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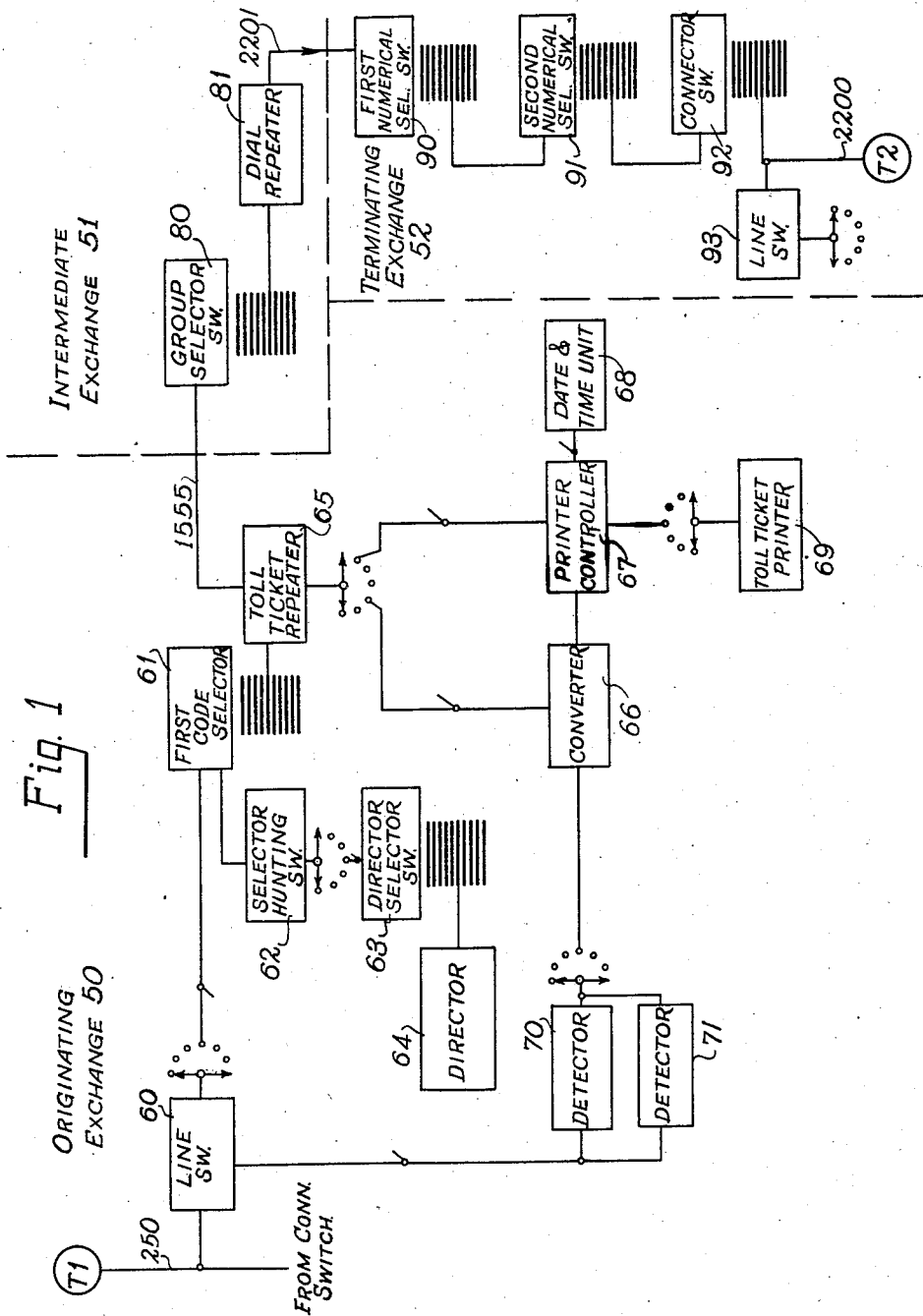
J. E. OSTLINE

2,297,365

TELEPHONE SYSTEM

Filed July 8, 1939

23 Sheets-Sheet 1



INVENTOR.
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BY *Davis, Lindsey, Smith & Shonts*

ATTORNEYS

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TELEPHONE SYSTEM

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23 Sheets-Sheet 2

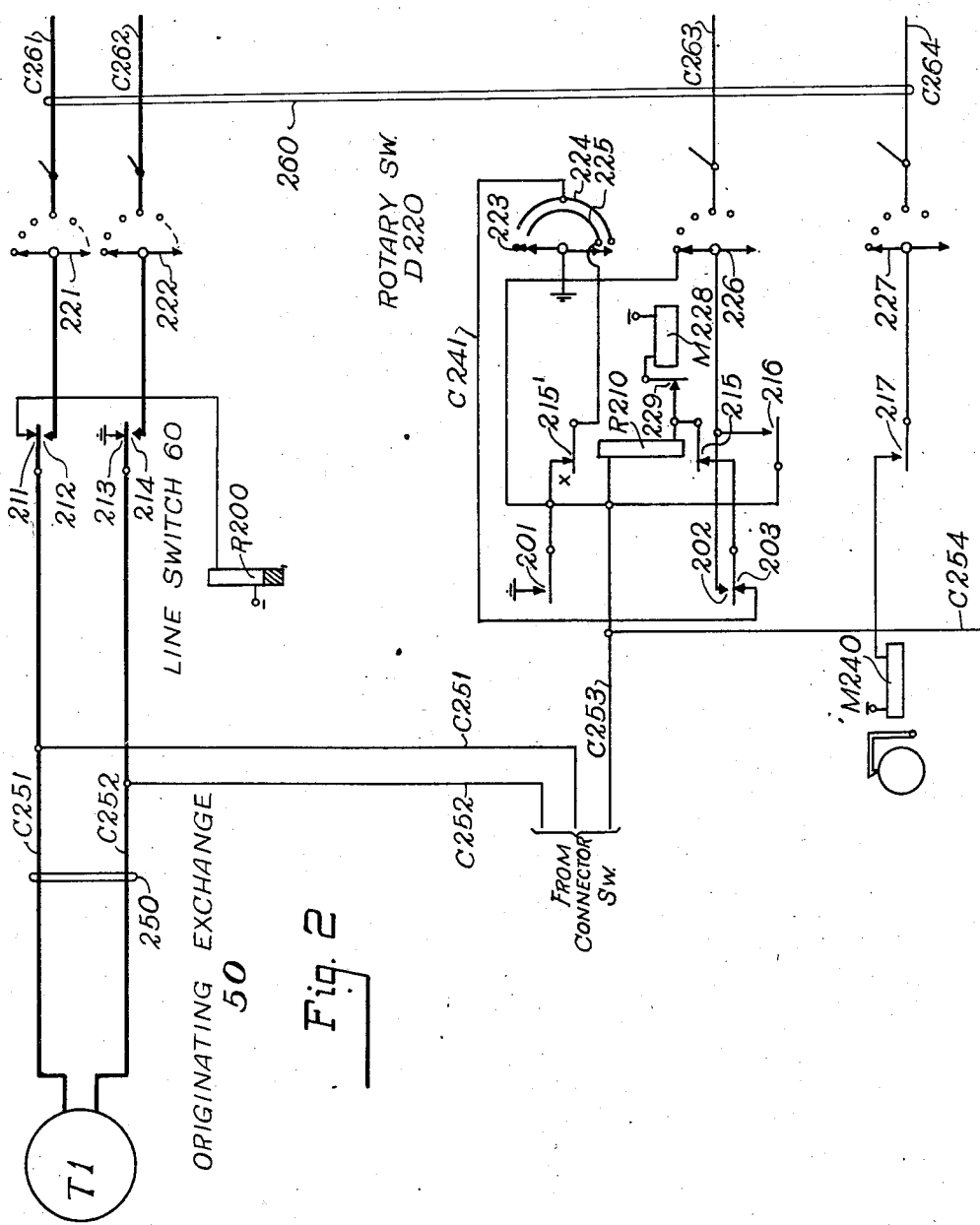


Fig. 2

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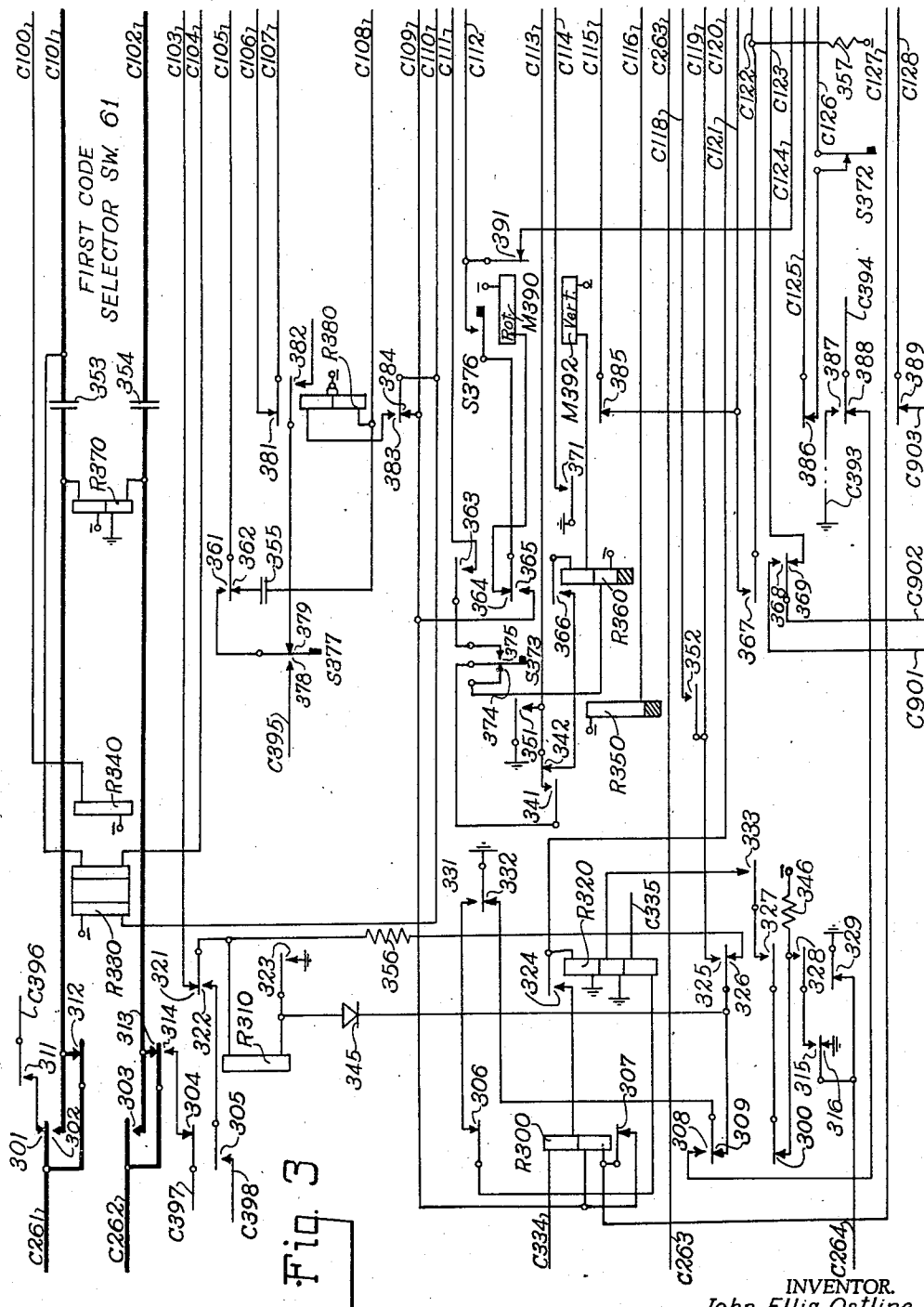
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23 Sheets-Sheet 3



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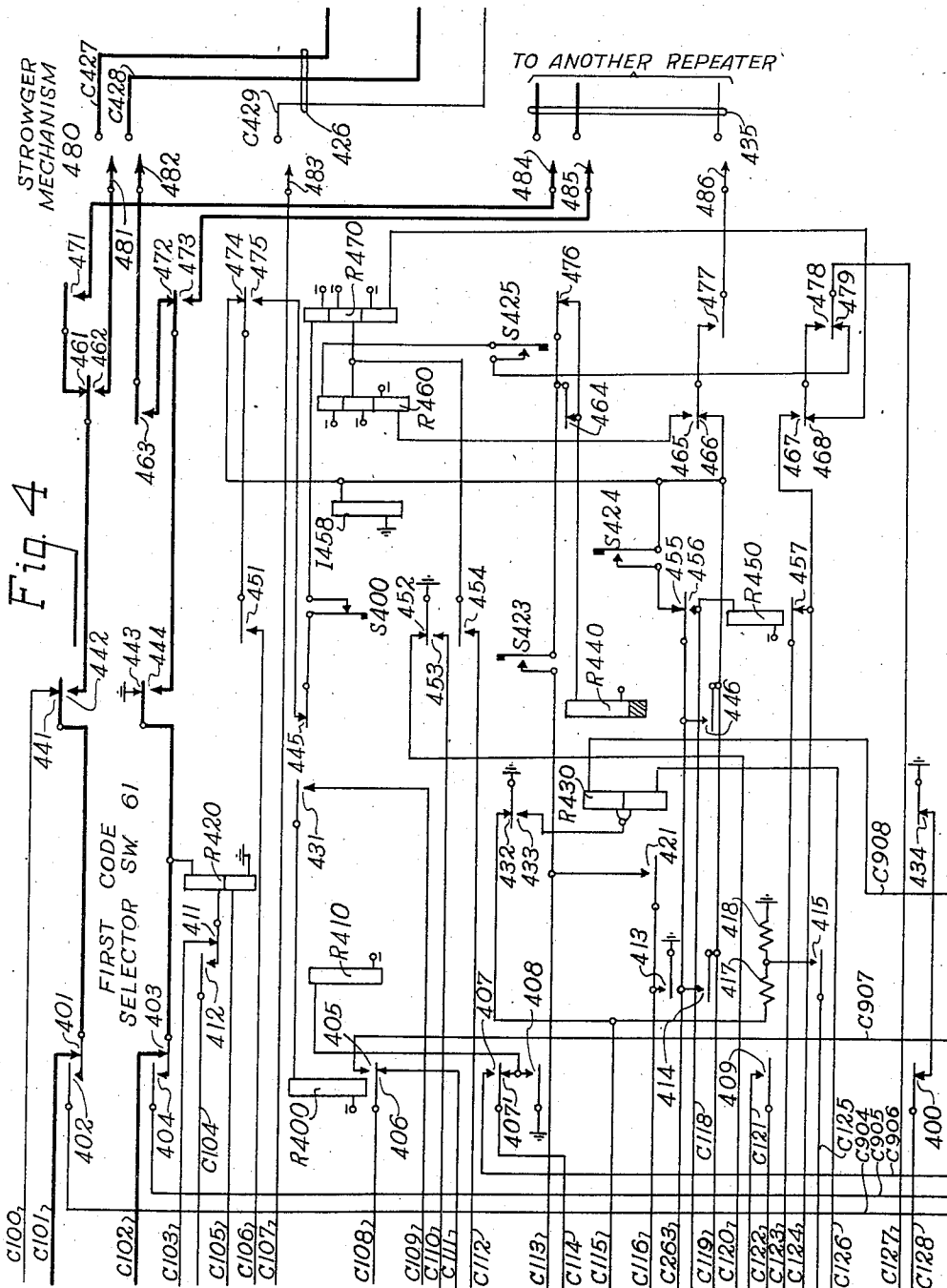
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23 Sheets-Sheet 4



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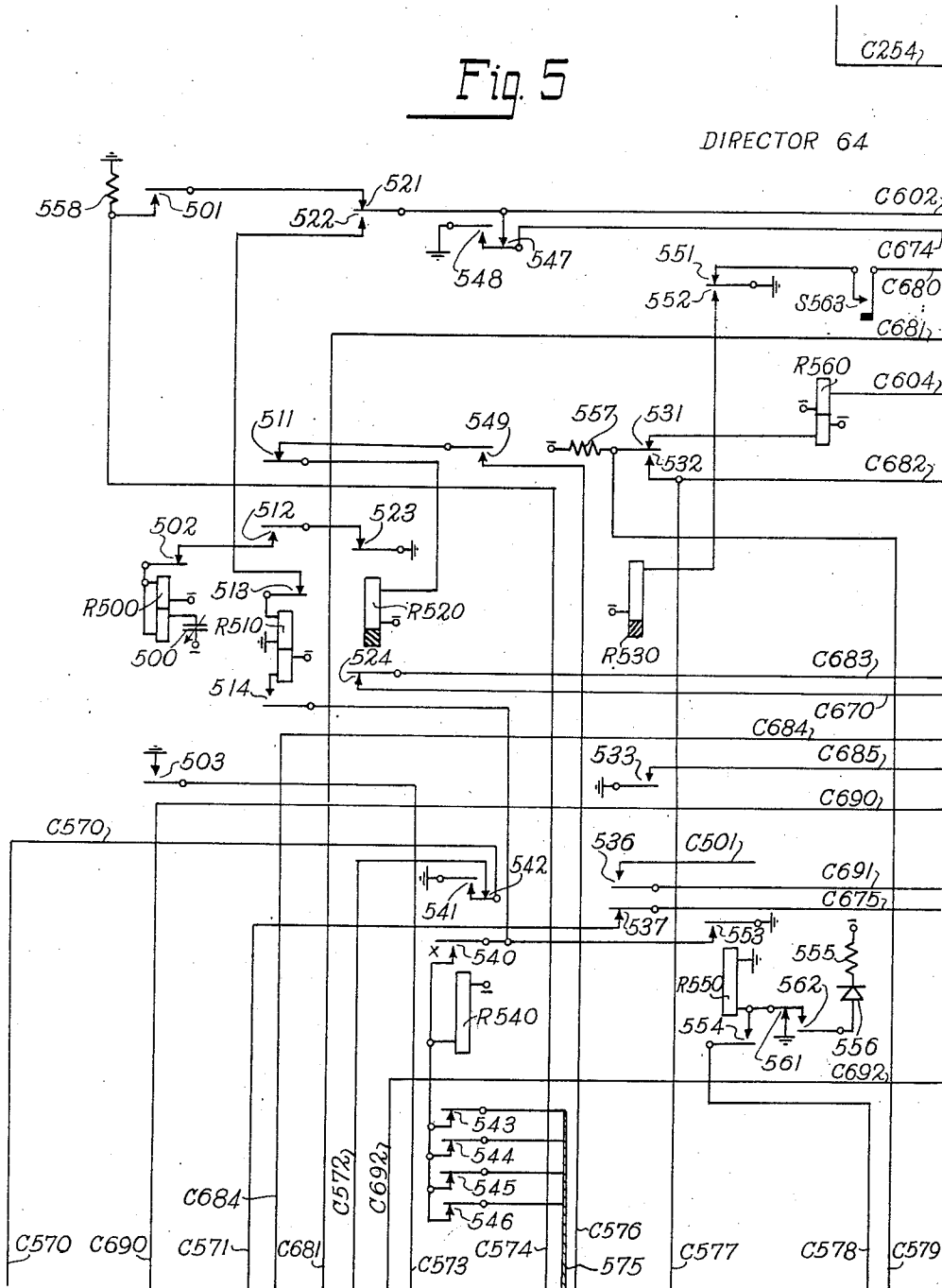
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Fig. 5



