in response to the code of this digit, a circuit is closed extending from the

ground on conductor 3138, No. 4 contacts of relays 3406, 3404 and 3402, conductor 3437, winding of relay 3304 to battery. Relay 3304 operates and closes through its one hundred make contacts to the common conductors of the multi-contact relay group.

The operation of relays 3411, 3412, 3415 and 3416 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 3138, No. 2 contacts of relays 3416, 3415, 3412 and 3411, conductor 3427, winding of relay 3902 to battery. Relay 3902 operates and closes through the second group of ten common conductors to the group of conductors extending to the relay contacts of register 3420. Therefore, with relays 3425 and 3426 operated in response to the code of the third digit 5 of the office code, a circuit is closed extending from ground on conductor 3138, No. 5 contacts of relays 3426 and 3425, conductor 3428, No. 5 contact-set of relay 3902, No. 15 contact on relay 3304, winding of relay 3200 to battery. Relay 3200 operates and marks thereby the code of the called office.

Relay 3200 and other similar code relays are each provided with four sets of contacts, the three left armatures of which are extended to cam 4006 of sequence switch 4010 and the right armature of which is connected to ground. The make contacts of these armatures are extended to various terminals on terminal block 3204 as more particularly described hereinafter.

To the terminals of another cross-connecting block, namely cross-connecting block 3205, are extended the windings of three groups of relays. The first group comprises relays 3211 to 3226, one for each letter of the alphabet; the next group of relays consists of ten relays, namely relays 3800, 3809, 3808—3801, inclusive, only relays 3800 and 3801 being disclosed, one for each of ten digits, and a third group of three relays or more, namely, relays 3812 to 3814, inclusive, each relay in said last group representing a calling zone, the area of which includes offices having a definite initial and overtime rate 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 3231 to 3137, inclusive, which extend, through commutator segments, to the magnets of the perforator 4120, the function of which is described hereinafter.

The contacts of relay 3200 and those of other code relays which make with the commoned armatures of all code relays that are extended to cam 4006, are cross-connected from block 3204 to block 3205, 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 3808—3810 depending on the digit. For instance, if the office Halifax is listed in the telephone directory as HAL, the contact No. 1 would be cross-connected to the winding of relay H, that is, relay 3218; contact No. 2 would be cross-connected to the winding of relay 3211 representing the letter A, while contact No. 3 would be cross-connected to the winding of relay 3222 as representing the letter L. On the other hand if, as is now the case in large metropolitan areas employing three-digit codes, it becomes 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 3222 would be cross-connected to the winding of any one of the relays in the group 3800—3801 so that the translation would be HA—1, HA—2, HA—3, etc., in accordance with the representation of the office in the telephone directory. The right contact of relay 3200 is cross-connected to the winding of relay 3812 or 3813 or 3814 depending upon the particular zone in which the office Halifax is located with respect to the calling office.

The code relay, 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 3200 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 determined by relay 3812, then the operation of relay 3200 partially prepares the circuit for each of the following relays; namely, relays 3211, 3218 and 3222 and completes an obvious circuit for relay 3812.

In the meanwhile with ground connected to conductor 3138, relays 4002 and 4201 have operated as already described. Relay 4002 closes a circuit from ground over its bottom outer contacts, back contacts of relay 4003, right lower contact of cam 4005, winding of magnet 4004 of switch 4010, to battery. The magnet operates and revolves the switch 4010 out of position 1 and into position 2. In position 2 a circuit is completed from ground on the inner contacts of relay 4002, upper right contact of cam 4006, upper contact of cam 4011, left winding of relay 4003, to 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 4002. Relay 4003, by breaking its back contact, opens the starting circuit of magnet 4004. Another circuit is also closed extending from ground over the inner contacts of relay 4002, upper contacts of cam 4006, conductor 4107, No. 1 contacts of relay 3200, jumper conductor between blocks 3204 and 3205, winding of relay 3218 to battery. Relay 3218 now operates and grounds perforator conductors 3233, 3235 and 3237. Each of the first two conductors extends to a segment of a commutator associated with tape reperforator 4120 while conductor 3237 is connected to the winding of the start magnet 4126 of said perforator. This reperforator, that is, 4120, is similar in construction to the tape perforator 100; that is, the pulsing conductors extend to commutator segments with corresponding segments in the second part of the commu-

tator extending to perforating magnets which, when operated on a pulse, cause the corresponding punch levers to be mechanically set to perforate the tape. The operation of these magnets in response to successive connections between corresponding distributor segments as the commutator brush makes one revolution around 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. When the distributor brush 4106 engages with and connects the seventh segments of the commutator together, a circuit is closed for magnet 4004 extending from ground through brush 4106, conductor 4007, right upper contact of cam 4005, winding of magnet 4004 to battery. The magnet operates and advances the switch to position 3 by which time brush 4106 will have again reached its first segment. As the switch leaves position 2, the circuit of relay 3218 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 through the left lower contact of cam 4006, conductor 4008, No. 2 contacts of relay 3200, winding of relay 3211, to battery. Relay 3211 operates and grounds conductors 3231, 3232 and 3237. The corresponding magnets are now operated in the tape perforator 4120 causing thereby the punching of holes in positions 1 and 2 of the tape as code perforations of the letter A. When the distributor brush 4106 again contacts with the seventh segments of the commutator the aforetraced circuit of magnet 4004 is again completed and the switch is advanced to position 4. As the switch moves past position 3, the circuit of relay 3211 is opened at the left lower contact of cam 4006 causing said relay to release, which in turn removes 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 4002 is extended by way of the right lower contact of cam 4006, conductor 4009, No. 3 contacts of relay 3200, winding of relay 3222, to battery. Relay 3222 now operates and grounds conductors 3232, 3235 and 3237 causing thereby the operation of the corresponding magnet in the tape perforator 4020 and the punching of holes in positions 2 and 5 of the tape in designation of the letter L. When the brush 4106 again contacts with the seventh segments of the commutator the circuit of magnet 4004 is again closed and the switch advanced to position 5. As the switch passes beyond position 4 the circuit of relay 3222 is opened and ground is removed from the perforator conductors and 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 numbers representing the called subscriber's number. Since, however, the tape now being made is the one which is to be fed into the printing mechanism for the making of the bill, the characters that are to be printed are to be properly spaced on the tape and it is usually desirable to leave a space on the bill between the office code and called number. For this purpose, it is necessary, therefore, to interpose a space character on the tape between the office name and the office number so that a space will be left between the two on the bill at the time the two designations are printed thereon. Hence, when the switch reaches position 5, a circuit is closed extending from ground on the inner contact of relay 4002, right upper contact of cam 4006, upper left contact of cam 4017, winding of relay 4018, to battery. Relay 4018 operates and grounds conductors 3233 and 3237, the first of which corresponds to the code of the space character and the second for closing the circuit of the perforator start magnet. The perforator is now operated, the space character code is punched in position 3 of the tape, and when the distributor brush reaches the last or seventh segments a previously traced circuit for magnet 4004 is closed, causing said magnet to operate and advance the switch to position 6. As the switch advances beyond position 5 the circuit of relay 4018 is opened thereby opening the circuit of the perforator start magnet and disconnecting ground from conductor 3233 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 4006 to the right upper contact of cam 4011, conductor 4012, No. 3 contact-set of relay 3506 of the thousands register 3500, No. 3 contact-set of relay 3501, conductor 3541, bracket line 4019, corresponding conductor 3541 in Fig. 30, winding of relay 3803 (not shown) to battery. Relay 3803 operates and grounds conductors 3231, 3236, and 3237, 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 4106 reaches the last or seventh segment, the previously described circuit for switch magnet 4004 is closed and switch 4010 is advanced to position 7. As the switch leaves position 6, ground is disconnected from the path of relay 3803 at the right upper contact of cam 4011 and said relay releases and disconnects ground from the perforator conductors.

When the switch reaches position 7, a circuit is closed extending from ground on cam 4011 over the right lower contact thereof, conductor 4013, No. 6 contacts of relays 3516, 3515, 3513 and 3511 of the hundreds register 3510, conductor 3446, bracket line 4019, conductor 3446 in Fig. 38, winding of relay 3806, (not shown) to battery. Relay 3806 in operating, grounds conductors 3131, 3133, 3135, 3136 and 3137 for operating the perforator 4120 to perforate the code of the digit 6. When the commutator brush of said perforator reaches the seventh segment, the previously traced circuit of magnet 4004 is closed and the switch is advanced to position 8. As it passes beyond position 7, ground is disconnected from the path of relay 3806 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 4011, conductor 4014, No. 7 contacts of relays 3526, 3523, 3522, 3521 of the tens register 3520, conductor 3447, bracket line 4019, conductor 3447 in Fig. 38, winding of relay 3807 (not shown) to battery. Relay 3807 operates and grounds conductors 3231, 3232, 3233, 3236 and 3237 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 of perforator 4120 reaches the seventh segment, the previously traced circuit of magnet 4004 is closed, operating said magnet and causing the switch to advance to position 9. When the switch leaves position 8 the circuit of relay 3807 is opened at the left lower contact of cam 4011 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 4016, conductor 4015, No. 8 contacts of relays 3536, 3533 and 3532 of the units register 3530, conductor 3448, bracket line 4019, conductor 3448 in Fig. 38, winding of relay 3808 (not shown) to battery. Relay 3808 operates and grounds conductors 3232, 3233, 3236 and 3237 causing thereby the operation of associated magnets in the perforator 4120 and the registration of the code of the digit 8 through the punching of holes in positions 2, 3 and 6 of the tape. When the commutator brush reaches the seventh segment, the circuit of magnet 4004 is closed and the switch advanced to position 10. As the switch advances beyond position 9, the circuit of relay 3808 is opened at the left upper contact of cam 4016 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 associated with reperforator 4120, a space must again be interposed between the last digit and the information that follows which will be the charge for the call. Consequently, when the switch reaches position 10 a previously traced circuit for relay 4018 is again closed, operating said relay which connects ground to conductors 3237 and 3233 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 4004 is again closed and the switch advanced to position 11. As it advances beyond position 10, the circuit of relay 4018 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 positions 14 to 20 the charge for the call is perforated in code form on the tape associated with reperforator 4120. This is done as follows:

