July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 1

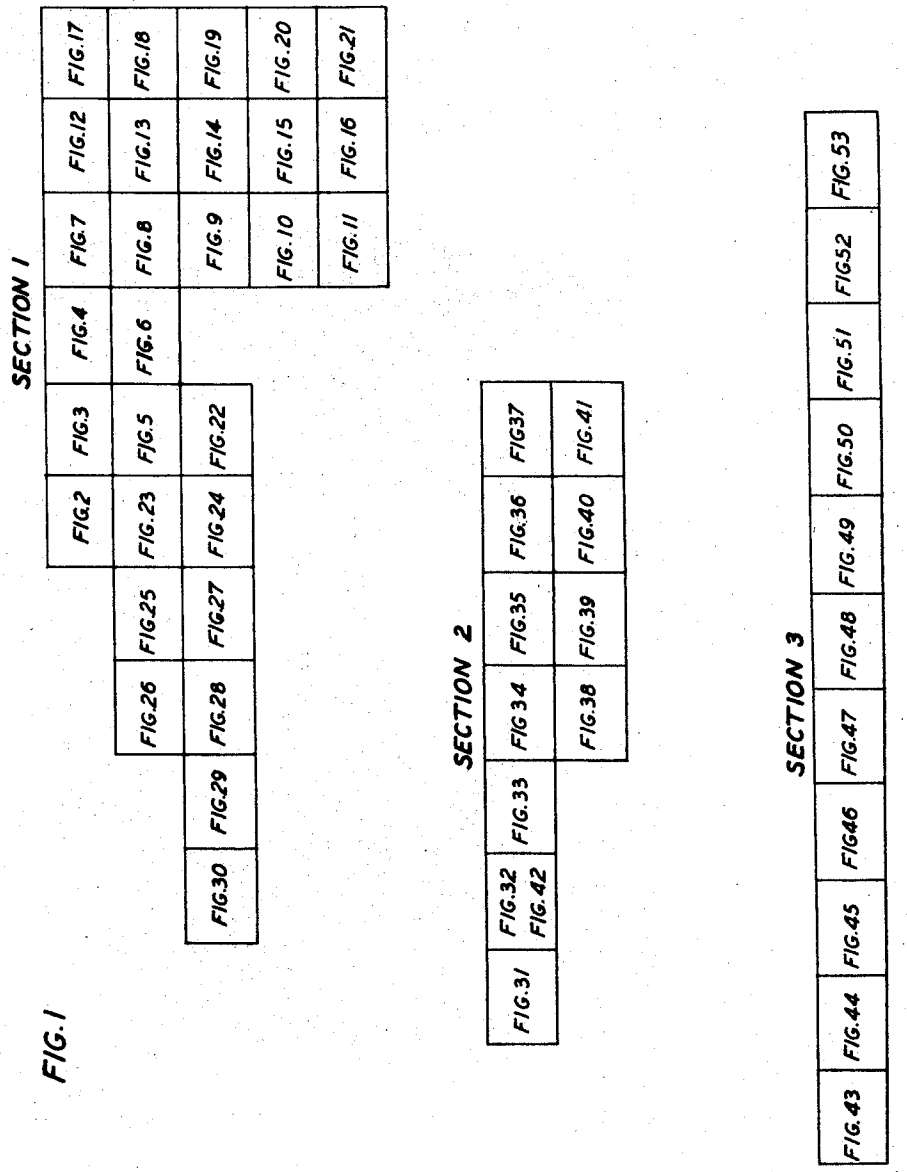

FIG. 1

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 2

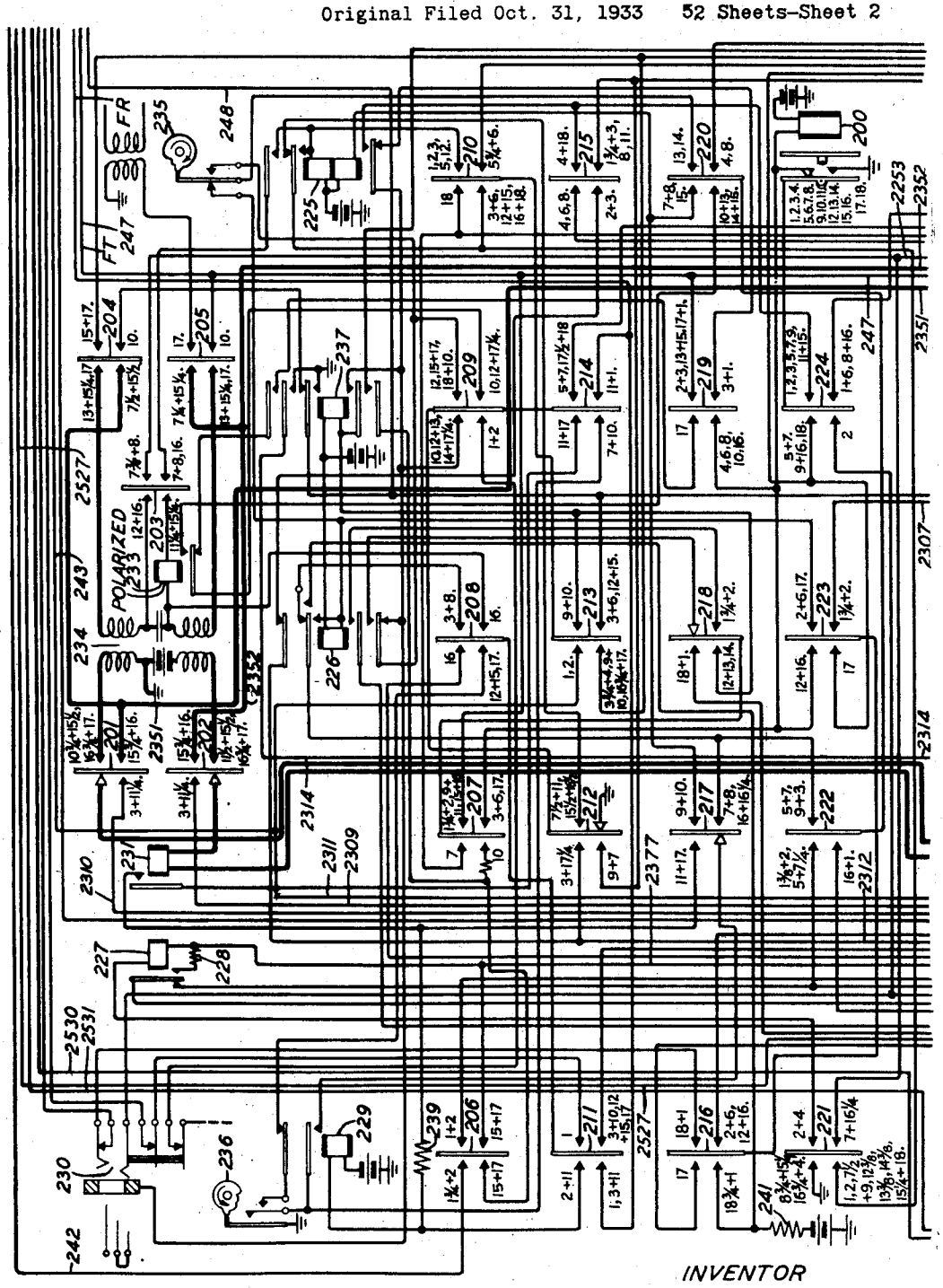

FIG. 2

INVENTOR
C. L. GOODRUM
BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 3

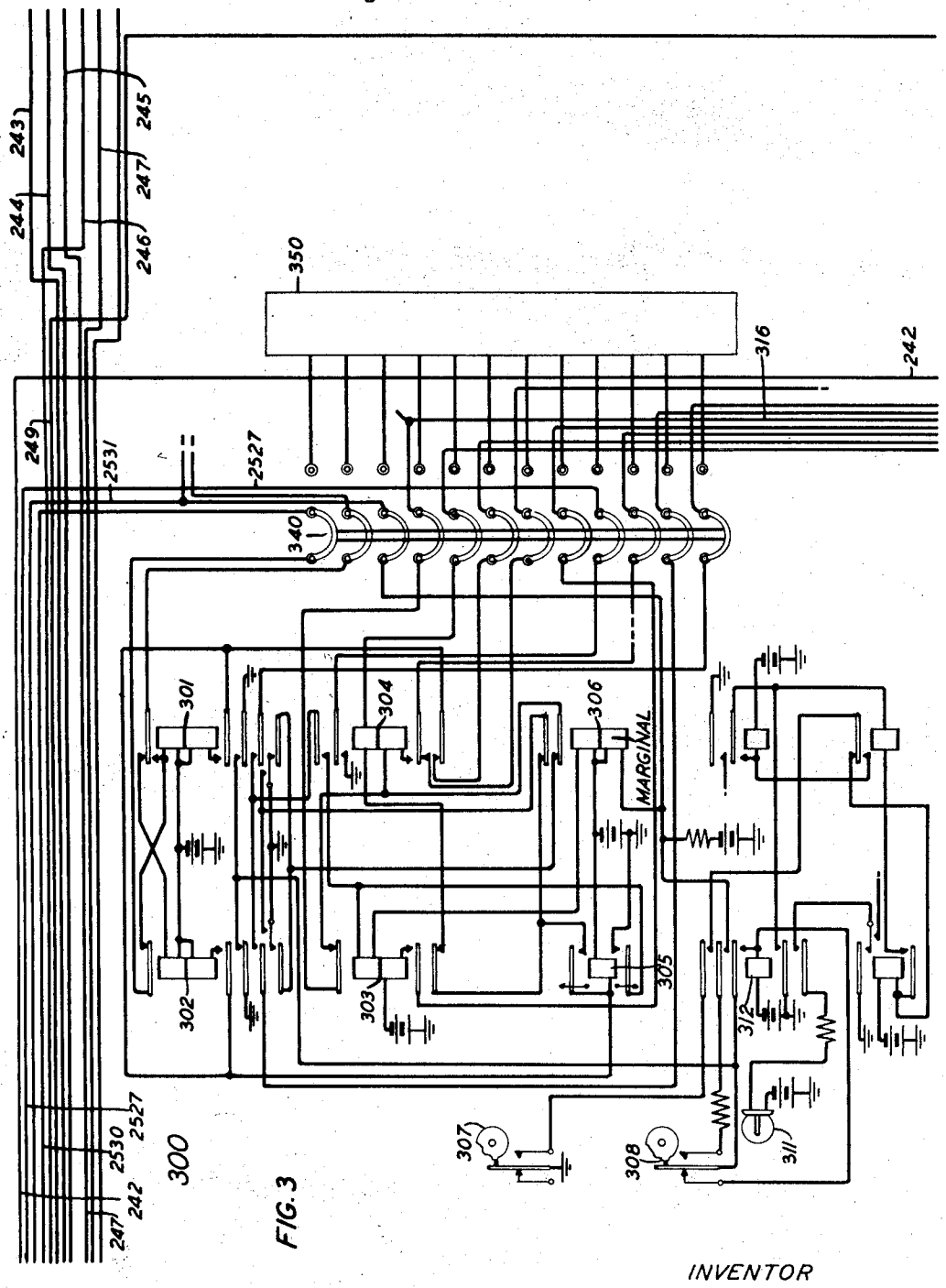

FIG. 3

INVENTOR
C. L. GOODRUM
BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 4

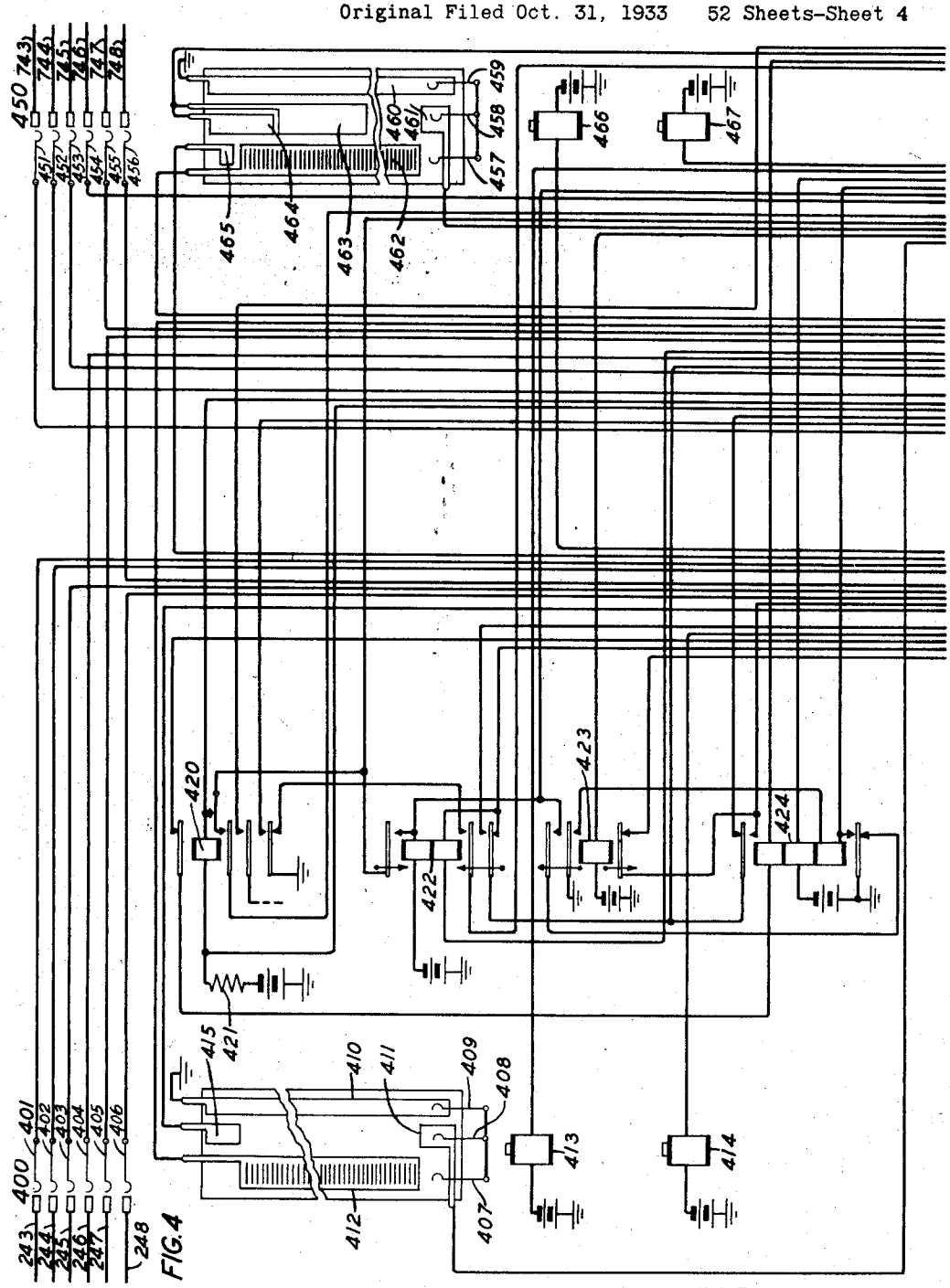

FIG. 4

INVENTOR
C. L. GOODRUM

BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 5

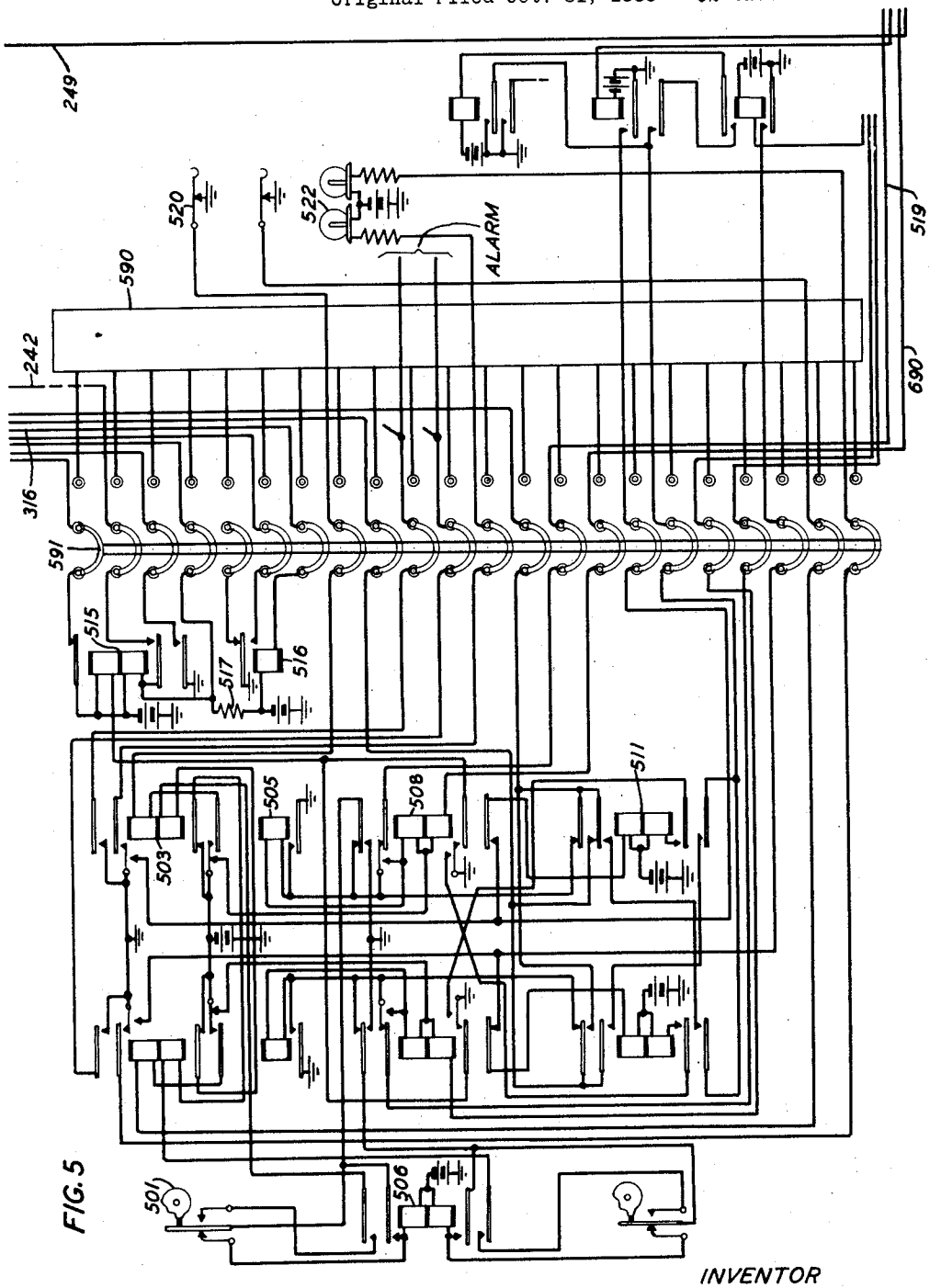

FIG. 5

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 6

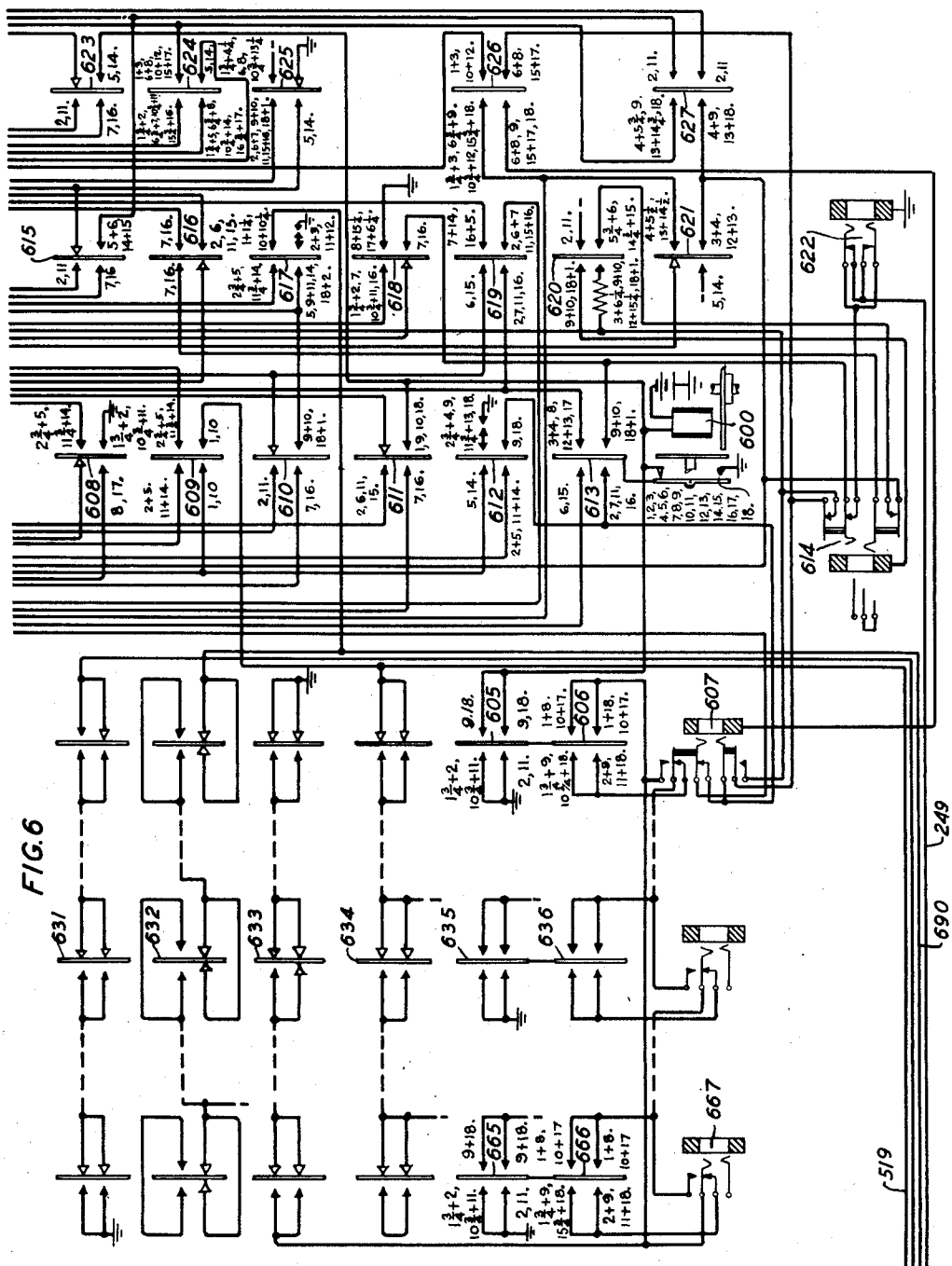

FIG. 6

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

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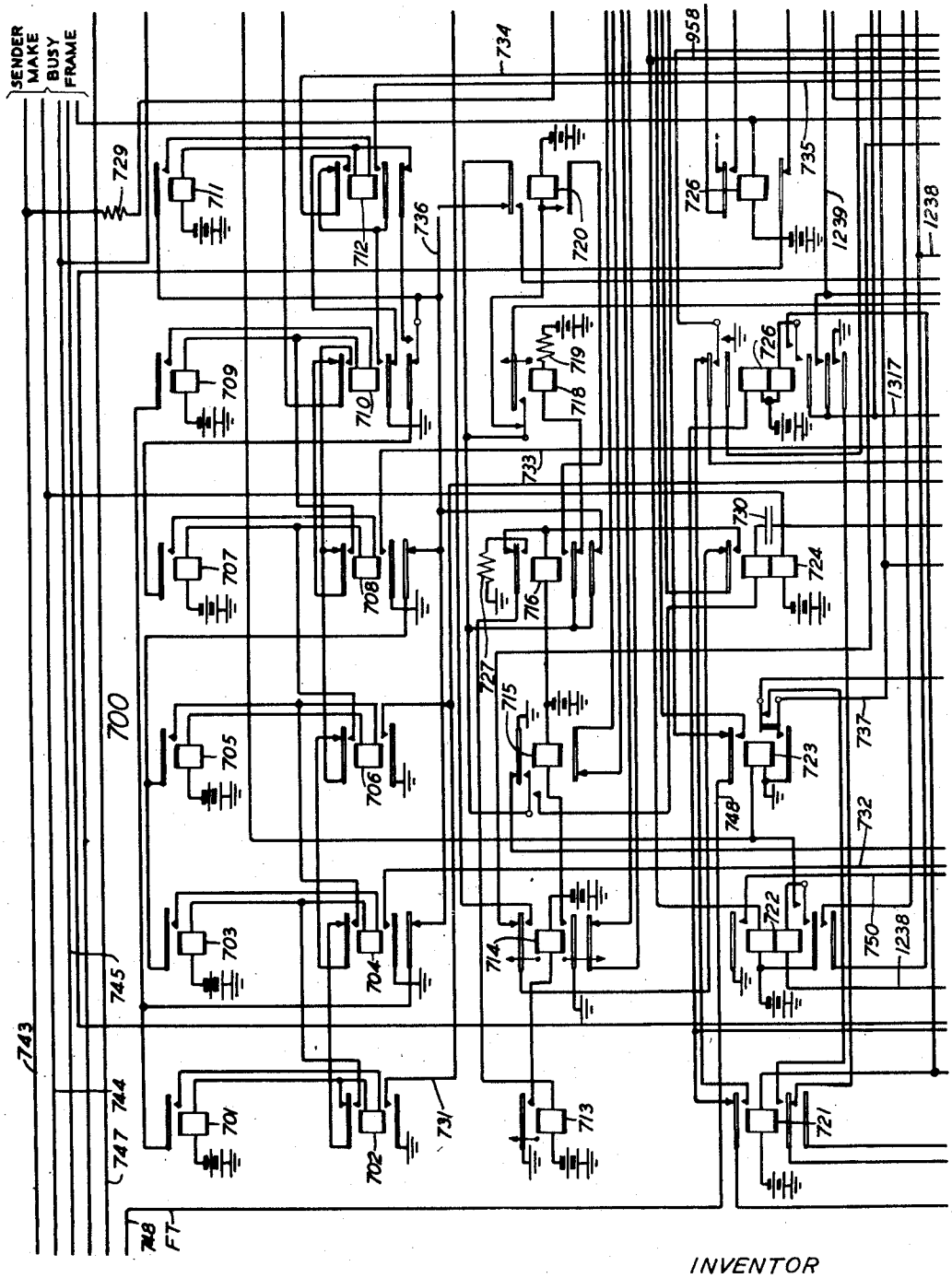

FIG. 7

INVENTOR
C. L. GOODRUM
BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 8

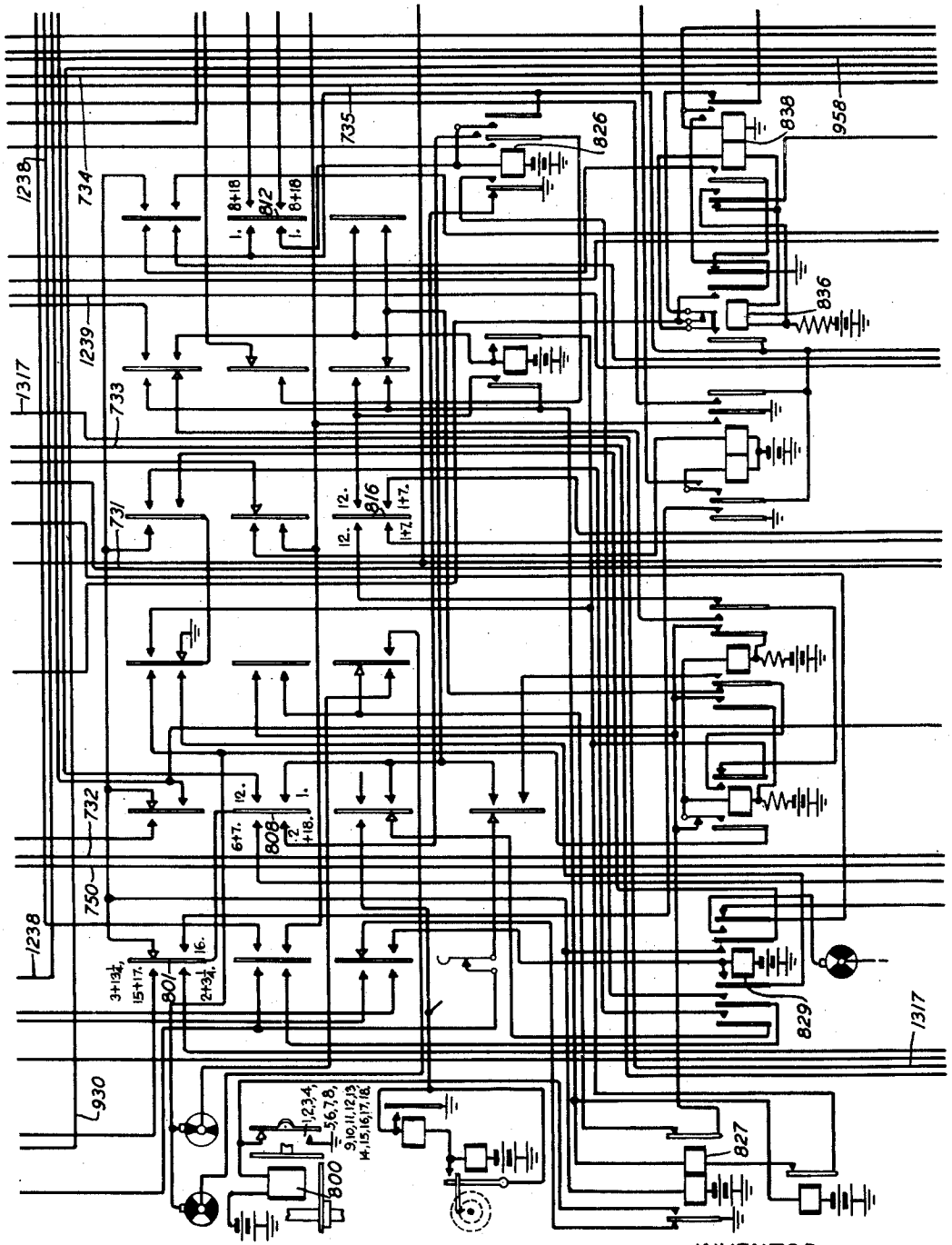

FIG. 8

INVENTOR
C. L. GOODRUM
BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

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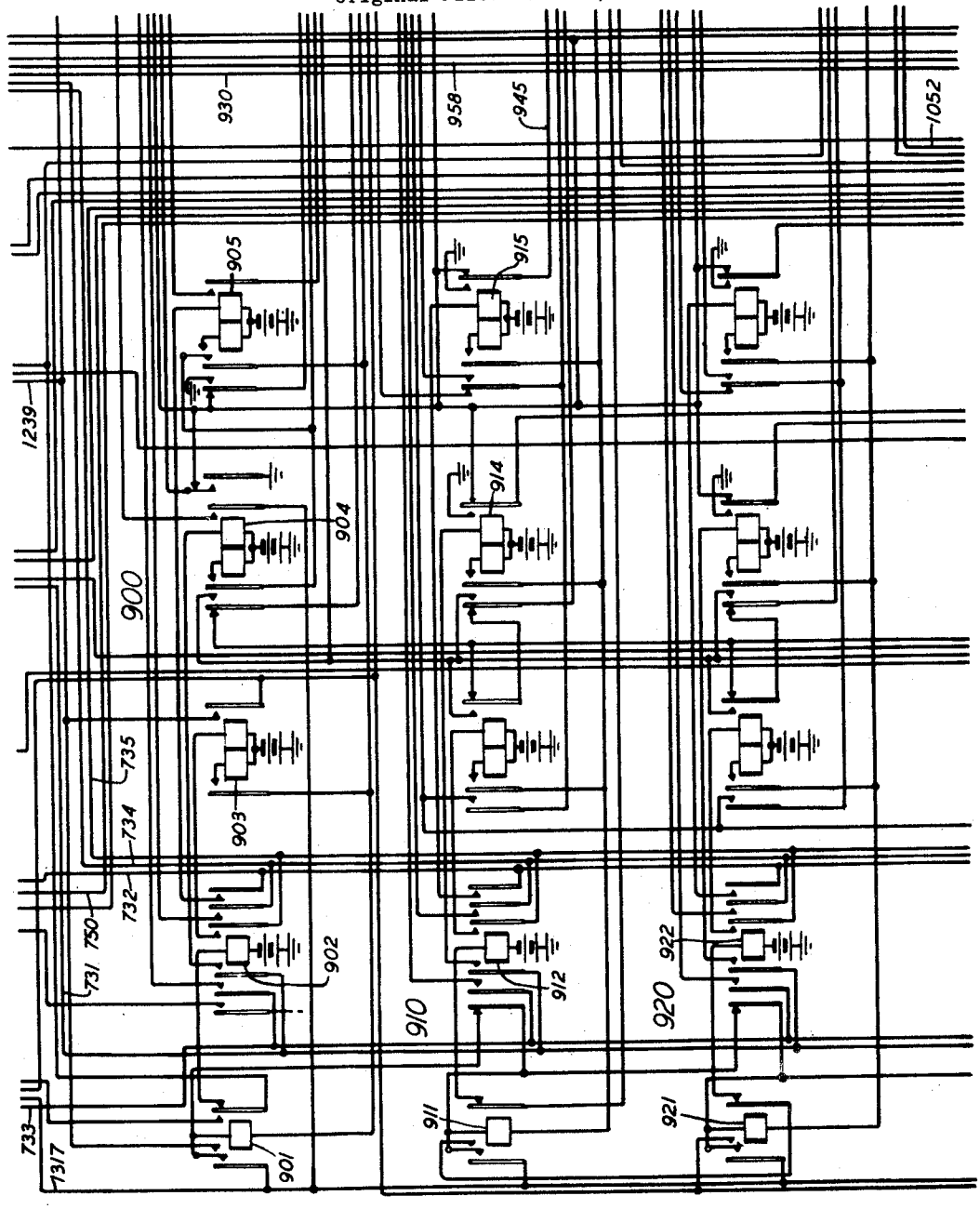

FIG. 9

INVENTOR
C. L. GOODRUM
BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 10

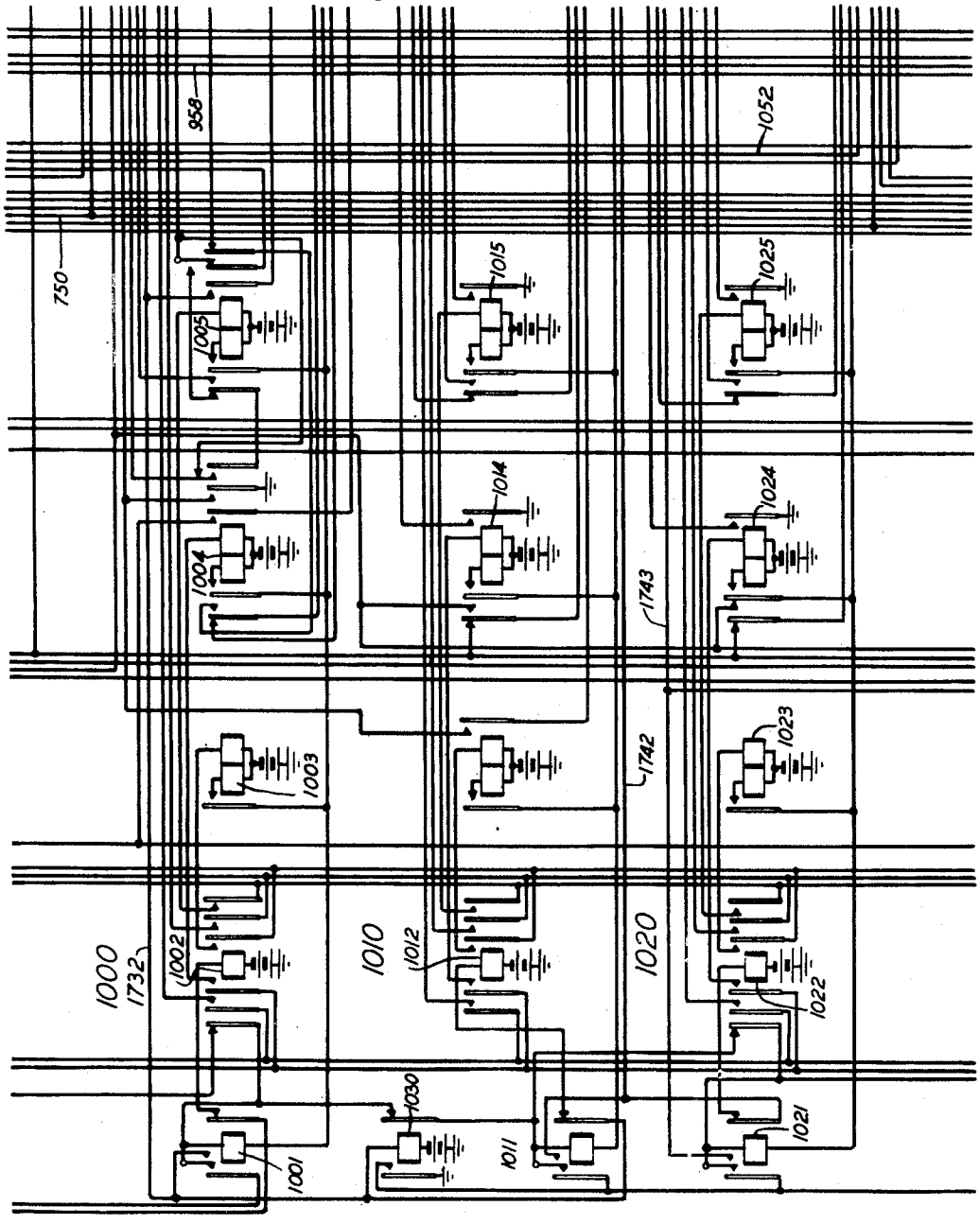

FIG. 10

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 11

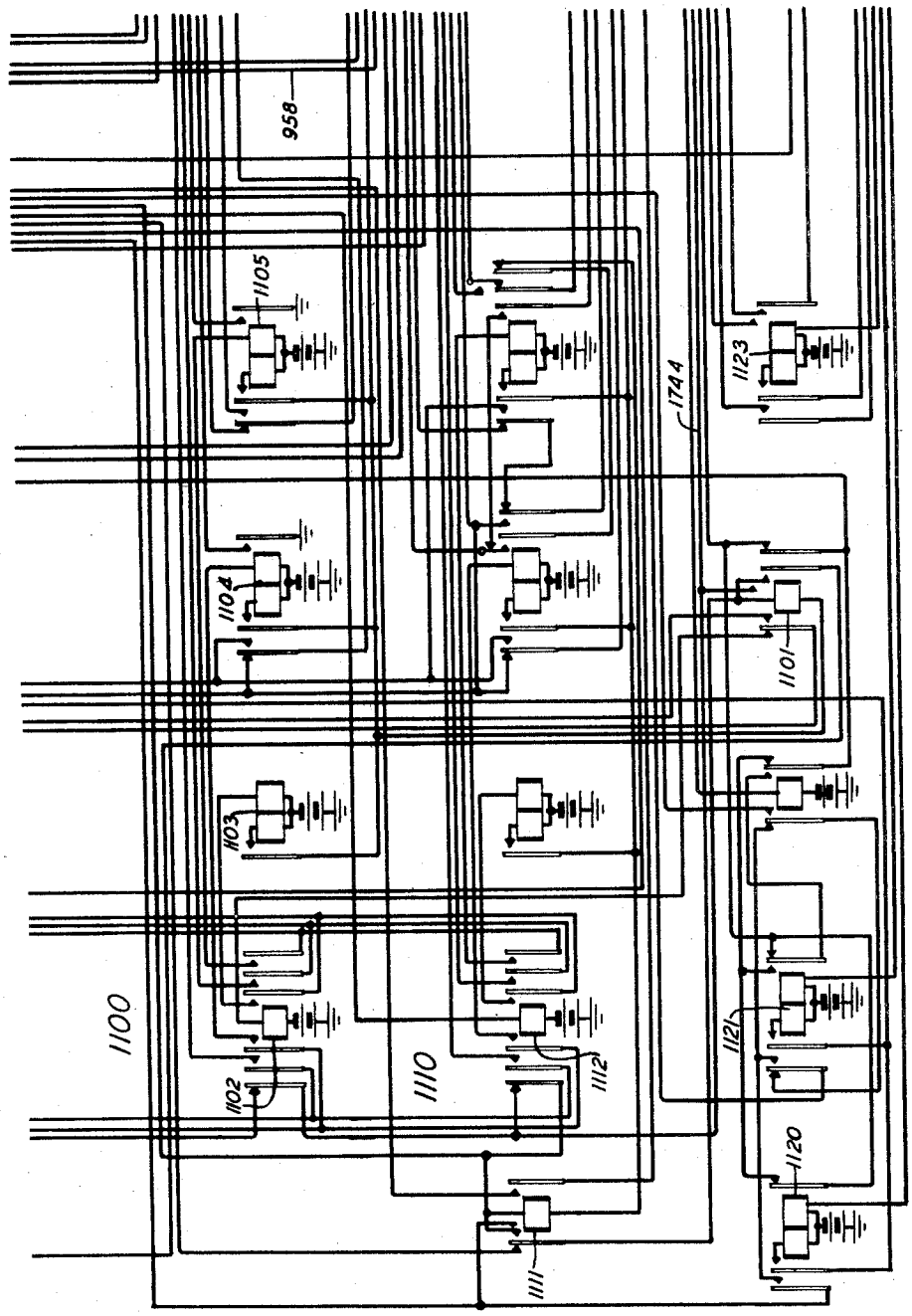

FIG. 11

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 12

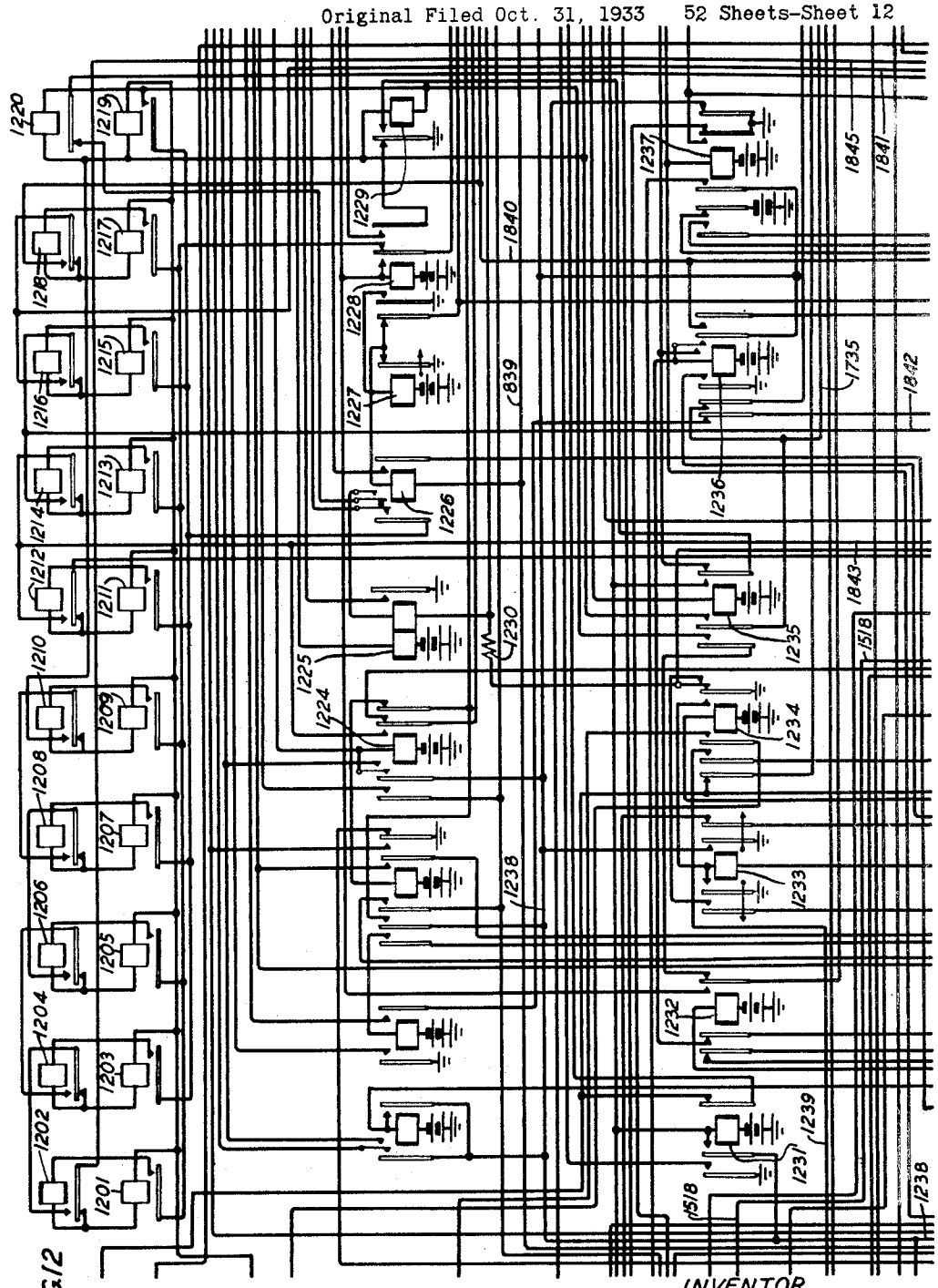

FIG.12

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

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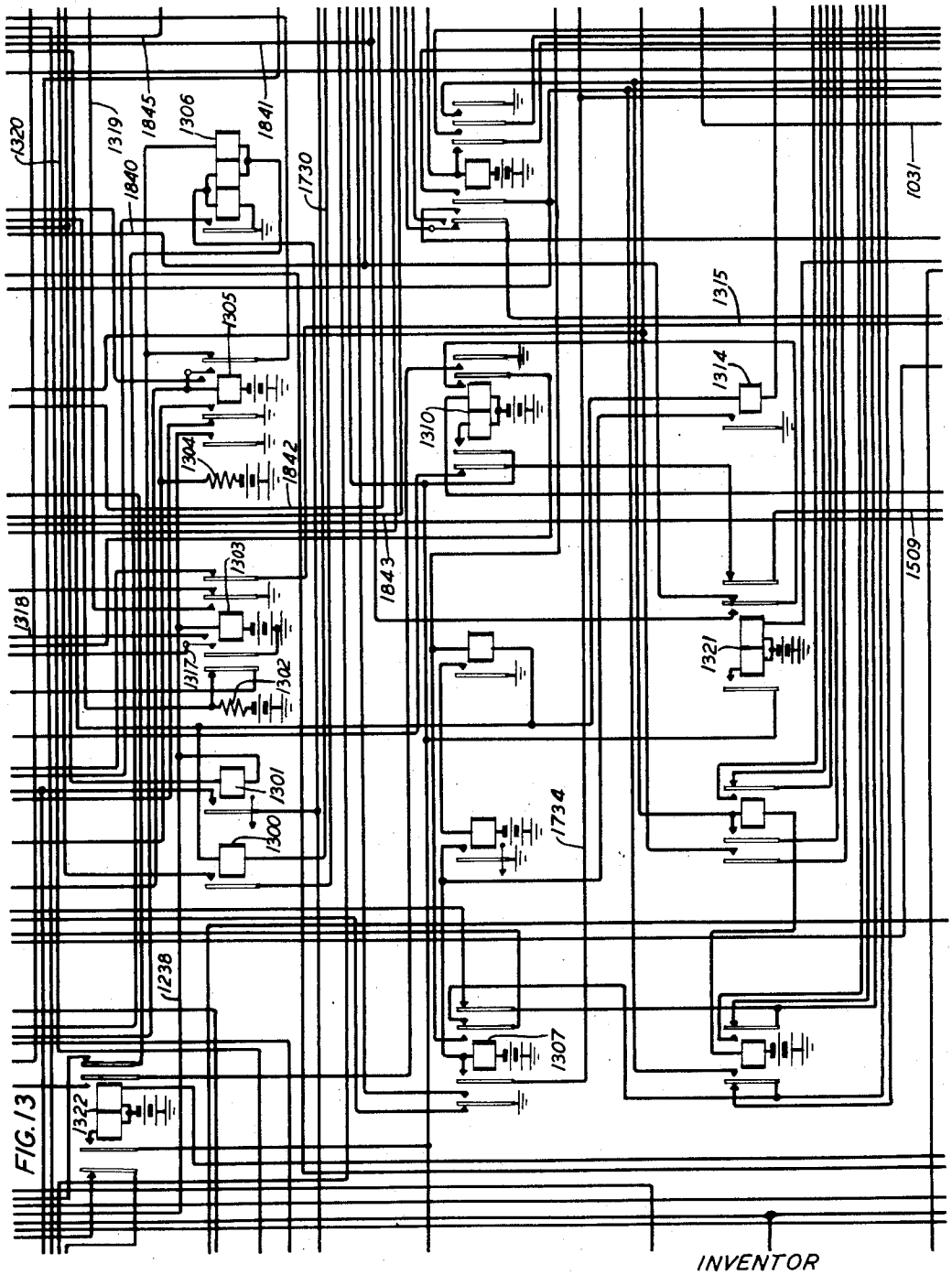

FIG. 13

INVENTOR
C. L. GOODRUM
BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

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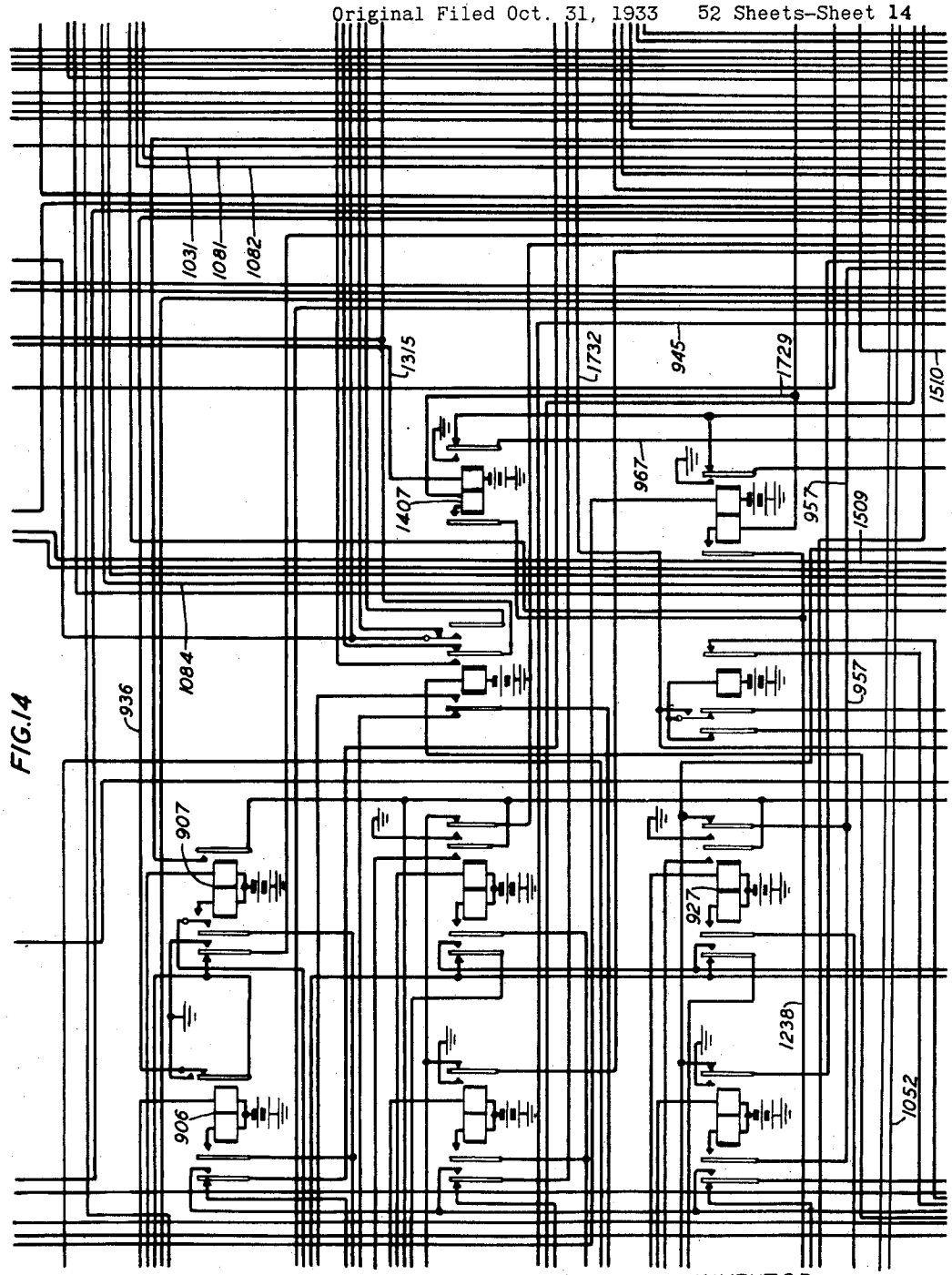