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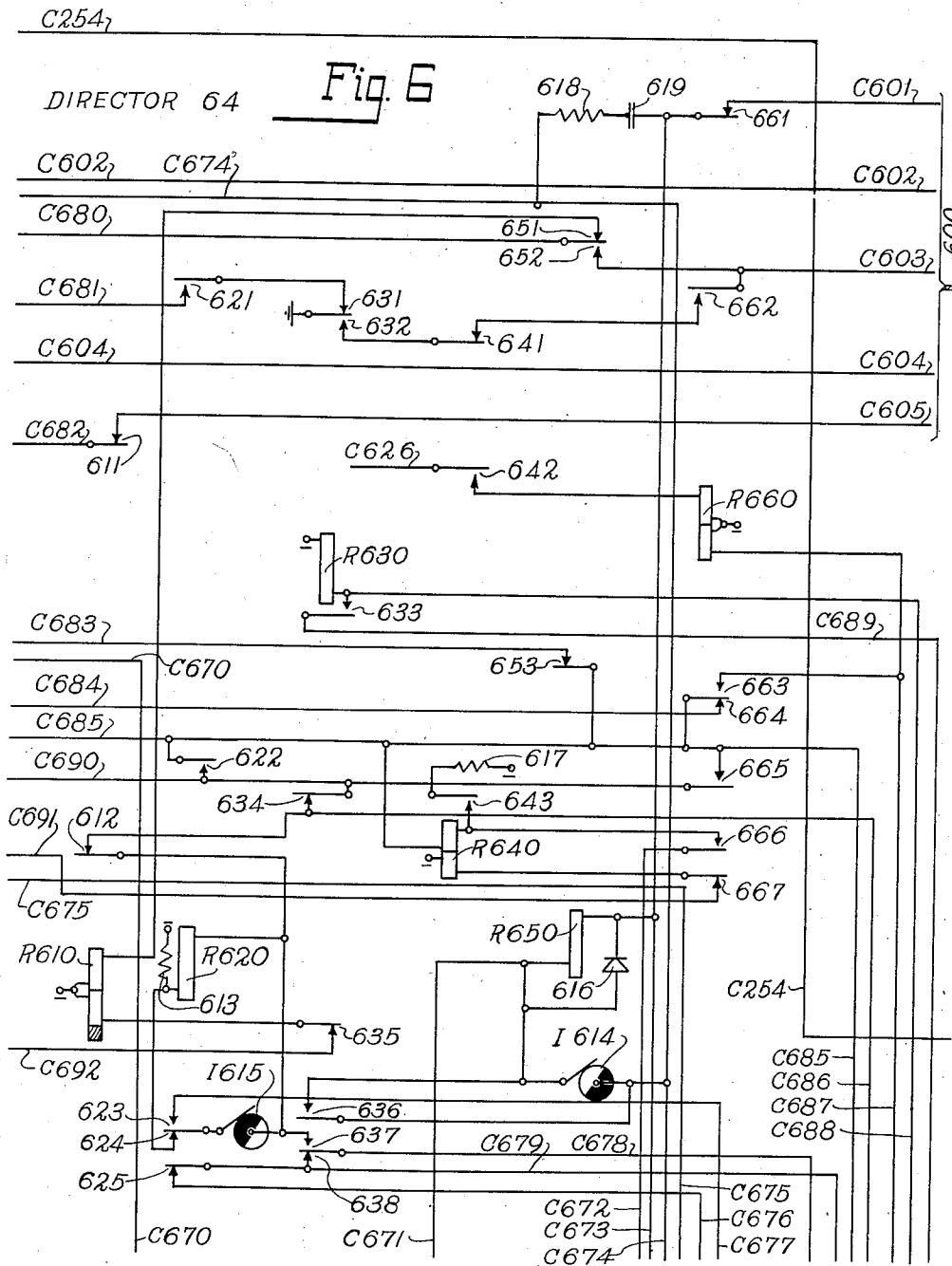
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23 Sheets-Sheet 6



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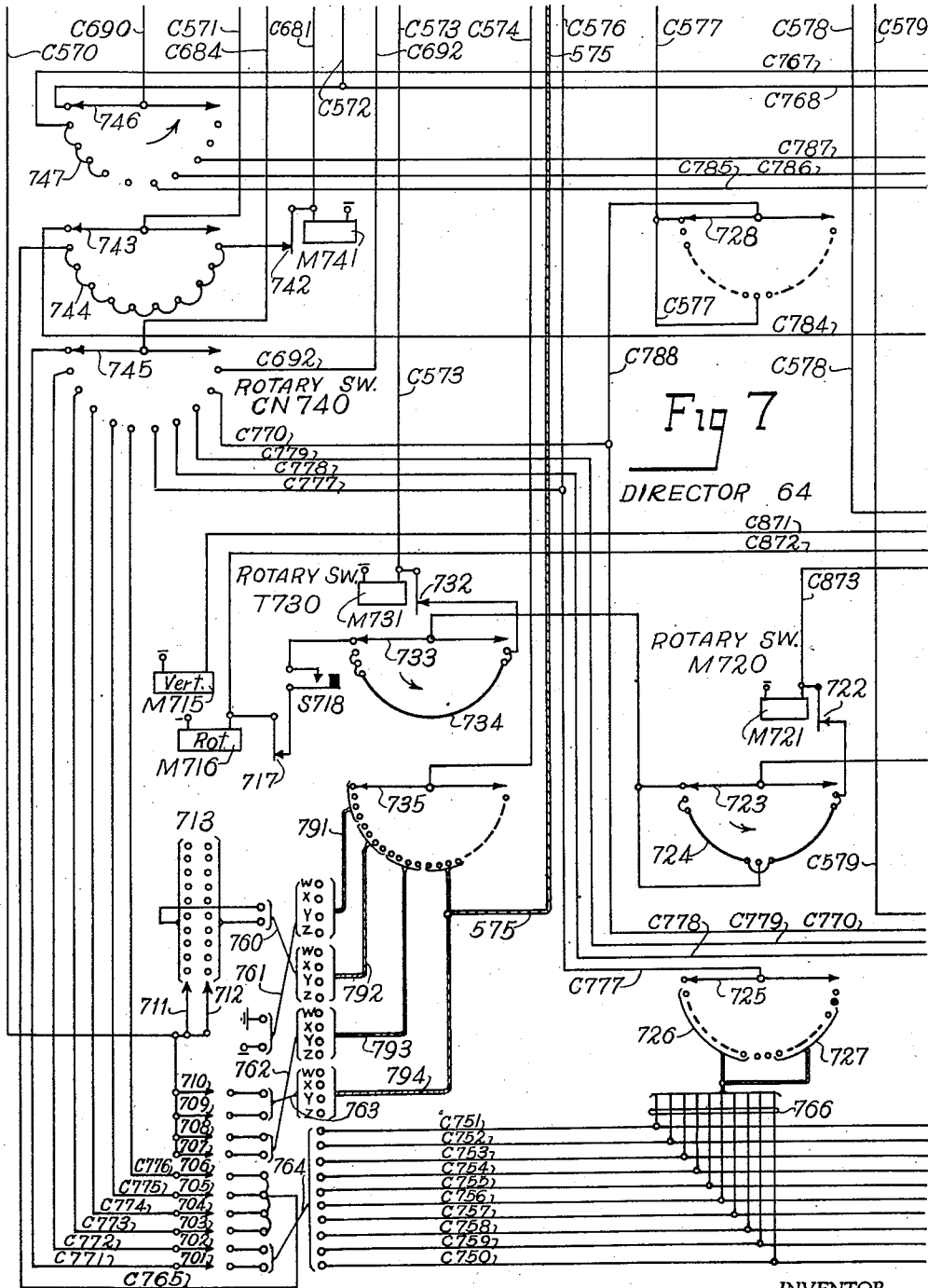
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STROWER JUMPER
MECHANISM FIELD
700 714

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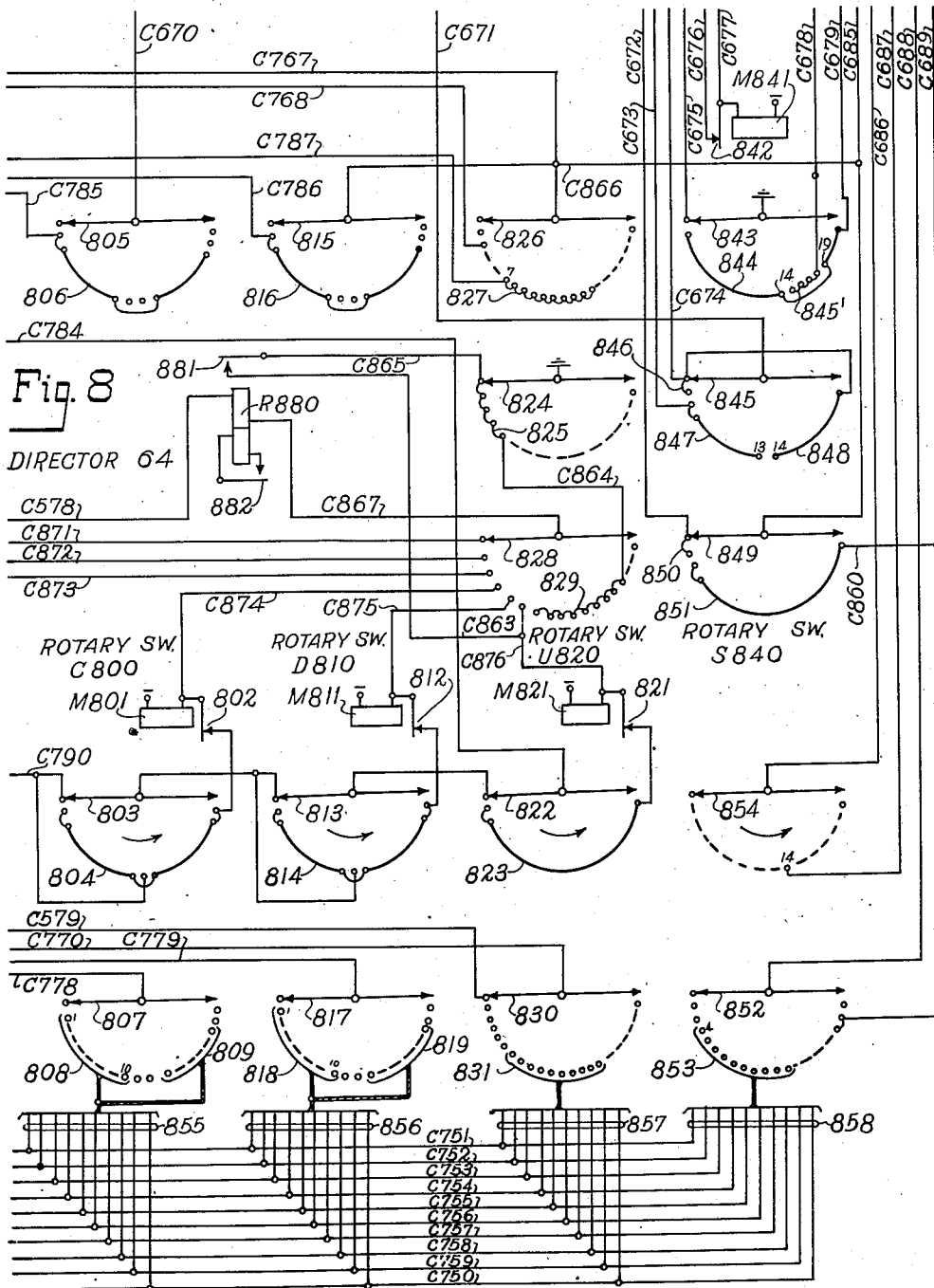
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TELEPHONE SYSTEM

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23 Sheets-Sheet 8



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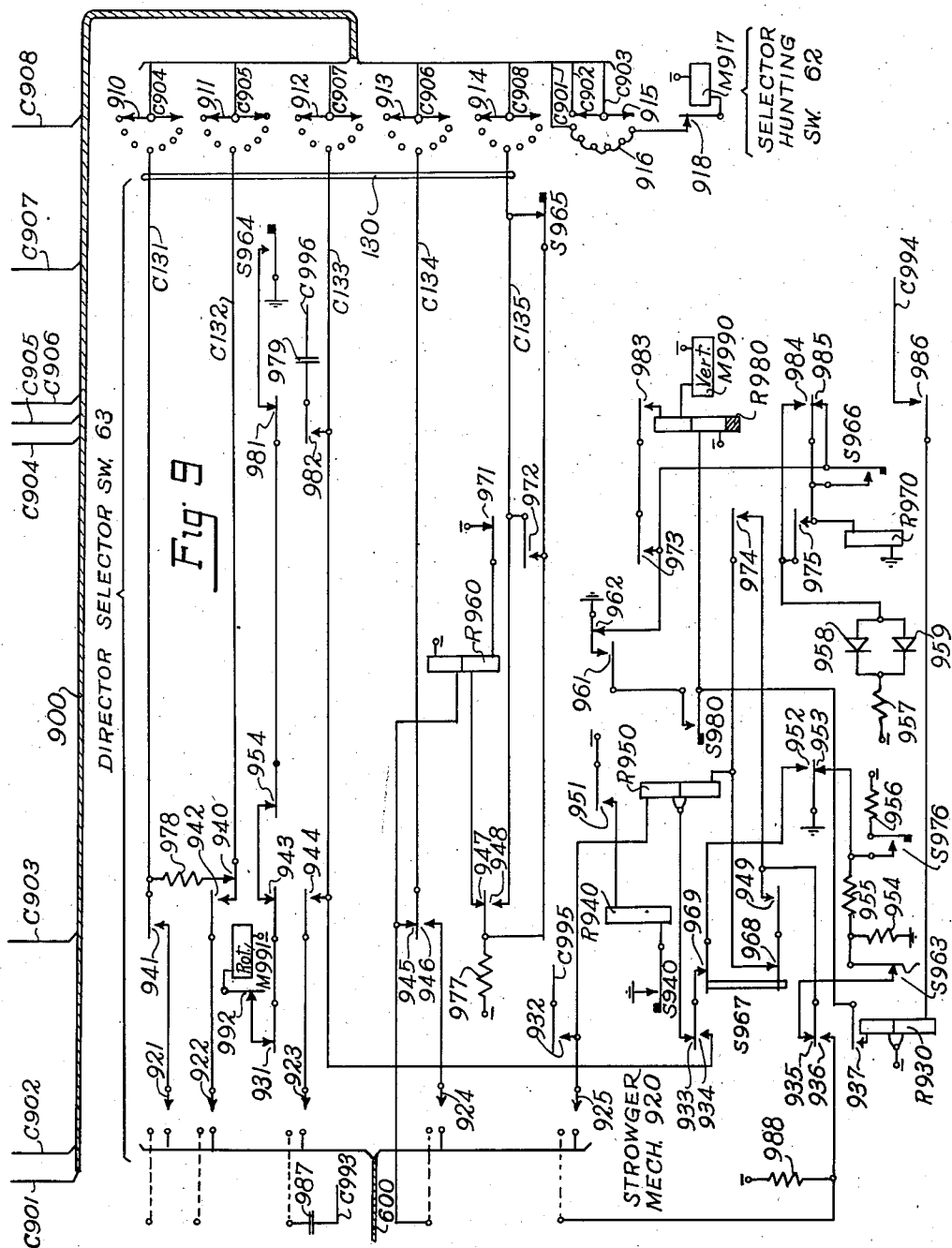
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TELEPHONE SYSTEM

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23 Sheets-Sheet 9



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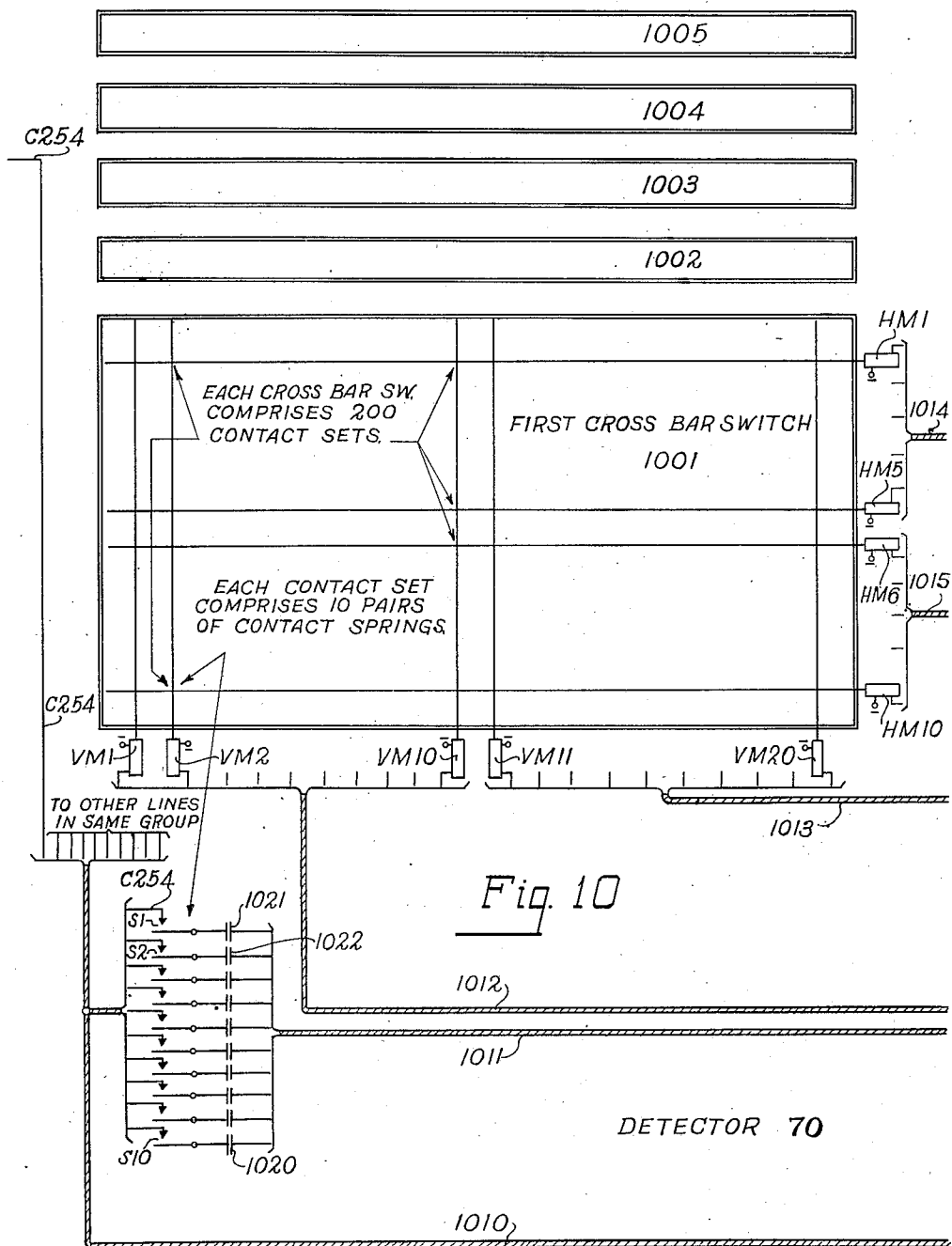
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TELEPHONE SYSTEM

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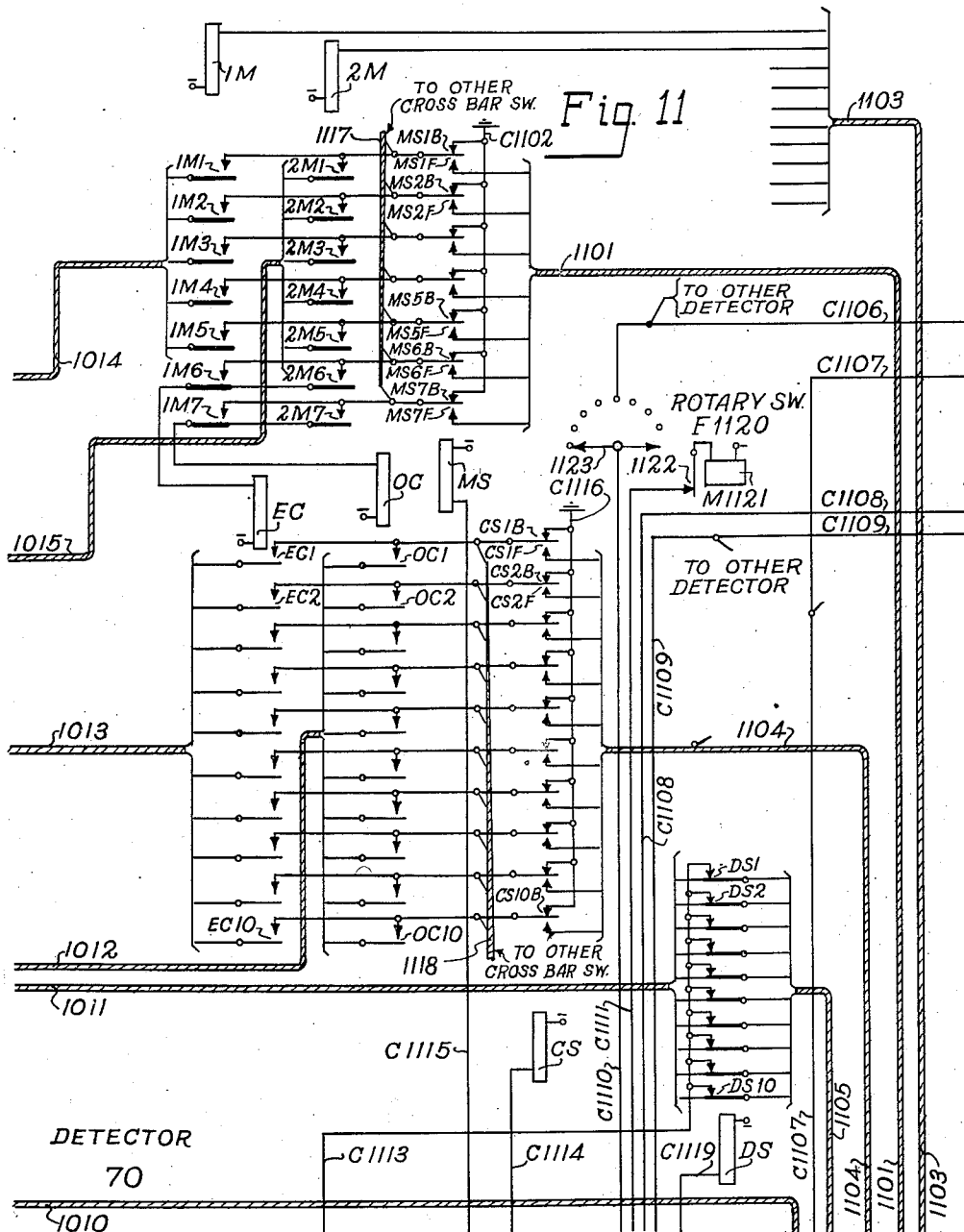
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CROSS BAR SW. CONTROL NETWORK