At the time ground was applied to conductor 3138, relay 4201 was operated as already described. This relay, in operating, connects ground to its outer contact, bottom outer back contacts of relay 4212, to conductor 4246. This conductor now supplies ground to the contacts of the relays in registers 3600, 3610 and 3620 some of which, 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 4201 closes a circuit extending over the top inner back contact of relay 4212, top contacts of relay 4205, inner back contacts of relay 4202, interrupter contacts and winding of magnet 4203 of switch 4210, to battery. Magnet 4203 operates and advances its brush 4204 over the terminals of its arc to the terminals of which are connected the ten conductors from registers 3600 and 3700, the conductor connecting with the No. 1 contacts of the relays in registers 3600 and 3700 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 amongst 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 3601, 3602, 3605 and 3606 in register 3600, then the ground on conductor 4246 will be extended over the No. 2 contacts of said relays to the second terminal of the arc of switch 4210. Hence when brush 4204 has reached the second terminal of its arc, a circuit is completed to the winding of relay 4202. Relay 4202 operates, opens the circuit of switch magnet 4203 and, over its outer contacts, closes one set of contacts in the circuit path of relay 4205. 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 4203, three other circuits are closed as follows: (1) ground on the inner contacts of relay 4201, top inner back contacts of relay 4212, top contacts of relay 4205, bottom inner back contacts of relay 4211, botton contacts of relay 4207, interrupter contacts and winding of magnet 4209 of switch 4220 to battery; (2) ground as traced to the bottom inner contacts of relay 4211, bottom middle back contacts of said relay, bottom contacts of relay 4213, interrupter contacts and winding of magnet 4214 of switch 4230 to battery; (3) ground as traced to the contacts of relay 4211, in parallel thereto over the bottom inner back contacts of relay 4212, winding of relay 4216, to battery. Magnet 4208 of switch 4220 operates and steps its brushes over the terminals of their cooperating arcs until brush 4208 reaches a grounded terminal whereupon an obvious circuit for relay 4207 is completed. The conductors connected to each of the several terminals of the arc associated with brush 4208 extend to the contacts of the relays in registers 3610 and 3710, 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 3611, 3612, 3613 and 3616, the ground on conductor 4246 is extended through the No. 7 contacts of said relays to the seventh terminal in the arc of switch 4220 accessible to brush 4208. Hence when the switch has advanced brush 4208 to the seventh terminal, a circuit is completed over said brush, winding of relay 4207 to battery. Relay 4207 operates, opens the circuit of magnet 4209 preventing the switch from taking any further steps and closes another contact-set in the circuit path of relay 4205.

In the same way, magnet 4214 of switch 4230 steps its brushes over successive terminals of their arcs until brush 4215 makes contact with a grounded terminal, whereupon a circuit is completed for relay 4213. The conductors connected to each of the several terminals of the arc associated with brush 4215 extend to the contacts of the relays in registers 3620 and 3720, 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 3622, 3624, and 3626, the ground on conductor 4246 is further extended through the No. 4 contacts of said relays to the fourth terminal in the arc of switch

4230 accessible to brush 4215. Hence when the switch has advanced brush 4215 to the fourth terminal of its arc, a circuit is completed over said brush, winding of relay 4213, to battery. Relay 4213 operates, opens the circuit of magnet 4214 preventing the switch from taking any further steps and completes a circuit extending from ground on its top contacts, top inner back contacts of relay 4211, top contacts of relay 4207, bottom contacts of relay 4202, winding of relay 4205 to battery. Relay 4205 operates and performs functions noted hereinafter.

In the meanwhile when relay 4216 operated, it closed a locking circuit through the winding of relay 4212, contacts of relay 4216 to ground on the inner contacts of relay 4201. Relay 4212, 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 4206, top inner back contacts of relay 4212 to ground on the inner contacts of relay 4201.

Thus until switches 4210, 4220 and 4230 take settings corresponding to each of the digits of the start conversation time, relay 4216 is operated and relay 4212 is short-circuited. When the setting is completed, as evidenced by the operation of relay 4205, the short circuit around relay 4212 is removed causing said relay to operate and lock in series with relay 4216. Should the brushes of any or all of the switches be resting on arc terminals immediately grounded by the extension of ground on conductor 4246 through the operated contacts of the relays in the start conversation registers 3600 to 3620 inclusive, then the particular cut-in relays effected; that is, relay 4202 or 4207 or 4213, 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 4201, top inner front contact of relay 4212, winding of relay 4211, to battery, causing said relay to operate. Although the operating circuit of relay 4205 is now opened at the top inner contacts of relay 4211, yet the relay will not release since, by relay 4211 making of its top inner front contact, a holding circuit is now provided for relay 4205, 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 4212 operates, ground is disconnected from conductor 4246 and, through the bottom outer front contacts of said relay, ground is connected to conductor 4252 which, in turn, extends to the commoned contacts of all relays in the finish conversation registers 3700, 3710 and 3720. The removal of ground from conductor 4246 opens the circuits of relays 4202, 4207 and 4213 which now release causing, in turn, the release of relay 4205. The ground on conductor 4252 now extends by way of the operated relays in registers 3700, 3710 and 3720 to one of the terminals in each of the switches 4210, 4220 and 4230. 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 4210, terminal 6 in that of switch 4220 and terminal 2 on that of switch 4230. If any of the terminals grounded are the same as those previously grounded for the start of the conversation time, any of the relays 4202, 4207 and 4213 will operate. This, however, is of no effect at the present time except in the case of relay 4213 in which, if it operates immediately upon the connection of ground over conductor 4252 to the contact of the arc to which brush 4215 is associated, the operation of relay 4251 is prevented as explained hereinafter. On the other hand, if at the time that relay 4211 operates and the self-interrupting circuit for magnet 4214 is established, relay 4213 has not operated, a circuit is completed for relay 4251 extending from battery through the lower winding of said relay, bottom outer contacts of relay 4211, back contacts of relay 4213 to ground on the bottom next to the inner contacts of relay 4211. Relay 4251 operates and locks in a circuit over its upper winding and inner front contacts, conductor 4247 to ground on the bottom contacts of relay 4104.

The purpose of operating relay 4251 if switch 4230 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 4211, a circuit is closed extending from interrupter 4206, top outer contacts of relay 4211, bottom contacts of relay 4218, winding of relay 4217, to battery. At the closure of the interrupter and the consequent operation of relay 4217, interrupter relays 4238 and 4237 operate, the former on the closure of the interrupter over a circuit from ground on the inner contacts of relay 4217, outer back contacts of relay 4237, winding of relay 4238, to battery. Relay 4238 operates and closes a locking circuit for itself through the winding of relay 4237 and its own contacts to ground on conductor 4247. Relay 4237, however, does not operate at this time since it is short-circuited by the operating ground for relay 4238. However, as soon as the interrupter opens its contacts, relay 4217 releases and relay 4237 operates in the above locking circuit.

It will be recalled that the office Halifax, marked by relay 3200, was assumed to be located in zone 1 which meant, of course, the operation of relay 3812 at the time relay 3200 operated.

"Zone 1" in this disclosure 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 4206 and the subsequent operation of relay 4217, a circuit is closed extending from ground on the outer contacts of relay 4217, inner front contacts of relay 4237, conductor 4248, inner contacts of relay 3812, conductor 4249, left inner back contacts of relay 4244, winding of relay 4245 to 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 3200 would have been cross-connected to the winding of relay 3813 and the above circuit would have been traced from ground on conductor 4248, inner contacts of relay 3813, conductor 4234, back contacts of relay 4242, winding of relay 4243 to 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 3200 would have been extended to the winding of relay 3814 and the above circuit would then be completed over the inner contacts of relay 3814, conductor 4235, back contacts of relay 4239, winding of relay 4241 to battery. In the event that the office is in zone 3 and relays 4239 and 4241 are operated, the two next sets of pulse interruptions will cause the operation and locking of relays 4242, 4243, 4244 and 4245. Should the office be in zone 2 and relays 4242 and 4243 are operated, then on the next set of pulse interruptions, relays 4244 and 4245 are operated and locked. Assuming, however, that the called office is in zone 1 then when relay 4245 operates, it closes a locking circuit for itself from ground on conductor 4247, contacts of relay 4245, winding of relay 4244, winding of relay 4245 to battery. Relay 4244, however, is maintained short-circuited by the operating ground for relay 4245 so that as long as the interrupter is on the grounded segment, relay 4245 remains operated and relay 4244 remains short-circuited.