FIG. 14

INVENTOR
C. L. GOODRUM
BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 15

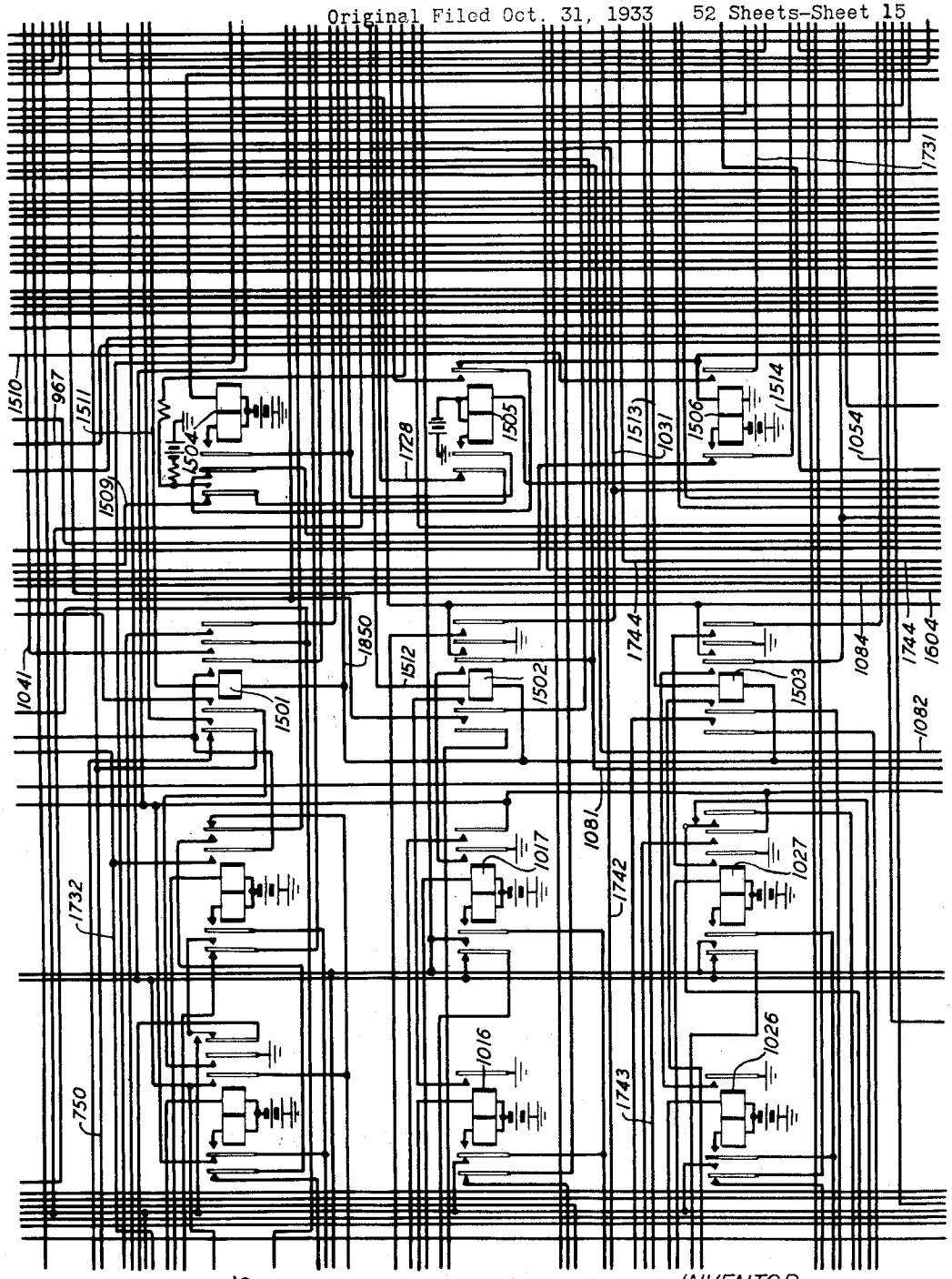

FIG. 15

INVENTOR
C. L. GOODRUM

BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 16

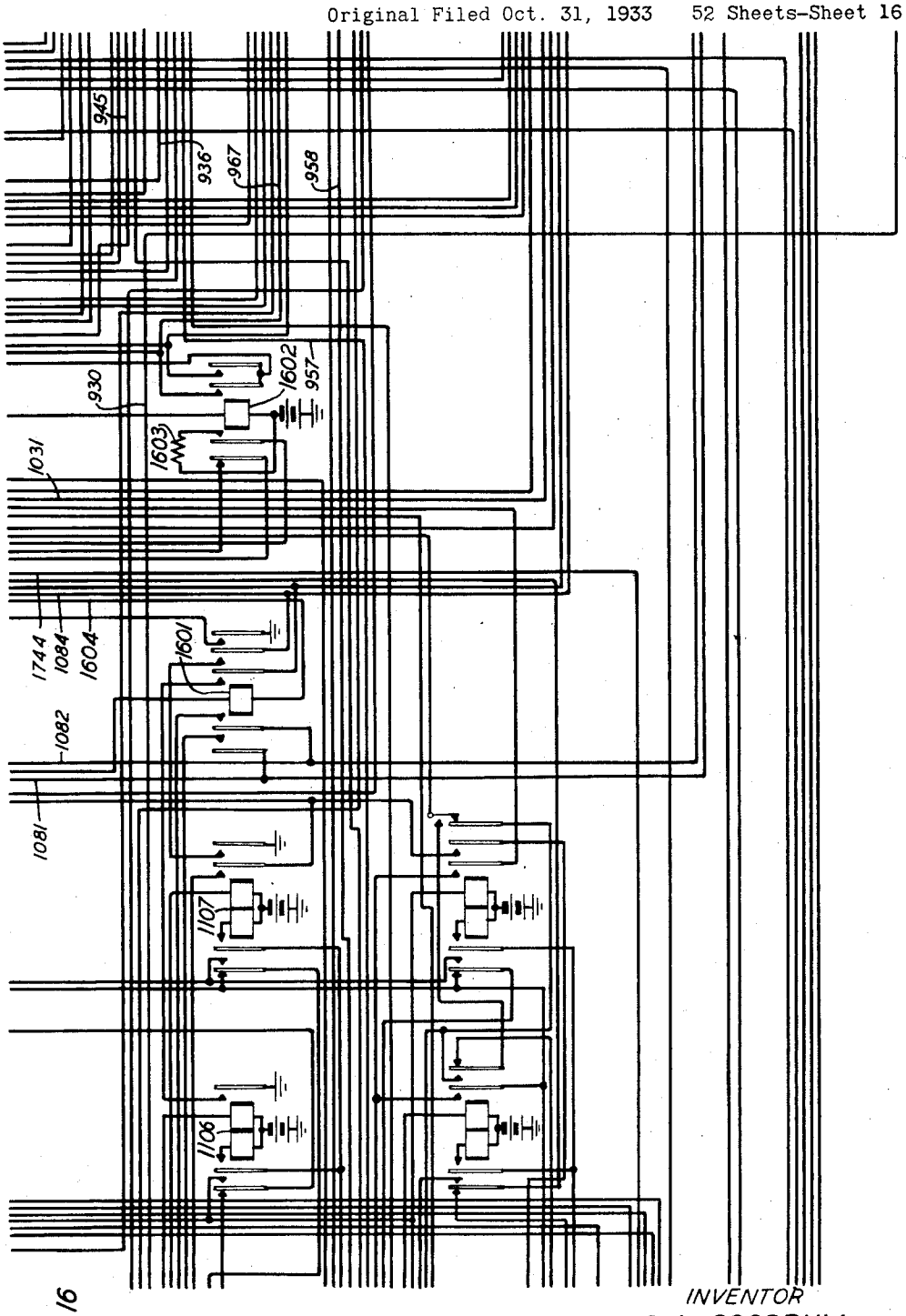

FIG. 16

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

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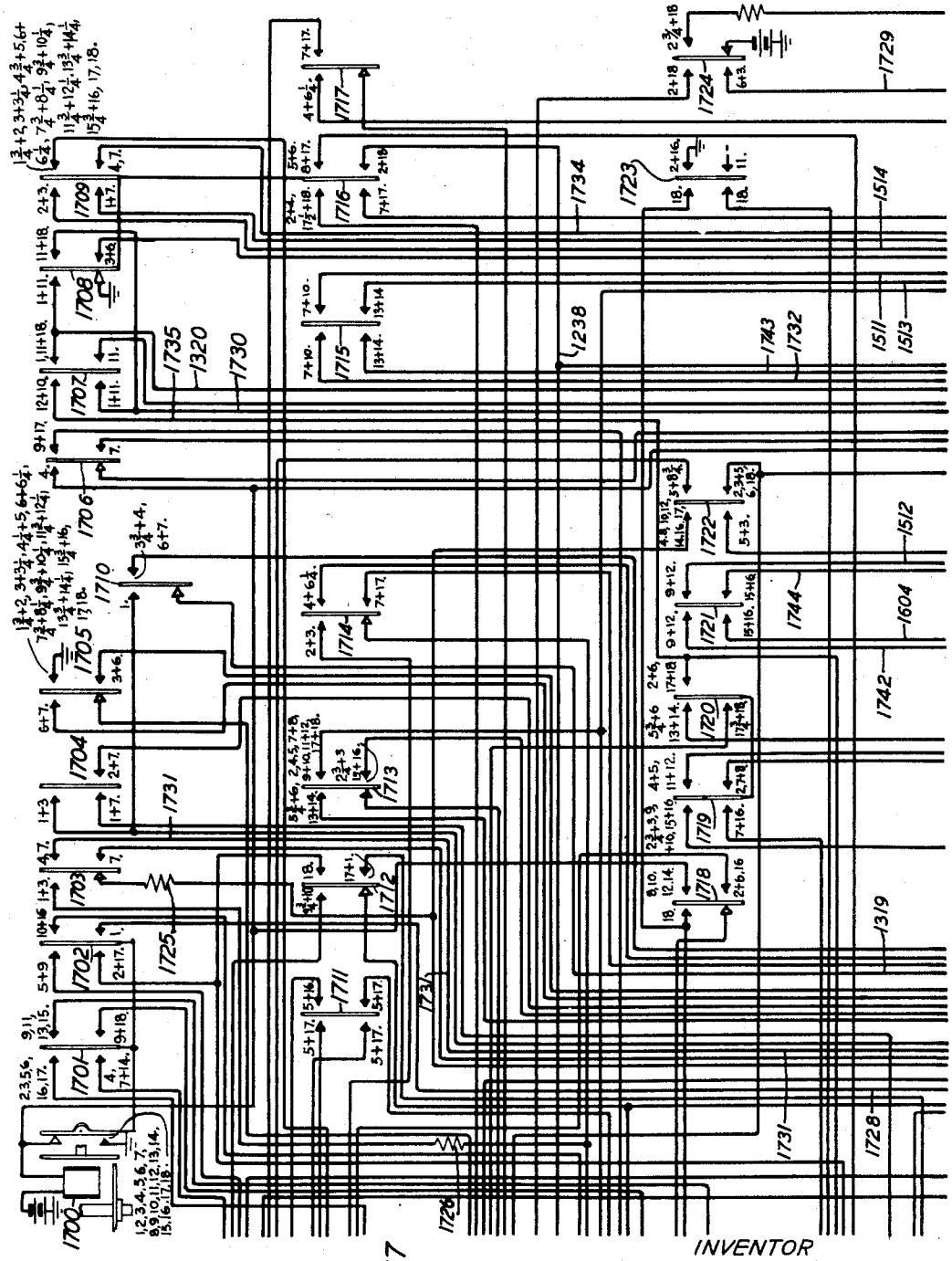

FIG. 17

INVENTOR
C. L. GOODRUM
BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 18

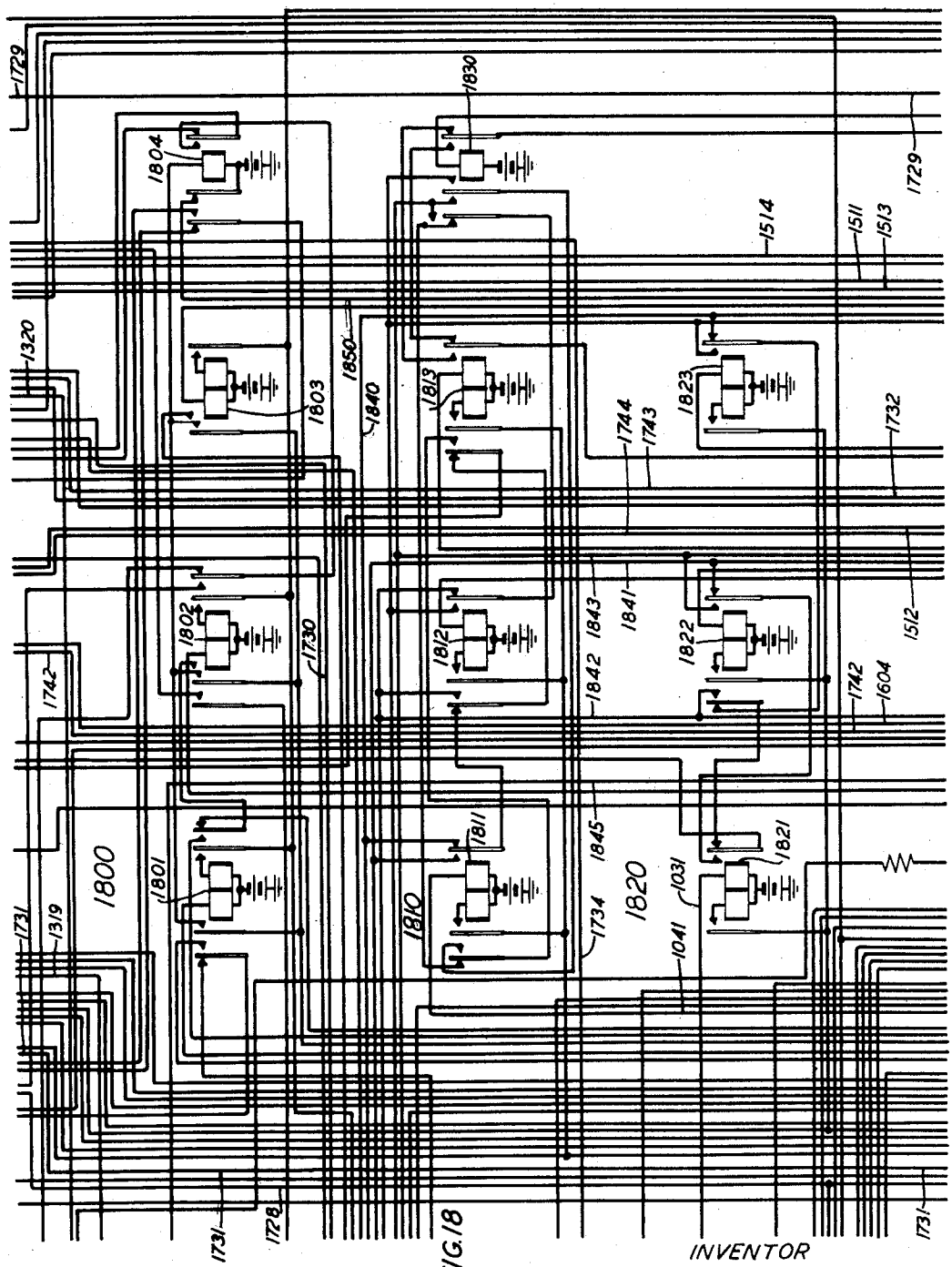

FIG 18

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 19

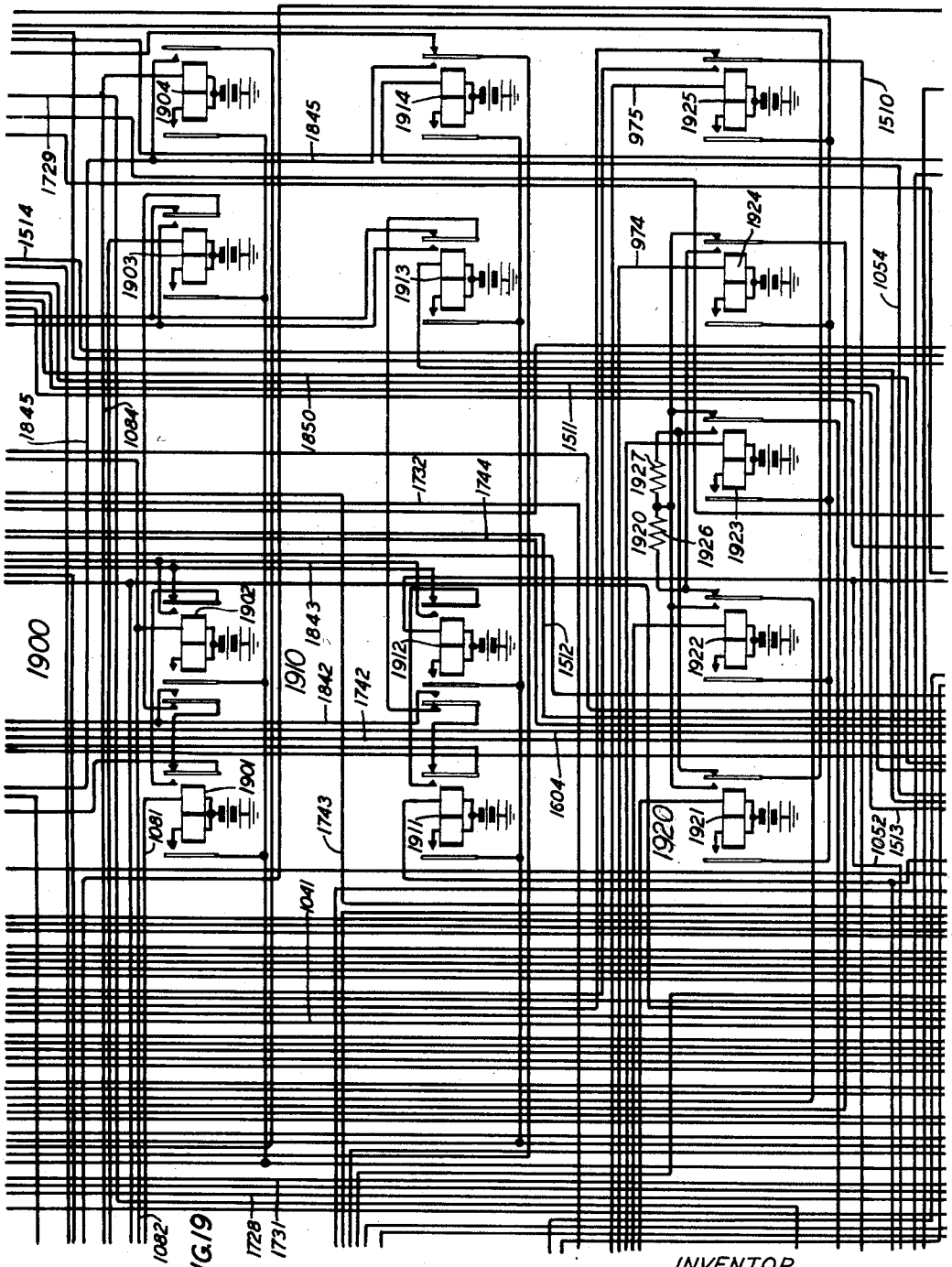

FIG. 19

INVENTOR
C. L. GOODRUM
BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

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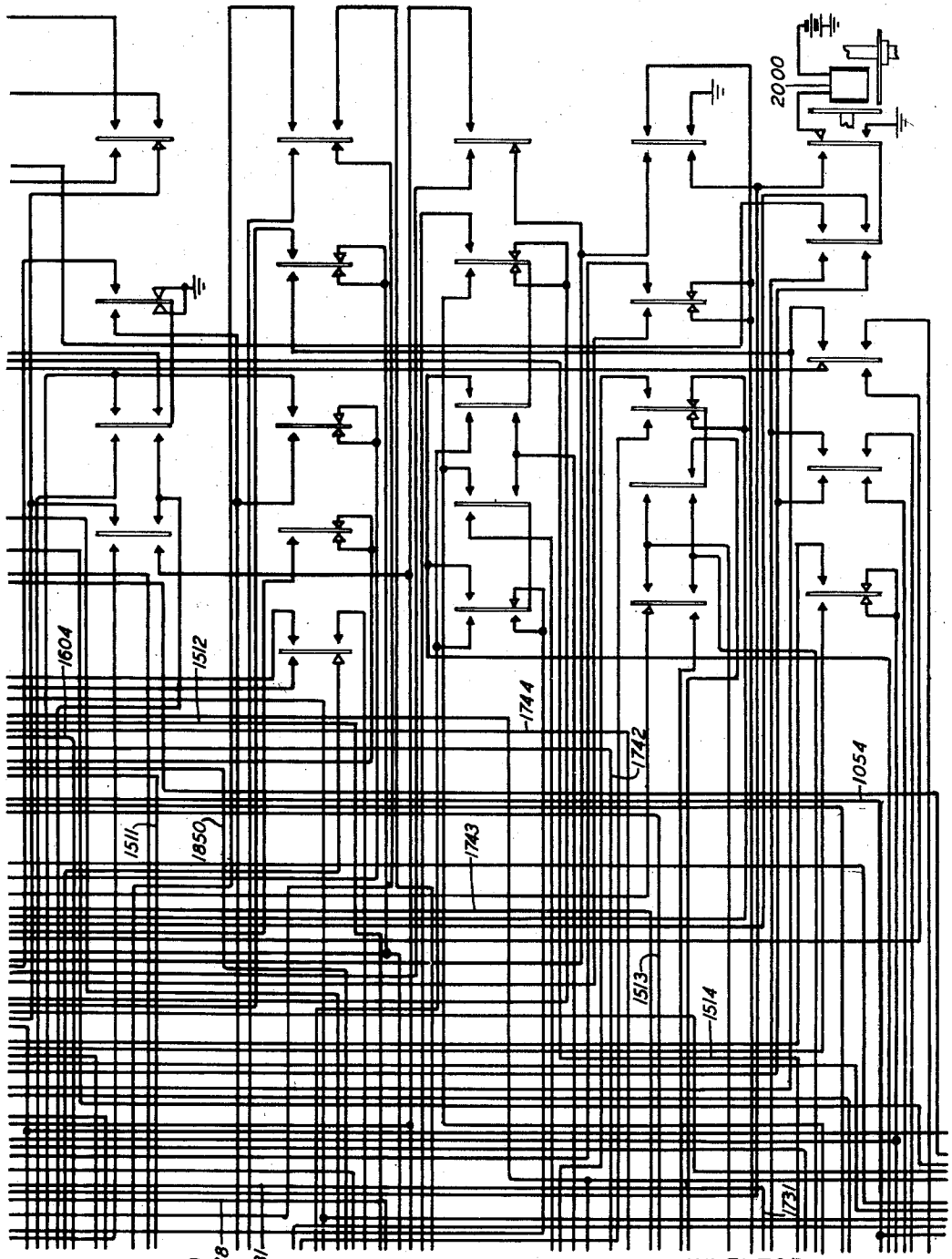

FIG. 20

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

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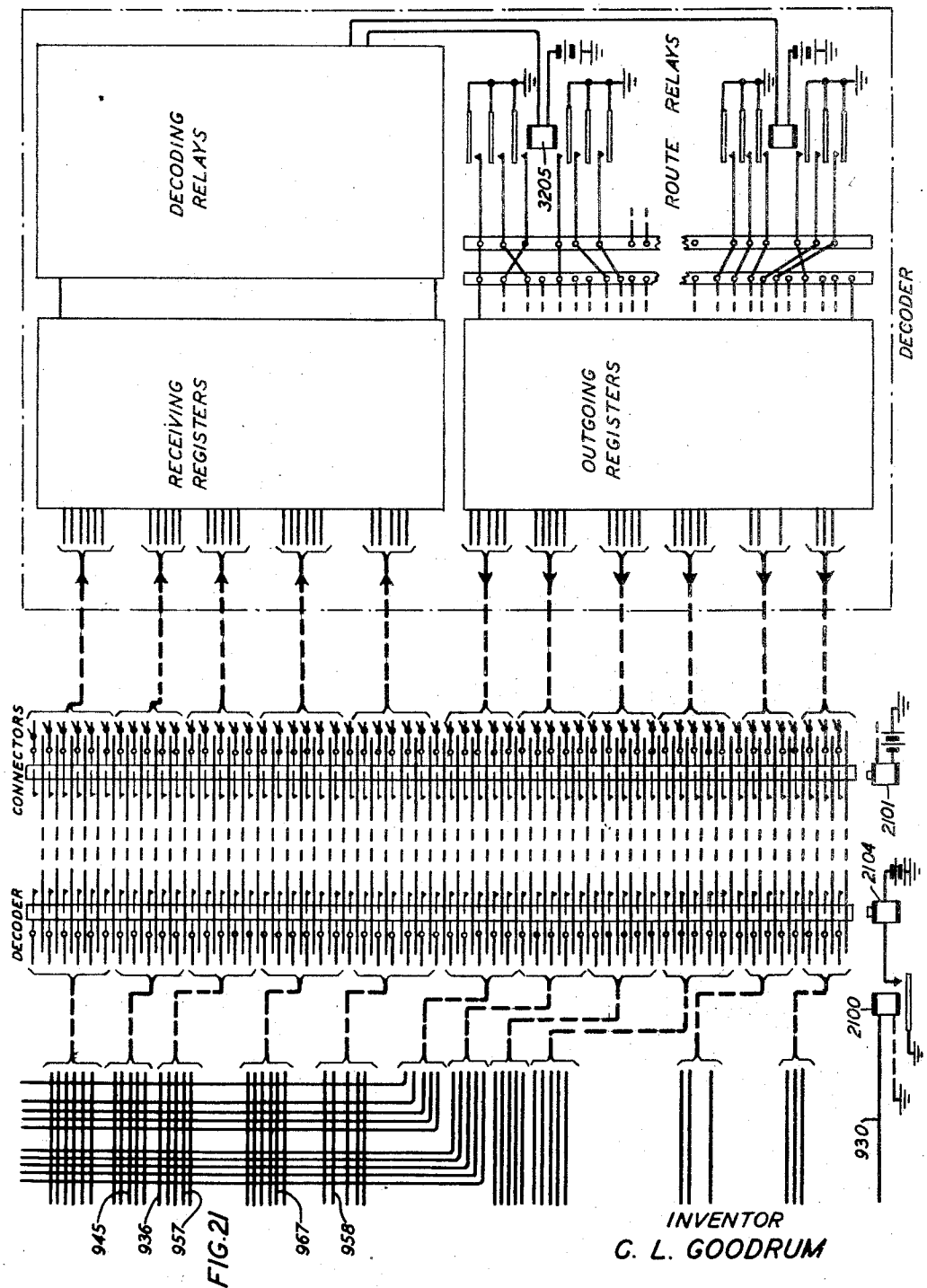

FIG. 21

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

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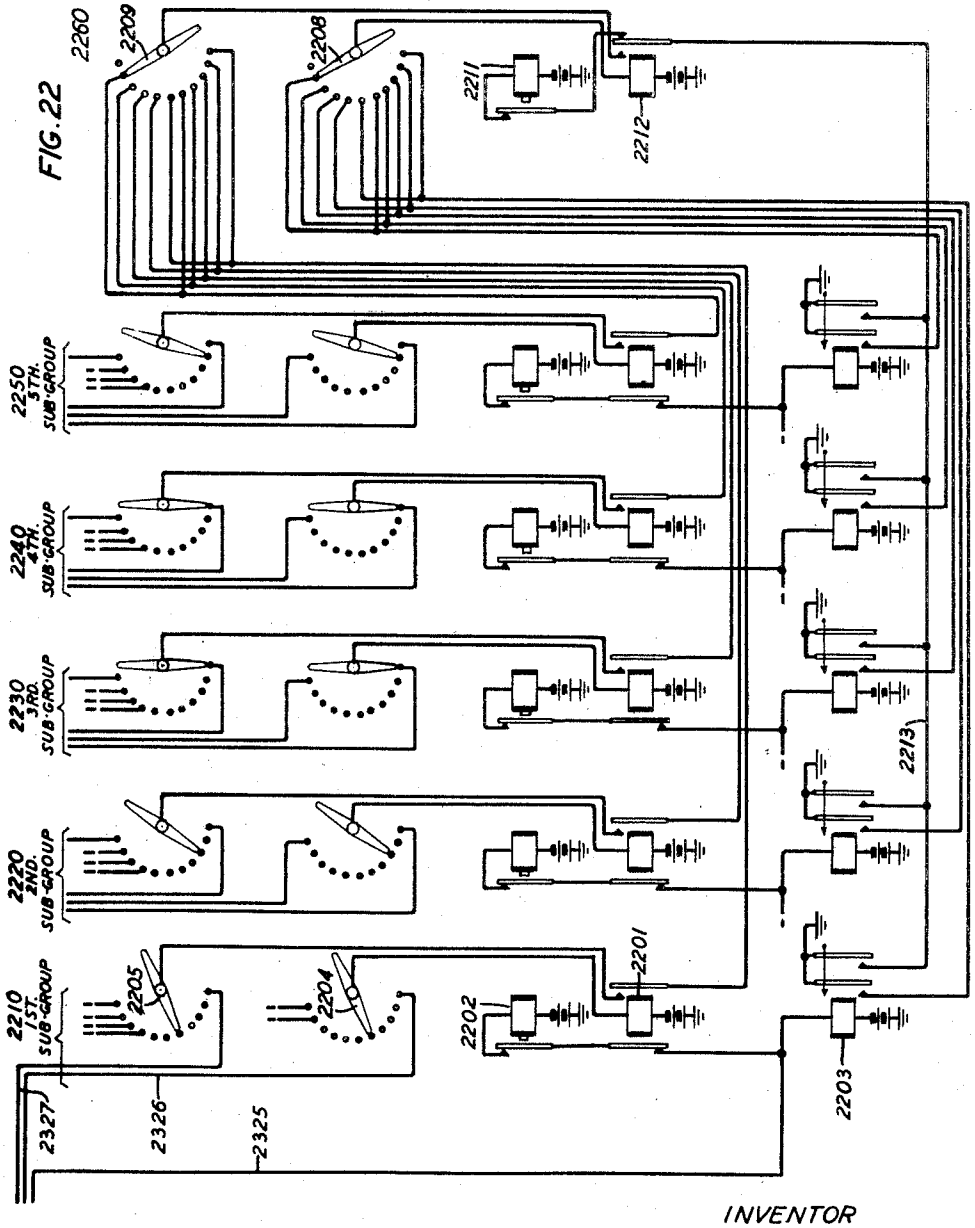
FIG. 22



INVENTOR
C. L. GOODRUM
BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 23

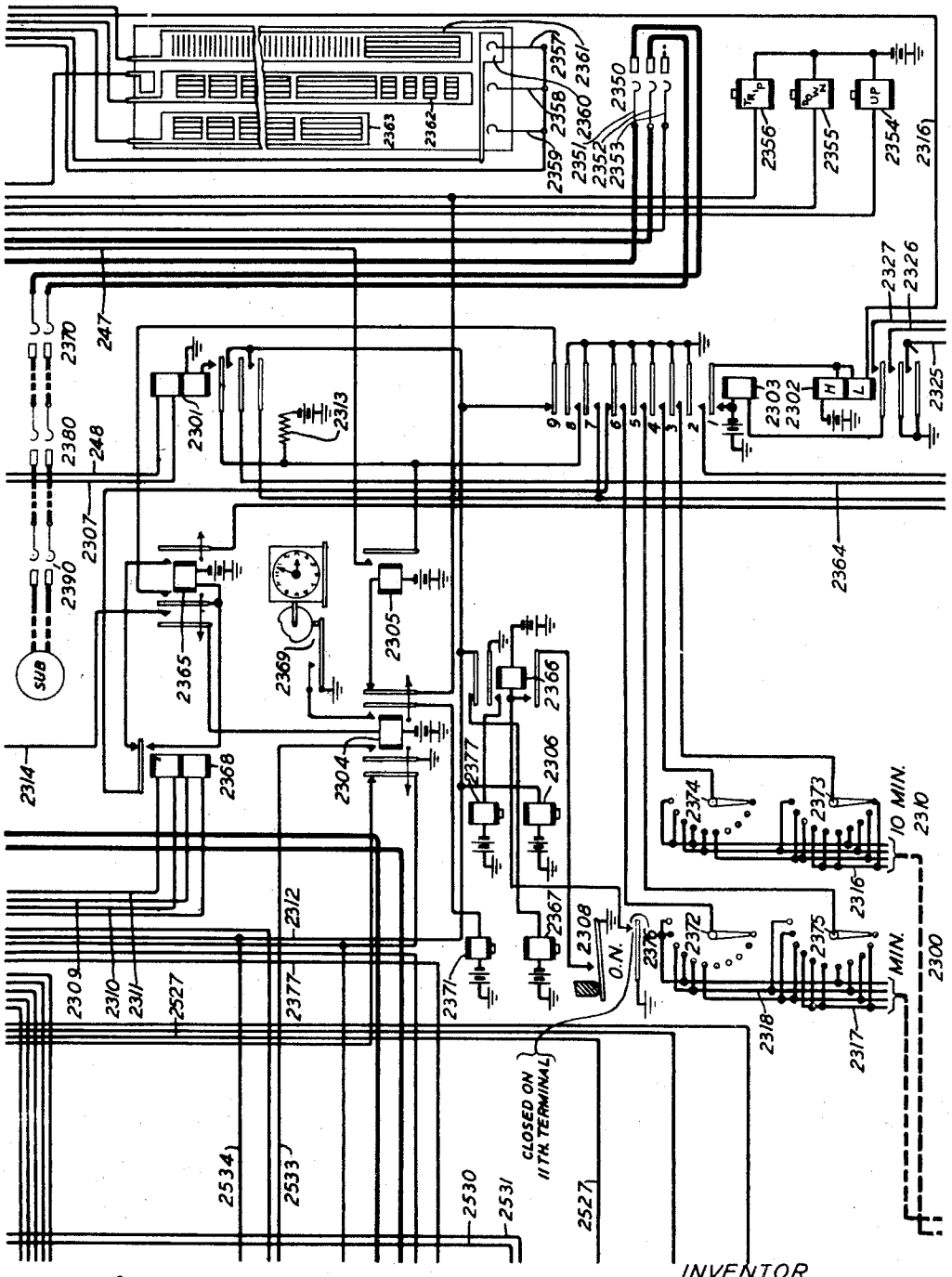


FIG.23

INVENTOR
C. L. GOODRUM
BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 24

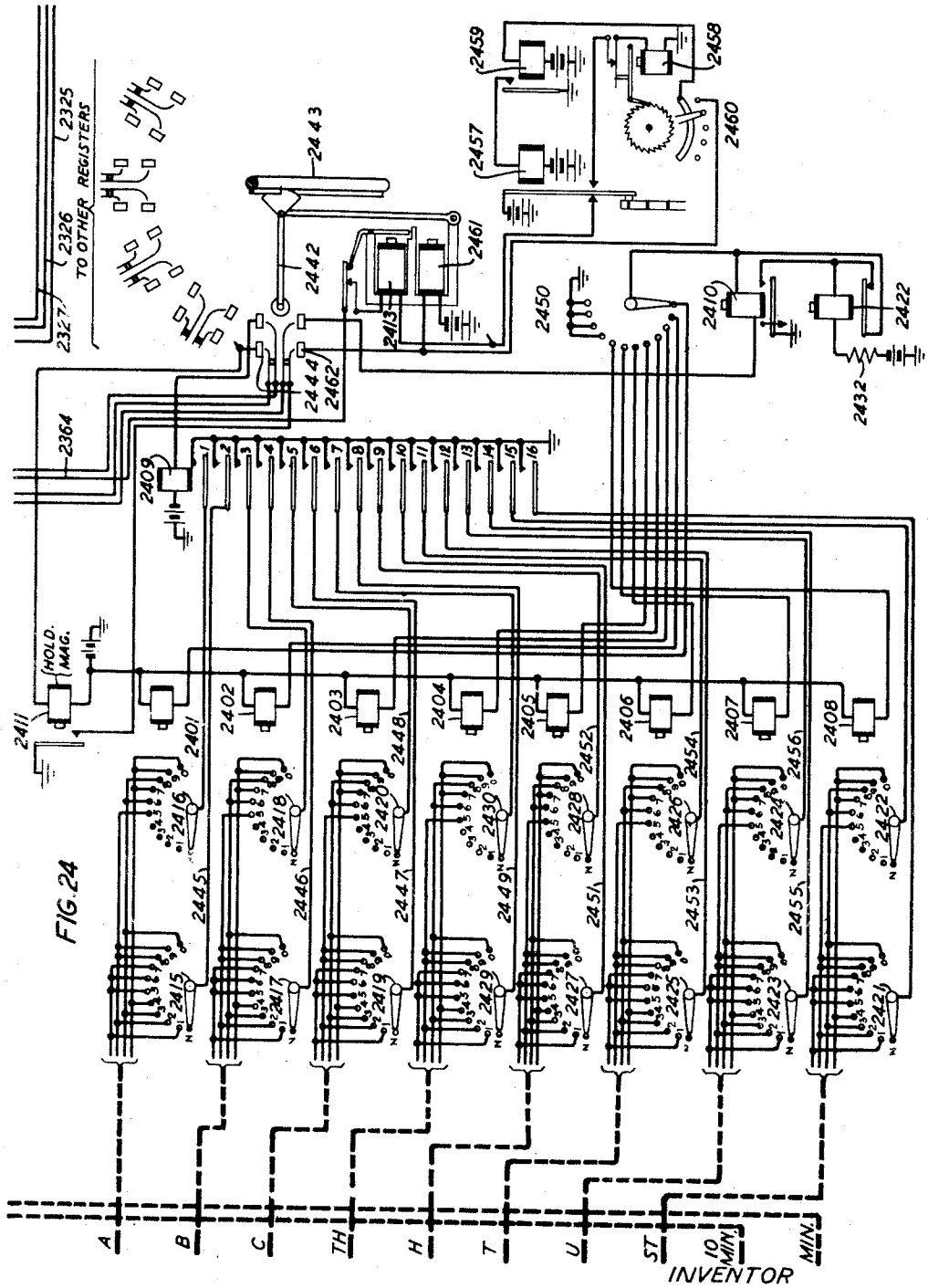


FIG. 24

INVENTOR
C. L. GOODRUM
BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

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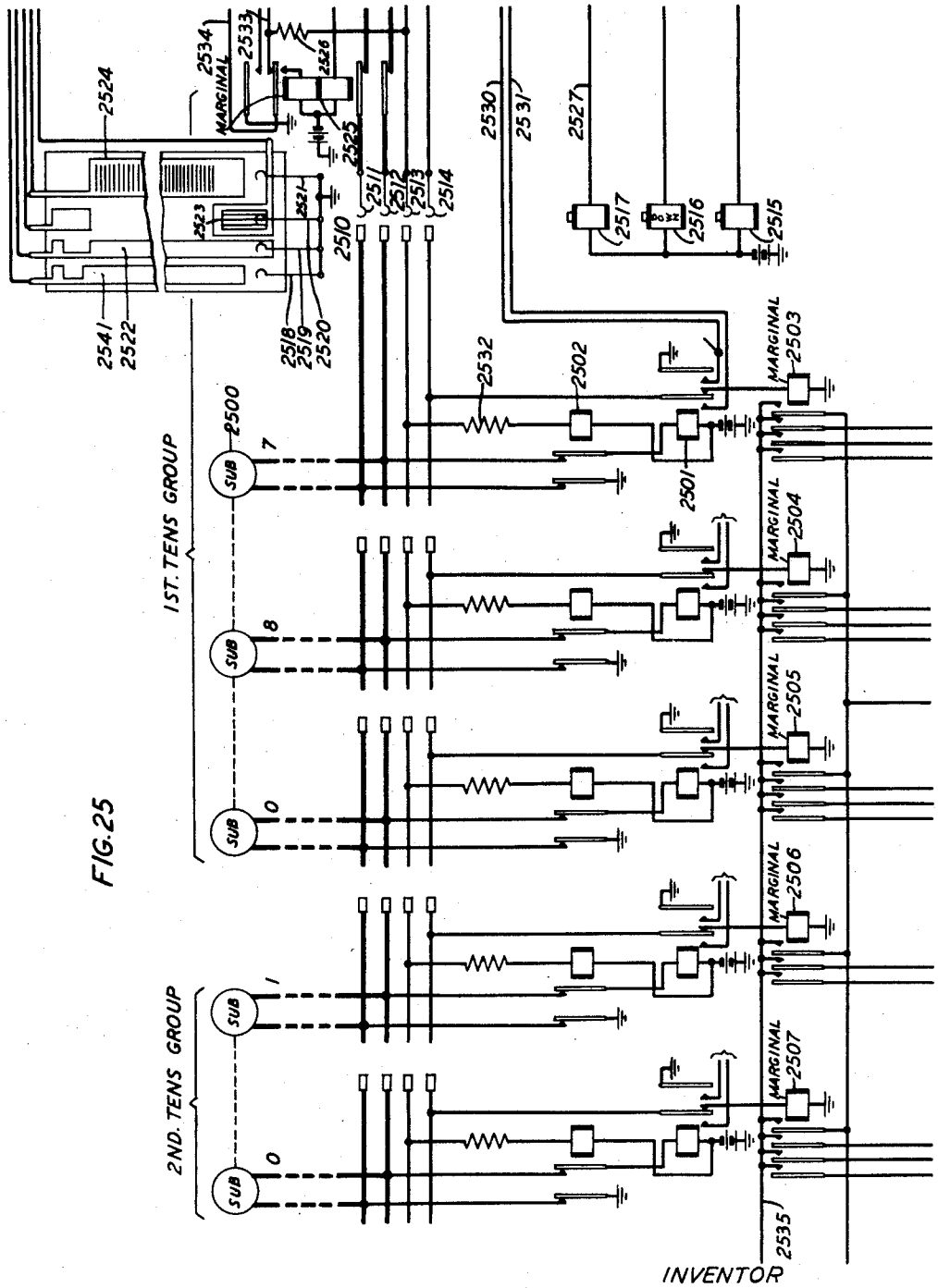

FIG. 25

INVENTOR
C. L. GOODRUM
BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

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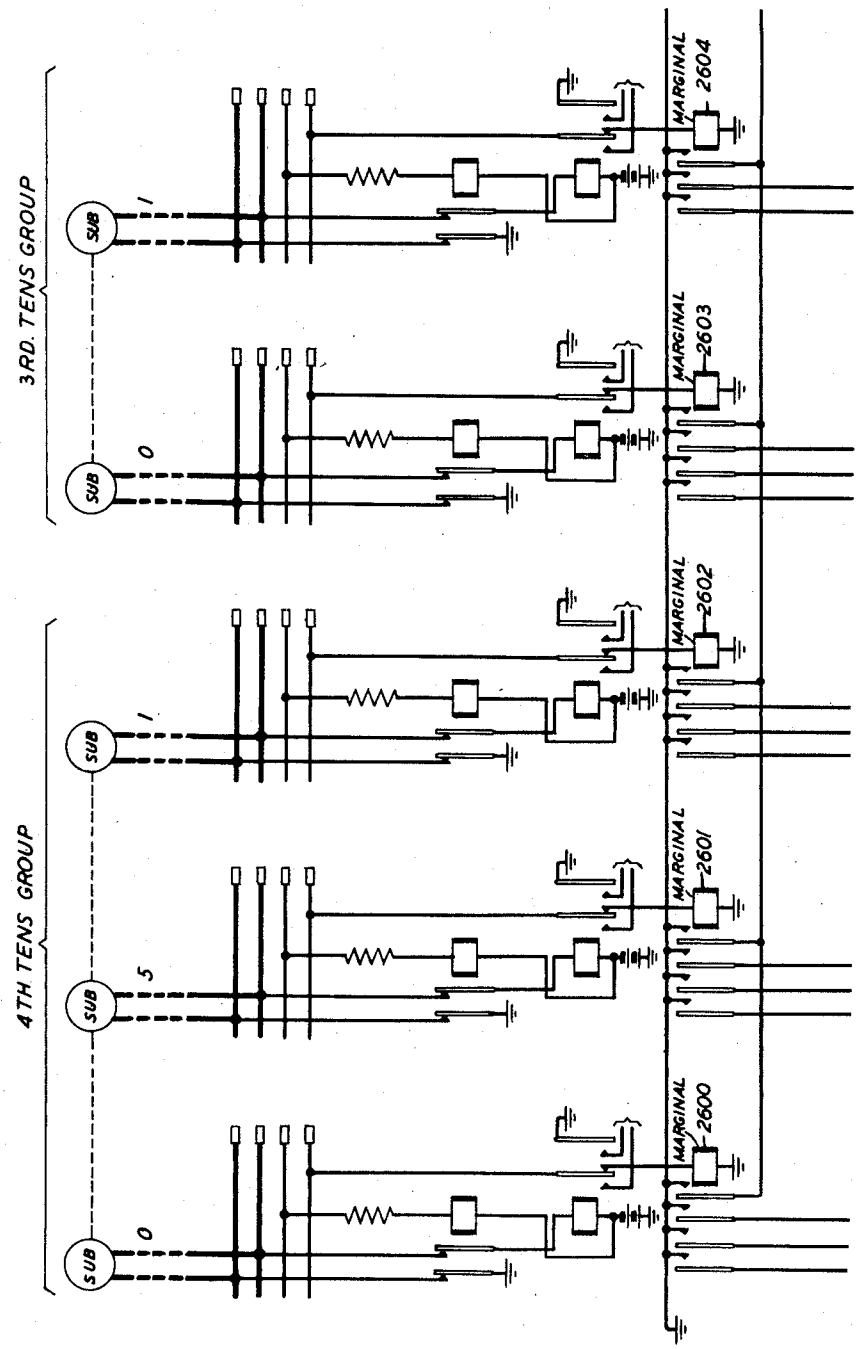

FIG. 26

INVENTOR
C. L. GOODRUM
BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 27

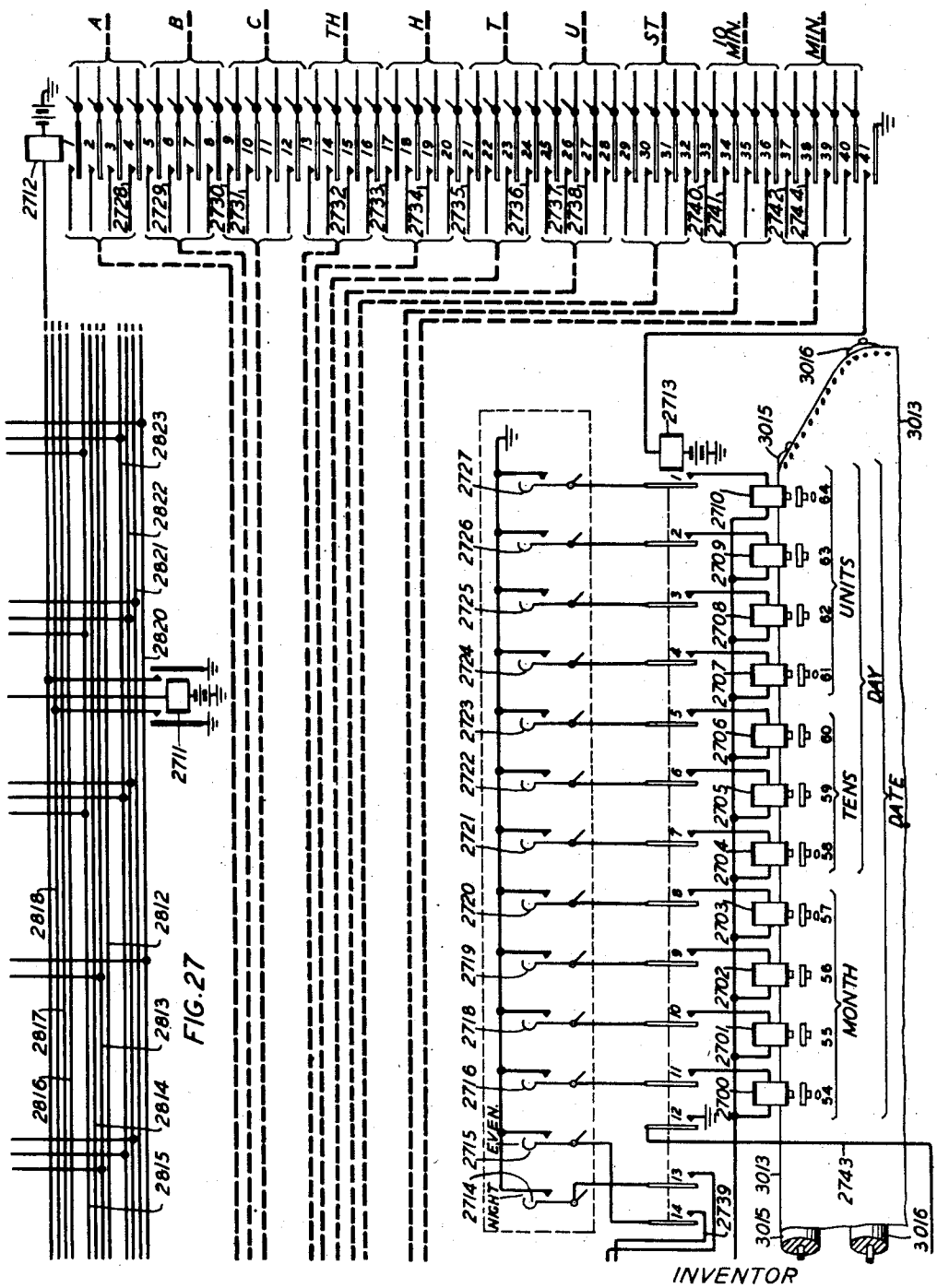

FIG. 27

INVENTOR
C. L. GOODRUM
BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 28

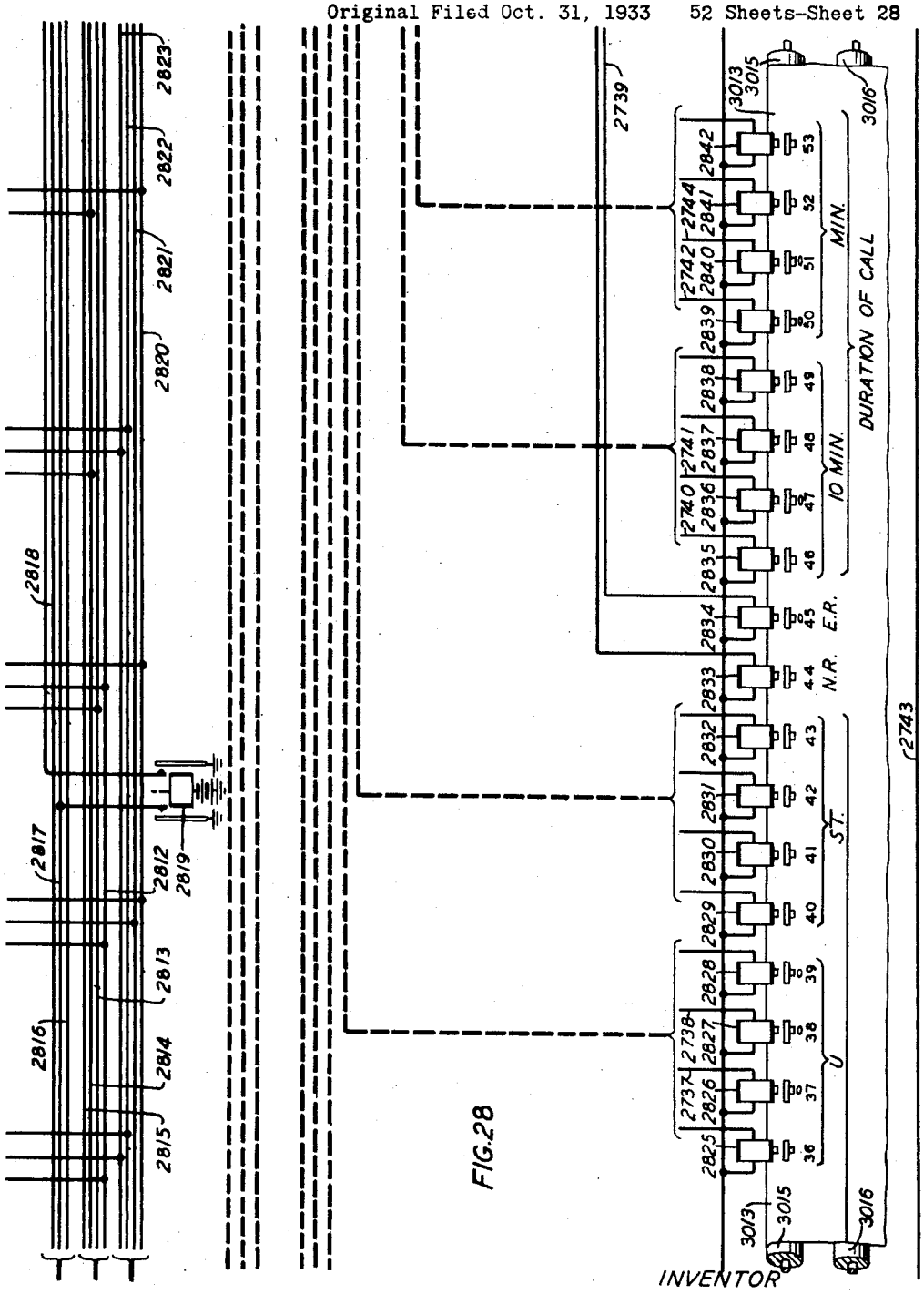

FIG. 28

INVENTOR
C. L. GOODRUM
BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 29

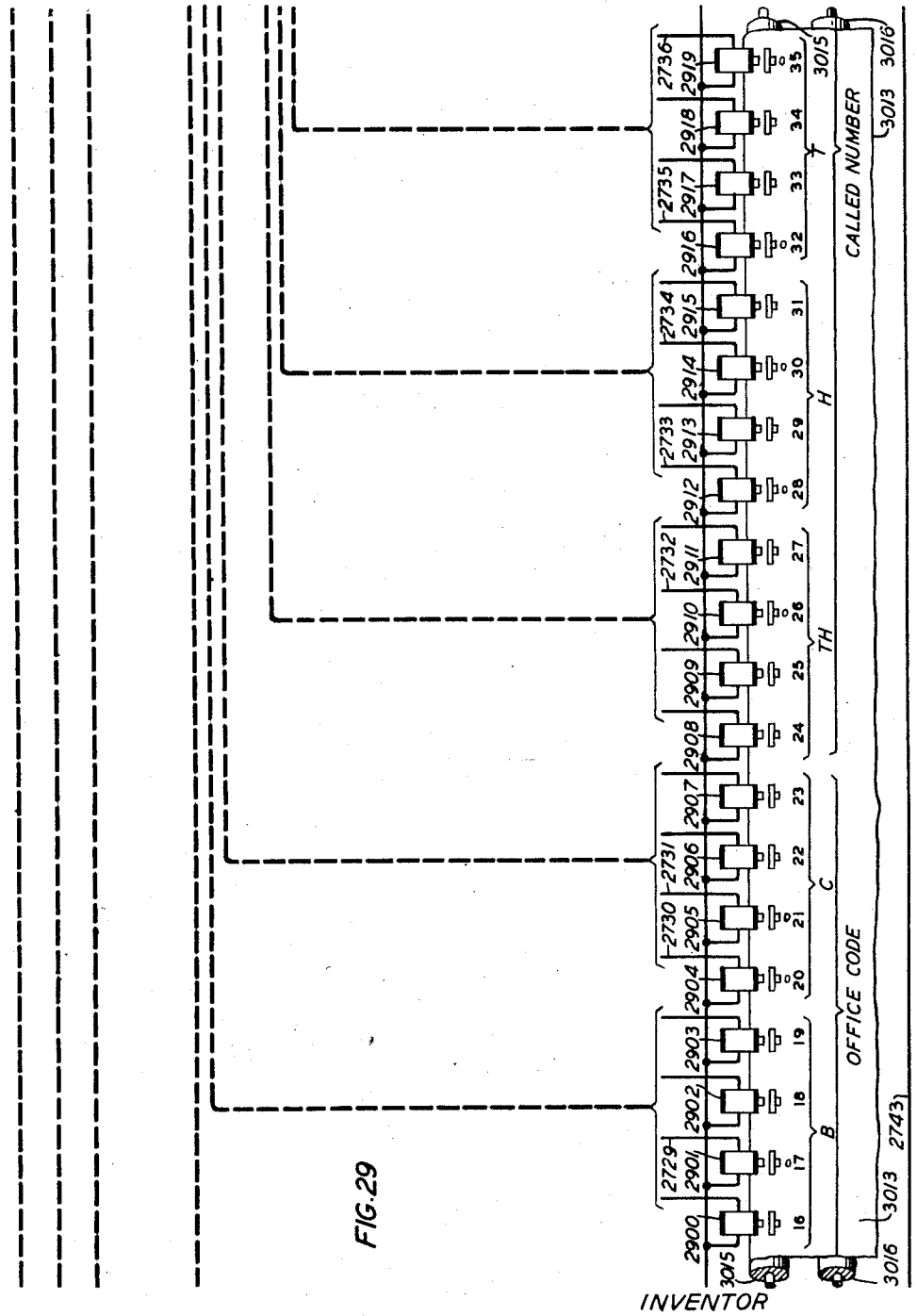

FIG. 29

INVENTOR
C. L. GOODRUM
BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

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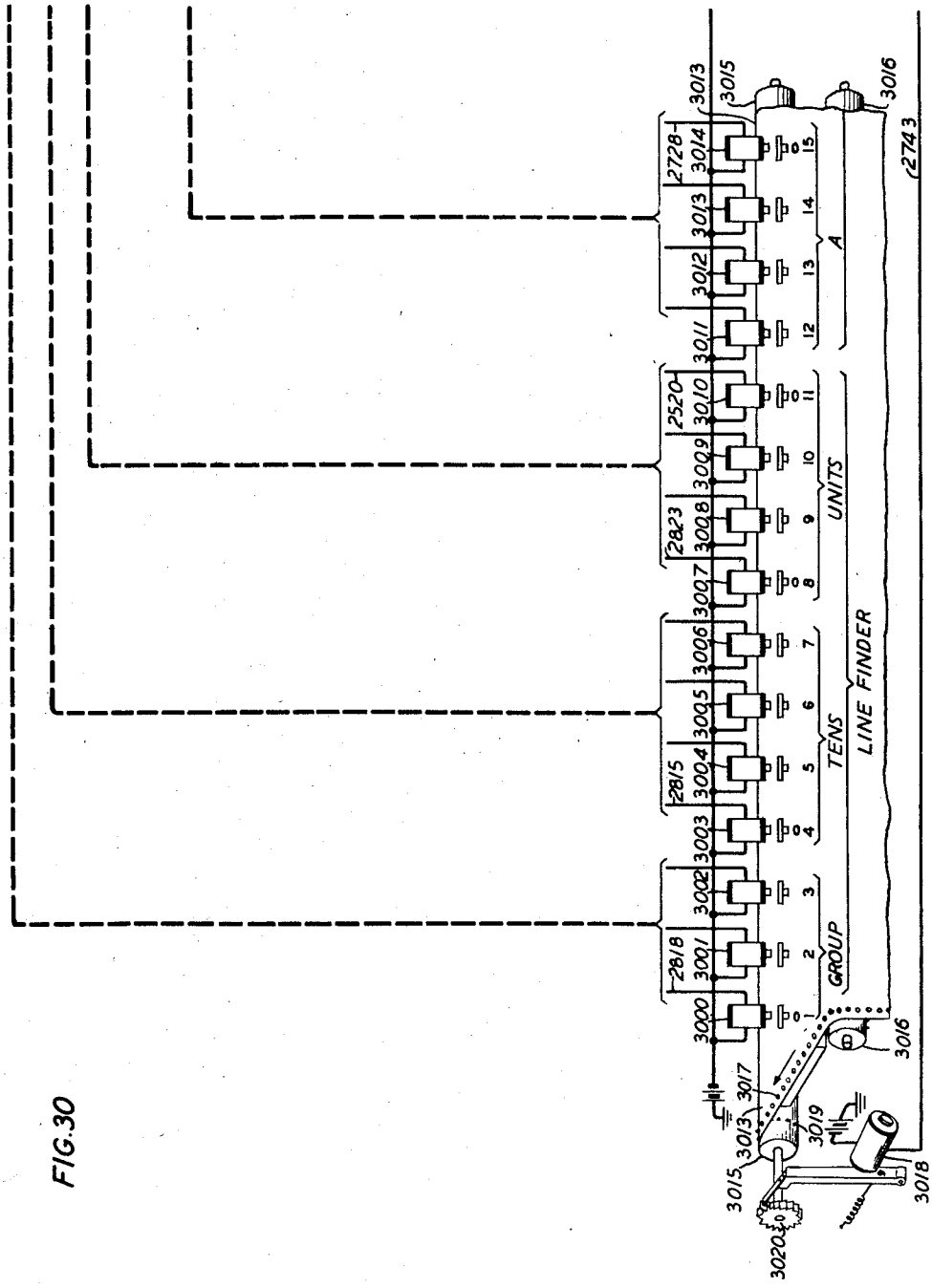