1100



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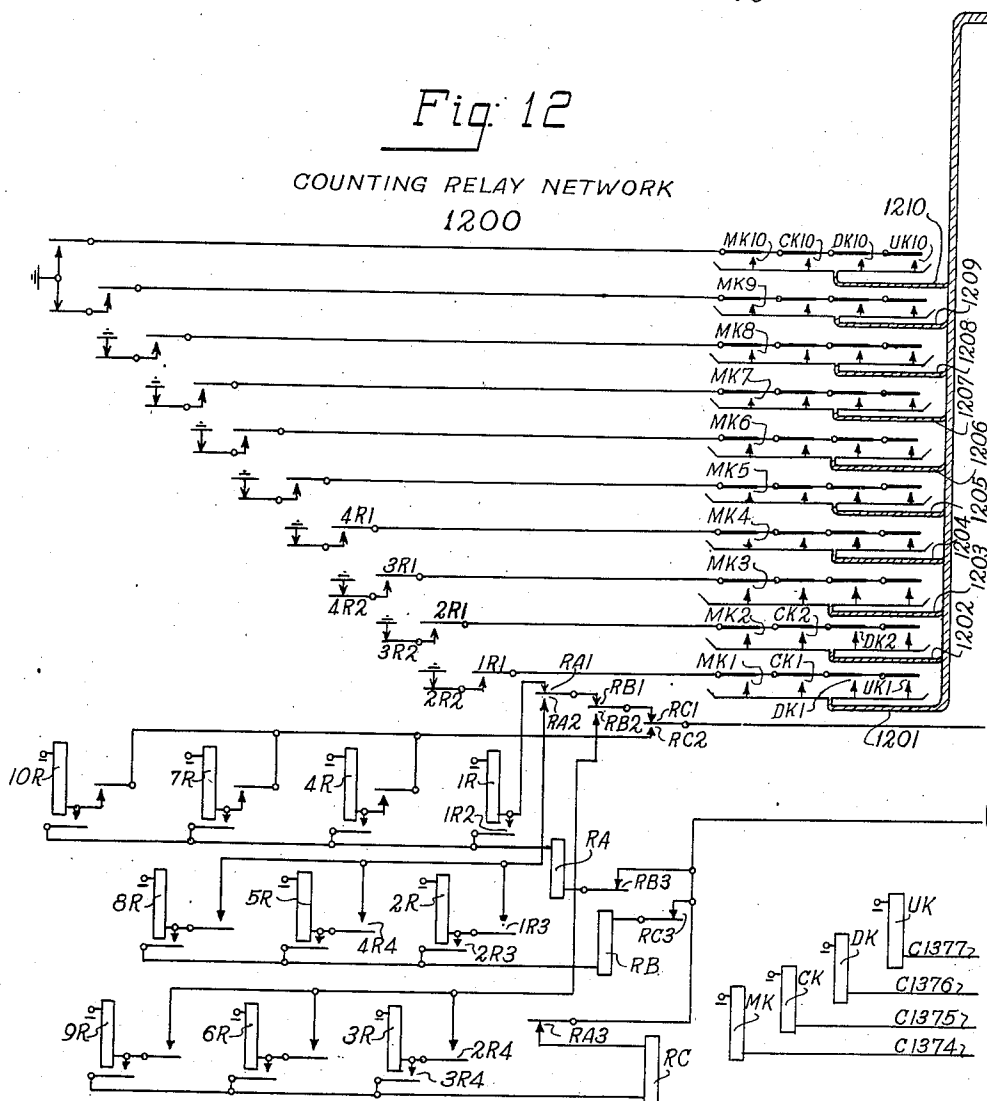
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DETECTOR
70

Fig. 12

COUNTING RELAY NETWORK
1200



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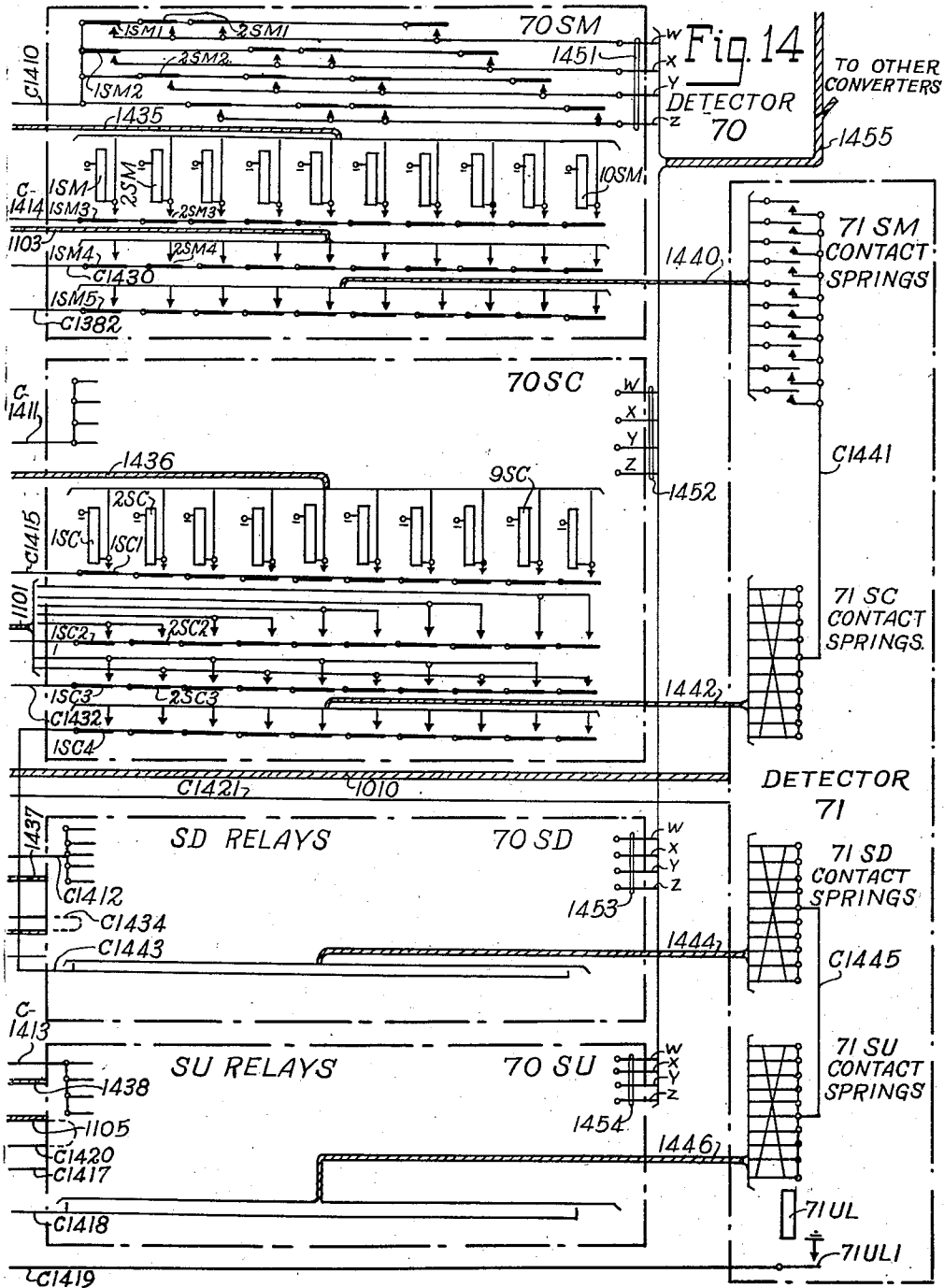
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TELEPHONE SYSTEM

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23 Sheets-Sheet 14



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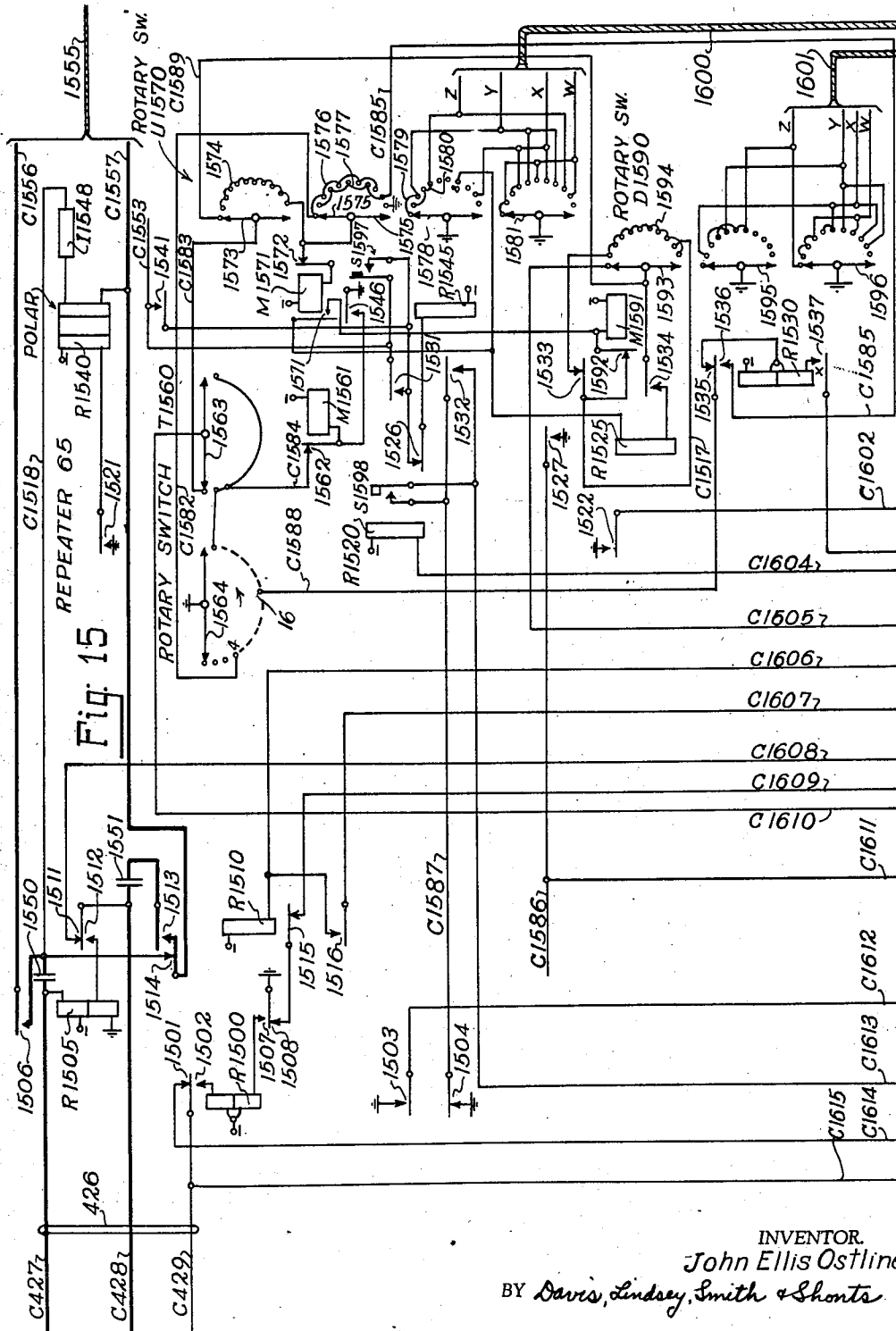
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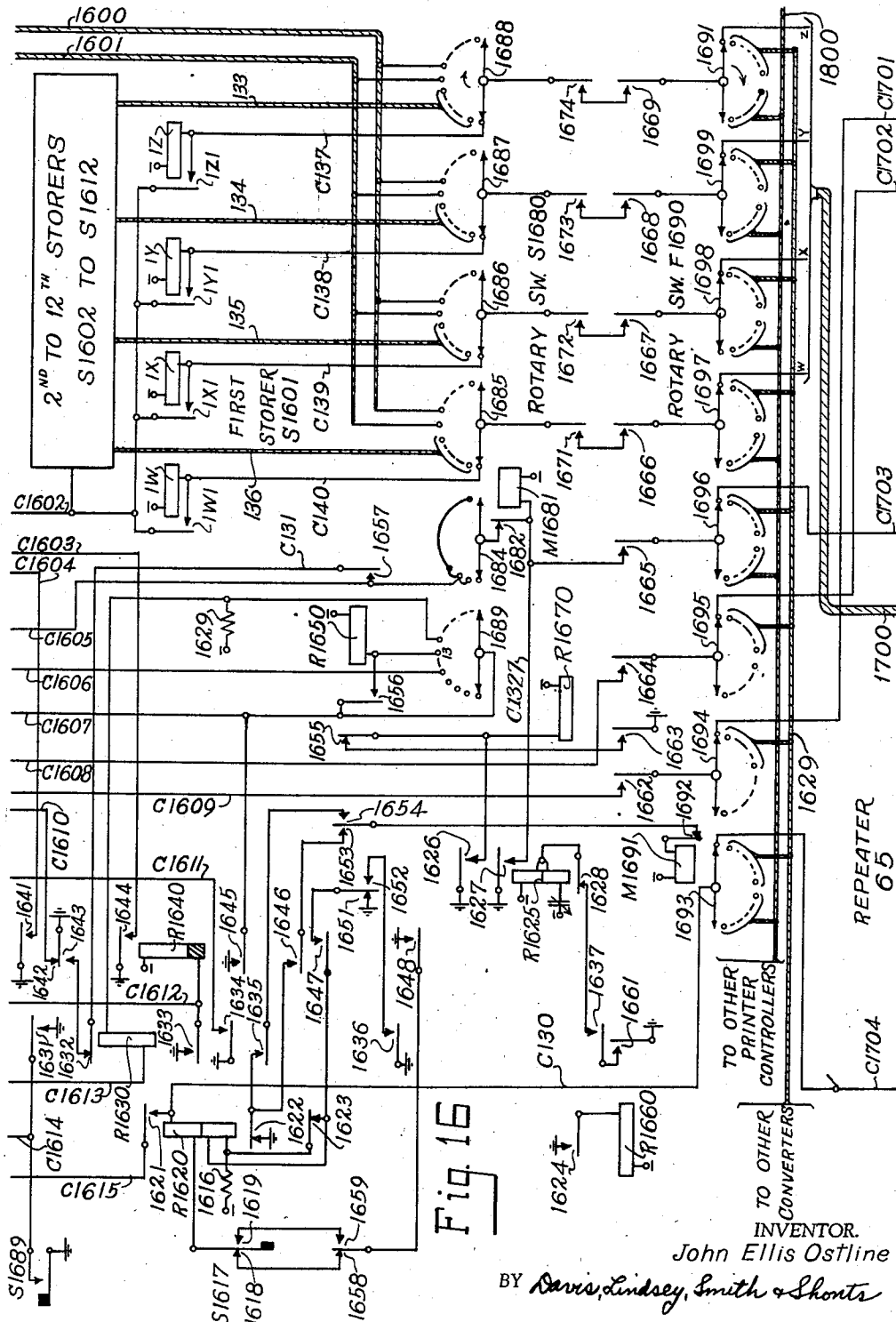


Fig. 16

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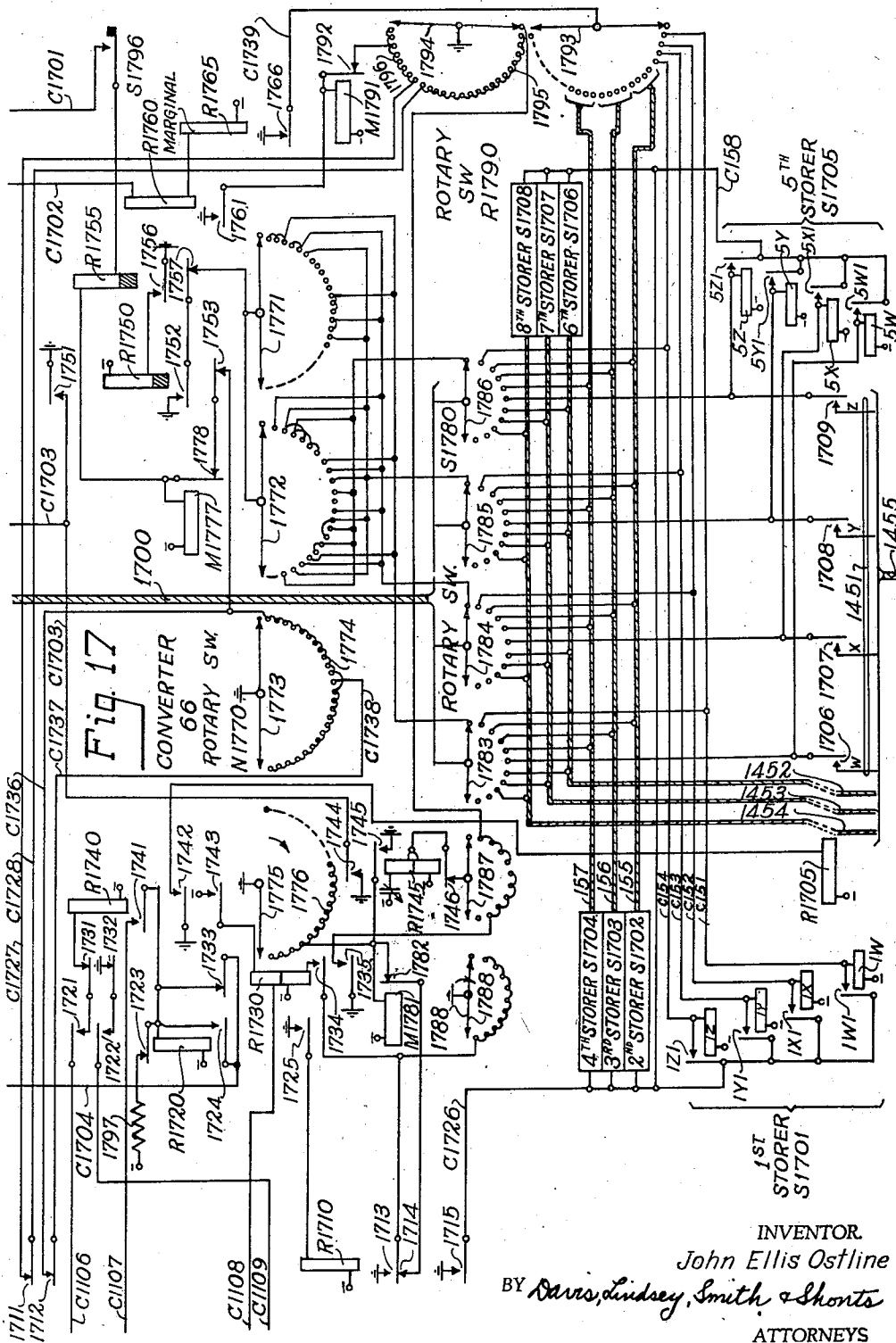
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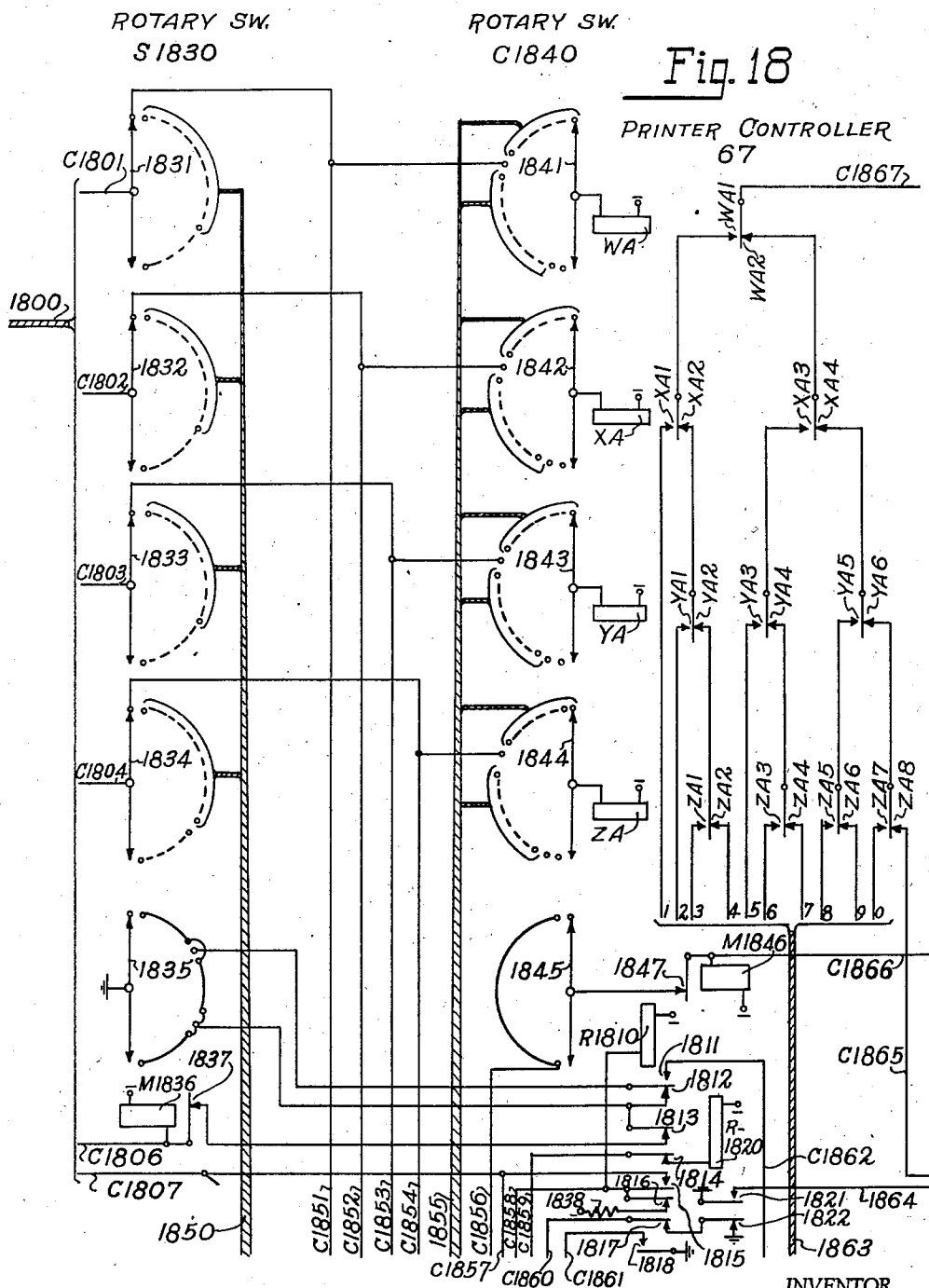
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23 Sheets-Sheet 18