In the meanwhile, and before relay 4217 releases, another circuit is completed extending from ground on the inner contacts of relay 4217, outer front contacts of relay 4237, left outer back contacts of relay 4244, conductor 4263, upper back contact of relay 4305, conductor 4349, winding of switch magnet 4101 of switch 4100, to battery and in parallel therewith over the lower back contact of relay 4103 to battery through the winding of magnet 4025 of the totalizing switch 4030. The magnets 4101 and 4025 operate, and being of the back stroke type, prepare the brushes 4105, 4106 and 4134 of switch 4100 and brushes 4028, 4029 and 4031 of switch 4030 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 breaks its contacts and relay 4217 releases, the switch magnets release, advancing their brushes one step over each of their separate cooperating arcs while relay 4244 operates and locks in series with relay 4245.

The advance of the brushes of switches 4100 and 4030 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 4210, 4220 and 4230 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 4100 and 4030 would be made to take two steps because two interrupter cycles of the interrupter 4206 would be taking place in the time taken to operate the two counting relay sets 4242—4243 and 4244—4245 which operate on the same interrupter cycles. 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 4235 as described, switches 4100 and 4030 would be made to take three steps because three interrupter cycles of the interrupter 4206 would be taking place in the time taken to operate the three counting relay sets 4239—4241; 4242—4243 and 4244—4245.

When relay 4244 operates, and relay 4217 releases on the next closure of the interrupter, ground on conductor 4248 is now traced as before to conductor 4249, front contacts of relay 4244, top outer front contact of relay 4212, bottom outer back contact of relay 4205, winding of stepping magnet 4209 to battery, operating said magnet and preparing brushes 4208 and 4260 to take a step. At the same time a parallel circuit is completed extending from ground on conductor 4249, front contacts of relay 4244, outer back contacts of relay 4232, conductor 4240, outer contacts of relay 3812, conductor 4236, back contacts of relay 4221, winding of relay 4219 to battery, causing relay 4219 to operate and establish a locking circuit for itself through the winding of relay 4221, contacts of relay 4219, left contacts of relay 4231, to ground on conductor 4247. Relay 4221 does not operate at this time due to the operating ground for relay 4219 being connected to the battery side of its winding. When the interrupter 4206 advances to an insulating segment and relay 4217 releases, ground is disconnected from conductor 4248 and hence from conductor 4249 thereby causing the operation of relay 4221, which now locks in series with relay 4219, and the release of magnet 4209 which now advances brushes 4208 and 4260 one step.

At the next operation of the interrupter, ground on conductor 4249 again completes the circuit of magnet 4209 while the ground on conductor 4236 is now advanced over the front contacts of relay 4221, back contacts of relay 4223, winding of relay 4222 to battery for the purpose of operating the counting relay set 4222—4223. On the break period of the interrupter relay 4223 operates and magnet 4209 releases advancing the brushes 4208 and 4260 one step.

Thus with each cycle of the operations of interrupter 4206, the minute switch 4220 is advanced one step and one set of counting relays in the group of relays 4219—4229 is operated; the process continuing until brush 4208 is advanced to the grounded terminal marked by the operated register 3710. It will be remembered, however, that switch 4220 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 3610 and that the terminal grounded by the minutes setting of the minutes conversation register 3710 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 4208 and 4260 have been advanced to their respective zero terminals, a circuit is completed extending from ground on the top outer contacts of relay 4212, brush 4260 and cooperating terminal, winding of relay 4261 to battery. Relay 4261 operates and closes an obvious circuit for switch magnet 4203 of the ten-minute switch 4210. When the interrupter makes with its insulating segment and switch 4220 is advanced to the first terminals, relay 4261 is released, causing thereby the release of magnet 4203 and the advance of switch 4210 to the next of No. 3 set of terminals.

In the meanwhile, and at the time switch 4220 has advanced to its second terminals and the interrupter has made five cycles of operation beginning with the cycle which first operated magnet 4209, the five sets of counting relays 4221 to 4229, 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. Since, however, a charge for the first five minutes has already been made by the operation of switches 4100 and 4030 at the time the circuit of their respective magnets was closed through the back contacts of relay 4244 and the release of said switches when relay 4244 operated, it now becomes necessary to make four other additional charges and count off fourteen more minutes, each charge being made in advance of the counting.

At the end of the fifth interrupter period, the brushes of switch 4220 will be resting on their respective second terminals, and relays 4228 and 4229 will have been operated. With the operation of relay 4229 a parallel circuit is closed for relays 4231 and 4232.

Relay 4232 locks in a circuit over its right winding and inner front contact to ground on conductor 4247, while the operation of relay 4231 unlocks the counting relay group 4218—4229 which now releases. The release of relay 4229 releases relay 4231 which, in turn, reestablishes the locking circuit of the counting relay group 4218—4229.

In the meanwhile, the operation of relay 4232 causes a set of contacts in the circuit of relay 4233 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 4220 have not yet been stepped to the terminal marked by the register 3710, the interrupter ground paths remain undisturbed and the circuit of relay 4233 is completed on the first ground pulse which marks the beginning of the overtime count. This circuit is completed from ground on conductor 4249, left inner front contacts of relay 4244, outer front contacts of relay 4232, conductor 4255, right back contacts of relay 4258, right winding of relay 4233 to battery causing this relay to operate and close a path for relay 4258 over its inner contacts to ground on the right contacts of relay 4231. Relay 4258 does not operate at this time since it is shunted on the other side of its winding by ground on conductor 4255.

Over its outer contacts relay 4233 closes the operating circuit of magnet 4101 extending from ground on conductor 4255, left contacts of relay 4258, outer contacts of relay 4233, conductor 4263, top inner back contacts of relay 4305, winding of magnets 4101 and 4025 to battery. The magnets operate and prepare to advance their brushes 4105, 4106 and 4107 and 4028, 4029 and 4031 one step.

In the meanwhile the interrupter ground extending to conductor 4236 has again been effective in operating the counting relay 4219 while that on conductor 4249 has likewise been effective in operating magnet 4209 over a previously described path so that, when relay 4217 releases in response to interrupter 4236 making with an insulating segment, the following operations take place: (1) relay 4258 operates in series with relay 4233 and opens the circuit of magnets 4101 and 4025 which now advance their brushes one step to register another charge; (2) relay 4221 operates and locks in series with relay 4219 over a previously described circuit (3) and magnet 4209 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 switch 4100 and totalizing switch 4030, the first set of counting relays in the group 4219—4229 is operated and switch 4220 is advanced one step. From this point on the circuit reoperates to count off five impulses for an additional five-minute period. When, however, brush 4208 reaches terminal 6, a circuit is completed for relay 4207 extending from ground on conductor 4252, through the No. 6 contacts of the operated relays of register 3710 (relays 3711, 3713, 3715 and 3716, which have responded to the tens digit 6 of the finish conversation time), terminal 6 and brush 4208, winding of relay 4207 to battery. Relay 4207 operates and closes a set of contacts in the path of the winding of relay 4205. The switch, however, is not prevented from further stepping since the circuit of the magnet 4209 is, at this time, independent of relay 4207. When the switch reaches terminal 7 and relay 4231 operates in response to the operation of the last set of counting relays 4228—4229, the counting relays are released and relays 4233 and 4258 are likewise released. Relay 4232, however, remains locked to ground on conductor 4247.

The charge made for overtime is not necessarily the same as the initial charge either for the same elapsed period or 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 3812 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 4244 and 4245 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 4219 and 4221 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 3813 and 3814 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 3813 and a call to this office would be charged 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 3814 would cause the operation of counting relays 4242—4243 and 4244—4245. On the first set of pulses that cause the operation of counting relays 4242 and 4243, a previously traced circuit from the inner contacts of relay 4217, through the back contacts of relay 4244, causes the operation of switch magnets 4101 and 4025, advancing the brushes of said switches and recording one charge. On the next set of interruptions which cause the operation of counting relays 4244 and 4245 the same circuit to switch magnets 4101 and 4025, is again completed and the switches, by advancing their brushes to the next set of terminals, register the second charge. Thereafter, the charging switch 4100 and the totalizing switch 4030 will advance under the control of relay 4233 as already described except that the number of counting re-

lays operated prior to the closure of the circuit for relay 4232 and that of relay 4233 depends, of course, on the number of minutes which constitute the overtime period. In the case of the zone marked by relay 3813, the overtime period is assumed to be three minutes. Consequently the ground on conductor 4255 is carried through the middle set of contacts of relay 3813, through conductor 4256 to the back contact of relay 4225 which, on impulses from interrupter 4206 and consequent operation of relay 4217, causes the operation of the three sets of counting relays 4224—4225; 4226—4227; and 4228—4229.