FIG. 30

INVENTOR
C. L. GOODRUM
BY
P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 31

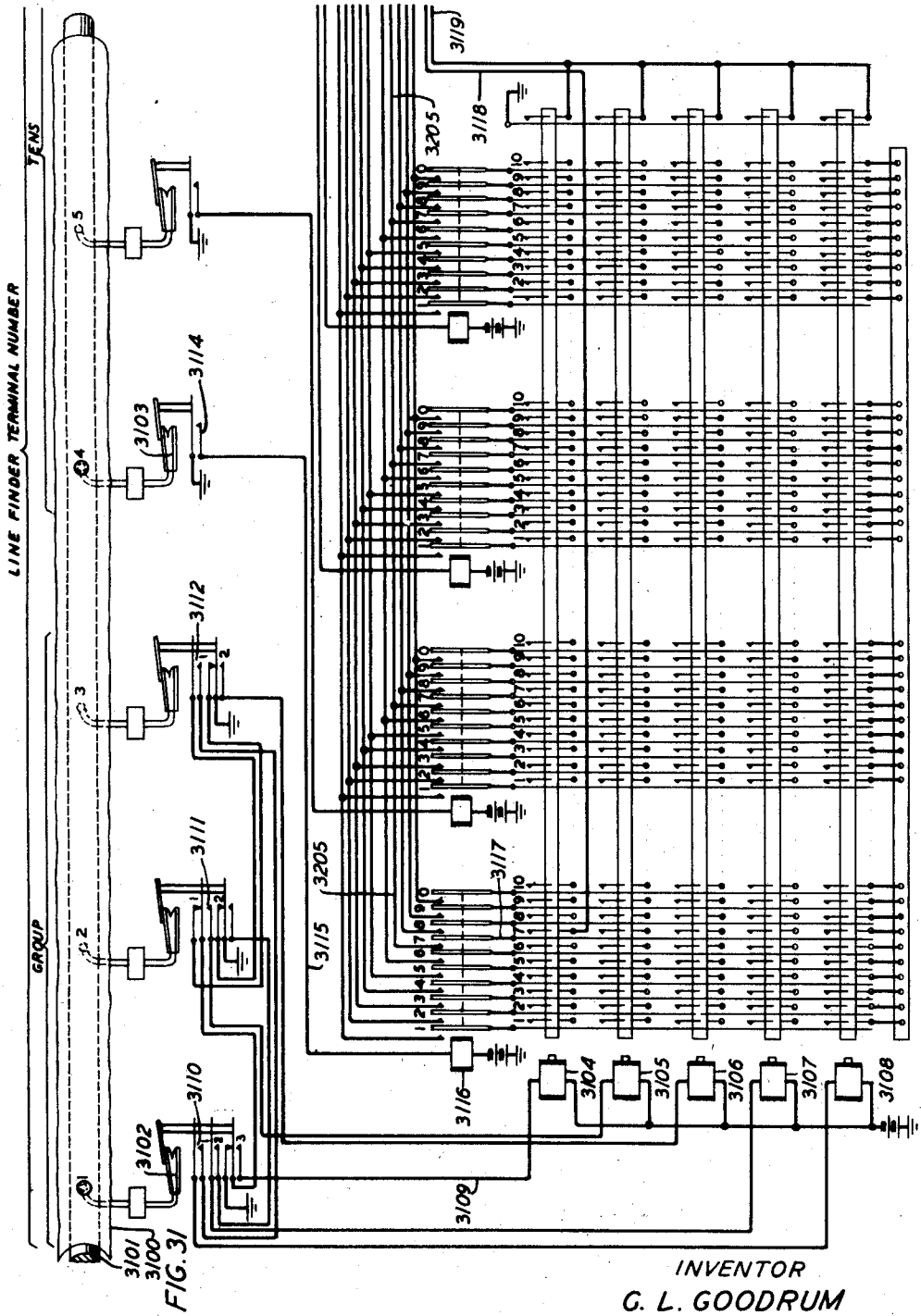

FIG. 31

INVENTOR
G. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 32

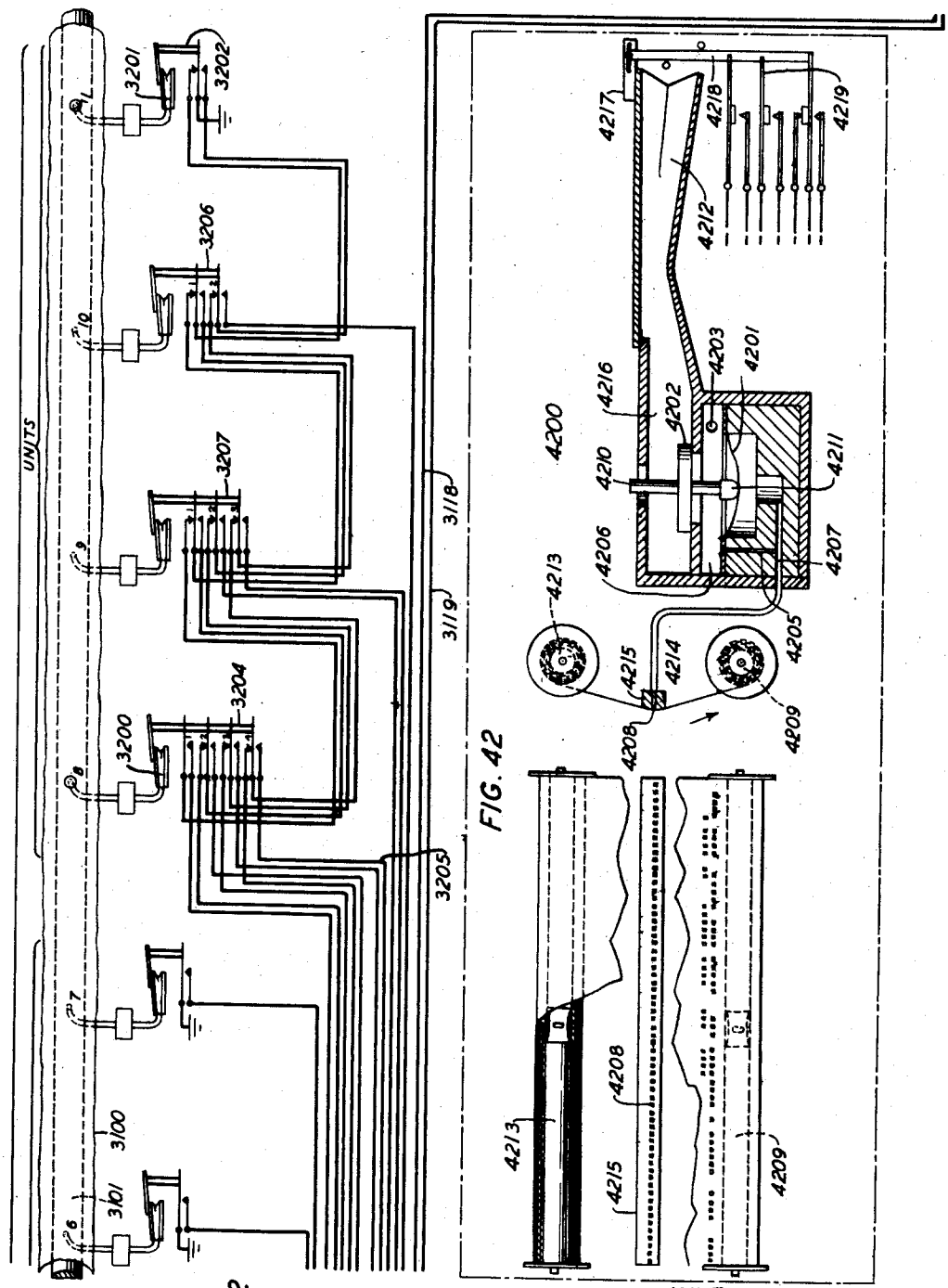

FIG. 32

FIG. 42

INVENTOR
C. L. GOODRUM
BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

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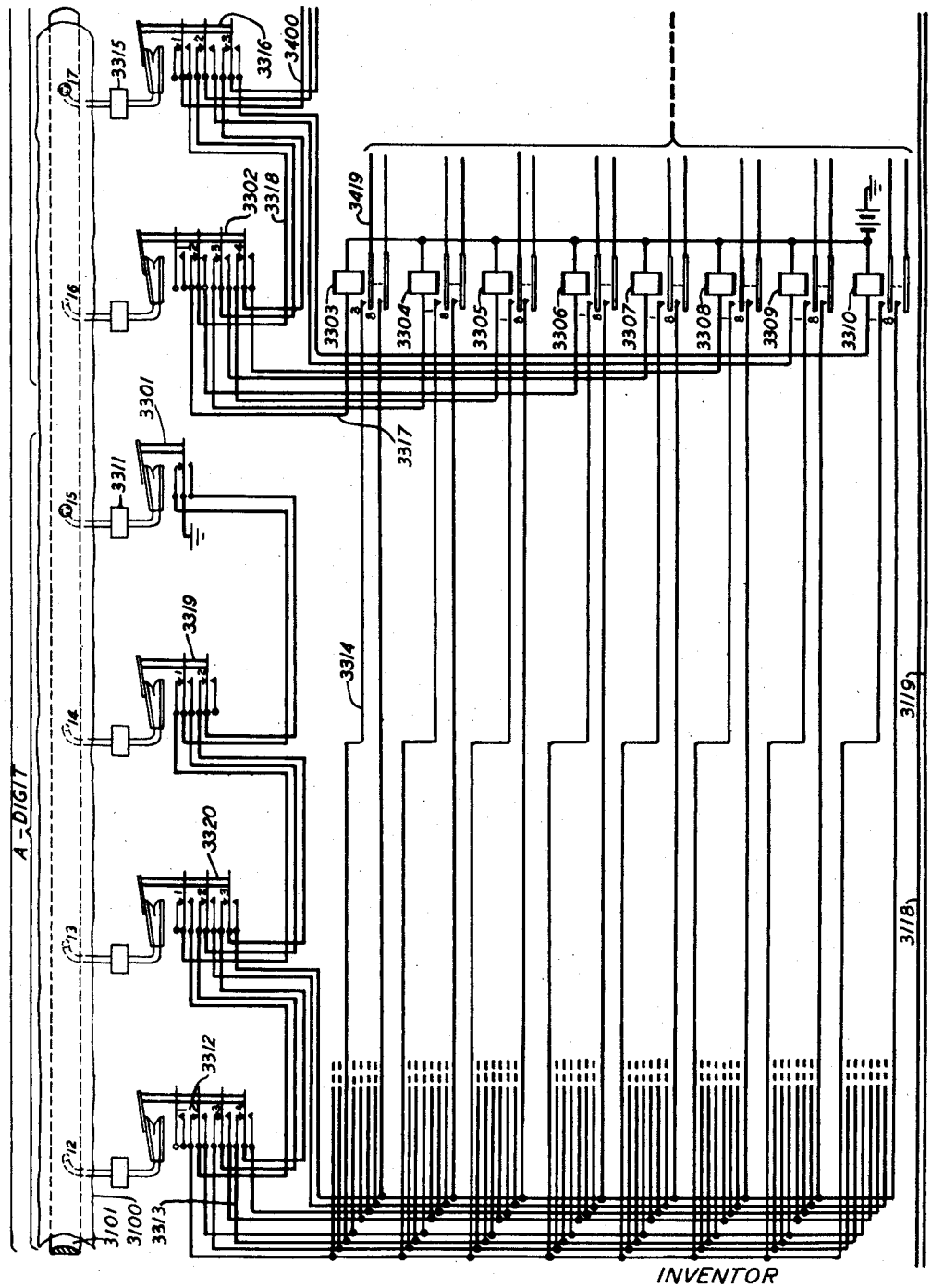

FIG.33

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

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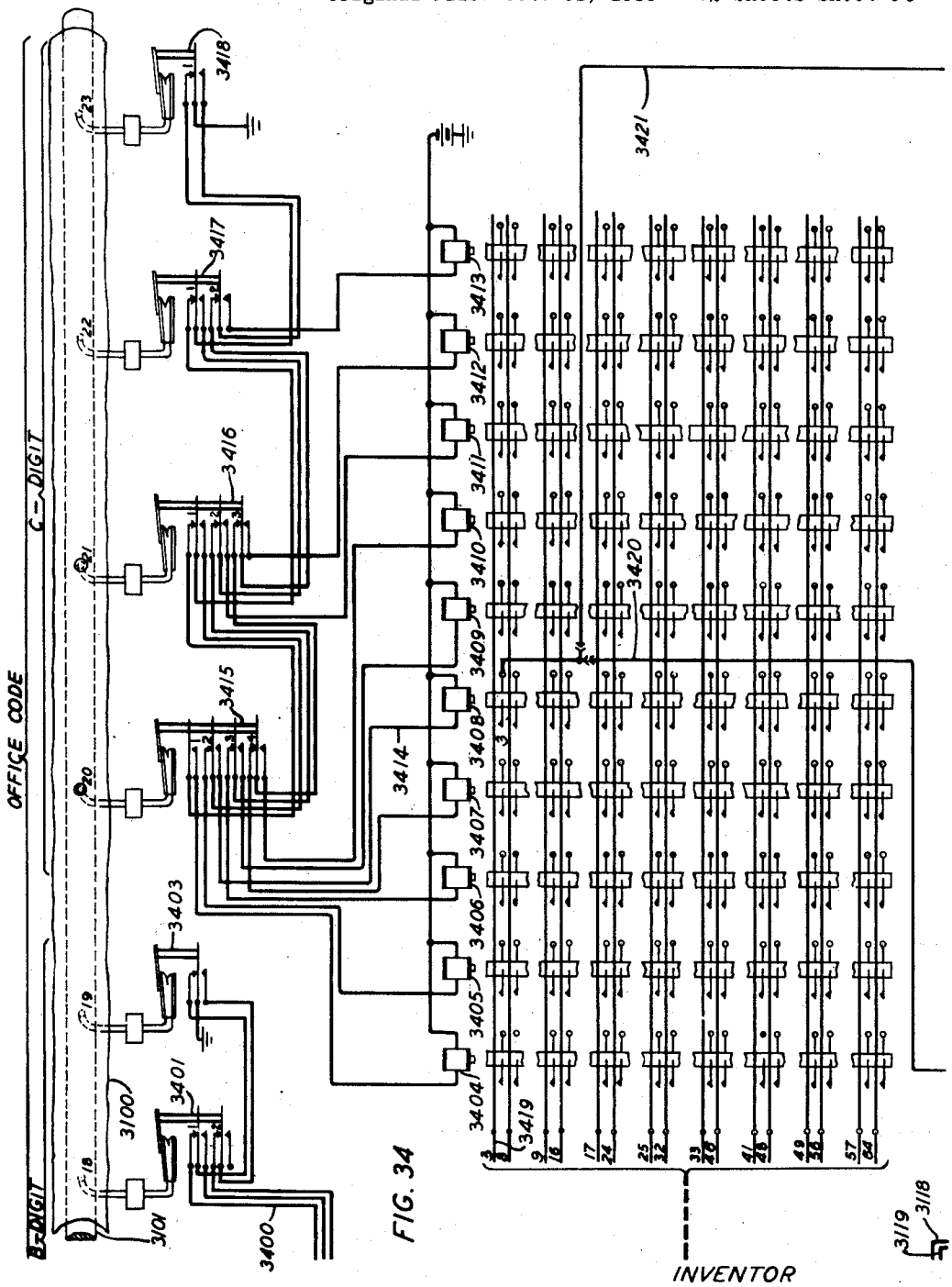

FIG. 34

INVENTOR
C L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 35

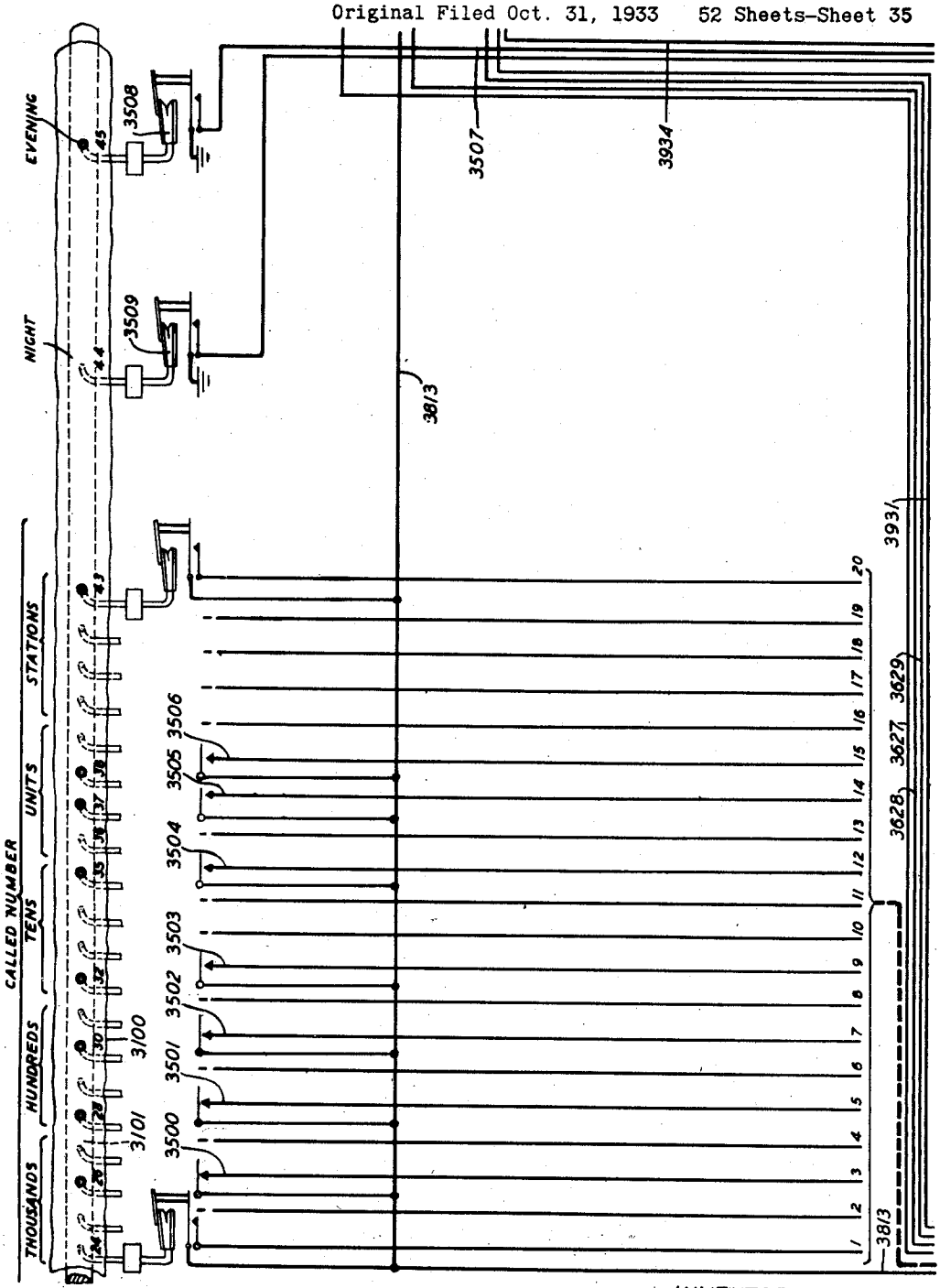

FIG.35

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 36

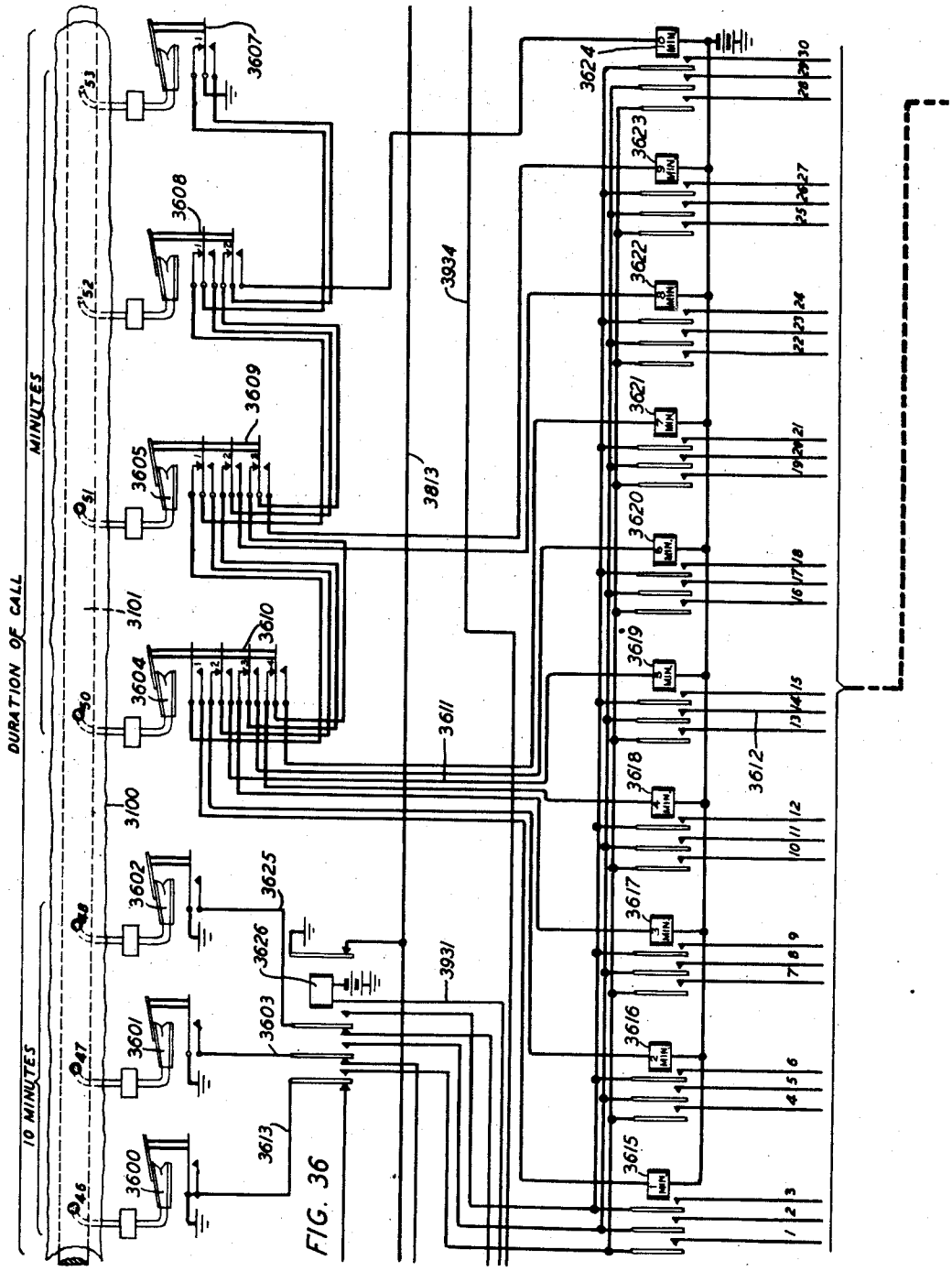

FIG. 36

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 37

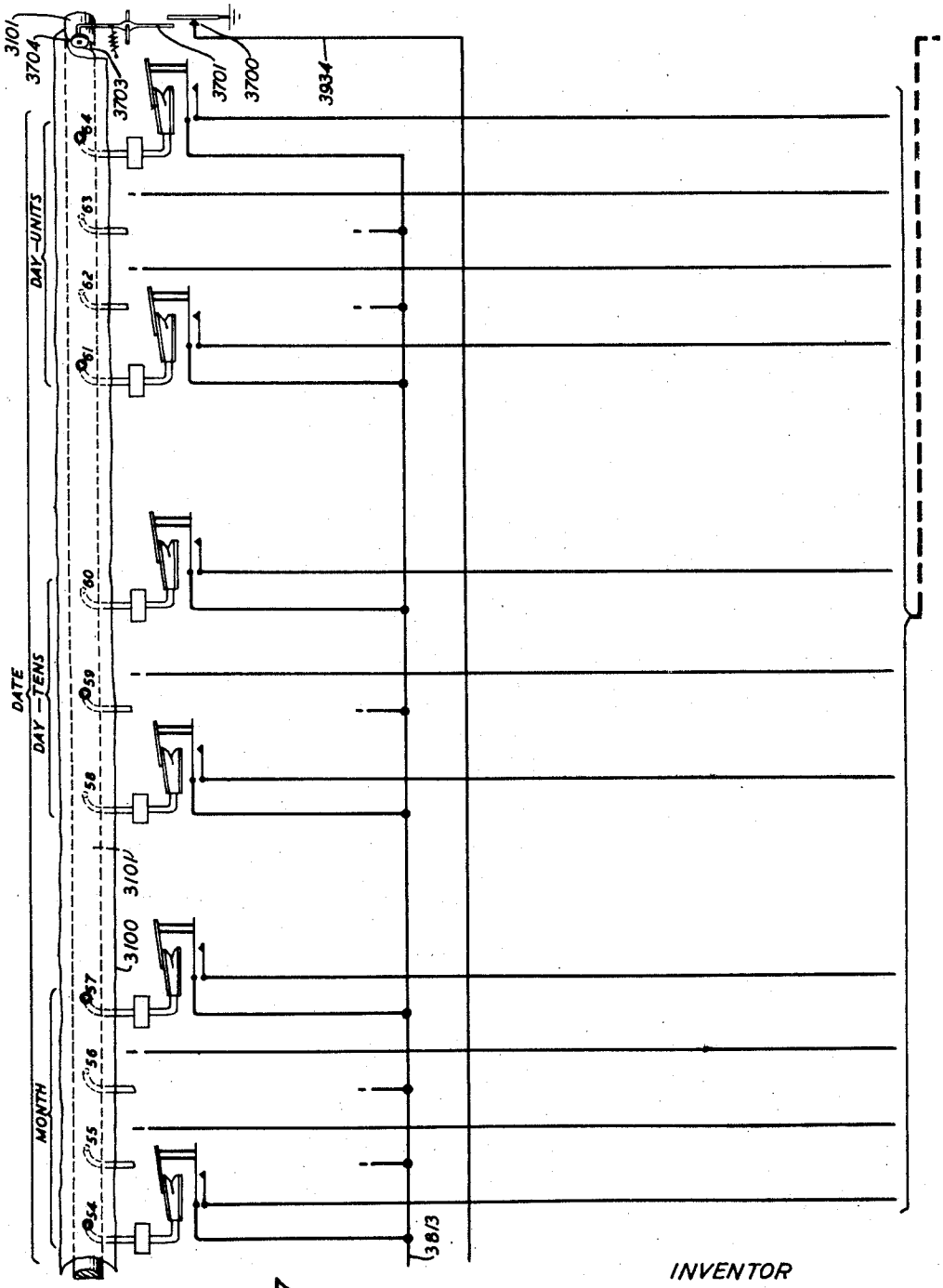

FIG.37

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 38

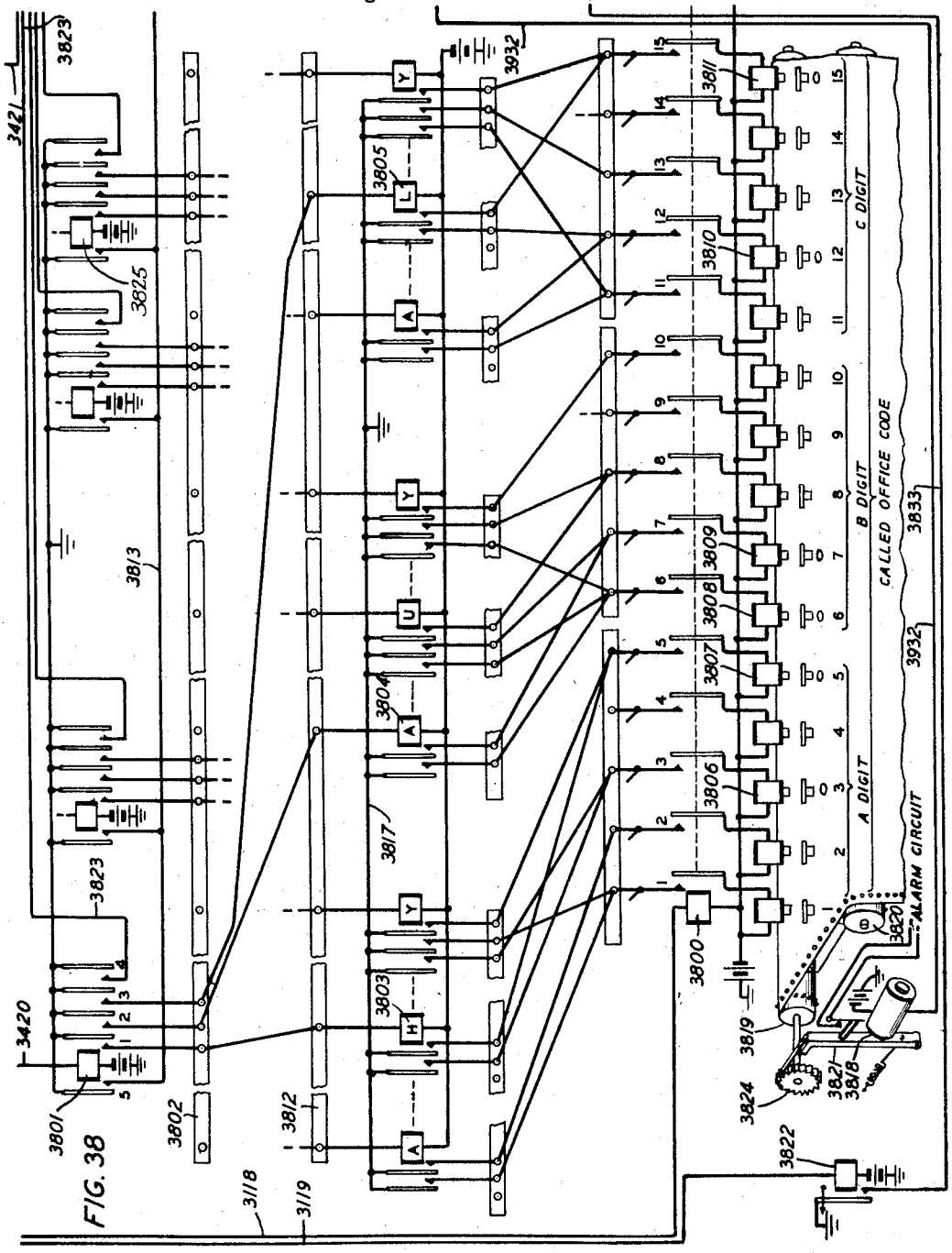

FIG. 38

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 39

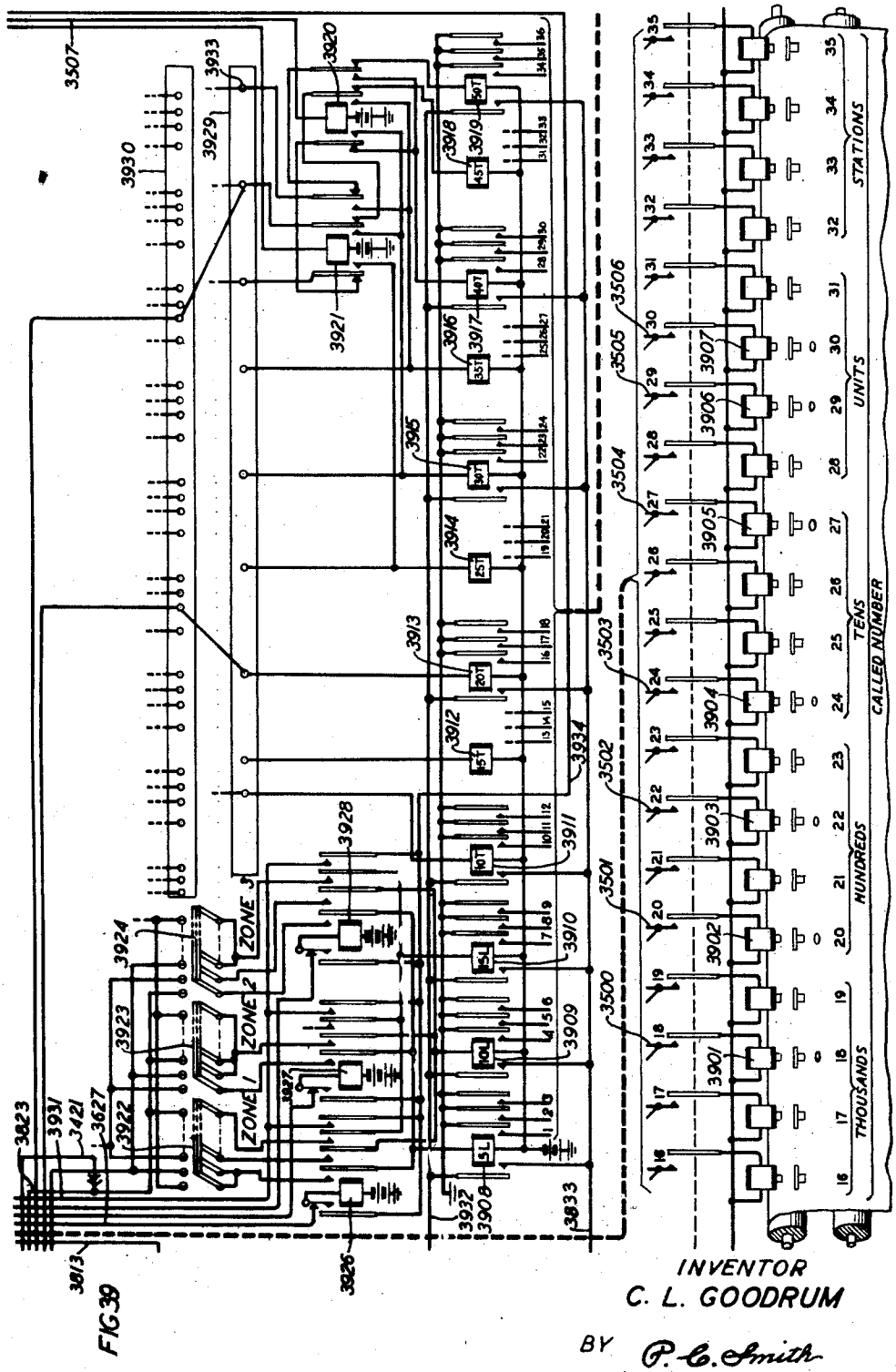

FIG 39

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939 C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 40

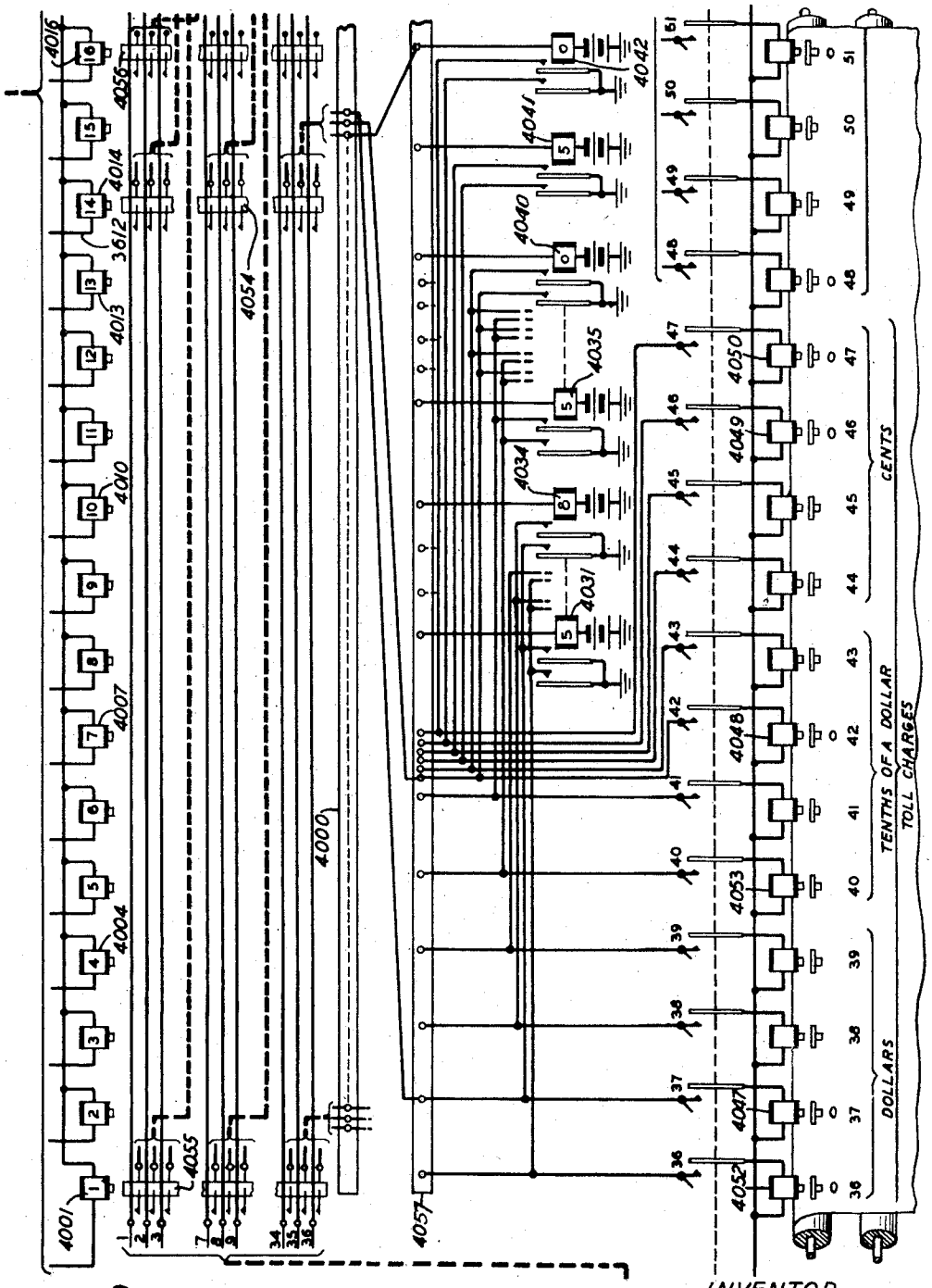

FIG. 40

INVENTOR
C. L. GOODRUM

BY P. C. Smith
ATTORNEY

July 11, 1939. C. L. GOODRUM 2,165,924

TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 41

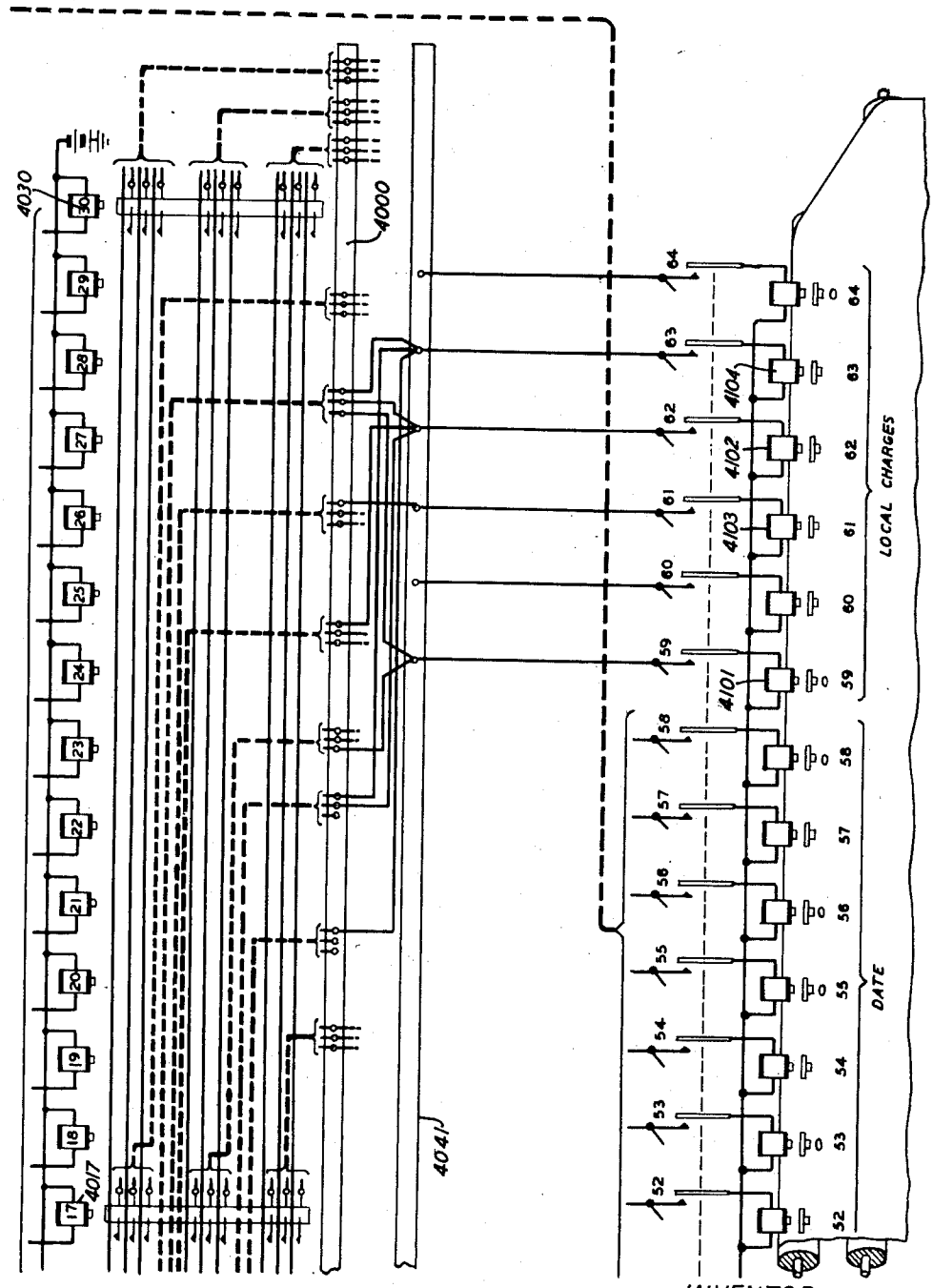

FIG. 41

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TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 42

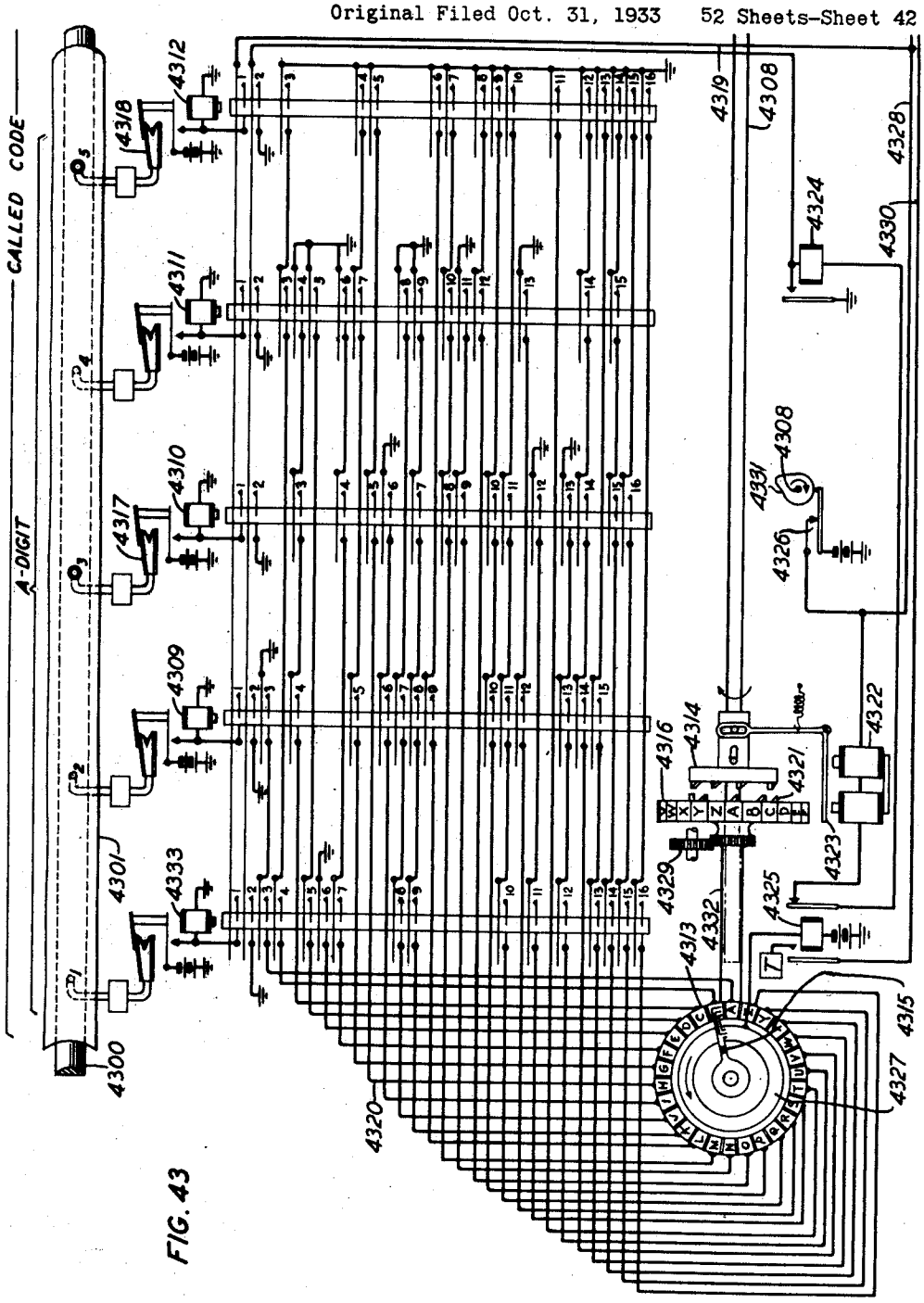

FIG. 43

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TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 43

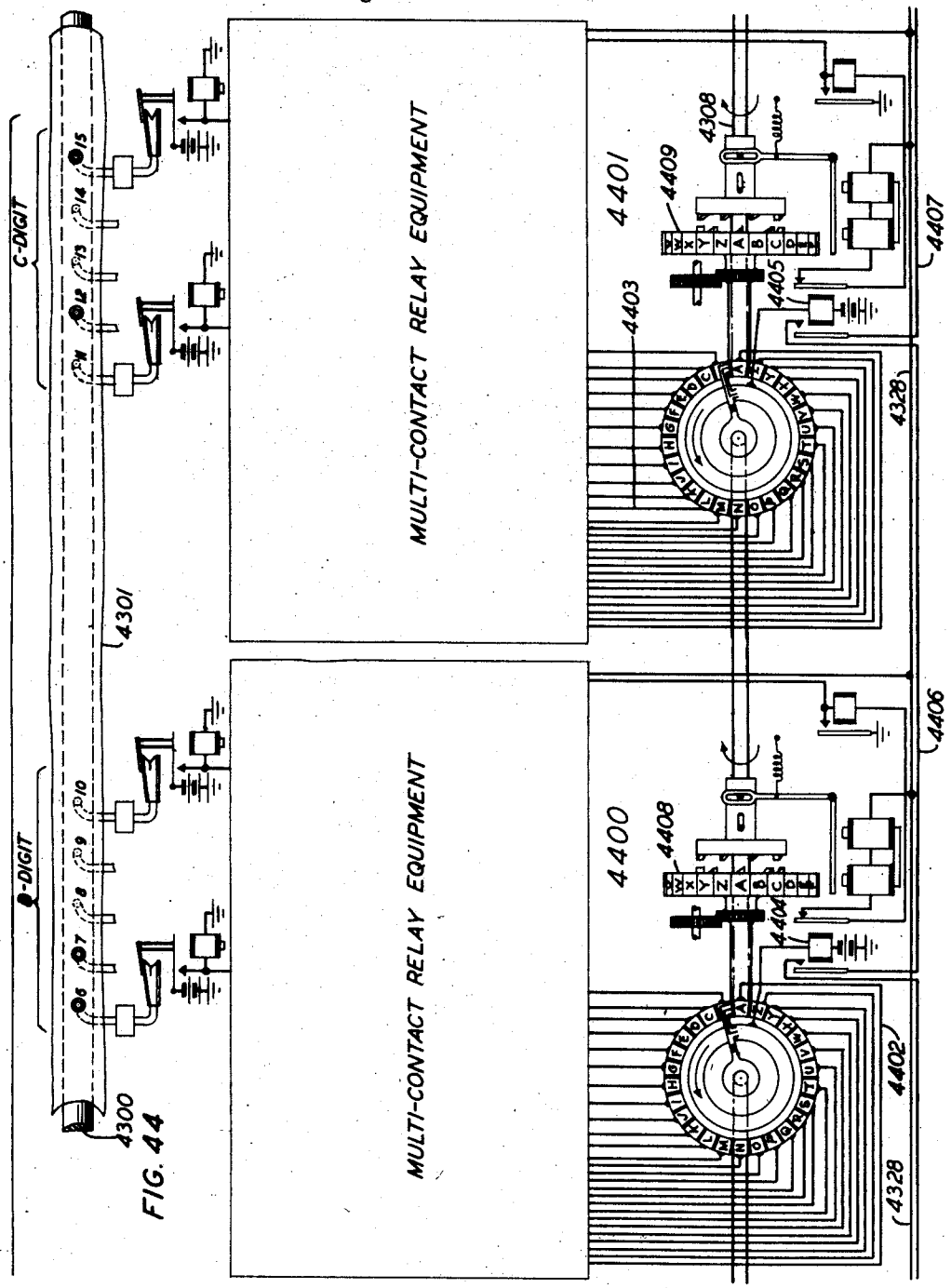

FIG. 44

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TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 44