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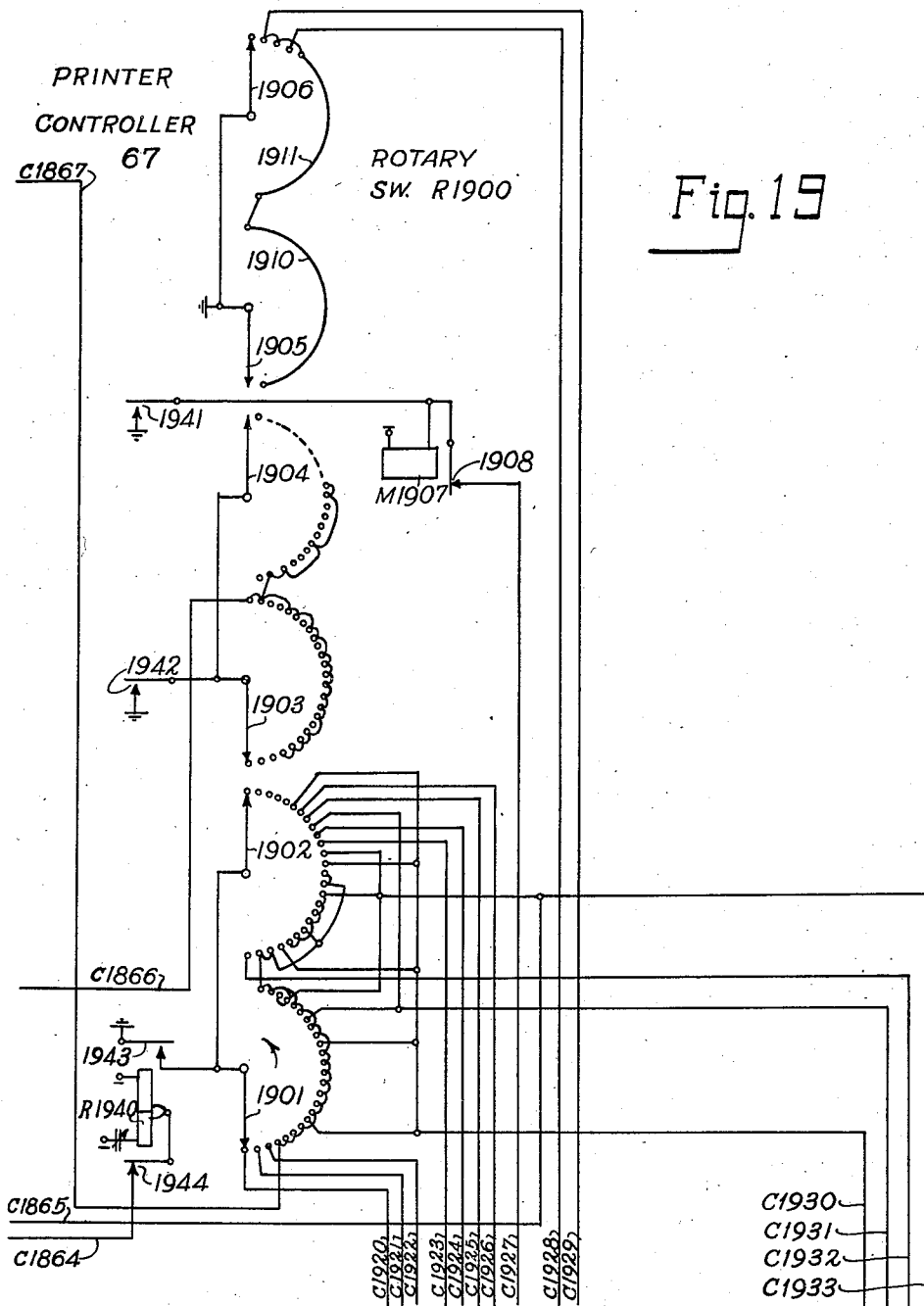
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23 Sheets-Sheet 19



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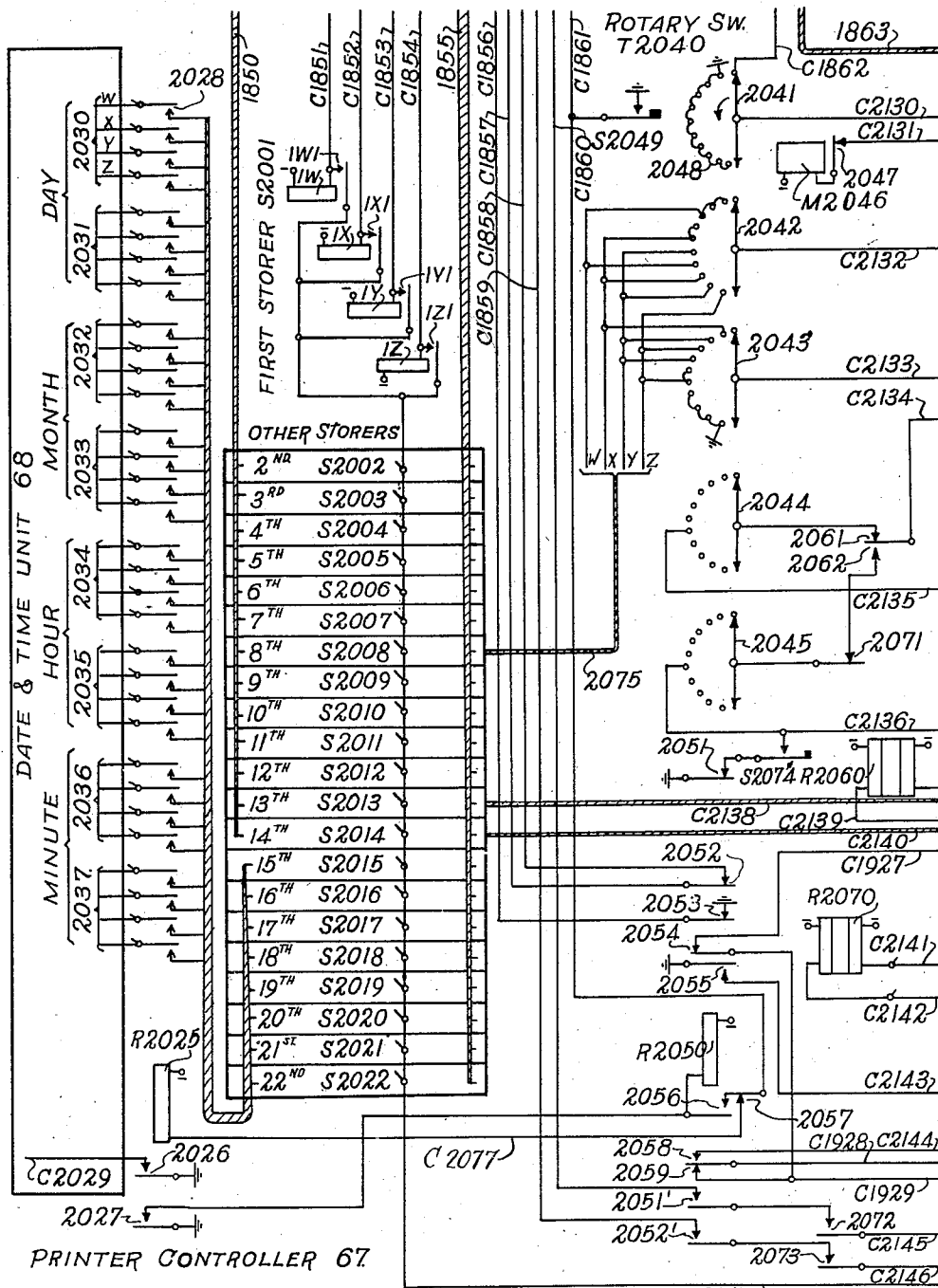


Fig. 20

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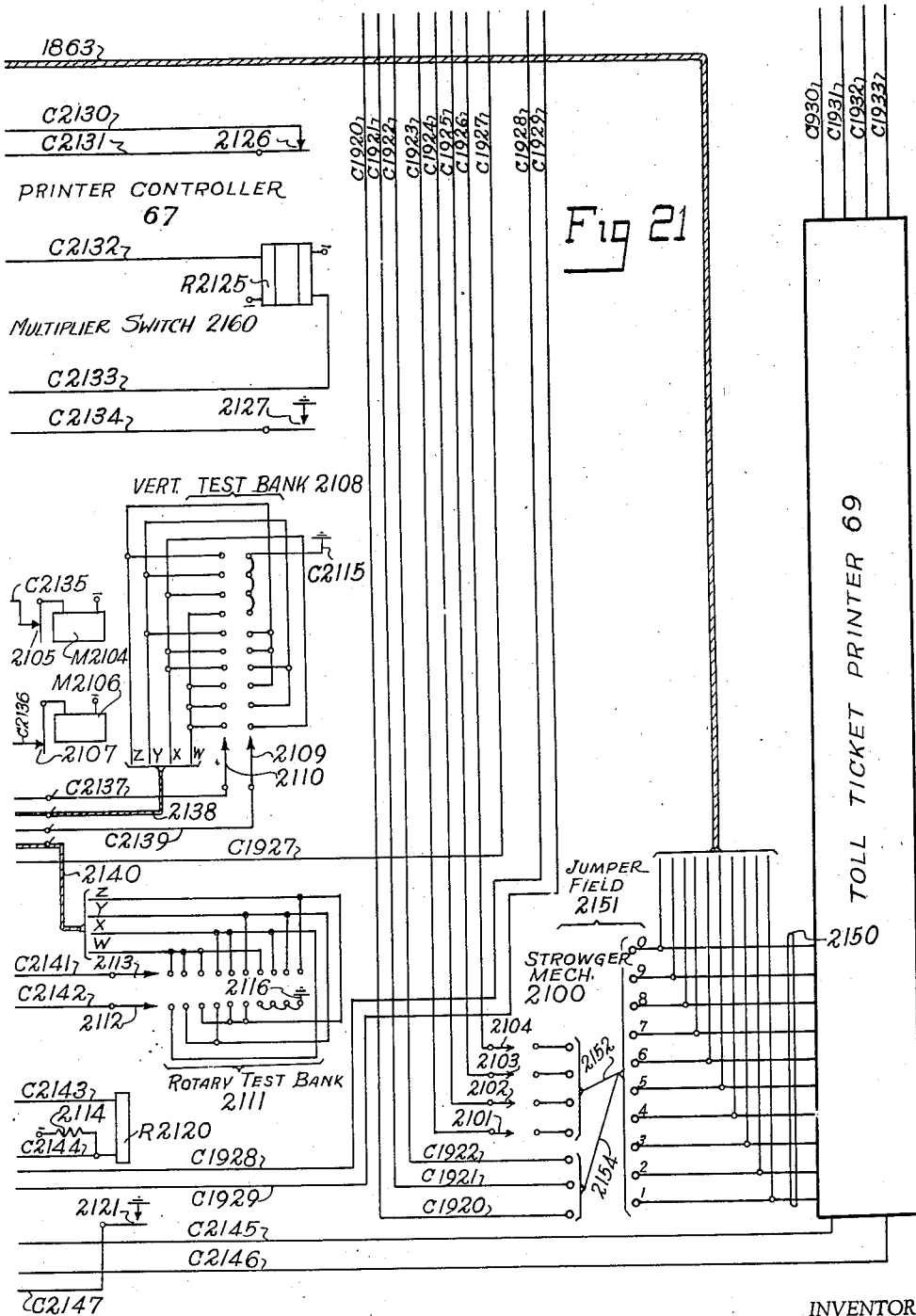
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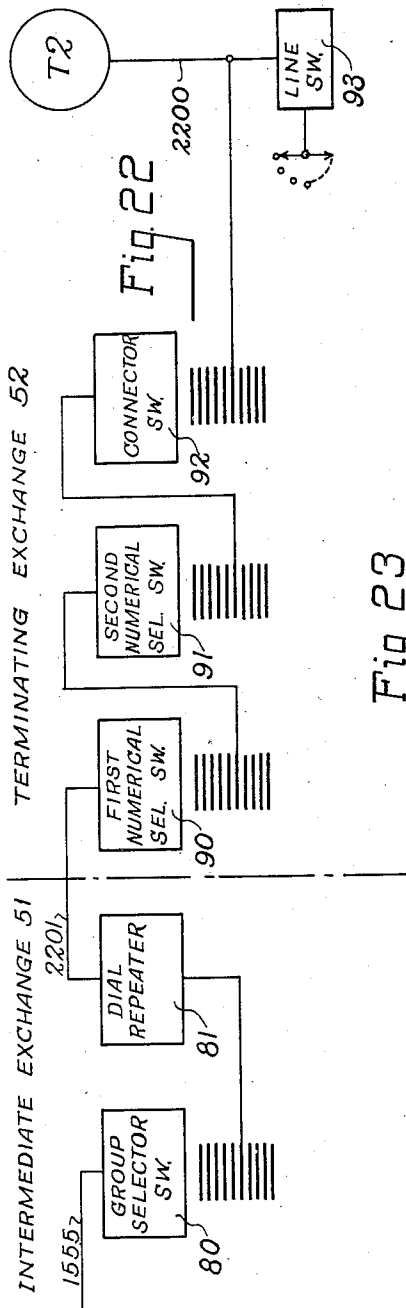
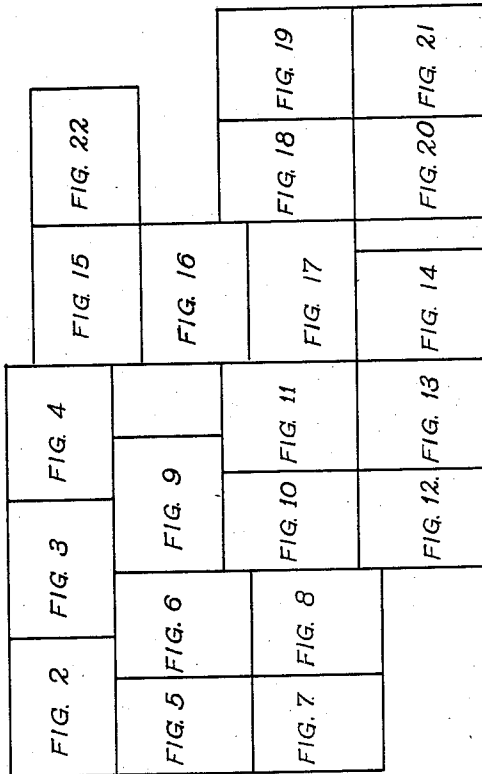


Fig 24

CALLING NO.	MON 2921	TICKET NO.	0509
CALLED NO.	MAD 5555	DATE	TIME
		DAY	MO. HOUR MIN
		10/12	12. 4.5
		RATE	DURATION OF CALL IN MINS.
		6	12
		COST OF CALL	12/11

Fig 23



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UNITED STATES PATENT OFFICE

2,297,365

TELEPHONE SYSTEM

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Application July 8, 1939, Serial No. 283,347
In Great Britain May 11, 1939

54 Claims. (Cl. 179-7.1)

The present invention relates to automatic telephone systems and more particularly to automatic recording apparatus operative to record given particulars of certain calls in the systems. More specifically the present invention relates to improvements in telephone systems of the character disclosed in the copending applications of John E. Ostline, Serial No. 273,727, filed June 12, 1939, Serial No. 278,728, filed June 12, 1939 and Serial No. 278,729, filed June 12, 1939.

In a telephone system serving a large metropolitan area and the adjacent suburban areas, it is usually desirable to handle calls between certain of the exchanges in the system as toll calls for which special charges are made depending upon the distances between the exchanges and the durations of the calls. In accordance with conventional practice, the connections for a call of this type are set up with the aid of an operator, which operator records upon a toll ticket certain particulars concerning the call including the codes of the calling and called exchanges, the directory numbers of the calling and called lines, the rate applicable to the call, the duration of the call and possibly the total cost of the call.

While a telephone system of the type described is entirely satisfactory in operation, it requires the services of a large number of operators and necessitates some delay in extending a call of the type mentioned while the information concerning the calling and called subscriber substations is being transferred from the calling subscriber to the operator.

Accordingly, it is an object of the present invention to provide, in an automatic telephone system, improved recording apparatus which is operative automatically to record, without the aid of an operator, given particulars of certain calls in the system for which special charges are made.

Another object of the invention is to provide, in an automatic telephone system including a register sender operative to control the extension of the connections for a call from one exchange to another, improved apparatus for selecting a rate factor applicable to the call which is controlled in accordance with the operation of the register sender.

Another object of the invention is to provide, in an automatic telephone system, an improved register sender which is operative to control over the two line conductors of an associated trunk line different registers associated with the respective line conductors of the trunk line.

A further object of the invention is to provide,

in an automatic telephone system, an improved detector operative to detect the designation of a calling line extending to an associated exchange.

5 A further object of the invention is to provide, in an automatic telephone system, an improved detector arrangement which is operative to detect and to check the designation of a calling line extending to an associated exchange.

10 A further object of the invention is to provide, in an automatic telephone system, a number of switches respectively operative to calculate at different rates the cost of a call extended between two exchanges, and an improved arrangement for selecting one of the switches depending upon the two exchanges between which the call is extended.

15 A further object of the invention is to provide, in an automatic telephone system, a switch operative to calculate the cost of a call extended between two exchanges, and an improved arrangement for controlling the operation of the switch depending upon the duration of the call.

20 The invention is illustrated as being embodied in an automatic telephone system comprising a number of exchanges, including an originating exchange, an intermediate exchange and a terminating exchange, and serving a large metropolitan area and the adjacent suburban areas, these areas being so disposed with respect to each other that it is desirable to make a special toll charge for a call extended from the originating exchange to the terminating exchange depending upon the distance between these exchanges and the duration of the call. Furthermore, each exchange terminates a large number of subscriber lines. Each of the exchanges is provided with a particular designation comprising three digits or letters; and each line terminating at each exchange is provided with a particular designation comprising four digits or numerals.

25 The originating exchange comprises a number of trunk circuits, each including first and second automatic switches, a number of groups of register senders or directors accessible to the first automatic switches, and a number of toll ticket repeaters accessible to the second automatic switches. This apparatus is so connected and arranged that when a call is initiated on one of the subscriber lines in the originating exchange, an idle one of the trunk circuits is automatically associated with the calling subscriber line, whereupon the subscriber at the subscriber substation associated with the calling subscriber line in the originating exchange proceeds to dial the three

digits designating the terminating exchange and the four digits designating the called line in the terminating exchange. When the first digit of the designation of the terminating exchange is dialed over the calling subscriber line, the first automatic switch associated with the selected trunk circuit operates to select an idle director in a corresponding group of directors.