In the same way, offices in zone 3 marked by zone relay 3814 for which charges 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 3814 would cause the operation of the three successive sets of counting relays 4239—4241; 4242—4243 and 4244—4245 with three successive operations of the charging switch 4100 and totalizing switch 4030. Ground on conductor 4255 is, in this case, carried through the middle contacts of relay 3814 to conductor 4257 which extends to the back contact of relay 4227 causing thereby the operation of the two sets of counting relays 4226—4227 and 4228—4229 and the consequent operation of the charging switch 4100 and the totalizing switch 4030 thereafter to record one charge for each interval of two minutes counted off by the counting relays.

Going back to the charging operations of the local call under consideration and remembering that two charges have been registered by switches 4100 and 4030 for the ten pulses already counted, and further remembering that brush 4208 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 4208 on terminal 7, the stepping circuit for magnet 4209 and the counting circuit of the counting relay group remains undisturbed so that another full count of five pulses again takes place, during which time brush 4208 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 4100 and 4030 in the manner described, thus making a total charge of three units for fifteen minutes of conversation. When, however, brush 4260 has advanced to the zero terminal of its arc (that is, during the third pulse count) the previously described circuit of relay 4261 is again completed, whereupon this relay energizes and completes the circuit of magnet 4203 which, when relay 4261 releases as a result of brush 4260 leaving the zero terminal, advances brush 4204 to terminal 4. Terminal 4, it will be remembered, is the terminal to which the ground on conductor 4252 has been extended by the operated combination of relays in register 3700 so that a circuit is now completed for relay 4264. Relay 4202 operates but performs no function at this time.

In the meanwhile switch 4220 keeps on stepping in response to interrupter relay 4217 until it reaches the sixth terminal, at which time all the counting relay pairs up to and including relays 4226—4227 have been operated. Since, however, the ground from conductor 4252 is extended to terminal 6 as already described, relay 4207 operates and a previously traced circuit is now completed for relay 4205, operating said relay and opening the stepping circuit of magnet 4209.

It will be remembered, however, that at the time brush 4259 of switch 4230 advanced from terminal 4, grounded by the tenths-of-a-minute start conversation register 3620, to terminal 2, grounded by the tenths-of-a-minute finish conversation register 3720, said brush had to pass through the zero terminal of its cooperating arc. Since relay 4251 was operated as a result of the movement of switch 4230 then, when brush 4259 made contact with the zero terminal, a circuit was completed for relays 4253 and 4254 extending from battery through the winding of relay 4253, winding of relay 4254, bottom contacts of relay 4251, zero terminal and brush 4259 to ground on the top outer contacts of relay 4212. Both of these relays operate and lock to ground on conductor 4247 through the contacts of relay 4253. Under such circumstances the operation of relay 4205 at the time relays 4202 and 4207 operate in response to brushes 4204 and 4208 coming to rest on the terminals grounded by the finish conversation registers, cause a circuit to be completed for relay 4218 extending from battery through the winding of said relay, outer contacts of relay 4254, outer contacts of relay 4251, bottom inner front contacts of relay 4205, top inner contacts of relay 4212, inner contacts of relay 4201 to ground. Relay 4218 operates, opens the circuit of relay 4217 which releases and thereafter does not respond to the interrupter 4206, thereby stopping any further pulse counting. On the other hand if, at the time switch 4230 advanced from the start conversation position to the finish conversation position, brush 4259 does not pass through the zero terminal of its cooperating arc relays 4253 and 4254 do not operate. Consequently at the termination of the pulse count as determined by the operating relay 4205, there is no circuit for operating relay 4218, relay 4217 will still be responsive to interrupter 4206 and the pulses continued for one more count during which time an additional set of counting relays in the group 4219—4229 is operated while the circuit which was previously completed to magnet 4209 with relay 4205 down is now transferred over the bottom outer front contact of relay 4205, inner back contacts of relay 4254, winding of relay 4253 to battery. Relay 4253 operates and at the time that interrupter 4206 is on its insulating segment relay 4254 also operates and further locks in series with relay 4253. Relay 4218 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 4230 will not advance its brushes between the start and finish conversation registrations and relay 4251 will not have been operated. Hence at the end of the fourth pulse count, relays 4207 and 4204 will operate as described, in turn operating relay 4205 and a circuit for relay 4218 is then completed extending from battery through its winding, top outer back contacts of relay 4251, bottom inner contacts of relay 4205 to a previously traced ground on the inner contacts of relay 4201. With the operation of relay 4218, relay 4217 is released and further counting and charging is prevented. 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 4230 will have advanced its brushes one terminal and relay 4251 will be operated as already described. At the end of the fourth count, however, pulse counting is not stopped since, with the operation of relay 4251, the circuit of relay 4218 is not closed until relay 4254 operates after the reception of the first pulse count of another series after the fourth. But inasmuch as relay 4233 operates at the beginning of the first pulse count, the circuit of magnet 4101 is closed to operate said magnet which, in operating, prepares its brushes to advance a step. At the end of the first pulse count, relay 4254 operates to stop further counting and relay 4258 operates to open the circuit of magnets 4101 and 4025 which release and advance their brushes one step to register an additional charge.

The operation of relay 4218 further closes a circuit extending from ground through its upper contacts, conductor 4262, winding of relay 4021 to battery. Relay 4021 operates and closes a circuit for magnet 4004 extending from ground on its contacts, left lower contact of cam 4005, winding of magnet 4004 to battery, operating said magnet and advancing the switch to position 15. In this position a circuit is completed extending from ground on the right upper contact of cam 4006, right upper contact of cam 4016, conductor 4022 to brush 4108 of switch 4110. Now switch 4110 is termed the "dollar" switch and if the total charges accumulated on switch 4100 for any one call are less than a dollar, the brushes of switch 4110 are resting on their zero terminal for reasons that are explained hereinafter. Consequently with brush 4109 on the zero, or top, terminal the circuit is further extended to conductor 4113, bracket line 4019, conductor 4113 in Fig. 38, winding of relay 3800 to battery. Relay 3800 operates and grounds the perforator conductors in the required combination for causing perforator 4120 to perforate the code of the digit 0 on the tape in the manner previously described.

When the distributor brush of perforator 4120 reaches its last segments a previously described path is closed to the right upper contact of cam 4005 and the circuit is now completed to magnet 4004 which, on operating, advances the sequence switch 4010 to position 16. As the switch leaves position 15, the circuit of relay 3800 is opened at the right upper contact of cam 4016 and relay 3800 releases and disconnects ground from the perforator conductors.

After the dollar designation it is necessary to perforate the code of the "period" character on the tape so as to separate the dollar units from the fraction of a dollar units of the charge. Consequently when the switch reaches position 16, a circuit is completed for relay 4023 extending from ground on the right upper contact of cam 4006, left lower contact of cam 4017, winding of relay 4023 to battery. Relay 4023 operates and grounds conductors 3233, 3234, 3235, 3236 and 3237, the first four being in accordance with the code of the period character and the fifth for operating the start magnet of the perforator. The period character is now perforated in the usual manner and, when the distributor brush 4106 of the perforator makes with the last segments, a previously described circuit for magnet 4004 is completed through the right upper contact of cam 4005 and the switch 4010 is advanced to position 17. As the switch passes beyond position 16 the circuit of relay 4023 is opened at the left lower contact of cam 4017 and relay 4023 is released, thereby disconnecting ground from the perforator conductors.

With the switch in position 17 and with brushes 4105 and 4135 of the charging switch 4100 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 4006, left lower contact of cam 4016, brush 4105 and fourth cooperating terminal, conductor 4114, bracket line 4019, conductor 4114 in Fig. 38, winding of relay 3802 (not shown) to battery. Relay 3802 operates and grounds conductors 3231, 3232, 3235, 3236 and 3237 to the perforator, all in accordance with the code of the digit 2. The perforator now causes the code of said digit to be perforated immediately succeeding that of the period character and thereafter causes the circuit of magnet 4004 to be closed whereupon switch 4010 is advanced to position 18. As the switch passes beyond position 17 the circuit of relay 3802 is opened at the left lower contact of cam 4016 and said relay releases and disconnects ground from the perforator conductors.

With the switch in position 18, a circuit is completed extending from ground on the right upper contact of cam 4006, right lower contact of cam 4016, brush 4106 and fourth terminal on the associated arc, conductor 4113, bracket line 4019, conductor 4113 in Fig. 38, winding of relay 3800 to battery. Relay 3800 now operates and grounds the perforator conductors required to perforate the digit 0 as already described. When the distributor brush 4106 of the perforator reaches the last segments, a previously described circuit for magnet 4004 is closed through the right upper contact of cam 4005 and switch 4010 is advanced to position 19. As the switch advances beyond position 18, the circuit of relay 3800 is opened at the right lower contact of cam 4016 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 4135 has access are divided into two groups. The first group, consisting of the odd terminals, are all connected to conductor 4113 for closing the circuit of relay 3800 which, when operated, causes the zero digit to be perforated. The other group, consisting of the even terminals, are all extended to conductor 4115 which, in Fig. 38, is connected to the winding of relay 3805 (not shown). Relay 3805 when operated grounds conductors 3235, 3236 and 3237 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 4105 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 4100 have been advanced to the next to the last or dollar set of terminals, relay 4102 operates. On the succeeding closure of interrupter 4206 when ground is connected to conductor 4263, a circuit is completed extending from ground on said conductor, top back contacts of relay 4103, inner contacts of relay 4102, winding of magnet 4112 to battery operating said magnet and preparing the switch 4110 to advance its brushes to the next set of terminals. When the interrupter advances to its insulating segment, the ground is removed, magnet 4112 is re-

leased and the brushes are advanced to register the one dollar increment for the call. When the switch has advanced to the normal terminal, relay 4102 is released. Thus every time switch 4100 makes one complete revolution in response to twenty charge units, switch 4110 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 4110 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 character, is now controlled through brush 4108 of switch 4110.