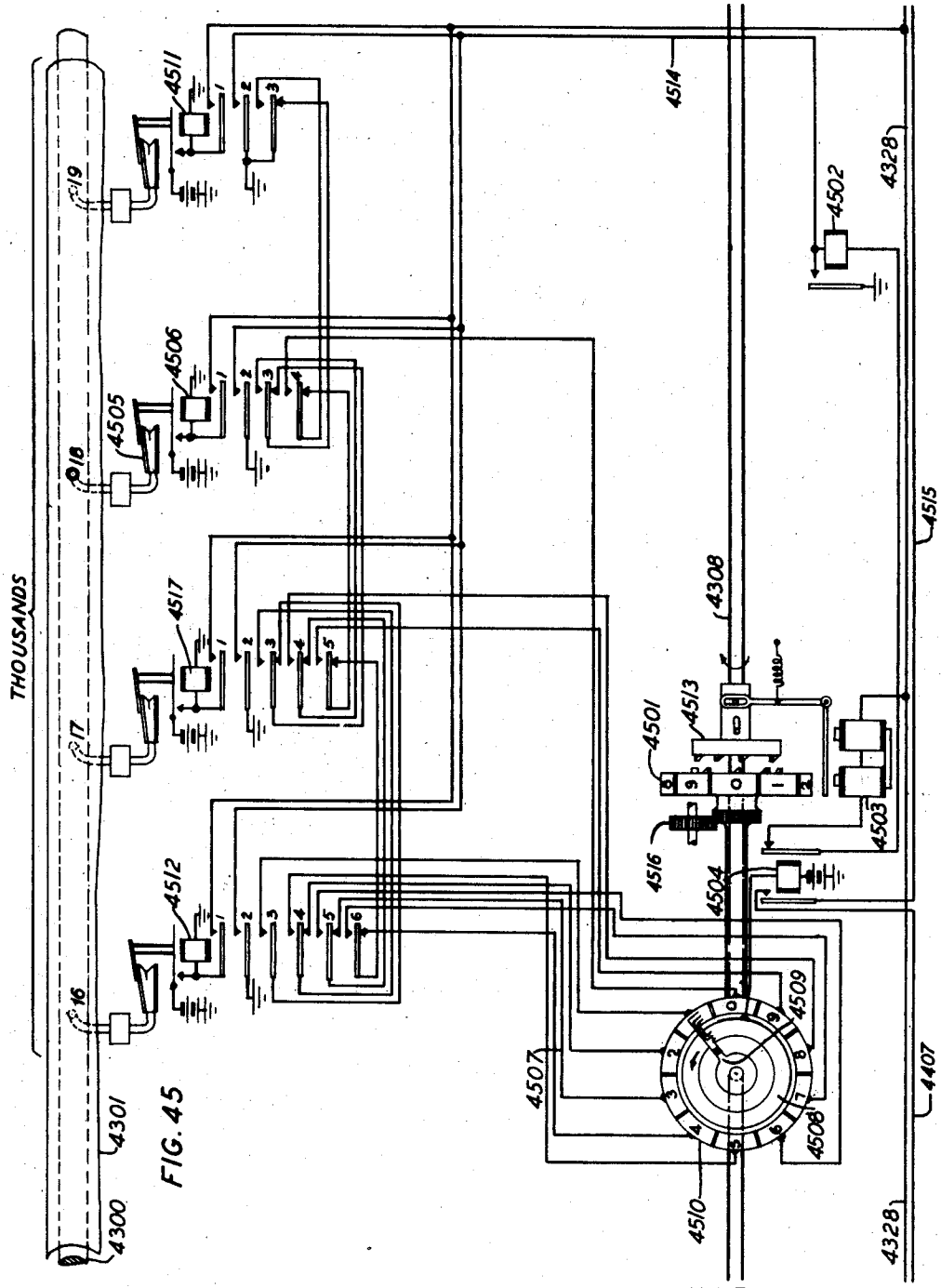

FIG. 45

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TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 45

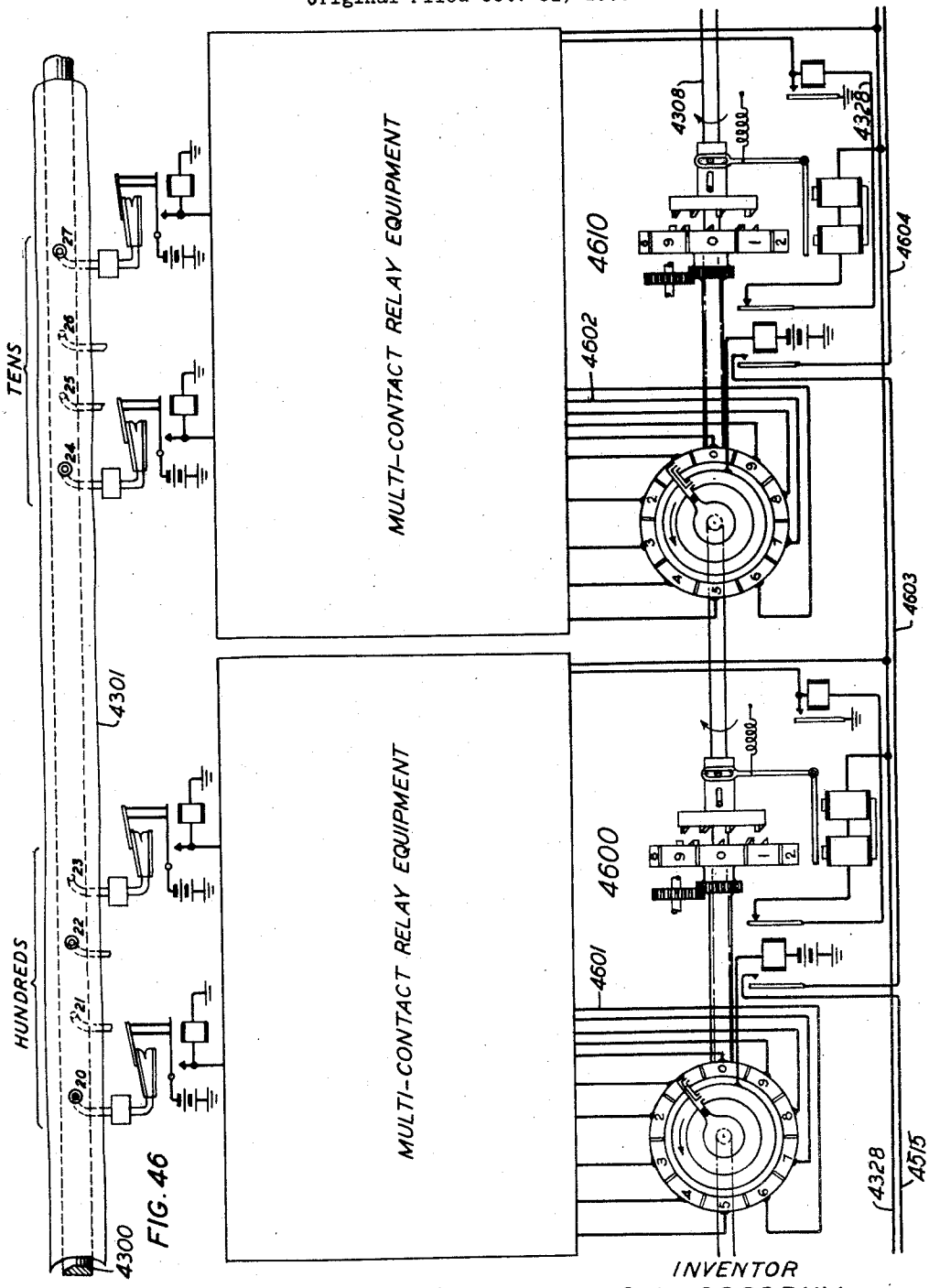

FIG. 46

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TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 46

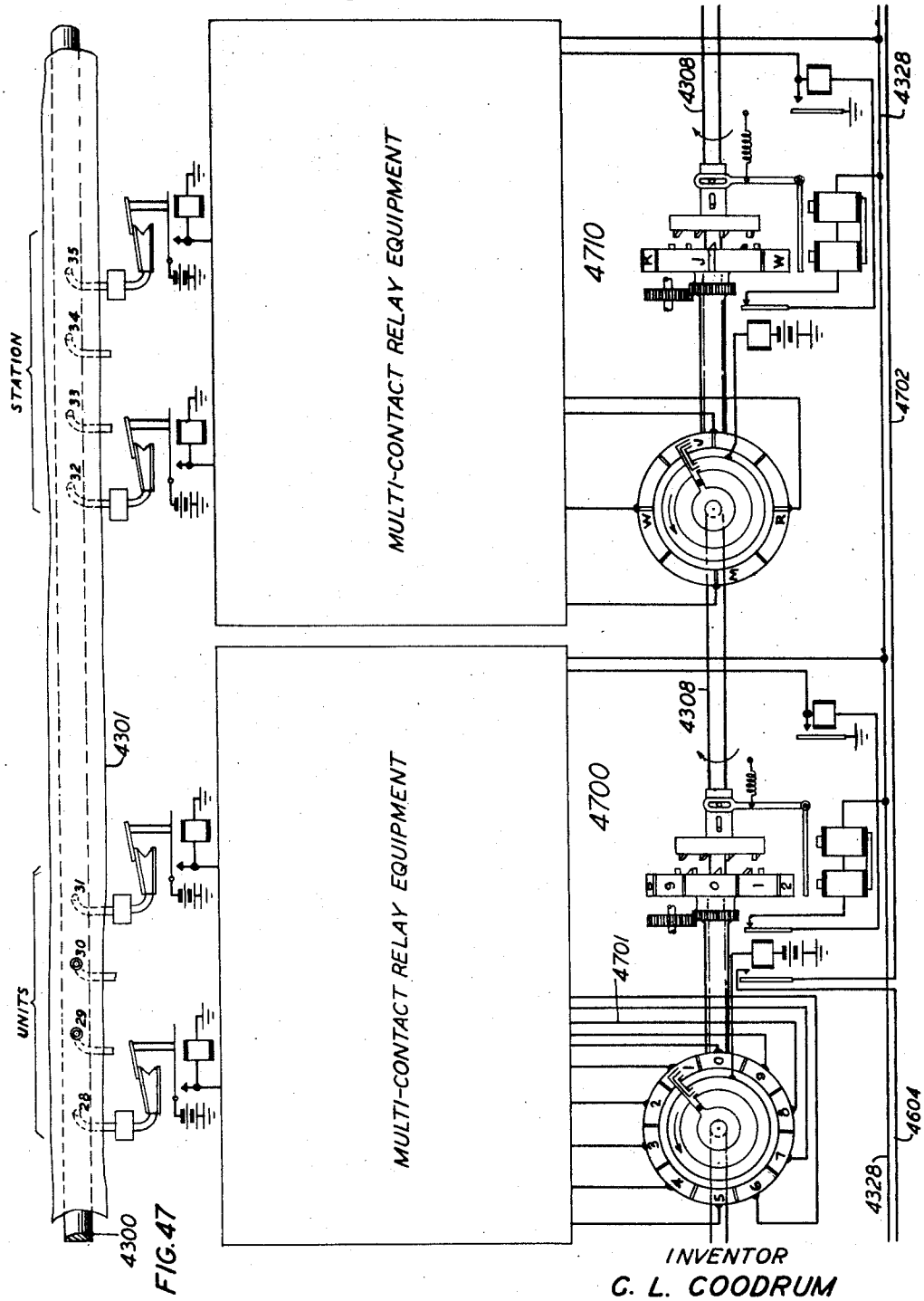

FIG. 47

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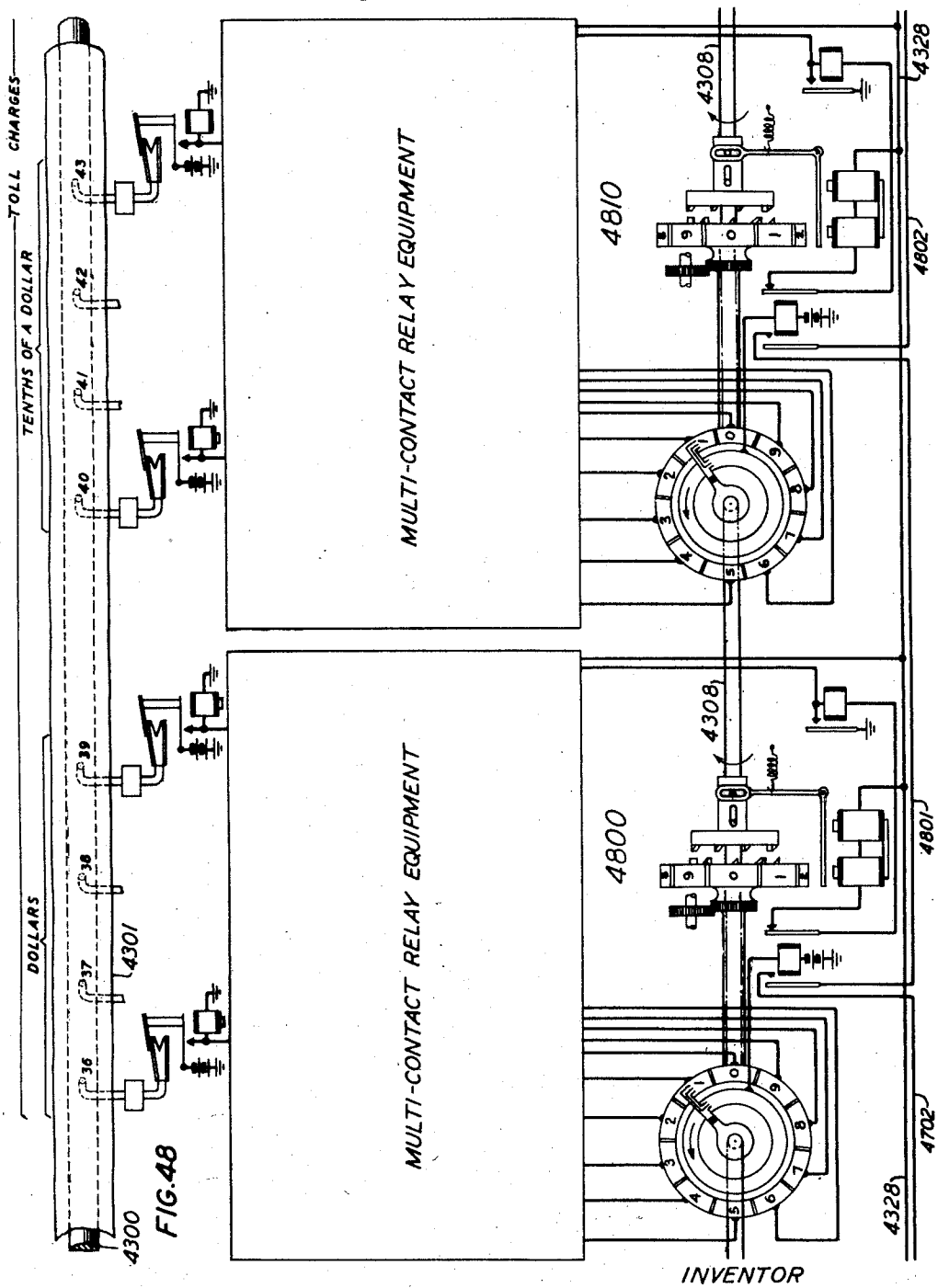
Original Filed Oct. 31, 1933 52 Sheets-Sheet 47



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Original Filed Oct. 31, 1933 52 Sheets-Sheet 48

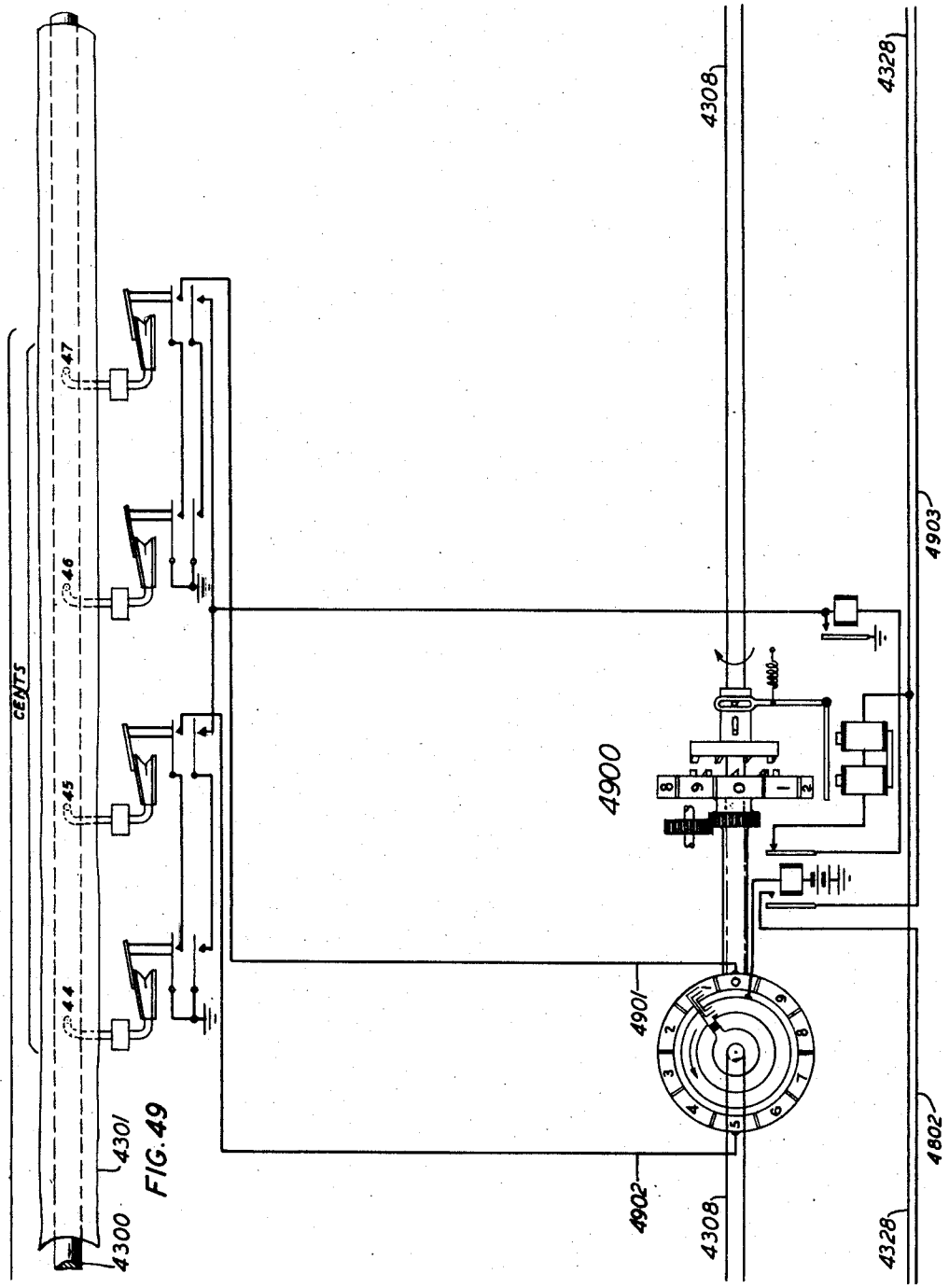

FIG. 49

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TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 49

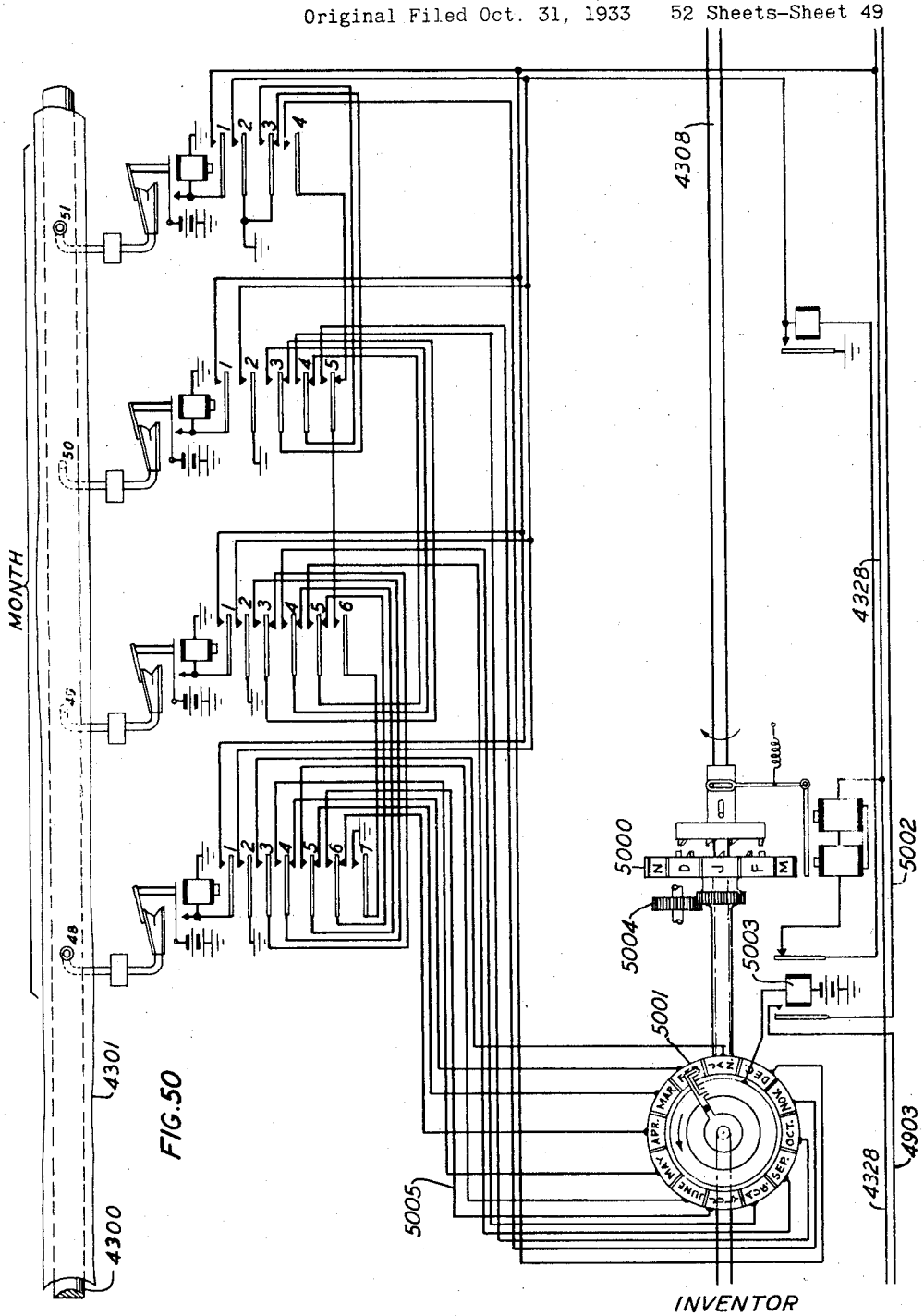

FIG.50

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TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 50

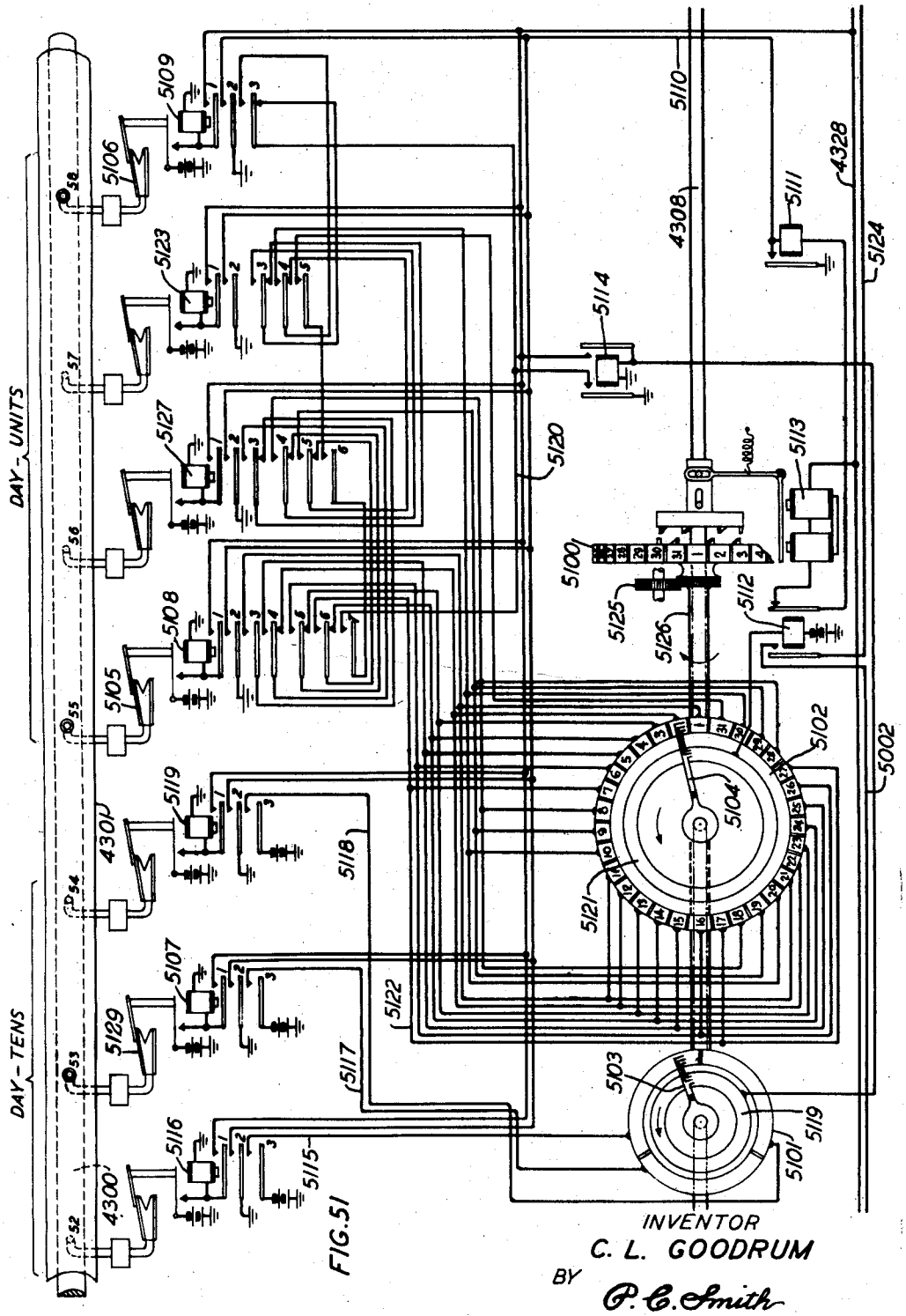

FIG. 51

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TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 51

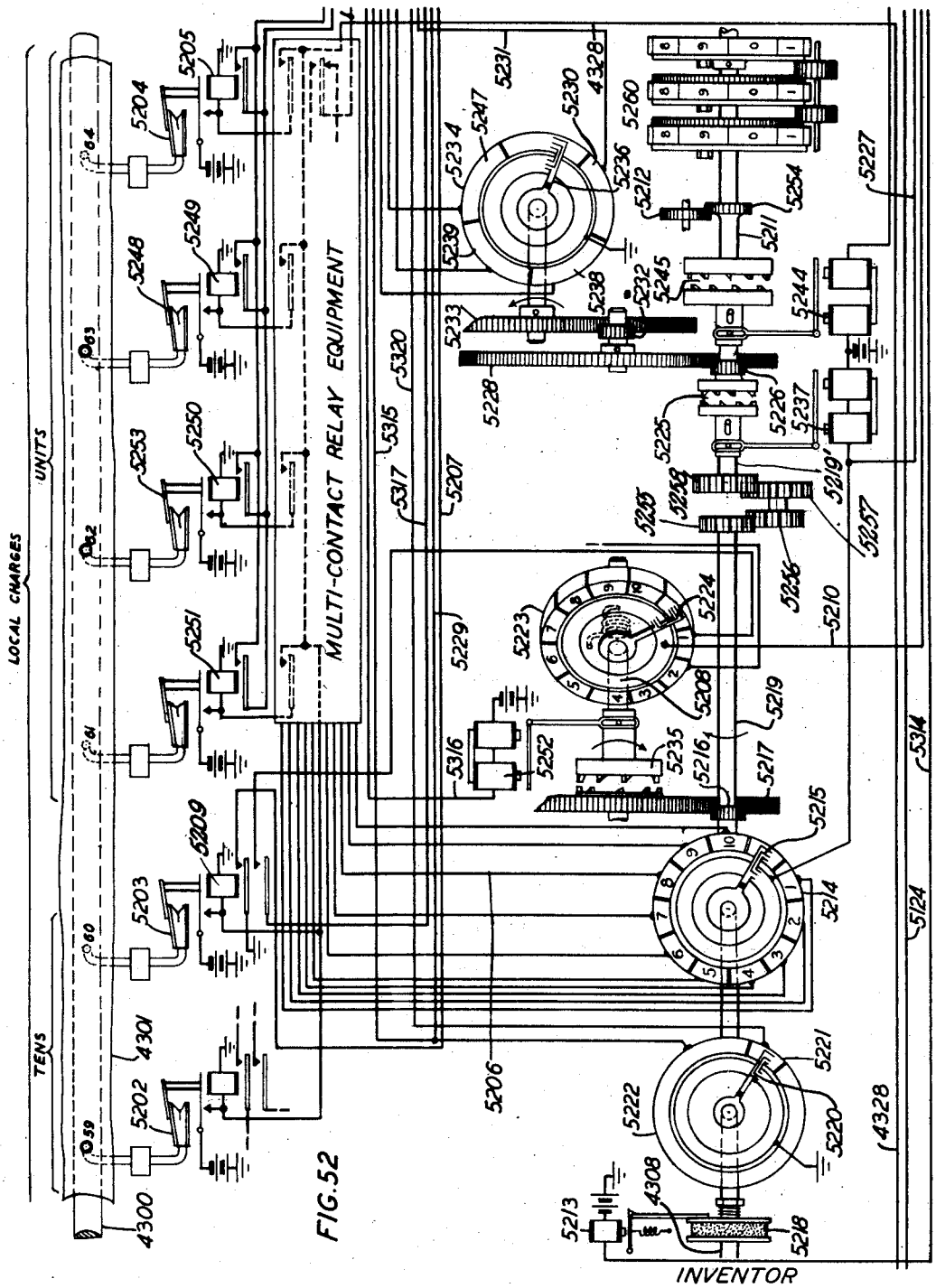

FIG. 52

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TELEPHONE SYSTEM

Original Filed Oct. 31, 1933 52 Sheets-Sheet 52

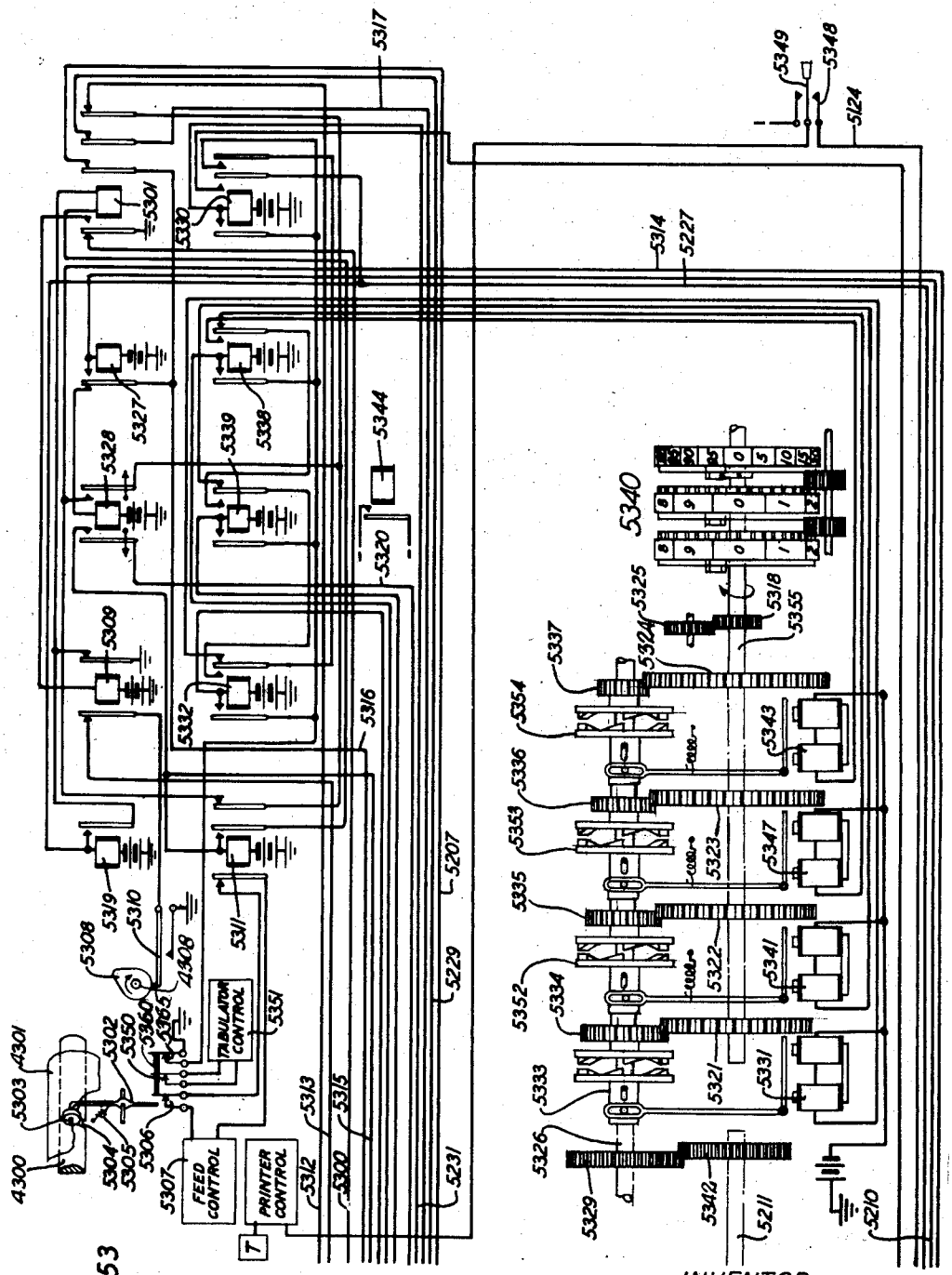

FIG. 53

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UNITED STATES PATENT OFFICE

2,165,924

TELEPHONE SYSTEM

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Application October 31, 1933, Serial No. 695,999
Renewed December 14, 1938

9 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 finally tabulated, computed and printed from 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 system; 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, a group of offices or a telephone area, within a stated billing period.

At the present time it is well known that charges for telephone service on some classes of subscribers' lines 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 the completed connection.

Furthermore, recent advances in the telephone art make it possible for the calling subscriber of an automatic telephone system to dial directly the office and number of a wanted subscriber 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. In such a connection, the meter of the calling subscriber is operated a plurality of times on 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 being 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 terminating, the total number of local charges accumulated over the period is determined. This total charge comprises not only the separate charges for local calls but also the equivalent, in terms of 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 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, the function of which is to preserve a record of the designation of the calling line, the destination of the call as well as the duration of conversation, so that, when the monthly bill for the line is made, the entries on the toll tickets are entered as separate items thereon. Obviously, as long as a subscriber's line has to be routed to a recording operator before a toll or long distance connection can be extended to its destination, direct dialing by the subscriber to such distant points, with all the economies of operation and efficiency of service incident to automatic operation, will be impossible.

The invention is intended to overcome this obstacle by placing the timing and ticketing of all calls to toll points to which direct dialing is possible, on a completely automatic basis. It is also possible, by means of the invention, to provide an automatic means for recording the charges on all local calls and other calls charged for in multiples of the local charge rate but without preserving an identity thereof. And finally, the invention provides further automatic equipment by which monthly bills, including all local and all toll charges, are automatically made up for each line from records automatically made and containing the record of all calls made by said line over the billing period.

The advantages of the invention are manifest. First of all it permits the extension of direct dialing to more distant points without any delays for making out tickets and thereby eliminates the possibility of errors incidental to the manual operation; it further 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 subscribers and the operating company, the former frequently complaining of being charged

for calls they allege they did not make; but it also eliminates the necessity of the costly routine of periodical meter readings in the case of local calls and other calls charged for in multiples of the local call base rate, together with the necessary organization of effort for transcribing the data so collected and further checking its accuracy. In other words the superiority of the invention, as applied to telephone billing practices, is to be found in the possibility of broadening the potential scope of the use of automatic telephone equipment and of reducing the costs 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 for its operation whereby all calls dialed directly by the subscriber and completed mechanically to a terminating office, whether local or toll, are recorded in a manner such that said record may be used as a basis of means for operating a printing tabulating mechanism for making automatically the subscriber's monthly bill.

A particular embodiment of the 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 the called subscriber through dial controlled panel type switching selectors, although I do not wish to be understood as limiting my invention to any particular type of apparatus or any specific system; the invention being readily adaptable by any one skilled in the art to other 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 mechanism common to the group. This record includes the date, an identifying designation of the calling line, the code of the called office, the duration of the conversation and such other items as are found necessary to record for billing purposes. Ordinarily, most of the information is required in the case of toll calls when an itemized history of the call is furnished the subscriber with his bill and, in such cases, the number of the called station is likewise recorded.

The recording equipment consists, in general, of a suitable recording apparatus, an allotter circuit for controlling the attachment of said recording apparatus to a first stage switching trunk common to a group of lines and connected to the calling line, and a call recorder which may be individual to the trunk or common to a group of trunks for registering the called office code, called office number and the duration of the call.

For registration purposes one recording apparatus may be conveniently allotted to one group of subscribers served by a particular group of switching trunks or, in those cases where line-finder equipment 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 machine for this group undesirably increases the holding time of the line finders, two or more such recording machines per line-finder group may be used, each machine serving a proportionately smaller group of lines.

The call recorder associated with the first stage switching trunk or line-finder-district selector comprises a pulsing relay for responding to dial impulses, registering devices, such as small step-by-step switches, for recording the dialed office code and, if desired, other switches for recording the number of the called subscriber, timing devices for timing the call and the necessary control relays. This call recorder may be supplied to a group of line finders where timing is only necessary on toll calls. But, if all calls are to be timed, whether local or toll, this equipment may be made a part of the line finder itself.

For the purpose of illustrating the invention, the recording machine herein used is a perforating mechanism comprising a suitable number of punch magnets for perforating holes in a tape of suitable size, as more particularly described hereinafter. Other recording mechanisms, for example those which are responsive to the setting of suitable light valves, might be used as well. However, the invention as described and claimed hereinafter is not limited to any particular type of recording mechanism since the one shown and described is only typical of many equivalent mechanisms which are well known and available to the art.

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 serially connected to the line in the well known manner. If the registering and timing device is not individual to each line finder but common to a group of them, then means are provided for connecting such apparatus to a line finder when it is taken into use.

The subscriber, upon receiving dial tone, dials the office code and number of the called subscriber, both of which become registered in the sender for the purpose of controlling the proper setting of the various switching selectors which operate to extend the calling line to that of the desired subscriber. Simultaneously with the registration of the office and called number code in the sender, said code and number are likewise registered in the line finder call recorder. If, after the called office code is registered in the sender, its translation by well known means indicates a local call for which no charge is to be made, such as for example, calls to the bureaus of the operating company or calls made by lines having unlimited service for a flat rate charge, or calls to operators, a signal to this effect is transmitted from the sender to the recorder whereupon said recorder immediately releases. If, on the other hand, the translation indicates a call which is to be timed regardless of whether said call is local or toll, a signal to this effect is transmitted from the sender to said call recorder which then remains connected to the line finder to perform the function of measuring the duration of the subsequently established connection.

When the called party answers, a timing circuit begins to measure time and continues to measure time until either party restores. When the calling party restores, responsive circuits are operated to cause an allotter which controls the group perforating machine to hunt for the line finder connected to the calling line and to cause the connection of said perforating machine to said line finder and its associated call recorder. As soon as the allotter connects with said line finder it causes the operation of a line identifying relay which, in turn, controls the operation of the perforating machine to record upon a tape the identification of the line as determined by said

relay. The perforating machine then records directly from the timing circuit and from the call recorder the called office code and number of the called line, and also the duration of the call. As soon as this information has been recorded on the tape associated with the punch magnets of the perforating machine the call recorder is released for allotment on another completed call in the same way.

The punched strip made by the perforating machine is not a narrow tape such as is used in printing telegraph systems but is a wide strip somewhat in the order of a player piano roll and the perforations required to record all the necessary information required for billing purposes are made simultaneously thereon so that the time required for punching a record is reduced to a minimum.

Since the perforating machine is common to a group of lines such as, for example, all the lines terminating on a line-finder frame, the record strip made by such a machine contains perforations of all calls made by all the lines of the group, not arranged under each line but arranged simply in the order of time in which the calls are made throughout the billing period. The next step in the embodiment of the invention is to sort the calls and allocate them to the lines from which they were made making a separate record for each line of all calls made from that line. During the making of this record, all information which is to be printed on the subscriber's bill is recorded thereon, all information which is not, is suppressed. Further, all the required translations for changing the recorded time of each call into the equivalent charge for the call is also made so that, what appears on the individual line record is only the information which is to be utilized by the tabulating and printing mechanism for printing or tabulating each item appearing on said record.

The equipment for sorting out from the primary record strip the calls made by the various lines of the group comprises an analyzer and a suitable number of tape perforating machines controlled by it, there being, according to one preferred arrangement, one analyzer per calling line group with as many perforators for each analyzer as there are lines in said group so that only a single passage of the punched strip through the analyzer is required. Each analyzer contains a series of pneumatic devices which respond to the perforations in the record strip as the record of each call passes through. When the recording mechanism which makes the record strip is different from the perforating machine herein used, the analyzer, of course, will contain, not the pneumatic devices which respond to a perforated record, but whatever other devices are responsive to the character of the record made on the strip by said other recording mechanism. The response of the analyzer to the identification number of the calling line causes the selection of the proper line perforator thus distributing the registration of the calls to the separate recording mechanisms appertaining to the different lines of the group. Before analyzing the punched strip, however, it is necessary to identify the so-called directory number of the calling line with its line finder or terminal code number, the relation of which to the directory number is purely arbitrary. To translate the identifying codes of the group record into directory line numbers, a supplementary or master perforated record is prepared for each line group which contains the perforations of the line-finder terminal number and, on the same line, the corresponding directory number. This master strip is then run through the analyzer ahead of the record strip and controls the operation of the analyzer in such a way as to punch on each individual record strip the number of the line and such information as to the class of service to which it is entitled as is necessary for a proper computation of the bill.

The pneumatic devices which respond to the office code and elapsed time of a call, control a translator which computes the charge for said call and determines whether or not the call is one to be itemized on the bill. As soon as the translation is made, the charge and, if the call is to be itemized, the date and office code and number of the called line, are punched by the perforator of the analyzer which was selected by the calling line code.

The passage of the original record through the analyzer thus produces a set of individual punched strips, one for each line of the group. Each of these records, in the preferred embodiment of the invention, shows local calls merely as individual charges while toll calls are punched in detail. The calls for each line will, of course, appear on these separate records in the order in which they are made and in a code suitable for tabulator operations.

The separate records as made up by the analyzer are now in a form to be run through the tabulators for printing the list of toll calls for each line and the total charge for the local calls for said line. Or, again, if preferred, it may be found feasible to have the tabulator make out the complete bill.

A clearer conception of the scope and purpose of the invention may be obtained from the following description and attached drawings in which:

Fig. 1 shows the general lay-out of all the figures pertaining to the invention which, for purposes of description, has been conveniently divided into three sections;

Figs. 2 to 30 inclusive, arranged as shown in Section I, Fig. I, comprise the apparatus and general circuit organization for automatically establishing a call between two subscribers and for making the record strip or primary tape as it will hereafter be called;

Figs. 2 and 23, taken together, show a district selector with its associated timing circuit;

Figs. 3 and 5, taken together, show the trip and frame start circuits of a line-finder-district selector;

Figs. 4 and 6 taken together, show a link circuit through which the district selector of Fig. 2 establishes connection with a register sender;

Figs. 7 to 21, inclusive, show a register sender;

Fig. 21 shows, schematically, a decoder and decoder connector;

Fig. 22 shows a district allotter circuit;

Fig. 24 shows a district call recorder;

Figs. 25 and 26 show the general grouping of subscribers' lines for identification purposes;

Figs. 27 to 30, inclusive, show the punching mechanism for perforating the designations of completed calls;

Figs. 31 to 42, inclusive, arranged as shown in Section 2 of Fig. 1 comprise the analyzer as follows:

Figs. 31 and 32, inclusive, is the line-finder terminal translator;

Figs. 33 and 34 show the office code translator;

Fig. 35 shows the called number register;
Fig. 36 shows time translator;
Fig. 37 shows the date register;
Fig. 38 shows the office name translator and part of the secondary punching machine;
Figs. 39 and 40 show the rate computor and parts of the secondary punching machine;
Fig. 41 shows a part of the secondary punching machine;
Fig. 42 shows the detailed construction of the pneumatic valve;
Figs. 43 to 53, inclusive, arranged as shown in Section 3 of Fig. 1, comprise such modified parts of the ordinary printing tabulator which comprise necessary parts of this invention.

The following description has been arranged in three separate sections as a matter of convenience to conform with the arrangement of the drawings, viz., (1) The preparation of the primary tape, (2) The preparation of the secondary tape and (3) the printing tabulator. The invention will be described in the same order.

Section I

Preparation of the primary tape.—Figs. 2 to 30 inclusive

Subscriber's line 2500 is one of a group of ten lines, said group comprising one of the four groups of lines shown in Figs. 25 and 26. The lines of these groups terminate on the banks of a line-finder frame to which line-finder switches have access in the known manner. In the disclosure of this invention, a line-finder-district selector comprises two mechanically moving elements operatively associated together, one element for finding and connecting with the terminals of a calling line, as shown by the arrangement of the line-finder brushes and terminals at 2510 and the other, usually termed the district selector, is used as a first switching stage for extending the calling lines indicated by the brushes of said selector and selector bank terminals at 2550. Further, in this disclosure of the preferred embodiment of the invention, the well known panel mechanical telephone system is used principally for the purpose of illustrating the ease with 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 line-finder-district selector shown in Figs. 2, 23 and 25 is but a modification of 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, and dated June 14, 1932. Likewise the trip, start and link circuits shown in Figs. 3, 5, 4 and 6 correspond respectively, exactly to the same circuits in the same numbered figures in the above mentioned patent. The sender, decoder and connector, which are shown in Figs. 7 to 21 inclusive of the drawings, are also similar to the corresponding parts of the above mentioned patent. The sender circuit, however, has been slightly modified for operation with my billing system as more completely described hereinafter. The decoder connector and decoder, schematically shown together in Fig. 21, are the control and translating units cooperating with the sender and are also fully described in the above mentioned patent. Hence, while the operation of these circuits, in relation to the invention, is believed to have been fully covered in the description following hereinafter, reference is made to the above mentioned patent for a more complete description of any and all parts of said circuits not fully covered herein.

Assuming, therefore, that subscriber 2500 initiates a call, then the removal of the receiver from the switchhook (not shown) closes a circuit from battery through the winding of line relay 2501, inner back contact of cut-off relay 2502, through the substation circuit, outer back contact of cut-off relay 2502 to ground. Relay 2501 operates, connects ground to conductor 2530 extending to trip circuit 300, and connects conductor 2531 to the line-finder terminal to which brush 2514 has access, 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. The purpose of the circuit is to trip the proper set of brushes on the line finder which hunts for the calling line and to insure 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 to the emergency trip circuit 350 should trouble arise.

The start circuit 500 is common to the ten trip circuits and serves to bring about the association, without interference, of calling subscribers' lines with district selectors and senders. The gang switch 591 which connects the start circuit 500 with the trip circuit 300 and with the link circuit 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 is associated 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 link is advanced to an allotted position. Therefore, only one link circuit is ready for use at a time. The link circuits serve to connect a calling line through a line-finder district selector circuit with a sender for recording the number of the wanted line and for controlling the establishment of the connection.

The connection of ground to conductor 2530, 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 the 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, connecting battery through its lower winding and through resistance 517 in parallel with conductor 242. With relays 304 and 515 operated, a holding circuit is completed

for relay 301 from ground at the outer front contact of relay 515, 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 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 front contact, outer upper front contact of relay 304, middle front contact of relay 301, outer back contact of relay 511, inner back contact of relay 508, 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, upper winding of relay 2301, conductor 2307, right contacts of cam 223, winding of relay 226 to battery. Relay 226 operates in this circuit and initiates the operation of line finder 2510. Relay 2301 operates, locks over its lower winding and bottom inner contacts to battery through resistance 2313. Through its bottom middle contacts relay 2301 partially closes a path from conductor 2312, bottom outer contacts of said relay, conductor 2364, winding of magnet 2413 to battery at the back contact of relay 2457, in preparation for the selection of and connection with a call recording mechanism at the time when the district selector switch 200 advances to position 3 as described hereinafter and at its lower contacts prepares the circuit of holding magnet 2411.

Relay 304 also closes a circuit from battery through winding of trip magnet 2517 of line finder 2510 over conductor 2527 to ground at its inner upper 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 does not operate in series with relay 303. Relay 303 opens the circuit of relay 516 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 inner upper front contact, upper contacts of cam 222, back contact of relay 227, commutator strip 2522, brush 2519 to ground. Relay 226 also closes a circuit from battery through the up-drive magnet 2515 of the line finder 2510, inner lower front contact of relay 226, right contacts of cam 218, outer lower front contact of relay 226, upper right contact of cam 209, lower right contact of cam 212 to ground. The line finder 2510 is moved upward in search of the calling line under the control of magnet 2515. When the line finder has passed the tripping zone so that the proper brush set has been made operative, brush 2520 encounters the conducting part of the commutator strip 2523 completing a circuit thereby from ground over brush 2520, segment 2523, upper contacts of cam 206, conductor 242 through make-busy keys (not shown) 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 2517. When brush 2520 leaves the segment 2523, relay 515 also releases to restore the operating circuit for the relays such as relay 304 in the other trip circuits.

When the line finder finds the calling line, a circuit is closed from ground over the upper contacts of cam 221, winding of relay 227, brush 2514, inner front contact of relay 2501, conductor 2531 which extends to the lower winding of relay 306 and the resistance 310 in parallel. Relay 227 operates in this circuit connecting ground over commutator strip 2522, front contact of relay 227, through resistance 228 in parallel with its winding, permitting relay 306 to operate. Relay 306 opens the locking circuit of relay 305 and the holding circuit of relay 301. The release of relay 305 opens the energizing circuit of relay 303 and that relay releases unless held locked because relay 516 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, this ground 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 over the upper right contact of cam 209, outer lower front contact of relay 226, upper right contacts of cams 218 and 207, conductor 247, brush 405, lower left and upper right contacts of cam 617, conductor 690, lower winding of relay 508 to battery. Relay 508 now operates, short-circuits relay 505, opens 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 for holding that relay operated. When the calling line is found, the operation of relay 227 also opens the locking circuit for relay 226 and that relay releases, opening the circuit of up-drive magnet 2515, bringing the line finder to rest. Relay 2301 whose operating circuit is opened with that of relay 226 does not release at this time as it is locked over its bottom winding as already described. The release of relay 226 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 2502, resistance 2532, brush 2513, resistance 2526, top inner back contact of relay 2525, conductor 2534, outer upper back contact of relay 226, lower contacts of cam 215, lower contacts of cam 212 to ground. Relay 2502, in operating, opens the circuit of the line relay 2501 which in turn disconnects ground from conductor 2530 releasing relays 301 and 306 in the start circuit and relay 227 in the district selector, and reconnects relay 2503 with the terminal engaged by brush 2514. 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 610 through the winding of relay 420, resistance 421 to battery. Relay 420 operates and locks over its lower front contact 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 prepares relay 424 for testing 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 up-drive 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 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 to ground through the upper and lower windings of relay 424. Relay 424 operates in this circuit and closes a locking circuit for itself from ground over its lower front contact, lower left and upper right contacts of cam 624, upper winding of relay 424 to battery over brush 454 as above traced. This circuit alters the potential on brush 454 so that no other link circuit which may be hunting can stop on this sender. The operation of relay 424 opens the circuits of relays 422 and 423 which now release. 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 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 is closed from ground over the lower right and upper left contacts of cam 608, brush 401, conductor 243, upper left contact of cam 213, upper right contact of cam 210, upper winding of relay 225 to battery. Relay 225 locks over its inner upper contact to ground over the left 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, upper right contact of cam 224, lower front contact of relay 225, lower back contact of relay 226, upper right contact of cam 200 to ground, advancing 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 cut-off relay 2502 is closed to ground over the upper left and lower right contacts of cam 212, holding the cut-off relay operated under the control of relay 2525 until the sequence switch leaves position 17¼. In position 3, ground is connected to conductor 2312 at the left upper contact of cam 212 and completes thereby the circuit of magnet 2413 of the call recorder as already described.

Now the number of recording mechanisms available to a group of line-finder-district selectors depends on the needs of the traffic. That is to say, it depends on the number of calls originated by the group which have to be recorded for charging purposes, whether local or toll. Hence, the number provided and the operative connection with, the group of line-finder-district selectors to which they appertain may be arranged with respect to each other in any convenient method known to the electrical switching art. In the preferred embodiment of the invention and simply by way of illustrating how one of the means can be used to attain this result, the well known Keith line switch arrangement, most extensively used in step-by-step automatic telephony, to connect together a calling district selector with an idle recording mechanism has been adopted. The mechanism of this switch and its inter-relation with its controlling circuit is so well known that it is sufficient to refer for a description of its operation to the prior art and particularly to any suitable text on the subject such as, for example, Smith and Campbell's "Automatic Telephony". Hence, it is herein simply referred to and shown diagrammatically in Fig. 24 without further encumbering this specification with a description of its operation beyond that which is necessary for a disclosure of the principles of our invention. Magnet 2413 is a part of the Keith line switch structure and when it operates, directs its plunger 2442 into the contact groove of its cooperating contact bank level, opposite to which contact groove the master switch shaft 2443 has previously directed the plunger. The engagement of contacts 2444 closes a circuit from battery through the winding of holding magnet 2411, lower contacts of relay 2301 to ground on conductor 2312. The operation of magnet 2411 operates mechanism for holding the digit registers of the recording mechanism and closes a circuit from ground over plunger operated contacts 2462 for holding magnet 2461, and causes the operation of relays 2459 and 2457 and stepping magnet 2458 of master switch 2400 to rotate shaft 2443 to position other plungers before contacts appertaining to another idle recorder. In position 3 a circuit is also closed from ground on conductor 2312, winding of release magnet 2306 of timing switch 2310 and, in parallel therewith, through the back contacts of relay 2366, to the winding of release magnet 2367 of timing switch 2300. Both switches 2300 and 2310 are of the rotary forward stroke construction, well known in the telephone art, except that they are modified by having their stepping pawls in engagement with their ratchet wheels to advance their wipers only when their release mag-

nets are operated and that their wipers are returned to normal only when these magnets are released and the stepping pawls are restored out of contact with the ratchet wheels. With magnets 2306 and 2367 operated, both switches are in condition to respond to timing impulses which are transmitted subsequently, as more completely described hereinafter.

With link sequence switch 600 in positions 2¾ to 3, conditions are set up in the sender to identify the class of service to which the calling subscriber is entitled. Subscribers, besides being divided in groups of convenient sizes for the purpose of 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 into 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 senders the group to which the calling subscriber belongs. This is done by establishing one of two conditions to the tip side of a 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 2500 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.

With sequence switch 200 in position 3, when sequence switch 600 also reaches position 3, a circuit is closed from battery through the winding of relay 229 and the upper left contact of cam 211 and in parallel through the lower winding of relay 2525 and the lower right contact of cam 211, thence over the lower left contact 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 2525 is marginal and does not operate at this time. 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 remove the idle 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, it 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 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 circuits: 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 and brush 452; conductor 247 is connected to conductor 747 over brush 405, left contacts of cam 617 and brush 455; conductor 248 is connected to conductor 748 over brush 406, left contacts of cam 612 and brush 456. The circuit connecting conductor 245 with conductor 745 extends, in position 5, 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, lower winding of relay 2368, conductor 2309, left contacts of cam 202, winding of relay 231, lowermost back contact of relay 2525, brush 2512, through the subscriber's substation and dial (not shown), back to linefinder brush 2511, bottom inner contact of relay 2525, left contacts of cam 201, conductor 2310, upper winding of relay 2368, conductor 2311, conductor 243, through the link circuit to conductor 743, resistance 729 to ground at the outer back contact of relay 1237. Relays 724 and 2368 operate in this circuit, the latter to perform functions to be described hereinafter. Relay 724 closes a circuit from battery through the winding of relay 716, front contact of relay 724 to ground at the 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, right back contact of relay 829, outer left front contact of relay 902 to the source of dial tone. A tone is thereby induced in the primary winding of relay 724 from whence it extends to the subscriber's line to inform him that he may proceed to dial.