In accordance with one feature of the invention, the selected director comprises a two-motion switch which is set in accordance with the second and third digits of the designation of the terminating exchange, a digit register operative to register the four digits of the designation of the called subscriber line and a code register which is controlled in accordance with the operation of the two-motion switch to register the three digits of the designation of the terminating exchange and a rate factor applicable to the call from the originating exchange to the terminating exchange.

Furthermore, the selected trunk circuit comprises two line conductors; and the selected director is so connected and arranged that it operates to send over one of the line conductors of the selected trunk circuit a first set of digits, comprising directive digits, which is determined by the setting of the two-motion switch therein, and a second set of digits corresponding to the four digits of the designation of the called subscriber line. Further, the director is operative to send in code over the other line conductor of the selected trunk circuit the three digits and the rate factor registered in the code register therein. Finally, the selected director is released after it has sent the two sets of digits over the selected trunk circuit. Also, the selected trunk circuit is so connected and arranged that when the director sends the first directive digit, the second automatic switch thereof selects an idle one of the toll ticket repeaters.

In accordance with a further feature of the invention, the originating exchange comprises a number of converters accessible to the toll ticket repeaters and two detectors accessible to each subscriber line in the originating exchange. When the selected toll ticket repeater is seized by the second automatic switch of the selected trunk circuit, it operates automatically to select an idle one of the converters; and when an idle one of the converters is selected, it operates to initiate operation of the two detectors. The selected toll ticket repeater is so connected and arranged that it repeats over a toll line extending therefrom to the intermediate exchange the remainder of the directive digits of the first set of digits and all of the digits of the second set of digits sent by the selected director over the selected trunk circuit. The intermediate exchange comprises a switch train which is operative in response to the remainder of the directive digits of the first set of digits sent over the toll line from the selected toll ticket repeater to seize a toll line extending to the terminating exchange; and the terminating exchange comprises a local switch train which is operative in response to the second set of digits sent over the toll line from the selected toll ticket repeater to seize the called subscriber line.

In accordance with another feature of the invention, the selected director and the selected toll ticket repeater are so connected and arranged that the director is operative automatically to send the first set of digits therefrom over the selected trunk circuit; while the operation of the

director to send the second set of digits therefrom over the trunk circuit depends upon the operation of the selected toll ticket repeater to find an idle one of the converters in the group of converters accessible thereto.

The selected toll ticket repeater and the selected converter comprise a number of code registers and are so connected and arranged that the second set of digits sent by the selected director over the selected trunk circuit are converted in the selected converter into codes and then transferred to the selected toll ticket repeater and registered in the code registers therein. Furthermore, the selected converter operates to register in the code registers therein codes corresponding to the three digits designating the terminating exchange and the rate factor sent by the selected director over the selected trunk circuit.

In accordance with another feature of the invention, the two detectors operate independently to detect the designation of the calling subscriber line and comprise code registers in which the four respective digits of the designation of the calling subscriber line are registered. Further, the two detectors are so connected and arranged that in the event the corresponding code registers therein register digits of different numerical values, an alarm is operated; while in the event the corresponding code registers therein register digits of the same numerical values, these codes are transferred to the code registers in the selected converter, whereupon the two detectors are released. The selected converter then operates to transfer the several codes registered in the code registers therein to the code registers in the selected toll ticket repeater and is then released.

In accordance with a further feature of the invention, a timer is provided in the selected toll ticket repeater which is operated when the call is answered at the subscriber substation associated with the called subscriber line in order to establish a rate factor depending upon the duration of the call, which rate factor is registered in the code registers in the selected toll ticket repeater. Furthermore, the originating exchange comprises a toll ticket printer, a number of printer controllers accessible to the toll ticket repeaters, and a date and time unit commonly associated with the printer controllers, each printer controller comprising a number of code registers. When the established connection between the calling subscriber line and the called subscriber line is released, the selected toll ticket repeater operates automatically to select an idle one of the printer controllers, whereupon the date and time unit operates certain of the code registers in the selected printer controller to register therein information concerning the month, day, hour and minute of the release of the established connection between the calling subscriber line and the called subscriber line. The selected toll ticket repeater then operates to transfer the codes stored in the code registers therein to the code registers in the selected printer controller, whereupon the selected toll ticket repeater is released.

In accordance with a further feature of the invention, the printer controller comprises a number of two-motion switches respectively operative to calculate at different rates the total cost of a call. The selected printer controller then operates to select a predetermined one of the calculating switches, depending upon the code registered in a given one of the code registers therein and corresponding to the rate factor

applicable to the call. The selected printer controller then operates to set the selected calculating switch in accordance with the codes registered in a given two of the registers therein and corresponding to the ten and unit digits in minutes of the duration of the established connection between the calling subscriber line and the called subscriber line. The selected printer controller then operates to cause the toll ticket printer to operate and print upon a toll ticket the designations of the originating and terminating exchanges, the designations of the calling and called subscriber lines, the month, date, hour and minute of the release of the established connection between the calling and called subscriber lines, the rate applicable to the call between the originating exchange and the terminating exchange, the duration in minutes of the call between the calling and called subscriber lines, and the total cost of the call in appropriate monetary values.

After the toll ticket has been printed by the printer, the selected printer controller and the printer are automatically released.

Further features of the invention pertain to the particular arrangement of the circuit elements of the system whereby the above-outlined and additional operating features are attained.

The novel features believed to be characteristic of the invention are set forth with particularity in the appended claims. The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings, in which Figure 1 illustrates the general arrangement of a telephone system embodying the present invention; Figs. 2 to 22, inclusive, taken together, illustrate the details of a system having incorporated therein the features of the invention as briefly outlined above; Fig. 23 illustrates the mode of combining Figs. 2 to 22, inclusive, to form a unified system; Fig. 24 illustrates a toll ticket printed by a toll ticket printer incorporated in the system; and Fig. 25 illustrates a portion of a modified form of a calling line detector incorporated in the system.

DESCRIPTION OF THE APPARATUS INCORPORATED IN THE TELEPHONE SYSTEM

Referring now more particularly to Fig. 1 of the drawings, the telephone system there illustrated comprises a plurality of exchanges including the exchanges 50, 51 and 52, the exchanges 50, 51 and 52 being respectively designated originating, intermediate and terminating exchanges in accordance with the route of a toll call traced hereinafter. Each of the exchanges has an ultimate capacity of 10,000 lines and serves a large number of local subscriber substations. More particularly, the exchange 50 serves a number of local subscriber substations including the subscriber substation indicated at T1 and associated with the subscriber line 250 extending thereto; while the exchange 52 serves a number of local subscriber substations including the subscriber substation indicated at T2 and associated with the subscriber line 2200 extending thereto. The exchanges 50 and 51 are interconnected by a group of outgoing one-way toll lines, including the toll line 1555, extending from the exchange 50 to the exchange 51, and a group of incoming one-way toll lines, not shown, extending from the exchange 51 to

the exchange 50; while the exchanges 51 and 52 are interconnected by a group of outgoing one-way toll lines, including the toll line 2201, extending from the exchange 51 to the exchange 52, and a group of incoming one-way toll lines, not shown, extending from the exchange 52 to the exchange 51.

Each exchange comprises a number of line switches individually associated with the subscriber lines terminating thereat, the line switch 60 being individually associated with the subscriber line 250 terminating at the exchange 50 and the line switch 93 being individually associated with the subscriber line 2200 terminating at the exchange 52. Furthermore, each exchange comprises a number of groups of first code selector switches which are accessible to the various line switches. For example, the exchange 50 comprises a group of first code selector switches, including the first code selector switch 61, which is accessible to a number of line switches, including the line switch 60. A selector hunting switch is individually associated with each first code selector switch, the selector hunting switch 62 being individually associated with the first code selector switch 61. Also, each exchange comprises a number of groups of director selector switches, for example, the exchange 50 comprises a group of director selector switches, including the director selector switch 63, which is accessible to a number of selector hunting switches, including the selector hunting switch 62. Furthermore, a number of groups of directors are provided at each exchange which are accessible to the various director selector switches. For example, a group of directors, including the director 64, is provided at the exchange 50 which is accessible to the director selector switch 63. Finally, each exchange comprises a local switch train including a number of first numerical selector switches, a number of second numerical selector switches, and a number of connector switches, the exchange 52 being provided with a local switch train including a first numerical selector switch 90, a second numerical selector switch 91 and a connector switch 92.

In addition to the apparatus described above, each exchange comprises toll ticketing apparatus including a number of toll ticket repeaters, a number of converters, a number of printer controllers, a date and time unit, a toll ticket printer, and two detectors. For example, the toll ticket apparatus incorporated in the exchange 50 comprises a toll ticket repeater 65, a converter 66, a printer controller 67, a date and time unit 68, a toll ticket printer 69, and two detectors 70 and 71. More particularly, the first code selector switches in the exchange 50 have access to the various toll ticket repeaters; while each toll ticket repeater is individually associated with one of the outgoing one-way toll lines extending from the exchange 50 to the exchange 51 and has access to each converter and each printer controller. The date and time unit 68 is accessible to each of the printer controllers; and the toll ticket printer 69 has access to each of the printer controllers. Finally, the two detectors 70 and 71 are connected in multiple, in a manner more fully described hereinafter, and have access to each line terminating at the exchange 50 and to each converter in the exchange 50.

Furthermore, each exchange comprises a number of group selectors individually associated

with the various one-way toll lines extending to the exchange and having access to the various one-way toll lines extending from the exchange. For example, the exchange 51 comprises a group selector switch 80 individually associated with the one-way toll line 1555 extending from the exchange 50 to the exchange 51, the one-way toll line 1555 being individually associated with the toll ticket repeater 65 in the exchange 50, and has access to the one-way toll line 2201 extending from the exchange 51 to the exchange 52, the one-way toll line 2201 including a dial repeater 81.

Preferably, each of the line switches included in the various exchanges is identical to the line switch 60 included in the exchange 50, which line switch comprises, as best shown in Fig. 2, a rotary switch D220 including five wipers 221, 222, 223, 226 and 227 provided with individually associated contact banks and a magnet M228 for driving the wipers noted. Also, the line switch 60 comprises a line relay R200, a hold relay R210 and a circuit network connected and arranged in a manner more fully described hereinafter. Finally, a call register meter provided with an operating magnet M240 is individually associated with the line switch 60.

Preferably, each of the first code selector switches included in the various exchanges is identical to the first code selector switch 61 included in the exchange 50, which first code selector switch comprises, as best shown in Figs. 3 and 4, a Strowger mechanism 480 including a wiper carriage movable in both vertical and rotary directions and an associated contact bank. More particularly, the Strowger mechanism 480 is of the 200 point type and comprises a first wiper set, including the wipers 481, 482 and 483, and a second wiper set, including the wipers 484, 485 and 486. The contacts arranged in the associated contact bank are divided into two groups accessible to the respective wiper sets, each group of contacts including ten vertically spaced-apart rows of contact sets and each row of contact sets being peripherally arranged and including ten individual contact sets. Also, the Strowger mechanism 480 comprises a vertical magnet M392 for driving the wiper carriage step by step in the vertical direction and a rotary magnet M390 for driving the wiper carriage step by step in the rotary direction. Furthermore, there are associated with the Strowger mechanism 480 four sets of switch springs S372, S373, S376 and S424 which are actuated when the wiper carriage is moved in the vertical direction away from its normal position; two sets of switch springs S423 and S425 which are actuated when the wiper carriage is moved in the rotary direction away from its normal position; and two sets of switch springs S377 and S400 which are actuated when the wiper carriage is moved in the rotary direction eleven steps away from its normal rotary position.

Furthermore, the first code selector switch 61 comprises a line relay R370, a hold relay R350, an impulse relay R340, a transfer relay R360, a tone relay R380, two timing relays R320 and R300, a switch-through relay R440, two switching relays R460 and R470, a test relay R430, a number of control relays R310, R330, R410, R420 and R450, an impedance element I458 and a circuit network connected and arranged in a manner more fully described hereinafter.

Preferably, each of the directors included in the various exchanges is identical to the director 64 included in the exchange 50, which director comprises, as best shown in Figs. 5, 6, 7 and 8, a Strowger mechanism 700 including a wiper carriage movable in both vertical and rotary directions, and an associated contact bank. More particularly, the Strowger mechanism 700 comprises a wiper set including ten wipers 701 to 710, inclusive; and the associated contact bank comprises ten vertically spaced-apart rows of contact sets, each row of contact sets being peripherally arranged and including ten individual contact sets. Further, the Strowger mechanism 700 comprises two vertical test wipers 711 and 712, which are moved only in the vertical direction by the wiper carriage, and an associated vertical test contact bank 713. Also, the Strowger mechanism 700 comprises a vertical magnet M715 for driving the wiper carriage step by step in the vertical direction and a rotary magnet M716 for driving the wiper carriage step by step in the rotary direction. Furthermore, there are associated with the Strowger mechanism 700 two sets of switch springs S563 and S718 which are actuated when the wiper carriage is moved in the vertical direction away from its normal position. Also, the director 64 comprises a rotary switch CN740, including three wipers 743, 745 and 746 provided with individually associated contact banks and a magnet M741 for driving the wipers noted; a rotary switch T730, including two wipers 733 and 735 provided with individually associated contact banks and a magnet M731 for driving the wipers noted; a rotary switch M720, including three wipers 723, 725 and 728 provided with individually associated contact banks and a magnet M721 for driving the wipers noted; a rotary switch C800, including three wipers 803, 805 and 807 provided with individually associated contact banks and a magnet M801 for driving the wipers noted; a rotary switch D810, including three wipers 813, 815 and 817 provided with individually associated contact banks and a magnet M811 for driving the wipers noted; a rotary switch U820, including five wipers 822, 824, 826, 828 and 830 provided with individually associated contact banks and a magnet M821 for driving the wipers noted; and a rotary switch S840, including five wipers 843, 845, 849, 852 and 854 provided with individually associated contact banks and a magnet M841 for driving the wipers noted. Also, it is noted that a jumper field 714 is arranged between the contact bank of the Strowger mechanism 700 and a given one of the contact banks of each of the rotary switches T730 and S840 for a purpose more fully described hereinafter.

The rotary switch CN740 constitutes a sequence switch for controlling the operation of the Strowger mechanism 700; the rotary switch T730 constitutes a storing and sending switch for the three letters designating the called exchange and the rate factor digit applicable to the call between the originating exchange 50 and the terminating exchange. The rotary switches M720, C800, D810 and U820 respectively constitute storing switches for the thousand, hundred, ten and unit digits of the directory number of the called subscriber line in the called exchange; while the rotary switch S840 constitutes a sending switch for the directive digits stored in the Strowger mechanism 700 and the thousand, hundred, ten and unit digits of the directory number of the called subscriber line in the called exchange re-

spectively stored in the rotary switches M720, C800, D810 and U820.

Further, the director 64 comprises a first impulsing device I614, a second impulsing device I615, two impulse relays R500 and R560, a test relay R510, a cut-off relay R610, a stop relay R630, two timing relays R640 and R660, a number of control relays R520, R540, R530, R550, R620, R650 and R880, and a control network connected and arranged in a manner more fully described hereinafter.

Preferably, each of the selector hunting switches included in the various exchanges is identical to the selector hunting switch 62 included in the exchange 50, which selector hunting switch comprises, as best shown in Fig. 9, a rotary switch including six wipers 910 to 915, inclusive, provided with individually associated contact banks and a magnet M917 for driving the wipers noted.

Preferably, each of the director selector switches included in the various exchanges is identical to the director selector switch 63 included in the exchange 50, which director selector switch comprises, as best shown in Fig. 9, a Strowger mechanism 920 including a wiper carriage movable in both vertical and rotary directions. More particularly, the Strowger mechanism 920 comprises a wiper set including five wipers 921 to 925, inclusive, and an associated contact bank comprising ten vertically spaced-apart rows of contact sets, each row of contact sets being peripherally arranged and including ten individual contact sets. Further, the Strowger mechanism 920 comprises a vertical magnet M990 for driving the wiper carriage step by step in the vertical direction and a rotary magnet M991 for driving the wiper carriage step by step in the rotary direction. Also, there are associated with the wiper carriage of the Strowger mechanism 920 four sets of switch springs S964, S965, S966 and S968 which are actuated when the wiper carriage is moved in the vertical direction away from its normal position; two sets of switch springs S940 and S976 which are actuated when the wiper carriage is moved in the rotary direction away from its normal position; a set of switch springs S967 which is actuated when the wiper carriage is moved in the rotary direction eleven steps away from its normal position; and a set of switch springs S963 which is actuated when the wiper carriage is moved in the vertical direction past the first level or row of contact sets in the associated contact bank. Further, the director selector switch 63 comprises an impulse relay R960, a transfer relay R980, a timing relay R930, a test relay R950, a number of control relays R940 and R970, and a control network connected and arranged in a manner more fully described hereinafter.

Preferably, one of the detectors included in each of the exchanges is identical to the detector 70 included in the exchange 50; while the other of the detectors included in each of the exchanges is identical to the detector 71 included in the exchange 50. Furthermore, the detectors 70 and 71 are substantially identical except that a digit storing element provided in the detector 70 is not provided in the detector 71, as is explained more fully hereinafter. The detector 70 comprises, as best shown in Figs. 10 to 14, inclusive, five crossbar switches 1001 to 1005, inclusive, each of these switches being identical and each having access to the control conductors of as many as two thousand of the subscriber lines terminating in the exchange 50.

Specifically, the crossbar switch 1001 comprises first and second groups of horizontal operating bars and first and second groups of vertical operating bars. The first group of horizontal operating bars includes five individual bars which are respectively operated by the magnets HM1 to HM5, inclusive; the second group of horizontal operating bars includes five individual bars which are respectively operated by the magnets HM6 to HM10, inclusive; the first group of vertical operating bars includes ten individual bars which are respectively operated by the magnets VM1 to VM10, inclusive; and the second group of vertical operating bars includes ten individual bars which are respectively operated by the magnets VM11 to VM20, inclusive. The first crossbar switch 1001 also includes two hundred contact sets which are operated under the joint control of the various horizontal and vertical operating bars, the arrangement being such that only one contact set is operated when the corresponding horizontal bar and the corresponding vertical bar is operated. Further, each contact set comprises ten pairs of contact springs, each contact spring terminating the control conductor of one of the subscriber lines extending to the exchange 50. Accordingly, the control conductors of any group of ten subscriber lines in a larger group of two thousand subscriber lines terminating at the exchange 50 may be selected by operating the appropriate horizontal and vertical bars of the first crossbar switch 1001. Similarly, the control conductors of any group of ten subscriber lines in the group of ten thousand subscriber lines terminating at the exchange 50 may be selected by operating the appropriate horizontal and vertical bars in an appropriate one of the crossbar switches 1001 to 1005, inclusive.

Furthermore, the detector 70 comprises crossbar switch control networks individually associated with the respective crossbar switches, the crossbar switch control network 1100 being individually associated with the first crossbar switch 1001. The crossbar switch control network 1100 comprises first and second relays 1M and 2M for respectively controlling the first and second groups of horizontal magnets HM1 to HM5, inclusive, and HM6 to HM10, inclusive; an odd hundred relay OC for controlling the first group of vertical magnets VM1 to VM10, inclusive; and an even hundred relay EC for controlling the second group of vertical magnets VM11 to VM20, inclusive. Further, the crossbar switch control network 1100 comprises a relay MS for controlling both of the first and second groups of horizontal magnets HM1 to HM10, inclusive; a relay CS for controlling both of the first and second groups of vertical magnets VM1 to VM20, inclusive; and a relay DS for controlling circuits extending by way of the individual pairs of contact springs included in each contact set in each crossbar switch. At this point it is noted that the cable 1011 comprises ten leads respectively connected to corresponding contact springs of the ten pairs of contact springs in each contact set in each crossbar switch.

Also, the detector 70 comprises a counting relay network 1200 including ten counting relays 1R to 10R, inclusive, three switching relays RA, RB and RC, four code storing devices 10SM, 10SC, 10SD and 10SU, and four selecting relays MK, CK, DK and UK. The code storing devices 10SM, 10SC, 10SD and 10SU are adapted respectively to store codes corresponding to the

thousand, hundred, ten and unit digits of the directory number of a calling subscriber line terminating at the exchange 50 in a manner more fully described hereinafter. Specifically, each of the code storing devices 70SM, 70SC, 70SD and 70SU comprises ten relays respectively corresponding to the ten digits. For example, the code storing device 70SM comprises ten relays 1SM to 10SM, inclusive, respectively corresponding to the thousand digits 1 to 0. Similarly, the code storing device 70SC comprises ten relays 1SC to 10SC, inclusive, respectively corresponding to the hundred digits 1 to 0. Finally the code storing devices 70SD and 70SU respectively comprise ten SD relays and ten SU relays bearing the previously mentioned relationships to the 10 ten digits and the 10 unit digits. The selecting relays MK, CK, DK and UK are arranged to associate the counting relay network 1200 selectively and sequentially with the code storing devices 70SM, 70SC, 70SD and 70SU. Also, four locking relays ML, CL, DL and UL are respectively associated with the four code storing devices 70SM, 70SC, 70SD and 70SU for a purpose more fully described hereinafter.