In a similar manner if the totalizing switch 4030 has been advanced to the last or dollar set of terminals relay 4027 operates from ground over brush 4031 and on the next closure of interrupter 4206 when ground is connected to conductor 4203, a circuit is completed over the lower back contact of relay 4103, inner contact of relay 4027, winding of magnet 4045 to battery, operating said magnet preparatory to advancing the brushes of the dollar totalizing switch 4040. On the next opening of the interrupter 4206, magnet 4045 releases and the brushes of switch 4040 are advanced one step. When switch 4030 has advanced to normal, relay 4027 releases. Thus every time switch 4030 makes one revolution to totalize twenty charge units, switch 4040 is advanced one step to register said twenty units in terms of one dollar units. When the dollar totalizing switch has advanced to the last or ten dollar set of terminals, relay 4032 operates from ground over brush 4036 and, on the next closure of the circuit of magnet 4045, a circuit is completed over the inner contact of relay 4032, winding of magnet 4041 to battery operating said magnet preparatory to advancing the brushes of switch 4050. On the next opening of the circuit of magnet 4045, magnet 4041 releases and switch 4050 is advanced one step. When switch 4040 has advanced to normal relay 4032 releases. Thus every time switch 4040 makes one revolution to totalize ten dollars in charges, switch 4050 is advanced one step.

Having completed the perforation of the call charge on the tape, it now becomes necessary to perforate on the tape 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 4010 is in position 19 a circuit is completed extending from ground on the right upper contact of cam 4006, right lower contact of cam 4017, winding of relay 4024 to battery, operating said relay which in turn grounds conductors 3232 and 3237. A perforation in position 2 of the tape is the "line feed" code. When the perforation has been made, switch 4010 is advanced to position 20 over a previously described circuit and, when said switch passes beyond position 19, the circuit of relay 4024 is opened at the right lower contact of cam 4017 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 4006, right upper contact of cam 4017, winding of relay 4025 to battery and, in parallel therewith over conductor 4026, winding of relay 4104 to battery. Both relays operate. Relay 4025 grounds conductors 3234 and 3237 for operating the perforator to punch a hole in position 5 of the tape as the code of the "carriage return" character while relay 4104 operates and performs functions noted hereinafter. When the distributor brush of the perforator has reached the last segments, a previously traced circuit for magnet 4004 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 4025 disconnecting ground from the perforator conductors.

In the meanwhile the operation of relay 4104 disconnects ground from conductor 4247 as a result of which all counting relay pairs and relays 4232 and 4251 locked thereto are released. Relay 4218, however, does not release when relay 4251 releases because it has slow-releasing characteristics which permit it to remain operated until after relay 4251 is released whereupon a holding circuit is closed for it over the top back contacts of relay 4251, bottom inner contacts of relay 4205, top inner contacts of relay 4212 to ground on the inner contacts of relay 4201. Relay 4104 further connects ground to the lower windings of relays 4103 and 4111. Both relays operate. Relay 4103 locks over its top winding and contact to ground on the arc of switch 4100 cooperating with brush 4134 if the switch is off-normal, as it will be if there is any call charge registered in the switch. A self-interrupting circuit is now completed for switch magnet 4101 extending from battery through its winding and interrupter contacts, bottom inner contacts of relay 4103 to ground on brush 4134. Relay 4103, on its bottom outer contacts further opens the path of magnet 4025 of the totalling switch 4030 so as to prevent any totalling operations during the time that the charging switches 4100 and 4110 are returning to normal. In the meanwhile relay 4111 has operated as already described and locked over its top winding and contacts to brush 4109 if switch 4110 is off-normal, and closes a self-interrupting path for magnet 4112 to the same brush. If the switch is normal; that is, if the charge for the single call is less than a dollar, brush 4109 will be resting on its normal terminal and no self-interrupting circuit is closed for magnet 4112. On the other hand, if the call charge is more than a dollar, the above circuit for magnet 4112 is established and the switch brushes are restored to normal. The totalizing switches remain in the positions to which they have been set.

When brush 4134 reaches the next to the last terminal, an obvious circuit is completed for relay 4102 which, on operating, closes a supplementary ground for relay 4103 and magnet 4101 by means of which the switch steps the brushes to the normal terminal.

The operation of relay 4104 further connects ground to conductor 4121 which completes a circuit to the lower winding of relay 3111 which locks over its upper winding and contact to ground on the top contacts of relay 3124. As soon as relay 3111 operates, ground is disconnected from conductors 3127 and 3138 causing the registers in Figs. 34, 35, 36, and 37 and all relays depending upon said grounds to release, and further releases relays 4201 and 4002. Relay 4002 unlocks relay 4003 in preparation for the next call while relay 4201 releases all relays in the

computer circuit of Fig. 42 which are locked thereto.

The operation of relay 3111 further opens the shunting ground to resistance 3151 whereupon the circuit of the distributor magnet 3144 is again made operative to advance the distributor brushes 3145 and 3149 over their respective segments and to advance the tape to the next set of perforations. If the next call is a local call, relay 3112 is operated as described releasing relay 3124 which in turn releases relay 3111. Relay 3111 now reconnects ground to conductors 3127 and 3138 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.

The individual tape passing through distributor 3100 contains the records of toll calls as well as local ones and since the record of the toll call must likewise appear on the final tape prepared by perforator 4120, its code characters must likewise be decoded into characters that will 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 totaling switches 4039, 4040 and 4050 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 completed to a called subscriber whose number is Evergreen 3721. The charge for the call may be further assumed to be $3.75 and made on July 31, 1933. The toll recording operator will then have depressed the proper keys on the keyboard sender 2810 to record "Chicago Ill. Evergreen 3721—JL.31'34—$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 the group of notations for a call on the individual tape passing through distributor 3100 is separated by a switching character from the group of notations of a succeeding call and that the notation following the switching character is either that of a "new call" designation if the call is a local one or that of an "operator" if the call is toll or long distance. If the call succeeding the local call previously described is a toll or long distance call, the switching character code becoming coincidental with the six selecting fingers of the distributor 3100 will be effective in controlling the operation of circuits to restore the brushes of switch 3115 to their respective normal terminals as already described. The next code following that of the switching character will be the "operator" code which, as noted in the code table, consists of a hole punched in positions 2 to 6, inclusive, of the tape. Consequently when selecting fingers 2 to 6, inclusive, pass through these holes a circuit is completed for relay 3125 extending from ground on the upper contacts of selecting finger 2 through similar contacts on the succeeding selecting fingers, lower winding of relay 3125 to battery. Relay 3125 operates and locks in a circuit over its upper winding and upper inner contacts, lower back contacts of relay 3112, inner back contacts of relay 3111 to ground. An obvious circuit is now closed for relay 3152 from the top outer contacts of relay 3125, operating said relay and opening the pulse conductors to the brushes of switch 3115. At this time, and for reasons already described, distributor brushes 3145 and 3149 are in contact with their normal segments so that as soon as relay 3125 operates, a circuit is completed from ground through brush 3149, upper middle contacts of relay 3125, conductor 3142, winding of relay 4122 of commutator 4130 to battery. Relay 4122 operates and, through its inner contact connects ground to the normal segment of commutator 4123 and thereby completes a circuit through brush 4124, winding of start magnet 4126 to battery. Over its outer contacts a parallel branch of the same circuit is completed to the winding of start magnet 4125 of distributor 4130. Both magnets operate and since the motor controlling the movement of distributor brush 4106 is in synchronism with that controlling the movement of brush 4124, both brushes will reach their first commutating segments at the same time. However, brushes 3145 and 3149 of commutator 3100 have likewise been simultaneously advancing and since the motor driving them is also in synchronism with each of the motors of the commutators 4120 and 4130, brushes 3145 and 3149 will reach their respective first commutating segments at the same time that brushes 4106 and 4124 will reach theirs.