In the meanwhile the operation of relay 2368 closes a circuit from ground on the back contacts of the No. 6 contact set of relay 2303, front contacts of relay 2368, winding of slow-release relay 2365, to battery. Relay 2365 operates and locks in a circuit extending over its left inner contacts, No. 9 contacts of relay 2303, to ground on conductor 2312.

It will be noted that relay 2368 is in series with relay 724 and both are in series with the subscriber's line. Hence both relays will respond to dial operations. In this description I will consider, first the circuit reactions in the sender following the responsiveness of relay 724 to dial impulses and subsequently I will describe the reactions following the responsiveness of relay 2368.

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 remain operated during the intervals between digits. When relay 724 closes its back contact in response to the first pulse, it connects ground 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 the lower front contact of relay 702 to conductor 731. With relay 902 operated a circuit is completed over the inner left contact of relay 904 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 armature of relay 702 and over the front contact of that relay to the winding of relay 703. Relay 703 locks through the winding of relay 704, front contact of relay 703, 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 connects ground to conductor 732 and over the outer right contact 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 remain operated. The fourth pulse operates relays 707 and 708 which open the locking circuits of relays 703 to 706, releasing relays 904 and 905. Relay 708 also connects ground to conductor 733 and over 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 and battery. 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 to 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 grounded conductor 736, alternate contact of relay 710, lower back contact 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 710, the back contacts of relays 706, 704 and 702 to the winding of relay 701. This relay locks through the winding of relay 702, as before, 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 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 the 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 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 to the right winding of relay 903 and battery.

When the last pulse of the digit has been received, relays 730 and 716 remain operated for a considerable length of time. The circuit of relay 716 is thereby opened and a circuit is closed from battery through the winding of relay 720, normal contacts of relay 718 to ground at the front contact of relay 715. Relay 720 closes a holding circuit for itself under the control of relay 716. It also connects ground from the front contact of relay 715, over the front contact of relay 720, outer left back contacts of relays 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 windings of the operated relays of secondary register 900 to battery. This provides a locking circuit for the register relays as well as an operating circuit for relay 901. It may be noticed, however, that the locking circuit of relay 904 is only closed when either relay 905 or 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 were operated.

Relay 901 in operating locks over its outer left contact to grounded conductor 1317. It also opens the circuit of relay 902, disconnecting 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 that the called subscriber's number is Halifax 3678 which requires the code 4—2—5 to be used, 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 has been received, the register relays lock in series with relay 911 which, in turn, operates and locks to conductor 1317, opens the circuit of relay 912 and connects ground from conductor 1317 over the inner front contact of relay 911 and the back contact of relay 921 to the winding of relay 922 to prepare for recording the 3d digit on register 920.

Following the registration of the office code the numerical digits are recorded, the thousands digit on register 1000, the hundreds digit on register 1010, the tens digit on register 1020 and the units digit on register 1100. If the call is one that is to be completed at a manual office where station 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 to 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 through relay 1101. The operating circuit for the cut-in relay 1112 of the station register 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 digit, closes a circuit from battery through the winding of sequence switch magnet 1700, lower right contact of cam 1702, conductor 1728, left back contacts 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 lower left contact of cam 1708 and the lower right 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 over the lower right and upper left contacts of cam 1724, winding of relay 1226, right back contact of relay 1227 to ground, operating relay 1226 to prepare for the closing of the fundamental circuit.

In the meanwhile relay 2368, in series with relay 724, has been simultaneously following the dial pulses. On the first pulse a circuit is closed from ground on the back contacts of the No. 6 contact set of relay 2303, back contacts of relay 2368, right inner contacts of relay 2365, contacts closed by plunger 2442, winding of relay 2410, brush and the first cooperating terminal of arc 2431 of rotary switch 2450, winding of the first digit stepping switch magnet 2401, to battery. Relay 2410 operates and, in turn, closes an obvious circuit for rotary switch magnet 2422. Switch 2450, however, is of the back-stroke moving type so that, so long as its magnet 2422 remains operated, brush 2431 remains on the first terminal. Stepping switch 2401, on the other hand, is of the forward-stroke type, that is, advances its brush assembly on the operation of the magnet so that, with the operation of magnet 2401, brushes 2415 and 2416 of said switch are advanced one step. At the end of the pulse, relay 2368 reoperates and opens the circuit of relay 2410 and switch magnet 2401. The magnet releases, but relay 2410, being slow-release, holds its operated position between pulse intervals. Each succeeding pulse of the first digit, therefore, alternately closes and opens the circuit of relay 2368, and in response thereto, the first digit register switch magnet 2401 advances its brushes 2415 and 2416 one step for each pulse. These brushes are retained in their advanced position by virtue of the operated condition of magnet 2411. When all the pulses of the first digit have been received and recorded relay 2368 reoperates and remains on its front contact for a longer period than it does between pulse intervals. Relay 2410 now releases, in turn releasing switch magnet 2422. On the release stroke of said magnet, brush 2431 is advanced one step, connecting said brush with the second terminal of the associated contact bank, and extending thereby the circuit path through relay 2410 to the winding of the second digit register magnet 2402.

On the first pulse of the second digit, the release of relay 2368 closes the previously described circuit through the winding of relay 2410 but now completed through the winding of magnet 2402 to battery, causing both the relay and the magnet to operate. The former causes the operation of magnet 2422 while the latter operates and advances switch brushes 2417 and 2418 one step over the terminals of their corresponding and respective arcs. Magnet 2402 now steps with each pulse and advances the switch brushes 2417 and 2418 a corresponding number of steps so that, when all the pulses of the second digit are received, these brushes will have been positioned on terminals on their respective arcs corresponding to the numerical designation of the digit. At the end of the digit, relay 2410 releases, in turn, releasing magnet 2422 and advancing brush 2431 to the third terminal of its arc, thereby connecting the winding of relay 2410 to the winding of third digit register magnet 2403.

The impulses of the third digit now cause the setting of brushes 2419 and 2420 of switch 2403 upon terminals corresponding to the numerical designation of this digit.

The first pulse of the fourth or thousands digit extends the pulsing circuit through the winding of fourth digit magnet 2404 and the pulses of this digit cause the setting of brushes 2429 and 2430 on terminals corresponding to the numerical designation of the fourth digit. The pulses of the fifth or hundreds digit are recorded on arcs cooperating with brushes 2427 and 2428 of fifth digit switch 2405. The pulses of the sixth or tens digit are recorded on the terminals of the arcs cooperating with brushes 2425 and 2426 of the sixth digit switch 2406. The pulses of the seventh or units digit are recorded on the terminals of the arcs cooperating with brushes 2423 and 2424 of the seventh digit switch 2407 and, if there is a party station's digit, the pulses of said digit are recorded on the terminals of arcs cooperating with brushes 2421 and 2422 of the eighth digit switch 2408.

When all the digits are thus registered in the call recorder, relay 2368 reoperates, thereby opening the circuit of relay 2410 and the station's digit switch magnet 2408. Relay 2410 releases, in turn, releasing magnet 2422 and causing brush 2431 to advance to the next terminal. On reaching this terminal, a self-interrupting circuit is closed from the grounded spare terminals on the arc cooperating with brush 2431, interrupter contacts of magnet 2422, winding of magnet 2422, resistance 2432 to battery. Magnet 2422 operates in this circuit and advances brush 2431 over the grounded spare terminals until it again reaches the terminal of first digit magnet 2401

at which time said self-interrupting circuit will have been opened and the recorder is ready to perform further functions as completely described hereinafter.

Returning, now, to the operation of the sender, 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 is operated 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, right back contact of relay 838, left back contact of relay 836, lower back contact of relay 723, inner lower back contact of relay 721 to conductor 930. Battery on this conductor is supplied to the windings of relay 2100 individual to this sender in the decoder connector.

The decoder connector comprises a complete circuit as shown in Fig. 21 to Fig. 24, inclusive, of the Raymond-Scully patent above mentioned. It is a connecting medium for connecting together, at the proper time, a sender and a decoder. It comprises a plurality of 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 accomplished through a multi-contact relay having an appropriate number of contacts, while the connection of a decoder to any channel is likewise accomplished through a multi-contact relay; with this difference, however, that while a sender can connect with a decoder through one channel only and is therefore provided with a multi-contact relay only in that channel, the decoder must have accessibility to the senders in every channel. It is, therefore, 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 the invention and is simply a connecting medium between the sender and the decoder, it is not thought necessary to encumber this specification with a complete description of its further arrangement and operation but reference is made to said Raymond-Scully patent for a complete description. Suffice it to say that the operation of relay 2331 results in the operation of the 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 to the manner described in the above mentioned patent to Raymond-Scully.

The decoder itself is a device for translating the dialed office code into the proper electrical equivalent which, when transmitted to the sender, can be utilized by it to set the train of selectors into the proper and respective positions for reaching the desired 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 purpose 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 for the selection of a trunk extending in the wanted direction, the decoder is connected to the sender through the medium of the 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 registered code 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 dialed 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" determined by the operation of the route relay corresponding to the code.

The decoder, or any translating device, is not a part of the invention and the various registers mentioned above therefore are but schematically shown in Fig. 21. The specification will be limited in describing 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 wanted code as registered on the operated relays of registers 900, 910 and 920. Since the office code of the wanted number is 4—2—5, relays 906, 915 and 927 will have been operated in each of the above registers, respectively. The following 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 registers 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 register 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 2500 is entitled. Relay 1407 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 also closes a circuit from ground over its right front contact, conductor 967, through the decoder connector to another completing circuit in the decoder for recording the class of service to which the subscriber is entitled.

Now in accordance with the operations described for the recoder in the above mentioned Raymond-Scully patent, after the code and class of service records have been set up in the appropriate receiving registers of said decoder, cir-

cuits 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 purposes 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, operate in different combinations for grounding conductors which connect with the selection registers of the sender, shown in Figs. 18 and 19. These registers are **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 records the equivalent of electrical information which is later utilized by the sender to guide and position the train of selectors for establishing the talking connection between the calling subscriber's line and 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 purposes of future operations that the following relays are operated in each selection register by the outgoing registers in the decoder which responded to 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 three of the operated relays of the selection register, namely relays **1310** and **1321** are, for convenience, located in different figures of the drawings. Relays **1120**, **1121**, **1123**, **1322** and **1504** are also parts of the selection register and located in a different figure likewise 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 whose code is 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, 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 selections relays **1310** and **1321**, two-wire office relay **1322**, class register relay **1801**, **1802** and **1803** and the compensating resistance register relays **1921** to **1925**, all of which comprise parts of the sender selection registers. In addition, this ground extends over the left contacts of cam **1704** in positions 2 to 3 of sequence switch **1700** to form the locking circuit for the district brush register relays **1811** to **1813**, the district group register relays **1901** and **1910** and the zone relays **1504** and **1505**, while said ground further extends 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 the start conductor **930**, the effect of which is to release sender connector relay **2100** in the decoder connector. This relay, in turn, releases multicontact relays **2101** and **2104** thereby completely disconnecting the sender from the decoder, while other circuits are responsive in the decoder, as described in the Raymond-Scullly patent, to restore the decoder to normal.

Recapitulating the operations in the sender as a result of its connection with the decoder and assuming the connection to be extended to a panel type office in the local zone, the following relays have been operated in the selection register as a result of the code translation by the decoder; relay **1924** to indicate that a short trunk needs considerable compensating resistance in the revertive pulse 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 and by circuits controlled through their back contacts indicate a full mechanical type call; relay **1812** indicating that the third district brush is to be selected; relays **1322** and **1310** indicating 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.

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 upper winding of relay **225**, upper right contact of cam **210**, lower right contact of cam **213**, conductor **248**, through the link circuit to conductor **748**, upper front contact of relay **723**, lower contacts of cam **1722**, winding of relay **1300**, back contact of relay **1220**, inner left contact of relay **1226**, right winding of relay **1225**, resistance **1230**, left back contact of relay **1506**, conductor **1514**, upper right contact of cam **1709**, lower left contact of relay **1708** to ground. Relay **225** operates in this circuit locking over its inner upper front contact and the lower left 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**, upper right contact of cam **224**, lower front contact of relay **225**, lower back contact of relay **226**, upper right contact of cam **209** to ground, advancing sequence switch **200** to position 4. In this position the operating circuit of relay **225** is opened but the relay remains operated in its locking circuit. It also closes a circuit from battery through the winding of up-drive magnet **2354** of district selector **2350**, upper contacts of cam **215**, lower front contact of relay **225** to ground as above traced. Magnet **2354** causes the district selector to move upward in a brush selecting movement. In this movement it closes a circuit from ground

over the lower contacts of cam 212, brush 2358, commutator strip 2362, lower contacts 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 2358 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 left contacts of cam 1708, conductor 1320, front contact of relay 1300, conductor 1730, left contacts of cam 1707, conductor 1735, upper right contact of cam 1720, lower right 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, upper right contact of cam 1709, lower left contact of cam 1708 to ground. Relay 1216 can not operate because its winding is shunted by the operating circuit of relay 1215. When commutator brush 2358 makes contact with the first conducting segment of strip 2362, closing the shunt around the winding of relay 1300, that relay releases permitting relay 1216 to operate. When brush 2358 reaches an insulating segment, relay 1300 reoperates and the circuit closed over its contact is extended over the front contact of relay 1216, back contact of relay 1218, winding of relay 1217 to battery. Relay 1217 operates and locks through the winding of relay 1218, back contact of relay 1228, lower left and upper right contacts of cam 1705 to ground, but relay 1218 does not operate until brush 2358 reaches the next conducting segment. When brush 2358 leaves this segment, relay 1300 reoperates and the circuit is extended over the front contact of relay 1218, lower left and upper right contacts of cam 1713 to the winding of relay 1219 and battery. When brush 2358 reaches the third conducting segment, shunting relay 1300 for the third time, relays 1220 and 1229 operate in the locking circuit of relay 1219.

The operation of relay 1220 opens the fundamental circuit, releasing both relays 1300 and 225. The release of relay 225 opens the circuit of magnet 2354 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, lower contacts of cam 219, lower back contact of relay 225, back contact of relay 226, upper right 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 2356, upper right contact of cam 214 to ground, rotating the trip rod to trip the selected set of brushes when the selector next moves upward. Another circuit is closed in parallel with trip magnet 2356 by way of the right back contact of relay 2304, winding of relay 2305 to battery. Relay 2305 operates to perform functions hereinafter described.

Concurrently with the preparation of the district selector for making group selections, which is the selection subsequent to the operation of trip magnet 2356, other circuits are closed to signal the character of call which is being set up to the call recorder. At this junction it is thought advisable to mention the fact that the preservation of the connection of the call recorder to the district selector on a signal from the sender that the call is to be extended within the local rate area is entirely a function of whether or not the operating company desires to handle the charging of local calls purely on a subscriber meter basis, and to time and preserve a record of only such calls as are extended beyond the local area, or whether it desires to time and record all calls to be charged regardless of whether they are local or toll. The invention is entirely flexible for accommodation with a variety of telephone commercial and billing practices and any type of apparatus or telephone systems. In some cases, for instance, and as already indicated, the operating company may desire to make a record of toll calls only. In other cases, in addition to the toll record, a record of the charges for local calls may also be thought desirable, with this difference, however, that while the calls made and the time of each call are properly correlated to the calling line from which they are made, no record is preserved of the called line number. And yet there are other practices where the operating company desires the usual record of the billing details of a toll connection but also complete details of local connections for verifying the identity of calls in case of disputes. The invention is easily adaptable to each of these three representative practices as well as to others and the slight modifications in the apparatus or circuits which may be required to effect its adaptation to any system or commercial practice may be easily discerned from the typical means herein disclosed for accomplishing such modifications.

If, now, it is assumed that the operating company desires to obtain its record of local calls from the operation of a subscriber's meter and desires no permanent record of such calls, or of calls made from flat rate subscribers or for "free" calls generally, then there is no further necessity of holding the district call recorder or the record of the called line therein. Further, if it is assumed that the operating company desires to preserve a record of all charged calls whether local or toll, then whether the call recorder is held connected to the district or not depends upon whether, in the case of local calls, the operating company desires to make a record of the destination of the call and the time of the connection without making any further use of the called line number in the subsequent use of that record in the preparation of the record for printing the monthly bill. It is evident that where local calls and calls charged for on a local rate basis are billed in bulk to the subscriber, a preservation of the complete record of calls would be desirable should a dispute arise about the accuracy of the total local charges. If, therefore, on local calls, and calls charged for on a local rate basis, the operating company desires no record of the destination of the call, the call recorder is dismissed; if, on the other hand, a record of the destination of the call is to be made, regardless of the type of call, the recorder is held. Consequently, in the first case, when the sender through the operation of relays 1310 and 1322 in the selection register, recognizes the call as one to be completed in the local area, a dismiss signal is transmitted from the sender to the call recorder by the completion of a circuit from ground on the right outer contact of relay 1310, right front contact of relay 1322, right contact of relay 1226, left contacts of cam 1714, back contact of relay 1231, conductor 747 and bank

terminal connected thereto, brush 455, through the link circuit as already described, brush 405, and terminal cooperating therewith, conductor 247, contacts of relay 2305, bottom inner contacts and winding of relay 2301 to ground. The holding winding of this relay is now shunted and said relay is caused to release. The ground closure from the sender to the lower winding of relay 2301 and the consequent release of this relay is the signal transmitted to the recorder that the call is completed within the local rate zone. Under such circumstances, therefore, there is no further necessity to hold the recorder so that, with the release of relay 2301, the circuit of magnet 2411 is opened, opening the circuit of plunger holding magnet 2461 and releasing the call recorder from the district selector. Holding magnet 2411, due to its mechanical relationship to the pawls of the separate digit recording switches, also causes the return to normal of all the brushes of said switches. The recording circuit is now normal and ready for seizure by any other district selector allotted for service.

In the second case where the operating company desires to preserve a record of the called line office and number for local calls as well as for calls beyond the local area, the discriminating signal described above is not transmitted, relay 2301 is not released and the recording circuit is held. Where the number of "free" calls is small in proportion to all other calls which have to be recorded, the separation of a district selector from a call recorder and their connection together through the medium of a connecting switch when needed, may not be economical. In such an event, it is entirely possible to incorporate the recorder as a part of the district selector and to omit the connecting medium, like the Keith line switch, for example. In any event, the gist of this feature of the invention is a call recording circuit which may be made either integral with or separated from the district selector according to the commercial practices of the operating company. For the purpose of illustrating the operation of the invention, it will be assumed that the call Halifax 3678 while not a local call, is to be charged for on a five cent local base rate, say ten cents for the initial conversation period of five minutes and five cents for each additional five minutes or fraction thereof. Also, that while no record of the called line number or date of the call is to appear in the monthly bill, nevertheless a record of the complete telephonic transaction is to be made on the primary tape.

It is also evident without any further amplification or description that in the case as assumed wherein the call recorder is to be held, the dismissing signal to the call recorder as above described could be eliminated either by removing the ground closure through the talking selection relays 1310 and 1322 or by changing the translation of the code in the decoder so that the operation of the route relay 3205 in response to the called code in the local area will result in the operation of relay 1310 and the non-operation of relay 1322 or the non-operation of either or by any other suitable means which avoids the signal and yet does not change the remainder of the selection register settings for the proper positioning of the various selectors in extending the calling line to the called line.

The necessary details of the call which have to be recorded on the primary tape, under the above assumption are:

1. A record of the calling line number.
2. A record of the called line number.
3. The time of conversation.
4. The date.

Under the circumstances of the above assumption, therefore, and in accordance with the circuit and apparatus structure used to disclose the preferred embodiment of the invention, the translation of the code by the decoder results in the non-operation of either one or both talking selection relays 1310 and 1322 and the ground closure described above as having been transmitted from the sender to dismiss the call recorder is not available. Hence, relay 2301 is not released and the call recorder is not dismissed. Nothing further happens to the recording or timing apparatus until the called subscriber answers. The rest of the connection beyond district brush selection is set up as follows:

When relay 1229 operates as previously described it closes a circuit from battery through the winding of relay 1228, 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. Relay 1228 also closes an obvious circuit for relay 1227. When relays 1228 and 1227 both operate, the circuit of relay 1226 is opened and that relay releases. The operation of relay 1228 opens the locking circuit for the odd numbered counting relays, while the release of relay 1226 opens the locking circuit for the even numbered counting relays including 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, upper 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 and that relay releases. When relay 1228 recloses its back contact, relay 1226 reoperates over the back contact of relay 1228, upper left contact of cam 1716 and the lower left contact of cam 1708 to ground.

The release of relay 1220, the reoperation of relay 1226 and the advance of sequence switch 1700 reclose the fundamental circuit. Relays 225 and 1300 again operate, relay 225 locking as before and advancing sequence switch 200 to position 6 in which position the up-drive magnet 2354 is again operated under the control of relay 225 and an intermittent circuit prepared from ground as above traced over brush 2359, commutator strip 2363, lower 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 operation, 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 upper left 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.

With sequence switch 200 in position 7, relay 225 is reoperated in the circuit which may be traced from battery through the lower winding of relay 225, upper left contact of cam 220, right contact of cam 222, lower contacts of cam 217, front contact of relay 229, lower left contact of cam 214, to ground. Relay 225 advances sequence switch 200 out of position 7 and into position 8. When sequence switch 200 reaches position 7½, the testing circuit from the first outgoing trunk is closed over the sleeve of that trunk, sleeve brush 2353 of the district selector, lower contacts of cam 221, inner upper front contact and winding of relay 225 to battery. Therefore, if the first outgoing trunk is busy, as indicated by ground connected to its sleeve terminal, relay 225 is held operated. Another holding circuit is closed over the outer upper front contact of relay 225, and the right contacts of cam 203, to the sleeve brush. If relay 225 remains operated in position 8, up-drive magnet 2354 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 lower winding, upper left and lower right contacts of cam 220, centering commutator strip 2361, brush 2357, left contacts of cam 215, lower front contact of relay 225, back contact of relay 226, upper right contact of cam 209 to ground.

When an idle trunk is found and the brushes of the selector are properly centered, relay 225 releases, advancing sequence switch 200 to position 9. In position 9 relay 225 is operated through its lower winding, upper right and lower left contacts of cam 217, front contact of relay 229, lower left contact of cam 214, to ground. Relay 225 advances sequence switch 200 to position 10 where 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, upper back contact of relay 237, lower contacts of cam 204 to brush 2351 and thence to the tip conductor of the office selector, and the ring of the fundamental circuit is extended from conductor 247, over the lower right and upper left contacts of cam 205 and brush 2352 to the ring conductor of the office selector. At the office selector, the tip and ring conductors extend to battery and ground respectively.

In the sender, the operation of relays 1220 and 1229 performs the same function as above described, advancing sequence switch 1700 to position 4. With sequence switch 1700 in position 4, a circuit is closed from battery through the winding of relay 1602, upper right and lower left 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, inner left back contact of relay 1504, right back contact of relay 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 the office selector over the fundamental circuit to conductor 748, upper front contact of relay 723, left back contact of relay 1804, through resistance 1725, lower left and upper right contacts of cam 1703, conductor 1731, right front contact of relay 1506, conductor 1510, right front contact of relay 1925, winding of relay 1314, back contact of relay 1220, inner left contact of relay 1226, right winding of relay 1225, left contacts of cam 1717, back contact of relay 1921, through resistances 1927 and 1926, back contact of relay 1922, upper right and lower left contacts of cam 1714, back contact of relay 1231 to conductor 747 and thence to 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 in the circuit 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 conductor 1734 and the lower right 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 of the switch 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 lower right contact of cam 1722, lower left 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.

The operations for making office selections are very much the same as those 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, upper right contact of cam 1720, upper right contact of cam 1719, back contact of relay 1821, left back contact of relay 1822, right back contact of relay 1823 to conductor 1840, lower left and upper right 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 in 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 selections are 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, in this case, over the upper contacts of cam 1720, right back contact of relay 1911, outer left front contact of relay 1912 to conductor 1842. Two revertive impulses therefore cause the operation of relays 1215 to 1218, inclusive. With relay 1218 operated the circuit now extends over the left contacts of cam 1713, right front contact of relay 1914, conductor 1845 to the back contact of relay 1202, winding of relay 1201 and 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 eight 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 trunk outgoing to the incoming selector located at the wanted office. As in position 6, the fundamental circuit is not reclosed until relay 1227 has released.

As soon as sequence switch 1700 leaves position 3, the locking circuit for the relays of registers 1900 and 1810 is opened, and relays 1901, 1902 and 1812 release. When sequence switch 1700 reaches position 7, a circuit is closed from battery over the inner left back contact of relay 1804, conductor 1850, through the winding of relay 1501, conductor 1511, upper 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 1830 is now included in this register. Since the number of the called subscriber was assumed to be 3678, relays 1004 and 1005 of register 1000 will have been operated and a circuit will be closed from ground over the middle right contact of relay 1004, outer right front contact of relay 1501, winding of relay 1830 to battery. A second circuit is closed from conductor 1732 which is grounded by the operation of relay 1001, inner right contact of relay 1005, middle right contact of relay 1501, conductor 1041, winding of relay 1811 to battery.

In position 7 of sequence switch 1700 the trunk testing circuit extends as traced in position 4, except that the quantity of compensating resistance inserted in the fundamental circuit is now controlled by relays 1923 and 1924 and the circuit, therefore, extends from the lower left contact of cam 1714 to the lower left 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. Relay 1602 and relay 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 distant selector permits the operation of relay 1314, in turn operating relay 1307 which locks as long as sequence switch 1700 is in position 7. It closes a circuit from ground over its outer left contact and the lower contacts of cam 1706, right back contact of relay 1804 to the winding of sequence switch 1700 advancing the 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.

In position 8 incoming brush selection takes place in a manner similar to the previous selections, the fundamental circuit extending as for office selection except that resistance 1926 is included alone as in the test circuit. The counting relay circuit for this selection extends from ground over the contact of relay 1300 to conductor 1735, inner left back contact of relay 1236, lower 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 and thence to the winding of relay 1217 so that two revertive pulses are received and the second brush set of the incoming selector is chosen.

The operation of relay 1229 closes a circuit from ground over its front contact, right back contact of relay 1235, lower left and upper right 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, upper contacts of cam 1721, conductor 1742, inner left front contact of relay 1011, to ground at the front contact of relay 1030. Incoming group selection is under the joint control of the thousands and hundreds registers, and therefore can be made only after the hundreds digit has been recorded as indicated by the operation of relay 1011. 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 1010 with office brush register 1820 which now becomes the final brush register and, with relay 1901 of the district group, register 1900 now becomes the incoming group register. Under the assumption made, relays 1014 and 1017 are operated. A circuit is closed from ground at the right contact of relay 1014, outer right front contact of relay 1502, conductor 1031, right winding of relay 1821, to battery. Another circuit is closed from ground over the inner right contact of relay 1017, inner right contact of relay 1502, conductor 1081, right winding of relay 1901 to battery. Since relay 1830 was operated, a circuit is closed from ground over the upper front contact of relay 722, conductor 750, outer left front contact of relay 1501, right front contact of relay 1830, right back contact of relay 1813 to the winding of relay 1902 and battery.

With 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 lower left contact of cam 1719, and thence over the upper left contact of cam 1719, right front contact of relay 1901, 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 it when found. The operation of relay 1229 advances sequence switch 1700 to position 11. When sequence switch 1700 leaves position 10, relay 1501 releases in turn releasing the relays of register 1810. In this position, the fundamental tip is connected to the fundamental ring to dissipate any charge due to cable capacity which may have accumulated thereon before starting final selection. The circuit extends for this purpose from conductor 748 to the back contact of relay 1804, through resistance 1725, left 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 where the fundamental circuit is reclosed for final brush selection.

The counting relay circuit for final brush selection extends from ground over the lower left and upper right contacts of cam 1708, conductor 1730, front contact of relay 1300, conductor 1320, upper contacts of cam 1707, conductor 1735, inner left back contact of relay 1236, lower left and upper right 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 from battery over the back contact of relay 1804, conductor 1850, through the winding of relay 1503, conductor 1513, lower contacts of cam 1715, conductor

1743, inner front contact of relay 1021 to ground at the front contact of relay 1030. Relay 1503 connects the tens register 1020 with the relays of register 1910 which now becomes the final tens register. Since relays 1025 and 1027 were operated, 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, lower left contact of cam 1719, upper left 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, left contacts of cam 1713, front contact of relay 1914 to conductor 1845, back contact of relay 1202, winding of relay 1201 to battery. Five more impulses operate relays 1201 to 1210 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 the relays of register 1910.

In position 15 a circuit is closed from battery over conductor 1850 through the winding of relay 1601, conductor 1604, lower 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 serves as the final units register. Since relays 1104, 1105 and 1107 are operated, circuits are closed from ground over the right contact of relay 1104, inner left contact of relay 1601, conductor 1081, winding of relay 1901 to battery, from ground over the right contact of relay 1105, outer left contact of relay 1601, conductor 1082, 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 1084, right winding of relay 1904 to battery. Relay 1601 also closes a circuit from ground at its 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 over the left 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 the lower contacts of cam 1713, front contact of relay 1904 to conductor 1845 and 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 this position of sequence switch 1700, the operation of relay 1229 causes the operation of relay 1228 in turn operating relay 1227 and releasing relay 1226 to release the counting relays in the manner previously described. With relay 1229 released, and relay 1228 operated, sequence switch 1700 is advanced to position 17, releasing relay 1601 and the relays 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 reversed battery is connected to the fundamental circuit. Therefore, relays 1300 and 1225 are both operated. Relay 1225, in operating, closes a circuit from ground at its contact over the 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 upper left and lower right contacts of cam 1711, winding of relay 1235 to battery. With relay 1235 operated, the operation of relay 1300 closes a circuit from ground over its front contact to conductor 1735 as previously traced, inner left front contact of relay 1235, winding of relay 1219 to battery. Relay 1219 operates and locks as before described. A relay in the incoming selector also operates over the fundamental circuit and advances the incoming selector to a position where the reversed battery is removed. Relay 1300, therefore, releases, but relay 1225 is locked holding relay 1235 operated. The release of relay 1300 removes the shunt from relays 1220 and 1229 and these relays now operate. 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, right contacts of cam 812 through the 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 cam 1705, operates relay 1227, releases relays 1226, 1219, 1220 and 1229. When relay 1229 releases, it closes a circuit 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 release. Relay 1231 remains locked and holds relay 1232 operated. Relay 1228 also releases, reclosing the circuit of relay 1226 over the upper left 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 cannot 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. With sequence switch 200 in position 11, ground is connected to conductor 245 over the lower right contact of cam 214. This ground is connected to conductor 245 before relay 229 is disconnected therefrom and, therefore, reoperates that relay. 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 239, front

contact of relay 231, upper left contact of cam 214 to ground in which it is held operated through position 17 of the sequence switch under the control of the calling subscriber. Sequence switch 200 is advanced from position 11 to position 12 over the upper right contact of cam 224, right contacts of cam 215 and the lower contacts of cam 212. When sequence switch 200 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 locks over its outer right front contact to conductor 745. It also connects ground in shunt of battery through resistance 1304 so that relay 1233 also releases.

With relay 1234 released, the circuit for making talking selection is completed as follows: battery through the upper winding of relay 225, upper right contact of cam 210, lower right contact of cam 213, conductor 248 through the link circuit to conductor 748, front contact of relay 723, lower contacts of cam 1722, winding of relay 1308, back contacts of relay 1220, front contact of relay 1226, right winding of relay 1225, resistance 1230, inner right back contact of relay 1234 to ground. Relay 1308 closes a counting relay circuit from ground as previously traced to the upper right contact of cam 1720, lower left contact of that cam, 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, upper right contact of cam 224, lower front contact of relay 225, upper left contact of cam 209 to ground. As sequence switch 200 advances out of position 12 through positions 12⅜ and 13⅜ ground is connected over the left contacts of cam 221 and lower left contact of cam 210, lower right contact of cam 213, to conductor 248 in shunt of the winding of relay 1308. Relay 1308 releases twice, permitting relays 1217, 1218, 1219, 1220 and 1229 to operate. Relay 1220 opens the holding circuit for relay 225 which now releases holding sequence switch 200 in position 14 in which a charge is made.

When sequence switch 200 advances to position 11¼ the dialing circuit is opened and in position 11½ the calling subscriber's talking circuit is completed from ground over the upper left winding of repeating coil 234, upper contacts of cam 201, bottom inner contact of relay 2525, brush 2511 of the line finder 2510, through the subscriber's substation back to brush 2512, bottom outer contact of relay 2525, winding of relay 231, lower contacts of cam 202, lower left winding of repeating coil 232 to battery. The cuttings of cam 202 overlap 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 closes a circuit from ground over the front contact of relay 1229, back contact of relay 1235, left contacts of cam 1718, winding of relay 1237 to battery. It also connects ground over the left back contact of relay 1234 and the left contacts of cam 1723 to the winding of relay 1237 to insure its operation. The release of relay 225 also connects ground over the upper left contact of cam 209, lower back contact of relay 225, right contacts of cam 219, conductor 247, through the link, to conductor 747. The operation of relay 1237 opens the circuit of relay 1301, connects battery through the resistance 1302 over the outer left front contact of relay 1235 and 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 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 closes a circuit from ground at the lower back contact of relay 420, 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 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 terminal bank. This is determined by the use of commutator segments 463 and 464. Segment 464 extends over the top ten terminals and segment 463 extends 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 over the right contacts of cam 615 is held closed 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, the circuit is closed from battery through resistance 421, winding of relay 420, upper left and lower right contacts of cam 619, 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 segment 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 its 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 engaging any set of terminals below the eightieth set, relay 422 releases when sequence 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 lower right con-

tact of cam 212, lower right contact of cam 214, lower left and upper right contacts of cam 211, contact of jack 230, conductor 249, contact of jack 622, contact of jack 614, lower contacts of cam 618, upper back contact of relay 424, lower left and upper right contacts of cam 619 to the winding of relay 423 and battery. Relay 423 closes a circuit from battery through the upper winding of relay 422 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 iner upper front contact 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, contact of jack 614 to brush 404 to test for a district selector in the awaiting link condition. With relay 422 operated the circuit of up-drive magnet 413 of the district finder is closed 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, battery through a predetermined resistance is connected to the terminal to which brush 404 has access over a circuit similar to that traceable from battery through resistance 241, lower left and upper right contacts of cam 216, contact 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 locks over its inner lower contact and the upper left and lower right contacts of cam 625. It also opens the circuit of up-drive magnet 413 and closes a circuit from ground over its lowermost front contact, upper right and lower left contacts of cam 611, winding of down-drive magnet 414 to battery. The district finder is restored to normal in this circuit. Relay 420 also opens the testing circuit leading to brush 404 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 to resistance 421, shunting and releasing relay 420 which restores the testing circuit as well as the circuit of up-drive magnet 413 and the hunt continues.

When a district is found in position 1, relay 424 operates opening the circuit of relay 423 which now releases, closing a circuit from battery, through sequence switch magnet 600, lower left contact of cam 613, contact 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 from ground over the upper right and lower left contacts of cam 618, upper front contact of relay 424, left contacts of cam 606, brush 401, to the tip conductor of the district selector engaged by finder 400 whence the circuit is similar to that traceable over conductor 243, upper left contact of cam 213, upper right contact of cam 210, upper winding of relay 225 to battery. This relay operates, locks over its inner upper front contact and the left contacts of cam 221 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 from 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, when this link reaches position 2, a circuit is closed from ground over the left contacts of cam 635, right contacts of cam 636, contact 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. With relay 1305 released, as well as the 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 contact of relay 714, back contact of relay 1233, back contact 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 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, it if should be off normal. The disconnection of ground from conductor 1238 releases relay 826 which controls the time measure switch, thereby closing a circuit from ground at its back contact, lower left contact of cam 808, upper right contact of cam 801, 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.

In the district selector when the sequence switch 200 comes to rest in the talking position selected, i. e., position 14, the outgoing end of the talking circuit is established from tip brush 2351, left contacts of cam 204, upper right winding of repeating coil 234, left contacts of cam 203, winding of relay 233, lower right winding of repeating coil 234, left contacts of cam 205 to ring brush 2352.

In the meantime the incoming selector connects ringing current in the known manner to the called subscriber's line and, when that subscriber responds by removing his receiver from the hook, the current flow through relay 233 is reversed so that relay 233 operates, closing a cir-

cuit from ground over the lower right contact of cam 209, front contact of relay 233, lower left and upper right contacts of cam 220, left contact of interrupter 235, the winding of relay 226 to battery. Relay 226 locks over its inner upper front contact, right contact of cam 222, lower left contact of cam 220 to ground under the control of relay 233. When interrupter 235 closes its right contact a circuit is closed from ground on this contact the outer lower front contact of relay 226, upper right and lower left contact of cam 216, winding of relay 237 and battery. Relay 237 operates and locks to ground through its bottom inner contacts, the upper left contact of cam 209 to ground. The operation of relay 237 is the signal to the district selector after the interval measured by interrupter 235 to allow for line disturbances, that the called subscriber has answered and indicates the instant from which the conversation period is to be measured. Consequently after the operation of relay 237, a circuit is completed from ground through the top middle contacts of relay 237, conductor 2314, left outer contacts of relay 2365, winding of relay 2304 to battery. Relay 2304 operates and, through its left inner contacts, connects ground to conductor 2533 which extends to resistance 2526 and sleeve brush 2513 while through its right inner contacts it closes a circuit from ground through clock controlled interrupter 2369, right inner contacts of relay 2304, winding of magnet 2371 of timing switch 2300 to battery. Timing switch 2300, as well as timing switch 2310, is of the positive stepping type similar to any of the register switches 2401 to 2408, inclusive, so that, with the closure of the interrupter 2369 after the passage of the proper time interval, the close of the above described circuit to magnet 2371 will cause brushes 2372 and 2375 of switch 2300 to advance one terminal on their respective contact arcs.

Now interrupter contact 2369 may be closed periodically at any suitable interval. In this disclosure, it is assumed that it closes once every minute. Since each of the contact arcs of switch 2300 has eleven terminals, the rotation of brushes 2372 and 2375 over one complete revolution measures a conversation period of ten minutes.

However, telephone conversations may last more than ten minutes, especially those relating to local calls. It becomes necessary, therefore, to provide some recording mechanism which will record the passage of each ten minute interval of whatever may happen to be the maximum conversation period which has to be recorded. For this purpose, switch 2310 is added. Its brushes, as more completely described hereinafter, advance one terminal for every complete revolution of the brushes of the minute switch 2300. Since switch 2310, like switch 2300, is provided with a terminal bank having ten working terminals for each brush, it is possible thereby to record a conversation period of 100 minutes or one hour and 40 minutes. When it is desirable to record conversation periods longer than this on the basis of one minute intervals other switches may be added to record the additional time. Or again, switches of larger terminal capacity may be used and the standard base interval reduced from one minute to 30 seconds. In the present embodiment of the invention, in order not to encumber the specification and the illustrative figures with descriptions and disclosures which illustrate capacity of registration rather than the principle upon which registration is based, it has been assumed that, although the use of switch 2310 permits recording maximum conversation periods of one hour and 40 minutes, the maximum conversation period is limited to 30 minutes and that the base interval is one minute. Consequently when the brushes of switch 2300 have advanced to the 11th terminal, switch contacts 2376 are closed and a circuit is completed from ground on said contacts, winding of relay 2366 to battery. Relay 2366 operates, locks over its bottom contacts to ground on the off normal contacts 2308 of the minute switch 2300 and opens the circuit of release magnet 2367 of switch 2300 thereby permitting the return of brushes 2372 and 2375 to the normal terminals on their respective arcs. Relay 2366, through its top inner contacts, further completes a circuit to the winding of magnet 2377 of the 10 minute switch 2310 which, in its mechanical structure, is identical with the minute switch 2300.

The operation of switch magnet 2377 causes brushes 2374 and 2373 to be advanced one terminal on their respective contact arcs to register, by such advance, an elapsed interval of ten minutes of the conversation period.

In the meanwhile the return to normal of the minute switch 2300 caused the opening of the off normal contacts 2308 in consequence of which relay 2366 releases and, in turn, opens the circuit of magnet 2377 and recloses the circuit of holding magnet 2367 which, by its operation, permits the brushes 2372 and 2375 to advance once again along their respective arcs on the registration of the second ten minute interval or fraction thereof.

With the 10 minute switch 2310 registering a ten minute conversation period, and the minute switch 2300 normal during the succeeding one minute interval, the timing mechanism is ready to register another 10 minute interval or fraction thereof and further, at the proper time, another ten minute interval; the timing continuing until the conversation is terminated, every revolution of the minute switch 2300 measuring a ten minute period and every step of 10 minute switch 2310 recording a 10 minute interval. The total conversation period, therefore, is measured by the number of terminals traversed by the brushes of switch 2310 representing so many ten minute intervals and the number of terminals to which the brushes of switch 2300 has been advanced representing the number of minutes less than ten.

At the end of the conversation, when the called subscriber restores his receiver to the switchhook, the current flow 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 from ground over interrupter 236, back contact of relay 229, lower left contact of cam 206, lower right contact of cam 211, lower winding of relay 2525 to battery. Relay 2525 operates and locks through its upper winding and inner front contact, conductor 2534, to ground over the upper left and lower right contacts of cam 212. Relay 2525 further disconnects the tip and ring conductors of the calling line from the tip and ring brushes of the line finder district selector, but ground from the left contact of relay 2304 is still connected through resistance 2526 to brush 2513. Relay 2525 also connects ground through its top outer contacts, lower right contact of cam 216, upper left contact of cam 223, through the winding of sequence switch magnet 200 to battery, advancing the sequence switch to position 17. As the sequence switch passes through posi-

tions 15 to 17, the locking circuit of relay 237 is held closed through the left upper contact of cam 209. Consequently, a circuit is closed from battery through both windings in series of relay 2302, conductor 2316, bottom outer contacts of relay 237, bottom contacts of cam 206, conductor 2317, brush 2514 and associated terminal, back contacts of relay 2501, winding of line identifying relay 2503 to ground. Relay 2302 operates in this circuit to perform functions hereinafter described, but relay 2503, being marginal, does not operate.

Figs. 25 and 26 show the manner in which subscribers' lines are divided into groups for purposes of identification. Both figures, taken together, show ten lines of a main group of forty lines. Each line has an identifying relay, like relay 2503, connected to the back contact of its associated line relay. Now in a line-finder frame of the panel type which normally accommodates 400 lines, the lines of said frame can be divided into ten main groups of forty lines each when one recording machine is to be used for recording all calls made by the lines on one frame. However, it is possible that, due to the number of calls which may originate from so large a group, the use of one machine for the entire group may unduly add to the holding time of line-finder-district selectors since each of said selectors is held in position 17 until the record of the call is made. Hence, in this embodiment of the invention, it has been assumed that one recording machine would be used for the lines of one-half of the frame or two hundred lines instead of for the whole frame or four hundred lines. Consequently, for purposes of identification, each group of two hundred lines is divided into five main groups of forty lines each instead of ten main groups, although if one recording machine is sufficient for one frame or for a group of frames, other appropriate subdivisions readily suggest themselves.

Each group is provided with an identifying relay, such as relay 2711 or 2819. Since, according to the assumption, there are five groups of 40 lines each, there are 5 group identifying relays for one half of the frame. Each of these group relays is electrically responsive to the operation of each and every line-identifying relay within its own group so that the operation of a line-identifying relay and the resulting operation of the group identifying relay marks the subscriber's group and the numerical position of that line within the group.

The forty lines of each group are next subdivided into four sub-groups of ten lines each, as for example, the subdivision schematically disclosed in Figs. 25 and 26. The calling subscriber's line, therefore, is identified by (1) the operation of the group-identifying relay of the particular one of the five groups of forty lines to which it belongs, (2) by identifying the particular sub-group of tens of the four such sub-groups in each group of forty in which the line belongs and (3) of identifying its numerical position within the sub-group itself.

The entire identification is carried out by the use of code characters, as more completely described hereinafter, there being a separate code character for each of the three identifying elements mentioned above. In order to identify the main group, since there are but five groups to one half of the frame, use is made of three separate signaling conductors provided in common to all the group relays of one half of the frame. When these conductors are connected to ground either singly or in proper combination through the operated group relay, the conductor or conductors so grounded identifies the group associated with the operated group relay. These conductors are designated on Fig. 28: 2818, 2817, 2816, and they are grounded as follows to identify each one of the five main groups:

Conductors grounded	Main group
2818	1
2817	2
2816	3
2818–2817	4
2818–2816	5

The identification of the sub-group of ten subscribers within the main group of 40 lines is carried out on the same principle. There are four separate signaling conductors which, by the operation of the line identifying relay, as described hereinafter, grounds one of said conductors to denote the particular sub-group in which the calling line is located. These conductors are designated in Fig. 28 as conductors 2815, 2814, 2813, 2812. The combination which identifies each of the four sub-groups is as follows:

Conductors grounded	Sub-group
2815	1
2813	2
2814	3
2812	4

The identification of the numerical position of the calling line within a sub-group is carried out by the use of four identifying conductors. These conductors are connected to the individual line identifying relays in a particular order so that the operation of an identifying relay grounds the signaling conductors connected thereto either singly or in a combination to identify the particular line in the sub-group. The order of grounding is as follows:

Conductors grounded	Number of the line within the sub-group
2820	1
2821	2
2822	3
2823	4
2820–2821	5
2820–2822	6
2820–2823	7
2821–2822	8
2821–2823	9
2822–2823	0

It must not be supposed, however, that the specific arrangement of line grouping as outlined above limits the scope of this part of the invention to the preferred example herein described and disclosed. The example given above is chosen for illustration simply because it typifies the gist of this part of the invention, which is an arrangement of apparatus and controlling circuits for transmitting to the recording machine, described hereinafter, a group of signals for identifying the calling line. The above described arrangement of circuits and apparatus is necessarily dependent on the group arrangement of the lines, the character of the telephone system of which they form a part and the kind of the identifying character to be transmitted. Therefore, while the subscriber identifying circuits shown in Figs. 25 to 28 inclusive are merely typical and illustrative of one suited to a panel telephone system with a particular arrangement of lines, any identi-

fying character and the means of transmitting the same which is adapted to the character of the telephone system to which the invention is applied and the type of recording machine used is to be understood as coming within the scope of the invention.

Returning, now, to the operation of the circuit, it will be recalled that, as the district selector sequence switch 200 advanced from position 15 to position 17, a circuit was completed between relay 2302 of the district timing circuit and the identifying relay 2503 of the calling line and that, due to the high resistance of the top winding of relay 2302, relay 2503 did not operate but relay 2302 did operate, all as above described. The operation of relay 2302 closes a circuit extending from ground through its bottom outer contact, conductor 2325, winding of relay 2203 to battery and, in parallel therewith, back contact of relay 2201, winding of motor magnet 2202 to battery. Simultaneously, another circuit is closed from ground over the bottom inner contacts of relay 2302, conductor 2326, to the first arc contact with which brush 2204 cooperates to mark the district selector of Figs. 2 and 3 as one having a call to be registered in the recording mechanism.

Fig. 22 shows an allotter circuit whose function is to close through the appropriate circuits for connecting the district selector awaiting call registration in position 17 with the recording mechanism common to a line-finder frame, which mechanism is to record on a tape the necessary items of information with regard to the call, as described hereinafter. Essentially the allotter comprises a switching mechanism provided with a suitable number of contact terminals to which all the district selectors associated with one line-finder frame are connected. When relay 2302 is operated in response to the proper association of the district selector timing circuit with the identification relay 2503 of the calling line, the particular selector switch of the allotter circuit is operated to select on its terminal arcs those terminals to which the district selector associated with the calling line is connected. Specifically, the allotter shown in Fig. 22 comprises a plurality of switches 2210 to 2250, inclusive, instead of one switch, in order to reduce the time taken for switch brushes to reach the contacts of the district to be identified. All the district selectors of the group available to one line-finder frame associated with one recording machine are divided for convenience into subgroups and the individual selectors of each of these sub-groups are terminated on the arc terminals of a fast hunting sub-group switching mechanism. If, as in the specific case under illustration, the number of district selectors available to one line-finder frame is fifty, then the group of fifty is divided into five sub-groups of ten selectors each, switch 2210 being associated with the first group and switch 2250 being associated with the fifth group. The starting and marking conductors of each selector in each subgroup, as for instance conductors 2325 and 2326, respectively, are connected simultaneously to the allotter switch of the particular sub-group to which they belong.

Switch 2260 in the allotter is a master switch which, at the proper time, causes the connection of the selector awaiting call registration in any allotter sub-group with the recording mechanism. Assuming the district selector whose operations are being described to belong in the first sub-group, then switch magnet 2202 is operated in preparation for advancing its brushes 2204 and 2205. If the district selector is not connected to the first terminals, then the switch magnet 2202 and relay 2203 operate as above described. Brushes 2204 and 2205 are advanced to the next set of terminals, at which time magnet 2202 will have reclosed its interrupter contacts to reclose the magnet circuit above described, causing said magnet to reoperate and advance the brushes to the next set of terminals. This operation continues until the brushes reach the respective terminals to which conductor 2326 of the district selector is connected, whereupon a circuit is closed from ground through the bottom middle contacts of relay 2302, conductor 2326, brush 2204 and its associated terminal, winding of relay 2201 to battery. Relay 2201 operates, opens the circuit of magnet 2202 thereby arresting its further advance and further prepares a circuit from battery through the winding of relay 2303, inner contacts of relay 2302, conductor 2327, brush 2205 and its associated terminal, front contact of relay 2201, to the first terminal of the arc of master switch 2260 with which brush 2209 cooperates. In the meanwhile and at the time when relay 2203 operated, a circuit was closed from ground through its outer contacts, conductor 2213, back contacts of relay 2212, interrupter contacts of magnet 2211 of master switch 2260, winding of said magnet to battery. The switch magnet operates and advance brushes 2208 and 2209 step-by-step over their respective arcs. When brush 2208 reaches the first terminal, a circuit is closed from ground through the inner contacts of relay 2203, brush 2208 and its associated terminal, winding of relay 2212 to battery. Relay 2212 operates, breaks its back contacts, prevents magnet 2211 from any further operations, and connects its front contact to brush 2209. When switch 2210 has advanced to where its brushes have established contact with the waiting district selector and relay 2201 operates as a result, the circuit through the winding of relay 2303 extended to brush 2209 as above described, is now completed through the front contacts of relay 2212 to ground at the inner contact of relay 2203.

Relay 2303 operates, opens the locking circuit of relay 2365 at its No. 9 contacts causing said relay, after an interval, to release, closes the circuit of relay 2409 over its No. 2 contacts, short circuits the top high resistance winding of relay 2302 over its No. 1 contacts and closes a holding circuit over its No. 7 contacts for magnet 2411. The current now flowing through the circuit comprising the identifying relay 2503 and the bottom low resistance winding of relay 2302 is such that relay 2503 operates to perform functions hereinafter described. Relay 2203 and other similar sub-group relays of the allotter are made slow to operate in order to give the subgroup switches 2210—2250 an operating start before closing through the circuit to the master start switch magnet 2211. In this manner there will be no possibility of falsely moving brushes 2208 and 2209 off the terminals of the respective sub-groups before the sub-group switch has actually started operating.

In the present embodiment of the invention, as already indicated, there is provided one registering mechanism for each group of 200 lines for registering the call history record of all calls originated and successfully completed by the lines within the group, independent of the type

or character of the service to which each of said lines is entitled. That is, if it is assumed that the line-finder frame is of a known panel construction and accommodates 400 lines, then one registering mechanism will take care of all the records for 200 lines of this frame while a similar mechanism is provided for the registration of calls for other groups of 200 lines. The registering mechanism used herein is a tape punching device comprising a number of punch magnets and cooperating pay-out and take-up mechanism for advancing, at the proper time, unperforated tape underneath the punching prongs of the several magnets. The important parts of the mechanism are schematically disclosed in Figs. 27 to 30, inclusive. It comprises a group of punch magnets 3000 to 3010 inclusive for recording, in code form, the calling subscriber's line-finder terminal number that is, the group number identified by relay 2503; magnets 3011 to 3014 inclusive and magnets 2900 to 2907 inclusive for recording in code form the called office code; magnets 2908 to 2919 inclusive and magnets 2825 to 2832 inclusive for recording the called line number, also in code form; magnets 2833 and 2834 for recording whether the call is to be charged at the evening or night rate; magnets 2835 to 2842, inclusive, for recording in code form the conversation time, and magnets 2700 to 2710 inclusive, the date in code form. For this purpose, therefore, a perforating machine is required which is capable of making sixty-four punches for registering by code all of the above information. Since the record is to be perforated in a single line across the tape, the width of said tape is approximately 8 inches, provided, as indicated in the several figures, with 64 separate punch positions, 1 to 64 inclusive. The punch prongs are arranged in a die with a magnet for each punch, the magnets being associated with their respective punches by punching mechanism controlled through the operation of the magnet armature in the well known manner. The type of punch magnet contemplated in this invention is well illustrated by the one disclosed in Patent No. 1,851,838, granted to R. Hoover et al. on March 29, 1932.

As described hereinafter, any combination of magnets may be selected and, if operated, force their respective punches through the broad paper tape, perforating the same. In addition to the die and punches, the perforating machine is equipped with a tape pay-out reel 3016, a take-up reel 3015 and a magnet 3018 of the back stroke type for advancing the tape a step after each perforating operation, as more completely described hereinafter. The tape has a series of perforations 3017 at one of its edges somewhat similar to that of a moving picture film. The advancing mechanism engages these perforations by means of sprocket teeth 3019 to insure the advance of the tape a definite distance for each step.

Associated with each perforating machine is a multi-contact relay 2712 by means of which the windings of forty of the sixty-four punch magnets are connected to the timing switches 2300 and 2310 of the district selector and to the recorder registers of Fig. 24. The three punch magnets 3000, 3001 and 3002 are connected to the several contacts of the main group relays such as 2711 and 2819 and eight punch magnets, 3003 to 3010 inclusive are permanently connected to the contacts of the line-finder terminal-indicating relays 2503—2507 and 2600—2604—, and to the other indicating relays in the main groups. The remaining punch magnets 2833 and 2834 and 2700 to 2710, inclusive, which are used to record the rate of charge and the date of the call, are connected through the contacts of relay 2713 to the contacts of the mechanically locking keys 2714 to 2727, inclusive, which determine the date and the rate setting. These keys are common to the office and their contacts are, therefore, wired in multiple to the multi-contact relays associated with the punching machines of each of the line-finder frames thereby requiring but one operation for setting the date and rate indications for the entire office. Further, these keys may be of any suitable type of construction, that is, they may be manually operated requiring re-setting at the required periods or they may be clock controlled and automatic without departing from the spirit of the invention.

Before proceeding with the further operation of the system, it is desirable to describe briefly the code system adopted for recording all the information to be perforated on the primary tape.