It is noted that the code storing device 70SM is connected and arranged to control by way of the cable 1103 the magnets 1M, 2M, 3M, 4M, etc., respectively associated with the first crossbar switch 1001, the second crossbar switch 1002, etc.; the code storing device 70SC is connected and arranged to control by way of the cable 1101 the first and second groups of horizontal magnets in the various crossbar switches; the code storing device 70SD is connected and arranged to control by way of the cable 1104 the first and second groups of vertical magnets in the various crossbar switches; and the code storing device 70SU is connected and arranged to control by way of the cable 1105 the circuits which are adapted to be completed through the individual pairs of contact springs in the various contact sets in the various crossbar switches.

Further, the code storing devices 70SM, 70SC, 70SD and 70SU are adapted to mark by way of the WXYZ leads in the first, second, third and fourth groups of marking leads 1451, 1452, 1453 and 1454, respectively, in the cable 1455, the thousand, the hundred, the ten, and the unit digits of the directory number of the calling subscriber line terminating at the exchange 50.

More particularly, it is noted that each of the code storing devices marks by way of the four or WXYZ leads in the associated group of marking leads the particular digit by utilizing a code arrangement. For example, the code storing device 70SM marks by way of the WXYZ leads in the first group of marking leads 1451 in the cable 1455 the particular thousand digit of the directory number of a calling subscriber line terminating at the exchange 50 in accordance with the following code:

Particular thousand digit	Marked leads in first group of leads 1451
1.....	W-X
2.....	W-Y
3.....	W-Z
4.....	X-Y
5.....	X-Z
6.....	Y-Z
7.....	W
8.....	X
9.....	Y
10.....	Z

Further, the detector 70 comprises a rotary switch F1120 including a wiper 1123 provided with an associated contact bank and a magnet M1121 for driving the wiper noted; a transformer 1355 associated with a tone lead C1107 common to the five crossbar switches, a 2000 cycle alternating current generator 1352; a vacuum tube detector or rectifier 1305; and an alarm device A1300. Furthermore, the detector 70 comprises a start relay R1350, two test relays R1320 and R1330, an alarm relay R1340, a check relay R1360, an impulse relay R1310, a reset relay R1300, and a control network connected and arranged in a manner more fully described hereinafter.

The detector 71 is connected and arranged in a manner substantially identical to that of the detector 70 except that the four code storing devices 71SM, 71SC, 71SD and 71SU therein are not connected and arranged to mark by way of the WXYZ leads in the four groups of marking leads 1451, 1452, 1453 and 1454 the codes stored therein. Further, the code storing devices included in the respective detectors 70 and 71 are connected and arranged to provide a series chain circuit for controlling the energization of the check relay R1360 for a purpose more fully described hereinafter.

Preferably, each of the toll ticket repeaters in the various exchanges is identical to the toll ticket repeater 65 included in the exchange 50, which toll ticket repeater comprises, as best shown in Figs. 15 and 16, a rotary switch S1680 including six wipers 1684, 1685, 1686, 1687, 1688 and 1689 provided with individually associated contact banks and a magnet M1681 for driving the wipers noted; a rotary switch F1690 including eight wipers 1693, 1694, 1695, 1696, 1697, 1698, 1699 and 1691 provided with individually associated contact banks and a magnet M1691 for driving the wipers noted; a rotary switch U1570 including four wipers 1581, 1578, 1575 and 1573 provided with individually associated contact banks and a magnet M1571 for driving the wipers noted; a rotary switch D1590 including three wipers 1596, 1595 and 1593 provided with individually associated contact banks and a magnet M1591 for driving the wipers noted; and a rotary switch T1560 including two wipers 1563 and 1564 provided with individually associated contact banks and a magnet M1561 for driving the wipers noted. Furthermore, there are associated with the rotary switch U1570 two sets of switch springs S1597 and S1598 which are actuated when this rotary switch is operated away from its normal rotary position. Also, there is associated with the rotary switch S1680 a set of switch springs S1689 which is actuated when this rotary switch is operated away from its normal rotary position. Finally, there is associated with the rotary switch F1690 a set of switch springs S1617 which is actuated to one position when the rotary switch F1690 occupies any one of its first to twelfth operated positions and which is actuated to a second position when the rotary switch F1690 occupies any one of its thirteenth to twenty-fifth operated positions.

Further, the repeater 65 comprises twelve code storing device S1601 to S1612, inclusive, which are utilized for a purpose more fully described hereinafter. Each of the code storing devices includes four relays comprising WXYZ relays. For example, the first code storing device S1601 includes four relays 1W, 1X, 1Y and 1Z which are operated to store the code in the first code storing device S1601 in a manner more fully de-

scribed hereinafter. Finally, the repeater 65 comprises a hold relay R1500, a line relay R1505, a time start relay R1540, two timing relays R1545 and R1525, a test relay R1620, an impulse relay R1625, two switching relays R1660 and R1670, a number of control relays R1510, R1520, R1530, R1630, R1640 and R1650, an impedance element I1548, and a circuit network connected and arranged in a manner more fully described hereinafter.

Preferably, each of the converters included in the various exchanges is identical to the converter 66 included in the exchange 50, which converter comprises, as best shown in Fig. 17, a rotary switch N1770 including four wipers 1771, 1772, 1773 and 1775 provided with individually associated contact banks and a magnet M1777 for driving the wipers noted; and a rotary switch R1790 including two wipers 1793 and 1794 provided with individually associated contact banks and a magnet M1791 for driving the wipers noted. Further, there is associated with the rotary switch R1790 a set of switch springs S1796 which is actuated when the rotary switch R1790 is operated away from its normal rotary position. Furthermore, the converter 66 comprises eight code storing devices S1701 to S1708, inclusive, which are utilized for a purpose more fully described hereinafter, each of the code storing devices including four relays, comprising WXYZ relays, which are operated to store the code therein. Also, the converter 66 comprises an impulse relay R1745, a test relay R1740, a switching relay R1705, a cut-off relay R1730 and a number of control relays R1710, R1720, R1750, R1755, R1760 and R1765, and a circuit network connected and arranged in a manner more fully described hereinafter.

Preferably, each of the printer controllers included in the various exchanges is identical to the printer controller 67 included in the exchange 50, which printer controller comprises, as best shown in Figs. 18, 19, 20 and 21, ten multiplier switches, one of which is illustrated at 2160. The multiplier switch 2160 comprises a Strowger mechanism 2100 including a wiper carriage movable in both vertical and rotary directions, a main wiper set including four wipers 2101, 2102, 2103 and 2104 carried by the wiper carriage, a vertical test wiper set including two wipers 2109 and 2110 movable only in the vertical direction with the wiper carriage, and a rotary test wiper set including two wipers 2112 and 2113 movable only in the rotary direction with the wiper carriage. Further, the Strowger mechanism 2100 comprises a main contact bank associated with the main wiper set and including ten vertically spaced-apart rows of contact sets, each row of contact sets being peripherally arranged and including ten individual contact sets. Also, the Strowger mechanism 2100 comprises a vertical test bank 2108 associated with the vertical test wiper set and a rotary test bank 2111 associated with the rotary test wiper set. Finally, the Strowger mechanism 2100 comprises a vertical magnet M2104 for driving the wiper carriage step by step in the vertical direction and a rotary magnet M2106 for driving the wiper carriage step by step in the rotary direction. Also, there is associated with the wiper carriage of the Strowger mechanism 2100 a set of switch springs S2074 which is actuated when the wiper carriage is moved in the vertical direction away from its normal position.

Furthermore, the printer controller 67 comprises a rotary switch S1830 including five wipers 1831, 1832, 1833, 1834 and 1835 provided with individually associated contact banks and a magnet M1836 for driving the wipers noted; a rotary switch C1840 including five wipers 1841, 1842, 1843, 1844 and 1845 provided with individually associated contact banks and a magnet M1846 for driving the wipers noted; a rotary switch R1900 including six wipers 1901, 1902, 1903, 1904, 1905 and 1906 provided with individually associated contact banks and a magnet M1907 for driving the wipers noted; and a rotary switch T2040 including five wipers 2041, 2042, 2043, 2044 and 2045 provided with individually associated contact banks and a magnet M2046 for driving the wipers noted. Also, a set of switch springs S2049 is associated with the rotary switch T2040 which is actuated when the rotary switch T2040 is operated away from its normal rotary position. Furthermore, the printer controller 67 comprises twenty-two code storing devices S2001 to S2022, inclusive, which are utilized for a purpose more fully described hereinafter. Each of the code storing devices includes four relays, comprising WXYZ relays, which are operated to store therein the code, in a manner more fully described hereinafter.

Furthermore, the printer controller 67 comprises four marking relays WA, XA, YA and ZA associated with the respective wipers 1841, 1842, 1843 and 1844 of the rotary switch C1840, an impulse relay R1940, a hold relay R1810, and a number of control relays R1820, R2025, R2050 and R2120. A test relay R2125, a transfer relay R2060 and a stop relay R2070 are included in the printer controller 67 and are commonly associated with each of the multiplier switches included therein. Finally, the printer controller 67 comprises a circuit network connected and arranged in a manner more fully described hereinafter.

Preferably, the date and time units included in the various exchanges is identical to the date and time unit 68 included in the exchange 50, which date and time unit is connected and arranged in a manner identical to that of the unit disclosed in Figs. 36 to 39, inclusive, of the copending application of John E. Ostline, Serial No. 278,728, filed June 12, 1939. More specifically, the date and time unit 68 comprises eight groups of marking leads 2030 to 2037, inclusive, wherein each group of marking leads includes four or WXYZ leads. More particularly, the two groups of marking leads 2030 and 2031 correspond to the ten and unit digits of the day; the two groups of marking leads 2032 and 2033 correspond to the ten and unit digits of the month; the two groups of marking leads 2034 and 2035 correspond to the ten and unit digits of the hour; and the two groups of marking leads 2036 and 2037 correspond to the ten and unit digits of the minute. At this point it is noted that the eight groups of marking leads 2030 to 2037, inclusive, are commonly associated with each of the printer controllers in the exchange 50, these groups of marking leads being respectively associated with the code storing devices S2015 to S2022, inclusive, incorporated in the printer controller 67.

Preferably, each of the toll ticket printers included in the various exchanges is identical to the toll ticket printer 69 included in the exchange 50, which toll ticket printer is connected and arranged in a manner identical to that of the

toll ticket printer disclosed in Figs. 29 and 30 of the copending application of John E. Ostline, Serial No. 278,729, filed June 12, 1939. At this point it is noted that a group of marking leads 2150 comprising ten individual marking leads extending to the printer 67 is associated with the main contact bank of the Strowger mechanism in each of the multiplier switches by way of a jumper field, the contact bank of the Strowger mechanism 2100 of the multiplier switch 2160 being associated with the group of marking leads 2150 by way of the jumper field 2151. Furthermore, the contact bank individually associated with the wiper 1901 of the rotary switch R1900 included in the printer controller 67 is associated with the group of marking leads 2150 by way of the jumper field 2151. The connections in the jumper field 2151 between the group of marking leads 2150 and the contact banks noted are provided for a purpose more fully described hereinafter.

Preferably, each of the group selector switches, such as the group selector switch 80 in the exchange 51, and each of the numerical selector switches, such as the numerical selector switches 90 and 91 in the exchange 52, is a selector switch of the well-known Strowger type; while each of the connector switches, such as the connector switch 92 in the exchange 52 is a connector switch of the well-known Strowger type. The dial repeater 81 operatively associated with the one-way toll line 2201 extending from the exchange 51 to the exchange 52 may be any one of a number of well-known types, and the details of the construction and arrangement of this dial repeater are not described herein as they form no part of the present invention.

The toll ticket printer 69 is so constructed and arranged that it is adapted to be controlled from any one of the printer controllers to print a toll ticket of the character of that shown in Fig. 24. Referring to Fig. 24, it is noted that the toll ticket printer 69 is operative to print the following information upon the toll ticket:

1. The exchange code and directory number of the calling subscriber line.
2. The exchange code and directory number of the called subscriber line.
3. The day and month of the call.
4. The hour and minute of the call.
5. The rate applicable to the call.
6. The duration of the call in minutes.
7. The cost of the call in appropriate monetary values. (In the present example, in shillings and pence.)

As previously noted, a modified form of detector arrangement may be substituted for the detectors 70 and 71. This modified form of detector arrangement utilizes only one detector and is otherwise substantially identical to the detector 70, shown in Figs. 10 to 14, inclusive, except that the code storing devices 70SM, 70SC, 70SD and 70SU and the counting relay network 1200 included in the detector 70 have been replaced with rotary switches. More specifically, it is contemplated that the alternative form of detector arrangement will comprise apparatus substantially identical to the apparatus shown in Figs. 10, 11 and 13 included in the detector 70 and the apparatus shown in Fig. 25.

Referring now more particularly to Fig. 25, this portion of the alternative form of the detector arrangement comprises a rotary switch M2500 in-

cluding four wipers 2501, 2502, 2503 and 2504 provided with individually associated contact banks and a magnet M2505 for driving the wipers noted; a rotary switch C2510 including five wipers 2511, 2512, 2513, 2514 and 2515 provided with individually associated contact banks and a magnet M2516 for driving the wipers noted; a rotary switch D2520 including four wipers 2521, 2522, 2523 and 2524 provided with individually associated contact banks and a magnet M2525 for driving the wipers noted; a rotary switch U2530 including four wipers 2531, 2532, 2533 and 2534 provided with individually associated contact banks and a magnet M2535 for driving the wipers noted; a rotary switch S2540 including four wipers 2541, 2542, 2543 and 2544 provided with individually associated contact banks and a magnet M2545 for driving the wipers noted; and a rotary switch F2580 including a wiper 2581 provided with an associated contact bank and a magnet M2582 for driving the wiper noted. Also associated with the rotary switch U2530 is a set of switch springs S2537 which is actuated when the rotary switch U2530 is operated away from its normal rotary position. Further, this portion of the modified form of the detector arrangement comprises an impulse relay R2555, two test relays R2550 and R2560, a start relay R2585, a control relay R2570, and a circuit network connected and arranged in a manner more fully described hereinafter.

It is noted that the rotary switches M2500, C2510, D2520 and U2530 constitute code registering switches and respectively correspond to the code storing devices 70SM, 70SC, 70SD and 70SU in the detector 70. Further, the rotary switch S2540 constitutes a sequence switch and performs substantially the same functions as the selecting relays MK, CK, DK and UK in the detector 70. Finally, it is noted that certain of the relays provided in this portion of the alternative form of the detector arrangement correspond to certain of the relays provided in the detector 70. The particular manner in which this portion of the alternative form of the detector arrangement co-operates with the apparatus, shown in Figs. 10, 11 and 13, of the detector 70 is described more fully hereinafter.

A better understanding of the connection and arrangement of the apparatus incorporated in the telephone system will be facilitated from a consideration of the detailed operation of the various pieces of apparatus incident to the extension of a call from the originating exchange 50 to the terminating exchange 52, as will appear hereinafter.

Selection of an idle director selector switch

When a call is initiated at the subscriber substation associated with one of the subscriber lines terminating at the originating exchange 50, an idle director selector switch is automatically associated with the calling subscriber line in a manner more fully described below. For example, when a call is initiated at the subscriber substation T1 by removing the receiver of the telephone instrument thereat from its associated switch-hook, a bridge path is completed thereat between the line conductors C251 and C252 of the subscriber line 250 and a circuit is completed for energizing the winding of the line relay R200 in the line switch 60 individually associated with the subscriber line 250. This circuit extends from ground by way of the contacts 213, C252, the bridge path at the subscriber substation T1 be-

tween the line conductors C252 and C251, C251, the contacts 211 and the winding of R200 to battery. When energized over the above-traced circuit, the line relay R200 operates to complete, at the contacts 201 and 202, a circuit for energizing the magnet M228 of the rotary switch D220 and a path for short-circuiting the winding of the hold relay R210. The circuit for energizing the winding of the magnet M228 extends from ground by way of the contacts 201, the wiper 226 and engaged first contact in the associated contact bank of the rotary switch D220, the contacts 202, 215 and 229, and the winding of M228 to battery. The path for short-circuiting the winding of the hold relay R210 extends from the upper terminal of the winding of R210 by way of the wiper 226 and engaged first contact in the associated contact bank of the rotary switch D220, and the contacts 202 and 215 to the lower terminal of the winding of R210. Also, upon operating, the line relay R200 completes, at the contacts 201, an obvious path for applying ground potential to the control conductor C253 of the subscriber line 250, thereby to mark the subscriber line 250 as busy to the connector switches of the local switch train in the exchange 50 having access thereto. When the winding of the magnet M228 is energized over the above-traced circuit, the magnet M228 operates to interrupt, at the contacts 229, a point in the previously traced circuit for energizing the winding thereof and to prepare the wipers 221, 222, 223, 226 and 227 of the rotary switch D220 to be driven one step in the clockwise direction. When the previously traced circuit for energizing the winding of the magnet M228 is interrupted at the contacts 229, the magnet M228 restores to drive the wipers noted of the rotary switch D220 one step in the clockwise direction and to re-complete, at the contacts 229, a test circuit for energizing the winding of the magnet M228.

More particularly, when the wiper 226 of the rotary switch D220 is driven one step in the clockwise direction, it disengages the first contact in the associated contact bank and engages the second contact in the associated contact bank, which second contact terminates the control conductor of a trunk line extending to a first code selector switch. Assuming that the first code selector switch is busy, ground potential appears upon the control conductor thereof, whereupon an alternative circuit is completed for energizing the winding of the magnet M228 and an alternative path is completed for short-circuiting the winding of the hold relay R210. The alternative circuit for energizing the winding of the magnet M228 extends from the grounded control conductor of the trunk line extending to the busy first code selector switch by way of the wiper 226 of the rotary switch D220, the engaged second contact in the associated contact bank, and the contacts 202, 215 and 229, and the winding of M228 to battery. The path for short-circuiting the winding of the hold relay R210 extends from ground potential appearing upon the wiper 226 of the rotary switch D220 by way of the contacts 202 and 215, the winding of R210 and the contacts 201 to ground. When the magnet M228 is energized over the above-traced alternative circuit, it again operates and restores as previously explained, thereby to drive the wipers noted of the rotary switch D220 an additional step in the clockwise direction. The magnet M228 continues to operate in order to drive the wipers noted of the rotary switch D220 step by step in the clockwise direction until the wiper 226 of the rotary

switch D220 engages a contact terminating the control conductor of a trunk line extending to an idle first code selector switch, whereupon further operation of the magnet M228 is arrested due to the absence of ground potential appearing upon the control conductor of the trunk line extending to the idle first code selector switch.

Assuming that the first code selector switch 61 is the first idle first code selector switch in the associated group of first code selector switches, the magnet M228 continues to operate until the wipers of the rotary switch D220 are operated into engagement with the contacts in the associated contact banks terminating the conductors of the trunk line 260 extending to the first code selector switch 61, whereupon further operation of the magnet M228 is arrested due to the absence of ground potential upon the control conductor C263 of the trunk line 260. Also, at this time, the previously traced alternative path for short-circuiting the winding of the hold relay R210 is interrupted, whereupon the winding of the hold relay R210 is energized in series with the winding of the magnet M228. This series circuit extends from ground by way of the contacts 201, the winding of R210, the contacts 229 and the winding of M228 to battery. When energized over the above-traced circuit, the hold relay R210 operates; however, the magnet M228 does not operate due to the high series resistance of the winding of the hold relay R210. Upon operating, the hold relay R210 interrupts, at the contacts 211 and 213, points in the previously traced circuit for energizing the winding of the line relay R200 and completes, at the contacts 212 and 214, a circuit for energizing in series the upper and lower windings of the line relay R370 in the first code selector switch 61; however, the line relay R200, being of the slow-to-release type, does not immediately restore. Also, upon operating, the hold relay R210 completes, at the contacts 217, a circuit for energizing the winding of the meter magnet M240, this circuit extending from ground in the first code selector switch 61 by way of the contacts 329, the conductor C264 of the trunk line 260, the wiper 227 and engaged contact in the associated contact bank of the rotary switch D220, the contacts 217 and the winding of the meter magnet M240 to battery. When energized over the above-traced circuit, the meter magnet M240 operates, thereby to cause the meter to register a call upon the associated subscriber line 250.