By this time the tape has been advanced to the code of the first letter of the city which, if the call is completed to Chicago 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 selecting fingers 2, 3 and 4 pass through these perforations, ground is connected to the conductors extending to segments 2, 3 and 4 of commutator 3147 and when brushes 3145 and 3149 reach their respective second segments, at which time brushes 4106 and 4124 reach theirs, a circuit is completed from ground on segment 2 of commutator strip 3147, brush 3149, upper middle contacts of relay 3125, conductor 3142, winding of relay 4122 to battery. Relay 4122 operates on this pulse, and connects ground over its middle contacts to the upper strip of commutator 4123. Since, at this time, brush 4124 is in engagement with segment 2 of this commutator the circuit is completed to conductor 3232, segment 2 and brush 4106 of perforator 4120, punch magnet 2 of said perforator to battery. This magnet now operates to set the corresponding perforator punch to punch a hole in position 2 of the tape. When brush 3149 has passed beyond segment 2 relay 4122 is released and magnet 2 is likewise released. In the same way when brushes 3145 and 3149 reach segments 3 and 4, respectively, the above circuit for pulse relay 4122 is reclosed and inasmuch as brush 4124 reaches corresponding segments on its commutator at the same time that brushes 3145 and 3149 reach theirs, a circuit is closed, in succession, to magnets 3 and 4, respectively, of perforator 4120 which will set their corresponding punches to punch holes in positions 3 and 4 of the tape. In this manner the code of the letter C on the individual tape is transmitted to perforator 4120 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 final tape, it also results in the operation of relays 4127 and 4128. These relays now lock over their inner contacts to ground on interrupter 4129. This interrupter is carried on the shaft of distributor brush 4124 and makes its upper contact during the time that brush 4124 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 4124 has advanced to segment 6, a circuit is completed from ground on the outer normal contacts of relay 4127, outer make contacts of relay 4131, outer back contacts of the relays connected to segments 3, 4 and 5, outer make contacts of relay 4128, conductor 4132, upper winding of relay 4353, to battery. Relay 4353 operates, closes and obvious circuit to "dash-pot" slow operate alarm relay 4355, locks in the circuit extending from battery through its lower winding and bottom inner contacts, conductor 4354, to ground on the upper outer contacts of relay 4338, disconnects ground from brush 4303 of switch 4300 and closes the path of switch magnet 4301 from battery through its winding, conductor 4133 to the lower contact of interrupter 4129. When the commutator brush 4124 is on the insulating segment between commutating segment 6 and the normal segment, the upper contact of interrupter 4129 breaks thereby releasing relays 4131 and 4128, and makes its lower contact whereupon the circuit of switch magnet 4301 is completed and the magnet operated preparatory to advancing its brushes on the release of the magnet. When brush 4124 makes its normal segment the lower contact of interrupter 4129 is opened, the switch magnet released and the brushes of switch 4300 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 punch holes of the dollar sign code in coincidence with the distributor selecting fingers. 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, selecting fingers 1 and 6 pass through aforesaid holes and cause the sequential grounding of conductors 3231 and 3236. This causes the punching of the code on the tape associated with perforator 4120 in the described manner while, at the same time, the grounds on conductors 3231 and 3236 are extended to brushes 4311 and 4316, respectively, of switch 4300. The ground on conductor 4311 completes a circuit extending over the first terminal to which it is connected, lower winding of relay 4321 to battery and operating said relay which then locks in a circuit over its upper winding and contact to ground on conductor 4354. In the same way the ground on brush 4316 completes a circuit through the terminal to which it connected, lower winding of relay 4326 to battery. This relay also operates and locks in a circuit through its upper winding and contacts to ground on conductor 4354. At the same time, relays 4127 and 4128 also operate and lock as brush 4124 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, relay 4131 and 4128 operated and the rest normal, the operation of the six relays connected to the segments of commutator 4123 in any other combination is ineffective.

While the brushes of switch 4300 are connected to their respective first terminals, a circuit is closed for relay 4302 extending from ground on brush 4304 and the first terminal of the arc, lower winding of relay 4302 to battery. Relay 4302 operates and then locks in a circuit over its upper winding and contact to ground on conductor 4354. This relay performs no function at this time but is operated in advance to prepare a circuit at a later time for relay 4305 as described hereinafter.

At the end of the revolution of brush 4124 and also of brushes 4106, 3145 and 3149, interrupter 4129 again closes its lower contact and closes the previously described circuit of magnet 4301 which operates and, when the interrupter opens its contact, releases to advance the brushes of switch 4300 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 will be required to punch the period code between the dollar and cents quotation. This code comprises holes punched in positions 3, 4, 5 and 6 and results in the punching of corresponding positions in the tape controlled by perforator 4120. In this case, however, switch 4300, having been advanced to the second group of terminals which are blank, the period code has no effect on the circuit shown in Fig. 43.

When the individual tape is advanced to the code of the next digit which is that of the digit 7 the selecting fingers 1, 2, 3 and 6 are operated, whereupon the required four pulses are sent in the required order which causes conductors 3231, 3233 and 3236 to be grounded in the sequence named and causes switch 4300 to advance to the third set of terminals as described. The code of the digit 7 is punched in the described manner on the tape associated with perforator 4120 while, as the punch magnets of said perforator are operated, brushes 4311, 4312, 4313 and 4316 are grounded. Successive circuits are therefore completed from ground on brush 4311 and the third terminal of its arc, lower winding of relay 4331, operating said relay and locking it through its upper winding and contact to ground on conductor 4354; ground on brush 4312 and third terminal of its arc, lower winding of relay 4332 to battery, operating said relay which locks over its upper winding and contact to ground on conductor 4354; ground on brush 4313 and third terminal of its arc, lower winding of relay 4333 to battery, operating said relay which now locks over its upper winding and contact to ground on conductor 4354; ground on brush 4316 and third terminal of its arc, lower winding of relay 4336 to battery, operating said relay which now locks over its upper winding and contact to ground on conductor 4354.

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 4300, having been advanced to the fourth group of terminals in advance of the relay 4122 responding to said pulses, brushes 4315 and 4316 are grounded in the described manner whereupon one circuit is completed from ground on brush 4315 and its fourth terminal, lower winding of relay 4345 to battery causing said relay to operate and lock over its

upper winding and contacts to ground on conductor 4354, and another circuit from ground on brush 4316, lower winding of relay 4346, to battery, causing this relay to operate and lock over its upper winding to ground on conductor 4354. These two relays now close a circuit extending from ground on the lower make contacts of relay 4346, lower back contacts of relays 4341, 4342, 4343, 4344, lower make contacts of relay 4345, winding of relay 4327 to battery. Relay 4327 operates and performs functions which are described hereinafter.

At the end of the revolution of brush 4124, switch 4300 is advanced to the fifth set of terminals whereupon a circuit is completed extending from ground on brush 4304, lower contacts of relay 4302, winding of relay 4305 to battery. Relay 4305 operates and through its lower middle contacts grounds conductor 4306 which extends to the upper back contacts of relay 3111 and short-circuits start magnet 3144 thereby preventing any further advance of the individual tape.

The toll charge figures having been recorded on the registers shown in Fig. 43, the operation of circuits are now initiated to pass this registration to the totalizing switches 4030, 4040 and 4050 in order that the toll charges may be included in the total. Hence when relay 4305 operates the path from interrupter 4307 is closed to the "pick-up" relays 4308 and 4309 so that on the make period of the interrupter a circuit is completed for operating relay 4308 extending from ground through said interrupter, top outer contacts of relay 4305, back contacts of relay 4309, winding of relay 4308 to battery. Relay 4308 operates and establishes a locking circuit through the winding of relay 4309, contacts of relay 4308, to ground on the top outer contacts of relay 4338. On the open period of the interrupter, relay 4309 operates to perform functions described hereinafter.

In the meanwhile relay 4305 closes an obvious circuit for relay 4317 which operates. When, therefore, interrupter 4307 again closes its contacts after relays 4308 and 4309 have operated, a circuit is closed extending from ground through said interrupter, front contacts of relay 4309, 4305, front contacts of relay 4309, contacts of relay 4317, back contacts of relay 4318, winding of magnet 4319 of switch 4320 to battery and in parallel therewith over the back contact of relay 4318, bottom outer front contacts of relay 4305, conductor 4348, winding of magnet 4045 to battery. Magnets 4319 and 4045 operate and prepare to advance their respective brushes one step. When the interrupter opens its contacts magnets 4319 and 4045 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 4040, being the dollar totalizing switch, by its advance, will add as many dollars to its previous registration as it takes steps, and the operation will be stopped only when brush 4329 of switch 4320 becomes connected to the terminal on its arc which makes 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 4321 to 4326, inclusive, and that the particular code caused the operation of relays 4321 and 4326. Hence a ground is caused to be extended to the third terminal of the arc accessible to brush 4329 from ground over the inner contacts of relays 4326 and 4321, No. 1 back contacts of relays 4325, 4324 and 4323 and the No. 2 back contact of relay 4322 to said third terminal. Therefore, after the third pulse, and with brushes 4328 and 4329 on their respective third terminals, a circuit is completed from ground on brush 4329, winding of relay 4318 to battery, operating said relay, opening the circuit of magnet 4319, and closing a circuit for relay 4339 extending from ground on the bottom inner contacts of relay 4305, outer contacts of relay 4318, winding of relay 4339 to battery. Relay 4339 operates and closes a path from the interrupter 4307 to the winding of magnet 4347 of switch 4330 and also, in parallel, to that of switch 4030. On the next ground pulse of interrupter 4307, a circuit is therefore completed for magnets 4347 and 4025 extending from ground through said interrupter, front contacts of relay 4309, contacts of relay 4339, bottom contacts of relay 4337, winding of magnet 4347 to battery and, in parallel therewith through the back contacts of relay 4337, top inner contacts of relay 4305, conductor 4349, lower back contact of relay 4103, winding of magnet 4025 to battery. The magnets now operate and prepare to advance their brushes one step for each pulse interruption. Switch 4030 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 4351 of switch 4330 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 7 the code of which has caused the operation of relays 4331, 4332, 4333 and 4336 as already described. Consequently, a ground is extended to the fourteenth terminal of the arc accessible to brush 4351 extending from ground on the inner contacts of relay 4336, inner contacts of relay 4331, No. 1 contacts of relays 4335 and 4334, No. 1 front contacts of relay 4333, and No. 1 contacts of relay 4332 to the fourteenth terminal of the arc accessible to brush 4351 so that after switch 4330 has taken fourteen steps and switch 4030 has likewise taken fourteen steps and added seventy cents thereby to the total, a circuit is completed for relay 4337 extending from ground on brush 4351, winding of relay 4337 to battery. Relay 4337 operates and opens the circuit of magnets 4025 and 4347, preventing them thereby from further operation and, through its upper outer contacts, completes a circuit for relay 4349 if relay 4327 has operated in response to the last digit of the charge being a five. Under such circumstances it becomes necessary to step the totaling switch 4030 another step to register an additional five cents and this is done by means of relays 4349 and 4350. Therefore, when relay 4337 operates, the interrupter circuit on the next ground pulse is now completed as before to the front contacts of relay 4309, top inner contacts of relay 4337, inner contacts of relay 4327, inner back contacts of relay 4350, winding of relay 4349 to battery. Relay 4349 operates, establishes a locking circuit through the winding of relay 4350 and