The various records which are required to be punched and the punch positions on the primary tape where the punch-mark registrations of said records are to made, follow:

Table I

	Punch positions	Number of punches
To record the line-finder terminal	1 to 11, incl.	11
To record the called office code	12 to 23, incl.	12
To record the called number	24 to 43, incl.	20
To record the night rate	44	1
To record the evening rate	45	1
To record the conversation time	46 to 53	8
To record the date of the call	54 to 64	11
Total		64

As already indicated, the record of each item is made by code, and the code characters for indicating the line-finder terminal number of the calling line has been described. The several combinations of operated punch magnets for identifying the line-finder terminal number of the calling line is as follows:

Table II.—Terminal number

Punch magnets operated	Punch positions	Group designation
3000	1	1
3001	2	2
3002	3	3
3000-3001	1-2	4
3000-3002	1-3	5
		Tens designation
3003	4	1
3004	5	2
3005	6	3
3006	7	4
		Units designation
3007	8	1
3008	9	2
3009	10	3
3010	11	4
3007, 3008	8-9	5
3007, 3009	8-10	6
3007, 3010	8-11	7
3008, 3009	9-10	8
3008, 3010	9-11	9
3009, 3010	10-11	0

The code character for each of the other seveal items is based on the same code system of providing three or four signaling conductors grounded in appropriate combination, and each of which is connected to a separate punch magnet. In the case of the called office code, each of the code letters is the equivalent of one of

ten possible digits. Consequently, the code of each separate letter is obtained by providing four conductors each connected to the windings of magnets 3011 to 3014, respectively, and grounded separately or in the required combination for representing the digit or letter of the code. The several combinations of operated punch magnets for the first or A digit of the called office code are as follows:

Table III.—A digit

Punch magnets operated	Punch positions	Digit or letter designated
3011	12	1
3012	13	2, A, B, C,
3013	14	3, D, E, F,
3014	15	4, G, H, I,
3011, 3012	12-13	5, J, K, L,
3011, 3013	12-14	6, M, N, O,
3011, 3014	12-15	7, P, R, S,
3012, 3013	13-14	8, T, U, V,
3012, 3014	13-15	9, W, X, Y,
3013, 3014	14-15	0, Operator.

The several combinations of operated punch magnets for the second or B code digit are the same as shown in Table III except that the punch magnets operated are 2900 to 2903 inclusive, and perforations are punched in the tape in punch positions 16 to 19 inclusive. The combinations of operated punch magnets for the third or C code digit are the same as shown in Table III except that the punch magnets operated are 2904 to 2907, inclusive, and perforations are punched in the tape in punch positions 20 to 23, inclusive. Similarly, the several combinations of operated punch magnets for the numerical digits of the called line number are the same as shown in Table III, except that magnets 2908 to 2911, inclusive, punch perforations in punch positions 24 to 27, inclusive, for recording the thousands digits; magnets 2912 to 2915, inclusive, punch perforations in punch positions 28 to 31, inclusive, for recording the hundreds digit; magnets 2916 to 2919, inclusive, punch perforations in punch positions 32 to 35, inclusive, for recording the tens digit and magnets 2825 to 2828, inclusive, punch perforation in punch positions 36 to 39, inclusive, for recording the units digit.

The station's digit may comprise one of four letters, J, M, R or W. Each of these may be expressed in code characters made up of three conductors either singly or in combination to represent each of the letters. In the present embodiment of the invention, it was deemed simpler to represent each letter by a particular punch position on the tape so that the grounding of one of four conductors and the consequent operation of the associated punch magnet designates the dialed party letter as follows:

Table IV.—Party letter

Punch magnet operated	Punch positions	Party letter
2829	40	J.
2830	41	M.
2831	42	R.
2832	43	W.

The night and evening rate designations are each signaled by a separate signaling conductor controlled through keys, suitably located at the same desk as the keys which control the date setting.

Table V.—Rate designations

Punch magnet operated	Punch positions	Rate
2833	44	Night.
2834	45	Evening.

The duration of the call is recorded in code form. The timing circuit of the district selector, as disclosed, is arranged to record conversation time of one hour and 40 minutes and for this purpose two groups of four signaling conductors each are provided; the first group to record intervals of ten minutes or less which provides for a maximum registration of two hours of conversation time, and the second to record separate minute intervals, as follows:

Table VI.—Conversation time (2 hours)

Punch magnets operated	Punch positions	Time
2835	46	10 minutes or less.
2836	47	20 minutes.
2837	48	30 minutes.
2838	49	40 minutes.
2835, 2836	46-47	50 minutes.
2835, 2837	46-48	60 minutes.
2835, 2838	46-49	1 hr. 10 minutes.
2836, 2837	47-48	1 hr. 20 minutes.
2836, 2838	47-49	1 hr. 30 minutes.
2837, 2838	48-49	1 hr. 40 minutes.
2835, 2836, 2837	46-47-48	1 hr. 50 minutes.
2835, 2837, 2838	46-48-49	2 hrs.

However, it will be remembered that it was assumed for purposes of illustration, that the maximum time to be registered would be limited to 30 minutes and in 10 minute intervals with the fractions thereof registered in minute intervals. Hence, for the registration of the three ten minute intervals comprising the thirty minutes, only three magnets are necessary, punching, say, perforations in positon 46, 47 and 48 (and disconnecting the winding of magnet 2838 for punch position 49) as follows:

Table VII.—Conversation time (30 minutes)

Punch magnets operated	Punch positions	Time
2835	46	10 minutes or less.
2836	47	20 minutes or less but more than 10 minutes.
2837	48	30 minutes or less but more than 20 minutes.

The minutes elapsed time code on the basis of a 30 minute conversation period comprises four magnets operated singly or in combination to indicate minute intervals of elapsed time, as follows:

Table VIII.—Conversation time (minute intervals)

Punch magnets operated	Punch positions	Time (up to 10 mins.)
		Minutes
2839	50	1
2840	51	2
2841	52	3
2842	53	4
2839, 2840	50-51	5
2839, 2841	50-52	6
2839, 2842	50-53	7
2840, 2841	51-52	8
2840, 2842	51-53	9
2841, 2842	52-53	10

The date of the call requires three separate code characters, one for the month and two for the day. Since provision is required for twelve separate code designations, one for each month of the year, each of these designations is obtained through four separate conductors and associated punch magnets, singly or in combination for each of the required characters, as follows:

Table IX.—Date—month

Punch magnets operated	Punch positions	Month
2700	54	January.
2701	55	February.
2702	56	March.
2703	57	April.
2700, 2701	54-55	May.
2700, 2702	54-56	June.
2700, 2703	54-57	July.
2701, 2702	55-56	August.
2701, 2703	55-57	September.
2702, 2703	56-57	October.
2700, 2701, 2702	54-55-56	November.
2700, 2702, 2703	54-56-57	December.

The designation of the day of the month is divided in two parts, a tens and units part. Since there are but three possible ten day groups to the month, each of the three groups may be characterized by a separate conductor and associated magnet, as follows:

Table X.—Date—tens digit of day designation

Punch magnet operated	Punch positions	Tens digit
2704	58	1-10
2705	59	11-20
2706	60	21-31

The units digit comprises eleven possible characters, one for each of the eleven digits, as follows:

Table XI.—Date—units digit of day designation

Punch magnet operated	Punch positions	Units digit
2707	61	1
2708	62	2
2709	63	3
2710	64	4
2707, 2708	61-62	5
2707, 2709	61-63	6
2707, 2710	61-64	7
2708, 2709	62-63	8
2708, 2710	62-64	9
2709, 2710	63-64	10
2707, 2708, 2709	61-62-63	11

Returning now to the operation of the circuit, it will be assumed that the followng conditions exist with respect to the record of the call to be printed when multi-contact relay **2712** operates:

Subs. line terminal	Called office code	Called No.	Rate	Duration of call	Date	Rate of charge
117	Halifax 425	3678	Evening	*Minutes* 15	July 17	15 cents for 5 minutes, 5 cents for each 2 minutes or fraction thereof.

It will be recalled that the present embodiment of the invention assumes the use of one punching machine for half of a line-finder frame which, in turn, is of the well known panel type accommodating 400 subscribers. In such an event the 200 lines on one half of the frame are divided into five groups of forty lines each, as already described, wherein relay **2711** indicates one of the five groups by the proper connection of its left inner contact to the group indicating conductors **2816**, **2817** and **2818** and that the individual indicating relay **2503** associated with the calling subscriber's line indicates the proper tens and units in that group. As shown in Fig. 27, relay **2711** has its indicating contact connected to conductor **2818**, so that when relay **2711** operates, a circuit is closed from ground on its left contact, conductor **2818**, winding of punch magnet **3000** to battery. Magnet **3000** operates and punches a hole in the No. 1 punch position of the tape, indicating, according to the three conductor codes described above, that the calling line is to be found in the first main group. When relay **2711** operates, it further closes an obvious circuit to the winding of multi-contact relay **2712** associated with the punch machine serving the 200 lines in which the line of the call to be registered belongs. Relay **2711** operates and cuts through to the punch machine the called office code-signaling conductors, the called line number-signaling conductors and the elapsed time-signaling conductors. It further closes an obvious circuit for multi-contact relay **2713** which, on operating, closes through the date, night and evening rate signaling conductors. Relay **2713** further closes a circuit from ground on its No. 12 contact set, conductor **2743**, winding of advance magnet **3718** to battery. The magnet operates and causes the pawl to advance into the next notch of ratchet wheel **3017**, of the take-up roll **3015**. The magnet remains in this position with the pawl engaged, keeping the take-up roll stationary until the magnet releases, as more particularly described hereinafter.

The tens designation indication is controlled through four conductors which, according to the adopted code, furnish four separate indications. The calling line is assumed to be in the first tens group. Consequently, the outer contact of relay **2503** is connected to conductor **2815**. Hence, when relay **2503** operates as above described, a circuit is closed from ground on conductor **2535**, outer contact of relay **2503**, conductor **2815**, winding of punch magnet **3003** to battery. Magnet **3003** operates and causes a hole to be punched on the No. 4 punch position of the tape indicating thereby that the calling line terminal is in the first tens group of the first group of forty lines.

The units digit of the calling line terminal is **7** and according to the code, conductors **2820** and **2824** are to be grounded. Consequently when relay **2503** operates, the following circuits are closed: (1) ground on conductor **2535**, next to the outer contact of relay **2503**, conductor **2823**, winding of punch magnet **3007** to battery. Magnet **3007** operates and causes a hole to be punched in the No. 8 punch position of the tape; (2) ground on conductor **2535**; next to the inner contact of relay **2503**, conductor **2520**, winding of punch magnet **3010** to battery. Magnet **3010** operates and causes a hole to be punched in the No. 11 punch position of the tape. Thus, holes punched in positions Nos. 8 and 11 indicate the seventh digit of the calling line line-finder terminal.

Summing up the code punchings for the line terminal designation:

Group 1	Tens 1	Units 7
Tape punching position 1	4	8, 11

All the holes punched on the tape of the call being illustrated are shown as small circles immediately above the punch position number.

The called subscriber's number was assumed to be Halifax 3678, wherein the first three digits dialed for Halifax correspond to the numerical code 425 of the ordinary telephone impulse dial. Consequently, when the subscriber dialed 425, the brushes **2415** and **2416** of the "A" digit switch **2401** were set on terminal 4 of the cooperating arcs in response to the reception of four impulses for the first digit, brushes **2417** and **2418** of the "B" digit switch **2402** were set on terminal **2** of the cooperating arcs in response to the reception of two impulses for the second digit, and brushes **2419** and **2420** of the "C" digit switch **2403** were set on terminal **5** of the cooperating arcs in response to the reception of five impulses for the third digit.

Now the code perforations of the "A" code digit designation are made by punch magnets **3011** to **3014**, inclusive, as already described. Since the "A" code digit of the called office code is assumed to be 4, then, when relay **2712** operates, a circuit is closed from ground on the No. 2 contacts of relay **2409**, conductor **2445**, brush **2415** and associated No. 4 terminal, No. 4 contacts of relay **2712**, conductor **2728**, winding of punch magnet **3014**, to battery. Magnet **3014** operates and causes a hole to be punched in position 15 of the tape, thereby recording in code form, the digit 4 for the "A" code digit.

The code perforations of the "B" code digit designations are performed by punch magnets **2900** to **2903**, inclusive, as already described. Since the "B" digit of the called office code is 2, then, when relay **2712** operates, a circuit is closed from ground on the No. 4 contact set of relay **2409**, conductor **2446**, brush **2417** and its associated No. 2 terminal, No. 6 contacts of relay **2712**, conductor **2729**, winding of punch magnet **2901** to battery. Magnet **2901** operates and causes a hole to be punched in position No. 17 of the tape thereby recording, in code form, the digit 2 for the "B" code digit.

The code perforations of the "C" code designation are made by punch magnets **2904** to **2907**, inclusive, as already described. Since the "C" digit of the called office code is 5, then, when relay **2712** operates, the following circuits are closed; (1) ground on the No. 6 contacts of relay **2409**, conductor **2447**, brush **2419** and associated No. 5 terminal, No. 9 contacts of relay **2712**, conductor **2730**, winding of punch magnet **2904** to battery. Magnet **2904** operates and causes a hole to be punched in position No. 20 of the tape; (2) ground on the No. 5 contact set of relay **2409**, conductor **2448**, brush **2420** and associated No. 5 terminal, No. 10 contacts of relay **2712**, conductor **2731**, winding of punch magnet **2905** to battery. Magnet **2905** operates and causes a hole to be punched in position No. 21 of the tape. Holes punched in positions 20 and 21, therefore, indicate the digit 5 of the "C" code.

The called subscriber's number was assumed to be 3678. Consequently when the subscriber dialed 3678, the numerical switches of the call recorder advanced their respective brushes over their cooperating arcs to terminals corresponding respectively to the digit impulses received.

The code perforations of the thousands digit code designation are made by punch magnets **2908** to **2911**, inclusive, as already described. Since the thousands digit of the called subscriber's number is 3, then, when relay **2712** operates, the following circuit is closed: ground through the No. 7 contact set of relay **2409**, conductor **2449**, brush **2429** and the associated No. 3 terminal, No. 15 contacts of relay **2712**, conductor **2732**, winding of punch magnet **2910**, to battery. Magnet **2910** operates and causes a hole to be punched in position No. 26 of the tape to indicate the thousands digit 3.

The code perforations of the hundreds designation are made by punch magnets **2912** to **2915**, inclusive, as already described. Since the hundreds digit of the called subscriber's number is 6, then, when relay **2712** operates, the following circuits are closed: (1) ground on the No. 10 contact set of relay **2409**, conductor **2451**, brush **2427** and its associated No. 6 terminal, No. 17 contacts of relay **2712**, conductor **2733**, winding of magnet **2912** to battery. Magnet **2912** operates and causes a hole to be punched in position No. 28 of the tape; (2) ground on the No. 9 contact set of relay **2409**, conductor **2452**, brush **2428** and its associated No. 6 terminal, No. 19 contact set of relay **2712**, conductor **2734**, winding of punch magnet **2914**, to battery. Magnet **2914** operates and causes a hole to be punched in position 30 of the tape which, with the hole punched in position No. 28, indicates in code form the hundreds digit 6.

The code perforations of the tens designation are made by punch magnets **2916** to **2919**, inclusive, as already described. Since the tens digit of the called subscriber's number is 7, then, when relay **2712** operates, the following circuits are closed: (1) ground on the No. 12 contact set of relay **2409**, conductor **2453**, brush **2425** and associated No. 7 terminal, No. 21 contacts of relay **2712**, conductor **2735**, winding of punch magnet **2916** to battery. Magnet **2916** operates and causes a hole to be punched in position No. 32 of the tape; (2) ground on the No. 11 contact set of relay **2409**, conductor **2454**, brush **2426** and its associated No. 7 terminal, No. 24 contacts of relay **2712**, conductor **2736**, winding of punch magnet **2919** to battery. Magnet **2919** operates and causes a hole to be punched in position No. 35 of the tape. Holes punched in positions 33 and 35 indicate the designation of the tens digit 7.

The code perforations of the units designation are made by magnets **2825** to **2828**, inclusive, as already described. Since the units digit of the called subscriber's number is 8, then, when relay **2712** operates, the following circuits are closed: (1) ground through the No. 14 contact set of relay **2409**, conductor **2455**, brush **2423** and associated No. 8 terminal, No. 26 contacts of relay **2712**, conductor **2737**, winding of punch magnet **2826** to battery. Magnet **2826** operates and causes a hole to be punched in position No. 37 on the tape; (2) ground through the No. 13 contact set of relay **2409**, conductor **2456**, brush **2424** and its associated No. 8 terminal, No. 27 contact set of relay **2712**, conductor **2738**, winding of punch magnet **2827** to battery. Magnet **2827** operates and causes a hole to be punched in position No. 38 of the tape which, in conjunction with the hole punched in position No. 37, designates in

code form, the units digit 8 of the called subscriber's number.

The rate of charge according to the assumption, is the rate termed "evening rate". It is controlled by the depression of key 2715. Consequently when relays 2712 and 2713 operate as already described, another circuit is closed from ground on the contacts of key 2715, No. 14 contact set of relay 2713, conductor 2739, winding of punch magnet 2834 to battery. Magnet 2834 operates and punches a hole in position No. 45 of the tape, thereby designating the evening rate in code form.

It has been assumed further that the conversation time is 15 minutes and that the district timing switches 2300 and 2310 measure a maximum of 30 minutes. Hence when the conversation is terminated, brushes 2373 and 2374 of the 10-minute switch 2310 are resting on the second terminals of the respective arcs and brushes 2375 and 2372 of the minutes switch 2300 are resting on the fifth terminals of their respective arcs. Consequently when relay 2712 operates, the following circuits are closed: (1) ground through the No. 3 contact set of relay 2303, brush 2373 and its associated second terminal, No. 34 contact set of relay 2712, conductor 2741, winding of punch magnet 2836 to battery. Magnet 2836 operates and causes a hole to be punched in position 47 of the tape thereby designating, in code form, that the conversation has lasted less than 20 minutes, but more than 10 minutes; (2) ground through the No. 5 contact set of relay 2303, brush 2375 and its associated fifth terminal, No. 37 contact set of relay 2712, conductor 2742, winding of punch magnet 2839, battery. Magnet 2839 operates and causes a hole to be punched in position 50 of the tape; (3) ground on the No. 6 contact set of relay 2303, brush 2372 and its associated fifth terminal, No. 38 contact set of relay 2712, conductor 2744, winding of punch magnet 2840 to battery. The magnet operates and punches a hole in punch position 51 which, in conjunction with the hole punched in position 50, indicates that five additional minutes have been consumed beyond the 10 minute interval, or 15 minutes in all.

According to the assumption, the date of the call being registered is July 17. The month of July, being the seventh month of the calendar year, represents the seventh of the twelve combinations of the four conductor code, above described. Hence keys 2716 and 2720 are operated and multicontact relay 2713 is also operated. The following punch magnet circuits are closed: (1) ground on contacts of key 2716, No. 11 contact set of multi-contact relay 2713, winding of punch magnet 2700, battery. Magnet 2700 operates and causes a hole to be punched in position 54 of the tape; (2) ground on the contacts of key 2720, No. 8 contact set of relay 2713, winding of magnet 2703 to battery. Magnet 2703 operates and causes a hole to be punched in position No. 57 of the tape which, in conjunction with the hole punched in position 54, designates in code form, the month of July as the month when the call is made.

The days of the month are divided, for code purposes into two parts, the tens digit and the units digit, as already described; there being three tens digits and eleven units digits. The three tens digits are identified by the three conductor combinations controlled through the three tens digit keys, viz: keys 2721, 2722, and 2723 while the eleven units digits are identified by the eleven conductor combinations controlled through the four digit keys 2724 to 2727, inclusive. Hence, on the seventeenth day of the month, key 2721 is depressed for the tens digit one and keys 2724 and 2727 are depressed for the units digit seven. Consequently, when multicontact relay 2713 operates, the following circuits are closed: (1) ground on the contacts of key 2721, No. 7 contact set of relay 2713, winding of punch magnet 2704 to battery. Magnet 2704 operates and causes a hole to be punched in position 58 of the tape; (2) ground on the contacts of key 2724, No. 4 contact set of relay 2713, winding of punch magnet 2707, battery. Magnet 2707 operates and causes a hole to be punched in position 61 of the tape; (3) ground on the contacts of key 2727, No. 1 contact set of relay 2713, winding of punch magnet 2710 to battery. Magnet 2710 operates and causes a hole to be punched in position 64 of the tape. A hole punched in position 58, another in position 61 and yet another in position 64 designate in code form the seventeenth day of the month.

While the circuits of each of the punch magnets involved in the perforation of the record of the call have been described in a manner consistent with the arrangement of the magnets in the various drawings, it will be realized that these magnets are operated simultaneously after relays 2712 and 2713 are operated, which occurs during the interval when switch 200 is in position 17. When switch 200 reaches position 17, relay 226 is released and relay 237 is locked as already described. Hence, in this position, a circuit is closed from ground on interrupter contacts 236, top back contacts of relay 229, lower left contact of cam 208, right lower contact of cam 211, left back contact of relay 2304, upper left contact of cam 216, right upper contact of cam 223, winding of relay 226 to battery, thereby operating relay 226. Relay 226 locks over its inner upper front contact, the right and lower left contacts of cam 222, commutator strip 2541 and brush 2518 to ground. With relay 226 operated, magnet 200 is energized over the lower right contact of cam 207, upper right contact of cam 218, lower front contact of relay 226, upper right contact of cam 209 to ground. Sequence switch 200 is thereby advanced to position 18. As sequence switch 200 leaves position 17¼ the above described circuit, including the identifying relay 2503 and the lower winding of relay 2302 is opened, thereby causing these relays to release. With relay 2503 released, magnet 2411 is released to restore the recorder and to release plunger holding magnet 2961 thereby disconnecting the recorder from the district selector. Ground is removed from the tens and units punch magnets 3003, 3007 and 3010. The circuit of group relay 2711 is also opened. Relay 2711 releases, removes ground to the winding of punch magnet 3000 and further opens the circuit of multicontact relay 2712 which, on releasing, further releases relay 2713. With both of these relays released all conductors leading to the punch magnets are opened, causing them to release and withdraw their respective punches from the perforated tape. Relay 2713 further opens the circuit of advancing magnet 3018 which, on releasing, causes the pawl attached to its armature to advance the tape roll 3015 one notch to prepare the tape for the registration of a subsequent call by any line in that half of the line finder frame served by the punching mechanism.

It will be noted that the time allowed for the

operation of the punch magnets is controlled by the release of relay 2304 since it is through the left back contacts of this relay that the circuit for operating relay 226 is controlled and which, in turn, controls the advance of sequence switch 200 from position 17 to position 18. Relay 2304 is made very slow-release in order to allow ample time. But should the magnetic or mechanical structure of the punch magnets make additional time necessary, other slow-release relays may be added in series with relay 2304 or the required interval may be obtained by any other suitable means controlled by the release of relay 2304. Beyond position 17¼ the circuit of relay 237 is also opened and ground is removed from conductor 2312, thereby releasing holding magnets 2367 and 2306 to release the timing switches 2300 and 2310.

With relay 237 released, ground is disconnected from brush 2512 and cut-off relay 2502, thereby restoring the subscriber's line circuit to normal. In position 18 the down-drive magnet 2355 of the district selector is energized in a circuit from battery through the winding of magnet 2355, left contacts of cam 210, left contacts of cam 221 to ground. At the same time a circuit is closed from battery through the winding of down-drive magnet 2516 of the line finder, upper contacts of cam 218, bottom outer front contacts of relay 226, upper right contact of cam 209 to ground. When the line finder reaches normal, the locking circuit of relay 226 over commutator strip 2541 is opened so that relay releases. When the district selector reaches normal, a circuit is closed from battery through the winding of sequence switch magnet 200, upper left contact of cam 224, normal commutator segment 2360, brush 2357, lower contacts of cam 212 to ground, advancing sequence switch 200 to position 1 where it awaits selection by another link in the manner above described.

Section II.—Secondary tape

Having described the formation of a permanent record of the history of all calls over a defined billing period made by a group of lines having access to one recording machine, the next step is to use this record for making a separate record for each line of all the calls made by each of said lines in the group. Each of the records thus made is of a character which can be used with a commercial printing tabulator, modified according to the needs of the present invention, to print the subscriber's bill, as more completely described hereinafter.

It will further be remembered that, due to the character of the recording machine used, the primary record is contained on a roll of paper, not unlike a player piano roll, in which the transverse series of punches is a code record of one call, and that the record of all the calls consecutively contained thereon are not grouped with respect to the lines making the calls. Hence, the record of all the calls made by the group of 200 lines must be broken down into a separate record for each line and containing thereon the record of all calls made from said line while the coded information of each call so recorded must be revised, translated or suppressed in accordance with the manner in which the charge for the call is to be entered on the printed bill.

In order to sort out and decode each of the calls, therefore, it becomes necessary to have some mechanism which is responsive to the character of the record made on the primary tape. Since the record in this case is a tape having a series of holes punched therein by a perforating machine, transversely across the tape, the mechanism which is responsive to such perforations is a pneumatically controlled device, not unlike the pneumatic system of a player piano.

Although pneumatic systems in the piano art are old, it is believed that their application to automatic decoding systems of the character herein described and claimed is new. For this reason, the principle of the pneumatic system by which the perforated record is translated will be described in detail.

Fig. 42 shows the important parts of the pneumatic system responsive to one perforation and is commercially known in the piano player art as the single valve system. Since the perforated record of a call involves a number of perforations transversely made across a tape provided with 64 punching positions, there will be 64 pneumatic devices of the kind shown in Fig. 42, each responsive to a perforation in the particular punch position in the tape for which a pneumatic valve is provided.

The valve 4200 comprises a disk 4202 placed so that it rests above a leather pouch or diaphragm 4201. The disk is centered on a wooden spindle 4210. A button 4211 at the end of the spindle rests just above the pouch. The latter is bedded in the floor of a chamber 4206 which is connected by means of a suitable port 4203 with the bellows system (not shown) so that a state of reduced air pressure or partial vacuum may be maintained within it. Under the pouch is a channel 4207 which is not connected with the chamber save by a small vent 4205 and which connects with a channel 4207 connecting with the paper tracker duct 4208.

The top of the disk 4202 is exposed to the outer air, but it rests upon the roof of the chamber 4206 in such a way as to shut off any air from entering the chamber over its top. Sixty-four of these valves are arranged in any suitable manner and connected to one general port leading to the bellows with an individual bellows or pneumatic 4212 corresponding to each valve. As is shown in the figure, all the channels 4214 for all of the valves are brought together in straight line terminating in a smooth brass tracker bar 4215 which is as long as the width of the primary tape, and along which sixty-four tracker ducts like 4208 are spaced so that each punch position of the primary tape covers one opening 4208 of the channel. The perforated tape record is wound on a pay-out reel 4213 and rewound on a take-up reel 4209. Both reels are driven by a power mechanism of any suitable description whose speed can be controlled to suit the operating characteristics of the decoding equipment controlled by each of the pneumatic valves responsive to the tape perforations, as more completely described hereinafter.

As already indicated, the ends of the channels are brought together on the face of the tracker bar 4215 in the same order as the punch positions of the primary tape and the punched record travels across the bar at the speed required to operate each of the several decoding mechanisms when the perforated holes on the tape coincide with the channel openings.

Assume, now, that the perforated tape is in a position to seal up the tracker duct 4208, that is, no perforations are present. If, now, the chamber 4206 is put in a state of partial vacuum by the operation of the bellows acting through the

port 4203, it follows that whatever air is in the tracker duct 4207 will leak out into the chamber 4206 through the vent 4205 until the pressure in the chamber and that in the duct are equal but both below normal. Consequently, the atmospheric pressure above the disk 4202 will press down and hold the disk firmly on the roof of the chamber, keeping the pouch 4201 down and preventing any air from reaching the chamber through its roof. Hence, there will be free passage of air from the pneumatic 4212 to the atmosphere whereby the pneumatic will remain expanded as shown.

Suppose, now, that, in the process of decoding the primary tape, the perforation in a position registers with its associated tracker duct. Immediately the atmospheric air will rush into the tracker duct through channels 4214 and 4207, killing the partial vacuum and restoring the normal pressure under the pouch. The pouch, being larger than the disk, will therefore overcome the pressure which is holding down the latter from above and will force the disk upwards until it presses against the underside of the channel 4216 which is above the roof of the chamber and leads to the pneumatic 4212. Thus, the atmospheric air will be shut off from the pneumatic while a passage is opened between the latter and the chamber. The atmospheric air trapped in the pneumatic, therefore, will at once rush out into the low-pressure chamber 4206, and the pneumatic will collapse by the action of the atmospheric pressure on its outside movable wall. The collapse of the pneumatic causes the lug 4217 carried by the movable wall to bear on the connecting rod 4218 which operates a contact assembly 4219. These contacts now operate and close electric circuits which control a part of the decoding equipment as more completely described hereinafter.

When the atmospheric air entered the chamber by way of the duct it did not, however, discharge at once through the vent 4205 into the chamber 4206 and so nullify the effect of opening the duct. The vent is too small to empty the channel of atmospheric air so long as an end of the latter is open. The quantity of atmospheric air flowing constantly down into the channel 4214 is always greater than the capacity of the vent to reduce its pressure by absorption into the chamber. Therefore, so long as the end of the channel is open, that is to say, so long as a perforation in the paper registers with the entrance to the channel, it remains under atmospheric pressure, and the pouch and the valve remain up. The pneumatic, in consequence, remains collapsed and maintains contact assembly 4219 operated. When the perforation has travelled past the entrance of the channel and said channel is closed by the succession of the air tight surface of the paper, the atmospheric air trapped in the channel is reduced in pressure by the absorption of part of it into the chamber through the vent. Consequently, the pressure under the pouch 4201 is reduced below the pressure above the top of the disk. The disk, therefore, drops, the roof of the chamber is at once sealed again, atmospheric air flows into the pneumatic which re-inflates and raises rod 4218 which, in turn, restores the contact assembly 4219 to its original position.

Each pneumatic, therefore, controls the operation of its own contact assembly, there being, as already mentioned, sixty-four pneumatics like 4212 and sixty-four valve systems with an equal number of contact assemblies although the separate contact assemblies may differ from one another by the contact combination required to care for the proper operation of the electrically responsive apparatus controlled therethrough. The number of pneumatics, of course, may be expanded or restricted depending upon the size of the record to be decoded.

While the manner by which the chamber 4206 is maintained at workable pressures lower than atmospheric forms no part of the invention and hence is not shown, any workable and commercial device for maintaining such a pressure may be used without departing from the spirit of the invention.

Having described the pneumatic system and the necessary apparatus by which a perforated record causes its operation, we will proceed to describe how, by the use of said apparatus and the manner of its operation, the perforations on the primary tape control the making of a secondary record for each line containing, in chronological order, a record of all the calls made by said line during the billing period.

In order to obtain a clear understanding of the principle underlying this part of the invention as well as the details of its operation, Figs. 31 to 41, inclusive, should be arranged as indicated in Section II of Fig. 1. With the drawings so arranged, 3100 represents the perforated record as passing across the surface of the tracker bar 3101, the entire width of the perforated record being extended across Figs. 31 to 37, inclusive for a clearer exposition of the decoding apparatus. Each one of the tractor ducts leads to a pneumatic valve and attached pneumatic of the type described. These valves are schematically represented in Figs. 31 to 37, inclusive. While there are in all sixty-four such pneumatics to correspond to the sixty-four punch positions on the primary tape only representative combinations of the entire number of pneumatics together with their contact assemblies are shown in said drawings for the sake of clarity.

Before proceeding with the detailed description of the making of secondary record for each line it is desirable, first of all, to point out the operating objects sought to be accomplished when the perforated primary tape travels across the tracker bar and the call record punches come into coincidence with the tracker openings for operating the pneumatics involved.

As already mentioned, while the calls completed during the billing period by the group of 200 subscribers served by one perforating machine are recorded in chronological order, they are not, however, grouped together with respect to the lines from which they were made. Since the printing tabulator, as described hereinafter, prints the entire bill for one line at a time, it is necessary to sort these calls, allocate them to the lines from which they were made and make a separate record of these calls for each line, said record being subsequently used to operate the tabulator to print the subscriber record of calls, where one is necessary, and the bill therefor. In order to do this, it becomes necessary to make another record, one for each line in the group and containing thereon a record of all calls made from that line. In this manner all the calls recorded on the primary tape are transferred to two hundred secondary records individual to each of the lines in the group. For this purpose, two hundred secondary punching machines are provided, one for each line-finder terminal of the group of two hundred lines and all controlled

through one common analyzing mechanism, herein called the analyzer and shown in Figs. 31 to 41, inclusive. Obviously, if a secondary punching machine appertains to a line-finder terminal number and the entire office, for billing purposes, is divided into a plurality of two hundred line groups, each group being one half of a line-finder frame and each terminal in the group having the same identifying number as corresponding terminals in all other groups, then all groups will make similar primary tape records so far as line-finder terminal number identifications are concerned. When it follows that one analyzer is sufficient with which to decode the primary tape records of all the groups in the office. Further, since corresponding terminal numbers in different line-finder groups are recorded on the primary tape by the same code method as above described, the analyzer makes no distinction between the line-finder terminal number codes recorded in one primary tape and those recorded in another. Hence each of the 200 secondary tape records ultimately produced by each primary tape record so analyzed relates back to the correct subscribers by identifying not only the line-finder terminal number but also the line-finder group to which the primary tape appertains. This discrimination between line-finder groups, of course, is not evident from any record in the primary tape but simply from the fact that each primary tape belongs to a different line-finder group. In this manner the analyzer and the two hundred secondary punching machines cooperatively associated with it can be made to serve one office of 10,000 lines.

By the application of the same principle to an entire telephone area, one analyzer and its 200 secondary punching machines can be made to serve each and every office in said area. For if the subscribers in each of the offices are divided into 200 line groups and the line-finder terminal numbers in each group correspond to the line-finder terminal numbers in every similar group throughout the area, then all primary tape records, as far as line-finder identification numbers are concerned, are identical regardless of the office of origin or of the particular group therein. Each of the 200 secondary records produced by some one primary tape record then relates back to a particular line-finder terminal number, the subscriber corresponding to which is then further identified by the line group to which the primary tape belongs and to the office in which said tape was made.

There is, however, one important difference between the use of the analyzer for one telephone office and its use for one telephone area. In the latter case, the offices are usually divided into different calling zones for each of which a different charge rate may prevail for calls completed from any office within the zone to points outside of the zone. Since, as described hereinafter, the secondary record of any line does not contain, in code form as does the primary tape, the record of the telephone conversation time but only a record of the charge to be made for the call, analyzer, in the case it is common to the area, must contain facilities for distinguishing the primary tape records emanating from the offices in the different zones in order that, in making the secondary record for a line from a given primary record of an office, the proper charge rate applicable for the zone in which said office is located may be used in computing the charge for the call.

The analyzer as shown in Figs. 31 to 41, inclusive, performs six separate functions. Its entire mechanism, therefore, may be functionally divided into six parts as follows:

Part 1.—The mechanism which is responsive to the perforated records on the primary tape.

Part 2.—The means for selecting the secondary punching machine appertaining to the line-finder terminal number registered with the call record and thereby to distribute the call records on the primary tape common to 200 lines over 200 secondary tapes, one for each line-finder terminal number or subscriber appertaining thereto.

Part 3.—The means for translating the called office code into a called office name, if necessary, and of further means responsive to the called office code record for determining the charge rate to be applied.

Part 4.—The means responsive to that part of a call record on the primary tape which involves certain information to be further copied as a part of the secondary record.

Part 5.—The apparatus for computing the charges for each toll call into money units, and for each local call into call charge units, together with the means for associating the conversation time in minutes and also the evening or night rate indication with the said apparatus for computing charges.

Part 6.—The means for associating the line-finder terminal number on the primary tape with the directory number of the subscriber to which said line-finder terminal number appertains and the zone of the office in which the office containing said line belongs.

To describe the operation of the analyzer for the most general case, let it be assumed that it is to be used for decoding primary records from a plurality of telephone offices comprising a local telephone area divided into a number of different calling zones and that each of said zones defines the charge rate for calls established from any office within the zone to all other zones of said local area. Furthermore, all of the offices in the area are to be assumed to have their subscriber lines uniformly divided into groups of 200, and that corresponding line-finder terminal numbers in all the groups in the area are the same and recorded on all primary tapes in the manner already described. It will also be recalled that the object of breaking down the primary record of calls made by a group in any office is to make a secondary tape record for each line in that group, and that, in order to accomplish this with one common analyzer for the whole area, as for one office, 200 secondary punching machines operate in combination with the one anlyzer. Each of these machines is of the same structure as the one used for punching the primary tape. It has a feed mechanism comprising advance magnet **3818**, a cooperating ratchet mechanism **3821**, a take-up reel **3819**, and a tape feed roll **3820**, a group of punch magnets and controlling circuits for operating the same to perforate a number of holes across the tape to indicate the required information relating to one call. Each punch magnet has a punch associated with its armature, for example, in the manner disclosed in Patent 749,033, granted January 5, 1904, F. G. Creed. The schematic representation of such a secondary punching machine is shown in the lower portions of Figs. 38 to 41, inclusive, and will be considered in detail in connection with the operation of the analyzer.

Associated with each punching machine and forming a part thereof, is a multi-contact relay, such as relay **3800** which, when operated, extends a number of conductors from the analyzer to the punch magnets of the related punching machine. The conductors from the analyzer are multipled to corresponding contacts of other multi-contact relays. That is, of the entire 200 multi-contact relays, only one is operated at one time so that any electrical condition imposed on the commoned conductors as the result of the decoding process initiated by the perforations of a call record on the primary tape will be extended only to the punch magnets of that punching machine whose associated multi-contact relay has been operated. Thus, it is only necessary to select the multi-contact relay designated by the code of the line-finder terminal number contained in the call record in the primary tape to insure the selection of the secondary punching machine which has been made to appertain to that number and hence to the subscriber represented by that number.

Now, in the example chosen to illustrate the manner in which our entire invention operates, it has been assumed that the calling line-finder terminal is **117** and that, to record on the primary tape the code of such a number, holes were punched on the primary tape in punch positions 1, 4, 8 and 11. Consequently, when the primary tape advances to the position where the perforations which record the assumed call are coincidental with the corresponding holes in the tracker bar **3101**, the exposure of the vent holes to the atmosphere as a result of the coincidence of the perforations with the tracker hole openings causes the associated valves to operate as described and cause the collapse of their associated pneumatics **3102**, **3103**, **3200** and **3201**. The collapse of the pneumatics, in turn, causes the operation of their respective contact assemblies **3110**, **3114**, **3204** and **3202**. By this operation a group of decoding circuits is operated by which the particular multi-contact relay of the secondary punching machine appertaining to the line-finder terminal number 117, recorded on the tape, is caused to be selected and operated.

The entire scheme for the selection of one of the 200 secondary punching machines or, what amounts to the same thing, the one multi-contact relay which causes connection thereto, is based on a group of relays which controls, by elimination, the selection of the one conductor which is connected to the winding of the particular multi-contact relay sought to be selected. The pneumatics operated in response to the code perforations of the line-finder group code close circuits to operate a group relay which, through its contacts extends a group of 40 common conductors to a particular main group of 40 other conductors correlated to the main group of 40 lines indicated by the operated pneumatics of the group code. The operation of the "tens" code group of pneumatics further causes the extension of a group of tens conductors, into which the main group of 40 conductors is divided, to the contact assemblies of the units code pneumatics while the operation of the latter pneumatics, according to the units code perforations of the line-finder terminal number, completes the circuit over one particular conductor in the selected group of ten conductors thus partially extended. This conductor is connected to the winding of the multi-contact relay appertaining to the line-finder terminal number.

The line-finder terminal number of the line of origin of the call under consideration is assumed to be 117 which means, first of all, the first group of the five main groups of 40 lines each into which the group of 200 lines is divided. Consequently, the operation of the group pneumatic **3102**, in response to the hole punched in position 1 of the primary tape, causes a circuit to be closed to the first group relay **3104** extending from battery through the winding of multi-contact relay **3104**, conductor **3109**, make contacts of the No. 3 contact set of contact assembly **3110**, normal contacts of the No. 1 contact set of contact assembly **3111**, normal contacts of the No. 2 contact set of contact assembly **3912**, to ground. Relay **3104** operates and closes its contacts through to the common conductors which extend to the other four group relays, namely, **3105**, **3106**, **3107** and **3108**. Relay **3104** further closes a circuit from ground on a supplementary contact, conductor **3119**, winding of relay **3822** to battery. Relay **3822** operates but performs no useful function at this time.

The operation of tens code pneumatic **3103**, in response to the hole punched in position 4 to indicate the first tens group, causes a circuit to be closed from ground on contacts **3114**, conductor **3115**, winding of relay **3116**, to battery, thereby operating this relay and further extending the first subgroup of ten conductors to the contact assemblies of the units code pneumatics, while the remaining 30 conductors remain unextended.

Finally, the operation of units code pneumatics **3200** and **3201**, in response to holes punches in positions 8 and 11 corresponding to the seventh units digit, now causes a circuit to be closed from ground on the alternate contact of the contact assembly **3202**, the normal contact of the No. 2 contact set of contact assembly **3206**, the normal contact of the No. 3 contact set of contact assembly **3207**, the alternate contact of the No. 4 contact set of the contact assembly **3204**, conductor **3205**, No. 7 contact set of relay **3116**, conductor **3117**, No. 7 contact of relay **3104**, conductor **3118**, winding of multi-contact relay **3800**, to battery. Multi-contact relay **3800** is the multi-contact relay marked by the line-finder terminal number 117, is one of the 200 similar relays, one for each line of the unit group of 200 which associates a particular secondary punching machine with a particular line-finder terminal number of any office within the telephone area. The operation of multi-contact relay **3800** now closes 64 sets of contacts, each of which extends a common conductor from the analyzer to the winding of a punch magnet of the secondary punching machine. The secondary punching machine has, therefore, 64 punch magnets each of which, when operated, perforates a hole in a correspondingly numbered position. The entire record of a call as it is to be transmitted for printing to the printing tabulator, as described hereinafter, will be contained in the series of holes punched transversely across the secondary tape.

Having selected the secondary punching machine correlated to the proper line finder terminal number, I will now describe how the remaining information contained on call record perforations of the primary tape is translated, suppressed or directly reperforated on the secondary tape by the secondary punching machine.

It will be recalled that immediately next to the code registration of the line finder terminal number there is registered on the primary tape

the called office code between punch positions 12 to 23, inclusive. Now the office code translator of the analyzer comprises a series of pneumatics which operate in accordance with the A code perforations contained between positions 12 to 15, inclusive, the B code perforations contained between positions 16 to 19, inclusive, and the C code perforations contained between positions 20 to 23, inclusive. Each office code digit is punched in accordance with the four unit code as previously described. When, therefore, the particular punched holes of the entire office code uncover the corresponding tracker duct openings connecting with the pneumatics responsive to the above punch positions, their operation causes the closure of their respective contact assemblies which, in turn, cause the consequent operation of another group of translating relays as follows:

The operation of the pneumatics for the A digit in accordance with the code of that digit, grounds one of eight conductors, all of which are multiplied to corresponding contacts of eight relays. The operation of each of the relays is, in turn, controlled through the contact assemblies of the B digit pneumatics. These relays, in Fig. 33, are designated **3303** to **3310**, inclusive. Since the eight conductors from the A code pneumatics are multiplied to each of these relays, it is evident that any one of the eight conductors may be extended through any one of the eight B digit relays which may be operated, making it thus possible to extend 64 conductors in all through all of the eight relays. The operation of one of these relays further extends the grounded conductor from the operated A code pneumatics to the multiplex contacts of ten C code multi-contact relays **3404** to **3413**, inclusive, each one of which, in turn, is operated by the proper combination of C code pneumatics. The conductor grounded by the A code pneumatic is then carried through the B code relay operated by the B code pneumatic, to the contacts of the particular C code relay operated by the C code pneumatics, which latter operated in response to the C digit perforation on the primary tape. The contact so grounded is the particular code point appertaining to the called office code punched on the primary tape.

As an example, it will be remembered that the called office code of the call used for illustration is Halifax or 425. Consequently, the punching of a hole in position 15, corresponding to the code punch position for A digit 4, causes the corresponding pneumatic **3311** to operate and close contact assembly **3301**, after which a path is closed from ground on the alternate contact of contact assembly on **3301**, the normal contact of the No. 2 contact set of contact assembly **3319**, the normal contact of the No. 3 contact set of contact assembly **3320**, the normal contact of the No. 4 contact set of contact assembly **3312** to conductor **3313**, which extends in parallel to the No. 3 contact set of all of the B digit code relays **3303** to **3310**, inclusive, the No. 1 and No. 8 contact sets of which only are shown for all of said relays except **3303** for which are shown the No. 3 and No. 8.

The coincidence of the hole punched in position 17 as the code perforation of the B digit 2, causes the operation of pneumatic **3315** which, in turn, operates its associated contact assembly **3316** and thereby causes a circuit to be closed from ground, normal contact of contact assembly **3403**, normal contact of the No. 1 contact set of contact assembly **3401**, conductor **3400**, the alternate contact of the No. 1 contact set of contact assembly **3316**, conductor **3318**, the normal contact of the No. 2 contact set of contact assembly **3302**, conductor **3317**, winding of relay **3303** to battery. The first B digit code relay **3303** operates in the above circuit and closes its eight sets of contacts, further extending thereby conductor **3313** through conductor **3314**, through its 3rd contact set to conductor **3419**.

The coincidence of the holes punched in positions 20 and 21 in response to the perforation of the code for the C digit 5, causes a circuit to be closed from ground, normal contact of contact assembly **3418**, normal contact of the No. 1 contact set of contact assembly **3417**, the alternate contact of the No. 1 contact set of contact assembly **3416**, the alternate contact of the No. 2 contact set of contact assembly **3415**, conductor **3414** to battery through the winding of multi-contact relay **3408**. Relay **3408** operates. Ground on conductor **3419** is now further extended over the No. 3 contact set of multi-contact relay **3408**, conductor **3420**, winding of code relay **3801** to battery. Relay **3801** is the relay which identifies the called office code. Since, therefore, the translating facilities provide for 640 possible code translations, the present embodiment of the invention discloses the possibility of using the automatic billing system for 640 possible called offices. However, it must be understood that no such limitation is intended. The telephone art is replete with innumerable devices for translating any number of codes, all of which devices may be easily modified for incorporation into the invention. Where, for instance, the number of codes to be translated is greater than 640, such as might be the case if more than eight digits were to be used for the A code or B code or both, the four-unit code provided for translating each of these digits can be easily expanded to include two more conductors in the A code group and two more relays in the B code group thereby furnishing circuit facilities for translating a maximum of a thousand codes. However, the number of codes which may be translated is not the essence of the invention; these facilities may be expanded or restricted in accordance with the traffic complexities and the number of called offices involved in any particular area for which the billing system is adapted. What is included as a part of the invention is simply a code translator responsive to the code record contained in the primary tape.

The object of translating the office code is twofold; first, the called office must furnish the basic traiff rate applicable to the call so that, in computing the total charges for the call, the correct base charge may be applied; secondly, in the case of a toll call or of any call for which the called office and number is to be itemized on the bill, the office code designation as thereon printed must appear as shown in the telephone directory.

Therefore, each code relay like **3801** must furnish controlling means for indicating the base charge and other means for indicating the office name. For both of these purposes, each office code relay, like relay **3801**, contains five sets of contacts which, when the relay operates, grounds five separate conductors, three of which extend to cross-connecting frame **3802**, the fourth conductor **3823** is extended to a terminal on a plurality of zone switches, **3922**, **3923** and **3924** for supplying the rate indication, and the fifth con-

ductor 3813, for supplying ground to the contact assemblies of the pneumatics which control the called number and date registration for a purpose described hereinafter.

The three conductors extending to the cross-connecting frame 3802 are further cross-connected by way of block 3812 for operating relays which, in turn, control certain punch magnets of the punching machine for perforating the code of the called office in the letter code in which said office appears in the directory. However, in order to minimize the number of punches required for this purpose, each of the letters corresponding to a letter in the office code is punched in a five-unit code such as is used, for example, in printing telegraph systems. A set of relays A to Y, inclusive, therefore, is provided for each code digit and the conductors on the code relays corresponding to individual offices are cross-connected to these letter relays as required by the letters of the office code. For example, the office name of the called office corresponding to code 425 has been assumed to be Halifax, the first three letters of which are dialed by the subscriber as the code of the wanted office. Since relay 3801 is the code relay corresponding to office code 425 and, therefore, to its letter equivalent Halifax, the conductor grounded by the No. 1 contact set of relay 3801 is cross-connected from block 3802 to block 3812 and from thence to the winding of the relay corresponding to letter H of the first group of twenty-six relays provided for translating the first digit of the office code into its letter equivalent. This relay, in Fig. 38, is designated as relay 3803. The conductor grounded by the No. 2 contact of relay 3801 is cross-connected to the winding of the relay corresponding to letter A of the second group of twenty-six relays corresponding to the letter translation of the B digit. This relay, in Fig. 38, is designated as relay 3804. The conductor grounded by the No. 3 contact set of relay 3801 is cross-connected to the winding of the relay corresponding to letter L of the third group of twenty-six relays corresponding to the letter translation of the C digit. This relay, in Fig. 38, is designated as 3805. Each relay in each group of letter relays is provided with as many contact pairs as are required by the five-unit code for characterizing the letter represented by the relay. The conductors connected to the front contacts of each of the letter relays of the first group are each further extended to one contact of a contact set of a group of five contact sets on relay 3800 reserved for the letters of one digit of the code. The same is true of the front contacts appertaining to the letter relays of the remaining two groups; the extensions to the contact sets of relay 3800 in each of these two other cases taking place to other separate groups of contact sets reserved for each of the other two letters. In this manner, the magnets operating between punch positions 1 to 5, inclusive, control the registration of the A digit in accordance with the five unit code, the magnets operating between punch positions 6 to 10, inclusive, control the registration of the B digit and the magnets which operate between punch positions 11 to 15, inclusive, control the registration of the C digit.

Returning to the illustration, the A digit code letter relays, of which only relays corresponding to the letters A, H and Y are shown, show relay 3803 of the letter H having two sets of contacts, the first of which is cross-connected to the No. 3 contact set of relay 3800 which, in turn, controls the operation of punch magnet 3806, and the second is cross-connected to the No. 5 contact set which, in turn, controls the operation of punch magnet 3807. Consequently, the operation of relay 3803, which occurs over an obvious circuit when relay 3801 operates, closes two circuits, as follows: (1) ground on conductor 3817, outer contact of relay 3803, No. 3 contact set of relay 3800, winding of punch magnet 3806, battery. The magnet operates and causes a hole to be punched in punch position 3 of the secondary tape; (2) ground on conductor 3817, inner contact of relay 3803, No. 5 contact set of relay 3800, winding of punch magnet 3807 to battery. The magnet operates and causes a hole to be punched in position 5 of the secondary tape. The holes punched in these two positions, that is, positions 3 and 5 designate the letter H, according to the above five-unit telegraph code.

Relay 3804 of the second group of letter relays of which only the relays corresponding to letters A, U and Y are shown, corresponds to the letter A. It has two sets of contacts and they are cross-connected to contact sets Nos. 6 and 7 of relay 3800, which control, respectively, the operation of punch magnets 3808 and 3809. The relays corresponding to letters U and Y show their contacts cross-connected to the appropriate contact sets of relay 3800 for the designation of their appertaining letters according to the above mentioned telegraph code. Hence, when relay 3804 operates, two circuits are closed as follows: (1) ground on conductor 3817, outer contact of relay 3804, No. 6 contact set of relay 3800, winding of punch magnet 3808, battery. The magnet operates and causes a hole to be punched in position No. 6 of the tape; (2) ground in conductor 3817, inner contact of relay 3804, No. 7 contact set of relay 3800, winding of punch magnet 3809 to battery. The magnet operates and causes a hole to be punched in position No. 7 of the tape which, in conjunction with the hole in position 6, designates the second letter A of the dialed office code.

Relay 3805 of the third group of letter relays of which relays corresponding to A, L and Y only are shown, corresponds to the letter L. It has two sets of contacts, the first of which is cross-connected to the No. 12 contact set of relay 3800 which, in turn, controls the operation of punch magnet 3810, and the second is cross-connected to the No. 15 contact set of said relay which, in turn, controls the operation of punch magnet 3811. Consequently, when relay 3805 operates two circuits are closed as follows: (1) ground on conductor 3817, outer contact of relay 3805, No. 12 contact set of relay 3800, winding of punch magnet 3810, to battery. Magnet 3810 operates and causes a hole to be punched in position No. 12 of the tape; (2) ground on conductor 3817, inner contact of relay 3805, No. 15 contact set of relay 3800, winding of punch magnet 3811 to battery. Magnet 3811 operates and causes a hole to be punched in position 15 of the tape which, in conjunction with the hole punched in position 12, designates the letter L of the dialed office code.

Thus relay 3801, corresponding to the called office code 425, has been translated for reperforation on the secondary tape into the appropriate letter code HAL which, it is assumed, is the letter code printed in the telephone directory. All other office code relays, of course, have their contacts extended through cross-connecting frames 3802 and 3812 to the appropriate one of each of the relays in the three groups of letter relays

which correspond to the A, B, C letters of the code identified by the separate office code relays.

It should be noted that if digit figures are used instead of digit letters for the office code, then since a maximum number of ten possible characters would be required for each of the three digits, the number of translating relays in each group would be reduced from twenty-six to ten. The four-unit code heretofore used for registering, in code form, the items of information on the primary tape could then be similarly used to register, also in code form, each of the numerical characters of the office code digits. Or, again, if, as is at present the case in large metropolitan areas, the last digit of the office code is one of the ten digits in order to provide for the use of the same office name for a plurality of offices such as, for example, Halifax 2, Halifax 3, etc., then, the last group of twenty-six letter relays can be omitted and ten relays for the four-unit code can be used to record the numerical character. Where, however, the four-unit code is used, only four punch magnets per digit are required instead of five.

The information on the primary tape next to be recorded on the secondary tape is the group of codes designating the called number. The punched holes indicative of the number appear in various combinations between positions 24 to 43 inclusive. Since the number may comprise five separate digits or characters including a party station designation, each digit or character is recorded by a four-unit code involving the perforation of one or two holes in four punch positions allotted for each digit, namely, the thousands digit registration between positions 24 to 27, inclusive, the hundreds digit registration between positions 28 to 31, inclusive, the tens digit registration between positions 32 to 35, inclusive, the units digit registration between positions 36 to 39 and the stations digit registration between positions 40 to 43, inclusive.

The called number, if it is to be itemized in the bill and therefore must be recorded on the secondary tape, needs no translation from the manner in which it is recorded on the primary tape. Hence, the record as contained in said tape may be directly copied into the secondary tape. Therefore under such circumstances, each of the pneumatics responsive to the several punch holes indicating the called number close contacts which extend ground on conductor **3813** to the separate contact pairs of the multi-contact relay **3800**, the mates of which contacts, in turn, extend, respectively, to the windings of separate punch magnets so that, when relay **3800** operates and the called number pneumatics responsive to the punched holes have operated, the punch magnets which have been directly connected by the operation of relay **3800** to the grounded contacts of said pneumatics, operate in the combinations corresponding to the holes in the primary tape and punch the same record and in the same codes on the secondary tape.