The circuit for energizing in series the upper and lower windings of the line relay R370 in the first code selector switch 61 extends from ground by way of the lower winding of R370, the contacts 313, the line conductor C262 of the trunk line 260, the wiper 222 and engaged contact in the associated contact bank of the rotary switch D220, the contacts 214, C252, the bridge path at the subscriber substation T1 between the line conductors C252 and C251 of the subscriber line 250, C251, the contacts 212, the wiper 221 and engaged contact in the associated contact bank of the rotary switch D220, the line conductor C261 of the trunk line 260, the contacts 312 and the upper winding of R370 to battery. When energized over the above-traced circuit, the line relay R370 operates to complete, at the contacts 371, a circuit for energizing the winding of the control relay R410, this circuit extending from ground by way of the contacts 371, C114, the contacts 407' and the winding of R410 to battery. When energized over the above-traced circuit,

the relay R410 operates to complete, at the contacts 413, a circuit for energizing the winding of the hold relay R350, this circuit extending from ground by way of the contacts 413, C116 and the winding of R350 to battery, whereupon the relay R350 operates. Also, upon operating, the control relay R410 completes, at the contacts 414, a path for applying ground potential to the control conductor C263 of the trunk line 260, this path extending from ground by way of the winding of the impedance element I458, C119 and the contacts 414 to the control conductor C263. This application of ground potential to the control conductor C263 of the trunk line 260 completes a holding circuit for energizing the winding of the hold relay R210 and the winding of the magnet M228 in the line switch 60 in series circuit relationship, this circuit extending from the grounded control conductor C263 by way of the wipers 226 and engaged contact in the associated contact bank of the rotary switch D220, the contacts 216, the winding of R210, the contacts 229 and the winding of M228 to battery. When this holding circuit is completed, the hold relay R210 is retained in its operated position; however, the magnet M228 does not operate due to the high series resistance of the relay R210 as previously noted. Subsequent to the completion of the above-traced holding circuit for energizing in series the windings of the hold relay R210 and the magnet M228, the line relay R200 restores to interrupt, at the contacts 201, the previously traced original circuit for energizing in series the winding of the hold relay R210 and the winding of the magnet M228.

Also, upon operating, the control relay R410 completes, at the contacts 415, a path for applying ground potential to the wiper 914 of the selector hunting switch 62 individually associated with the first code selector switch 61 for a purpose more fully described hereinafter. This path extends from ground by way of the resistor 418, the contacts 415, C125, the contacts 386, the set of switch springs S372, C126, the lower and upper windings of the test relay R430, and the control conductor C908 of the trunk line 900 extending between the first code selector switch 61 and the selector hunting switch 62 to the wiper 914 of the selector hunting switch 62. Also, upon operating, the relay R410 completes, at the contacts 412, a circuit for energizing the upper winding of the control relay R330 and the winding of the impulse relay R340. This circuit extends from ground by way of the contacts 443, the upper winding of R420, the contacts 412, C104, the right-hand winding of R330, C101, the contacts 401, the contacts 441, C100 and the winding of R340 to battery. When energized over the above-traced circuit, the control relay R420 and the impulse relay R340 operate; however, the control relay R330 does not operate due to the fact that both the left-hand and the right-hand windings thereof must be energized before this relay may be operated.

Upon operating, the hold relay R350 completes, at the contacts 351, a holding circuit for energizing the winding thereof, this circuit extending from ground by way of the contacts 351, C113, the contacts 421, C116 and the winding of R350 to battery. Also, upon operating, the hold relay R350 completes, at the contacts 352, a circuit for energizing the winding of the control relay R450. This circuit extends from the grounded control conductor C263 of the trunk line 260 by way of

the contacts 414, C119, the contacts 352, C118 and the winding of R450 to battery. When energized over the above-traced circuit, the relay R450 operates to complete, at the contacts 453, a circuit for energizing the left-hand winding of the control relay R330, this circuit extending from ground by way of the contacts 453, C110 and the left-hand winding of R330 to battery. When both the right-hand and the left-hand windings of the relay R330 are thus energized, this relay operates to prepare, at the contacts 331, a point in a circuit for energizing the lower winding of the timing relay R320 by way of the impulse conductor C335.

Upon operating, the impulse relay R340 completes, at the contacts 341, a circuit for energizing the lower winding of the transfer relay R360, this circuit extending from ground by way of the contacts 351, the contacts 341, the contacts 374 of the set of switch springs S373, and the lower winding of R360 to battery. When energized over the above-traced circuit, the transfer relay R360 operates to complete, at the contacts 368, a circuit for energizing the winding of the magnet M917 of the selector hunting switch 62 individually associated with the first code selector switch 61. The circuit for energizing the winding of the magnet M917 extends from ground in the first code selector switch 61 by way of the contacts 434 and 400, C128, the contacts 389, the conductor C903 of the trunk line 900, the wiper 915 and engaged first contact in the associated contact bank of the selector hunting switch 62, the conductor C902 of the trunk line 900, the contacts 368, the conductor C901 of the trunk line 900, the multiplied contact bank 916 associated with the wiper 915, the contacts 918 and the winding of M917 to battery. When energized over the above-traced circuit, the magnet M917 operates to condition the wipers 910, 911, 912, 913, 914 and 915 of the selector hunting switch 62 to be driven one step in the counterclockwise direction and to interrupt, at the contacts 918, the previously traced circuit for energizing the winding thereof, whereupon the magnet M917 restores. Upon restoring, the magnet M917 drives the wipers noted of the selector hunting switch 62 one step in the counterclockwise direction, whereupon the wiper 915 engages the second contact in the associated multiplied contact bank 916, thereby to complete an alternative circuit for energizing the winding of the magnet M917. This alternative circuit extends from ground in the first code selector switch 61 by way of the contacts 434 and 400, C128, the contacts 389, the conductor C903 of the trunk line 900, the wiper 915 and engaged contact in the associated multiplied contact bank 916, the contacts 918 and the winding of M917 to battery. When the above-traced alternative circuit for energizing the winding of the magnet M917 is completed, the magnet M917 operates intermittently, thereby to drive the wipers noted of the selector hunting switch 62 step by step in the counterclockwise direction until the wiper 914 of the selector hunting switch 62, having ground potential thereupon, engages a contact in the associated contact bank terminating a control conductor of a trunk line extending to an idle director selector switch having battery potential thereupon. Assuming that the director selector switch 63 is the first idle director selector switch in the group of director selector switches, when the wiper 914 of the selector hunting switch 62 engages the contact in the associated contact

bank terminating the control conductor C135 of the trunk line 130 extending to the director selector switch 63, further operation of the selector hunting switch 62 is arrested due to the presence of battery potential upon the control conductor C135. More particularly, when the wiper 914 of the selector hunting switch 62 engages the contact in the associated contact bank terminating the control conductor C135, a circuit is completed for energizing in series the upper and lower windings of the test relay R430 in the first code selector switch 61, this circuit extending from ground by way of the resistor 418, the contacts 415, C125, the contacts 386, the set of switch springs S372, C126, the lower and upper windings of R430, the conductor C908 of the trunk line 900, the wiper 914 and engaged contact in the associated contact bank of the selector hunting switch 62, C135, the set of switch springs S965 and the resistor 977 to battery.

When the upper and lower windings of the relay R430 in the first code selector switch 61 are energized in series over the above-traced circuit, the relay R430 operates to interrupt, at the contacts 434, the previously traced alternative circuit for energizing the winding of the magnet M917 of the selector hunting switch 62, thereby to arrest further operation of the selector hunting switch 62 as previously noted. Upon operating, the relay R430 completes, at the contacts 433, a holding circuit for energizing the upper winding thereof, this circuit extending from ground in the first code selector switch 61 by way of the contacts 423, the upper winding of R430, the conductor C908 of the trunk line 900, the wiper 914 and engaged contact in the associated contact bank of the selector hunting switch 62, C135, the set of switch springs S965, and the resistor 977 to battery. Also, upon operating, the relay R430 completes, at the contacts 431, a circuit for energizing the winding of the cut-through relay R400, this circuit extending from ground by way of the contacts 453, C110, the contacts 384, C109, the contacts 431 and the winding of R400 to battery. When energized over the above-traced circuit, the cut-through relay R400 operates to interrupt, at the contacts 401 and 403, the previously traced circuit for energizing the winding of the impulse relay R430 and completes, at the contacts 402 and 404, an alternative circuit for energizing the winding of the impulse relay R340 by way of the trunk line 900 extending between the first code selector switch 61 and the director selector switch 63. The last-mentioned circuit extends from ground in the first code selector switch 61 by way of the contacts 443 and 404, the conductor C905 of the trunk line 900, the wiper 911 and engaged contact in the associated contact bank of the selector hunting switch 62, the line conductor C132 of the trunk line 130, the contacts 940, the resistor 978, the line conductor C131 of the trunk line 130, the wiper 910 and engaged contact in the associated contact bank of the selector hunting switch 62, the conductor C904 of the trunk line 900, the contacts 402 and 441, C100, and the winding of R340 to battery.

Also, upon operating, the cut-through relay R400 interrupts, at the contacts 407, the previously traced circuit for energizing the winding of the relay R410 and completes, at the contacts 478, an obvious alternative circuit for energizing the winding thereof, thereby to retain the relay R410 in its operated position. Further, the cut-through relay R400 completes, at the con-

tacts 407, a circuit for energizing the upper winding of the impulse relay R960 in the director selector switch 63, this circuit extending from ground in the first code selector switch 61 by way of the contacts 371, C114, the contacts 407, the conductor C906 of the trunk line 900, the wiper 913 and engaged contact in the associated contact bank of the selector hunting switch 62, the conductor C134 of the trunk line 130, the contacts 945 and the upper winding of R960 to battery. When energized over the above-traced circuit, the impulse relay R960 operates to complete, at the contacts 961, a circuit for energizing the lower winding of the transfer relay R980, this circuit extending from ground in the director selector switch 63 by way of the contacts 961, the set of switch springs S980, and the lower winding of R980 to battery. When energized over the above-traced circuit, the transfer relay R980 operates to complete, at the contacts 984, a circuit for energizing the winding of the control relay R970, this circuit extending from ground by way of the winding of R970, the contacts 984, the multiplied unidirectional current conducting devices in the form of copper oxide rectifiers 958 and 959, and the resistor 957 to battery. When energized over the above-traced circuit, the relay R970 operates to complete, at the contacts 975, an alternative holding circuit for energizing the winding thereof, this circuit extending from ground by way of the winding of R970, the contacts 975, the multiplied rectifiers 958 and 959, and the resistor 957 to battery.

Also, upon operating, the transfer relay R980 prepares, at the contacts 986, an obvious circuit for energizing the lower winding of the timing relay R930 by way of the impulse conductor C994 and completes, at the contacts 982, a path for projecting dial tone current over the conductor C133 of the trunk line 130. This path extends from the ungrounded terminal of a grounded transformer winding by way of the dial tone conductor C996, the condenser 979, and the contacts 982 to the conductor C133 of the trunk line 130. Further, this dial tone current is projected by way of the conductor C133 of the trunk line 130, the wiper 912 and engaged contact in the associated contact bank of the selector hunting switch 62, the conductor C907 of the trunk line 900, the contacts 405, C108, the condenser 355, the contacts 362, C105 and the lower winding of the relay R420 to ground. The dial tone current traversing the lower winding of the relay R420 induces a corresponding current in the upper winding thereof which traverses a path extending from ground by way of the contacts 443, the upper winding of R420, the contacts 412, C104, the right-hand winding of the relay R330, C101, the condenser 353 and the contacts 312 to the line conductor C261 of the trunk line 260, and from ground by way of the lower winding of the line relay R370 and the contacts 313 to the line conductor C262 of the trunk line 260, the line conductors C261 and C262 of the trunk line 260 being connected together by way of the subscriber line 250 and the bridge path at the subscriber substation T1. Accordingly, this dial tone current traverses the bridge path at the subscriber substation T1, including the telephone instrument thereat, whereby the receiver of the telephone instrument produces dial tone in order to indicate to the subscriber thereat that he may dial the directory number of the called subscriber substation.

Selection of an idle director

Upon receiving dial tone, the subscriber at the subscriber substation T1 dials the directory number of the called subscriber line including the three letters identifying the exchange at which the called subscriber line is terminated and the four numerical digits identifying the particular called subscriber line at the called exchange. First, the subscriber at the subscriber substation T1 dials the first letter of the called exchange code, thereby to cause a series of impulses to be transmitted over the subscriber line 250 to the line relay R370 in the first code selector switch 61. More particularly, the previously traced circuit for energizing the line relay R370 by way of the subscriber line 250 is intermittently completed and interrupted, thereby to cause the line relay R370 to operate and restore intermittently or follow the impulses of the first letter of the called exchange code. Upon restoring, the line relay R370 interrupts, at the contacts 371, the previously traced circuit for energizing the upper winding of the impulse relay R960 in the director selector switch 63, thereby to cause the last-mentioned relay to restore. Upon restoring, the impulse relay R960 interrupts, at the contacts 961, the previously traced circuit for energizing the lower winding of the transfer relay R980 and completes, at the contacts 962, a circuit for energizing in series the upper winding of the transfer relay R980 and the winding of the vertical magnet M990, this circuit extending from ground by way of the contacts 962, 973 and 983, the upper winding of R980 and the winding of M990 to battery. When the transfer relay R980 is energized over the above-traced circuit, it remains in its operated position, this relay being of the slow-to-release type; and when the vertical magnet M990 is energized over the above-traced circuit, it operates, thereby to drive the wiper carriage of the Strowger mechanism 920 one step in the vertical direction. Upon reoperating, the line relay R370 in the first code selector switch 61 re completes, at the contacts 371, the previously traced circuit for energizing the winding of the impulse relay R960 in the director selector switch 63, thereby to cause the last-mentioned relay to reoperate and interrupt, at the contacts 962, the previously traced circuit for energizing in series the upper winding of the transfer relay R980 and the winding of the vertical magnet M990. The line relay R370 in the first code selector switch 61 continues to follow the impulses comprising the first letter of the called exchange code, thereby to cause the impulse relay R960 in the director selector switch 63 to operate in a similar manner, whereupon the vertical magnet M990 operates in a similar manner to drive the wiper carriage of the Strowger mechanism 920 step by step in the vertical direction a corresponding number of steps.

When the wiper carriage of the Strowger mechanism 920 is driven one step in the vertical direction away from its normal position, the sets of switch springs S980, S966, S965 and S964 are actuated. More particularly, the set of switch springs S980 is actuated into disengagement, thereby to interrupt a further point in the previously traced circuit for energizing the lower winding of the transfer relay R980; the set of switch springs S966 is actuated into engagement, thereby to prepare a path, traced hereinafter, for short-circuiting the winding of the relay R970, in order to cause this relay to restore when the di-

rector selector switch is ultimately released; the set of switch springs S965 is actuated into disengagement, thereby to interrupt a point in the previously traced path for applying battery potential to the control conductor C135 of the trunk line 130, a multiple path being completed at this time which extends from battery by way of the resistor 977 and the contacts 972 to the control conductor C135; and the set of switch springs S964 is actuated into engagement, thereby to prepare a circuit, traced hereinafter, for energizing the winding of the rotary magnet M991.

At the conclusion of the dialing of the first code letter of the called exchange, the line relay R370 in the first code selector switch 61 and the impulse relay R960 in the director selector switch 63 reoperate. The impulse relay R960 interrupts, at the contacts 962, the previously traced circuit for energizing in series the upper winding of the transfer relay R980 and the winding of the vertical magnet M990. The transfer relay R980, being of the slow-to-release type, restores shortly thereafter. Upon restoring, the transfer relay R980 interrupts, at the contacts 983, a further point in the previously traced holding circuit for energizing the upper winding thereof in series with the winding of the vertical magnet M990, interrupts, at the contacts 982, the previously traced path for projecting dial tone current over the conductor C133 of the trunk line 130, and completes, at the contacts 981, the previously mentioned circuit for energizing the winding of the rotary magnet M991. The last-mentioned circuit extends from ground by way of the set of switch springs S964, the contacts 981, 954, 943, 931 and 992, and the winding of M991 to battery. When energized over the above-traced circuit, the rotary magnet M991 operates to drive the wiper carriage of the Strowger mechanism 920 one step in the rotary direction and to interrupt, at the contacts 992, a point in the previously traced circuit for energizing the winding thereof in order to cause the rotary magnet M991 to restore. Upon restoring, the rotary magnet M991 re completes, at the contacts 992, the previously traced circuit for energizing the winding thereof, whereupon the rotary magnet M991 reoperates. Accordingly, the rotary magnet M991 continues to operate intermittently in order to drive the wiper carriage of the Strowger mechanism 920 step by step in the rotary direction until the wiper 925 carried by the wiper carriage engages a contact in the associated contact bank terminating the control conductor of a trunk line extending to an idle director and having battery potential thereupon.

At this point it is noted that the operation of the Strowger mechanism 920 in the vertical direction a predetermined number of steps corresponding to the first letter of the called exchange code was effective to cause the director selector switch 63 to select a corresponding group of directors. Assuming that the director 64 is the first idle director in the group of directors previously selected by the director selector switch 63, when the wiper 925 of the Strowger mechanism 920 engages the contact in the associated contact bank terminating the control conductor C605 of the trunk line 600 extending to the idle director 64, further operation of the rotary magnet M991 is arrested. More specifically, when the wiper 925 engages the contact in the associated contact bank terminating the control conductor C605 of the trunk line 600, a circuit is completed for energizing the upper and lower

windings of the test relay R950 in the director selector switch 63 in series with the lower winding of the control relay R560 in the director 64. This circuit extends from ground in the director selector switch 63 by way of the resistor 954, the set of switch springs S963, the contacts 935 and 974, the lower and upper windings of the test relay R950, the wiper 925 and engaged contact in the associated contact bank of the Strowger mechanism 920, the control conductor C605 of the trunk line 600, the contacts 611, C682, C577, the wiper 728 and engaged first contact in the associated contact bank of the rotary switch M720, C788, C770, and the wiper 830 and engaged first contact in the associated contact bank of the rotary switch U820 to the conductor C579. One branch of this path extends from the conductor C579 by way of the resistor 557 to battery; and the other branch of this path extends from the conductor C579 by way of the contacts 531 and the lower winding of R560 to battery. When energized over the above-traced circuit, the test relay R950 in the director selector switch 63 operates to interrupt, at the contacts 954, the previously traced circuit for energizing the winding of the rotary magnet M991, thereby to arrest further operation of the rotary magnet M991 as previously explained. Also, upon operating, the test relay R950 completes, at the contacts 952, a holding circuit for energizing the upper winding thereof in series with the lower winding of the impulse relay R560 in the director 64. This circuit extends from ground in the director selector switch 63 by way of the contacts 952, the contacts 969 of the set of switch springs S967, the contacts 933, and the upper winding of R950 to the wiper 925 of the Strowger mechanism 920, the path between the wiper 925 and battery at the lower winding of the impulse relay R560 in the director 64 being the same as that previously traced. When this holding circuit is completed, the impulse relay R560 in the director 64 is rendered fast to operate; however, it does not operate at this time.

When the wiper carriage of the Strowger mechanism 920 is moved one step in the rotary direction away from its normal position, the sets of switch springs S940 and S976 are actuated. More particularly, the set of switch springs S940 is actuated into engagement, thereby to prepare a point in a circuit, traced hereinafter, for energizing the winding of the control relay R940; and the set of switch springs S976 is actuated into engagement, thereby to prepare a circuit for energizing the lower winding of the test relay R950 subsequent to the operation of the last-mentioned relay. The last-mentioned circuit is completed, at the contacts 952, when the test relay R950 operates, and extends from ground by way of the contacts 952, the contacts 969 of the set of switch springs S967, the contacts 933, the lower winding of R950, the contacts 974 and 935, the set of switch springs S963, the resistor 955, the set of switch springs S976 and the resistor 956 to battery. When the last-mentioned circuit for energizing the lower winding of the test relay R950 is completed, this relay is rendered slightly slow to release subsequent to the release of the director 64 in a manner more fully explained hereinafter.