its own inner contact to ground on the top outer contacts of relay 4338 and through its outer contacts extends the interrupter ground to conductor 4349 to operate magnet 4025 as before described. At the end of the interrupter ground period, ground is removed from conductor 4349 allowing said magnet to release and advance its brushes one terminal to register a unit charge while relay 4350 now operates in series with relay 4356.

If the last digit had been a zero, then relay 4327 would not have been operated and, upon the operation of relay 4337, a circuit would have been completed for relay 4338 extending from ground on the bottom inner contacts of relay 4305, top outer contacts of relay 4337, normal contacts of relay 4327, lower winding of relay 4338 to battery. Relay 4338 now locks over its upper winding and inner contacts to ground on the normal contacts of relays 4356 and 4357. When the digit is a five, the operation of relay 4338 is postponed until the additional pulse, controlled by relays 4349 and 4350, is transmitted over conductor 4349.

When, therefore, relay 4350 operates, an obvious circuit is closed for relay 4338 which now locks as described. On its upper contact, relay removes ground from conductor 4354 and thereby causes the release of all relays locked thereto. Through its bottom inner contacts, relay 4338 connects ground to brush 4352 and through its bottom middle contacts to brush 4328. Since all of the terminals of the arcs to which each of these brushes are commoned, except the normal terminals, and connected to the interrupter contacts of magnets 4347 and 4319, respectively, a self-interrupting circuit is provided for each of said magnets by which the brushes of each of the switches are driven to the last terminals, whereupon an obvious circuit is closed for relay 4357 from ground on brush 4328 and an obvious circuit is also closed for relay 4356 from ground on brush 4352. These relays now operate and open the locking circuit of relay 4338 which releases and restores the entire circuit to normal. During the time that relay 4338 is operated, a supplementary ground is connected to conductor 4306 to hold distributor 3100 until the circuit of Fig. 43 has restored to normal, ground having been removed from said conductor with the release of relay 4305 following the disconnection of ground from conductor 4354.

Relay 4355 is a dash-pot relay of a known construction whose time of operation is adjusted to be equal to the time taken for the circuit operations described above, that is, from the time that ground is first applied to conductor 4132 to the time that relay 4338 releases. Should the circuit fail to function in the time prescribed, the operation of relay 4355 will cause an alarm circuit to be closed for the purpose of calling attention to the irregularity.

When ground is removed from conductor 4306, the short circuit is removed from start magnet 3144 and the individual tape is now caused to be advanced for the translation and computation of the codes in each of the succeeding calls, local or toll, each of said translations, together with the money charge, being re-punched on the final tape by perforator 4120, while the money charges are successively integrated on the totalizing switches 4030, 4040 and 4050.

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 4030, 4040 and 4050. In order to punch the code of the total charge, key 4042 is operated which then closes an obvious circuit for relay 4001. This relay, on operating, opens the circuit of relay 4002 and completes a circuit extending from ground, right inner contacts of relay 4001, left upper contacts of cam 4005, winding of magnet 4004 to ground. Magnet 4004 operates and advances switch 4010 to position 14.

In position 14 ground is connected from the left outer contacts of relay 4001, left upper and right lower contacts of cam 4046 to brush 4037 of switch 4050. Now, depending upon the particular terminal to which the brush 4037 has been driven by the successive charge integrations, a circuit will be completed to any one of the digit relays 3800—3809 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 4120 in the manner described and representing the number of tens of dollars in the total. When the code is punched, switch 4010 is advanced in the described manner to position 15 in which ground is then extended to brush 4035 of the dollars switch 4040 over the left outer contacts of relay 4001, left upper contact of cam 4046, upper contact of cam 4043 to brush 4035. In this case also the circuit is completed once again to the winding of one of the relays in the group 3800—3809 depending upon the terminal to which brush 4035 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 4010 is advanced in the described manner to position 16.

In this position a circuit is completed for the "period" code relay 4023 extending from battery through its winding, lower contact of cam 4044 to ground on the contacts of relay 4001. Relay 4023 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 4010 is advanced to position 17 in which position ground is connected to brush 4028 of switch 4030 by way of the left outer contacts of relay 4001 and left contacts of cam 4046. Switch 4040 is the tenths of a dollar switch with brush 4028 controlling the tenths and brush 4029 the units of the dollar designation. Accordingly, when ground is applied to brush 4028, a circuit is completed to one of the digit designating relays in the relay group 3800—3809 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 4010 is advanced to position 18 in the described manner. In this position ground is now applied to the units brush 4029 over a path extending from ground on the left outer contacts of relay 4001, left upper contact of cam 4046, left contact of cam 4044 to brush 4029. In this case, brush 4029 resting on a terminal corresponding to that on which brush 4028 is resting, completes a circuit either to the winding of relay 3800 if the total charges makes the units digit 0 or to relay 3805 if it makes it 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 previously described circuit for magnet 4004 is again completed through cam 4005 and switch 4010 returns to normal. In the

interval during which it is advancing through these positions, a circuit is completed for relays 4039, 4033 and 4026 extending from ground at the left outer contact of relay 4001, upper left contact of cam 4046, the lower contact of cam 4043 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 4038, 4036 and 4031, respectively, and close previously described circuits to restore the totalizing switches to normal in preparation for the adding operations 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 4120, it 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 instance, by Patent Re. 18,208 to E. R. Wheeler dated September 22, 1931. But although not described except by reference to the above patent it is understood to be one of the elements which enter into the invention.

What is claimed is:

1. In a telephone system, a tape recording means for recording items of billable information of an established telephone connection, a switching trunk for extending said connection, a tape register, means in said switching trunk responsive to the extension of said connection for operatively associating said tape register with said switching trunk for recording in said register items of billable information for said connection, and means responsive to said registration for operating said tape recording means to record said items in permanent form.

2. In a telephone system, means for establishing a telephone connection to a called line, a tape recording means for recording items of billable information of said connection, said recording means comprising a group of recording magnets, a tape register, means responsive to the extension of said connection for operatively associating said tape register with said connection, means for registering the digits of the designation of the called line in said tape register, and means for operating said recording magnets of said tape recording means for making a permanent record of said registered information.

3. In a telephone system for the automatic billing of connections, a calling line, a called line, means for identifying said calling line, a switching trunk, a tape recorder, means including said trunk for establishing a talking connection between said calling line and said called line, means operatively associated with said trunk for identifying said called line, means responsive to the extension of said talking connection for registering said called line identity from said called line identifying means, means responsive to the response of the called subscriber for registering the starting time of said connection, means responsive to the termination of said talking connection for registering the finishing time of said connection, and means responsive to each of said successive registrations for recording on said tape recorder each of said registrations.

4. In a telephone system for the automatic billing of connections, a calling line, a called line, an operator's position, means including said operator's position for establishing a talking connection between said calling line and said called line, a tape recorder, an impulse receiver, an impulse transmitter at said position, means responsive to the extension of said calling line to said operator's position for operatively connecting said impulse transmitter and said impulse receiver to said connection, means responsive to the reception of a plurality of a series of impulses by said impulse receiver transmitted from said transmitter for operatively connecting said tape recorder with said impulse receiver to record said impulses on the tape associated with said recorder.

5. In a telephone system for the automatic billing of connections, means for establishing a local connection between lines, means for establishing a toll connection between lines, means for registering the designation of completed calls comprising a tape recorder having a tape, a tape register, a manually controlled impulse transmitter, an impulse receiver, means responsive to the extension, establishment and termination of said local connection for operatively associating said tape register with said connection for registering the called and calling line identities and the start and finish of conversation, means responsive to said registrations for connecting said tape register with said tape recorder to record on said tape the designations stored in said tape register, means responsive to the extension, establishment and termination of said toll connection for operatively connecting said impulse transmitter and said impulse receiver to said connection for transmitting and receiving a plurality of series of impulses indicative of the designation of said toll connection, and means responsive to the reception of said impulses for operatively connecting said tape recorder to said impulse receiver to record the designation of said toll connection on said tape as characterized by said plurality of series of impulses.