Since each one of the pneumatics operated by the holes of the called number code controls an associated contact assembly which has but one pair of contacts, all of these separate pneumatics are not shown, but only the first, which is responsive to punch position 24, and the last, which is responsive to punch position 43, the conductors connected to all of the other pneumatics being simply indicated as connected thereto and extending to contact sets Nos. 16 to 35, inclusive, of multi-contact relay **3800**.

It will be remembered that the called subscriber's number was assumed to be 3678. In consequence of this, the thousands digit 3 is represented by a hole punched in position 26 of the primary tape, thereby causing the operation of the corresponding pneumatic (not shown), and the consequent grounding of conductor **3500** by way of ground on conductor **3813** connected thereto through the No. 5 contact set of office code relay **3801**. Hence, a circuit is closed from ground on conductor **3500**, No. 18 contact set of relay **3800**, winding of punch magnet **3901** to battery. Magnet **3901** operates and causes the punching of a hole in position No. 18 of the secondary tape thereby recording, in code form, the thousands digit 3.

The registration of the hundreds digit 6 caused holes to be punched in positions 28 and 30, respectively, of the primary tape, thereby causing the consequent grounding of conductors **3501** and **3502** by way of conductor **3813**. Hence circuits are closed: (1) from ground on conductor **3501**, No. 20 contact set of relay **3800**, winding of punch magnet **3902**, battery. The magnet operates and causes a hole to be punched in position 20 of the tape; (2) ground on conductor **3502**, No. 22 contact set of relay **3800**, winding of punch magnet **3903** to battery. The magnet operates and causes a hole to be punched in position 22 of the tape which, in conjunction with the hole punched in position 20, records, in code form, the hundreds digit 6.

The registration of the tens digit 7 caused holes to be made in positions 32, 35, respectively, of the primary tape, thereby causing the consequent grounding of conductors **3503** and **3504** by way of conductor **3813**. Hence, circuits are closed: (1) from ground on conductor **3503**, No. 24 contact set of relay **3800**, winding of punch magnet **3904** to battery. The magnet operates and causes a hole to be punched in position 24 of the tape; (2) ground on conductor **3504**, No. 27 contact set of relay **3800**, winding of punch magnet **3905** to battery. The magnet operates and causes a hole to be punched in position No. 27 of the tape which, in conjunction with the hole punched in position 24 records, in code form, the tens digit 7.

The registration of the units digit 8 caused holes to be punched in positions 37 and 38, respectively, of the primary tape thereby causing the consequent grounding of conductors **3505** and **3506** by way of conductor **3813**. Hence, circuits are closed: (1) from ground on conductor **3505**, No. 29 contact set of relay **3800**, winding of punch magnet **3906**, to battery. The magnet operates and causes a hole to be punched in punch position 29; (2) ground on conductor **3506**, No. 30 contact set of relay **3800**, winding of punch magnet **3907**, to battery. The magnet operates and causes a hole to be punched in punch position No. 30, which in conjunction with the hole punched in position 29, records in code form, the units digit 8.

There being no station's letter for the assumed number of the called subscriber, no holes were punched in positions 40 to 43, inclusive, of the primary tape. Consequently, their corresponding pneumatics in the analyzer are not operated and the corresponding punch magnets for positions 32 to 35 of the secondary tape remain unoperated.

The secondary tape besides containing the requisite perforations to print the called office and number when required, must contain, as well, a punched code which designates (*a*) the charge for the call in terms of a base call charge unit if the call is completed within what has been defined as

the local area, (b) the charge for the call in money units if said call has been completed to a toll point. In the case of local calls, or such calls completed to points within the local area for which different rates apply for different calling zones, it is the usual practice for the operating company to bill such charges to the subscriber only in terms of standard local charge units rather than in money units and furnish no itemized account for the call. For example, local calls may be designated as calls which may be made for five cents for a standard period of conversation, and five cents for each defined overtime period thereafter; others for ten cents or two call charge units for the initial conversation period and five cents or one local charge unit for each period of overtime thereafter, and yet others may have an initial charge rate of fifteen cents or three local charge units of five cents each for the first period of conversation and five cents or one call charge unit for each defined period of overtime thereafter. For instance, if the subscriber has conversed for fifteen minutes over a connection in which the initial charge is five cents and the overtime charge is five cents for each additional five minutes or fraction thereof, the bill to the subscriber would merely indicate three local calls at five cents each. Or again, if the call is to an office within the local area but for which the base rate charge is ten cents for the first five minutes and five cents for each three minutes of overtime or fraction thereof, this call would be billed to the subscriber as five local five cent calls without an itemized account of the fact that the call was completed to the "ten cent" area. The same thing would be true for the fifteen cent rate wherein the base rate would be charged as three local charge units and the overtime charged in terms of conversation periods adjusted to the local base rate. In other words, the operating company may deem it expedient to make no distinction between the three different types of calls and subject them all to the "bulk billing" practice so long as a detailed account of a call is confined to such as are characterized as "toll" calls; that is, calls completed to toll points.

It will be observed that, in the preferred embodiment of the invention, the primary tape is arranged to make no distinction between calls which have to be itemized or separately reported as a part of the subscriber's bill, and those which do not have to be so itemized. A toll call typically represents the former while a purely local call typically represents the latter. And it will be recalled that the district call recorder was arranged to select a primary punching machine for all calls, whether local or toll, on a signal from the sender and to cancel the record of the called office code and number for other than toll calls if the charges for local calls were to be obtained from message registrations on the subscriber's meter. However, where no meter is provided at the subscriber's line, the call recorder preserves the record of the called code and, if desired, the record of the called number. But the fact that the entire record of the call, whether local or toll, is so contained on the primary tape does not mean that all items so recorded must necessarily be repeated on the secondary tape. In the case of local calls or calls to be charged for on a local rate basis as above described, the called office and number, although recorded on the primary tape, are not itemized on the bill. Hence, although this information appears on the primary tape in code form, it must not appear on the secondary tape. It will be observed from Fig. 38 that the called office code relay, relay **3801**, has three sets of contacts used for connection to the office code letter relays, as already described, another set of contacts for controlling the charge for the call, as described hereinafter, and yet another set of contacts which, when the relay is operated, grounds conductor **3813**. In the case of calls to those offices which are to be reported on a bulk-billing basis and for which an itemized report of such calls is not to be furnished the code relay can be omitted entirely and conductor **3420** which is connected to its winding can be extended directly to the proper charge terminal on the zone switching blocks **3922**, **3923** and **3924**. As a matter of convenience, two conductors are shown as extending from the code contact in Fig. 34, namely, conductor **3420** when a code relay is used, and conductor **3421** when the code relay is not used. In the latter case, conductor **3421** extends directly to the zone switching blocks **3922**, **3923**, and **3924**. Under such circumstances, the coincidence of the punched holes in the primary tape designating the called office and the consequent operation of the corresponding pneumatics, will not cause a record of such designation to be perforated on the secondary tape, for, in such a case, the entire translation of the office code, without the code relay, results in the grounding of conductor **3421**. Since no code relay is thus operated, the punch magnets between punch positions 1 to 15, inclusive, of the secondary tape can not operate. No office code record, therefore, is punched on the secondary tape. And, further, since there is no code relay, conductor **3813** is not grounded so that, although the primary tape perforations of the called number cause the operation of their corresponding pneumatics, nevertheless no punch magnet circuits are closed through their respective contact assemblies since these circuits are completed to ground on conductor **3813** and to which no ground is now connected. Hence, the punch magnets operating between positions 16 to 35, inclusive, do not operate and no called number is recorded.

It is entirely possible, of course, to suppress the perforation of the office code and number in the primary tape. The call recorder, which registers the digit impulses at the same time they are registered in the sender, can be easily arranged to receive from the sender the zone of the calling subscriber and thereby the implied information as to whether the called number is or is not to appear on the bill. Under such circumstances, the ground which controls the completion of the circuits to the various magnets of the primary punch machine for recording said number can be placed under the control of that signal. It is thought, however, that, for record purposes, it would be desirable to make a permanent record of the call and that such a record can be appropriately made on the primary tape. If the subscriber should dispute the accuracy of his bill with regard to local calls charged for in local service units, the operating company is in a position to prove to his satisfaction that some of the calls entered in his bill as local calls, although charged for on a local rate base, nevertheless have initial and overtime charges different from the standard local unit. Hence, in the preferred embodiment of the invention, I have disclosed what appears to me to be the more desirable commercial arrangement. But either method is perfectly satisfactory and both are included as a part of the invention.

Further, in the present embodiment of the invention, and in order to show the completeness with which all items of information may be re-

ported to the subscriber if so desired, the disclosure is arranged to record all information on the secondary tape even though the call is completed within the local area. Since the called office Halifax is assumed to be within the local area and one for which the initial call period is three times the base rate, this called office and number would ordinarily not be printed on the bill. We can, however, without injury to the description of the invention but simply to aid in its clarity assume, alternately, that the office Halifax is within the local area or outside of it and that, in this instance, it is outside, that is, in the toll area and for which the called office code and number must appear as a separate item on the bill, making it necessary to punch a record of said office and number on the secondary tape, as already described. On the other hand, if the office Halifax is within the local area as originally assumed and the charge for a call to which is to be made in multiples of the local service unit and an itemized account of said call is not to be entered in the bill, the code relay 3801 can be entirely omitted and conductor 3421 extended directly to the zone switches, as already described. Now, when the office code and called number pneumatics operate, the absence of any connection to the letter translating relays on the one hand, and the absence of ground in conductor 3813 on the other, will not cause the punch magnets from punch position 1 to 35 to operate, thereby suppressing the called office and number from the record of the call on the secondary tape.

Having recorded the called office and number on the secondary tape, it now becomes necessary to record the charge to be made for the call. This information is to be recorded in terms of local service units if the call is completed to an office within the local area and in terms of actual money charges if the call is completed in the toll area. Since the only information recorded on the primary tape which relates to the charge to be made for the call is the code of the office to which the call is completed and the duration of the conversation, the information to be recorded in the secondary tape is a translation of the time consumed for the call in terms of the local rate charge or the total money charge, in either case as determined by the prescribed rate for the office. This translation is achieved through the rate computer, shown in Figs. 39 to 41 inclusive.

The structural arrangement of the rate computer, as disclosed in the present embodiment of the invention, is based on a predetermined rate structure. It involves the combination of means responsive to the elapsed interval of conversation, divisible into a predetermined initial period and a number of predetermined overtime increments thereof, and means responsive to the rate indication as determined by the code of the called office and the zone of the calling office. This combination marks a group of contacts which are further utilized to operate a required number of magnets to punch the charge for the call in code form, in terms of multiples of local service units or in actual money charges, different groups of magnets being reserved to punch the different types of charges.

Necessarily, then, the number of groups of marking contacts to be provided in the computer depends on the number of different conversation periods which may be obtained out of each base charge for the maximum period of conversation which can be registered. For instance, if the entire local area is divided into three calling zones and the maximum conversation period which can be recorded is thirty minutes, then, on calls from offices located in the first zone the number of groups of contacts to be provided for this rate is a function of the initial period of conversation, the overtime increments thereof and the maximum period of conversation. If calls from this zone are to be charged for on the basis of a five minute initial conversation period and thereafter in overtime increments of five minutes or fraction thereof, then, for a maximum conversation period of thirty minutes, there would be a possibility of six different charges as defined by the duration of the call. A group of contacts, therefore, is provided for each different charge. Or, again, on calls from offices located in the second zone for which the base rate may be assumed to be ten cents, the number of groups of contacts to be provided for this rate is likewise a function of the initial period of conversation, the overtime increments thereof and the maximum period of conversation. If the calls from this zone to points outside of the zone but within the local area are to be charged for on the basis of ten cents for an initial period of conversation lasting five minutes and thereafter five cents for each three minute increment or fraction thereof, then, for a maximum period of conversation of thirty minutes there would be a possibility of ten different charges as defined by the duration of the call. And, in the same way, calls from zone 3 to points outside of the zone but within the local area which may be assumed to be charged for on the basis of fifteen cents for the initial five minute period of conversation and thereafter five cents for each two minute increment or fraction thereof, there would be a possibility of fourteen different charges as defined by the duration of the call.

In the same manner the maximum number of different charges for each toll rate provided may be determined. Once a group of contacts is fixed to represent a specific charge it remains fixed unless and until the rate structure is changed, at which time the maximum number of possible charges for each rate is redetermined by the newly defined initial and overtime periods assigned for the rate.

Obviously, once the charge is identified by a specific group of contacts, the registration of the charge on the secondary tape may be controlled by circuits effective through said contacts. And the character of the registration may be adapted to conform to what the operating company finds suitable to report to the subscriber to be charged. The most prevalent practice, as already indicated, is to report each charge for a toll call as a separate item in the money unit representing said charge while all local calls, that is, calls completed within the local area, are not so identified and are reported in bulk as so many local rate calls, including those for which the charge for the initial period is a multiple of the local service unit. If the registration mechanism of the computer is adapted to the practice above illustrated and if it is borne in mind that the record as contained in the secondary tape is what actuates the printing tabulator, as described hereinafter, then, each separate charge for each call emanating from zone 2 or 3 will have to lose its identity in the registration and has to be recorded simply as so many local calls of five cents each. The registration of toll calls, on the other hand, will be in terms of dollars and cents. It must be evident, then, that the registration of the charge itself

on the secondary tape is entirely flexible, is a function, not only of what is to be registered, but also of the characters by which the registration takes place.

The registering mechanism of the computer, as contained in the present embodiment of the invention, is based on the practice above described. It then follows that, in illustrating one form of registering mechanism, no limitation of the scope of this phase of the invention to any specific type of register is intended. Any form of registration which is responsive to a defining contact, or group of defining contacts, is within the spirit and scope of the invention and not any particular structure which, in all events, must be consistent with the cooperating parts of the mechanism used for registration and the character of the information to be registered.

The registering and computing circuit of the analyzer, arranged for operation in accordance with the above practice, is shown in Figs. 36, 37, 39 to 41, inclusive. It comprises a group of ten "minute" relays, 3615 to 3624, inclusive, each responsive to the minutes pneumatic code record of a particular call and indicating how many minutes of the ten minute subdivision the call has lasted. Each of these relays has three pairs of contacts, and therefore, thirty pairs of contacts in all, the corresponding contact of each pair on each relay being multipled to each other and extended, through the front contacts of switching relay 3626, to one contact of the contact assembly of one of the "tens" pneumatics. The operation of one of the tens pneumatics, 3600, 3601 or 3602, in response to a ten minute subdivision of the duration of a call, and the operation of a minute relay in response to the operation of the appropriate pneumatic or pneumatics of the minute code, causes the grounding of one pair of the thirty pairs of contacts carried by all the minute relays.

From each contact pair of each minute relay is a conductor which extends to the winding of a multi-contact relay having thirty-six pairs of contacts. Since there are thirty pairs of contacts for all the minute relays, there are thirty multi-contact relays, relays 4001 to 4030, inclusive. One contact of each pair of contacts on each of said multi-contact relays is multipled to a corresponding contact on every other multi-contact relay making, thereby, one continuous conductor of all of said contacts. Since each multi-contact relay has thirty-six pairs of contacts, there are, therefore, thirty-six common conductors 1 to 36, as designated on Fig. 40, extending across all of said relays.

Now according to the present embodiment of the invention, the computer is arranged to discriminate between 12 basic rate charges, namely, three local rates, the five, ten and fifteen cent rate for local calls and of which the five cent rate is the local service unit, and nine toll basic rate charges, namely, the ten, fifteen, twenty, twenty-five, thirty, thirty-five, forty, forty-five and fifty cent base charges. Each of these rates is represented by a relay, namely, relays 3908 to 3919, inclusive. The winding of each of the toll rate relays, with the exception of relays 3917, 3918 and 3919, terminate on cross-connecting block 3929. The winding of each of the local rate relays, namely, relays 3906, 3909 and 3910 terminate on corresponding contacts on the right side of relays 3926, 3927 and 3928, respectively. Relays 3917, 3918 and 3919, representing the forty, forty-five and fifty cent base toll charges, respectively, are not connected directly to terminal block 3929. They are controlled, instead, through the contacts of two other relays, namely, relays 3921 and 3928 which are responsive, respectively, to the operation of the "night" and "evening" pneumatics 3599 and 3598. The rates represented by these three toll relays may change in the course of the day, and therefore, provision is made for adjusting the rate in accordance with established regulations for the evening and night revisions. When it is desirable to effect a similar change in the lower rates, relief relays may be introduced which will be likewise responsive to the night and evening pneumatics and the control of the lower rate relays extended through the contacts of these relief relays.

The thirty-six conductors extending across the thirty multi-contact relays are divided into groups of three conductors each, there being, therefore twelve groups. Each group is now extended to the contacts of a rate relay. Conductors 1, 2 and 3 of the first group are extended to the five cent rate relay 3906, conductors 4, 5 and 6 to the ten cent rate relay 3909—etc. concluding with conductors 34, 35 and 36 which extend to the contacts of the fifty cent base rate relay 3919. Hence, the operation of any base rate relay results in the grounding of three conductors which are common to the entire group of thirty multi-contact relays.

The rate conductor from each of the local code relays, as for example, conductor 3923 in the case of code relay 3901, or conductor 3421 for the same code where no code relay is used, is extended to the terminals of the switching blocks 3922, 3923, 3924.

Referring back to the assumption that the operation of the analyzer is herein described for its most extended application, that is, for a whole telephone area, it is assumed that all of the offices within that area are divided into a number of calling zones with respect to each of which different rates may apply for calls completed to offices outside of the zone. Hence, the rate conductor which extends either from the contacts of the called office relay, like relay 3901, or the office code translator, like conductor 3421, must be flexibly extended to the different base rate relays in accordance with the rate applicable to each of the different zones. Now for convenience of illustration, it is assumed that the entire telephone area is divided into three calling zones with respect to all telephone offices within the area and that the entire area itself further comprises but one zone with respect to toll calls or all calls completed by any office within the area to any office outside the area as defined by the minimum base toll rate of ten cents. This division, of course, is not strictly accurate as, in practical cases, the entire calling area may include parts of the toll area as well and to this extent the number of calling zones is increased to take parts in of the toll area. Since, however, the principle of division is always the same, namely, the use of one base charge for a calling zone to all called offices within the area, the use of three calling zones will be sufficient to illustrate the manner in which the rate computer of the analyzer can be adapted to any number of zones into which the telephone area may be divided.

Now at the time a primary tape is transmitted through the analyzer, not only is the office to which it belongs a matter of knowledge but also the various calling zones in which the lines of

that office are located. As will be described hereinafter the zone indication is recorded on a "master" tape in punch positions 46, 47 and 48, positions ordinarily reserved for the registration of the ten minute interval of conversation and is run through the analyzer ahead of the primary tape. Since but one of three zones is to be recorded in the example assumed, the operation of the corresponding pneumatic at that time by the master tape operates the analyzer to ground either conductor **3613**, **3603** or **3625** depending upon the zone. If the calling office is located in zone 1, a hole will have been punched in position 46 in which event conductor **3613** is grounded and a circuit is completed through the outer back contacts of relay **3626**, conductor **3627**, continuity contacts of zone relay **3926**, winding of relay **3926** to battery. Relay **3926** operates and locks to ground over conductor **3934** and contacts **3700** which are closed by lever **3701** when a tape record is threaded over the tracker bar **3101**, thus lifting roller **3704** out of groove **3703** in the tracker bar. If, on the other hand, the calling office is in calling zone 2, a hole will have been punched in position 47 to register this fact, whereupon conductor **3603** is grounded and a circuit is completed over the middle back contacts of relay **3626**, conductor **3628**, continuity contacts and winding of the second zone relay **3927** to battery, operating this relay which also locks to the same off-normal ground. Again, if the calling office is in zone 3, a hole is punched in position 48, conductor **3625** is grounded and a circuit is completed for zone relay **3928** which extends from ground on conductor **3625**, inner back contacts of relay **3626**, conductor **3629**, continuity contacts and winding of the third zone relay **3928** to battery. Relay **3928** operates and locks to off-normal ground. When any of these three relays operates, an obvious circuit is closed from ground over conductor **3934**, the right outer contacts of said relay, conductor **3931**, winding of relay **3626** to battery. Relay **3626** operates and transfers conductors **3613**, **3603** and **3625** to the time register whose function is described hereinafter.

Hence, as the result of initial perforations on the primary tape, made as described hereinafter, a zone relay is operated in the analyzer, which corresponds to the calling zone perforated on the primary tape. Prior to the running of the primary tape through the analyzer, however, the appropriate zone switch **3922**; **3923** or **3924** has to be set in conformity with the calling zone recorded on the tape. Therefore, if the correct switch has been set, and a code relay such as relay **3825** is operated, the proper zone relay is operated, a path will be prepared from battery, through the winding of relay **3908**, and the right inner contact of relay **3926**, if the zone 1 switch **3922** is operated, or through the winding of relay **3909** and the contacts of relay **3927** if the zone 2 switch **3923** is operated, or through the winding of relay **3910** and the contacts of relay **3928** if the zone 3 switch **3923** is operated. The path is further completed on the other side of the switch to ground on the rate conductor which is grounded either at the contacts of the code relay if one is provided, or is grounded at the translating point of the code translator in Fig. 34, if one is not provided.

Should it happen that the operated zone switch and the operated zone relay do not correspond, no path is provided for completing the circuit of any of the rate relays, in which event a rate relay can not operate. Since the path to the advance magnet **3818** is controlled through a closure of the left contacts of any of the rate relays, the tape can not be advanced to record subsequent calls. A suitable time alarm circuit is controlled through the back contacts of the advance magnet **3818** and if said magnet does not operate in the prescribed length of time it takes for the primary tape to advance from one set of perforations to another, an alarm is given which will call attention to the fact that the proper zone switch is not the one which was operated. In this way, the precaution is taken of making absolutely certain that the proper rate is applied for any given call. Thus, if the calling office is located in zone 1 and the called office Halifax is located within zone 3, and the basic rate for a call from zone 1 into zone 3 is fifteen cents for the initial charge period, conductor **3823** or conductor **3421**, would be extend to each of the zone switches and zone switch **3922** which would have been operated, would cause the energization of fifteen-cent relay **3910**.

On the other hand if the calling office is located in zone 2 and the called office Halifax is located in zone 3, and the basic rate for a call from zone 2 into zone 3 is ten cents for the initial charge period, switch **3923** of the second zone is thrown and the rate conductor of the Halifax office is thereby extended to the winding of the ten cent rate relay **3909**. Similarly, if the calling office is in zone 3, zone 3 switch **3924** will have to be operated and the rate conductor of the Halifax office extended to the five cent rate relay **3908** since the basic rate for calls within the same zone is five cents for the initial charge period.

On the other hand, if the called office is outside the local area and, of necessity, is in the toll area, then the rate conductor of that office would be extended to the winding of the appropriate toll base rate relay by appropriate cross connections between terminal blocks **3929** and **3930**. Therefore, the grounding of a rate conductor and the setting of the zone switch, if the call is completed in the local area, or the grounding of the rate conductor, if the call is outside of that area, results in the operation of a rate relay which determines the rate to be applied in computing the total charge for the call. Since, however, one group of the twelve groups of commoned conductors extending across the thirty multi-contact relays **4001–4030** is connected to the contacts of each of the twelve rate relays, the operation of a rate relay results in the grounding of the group of conductors which are extended to its contacts. The operated rate relay further closes a circuit from ground on the contacts of relay **3822**, conductor **3833**, left contacts of the operated rate relay, conductor **3932**, winding of advancing magnet **3818** to battery. The magnet operates, breaks its forward contacts to stop the alarm circuit while its pawl engages the next tooth in the ratchet wheel **3824** preparatory to advancing the tape on the release of the magnet, as described hereinafter.

The operation of the rate relay, then, grounds a particular group of three conductors. The interrelation of these conductors with the remainder of the rate computer will be described shortly, but it is sufficient at present to note that the office code relay or conductor which designates the code of the office, furnishes a rate indication for that code. From this indication and the record of the total conversation time, the translating computer, as described hereinafter,

computes the total charge, either in call charge units or in actual money units.

Returning, now, to the structural arrangement of the computer, the corresponding group of three contacts in each multi-contact relay which, when the relay operates, engage the three common conductors extending to the contacts of some one base rate relay, are further extended in groups of three to the cross-connecting terminal block, 4000. From the block each conductor in each group is further extended to the appropriate contact set of multi-contact relay 3800 which extends to the winding of a punch magnet in the group of magnets which registers the number of local call units in the case of local calls or to the winding of a punch magnet in the group of magnets which registers the actual money charges in the case of toll calls.

It is manifest from the arrangement of the rate computer as above described that each group of three contacts on each multi-contact relay represents a specific charge, and that the charge to be made for any call is marked by the grounding of the three common conductors extending to an operated rate relay and the operation of a particular multi-contact relay as determined by the ten minutes and the minute pneumatics. The group of three contacts on the multi-contact relay so operated which contact with the three grounded conductors extending thereto, fixes the charge for the call being recorded on the secondary tape. In the case of local calls, it, however, has been assumed that the identity of the rate itself will have been discarded once the total charge has been fixed in the computer by the marking of contacts which represent the charge and that said charge will be recorded simply as so many local calls at the local service rate. Hence, all groups of contacts on the multi-contact relays appertaining to the 5, 10 and 15 cents local base rate relays, that is, the groups of contacts in all multi-contact relays cooperating with common conductors 1 to 9, inclusive, are extended to those contact sets of relay 3800 which close through to the windings of punch magnets operating in punch positions 59 to 64, inclusive, in appropriate code combinations for recording the equivalent number of charges in local service units for calls whose charges are marked by the respective group of contacts engaging the three separate groups of conductors 1—3, 4—6, 7—9. According to the time rate structure assumed, which makes the charge of the longest local call that having a base rate of fifteen cents for the first five minutes, five cents thereafter for each two minutes increment or fraction thereof, this call is to be registered as the equivalent of 16 local calls at local service rate of five cents per call. Hence, magnets operating between positions 59 to 64 are divided into two groups, namely, a group of two magnets operating in positions 59 and 60 to register whether the number of local charges to be assessed is less than ten or more than ten, and another of four magnets operating between positions 61 to 64, inclusive, to register, in terms of a four unit code, the units digit of the total number of local service charges to be assessed. Each contact of the contact pairs on relay 3800 which extends to the winding of one of the magnets of the first group is cross-connected to the first conductor of the group of three which marks a local call charge, namely, to contact set 59 if the total charge is less than ten local service units and to contact set 60 if the total charge is more than ten local service units. To one or two contact pairs on relay 3800 of the four contact pairs extending to the winding of punch magnets operating between punch positions 61 to 64, inclusive, of the second group, are cross-connected one or two of the remaining conductors of the group of three which marks a local call charge. They are cross-connected as called for by the four unit code to represent one of the ten digits depending on the units number of the local charge.

In the case of toll calls, each group of three contacts which marks the charge can not be extended directly to the punch magnets to record the charge in equivalent number of base charges but must be cross-connected, instead, to record the actual money charge. This registration may involve punching the record of three numbers if the total charge for any one toll call is limited to $8.00, requiring a code record for each digit thereof. For this purpose three groups of relief relays, 4031 to 4034, inclusive, and 4035 to 4040, inclusive, and relays 4041 and 4042 are interposed between terminal block 4057 and the punch magnets to supply the additional conductors required by the four unit code for punching the code of the numerals 5 to 8, in the case of the dollars designation and 5 to 0 for the tens digit of the fraction of a dollar and 5 to 0 for the units of a dollar.

The toll charge punch magnets comprise a group of four magnets operating between punch positions 36 to 39, inclusive, to record in the four unit code, the number of dollars to be charged for the toll call, a group of four magnets operating between punch positions 40 to 43, inclusive, to record in the four unit code the tens digit of the fraction of a dollar, and another group of four magnets operating between punch positions 44 to 47, inclusive, to record in the same code either the 5 or 0 units digit of the fraction of a dollar since a telephone call is not charged ordinarily on any other base than five cent increments.

One contact of a set of three contacts closed by a multi-contact relay, for example relay 4014, is connected over terminals of blocks 4057 and 4041 directly through contacts of relay 3800 to one of four punch magnets for punching a hole in one of punch positions 36 to 39 if the dollar charge is less than five dollars or is connected to the proper one of relief relays 4031 to 4034 inclusive which in turn closes circuits over contacts of relay 3800 to combinations of the same four punch magnets if the dollar charge is five dollars or more. A second contact of the set of three contacts is connected over terminals of blocks 4000 and 4057 directly through contacts of relay 3800 to one of four punch magnets for punching a hole in one of punch positions 40 to 43 if the fraction of a dollar charge is less than fifty cents or is connected to the proper one of relief relays 4035 to 4039 inclusive which in turn closes circuits over contacts of relay 3800 to combinations of the same four punch magnets if the fraction of a dollar charge is fifty cents or more. The third contact of the set of three contacts is connected to either relay 4041 which on operating grounds conductors extending over contacts 44 and 45 of relay 3800 to operate punch magnets controlled thereover to register a five for the cents digit of the charge or to relay 4042 which on operating grounds conductors extending over contacts 46 and 47 of relay 3800 to operate punch magnets controlled thereover to register a zero for the cents digit of the charge.

The structure of the rate computer, as a unit, will be more apparent by describing a few specific instances of its operation. The call which has been hitherto described; viz., Halifax **3678**, has been assumed to have been made from a calling line in zone 1 and to have lasted 15 minutes. It was also assumed that the Halifax office is in the third calling zone. Hence, prior to the passage of the secondary tape through the analyzer, zone switch **3922** is closed, and relay **3926** operates as previously described. A circuit is now closed from ground on conductor **3823** or conductor **3421**, zone switch **3922**, next to outer right contacts of relay **3926**, winding of relay **3910**, to battery. Relay **3910** in operating, grounds conductors **7**, **8** and **9**. Since, further, the conversation has lasted fifteen minutes, a hole was punched in position 47 of the primary tape causing thereby the consequent operation of pneumatic **3601** and the grounding of conductor **3603** to indicate that the conversation has lasted more than ten minutes but less than twenty. The conversation, moreover, has lasted for five minutes beyond the ten minute period marked by position 47. Therefore, holes were punched in positions 50 and 51 in response to the setting of the minute switch of the district selector, causing thereby the operation of pneumatics **3604** and **3605**. A circuit is now closed from ground on the normal contact of the contact assembly **3607**, normal contact of the No. 1 contact set of contact assembly **3608**, alternate contact of the No. 1 contact set of operated contact assembly **3609**, alternate contact of the No. 2 contact set of operated contact assembly **3610**, conductor **3611**, winding of five-minute relay **3619** to battery. Relay **3619** operates. Since, however, conductor **3603** is grounded and relay **3626** is operated as already described, a circuit is now completed from ground on said conductor, middle front contacts of relay **3626**, middle contacts of relay **3619**, conductor **3612**, winding of multi-contact relay **4014** to battery. It is seen, therefore, that for a conversation lasting fifteen minutes, two relays were operated by the pneumatics, namely, the five-minute relay **3619**, and the multi-contact relay **4014**. Further, since the call is a local one having a fifteen cent base rate, relay **3910** was operated by the office code relay. Hence, conductors **7**, **8** and **9** are grounded by said relay which, in turn, extend to the corresponding make contacts of contact set **4054** of the multi-contact relay **4014**. These contacts, as already indicated, are extended to terminal block **4000** and from thence are cross-connected to the combination of punch magnets which perforate, in code form, the number of local unit charges which is to be made for a call that has lasted fifteen minutes to an office whose code relay **3801** or charge conductor **3421** caused the operation of the base rate relay **3910**.

Since, in the computer, no discrimination is made between a local rate five cent call and a local rate fifteen cent call except that the latter appears on the bill as the equivalent of three five cent calls and since, further, each additional two minutes of conversation or fraction thereof is simply added as another five cent call, it is therefore apparent that the fifteen minute call under consideration would be the equivalent of eight local calls of five cents each. Consequently, with contact set **4054** of multi-contact relay **4014** operated, charge conductor **7** is not extended and charge conductors **8** and **9** are extended over the middle and lower contacts of contact set **4054**, cross-connection blocks **4000** and **4057**, contact sets **62** and **63** of relay **3800** for operating punch magnets **4102** and **4104** to punch holes in positions 62 and 63 for designating in code form eight local charge units.

As a further illustration let it be assumed that the call to the Halifax office lasted five minutes or less in which case pneumatic **3600** operates instead of pneumatic **3601**. Conductor **3613** will therefore be grounded and one or more of the minutes pneumatics **3607** to **3610** inclusive will operate in accordance with the number of minutes the conversation has lasted. As a result, one of the minutes relays **3615** to **3619** inclusive operates. Hence, the grounding of conductor **3613** and the operation of one of the minutes relays results in the operation of either the first multi-contact relay **4001**, or the fourth relay **4004**, or the seventh relay **4007**, or the tenth relay **4010** or the thirteenth relay **4013**, depending upon which of the minutes relays **3615** to **3619** inclusive has been operated. The contact sets of any of these multi-contact relays which make contact with conductors **7**, **8** and **9**, grounded by the operation of charge relay **3910**, will extend these grounded conductors to corresponding sets of terminals on terminal block **4000** which, however, will be cross-connected together on the terminal block and connected to a single set of terminals on block **4057**. One of these terminals on block **4057** will then be extended over contact set **63** of relay **3800** to punch magnet **4104** for punching a hole in position 63 of the secondary tape to indicate three charge units for the call since the call has not lasted beyond the initial five-minute period.

As a further illustration, it will be assumed that a call has been made from an office in zone 1 to another office in the same zone for which the base rate is five cents for the first five minutes of conversation and that the call lasted but one minute. Zone switch **3922** and relay **3926** would be operated in this case and charge relay **3908** would also be operated in order to ground charge conductors **1**, **2** and **3**. Minute relay **3615** will be operated and pneumatic **3600** will ground conductor **3613** resulting in the operation of multi-contact relay **4001**. Relay **4001** now extends grounded conductors **1**, **2** and **3** over its contact set **4055** to terminal block **4000**. Since the charge to be made for the call is five cents or only one local charge unit, the conductor extending from the contact of contact set **4053** making with grounded conductor **3** is cross-connected from block **4000** to the terminal block **4057** which further connects with contact set **61** of multi-contact relay **3800**. When, therefore, relay **3800** is operated, the computer setting as above described will complete a circuit to punch magnet **4102** which, on operating, causes a hole to be punched in punch position 61 to designate, in code form, that one local charge of five cents is to be registered for the call.

If the conversation on a five cent call has lasted six minutes, then the minimum charge against the subscriber would be two local charge units. Minute relay **3620** will have been operated by the appropriate minutes pneumatics and, due to the operation of pneumatic **3600**, indicating a conversation period of less than ten minutes, an obvious circuit will have been closed to the sixteenth multi-contact relay, that is, relay **4016**. In this case, however, although the base charge is still five cents, yet the total charge will be equal to two local charges or ten cents and this fact, in the rate computer, is determined by

cross-connecting the conductors extending from the three contacts of contact set 4056 on relay 4016 engaging with conductors 1, 2 and 3, to the punch magnets operating between punch positions 61 to 66, inclusive, in accordance with the code to be punched to represent two local charges. Since the units registration of the number of local charges is accomplished by the perforation of holes between punch positions 61 to 66, inclusive in accordance with the code and since, further, the numeral 2 would be represented by a hole punched in position 62, only the conductor which extends from the contact of contact set 4056 that engages grounded conductor 3 is further extended from block 4000 to contact set 62 of relay 3800. On the operation of relay 3800, the punch magnet 4103 operates and punches a hole in position 62, to register, in code form, two local charge units for the call.

In the case of toll calls involving the operation of any basic rate charge relay 3911 to 3919, inclusive, the charge punchings on the secondary tape do not represent local charge units but the actual charge in dollars and cents. The reason for this is the fact that toll calls are not subject to bulk billing and are usually listed separately as a part of the monthly bill. The most usual practice is to list all the toll calls on a separate slip, together with their listing and total charges and transmit it to the subscriber along with the regular bill containing the bulk summation of all calls within the local area.

For example, if the call Halifax 3678 were assumed to be a toll call instead of a local one, and its base rate were fifty cents for the first three minutes and fifteen cents thereafter for each one minute or fraction thereof, then, if the call lasts for fifteen minutes, the total charge would be $2.30.

In this case, the rate conductor 3823, instead of having been extended to the zone switches, would have been extended to terminal block 3930, from which it would then be cross-connected to that terminal on block 3929 which is further connected to the winding of the fifty cent base rate relay 3919. This terminal, for convenience, has been marked 3933 and extends to the winding of relay 3919 by way of the outer right back contact of relay 3921, and the outer right back contact of relay 3920. Consequently, when conductor 3823 is grounded by the operation of the office code relay 3801, relay 3919 operates in the path above described, thereby grounding common conductors 34, 35 and 36. Further, since one of the zone relays 3926, 3927 and 3928 will have been operated because the entire local area has been assumed to be divided into three local zones, relay 3626 operates in the manner already described and transfers conductors 3613, 3603 and 3625 to the armature contacts of the minute relays. Through the left contacts of relay 3919 a circuit is completed from ground on the left contact of relay 3822, conductor 3833, left inner contacts of relay 3919, conductor 3932, winding of advance magnet 3818 to battery. Magnet 3818 operates, its pawl engages the next tooth on ratchet 3824 preparatory to advancing the take-up spool 3819 and, at the same time, breaks the armature contacts to stop the alarm circuit. The toll call conversation has been assumed to have lasted fifteen minutes. Hence, relays 3619 and 4014 are operated in the manner previously described and the three contacts of relay 4014 which have engaged the grounded conductors 34, 35 and 36 extend these conductors to a set of terminals on block 4000, which are cross-connected to terminals on block 4057. Since the three contacts on relay 4014 which engage conductors 34, 35 and 36 mark a total charge of $2.30, conductor 34 is extended to contact set 37 of relay 3800, conductor 35 is extended to contact set 42 of relay 3800, while conductor 36 is extended to relief relay 4042 which, on operating, grounds contact sets 46 and 47 of relay 3800. When relay 3800 operates punch magnet 4047 punches a hole in position 37 to record the digit 2, the operation of punch magnet 4048 punches a hole in position 42 to record the digit 3 while punch magnets 4049 and 4050 punch holes in positions 46 and 47 respectively, to record the digit 0. The charge $2.30 is thus recorded on the secondary tape as a part of the call record.

If, in connection with this call, the "evening" rate is assumed to apply, then a hole is punched in position 45 of the primary tape, in consequence of which, pneumatic 3508 operates and closes the circuit of relay 3920 by grounding conductor 3507. The operation of relay 3920 opens the path to the winding of relay 3919 and closes one to the winding of the forty cent base rate relay 3917 which can be assumed to be the evening rate where the day rate is fifty cents. It will further be assumed that with a base rate of forty cents, ten cents instead of fifteen cents will be charged for each minute of overtime conversation. Consequently, the ground on conductor 3823 is effective in this case to operate relay 3917 over a circuit extending through the outer right back contact of relay 3921, outer right front contact of relay 3920, winding of relay 3917 to battery. Relay 3917 operates and grounds conductors 28, 29 and 30 which, as already described, extend to correspondingly numbered contacts on all multi-contact relays that, in turn, terminate in groups of three on block 4000. The operation of multi-contact relay 4014 extends ground over the contacts (not shown) engaging conductors 28, 29 and 30 to a set of terminals (not shown) on block 4000. One of these terminals is further cross-connected to contact set 36 of relay 3800, another to the winding of relief relay 4032 (not shown) in the group 4031 to 4034 and which, when operated, grounds conductors connecting with contact sets 40 and 42 of relay 3800, while the third is cross-connected to relay 4042 which, when operated grounds conductors connecting with contact sets 46 and 47 of relay 3800. This particular cross-connection, representing the charge of $1.60, causes the operation of punch magnets 4052, 4053, 4048, 4049 and 4050 causing holes to be punched in positions 36, 40, 42, 46 and 47 to record in code form $1.60.

If the call is made at a time when the "night" rate applies, then the rate code woud have caused a hole to have been punched in position 44 of the primary tape, which would cause the operation of pneumatic 3509 and the subsequent operation of relay 3921 over an obvious circuit. It will be assumed that the night rate is thirty-five cents and that ten cents is charged for each minute of overtime conversation. In this case, the rate conductor 3823 which has been assumed connected to terminal 3933 would be transferred to the thirty-five cent rate relay 3916 over the outer right front contact of relay 3921. This rate relay would ground common conductors 25, 26 and 27 in the same manner as relay 3917 grounds conductors 28, 29 and 30, the extension of which through a contact set (not shown) of relay 4014 to terminal block 4000 and the further extension

thereof to contact sets 36, 40, 41, 42 and 49 of relay 3800 causes the operation of punch magnets to punch holes in the corresponding punch positions for the registration of the charge $1.55 which is the charge marked by the group of contacts on relay 4014 engaging common conductors 25, 26 and 27.

The remaining information which has to be recorded on secondary tape is the date which, it will be remembered, is punched in eleven positions of the primary tape, beginning with punch position 54 and ending with punch position 64. The pneumatics controlled through these positions, like those which are controlled through positions 24 to 43 and involving the called number, control the grounding of conductors extending directly to the contact sets of multi-contact relay 3800 through which the grounds are then further extended to the windings of the several punch magnets which, on operating in the appropriate combination called for by the code for each of the remaining items, that is, the month and the day, (the latter subdivided into a tens and units code) cause corresponding holes to be punched in the secondary tape to record therein the same information and in the same code the date setting contained in the primary tape. The punch positions 48 to 58 on the secondary tape correspond to positions 54 to 64 on the primary tape. Consequently, the registration of the date July 17th of assumed call, which was recorded by holes punched in positions 54, 57, 59, 61 and 64 will now be recorded by holes punched in positions 48, 51, 53, 55 and 58 of the secondary tape.

It is thus clear that the secondary tape comprises a transverse series of perforations arranged in definite groups and in appropriate codes to indicate the following information for a toll call: the called office, the called number, the total money charge, the date. For a local call, if the alternative wiring such as conductor 3421 is used, the only information is a record of the number of local charge units to be charged for the call since with no route relay such as 3801 operated, the office code is not translated and recorded on the secondary tape and no ground is connected to conductor 3813 for circuits controlled by the called number and date pneumatics.

As the primary tape advances over the tracker bar 3101 and the perforations of the terminal group record are succeeded by an interval of unpunched tape, the pneumatics are re-inflated, and, with the re-inflation of pneumatic 3102, relay 3104 releases, and the circuit of slow-release relay 3822 is opened. Since this relay is made slow to release, it will release after an interval whereupon the circuit of tape-advancing magnet 3818 is opened and magnet 3818, on its back stroke, advances the secondary tape one step to provide thereby a fresh supply of unpunched tape for recording the next call from the same subscriber's line. Relay 3822 is made sufficiently slow to release to allow sufficient time for the release of all punch magnets and their associated circuits as a result of the re-inflation of all pneumatics. The operated zone relay 3926, 3927 or 3928 and relay 3626 are held operated by off-normal switch 3700 until the primary tape has passed through the analyzer.

Separate entries for each call involving the same subscriber's line terminal are entered on successive lines so that the secondary tape contains a plurality of horizontal series of perforations, each series representing the data of one connection.

And in the same manner, as the primary tape advances across the tracker bar and the calls appertaining to different subscribers are presented for translation, the line-finder terminal perforations recorded with each call will cause the analyzer to select, in succession, each of the several punch machines assigned to the separate terminal numbers for recording on their cooperating secondary tapes, the data of the call recorded with the line-finder terminal number perforations.

From what has been described thus far, the secondary tape made for each subscriber's line contains a perforated record of each call made from said line over a defined billing period, as each of said calls is to be entered in the subscriber's monthly bill. This record contains: (1) a perforated record of each local call in terms of the total local charge units to be assessed for the call; (2) a perforated record of each toll call in terms of the total money charge for the call, as well as the record of the called office code, the called subscriber's number and the date.

However, it must be realized that since the analyzer contains a punching machine for each line in one-half of a line-finder frame, that is, two hundred punching machines, a similar record is made for each line without any indications on the secondary tape to distinguish one secondary tape from another. But each secondary tape must be identified with the subscriber to which it appertains because the printing tabulator, as described hereinafter, must receive some signal which marks the subscriber to which the particular secondary tape belongs.

The description of how and what forms the substance of this indication has been postponed, however, until the making of the secondary tape had been described because the perforation of the required information to indicate the subscriber's directory number is likewise based on the punching of a code which indicates that number. In point of time, however, and as already indicated, this information is punched on the secondary tape before any of the calls are recorded thereon.

As previously pointed out, the perforated record of all calls for the entire subdivision of two hundred lines on the primary tape gives the calling party's line-finder terminal number but not his telephone number, the relation between one and the other being purely arbitrary. It is, however, customary to handle the subscriber's account by his telephone number and consequently it become necessary to translate the line-finder terminal-number into the subscriber's directory number for accounting and billing purposes.

The record of the line-finder terminal-number, the telephone number and class of service to which the line is entitled is kept in the wire chief's department. From this information a "Master Record" is prepared on a tape of the same width as the primary tape and with the same code perforations and the same spacings as the primary tape. The master record contains the line-finder terminal-numbers of two hundred subscribers' lines in the code previously described and on the same lines therewith the directory numbers of said subscribers, with a last entry to denote the class of service to which the lines are entitled, all in the same code. For purposes which are described hereinafter, the perforations comprising the line-finder terminal-number appear in the same corresponding positions as the perforations of said number on the primary tape, i. e., positions 1 to

11; the perforations comprising the code of the corresponding directory number, however, are punched in punch positions 24 to 43, inclusive, of the primary tape, while those relating to the calling zone are punched in punch positions 46 to 48, inclusive, of the primary tape. Since these positions in the primary tape are used, respectively, for perforating the directory number of the called subscriber and the ten-minute intervals of elapsed conversation time, it is obvious that the directory number and class of service of a calling subscriber can likewise be punched thereon to effect the same reperforating equipment in the secondary punch machine. Therefore in addition to and preceding the perforations of the called number and elapsed time interval of the first call there may be recorded in the punch positions allotted therefor, and in the same code, the directory number and the calling zone of the entire calling line group.

The master record above referred to may be perforated by a hand-operated perforating machine or by any other suitable means. The line-finder terminal code, for instance, may be perforated on the master record blank by means of a permanent die, these perforations being the same for all master records since each master record, so far as line-finder terminal number arrangements are concerned, is the same for each half of a line-finder frame.

The master record tape only needs to be prepared by hand initially. But at each billing period it must be brought up to date. Where changes are required between line-finder terminals and directory numbers, they may be made by pasting a strip of paper over the telephone number and class of service perforations to be changed and then reperforating this tape to indicate the new number or class of service change. In the case of a "take-out" the covering of the telephone number and the class of service perforation with a blank strip of paper will suffice. Should a master record become worn or have too many corrections, it will be a simple matter to produce a new copy by feeding the old one through a punching machine of the character described.

Prior to running the primary tape of a particular group of lines through the analyzer, the master record tape is run first. As the line-finder terminal number code perforations for each subscriber's line become coincidental with the tracker holes of the pneumatics in the analyzer which are responsive to the line-finder terminal numbers, the particular multi-contact relays, such as relay **3800**, appertaining to the secondary punching machines of said line-finder terminal numbers are operated as already described to associate the proper secondary punching machines with the analyzer. Simultaneously therewith the perforations in positions 24 to 43 comprising the directory numbers of the calling subscribers corresponding to the line-finder terminal numbers become coincidental with the tracker holes of the pneumatics responsive to the code perforations of the called subscriber's number and, through operations in the analyzer already described, the codes of said directory numbers are perforated on the secondary tapes as the first item on said tapes and in punch positions 16 to 35 thereof, that is, in the same punch positions in which the numbers of the several called subscribers will subsequently appear, ground for the punch magnets being connected over the right back contact of relay **3625** to conductor **3813**. Assuming that there are three zones, then, when the master record has advanced to the last or zone perforation, the calling zone perforation is made in either position 46, 47 or 48, and result in the operation and locking of relay **3926** or **3927** or **3928** as already described, followed by the operation of relay **3625** which removes the ground from conductor **3813**. Where the number of zones exceeds three, then the perforations may be made in a code suitable to the registration of each of the entire number and the number of zone relays and zone switches shown in Fig. 39 may be increased in conformity therewith.

As the punched holes of the master tape are followed by an intervening space of unpunched tape, the secondary punching machine appertaining to the particular line-finder terminal number releases as already described with the exception of the operated zone relay **3926**, **3927** or **3928** and relay **3626**. The succession of the next transverse series of punches relating to another line-finder terminal number and its corresponding directory number then causes the selection of the secondary punching machine appertaining to this next line-finder terminal number. In this manner, the master tape operates the analyzer and causes it to select, in succession each one of the two hundred secondary punching machines for perforating on each of their secondary tapes the telephone number and class of service indications of each of the corresponding two hundred lines. The first line perforations of the secondary tape record, therefore, the directory number of the calling subscriber and the calling zone in which the office appertaining thereto belongs.

Just before the master record tape has been completely run through, the individual primary tape to which said master record appertains is then inserted and run through the analyzer to record on the separate secondary tapes all the calls made by the separate subscribers in the line group, as already described care being taken that ground on conductor **3934** is not disturbed by any false release of switch **3708**.

Section 3.—The printing tabulator

The secondary tape is assumed to contain a record of all local and toll calls for a billing period made from the station to which the tape appertains. Consequently, when the tape is completed it is ready for passage through the printing tabulator, which is responsive to the perforations denoting the several calls. The tabulator, through its operation, adds up the local calls in the equivalent number of local charge units and prints the total charges therefor on what may be called the "local service charge" bill. It further prints an itemized list of all toll calls on a separate slip together with their individual charges and the total of these toll charges.

Any commercial printing tabulator, or electric typewriter, with an adding attachment capable of performing the above functions is contemplated for use as a part of this invention and the mechanism selected for illustrating its most generalized application is the one commercially known as the Hollerith tabulator disclosed in Patent No. 685,608 to H. Hollerith dated October 29, 1901, together with the improvements made thereon as disclosed in Reissue Patent 16,304 to C. D. Lake dated March 30, 1926, and Patent No. 1,600,413, also granted to C. D. Lake on September 21, 1926. This tabulator, of course, is of a kind principally adapted for operating in con-

junction with a punched card of relatively small dimensions containing various punched codes of accounting and bookkeeping items and the like. It is proposed, therefore, that while the operating mechanism and the associated circuits of this tabulator shall remain undisturbed as far as possible, nevertheless it is obvious that some important modifications of its structure will have to be made in order to adapt it for operation with the continuous secondary tape of the character above described and for printing and tabulating the character of the information perforated therein. Hence, while this specification describes the operating features of such modifications as are both novel and necessary to the complete operation of my invention, it is not intended to burden this specification with a detailed description of the entire mechanism of the printing tabulator or of its well known mechanical parts with which persons skilled in printing tabulator mechanisms are entirely familiar. Reference, however, is made to the above mentioned patents for a more complete description of such parts of the tabulator as are omitted from the following description.

As already indicated, the Hollerith commercial printing tabulator uses a punched card through the holes of which electrical brushes close electric circuits controlling the separate magnets which effect the positioning of their respective counters. While the use of the same brush contacting system could be used in cooperation with the perforations of the secondary tape with the necessary re-alignment of the contacting brushes in a single horizontal row to agree with the horizontal perforations of the call registrations of the tape, it is thought that the use of the pneumatic system used for controlling the electrical elements involved in the perforations of the secondary tape appears to me to be a more desirable arrangement for illustrating the modification of the tabulator. In this manner, the ease with which the tabulator for any system of electro-mechanical recording can be modified to cooperate with the mechanism of the tabulator is thereby demonstrated.

As already indicated, the printing tabulator herein disclosed uses a pneumatic system for controlling the electrical elements which operate in response to the perforations in the secondary tape. This pneumatic system comprises a series of valves, each adapted to control the movable member of a pair of bellows, normally kept inflated by air at atmospheric pressure, when the valve is lifted by atmospheric air entering a valve chamber that is kept at partial vacuum. The collapse of the bellows controls the operation of a signaling device. And, of course, when the supply of outside air is cut off by the secondary tape covering the aperture through which the air is admitted, the valve chamber is again reduced to a partial vacuum, the valve is reseated in the chamber roof, the bellows are again expanded, and the contacts carried thereby to close the circuits of the signaling device are opened, leaving said device under the control of a separate locking circuit. Accordingly, the pneumatic system has a tracker-bar with atmospheric openings connected to a number of valve chambers equal to the number of punch positions in the secondary tape, while the motor control of the feeding mechanism is made responsive to the presence of the tape on the surface of the tracker-bar.

Figs. 43 to 53, inclusive, arranged as shown in Section III of Fig. 1, illustrate the presence of the secondary tape across the tracker bar of the tabulator. There are sixty-four pneumatics to correspond with the sixty-four punch positions of the secondary tape. Most of these pneumatics each controls a contact assembly which, separately or in combination with contact assemblies of other pneumatics of the code group registering a particular item of information, controls the responsive circuits of the tabulating and recording mechanism as more particularly described hereinafter. The tracker bar **4300** is shown extending across Figs. 43 to 53 inclusive with the secondary tape **4301** threaded over it. In Fig. 53 is disclosed a spring depressed rocker arm **5302** that carries a roller **5303** which is held lightly in the groove **5304** of said tracker bar by spring **4305** when no tape is on the tracker bar and causes the arm controlled contact switch assembly **5360** to be held open. When, however, the tape covers the surface of the bar and hence also the surface of the groove, roller **5303** is forced out of the groove **5304**, tilting the arm **5302** and thereby causing the closure of contacts **5306**, **5365** and **5350**. The closure of contacts **5306** closes the circuit of the tape feed motor control **5307**, said circuit being controlled through the left back contacts of relay **5311** which is normal at this time, operating the main shaft motor (not shown) for advancing the tape. The closure of contacts **5350** closes the circuit of tabulator motor control **5351** which revolves the shaft **4308** and shaft cams **4331** and **5308** keyed thereto. The tape **4301** is thus advanced across the face of the tracker bar **4300**, bringing successive rows of call perforations into coincidence with the tracker bar holes. The advance of said tape and the speed of rotation of countershaft **4308** are so adjusted with respect to each other that, with relay **5311** unoperated, the shaft **4308** makes one revolution between one series of perforations on the tape and the next.

Looking at the tape from left to right, the punch positions as therein shown are identical with those shown in relation to the punch magnets of the secondary punch machine, and the tracker bar holes correspond with the punch positions of the tape. The coded information therein recorded, therefore, is in the following order:

Called office code	Positions 1 to 15 inclusive.
Calling line number Called office number	Positions 16 to 35 inclusive.
Toll charges	Positions 36 to 47 inclusive.
Date	Positions 48 to 58 inclusive.
Local charges	Positions 59 to 64 inclusive.

The general principle controlling the modification of the tabulator for operation with this invention is:

(A) The setting of the appropriate letter wheels and counters in the case of toll calls for printing (1) the letter code of the called office and the number of the called subscriber, (2) the money charge therefor, (3) the date;

(B) The setting of the appropriate counters in the case of local calls for adding up the total number of minimum local charge units for all calls beyond the minimum of such charges allotted to a subscriber for a billing period and at stated rates which may diminish with the total units used at prescribed rates.

The printer mechanism of the tabulator can be conveniently divided into two parts, one part responsive to the toll entries which may be print-

ed on a separate slip of paper as entered, and the other part responsive to the local service units which are added successively.

Referring to the above mentioned drawings for a description of each of the above modifications, the pneumatics responsive to each of the punch positions 1 to 5, inclusive, each operate a multi-contact relay 4333, 4309, 4310, 4311 and 4312. The pneumatics operate in response to the perforations contained in these positions which, it will be recalled, are code perforations indicative of a particular letter designating the first letter of the code of the called office.

It will be recalled that the code perforations punched in positions 1 to 5 correspond to the five-unit code representing the first letter of the called office code and since, generally speaking, this letter may be any one of the twenty-six letters of the alphabet, the pneumatics operate in such combinations as to ground any one of twenty-six different conductors, one for each letter. These conductors, are extended to the twenty-six separate segments of the commutator 4313. Since, however, the letters Q and Z are generally not used in office codes, the conductors extending to segments Q and Z of commutator 4313 may be omitted. The distributor brush 4315 and letter wheel 4316 are mounted on sleeve 4332 and normally do not partake of the rotational movement of shaft 4308, as described hereinafter.

In order to describe how the setting of the letter wheel 4316 is effected, consider the operations of that part of the apparatus which is shown in Fig. 43. When the secondary tape is attached to the tracker bar and the contacts 5306 of the control apparatus are closed and, as a result thereof, the tape is advanced to the position where the perforations of the first call are coincidental with the corresponding tracker bar openings, then, since the name of the called office assumed for illustration is Halifax, with holes punched in positions 3 and 5 for designating the letter H, pneumatics 4317 and 4318 collapse and cause the operation of their associated multi-contact relays 4310 and 4312 respectively. These relays, in operating, close their contact assemblies and, in particular, close their respective No. 1 contact sets to common conductors 4319 and 4328, locking each of these relays to battery through contacts 4326 controlled by cam 4331, which contacts are closed at this time. A circuit is now closed extending from ground over the No. 5 contact set of multi-contact relay 4312, No. 5 contact set of multi-contact relay 4310, conductor 4328, to commutator segment H.

Now the letter wheel 4316 and brush 4315 are mounted on sleeve 4331 which is mounted loosely on shaft 4308 which is constantly driven at a uniform speed by the motor (not shown) operating in synchronism with the moving tape as already mentioned. Thus, the turning movement of the shaft will not actuate the sleeve 4332 until it is brought into positive connection therewith. The connection of the sleeve with the shaft 4308 is effected by means of a clutch 4321 comprising clutch teeth on wheel 4316 cooperating with teeth on disk 4314, splined on the shaft 4308 so that it will slide on the shaft and turn therewith. This clutch member is effective only in one direction of rotation thus avoiding any reversal of movement and permitting the operation of the mechanism at high speed and without objectionable vibration. The spring retracted armature 4323 of the clutch control magnet 4322 is in the form of a bell crank and the depending arm of said crank is suitably connected to the hub of the clutch disk 4321. When the control magnet is energized, its armature will be attracted toward the magnet and the movement of the armature will carry the clutch disk connected therewith into locking engagement with the letter wheel 4316. The operation of relay 4310, or 4312, also closes a circuit for relay 4324 in series with the clutch magnet 4322 extending from ground on the No. 2 contact set of either relay, winding of relay 4324, contacts of relay 4325, clutch magnet 4322, contacts 4326, to battery. Contacts 4326 are controlle by cam 4331 keyed to shaft 4308 and is timed so as to close contacts 4326 at the beginning of one revolution of the shaft and open them at the end. Magnet 4322 operates and throws the revolving clutch disk 4314 into engagement with the letter wheel 4316. Relay 4324 operates and locks through its contacts in series with the magnet 4322. The control of the letter wheel by magnet 4322 thus established by the operated pneumatics is maintained notwithstanding the relatively brief duration of the pneumatic contact assembly closures which are operated only during the coincidence of the punched holes with their associated tracker bar channel openings. Further, the previously grounded conductor 4320, traced through the contact paths of the operated multi-contact relays, is also undisturbed by the re-inflation of the pneumatics and the consequent opening of their respective contacts since the multi-contact relays 4310 and 4312 originally operated by the collapse of the pneumatics, are now locked under the control of contacts 4326 independent of the pneumatic contacts. The magnet circuit is locked under the control of the contacts of relay 4325 and contacts 4326 which latter are arranged to break the circuit simultaneously through magnet 4322 as well as other magnets, as described hereinafter, by the constantly revolving cam 4331 carried by the main shaft at the instant the advancing tape brings the next series of holes into nearness with the holes of the tracker bar.

In the meanwhile, the engagement of the clutch disk 4314 with the letter wheel 4316 imparts movement to the latter. Since, however, the distributor brush 4315 of the commutator is connected to wheel 4316 through sleeve 4332, the movement of the wheel, when engaged with the clutch, imparts movement to the distributor arm also. As the wheel revolves, successive letters on its periphery are advanced to face the sight position and, at the same time, distributor brush 4315 is rotated over the successive segments of commutator 4313. When the letter H on the tape wheel is advanced to the sight position, the distributor arm is in contact with commutator segment H whereupon a circuit is closed from battery through the winding of relay 4325, commutator ring 4327, distributor brush 4315, commutator segment H, conductor 4328 to ground on the No. 5 contact of relay 4312 as previously described. The operation of relay 4325 opens the circuit of clutch magnet 4322 and the circuit of relay 4324, causing both of them to release. The release of magnet 4322 throws out the clutch disk 4314 which disengages the letter wheel, causing it and the distributor brush 4315 to remain at rest in the position at which they are stopped, that is, with the letter H on the periphery of the letter wheel in the sight position and the distributor arm in contact with segment H of the commutator. In the meanwhile, as letter wheel

4316 revolves, gear 4329 revolves with it. This gear connects with the type-setting mechanism of the printer so that the positioning of the letter wheel simultaneously positions the corresponding printing wheel for the subsequent printing of the first letter designation of the call. The setting of the printing mechanism is accomplished in any suitable manner and hence is neither shown nor further described herein, except to mention that, with the operation of relay 4325, a path is closed from the printer motor control terminal T to conductor 4330 which, as described hereinafter, loops to other letter and numerical wheel mechanisms for completing the printer control circuit when all of said wheels have been set in response to the other perforations of a given record.

The letter wheel 4316 has now been set to conform with the code registration of the first letter of the called office code and while the shaft 4308 continues to revolve after the disengagement of the clutch, the position of the letter wheel remains undisturbed. At the end of the revolution, that is, just before the tape begins to uncover the tracker bar openings with the perforations of the next call record, cam 4331 opens contacts 4326 and unlocks multi-contact relays 4316 and 4312 which now release.

Simultaneously with the positioning of letter wheel 4316 of the first letter of the office name, all other wheels, involving the remaining two letters, as well as those comprising the called number and date are similarly and simultaneously set. Shaft 4308 is continuous and carries all the clutch discs for driving other indicating wheels. For the purpose of not incumbering this specification, only those wheel combinations which are electrically or structurally different from the one described will be explained in detail while the others will be briefly indicated.

Fig. 44 shows the letter wheel mechanism for the second letter of the code at 4400 and the letter wheel for the third letter of the code at 4401. Each of these wheels is set at the same time as letter wheel 4316 since the perforations of one call record become coincidental with the tracker bar openings simultaneously. Further, as the second letter of the code is A and the code of which requires perforations in punch positions 6 and 7, the operation of multi-contact relays (not shown) responsive to the operation of corresponding pneumatics cause a ground to be extended to conductor 4402 which through the operation of relay 4404 stops the letter wheel 4408 with letter A on its periphery in the sight position. At the same time relay 4404 extends the path from the printer motor control terminal T from conductor 4330 through its left contact to conductor 4406.

In the same way, the letter wheel 4409 for the third letter of the office name is revolved until the latter L is in the sight position, at which time ground on conductor 4403, closed thereto by the operation of multi-contact relays responsive to pneumatics operating in positions corresponding to punch positions 12 and 15 for the code of the letter L, closes a circuit to operate relay 4405 which opens the circuit of the clutch magnet, stops the letter wheel and associated distributor brush from any further displacement and further extends the printer control path to conductor 4407. The position of the three wheels, in their sight positions, now display HAL to conform with the directory name of the called office name while the printer type wheels geared to the separate letter wheels are set to corresponding letter positions.

Fig. 45 discloses in detail the electro-mechanical apparatus for controlling the setting of the thousands digit wheel. It comprises a multi-contact relay responsive to each pneumatic respectively, a numerical wheel 4501 with each of the ten digits designations on its periphery, a fixed commutator 4510 and the distributor brush 4509, all mechanically arranged as the similar combination shown in Fig. 43.

When, in response to a perforation in punch position 18, the code perforation for thousands digit 3 of the assumed called subscriber's number 3678, the pneumatic 4505 operates, an obvious circuit is closed for relay 4506 which, on operating, locks through its No. 1 contact set to battery on conductor 4328. A path is further closed from ground through the normal contact of the No. 3 contact set of relay 4511, the alternate contact of the No. 3 contact set of relay 4506, the normal contact of the No. 4 contact set of relay 4516, the normal contact of the No. 5 contact set of relay 4512, conductor 4507 to segment 3 on commutator 4510. At the same time, a circuit is closed from ground on the No. 2 contact set of relay 4506, conductor 4514, winding of relay 4502, back contact of relay 4504, winding of magnet 4503, conductor 4328, contacts 4326, to battery. Relay 4502 operates and locks to ground on its contacts while magnet 4503 operates and engages the clutch disk 4513 with the number wheel 4501 and rotates it until the numeral 3 on its periphery is in the sight position at which time distributor brush 4509 will have been rotated to segment 3, whereupon a circuit is closed from battery through the winding of relay 4504, commutator ring 4508, distributor brush 4509, commutator segment 3, conductor 4507 to ground. Relay 4504 operates, closes another contact of the series path of the printer control terminal T, opens the circuit of magnet 4503 and relay 4502, the latter unlocking and the former disengaging the clutch disk 4513 from wheel 4501, causing it thereby to remain in the position in which the numeral 3 appears in the sight position. When, just prior to the movement of the next series of punched holes on the tape into coincidence with the associated tracker bar holes, the shaft has completed its revolution, cam interrupter 4331 breaks the contacts 4326 whereupon battery is removed from conductor 4328 and multi-contact relay 4506 released. The tabulator has thus positioned the thousands wheel for the first or thousands digit of the called subscriber's number and the printer has been similarly positioned through gear 4516. The setting of the number wheel 4501 and associated type wheel for other thousands digit values will be apparent by tracing each of the conductors extending to the digital segments of the commutator 4510 to ground at one of the relays 4512, 4517, 4506 and 4511.

Punch positions 20 to 23 control pneumatics which are responsive to the code perforations of the hundreds digit of the called subscriber's number while punch positions 24 to 27 control pneumatics which are responsive to the code perforations of the tens digit of said number. The equipment and controlling circuits for the setting of the corresponding number wheel mechanims 4600 and 4610 are the same in both cases as that for the thousands digit, already described, and is, therefore, but diagrammatically indicated in Fig. 46. Since the hundreds digit of the called num-

ber is 6, requiring a perforation in punch positions 20 and 22, the operation of the multi-contact relays (not shown) responsive to the pneumatics of these positions causes ground to be connected to conductor 4601 connecting with the sixth segment of the commutator, causing thereby a positioning of the wheel to display the numeral 6. In a substantialy similar manner, ground is connected to conductor 4602 by the operation of the tens pneumatics in response to the code perforations of the digit 7 in punch positions 24 and 27. The printer control path is then extended from conductor 4515 over conductor 4603 to conductor 4604.

Punch positions 28 to 31, and 32 to 35, both inclusive, are responsive, respectively, to the code perforations of the units digit and the station's letter. The equipment and controlling circuits for setting the corresponding number wheel mechanisms 4700 and 4710 in each of these cases is the same as that for the thousands and hundreds digits and is, therefore, but diagrammatically illustrated in Fig. 47. For setting number wheel mechanism 4700, conductor 4701 is grounded in response to operations resulting from perforations in positions 29 and 30 for the digit 8 and causes the wheel to be positioned for the digit 8. Wheel 4710 is not disturbed for the assumed case since the called number does not have a station's letter.

The pneumatics of Figs. 48 and 49, operative in punch positions 36 to 47, inclusive, are responsive to the perforations of the codes which designate the total money charge for a toll call. Punch positions 36 to 39, inclusive, designate the dollar charges and, through the operation of the control circuits responsive to the operations of the pneumatics in these punch positions, cause the setting of the dollar wheel mechanism 4800 to correspond to the dollar charge designated by the code perforations in said positions.

Punch positions 40 to 43, inclusive, designate the tenths of a dollar charge and, through the operation of the control circuits responsive to the pneumatics in these punch positions, cause the setting of the tenths of a dollar wheel mechanism 4810 to correspond to the tenths of a dollar charge designated by the code perforations in said positions.

Punch positions 44 to 47, inclusive, designate the "cents" charge. In this case, however, only the 0 and the 5 setting is necessary since, as already mentioned, toll calls are only charged for in five cent increments. Hence, the pneumatics responsive to the perforations in these positions respond to the 0 or 5 code, each response grounding conductor 4901 and 4902, respectively, for setting the "cents" wheel 4900 either to the 0 or to the 5 position. The pneumatics for positions 44 to 47, inclusive, do not carry contacts adapted to operate multi-contact relays. The contact assemblies required to close the necessary circuits are only three in number, well within the lifting power of each of the pneumatics and, therefore, the contact assemblies are connected directly to the moving members of the bellows. It will be obvious, of course, that relays could be provided if desired.

As already mentioned, the mechanism for printing the total charges is driven by the three separate gears controlled by the wheels 4800, 4810 and 4900, respectively. This mechanism may take the form of a separate type wheel of similar construction to the wheels shown and, of necessity, will take the same setting as each of the separate wheels which are positioned for a particular toll charge. These printing wheels may, in turn, be geared to a group of integrating printing wheels which will be positioned successively to add up the charge of each additional toll call as the record thereof causes a new setting of the wheels which control them. When the entire record has been analyzed and a record of the individual toll items made, the total toll charges may be printed from the setting of the integrating wheels through a control which may be exercised by relay 5344, as suggested hereinafter.

It should be noted, however, that if the assumed call is completed within the local area there will be no perforations on the tape between positions 36 to 47 and also none in the other previously discussed positions relating to the called office code and number as well as none in positions 48 to 58, inclusive, to be discussed presently, which contain the code perforations of the date when the call was made. In fact, the perforations of a local call record are only those which may be contained between positions 59 to 64, and having to do with the codes of the charges in local service units since these codes are the only perforations made on the secondary tape for a local call.

Punch positions 48 to 51, inclusive, designate the code of the month in which the call was made. The electro-mechanical equipment made responsive to the pneumatic operations is the same as that previously described for any of the digits of the called number except that the wheel 5000 carries twelve indications on its periphery, one for each month of the year, while the commutator 5001 is correspondingly divided into twelve segments with a conductor connected to each segment, each of which conductors is extended through the appropriate combination of the multi-contact relays responding to the pneumatics which, in turn, operate in the combinations called for by the four-unit code as shown in Table IX.

In the case assumed in which the call to Halifax 3678 was made on July 17, holes were punched in positions 48 and 51 in response to the code for this month whereupon the corresponding pneumatics and multi-contact relays operate and ground conductor 5005 which, by operations corresponding to those previously described, causes the wheel 5000 to stop when the designation "July" on its periphery has been revolved to the sight position. Gear 5004 revolves with wheel 5000 to set the printer type to correspond with the month designated by the setting of the wheel 5000, while the operation of relay 5003 to stop the wheel from further rotation, advances the printer control path from conductor 4903 to conductor 5002.

Perforations made between punch positions 52 to 58, inclusive, designate the day of the month on which the call was made; punch positions 52 to 54, inclusive, designating the tens subdivision thereof, and punch position 55 to 58, the units subdivision. In this case, however, the mechanism shown in Fig. 51 comprises a number wheel 5100, a tens commutator 5101, with its distributor brush 5103, and a units commutator 5102 with its distributor brush 5104, the brushes 5103 and 5104 and wheel 5100 being connected by sleeve 5126 which is normally loose on shaft 4308. The tens commutator is divided into three segments, one for each tens subdivision of the month, and the units commutator

into thirty-one segments, one for each day of the month. The first segment of the tens commutator has a circular length equal to that of the first tens subdivisions of the units commutator, the second segment a circular length equal to the second tens subdivisions, while the third segment has a circular segment equal to the last eleven subdivisions. To the first segment extends conductor 5115 connecting with a contact on relay 5116, to the second extends conductor 5117 connecting with a contact on relay 5107 and to the third extends conductors 5118 connecting with a contact on relay 5119.

Now, the call Halifax 3678 was assumed to have been made on the seventeenth day of the month and the code perforations which designate this date consist of a hole in position 53, one in position 55 and a third in position 58. Consequently, when the perforations of the call record are aligned over the tracker bar openings, pneumatics 5129, 5105 and 5106 operate and cause the obvious operation of relays 5107, 5108 and 5109, respectively, which lock over their respective No. 1 contact-sets to battery on conductor 4328. Over their No. 2 contact-sets, ground is applied to conductor 5110 which causes a circuit to be closed from ground on said conductor, winding of relay 5111, back contact of relay 5112, winding of clutch magnet 5113 to battery on conductor 4328. Relay 5111 and clutch magnet 5113 operate, the former locking through a circuit including its contact and the latter throwing the clutch disk into engagement with the numerical wheel 5100 causing the latter to revolve with the shaft 4308. As the wheel revolves, distributor brushes 5103 and 5104 advance over their respective commutators. Since, however, a circuit over one of the conductors which are connected to the separate segments of commutator 5102 can only be completed by the application of ground to conductor 5120 which is done through the operation of relay 5114, distributor brush 5104 can only be effective in completing the circuit of relay 5112 if relay 5114 is operated. The circuit of relay 5114, however, is completed only when the distributor brush 5103 has revolved to the beginning of that segment which has battery connected to it. For instance, the call being illustrated, having been made on the seventeenth and relay 5107 having been operated in consequence of the perforation of the code of the tens subdivision of the mouth, battery is connected to conductor 5117. Hence, while the distributor brush 5103 is on the first segment, that is, while distributor brush 5104 is on any one of the first ten segments of its own commutator, relay 5114 remains normal. When, however, the shaft rotates sleeve 5126 to the point where distributor brush 5103 makes contact with the second segment, at which time distributor brush 5104 makes contact with segment 11, a circuit is closed from ground through the winding of relay 5114, commutator ring 5119, distributor brush 5103, second segment of commutator 5101, conductor 5117, No. 3 contact set of relay 5107 to battery. Relay 5114, operates, locks over its right contact to battery on conductor 4328 while over its left contact it connects ground to conductor 5120. As, now, the shaft continues revolving and distributor arm 5104 advances to segment 17, a circuit is completed from battery through the winding of relay 5112, commutator ring 5121, distributor brush 5104, conductor 5122, alternate contact of the No. 6 contact-set of relay 5108, normal contact of the No. 5 contact set of relay 5127, the normal contact of the No. 4 contact set of relay 5123, the alternate contact of the No. 3 contact set of relay 5109, conductor 5120, to ground on the left contact of relay 5114. Relay 5112 operates, extends the printer control path from conductor 5002 to conductor 5124, opens the circuit of magnet 5113 which releases and throws the clutch disk out of engagement with the wheel 5100 thereby causing it to come to rest with the numeral 17 on the periphery of the wheel in the sight position. Gear 5125, in the meanwhile, has rotated with wheel 5100 to set the corresponding printing mechanism for printing the numeral 17.

This concludes the setting of the tabulator for items which are printed as a part of a toll call, consisting of the called office code, the numerical designation of the called line, the toll charge in dollars and cents and the date on which the call was made.

As already mentioned, the operation of relay 5112 closes another contact of the printer control path extending the path to conductor 5124. This conductor terminates in one contact 5348 of a switch 5349 corresponding to contacts designated 53 and 54 in Fig. 36 of said patent, Re. 16,304 to Lake, above referred to. When these contacts are closed the circuit is completed to the printer control from terminal T of the printer control cross-connected to terminal T at the contact of relay 4325, thence extended by the operation of relays such as 4325, as previously described, through the series circuit above described extending to conductor 5124, contacts 5348 and 5349 to the other side of said printer control of Fig. 53. The printing apparatus of the tabulator, having been set in accordance with the setting of the wheels, the printing circuit is now operated to cause the various items to be printed in accordance with the indicator wheel and printer settings. At the end of one revolution, cam 4331 open contacts 4326 which removes ground from conductor 4328 unlocking thereby all the relays locked thereto in preparation for the re-setting of the wheels for the next call.

In case the perforated record of a call is that of a local call, then there are no perforations whatever in any of the punch positions between 1 to 58, inclusive. The only perforations present in the record in this case are those between positions 59 to 64, inclusive, which is the record, in code form, of the number of local charge units to be assessed for the call. In such an event the only part of the tabulator which is responsive to the perforated record, is the integrating local charge computer, diagrammatically illustrated in Figs. 52 and 53.

In order to describe the operation of the integrating computing mechanism which is responsive to the code of a local charge and which further integrates all the local charges appearing on one secondary tape, it will be assumed that the call Halifax 3678 represents a local call for which a charge of eight local service units is to be made, as already explained in the description of the rate computator of the analyzer. Further, in order to understand the arrangement of the computing mechanism, it is desirable first of all to indicate briefly what functions are to be accomplished by said mechanism.

According to the most prevalent telephone charging and billing practice with respect to what are known as message rate subscribers, telephone rates in large metropolitan areas are computed on the basis of an allowable defined maximum number of local calls for a given billing period

and for a stipulated minimum charge. Beyond that defined number of local calls, the remaining local service charges are computed at a rate per unit which diminishes with the total units used. For instance, subscribers may be given a maximum of sixty-five calls a month for a certain monthly charge, say, of $4.00 a month. The next one hundred calls may be charged at the rate of five cents each, the next hundred after that at four and one-half cents, the next hundred at four cents and next hundred at three and one-half cents. Therefore, the integrating mechanism of the printing tabulator which controls the associated printing apparatus for printing total local charges for a billing period, must be responsive to the several discriminations in the rate structure. Hence, the computing mechanism disclosed in this specification for adaptation to the commercial printing tabulator is arranged to (1) add up a required number of local charges which correspond to the number allowed over the billing period for the contracted minimum billing charge and eliminate them from any further consideration since the charge for these calls is, presumably, otherwise taken care of in a manner such as hereinafter described; (2) add up the required number of calls beyond the allowed maximum, compute the charge at the prescribed rate for each given number and cause the printing mechanism to print the total charges computed at the different rates.

Referring now to Figs. 52 and 53, it will be seen that there are five commutators, viz. 5214, 5222, 5223, and 5234. To the segments of commutator 5214 are connected the marking conductors which extend to the contacts of relays 5205, 5249, 5250 and 5251, controlled by the pneumatics responsive to the units digit code perforations of the total charge. The ground to any of these conductors is controlled through the left back contact of relay 5301 by way of conductor 5300 and is further controlled over the contacts of the relays above-mentioned so that when these relays operate either singly or in combination in response to a units code of the local charges, ground is extended to any one of the conductors. The wiring organization of the pneumatically controlled units multi-contact relays is identical with that of the pneumatically controlled relays shown in Fig. 45 and, therefore, is not shown in detail. Commutator 5223 is the tens commutator. Since, in the present embodiment of the invention, the rate structure assumed limits the maximum number of local charges for the longest local call to 14, there is but one conductor extending from the tens pneumatically responsive multi-contact relays, through the back contacts of relay 5301 to the number 1 segment of commutator 5223.

In this connection it will be observed that two punch positions, 59 and 60 on the tracker-bar, are reserved for the tens designation of the local charges, and two pneumatics, 5202 and 5203, are provided to respond to corresponding perforations in the tape. However, inasmuch as the disclosure of the present embodiment of the invention is predicated upon the assumption that the total of local charge units for any one call is fourteen, it is only necessary, as described later, to provide but one signal to indicate the difference between a call having less than ten charge units and one having more than ten. A perforation in position 59, for instance, indicates that the total of charge units for the call is less than ten, while a perforation in position 60 indicates that the total of charge units is more than ten but less than twenty. Should it be necessary to modify the mechanism to indicate a greater number of charges, say more than twenty but less than thirty, both perforations could be utilized to give this indication and the pneumatic equipment responding thereto and the electromechanical equipment controlled thereby could easily be modified to provide a corresponding control of the call recording apparatus, whose number of revolutions, in registering the total call units for any call, depends, of course, upon the maximum total for which the equipment is designed. In the description which follows, therefore, no use is made of pneumatic 5202 which operates when the total charged units are less than ten but pneumatic 5203 is utilized when it responds to a perforation in position 60 to indicate total charge units of more than ten but less than twenty. The perforations in position 59 and the equipment responding thereto have been disclosed in the present embodiment of the invention to show the ease with which the invention may be modified and expanded to include a record of as many local charge units as desired, it being evident that position 59 can be combined with position 60 and with other positions, if necessary, to give the record of the number of charges.

Commutator 5222 is but a feeding mechanism and its relation to the rest of the computing apparatus will become apparent from the description of the operation which follows.

Assume, first, that the number of local charge units to be assessed for the call is eight. Since the total of these charges is less than ten, pneumatic 5202 is operated in punch position 59 although as already explained it performs no useful function. The units pneumatics 5253 and 5248 operate in response to the code perforations in punch positions 62 and 63, respectively, for the units digit 8, causing thereby the operation of relays 5250 and 5249 which lock to battery on conductor 4328 in the same manner as the operation and locking of previously described pneumatically responsive multi-contact relays. Therefore, a path is extended from ground on the left back contacts of relay 5301, conductor 5300, through a normal contact of relay 5205, alternate contacts of relays 5249 and 5250 and a normal contact of relay 5251, conductor 5206 to segment 8 of commutator 5214. In the meanwhile, the operation of relays 5249 and 5250 further closes a circuit from ground on contacts 5310 which are controlled by cam 5308 keyed to the main shaft 4308 and timed to close contacts 5310 at the beginning of the revolution and open them at the end, left contact of relay 5309, conductor 5313, contacts of relay 5249 and 5250, conductor 5312, right outer back contact of relay 5301, back contact of relay 5311, conductor 5314, winding of start magnet 5213 to battery. Now commutators 5214 and 5222 are fixed but their respective distributor brushes 5215 and 5220 which occupy relatively similar positions on their respective commutators, are keyed to the shaft 5219, which further engages with main shaft 4308 through friction clutch 5218. Shaft 5219 also carries gear 5216 which is permanently meshed with gear 5217 and gear 5255 through which rotation is imparted to gear 5256, having unity gear teeth ratio with gear 5255. Gear 5256, on the other hand, is mounted on an auxiliary shaft with gear 5257 which meshes with gear 5258 that drives gear 5226 through the clutch

mechanism 5225. The gear teeth ratio between gears 5257 and 5258 is 11 to 10 to insure that gear 5226 makes one complete revolution in the time taken by distributor brush 5215 to complete ten-elevenths of a revolution for the purpose hereinafter set forth. When, therefore, magnet 5213 operates by the closure of the above circuit and the stop controlled thereby is raised, the shaft 5219 is freed to be driven by the friction clutch 5218. Both distributor brushes begin to revolve with the shaft 5219 away from their normal segments while gear 5216 also revolves and causes the rotation of gear 5217. However, the rotation of gear 5217 performs no useful function at this time. Also, when the distributor brush 5215 has been rotated from its normal segment, distributor brush 5220 will have also been rotated from its normal segment so that a circuit closed for relay 5311 from battery through the winding of said relay, conductor 5315, outer ring of commutator 5222, distributor brush 5220 to ground. Relay 5311 operates and over its inner front contact connects shunting ground to one terminal of the winding of relay 5301. When distributor brush 5220 reaches its normal position the shunt is removed, causing relay 5301 to operate in series with relay 5311 and to perform functions noted hereinafter. Relay 5311 also prepares a locking path for relay 5319 which operates as hereinafter described. At its left contact relay 5311 opens the feed control circuit to arrest the advance of the record tape until the record of the toll call has been tabulated. At its right outer back contact relay 5311 opens the circuit of start magnet 5213 thereby causing the release of said magnet which is then in a position to re-engage the stop latch of shaft 5219 at the end of one revolution of main shaft 4308. When the distributor brush 5215 reaches segment 8, the ground connected thereto over conductor 5206 completes a circuit through the distributor brush and commutator feed, winding of clutch magnet 5237 to battery, and in parallel therewith over conductor 5227, winding of relay 5319 to battery. Relay 5319 operates and locks over the right back contact of relay 5309 to ground thus locking magnet 5237 in its operated position. Magnet 5237 causes the disks of clutch 5225 to engage. Gear 5226 is keyed to the same shaft as the right disk of clutch 5225 and when the two clutch disks are coupled thereby and impart rotation to the shaft which carries gear 5226, said gear rotates by virtue of the rotation of shaft 5219 through gears 5255, 5256, 5257 and 5258 and causes the rotation of gear 5228 which is permanently meshed with it. Gear 5226, being now mechanically coupled to shaft 5219 now revolves in unison with the distributor brushes 5214 aud 5220.

It will be observed that distributor brush 5215 revolves past two segments of the commutator before it contacts with segment 8, and that after passing this segment, ground is removed from the circuit of clutch magnet 5237. The magnet, however, does not release since, at this time, it being held over the ground that locks relay 5319, the disks of clutch 5225 remaining engaged and gear 6226 because of the ratio between gears 5257 and 5258 making eight-tenths of a revolution by the time the distributor brush 5215 has rotated past segment 1.

It is to be noted that when gear wheel 5226 makes one complete revolution for every complete revolution of the distributor brushes 5215 and 5220, gear wheel 5228 which has a reduction gear ratio with respect to gear wheel 5226, will make one-tenth of a revolution equaling one-tenth of the monthly local calls allotted for the stipulated monthly rate. For instance, if the number of local charges allowed per month were to be 100 then the ratio of gear 5228 to gear 5226 would be 10 to 1. Hence, if the call being registered represents a charge of eight local service units, gear 5226 revolves eight-tenths of a revolution and gear 5228 revolves eight one-hundredths of a revolution in the registration of the eight call charges.

When the distributor brush 5220 has completed one revolution and is again resting on its normal segment, the short circuit around the winding of relay 5301 is removed, causing said relay to operate in series with relay 5311. At its left contact relay 5301 closes an obvious circuit for relay 5309 which opens the locking circuit of relay 5319 and that of clutch magnet 5237 whereupon said magnet releases and disengages the clutch 5225, causing both gears 5226 and 5228 to remain in the position to which they were thus advanced. Relay 5309 also opens the locking circuit of relay 5311 and the circuit of relay 5301 causing both of said relays to release. Relay 5311 upon releasing again causes the tape record to advance.

In the meanwhile, when the main shaft 4308 completes one revolution, cam 5308 causes contacts 5318 to open, thereby removing ground from the contacts of relay 4309, thus restoring to normal whatever apparatus was locked thereto while cam 4331 causes contacts 4326 to open, thereby disconnecting battery from conductor 4328. The removal of battery from conductor 4328 further unlocks relays 5249 and 5250 which release. The entire mechanism is now normal with the exception of gear 5228 which remains in the position to which it has been rotated in evidence of the registration of the eight local charges for the particular call.

It will now be assumed that the call which is to be registered contains ten or more local unit charges, say fourteen, as would be the case, for instance, in a connection between two offices for which the base rate is fifteen cents for five minutes, the overtime rate is five cents for each additional two minutes or fraction thereof and that the conversation has lasted twenty-seven minutes. In this case the units pneumatic 5204 operates in response to the perforation in punch position 64 of the units digit code and further operates relay 5205 which closes the previously traced circuit for start magnet 5213 for starting the rotation of shaft 5219. As soon as commutator brush 5220 moves off normal, relay 5311 operates as before and locks through the winding of relay 5301 to ground at the right back contact of relay 5309 after which brush 5220 leaves the off-normal segment as pointed out before. Relay 5301 being shunted does not operate. When the commutator brush 5215 engages segment 4 of commutator 5214 with units relay 5205 operated, relay 5319 and magnet 5237 operate in parallel as before and during the remainder of the first revolution of shaft 5219', gear 5228 is advanced four one-hundredths of a revolution. Relay 5311 upon operating opens the initial operating circuit of start magnet 5213 but this magnet does not release in this case because of an alternative operating circuit to be presently described. Relay 5311 at its left contact has also opened the circuit of feed control 5307 to arrest the further advance of the tape record so that the

operated pneumatics are maintained operated to hold their respective relays operated, in the present case relays 5205 and 5609.

In the meantime, pneumatic 5203 which operated at the same time as pneumatic 5204 under the assumption that the number of charges to be made is more than ten, has caused the operation and locking of relay 5209. Relay 5209 upon operating closed a circuit extending from ground over its inner contact, conductor 5207 inner back contact of relay 5301, conductor 5316, winding of clutch magnet 5252 to battery, and in parallel therewith, through the back contact of relay 5327 and winding of relay 5328 to battery. Relay 5328 operates and closes a supplementary circuit for start magnet 5213 over conductor 5314, the right contact of relay 5328, outer right back contact of relay 5301, conductor 5312 to ground over a contact of relay 5205. Relay 5328 at its left contact closes a supplemental shunt around the winding of relay 5301 which is effective to hold relay 5301 unoperated when brush 5220 reaches normal, this circuit extending from ground over brush 5220, normal segment 5221 of commutator 5222, conductor 5320, left contact of relay 5328, inner front contact of relay 5311, winding of relay 5301 to ground at the right back contact of relay 5309. Thus, on a call involving more than ten charge units, relay 5328 is effective to prevent the stopping of shaft 5219 at the end of its first revolution and to prevent the operation of relay 5301 which would otherwise operate at the end of the first revolution to release clutch magnet 5237. Shaft 5219, therefore, continues to rotate through a second complete revolution, driving gear wheel 5228 an additional ten one-hundredths of a revolution.

At the time relay 5328 operated in response to the operation of tens relay 5209, clutch magnet 5252 operated in parallel therewith over conductor 5316, moving clutch disk 5235, slidably keyed to auxiliary shaft 5208, into engagement with gear wheel 5217. Thus, during the first revolution of shaft 5219 as previously described, shaft 5208 is also rotated and rotates distributor brush 5224 over the segments of commutator 5223. Since the gear ratio between gear 5216 on driving shaft 5219 and gear 5217 is assumed to be 1 to 10, the distributor brush 5224 makes one-tenth of a revolution during the first revolution of shaft 5219 and will have been positioned on the No. 1 segment of commutator 5223 at the time the distributor brush 5220 on shaft 5219 moves off the normal segment 5221 at the beginning of the second revolution of shaft 5219. Consequently with tens relay 5209 operated, a circuit is closed from battery, winding of relay 5327, conductor 5210, distributor brush 5224 and the No. 1 segment of commutator 5223, lower front contact of relay 5209, conductor 5317, middle right back contact of relay 5301, conductor 5229, off-normal segment of commutator 5222 and brush 5220 to ground. Relay 5327 operates and locks itself in parallel with the winding of clutch magnet 5252 over the inner right back contact of relay 5301, conductor 5207 to ground at the inner front contact of relay 5209 and, at its back contact, opens the circuit of relay 5328. Relay 5328 upon releasing releases start magnet 5213 in order to stop the rotation of shaft 5219 when it has completed its second revolution and opens at its left contact one shunt around the winding of relay 5301. When the shaft 5219 has completed its second revolution and the remaining shunt for relay 5301 over conductor 5315 is removed at the time when distributor brush 5220 reaches its normal position, relay 5301 operates, releasing relay 5327 and clutch magnet 5252. Relay 5301 at its left contact closes the circuit of relay 5309 which operates thereby releasing relays 5319, 5301 and 5311 and clutch magnet 5237. Relay 5301 upon releasing releases relay 5309. When relay 5311 releases, the feed control 5307 again operates to advance the tape record whereby an unperforated portion of the record is brought over the openings of the tracker bar. Since the shaft cam 4331 opens the contacts 4326 at the time when the shafts 4308 and 5219 have completed their second revolution, the operated pneumatically controlled relays 5205 and 5209 now release. When clutch magnet 5252 releases, the distributor brush 5224 is moved back to normal position by a torsion spring, one end of which is attached to the auxiliary shaft 5208 and the other end to the frame of the mechanism and which spring was tensioned during the advance movement of brush 5224. The mechanism is now in condition to be reoperated in accordance with the record of the next succeeding call on the record tape.

The gear wheel 5228 has thus been advanced four one-hundredths of a revolution during the first revolution of shaft 5219' and ten one-hundredths of a revolution during the second revolution of shaft 5219' or a total of fourteen one-hundredths of a revolution indicative of fourteen call unit charges for the local call just considered. It remains in this advanced position following the release of clutch magnet 5237.

Having described the operation of the computing machanism for the registration of the total local service units for one call we will now proceed to describe its further operation with respect to the registration and integration of call charges beyond the maximum allowed and at a diminishing rate which increases with the number of units.

Let it be assumed that the rate structure allows a subscriber 100 calls for the regular monthly charge, an additional 100 calls at the rate of five cents each, the next 100 calls at four and one-half cents, the next 100 calls at four cents and the next 100 calls after that at three and one-half cents. The integrating gear 5228, as already indicated, is calculated to make one revolution for the maximum number of calls allowed for the monthly rate. This gear is keyed to a shaft on which is also keyed the gear 5232. Gear 5232 is, in turn, meshed with a larger gear 5233 which, in accordance with the rate structure assumed, bears the ratio of 5 to 1 with the gear 5232. The gear 5233 is keyed to a shaft carrying distributor brush 5236 which contacts with a commutator 5234 having as many segments as there are different rates. For the rate structure assumed there would be five segments including a segment for the fixed charge rate cared for in the monthly charge contract.

To the shaft which carries gear 5226 there is slidably connected one member of a clutch 5245 controlled through clutch magnet 5244 which is capable of engaging shaft 5211 with shaft 5219. The shaft 5211 is arranged to drive a group of call units counters 5260 capable of adding up to 10,000, gear 5254 meshing with gear 5212, and gear 5342 meshing with gear 5329 the latter two gears having a unity ratio. Gear 5329 is keyed to shaft 5326 on which are also slidably keyed clutch disks 5333, 5352, 5353 and 5354. These clutch disks may be engaged, respectively, with gears 5334, 5335, 5336 and 5337 loosely

mounted on shaft 5326 through the operation of the respective clutch magnets 5331, 5341, 5347 and 5343 to drive the integrating gears 5321, 5322, 5323 and 5324 keyed to shaft 5355. Shaft 5355 also drives the money charge counters 5340 and positions the printing mechanism through the rotation of gear 5318 in mesh with gear 5325.

If it be assumed that throughout one billing period a number of local calls are made which, so far as the total charge is concerned, can be represented as the equivalent of 500 local service charge units, then these calls are all recorded on the secondary tape. When the tape is run through the tabulator, all these local charge units are recorded in the computer mechanism in the manner described above; that is, by the operation of the gears 5226 and 5216, respectively, and the integrating gear 5228. As this last mentioned gear revolves in adding successive local charges, gear 5232 which is carried by the same shaft, causes gear 5233 also to revolve one-fifth of a revolution for each revolution of gear 5232 and hence for one revolution of gear 5228. But one revolution of gear 5232 is the equivalent of ten revolutions of gear 5226 which latter, in turn, revolves ten times in response to 100 local service units. It has been further assumed that 100 local service units is the maximum number of calls allowed the subscriber for the contracted monthly charge. Hence, when gear 5228 has completed one revolution, the contracted 100 local service units have been properly counted and gear 5233 has been advanced one-fifth of a revolution. Since these calls do not enter into the printing of that part of the bill which is controlled by the tabulator, neither the call units 5260 nor the money charge counters 5340 are in any way affected.

When gear 5228 completes the one revolution by which the contracted local service units are counted and gear 5233 has rotated one-fifth of a revolution, its associated distributor brush 5236 will have left the normal segment and will be making contact with its commutator segment 5230. A circuit is now completed for relay 5330 from ground over distributor brush 5236, segment 5230, conductor 5212, winding of relay 5330 to battery. Relay 5330 operates, locks to ground on contacts 5365 which are closed until the record tape has been entirely fed through and further closes a circuit from battery through the winding of clutch magnet 5331, back contacts of relay 5332, right outer contact of relay 5330 to ground at contacts 5365. Through its inner right contact, relay 5330 extends the circuit of the gear clutch magnet 5237 in parallel with the winding of magnet 5244. This magnet engages the clutch 5245 to couple shaft 5211 for rotation with shaft 5219. Hence, after the contracted local charges for the month are properly counted, the charges to be entered in the computing mechanism thereafter will cause magnet 5244 to operate in parallel with magnet 5237 to engage clutch 5245 and cause thereby the rotation of the call units counters 5260 through shaft 5211 in the well known manner to count up all local charge units beyond the contracted number. Through gear 5212, the printing counters are simultaneously set. The revolution of shaft 5211 also causes the rotation of the various rate gears as described hereinafter.

It will be remembered that the 100 local charges immediately following the maximum monthly allowance are assumed to be at the rate of five cents each. That is, when gear 5228 has completed one revolution the charge rate changes and actual computations begin in the computing mechanism. It will be further recalled that the circuit of magnet 5244, controlling the clutch mechanism 5245 and that of magnet 5331 controlling clutch 5333, have been closed as already described. Consequently, when clutch 5245 couples shaft 5211 to shaft 5219', gear 5242, through gear 5328, revolves shaft 5326 and the coupling of clutch disk 5333 with its cooperating gear 5334 causes the rotation of gear 5321. Gear 5334 bears a ratio of 5 to 10 with its driven gear 5321 so that each revolution of the latter is the equivalent of twenty calls at five cents each. Since the money charge counters 5340 are driven by shaft 5255, it follows that at each revolution of gear 5321 the right outside wheel is rotated one complete revolution to register one dollar. With five revolutions for counting the total of 100 calls, the total charge registered will be five dollars, each revolution of the outside wheel being recorded by the advance of the middle wheel through the intermediate gear shown between the two wheels to record one dollar, and each revolution of the middle wheel being recorded by the advance of the left outside wheel through the intermediate gear shown between the last two mentioned wheels to record ten dollars. Through gears 5318 and 5325 the printing type mechanism which may be of the same type construction as mechanism 5340 except that the numerical characters on the peripheries of its wheels are raised to permit an inking device to ink the surfaces of said characters for printing purposes is correspondingly set.

When 100 calls at the five cents rate have been thus recorded, gear 5228 will have made another revolution and gear 5233 will have advanced another fifth of a revolution. But the second advance of this gear will have brought its distributor arm 5236 in contact with segment 5238, and a circuit is closed from ground on said segment, winding of relay 5332 to battery. Relay 5332 operates, locks to ground at contacts 5365 and, over its right front contact further closes a circuit from ground at contacts 5365, right outer contact of relay 5330, right front contact of relay 5332, right back contact of relay 5339, winding of magnet 5341 to battery. Relay 5332 also opens the previously traced circuit for magnet 5331 which releases. Magnet 5341 operates and throws in its cooperating clutch disk 5352 to engage gear wheel 5335 whose ratio with its driven gear 5322 is 4½ to 10. This indicates that the local service units which have been charged at five cents per unit have been exhausted and that the rate is to be changed. Since gear 5335 bears a 4½ to 10 ratio with its gear 5322, then one revolution of gear 5335, which represents the registration of ten charge units, will have caused nine-tenths of a revolution of gear 5322. But since one revolution of gear 5334 causes an advance of the money charging counters 5340 involving, a rotation equivalent to fifty cents, then one revolution of gear 5335, likewise representing ten charge units, will cause a corresponding advance of said counters add forty-five cents to the total.

Ten revolutions of the gear 5226, one revolution of gear 5228, another fifth of a revolution of gear 5233 and the ten consequent revolutions of gear 5335 marks the full registration of 100 call charge units at four and one-half cents per unit causing the wheels of money charge counters 5340 to register an additional charge of four dollars and fifty cents or a total of nine dollars

and fifty cents and causes a corresponding setting of the printing type mechanism to print this amount, while the 100 calls at this rate are counted on call units counters 5260 in the same manner as the previous 100 calls at five cents were counted thereon. Hence, when the distributor brush 5236 has advanced to segment 5239 which occurs on the third full revolution of gear 5228, a circuit is closed from ground on segment 5239, winding of relay 5339 to battery. Relay 5339 operates, locks to ground on contacts 5365 opens the circuit of magnet 5341 and closes that of magnet 5347 by way of ground at contact 5365, right outer front contact of relay 5330, front contacts of relays 5332 and 5339, back contact of relay 5338, winding of magnet 5347 to battery. Magnet 5347 upon operating engages clutch disk 5353 with gear 5336 so that upon the advance of the tape to record the next group of 100 calls, gear 5336 is revolved. This gear has a 4 to 10 ratio to the gear 5323. Each revolution of the shaft 5211, in response to the addition of ten local charge units, causes gear 5336 to make one revolution and gear 5323 to make four-tenths of a revolution causing thereby a corresponding advance of the charge counters of money charge counters 5340 to add forty cents to the total for each ten call charge units and a corresponding setting of the printer type mechanism. When the additional 100 call units have been received and caused thereby the operation of the computing mechanism as already described, gear 5228 will have made one revolution, gear 5233 will have been advanced one-fifth of a revolution, the call unit counters 5260 will indicate a total of 300 calls, the money charge counters 5340 will indicate a total charge of thirteen dollars and fifty cents and the printing type mechanism, controlled through clutch 5225 will be set to print this amount.

Following the recording of the first 300 call units, the distributor brush 5236 will make contact with segment 5247 whereupon a circuit is completed from ground on said commutator segment, distributor brush 5236, winding of relay 5338 to battery. Relay 5338 operates, locks to ground at contacts 5365, opens the circuit of magnet 5347 and closes the circuit of magnet 5343 extending from ground at contacts 5365, right outer contact of relay 5330, front contacts of relays 5332, 5339 and 5338, winding of magnet 5343 to battery. Magnet 5343 operates and causes the engagement of clutch disk 5354 with the gear 5337 meshed to gear 5324. This gear 5337 has a ratio of 3½ to 10 with respect to gear 5324. Consequently, one revolution of gear 5337 which registers a receipt of ten local charge units, causes thirty-five one-hundredths of a revolution of gear 5324 and a similar rotation of the money charge counters 5340, which will advance to register thirty-five cents for the registration of each of the ten local charge units. For 100 calls at this rate, the money charge counters 5340 adds three dollars and fifty cents. At this time, call unit counters 5260 will indicate 400 calls, the money charge counters 5340 will indicate a total charge of seventeen dollars and the printing type mechanism will have been set to print this amount. Distributor brush 5236 will now rest on its normal segment again.

The information thus prepared for the printing mechanism by the computing tabulator through gears 5254 and 5212, will, set the printing mechanism to print 400 as the total number of calls made in excess of the 100 calls allowed at the flat rate as indicated by call unit counters 5260 and to print a total charge of seventeen dollars therefor as indicated by money charge counters 5340.

The mechanism of the computing tabulator as disclosed has been arranged, of course, as illustrating the principle by which the gearing and controlling circuits can be arranged for a specific rate structure and bulk billing discounts. When the number of local charge units exceeds 400 beyond the contracted number of such units for a given monthly period and lower rates are to be furnished for additional calls, it is believed that the principle of the arrangement of the computing tabulator as above described will easily furnish one skilled in the art with the means of expanding the equipment and modifying the controlling circuits to accord with further and additional rates.

The setting of the printing mechanism through gears 5254, 5212 and 5318, 5325 has been briefly indicated but may be accomplished by any suitable means. Thus the printing mechanism may itself comprise a number of printing wheels of similar construction to the number and letter wheels illustrated in the various figures of the drawings and further shown in Fig. 1 of Patent 1,881,585 and set substantially in the manner shown therein except for the difference in motive power. Being rotated by the gears mentioned, they will take an identical setting with said wheels when positioned in the manner described. That portion of the printing mechanism which is set to print the number of total charge units and the total amount of these charges may be, as said before, of similar construction to the call units counters 5260 and the money charge counters 5340, respectively.

At the termination of the record analysis, manual switch 5349 is operated. This serves to close the circuit of those printing magnets which cooperate with the group of printing wheels controlled by gear 5212 and the group controlled by gear 5325, which then operate to print the totals recorded on each of said groups of wheels, the former being a record of the total number of local charge units, in excess of the units allowed at the base rate, accumulated throughout the billing period at the different rates, and the latter being the total money charge for said units. When the printing is accomplished switch 5349 is again depressed against its lower contact in readiness to record individual toll calls of another record tape.

When the entire tape has been run through, contacts 5355 open releasing relays 5330, 5332, 5338 and 5339, furnish a totalizing signal by any suitable means for operating relay 5344. Relay 5344 operates and closes contacts to the totalizing and printing equipment control of the tabulator (not shown) to (1) add and print the total money charges on the toll slip which contains the itemized list of toll calls and their associated money charges as previously described, and (2) to print the total calls as indicated on call units counters 5260 and the money charges as indicated on money charge counters 5340 on the regular monthly bill including the prescribed charges which may be recorded on the printing wheels as an original setting thereof.

It will be recalled that the secondary tape 4301 which is passed through the tabulator mechanism has preliminary perforations therein indicative of the calling line directory number and that these perforations were made therein as a result of the passage of a master record through

the analyzer. Thus, prior to the operation of the tabulator mechanism in response to the perforations in the secondary tape appertaining to toll or local calls, the pneumatics in punch positions 16 to 35 operate in accordance with the preliminary perforations relating to the calling line directory number to cause the type mechanism of the tabulator to be set, in the same manner as previously described in connection with the setting of the printing mechanism in connection with called line numbers for printing on the bill the calling line directory number.

What is claimed is:

1. In a telephone system, a calling line, a called line, means for identifying said calling line, means for establishing a talking connection between said lines, said means including other means for discriminating between a timed and an untimed connection, timing and registering circuits operably associable with said talking connection, means in said timing and registering circuits responsive to said discriminating means when indicating a timed connection for registering the duration of said talking connection, a tape recorder, and means responsive to the termination of said connection for operably associating said tape recorder with said calling and called line identifying means and said timing and registering circuits for simultaneously recording said calling and called line identifications and the duration of said talking connection.

2. In a telephone system, a calling line equipped with a dial, called lines, means responsive to impulses from said dial for establishing local and toll connections between said calling line and said called lines, said means including other means for discriminating between local and toll connections, a registering circuit for making a registration of the designation of each of a plurality of connections comprising means for the connection thereof with said calling line, registers responsive to said impulses, means responsive to said discriminating means for making a registration of said toll connections, and means responsive to said discriminating means for disconnecting said registering circuit from said calling line if said discriminating means indicates a local connection.

3. In a telephone system, a calling line equipped with a dial, a called line, a tape recorder, means for identifying said calling line, a switching trunk, a first register associable with said trunk, a register sender, a second register associable with said trunk for registering the duration of a connection, means responsive to the initiation of a call from said calling line for connecting said trunk to said line, means for connecting said register sender to said calling line through said trunk, means in said sender for registering the code impulses of said called line designation, means in said first register simultaneously responsive with said impulse responsive means in said sender for registering therein the impulse code of the called line designation, a translator associated with said sender responsive to said code impulse registration in said sender for controlling the establishment of a talking connection between said calling line and said called line, said talking connection including said trunk, means in said translator for determining the character of said talking connection from said impulse code registration, and means responsive thereto on one character of talking connection for connecting said tape recorder to said first register, to said second register and to said calling line identifying means for simultaneously recording in said tape recorder said calling and said called line designations and the duration of said connection.

4. In a telephone system, a calling line, a called line, impulse responsive means for establishing a connection between said calling and said called lines, said impulse responsive means comprising a translator capable of determining whether a connection to be established is local or toll, a registering mechanism comprising an impulse circuit capable of being serially connected with said first mentioned impulse responsive means, registers responsive to said impulse circuit of said registering mechanism for registering the series of impulses designating said called line, means responsive to said translator for disconnecting said registering mechanism if said connection is local, a tape recording mechanism for recording the calling and called line designations, and means responsive to said translator for connecting said registering mechanism to said tape recording mechanism if said connection is other than local.

5. In a telephone system for 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, a plurality of registers responsive to the establishment of said connection for registering the designation of said wanted line and the duration of said connection, a plurality of other means for registering the date of said connection, a recording mechanism comprising a controllable impressible medium, means responsive to the termination of said connection for operably associating said mechanism with all of said registers and said calling line identifying means, and means responsive to the operation of said identifying means and to the setting of all of said registers for simultaneously recording on said medium the designation of said calling line and the designation settings of all of said registers.

6. In a telephone system for automatic billing of connections, a calling line, a called line, means for registering the designations of said lines, means for establishing a connection between said lines, means associated with said connection for registering the duration of said connection, tape recording means, including a controllable tape, means responsive to the termination of said connection for operably associating said tape recording means with all of said registering means, and a group of punch magnets operatively responsive to the setting of all of said registers for simultaneously perforating in said tape a plu- calling line, the designation of said called line rality of holes to record the designation of said and the duration of said connection.

7. In a telephone system for automatic billing of connections, a group of lines divided into a plurality of sub-groups, means for identifying each of said lines, called lines, means for establishing a plurality of connections between the calling lines in the several sub-groups and said called lines, registers operably associated with each of said connections for recording the respective called line designations and the respective duration of each of said connections, other registers for recording the date of each of said connections, a recording mechanism common to said group of lines, and an allotter circuit responsive to the termination of each of said talking connections for operably associating said recording mechanism in succession with each group

registers correlated with a terminated connection for recording the calling and called line designations and the date and duration of each of the appertaining connections.

8. In a telephone system for automatic billing of connections, a group of lines, another line, a recording mechanism common to said group of lines, means for establishing a connection between one of said lines in said group and said other line, registers associated with said connection for registering the designation of said other line and the duration of said connection, and an allotter circuit responsive to the initiation of the disestablishment of said connection for operably associating said recording mechanism with said registers for recording said other line designation and the duration of said connection as recorded on said registers.

9. In a telephone system for automatic billing of connections, means for establishing a plurality of telephonic connections, a group of registers associated with each of a number of established connections, means for setting up on each of said group of registers a registration of the calling and called line designations and the duration of a particular connection, means for setting up on other registering means a registration of the date of each of said connections, and a recording mechanism comprising means for connecting said mechanism with one of said group of registers associated with an established connection, a tape, a tape magnet for advancing said tape, a plurality of punch magnets connectible with said registers and responsive to the various settings thereof for simultaneously operating said magnets to perforate holes through said tape for recording by means of said holes the settings of said registers, means responsive to the operation of said magnets for operating said tape magnet, and means responsive to the release of said punch magnets for releasing said tape magnet to advance said tape.

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