6. In a telephone system for the automatic billing of connections, a calling line, a called line, means for identifying said calling line, means for establishing a talking connection between said lines including means for indicating the start and finish of said talking connection, a timing and registering circuit operably associable with said connection before, during and after the completion thereof and responsive to said calling line identifying means and said start and finish means for registering said line identification, the start and finish of said talking connection, and the number of the called line, and a tape recorder connectible with said timing and registering circuit after each registration and responsive to each registration for recording said line indentification designation, said called line number and the start and finish time of said connection.

7. In a telephone system for the automatic billing of connections, calling lines equipped with dials, called lines, means responsive to impulses from said dials for establishing connections between said calling lines and said called lines, a registering circuit, means for connecting said registering circuit with said calling lines, registers in said registering circuit responsive to impulses from said impulse responsive means for recording the designation of each of said called lines, other registers responsive to the start and finish time of each of said connections, and a

tape recorder responsive to the registration of each of said designations for recording on a continuous tape each of said designations.

8. In a telephone system for the automatic billing of connections, calling lines equipped with dials, called lines, means responsive to impulses from said dials for establishing connections between said calling lines and said called lines, a registering circuit, means for connecting said registering circuit with said calling line, registers in said registering circuit responsive to impulses from said impulse responsive means for recording the designations of each of said called lines, other registers responsive to the start and finish time of each of said connections, and a tape recorder responsive to the registration of each of said designations for perforating a code of each of said designations in a tape associated therewith.

9. In a telephone system for automatic billing of connections, a calling line, a called line, means for establishing a connection between said lines, means for registering the designation of said lines, means for registering the start and finish time of said connection, tape recording means responsive to the establishment of said connection including a tape, means responsive immediately after the registration of each of said designations for operably associating said tape recording means with all of said registering means, and a group of punch magnets in said tape recording means operatively responsive in succession of all of said registers for perforating in said tape a record of the designation of said calling line, the designation of said called line, and the start and finish time of said connection.

10. In a telephone system, a tape recording means for recording items of billable information of a telephone connection, a tape recording mechanism having a tape, a switching trunk for extending a connection and containing means for marking items of billable information as the connection is extended, a call registering mechanism, means responsive to the use of said switching trunk as a part of said connection for operatively associating said call registering mechanism to said switching trunk whenever said switching trunk has marked an item of billable information for registering the same in said registering mechanism, and means responsive to said last mentioned connection for operatively connecting said tape recording mechanism to said registering mechanism for further recording said item of billable information on said tape.

11. In a telephone system for the automatic billing of connections, a main group of lines divided into a plurality of subgroups, and a line identification circuit comprising means responsive to a calling line in any one of said subgroups for identifying the subgroup of said calling line, other means responsive to said calling line for identifying the position of said calling line within said subgroup, and means responsive to both of said means for recording both of said identifications.

12. In a telephone system for the automatic billing of connections, a plurality of lines divided into a number of subgroups and a line identification circuit for all of said lines comprising an identifying relay for each line, a group of relays for marking said subgroups, another group of relays for marking the position of corresponding lines in each of said subgroups, circuit means for each of said relay groups, said circuit means being controlled through the contacts of each of said line identifying relays for closing the circuit of a relay in one group to mark the calling line subgroup and for closing the circuit of a relay in the other group for marking the calling line in said subgroup, a tape recorder, means responsive to the extension of a calling line for operating the line identifying relay of said line to operate the proper subgroup and line marking relays in said two groups of relays, and means responsive to the operation of said marking relays for operating said tape recorder to record the identification of the subgroup and the identification of said calling line in said subgroup.

13. In a telephone system for the automatic billing of connections, a main group of lines divided into a plurality of subgroups, a line-extending switch connectible with any of said lines when calling, and a line identification circuit for said lines comprising an identifying relay for each line, a first group of relays for marking all line subgroups, a second group of relays for marking the position of corresponding lines in each of said subgroups, means responsive to the connection of said line-extending switch to a calling line for operating the line identifying relay of said line, means controlled by said line-extending switch and by said operated line identifying relay for operating a relay in said first group of relays to mark the subgroup of the calling line and to operate a relay in said second group of relays to mark the position of said calling line in said subgroup, a tape recorder, and means responsive to the operation of said marking relays for operating said tape recorder to record the identification of said subgroup and the identification of said calling line in said subgroup.

14. In a telephone system for the automatic billing of connections, a plurality of calling lines, a plurality of called lines, means for extending said calling lines to said called lines, a tape recording mechanism provided with a tape for recording thereon called numbers and the starting and finishing times of completed telephone connections, and a tape registering circuit for controlling the operation of said tape recording mechanism comprising means for registering a called number, means responsive to the establishment of said connection for registering the starting and finishing time of said connection, means for operative connection with any of said lines when extended for connecting any of said registering means with said line or its extension to register the called number or the starting or finishing time of the connection and means responsive after the registration of either the called number, or the starting time or the finishing time of said connection for operating said tape recording mechanism for recording the information so registered on said tape.

15. In a telephone system for the automatic billing of connections, a calling line, means for extending said line for a local connection, means for extending said line for a toll connection, a tape recorder having a tape for recording thereon items of billable information relating to completed calls including the calling line identity, called number, start and finishing time of a connection and the character of the call, a tape register for controlling the operation of said tape recorder, means for connecting said tape register to either of said calling line extensions, means for registering in said register items of information for said local call extension, means for connecting said register with said tape recorder after each registration to record said registration on said tape, and means responsive to the connec-

tion of said tape register to said calling line extension in case said extension is for a toll call for further connecting with said tape recorder to record on said tape the character of the call only.

16. In a telephone system for the automatic billing of connections, a tape recorder having a tape for recording thereon items of billable information relating to calls including the calling line identity, called line number and the starting and finishing time of a call, and a tape register circuit for controlling the operation of said recorder comprising a register for each of said items and a common group of relays operable by each of said registers for completing circuits to said tape recorder for recording the registered item on said tape.

17. In a telephone system for the automatic billing of connections, a calling line, a called line, means for extending said calling line to said called line, said means including an impulse control device for registering said called line number and for transmitting a plurality of a series of impulses designating said number, a tape recorder having a tape for recording thereon items of billable information relating to calls including the calling line identity, called line number, the starting and finishing time of a call, a tape register circuit for controlling the operation of said recorder comprising means for the connection thereof to said calling line extension, a group of impulse receiving registers associable with said impulse control device and operative by said plurality of a series of impulses designating the called number to register said impulses, means responsive to the registration of said impulses for connecting said tape register circuit to said tape recorder, and means responsive to said connection for operating said tape recorder in accordance with said impulse registration to record on said tape the number indicated by said registration.

18. In a telephone system for the automatic billing of connections, a calling line, a called line, means for extending said calling line to said called line, said means including other means for marking the start and finishing time of a connection, a tape recorder having a tape for recording thereon items of billable information relating to calls including the calling line identity, called line number, the starting and finishing time of a call, a tape register for controlling the operation of said tape recorder comprising means for the connection thereof to said calling line extension, an impulse timing circuit responsive to said starting time marking means to register the starting time of the completed connection, means responsive to said registration for connecting said tape register circuit to said tape recorder for recording said registration, means for thereafter disconnecting said tape register circuit from said calling line extension and from said tape recorder, and means responsive to said finishing time marking means for reconnecting said tape register to said calling line extension to register the finishing time of the completed connection.

19. In a telephone system for the automatic billing of connections, calling lines, called lines, means for establishing a connection from any of said calling lines to any of said called lines, said means including other means for transmitting a signal for each item of billable information relating to each of said calls, a tape register circuit, means for operatively associating said tape register circuit with any of said connections when ready to transmit any one of said signals, means in said tape register circuit responsive to said operative association for registering said signal, and a tape recorder having a tape responsive to said registration for recording said signal on said tape.

20. In a telephone system having a plurality of subscribers' lines, a tape recording means for recording items of billable information of telephone connections established from said plurality of lines, switching trunks for extending said connections, a registering mechanism, means in each switching trunk responsive to the extension of a connection thereover for operatively associating said registering mechanism with said trunk, means for operating said registering mechanism to register items of billable information for said connection, and means responsive to said registration for operating said tape recording means to record said items in permanent form.

21. In a telephone system having a plurality of subscribers' lines, means for establishing telephone connections from said lines to called lines, a tape recording means for recording items of billable information of said connections, a register, means responsive to the extension of a connection from any one of said lines for operatively associating said register with said connection, means for registering the digits of the designation of the called line in said register, and means for operating said tape recording means for making a permanent record of said registered information.

22. In a telephone system having a plurality of subscribers' lines, means for establishing telephone connections from said lines, a tape recording means for recording items of billable information of said connections, registering means, means operative in response to the establishment of a connection from any one of said lines for controlling said registering means to register items of billable information for said connection, and means for operating said tape recording means for making a permanent record of said registered information.

23. In a telephone system having a plurality of subscribers' lines, means for establishing telephone connections from said lines, a tape recording means for recording items of billable information of said connections, registering means, means operable in response to the establishment of a connection from any one of said lines for controlling said registering means for recording the identification of the calling line, the identification of the called line and the elapsed time during which the connection is in use for conversational purposes, and means for operating said tape recording means for making a permanent record of said registered information.

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