Also, upon operating, the test relay R950 completes, at the contacts 951, the previously mentioned circuit for energizing the winding of the control relay R940, this circuit extending from ground by way of the set of switch springs S940, 75

the winding of R940 and the contacts 951 to battery. When energized over the above-traced circuit, the relay R940 operates to complete, at the contacts 949, a multiple path around the contacts 974 in the previously traced circuit for energizing the lower winding of the test relay R950, thereby to render the completion of the last-mentioned circuit independent of the operated position of the control relay R970; to interrupt, at the contacts 947, the previously traced circuit for energizing the lower winding of the impulse relay R960 in the director selector switch 63 in series with the upper winding of the test relay R430 in the first code selector switch 61; and to complete, at the contacts 948, an alternative circuit for energizing the upper winding of the test relay R430 in the first code selector switch 61. The last-mentioned circuit extends from ground by way of the contacts 433, the upper winding of R430, the conductor C908 of the trunk line 900, the wiper 914 and engaged contact in the associated contact bank of the selector hunting switch 62, the control conductor C135 of the trunk line 130, the contacts 948, and the resistor 977 to battery. Further, the relay R940 interrupts, at the contacts 945, the previously traced circuit for energizing the upper winding of the impulse relay R960, thereby to cause the last-mentioned relay to restore; and completes, at the contacts 946, a path for applying ground potential appearing upon the conductor C134 of the trunk line 130 to the wiper 924 of the Strowger mechanism 920. Further, the relay R940 completes, at the contacts 944, an obvious connection between the wiper 923 of the Strowger mechanism 920 and the conductor C133 of the trunk line 130 and interrupts, at the contacts 943, a further point in the previously traced circuit for energizing the winding of the rotary magnet M991. Finally, the relay R940 interrupts, at the contacts 940, the previously traced circuit for energizing the winding of the impulse relay R340 in the first code selector switch 61 and completes, at the contacts 941 and 942, an alternative circuit for energizing the winding of the impulse relay R340. The last-mentioned circuit extends from ground in the first code selector switch 61 by way of the contacts 443 and 404, the conductor C905 of the trunk line 900, the wiper 911 and engaged contact in the associated contact bank of the selector hunting switch 62, C132, the contacts 942, the wiper 922 and engaged contact in the associated contact bank of the Strowger mechanism 920, the line conductor C602 of the trunk line 600, the contacts 547, C674, the wiper 845 and engaged first contact in the associated contact bank of the rotary switch S840, C671, the unidirectional current conducting device in the form of a copper oxide rectifier 616, C673, the contact 661, the line conductor C601 of the trunk line 600, the wiper 921 and engaged contact in the associated contact bank of the Strowger mechanism 920, the contacts 941, C131, the wiper 910 and engaged contact in the associated contact bank of the selector hunting switch 62, the conductor C904 of the trunk line 900, the contacts 402 and 441, C100, and the winding of R340 to battery.

Upon restoring, the impulse relay R960 in the director selector switch 63 completes, at the contacts 962, the previously mentioned path for short-circuiting the winding of the control relay R970, this path extending from ground by way of the contacts 962, the set of switch springs S966 and the winding of R970 to ground, thereby to

cause the last-mentioned relay to restore. When ground potential appearing upon the conductor C134 of the trunk line 130 is connected by way of the contacts 946 to the wiper 924 of the Strowger mechanism 920, a circuit is completed for energizing the upper winding of the impulse relay R560 in the director 64. This circuit extends from ground potential appearing upon the wiper 924 of the Strowger mechanism 920 by way of the engaged contact in the associated contact bank, the conductor C604 of the trunk line 600, and the upper winding of R560 to battery. When the upper winding of the relay R560 is thus energized, the lower winding thereof having previously been energized as hereinbefore explained, this relay operates. Upon operating, the relay R560 completes, at the contacts 562, a circuit for energizing the winding of the control relay R550, this circuit extending from ground by way of the winding of R550, the contacts 552, the unidirectional current conducting device in the form of a copper oxide rectifier 566, and the resistor 555 to battery. When energized over the above-traced circuit, the relay R550 operates to complete, at the contacts 552, an obvious circuit for energizing the winding of the control relay R530, thereby to cause the relay R530 to operate. Upon operating, the relay R530 interrupts, at the contacts 531, the previously traced circuit for energizing the lower winding of the relay R560; however, the last-mentioned relay remains in its operated position at this time due to the completed circuit for energizing the upper winding thereof. Also, upon operating, the relay R530 completes, at the contacts 532, an alternative path for applying battery potential in the director 64 by way of the resistor 557, the contacts 532, C682, and the contacts 611 to the control conductor C605 of the trunk line 600, thereby to retain the test relay R950 in the director selector switch 63 in its operated position. Further, the relay R530 prepares, at the contacts 536, a circuit for energizing the lower winding of the timing relay R640 by way of the impulse conductor C501.

Operation of the director to register the second and third letters of the called exchange code and the four digits of the directory number of the called subscriber line

When the calling subscriber at the substation T1 dialed the first letter of the code of the called exchange, the director selector switch 63 operated to select the idle director 64 in the corresponding group of directors, as previously noted. At this time, when the subscriber at the subscriber substation T1 dials the second letter of the called exchange, the line relay R370 follows these impulses and causes these impulses to be repeated to the impulse relay R560 in the director 64, which last-mentioned relay also follows these impulses. Each time the impulse relay R560 restores, it interrupts, at the contacts 562, the previously traced circuit for energizing the winding of the control relay R550 and completes, at the contacts 561, an obvious path for short-circuiting the winding of the relay R550, thereby to render the last-mentioned relay slow to release. Also, upon restoring, the impulse relay R560 completes, at the contacts 561, a circuit for energizing in series the upper winding of the control relay R880 and the winding of the vertical magnet M715. The last-mentioned circuit extends from ground by way of the contacts 561 and 554, C578, the upper winding of R880, the wiper 828 and engaged first contact in the asso-

ciated contact bank of the rotary switch U820, C871 and the winding of M715 to battery. When energized over the above-traced circuit, the relay R880 operates to complete, at the contacts 882, an obvious path for short-circuiting the lower winding thereof, thereby to render the last-mentioned relay slow to release. Also, upon operating, the relay R880 completes, at the contacts 881, a circuit for energizing the winding of the magnet M821 of the rotary switch U820, this circuit extending from ground by way of the wiper 824 and engaged contact in the associated contact bank 825, C865, the contacts 881, C863, C876 and the winding of M821 to battery. When energized over the above-traced circuit, the magnet M821 operates, thereby to condition the wipers 822, 824, 826, 828 and 830 of the rotary switch U820 to be driven one step in the counterclockwise direction. Also, when the winding of the vertical magnet M715 is energized by way of the above-traced circuit, the vertical magnet M715 operates to drive the wiper carriage of the Strowger mechanism 700 one step in the vertical direction. Each time the impulse relay R560 reoperates, it completes, at the contacts 562, the previously traced circuit for energizing the winding of the relay R550 and interrupts, at the contacts 561, the previously traced circuit for energizing the upper winding of the relay R880 in series with the winding of the vertical magnet M715. As previously noted, the relay R550 does not restore during impulsing due to the fact that the winding thereof is alternately energized and short-circuited. Similarly, the relay R880 does not restore during impulsing due to the completed path for short-circuiting the lower winding thereof. Accordingly, the vertical magnet M715 is repeatedly operated a predetermined number of times, corresponding to the second letter of the called exchange code, thereby to cause the wiper carriage of the Strowger mechanism 700 to be driven a corresponding number of steps in the vertical direction.

After the second letter of the called exchange code has been dialed, the impulse relay R560 reoperates, thereby to interrupt the previously traced circuit for energizing in series the upper winding of the relay R880 and the winding of the vertical magnet M715, whereupon the relay R880 restores shortly thereafter and further operation of the vertical magnet M715 is arrested. Upon restoring, the relay R880 interrupts, at the contacts 882, the previously mentioned path for short-circuiting the lower winding thereof and interrupts, at the contacts 881, the previously traced circuit for energizing the winding of the magnet M821 of the rotary switch U820, thereby to cause the last-mentioned magnet to restore. Upon restoring, the magnet M821 of the rotary switch U820 drives the previously noted wipers thereof one step in the counterclockwise direction. When the wiper 828 of the rotary switch U820 is driven one step in the counterclockwise direction, it engages the second contact in the associated contact bank, thereby to prepare a circuit, traced hereinafter, for energizing the upper winding of the relay R880 in series with the winding of the rotary magnet M716.

The calling subscriber at the substation T1 then dials the third letter of the called exchange code, whereupon the line relay R370 in the first code selector switch 61 and the impulse relay R560 in the director 64 follow the impulses of the third letter of the called exchange code, as

previously explained. The intermittent operation of the impulse relay R560 intermittently completes the previously mentioned circuit for energizing the upper winding of the relay R880 in series with the winding of the rotary magnet M716, this circuit extending, when completed, from ground by way of the contacts 561 and 554, C578, the upper winding of R880, the wiper 828 and engaged second contact in the associated contact bank of the rotary switch U820, C372 and the winding of M716 to battery. Also, the relay R880 reoperates and remains in its operated position during impulsing, as previously explained. Upon reoperating, the relay R880 reCompletes, at the contacts 881, the previously traced circuit for energizing the magnet M821 of the rotary switch U820, thereby to cause the last-mentioned magnet to operate and condition the wipers noted of the rotary switch U820 to be driven an additional step in the counterclockwise direction. Accordingly, the rotary magnet M716 is repeatedly energized in accordance with the impulses of the third letter of the called exchange code, thereby to cause the wiper carriage of the Strowger mechanism 700 to be driven a corresponding number of steps in the rotary direction. Further, it is noted that when the wiper carriage of the Strowger mechanism 700 is moved one step in the vertical direction away from its normal position, the set of switch springs S718 is actuated into engagement, thereby to prepare an alternative circuit, traced hereinafter, for energizing the rotary magnet M716. At the conclusion of the third letter of the called exchange code, the relay R880 again restores, thereby to interrupt, at the contacts 881, the previously traced circuit for energizing the magnet M821 of the rotary switch U820, whereupon the wipers noted of the rotary switch U820 are driven an additional step in the counterclockwise direction. More particularly, the wiper 828 of the rotary switch U820 engages the third contact in the associated contact bank, thereby to prepare a circuit, traced hereinafter, for energizing in series the upper winding of the relay R880 and the magnet M721 of the rotary switch M720.

At the conclusion of the third letter of the called exchange code the Strowger mechanism 700 occupies a predetermined vertical position corresponding to the second letter of the called exchange code and a predetermined rotary position corresponding to the third letter of the called exchange code. Accordingly, the wipers 701 to 710, inclusive, carried by the wiper carriage of the Strowger mechanism 700 engage the individual contacts of a predetermined contact set in the associated contact bank; and the test wipers 711 and 712 carried by the wiper carriage of the Strowger mechanism 700 engage a predetermined contact set in the associated vertical test contact bank 713. At this time there is registered in the contact bank associated with the wiper 735 of the rotary switch T730 the three letters of the called exchange code and the rate applicable to the call between the originating exchange 50 and the terminating exchange 52. In the event the call is a local call or a call to an adjacent exchange for which no toll charge is made, no rate is registered in the contact bank associated with the wiper 735 of the rotary switch T730. Further, it is noted that the first letter of the called exchange code is permanently connected by way of the straps 761 in the jumper field 714 to the WXYZ leads of the first group of leads 791, in view of the fact that the

first letter of the called exchange is permanently established due to the selection by the director selector switch 63 of the particular director 64. The second letter of the called exchange code is determined by the position of the vertical test wipers 711 and 712 with respect to the vertical test contact bank 713, and the marking path extends from the second group of WXYZ leads in the second group of leads 792 by way of the straps 760 in the jumper field 714 and the engaged contact set in the vertical test contact bank 713 to the vertical test wipers 711 and 712 of the Strowger mechanism 700. Finally, the third letter of the called exchange code is determined by the combination vertical and rotary position of the wipers 707 and 708 carried by the wiper carriage of the Strowger mechanism 700, and the marking path extends from the WXYZ leads in the third group of leads 793 by way of the straps 762 in the jumper field 714 and the engaged contact set in the main contact bank to the wipers 707 and 708 of the Strowger mechanism 700. Finally, in the event there is a toll charge for the call between the originating exchange 50 and the terminating exchange, this rate is determined by the combination vertical and rotary positions of the wipers 709 and 710 carried by the wiper carriage of the Strowger mechanism 700, and the marking path extends from the WXYZ leads in the fourth group of leads 794 by way of the straps 763 in the jumper field 714 and the engaged contact set in the main contact bank to the wipers 709 and 710 of the Strowger mechanism 700. Finally, it is noted that a predetermined number of the wipers 701 to 706, inclusive, of the Strowger mechanism 700 engage contacts in the associated main contact bank which are connected by way of the straps 764 in the jumper field 714 to predetermined ones of the marking leads C751 to C750, inclusive, in the group of marking leads 858; while the remainder of the wipers 701 to 706, inclusive, of the Strowger mechanism 700 engage contacts in the associated main contact bank which are multiplied together and connected to the cut-off lead C765, for a purpose more fully described hereinafter.

The number of wipers of the Strowger mechanism 700 which are connected by way of the straps 764 in the jumper field 714 to the marking leads in the group of marking leads 858 is determined by the route over which the call is to be extended from the originating exchange to the terminating exchange. At this point it is noted that this number of wipers may comprise any number between one and six, depending upon the route of the call as noted above. In the present example, where it is assumed that the call from the subscriber substation T1 in the originating exchange 50 is to be extended to the subscriber substation T2 in the terminating exchange 52, the number of wipers which are connected to marking leads in the group of marking leads 858 comprises two. Specifically, the wipers 701 and 702 of the Strowger mechanism 700 engage contacts in the associated contact bank which are connected by way of the straps 764 in the jumper field 714 to marking leads in the group of marking leads 858; while the remainder of the wipers 703 to 706, inclusive, of the Strowger mechanism 700 engage contacts in the associated main contact bank which are multiplied to the cut-off lead C765. The number of wipers of the Strowger mechanism 700 which are connected to marking leads in the group of marking leads 858 comprises two in the present example, in view of the fact

that the first code selector switch 61 will absorb one digit in order to find the idle toll ticket repeater 65 and the group selector switch 80 in the intermediate exchange 51 individually associated with the toll ticket repeater 65 will absorb an additional digit in order to find the idle dial repeater 81 individually associated with the toll line 2201 extending to the terminating exchange 52.

The particular leads in the group of marking leads 858 to which the contacts in the main contact bank of the Strowger mechanism 700 engaged by the wipers 701 and 702, respectively, are connected by way of the straps 764 in the jumper field 714 is determined by the two particular digits which it is desired to transmit from the director 64 to the first code selector switch 61 and to the group selector switch 80, as previously explained. These two particular digits, which it is desired to transmit respectively to the first code selector switch 61 and to the group selector switch 80, are, in turn, determined by the location of the particular group of trunk lines, including the trunk line 426 extending to the repeater 65, and by the particular location of the group of toll lines, including the toll line 2201 extending between the intermediate exchange 51 and the terminating exchange 52.

Assuming that the designations of the originating exchange 50 and the terminating exchange 52 are respectively MONROE and MADISON, the three letters of the codes of the respective exchanges will be MON and MAD. Further, it is assumed that the distance between the originating exchange 50 and the terminating exchange 52 is such that a rate factor of 6 is applicable to a toll call therebetween. Accordingly, at this time, there are registered in the contact bank associated with the wiper 735 of the rotary switch T730 digits respectively corresponding to the letters MAD and a rate factor corresponding to the digit 6. Further, it is noted that these digits are registered in the contact bank associated with the wiper 735 of the rotary switch T730 in code by appropriate markings of the WXYZ leads in the first, second, third and fourth groups of marking leads 791, 792, 793 and 794, respectively. The particular manner of marking the WXYZ marking leads is the same as that previously explained. For example, the rate factor 6 is registered in the fourth group of marking leads 794 by the straps 763 in the jumper field 714 extending between the marking leads YZ and the contacts in the main contact bank of the Strowger mechanism 700 which are engaged by the wipers 709 and 710.

Continuing now with the operation of the director 64 to register the four digits of the directory number of the called subscriber line 2200, when the subscriber at the subscriber substation T1 dials the first of these digits, the impulse relay R370 in the first code selector switch 61 and the impulse relay R560 in the director 64 operate as previously explained, thereby to cause the upper winding of the relay R880 and the winding of the magnet M721 to be energized in series circuit relationship. Each time the magnet M721 is energized and subsequently deenergized, the wipers 723, 725 and 728 of the rotary switch M720 are moved one step in the counterclockwise direction. More particularly, the magnet M721 of the rotary switch M720 is energized and subsequently deenergized a number of times corresponding to the first digit of the directory number of the called subscriber line 2200. At the conclusion of the first digit of the directory number of the called

subscriber line 2200, the relay R880 restores, thereby to interrupt the previously traced circuit for energizing the winding of the magnet M821 of the rotary switch U820, whereupon the wipers of the rotary switch U820 are driven an additional step in the counterclockwise direction. Specifically, the wiper 828 of the rotary switch U820 is driven into engagement with the fourth contact in the associated contact bank, thereby to prepare a circuit for energizing the upper winding of the relay R880 in series with the winding of the magnet M801 of the rotary switch C800. Hence, at the conclusion of the first digit of the directory number of the called subscriber line 2200, the wiper 725 of the rotary switch M720 engages a contact in the associated contact bank corresponding to the first digit of the directory number of the called subscriber line 2200 and connected by way of one of the leads in the group of marking leads 766 to a corresponding one of the leads in the group of marking leads 858.

In view of the above description of the operation of the director 64 to register in the rotary switch M720 the first digit of the directory number of the called subscriber line 2200, it will be understood that the director 64 operates in a similar manner, thereby to register in the rotary switches C800, D810 and U820, respectively, the second, third and fourth digits of the directory number of the called subscriber line 2200. In this connection, it is noted that when the wiper 828 of the rotary switch U820 disengages the fifth contact in the associated contact bank thereof, the wiper 824 of the rotary switch U820 disengages the fifth contact in the associated contact bank, thereby to interrupt the previously traced circuit for energizing the winding of the magnet M821 of the rotary switch U820 by way of the wiper 824 of the rotary switch U820. Furthermore, when the wiper 828 of the rotary switch U820 disengages the fifth contact in the associated contact bank, it immediately engages the sixth contact therein, thereby to prepare a circuit for energizing the winding of the magnet M821 directly in series with the upper winding of the relay R880. This circuit extends, when completed, from ground by way of the contacts 561 and 554, C578, the upper winding of R880, the wiper 828 of the rotary switch U820, the engaged sixth contact in the associated contact bank, C876 and the winding of M821 to battery. Accordingly, after the fourth digit of the directory number of the called subscriber line 2200 has been dialed at the subscriber substation T1, there are registered in the rotary switches M720, C800, D810 and U820, respectively, the first, or thousand digit; the second, or hundred digit; the third, or ten digit; and the fourth, or unit digit of the directory number of the called subscriber line 2200.

Operation of the director to transmit the directive digits and the four digits of the directory number of the called subscriber line registered therein

The Strowger mechanism 700 occupies its fully operated position and the wipers noted of the rotary switch U820 engage the third contacts in the associated contact banks at the conclusion of the third letter of the called exchange code and prior to the time the first digit of the directory number of the called subscriber line 2200 is dialed at the subscriber substation T1, as previously explained. When the wiper 826 of the rotary switch U820 engages the third contact in the associated contact bank, a circuit is com-

pleted for energizing the control relay R620. This circuit extends from ground by way of the contacts 533, C685, C666, the wiper 826 of the rotary switch U820 and engaged third contact in the associated contact bank, C768, the wiper 746 of the rotary switch CN740 and the engaged first contact in the associated contact bank, C690, the contacts 634 and 612, the winding of R620 and the resistor 613 to battery. At this point it is noted that when the director 64 is seized by the director selector switch 63, a motor, not shown, is operated to drive the first and second impulsing devices I614 and I615 in synchronism. More particularly, the first and second impulsing devices I614 and I615 are rotated at a rate of ten revolutions per second and are arranged 180 degrees out of phase with respect to each other, each of these impulsing devices comprising a wiper and an associated drum, including complementary conducting and insulating portions. Accordingly, when the conducting portion of the drum of the first impulsing device I614 engages the associated wiper, the insulating portion of the drum of the second impulsing device I615 engages the associated wiper. Further, it is noted that the first impulsing device I614 constitutes line impulsing means; while the second impulsing device I615 constitutes control impulsing means. Finally, it is noted that a path is provided for short-circuiting the winding of the control relay R620 which extends from the upper terminal of the winding of R620 by way of the second impulsing device I615 and the contacts 624 to the lower terminal of the winding of R620. Accordingly, the above-traced circuit for energizing the winding of the relay R620 incident to the operation of the rotary switch U820 to cause the wiper 826 thereof to engage the third contact in the associated contact bank is not completed immediately unless the second impulsing device I615 occupies a position wherein the insulating portion of the drum thereof engages the associated wiper, thereby to interrupt the above-traced path for short-circuiting the winding of the relay R620.

Upon operating, the relay R620 interrupts, at the contacts 624, a further point in the above-traced path for short-circuiting the winding thereof and completes, at the contacts 622, a holding circuit for energizing the winding thereof, this circuit extending from ground by way of the contacts 533, C685, the contacts 622, 634 and 612, the winding of R620 and the resistor 613 to battery. Also, upon operating, the relay R620 completes, at the contacts 621, a circuit for energizing the winding of the magnet M741 of the rotary switch CN740, this circuit extending from ground by way of the contacts 631 and 621, C681 and the winding of M741 to battery. When energized over the above-traced circuit, the magnet M741 operates, thereby to condition the wiper 743, 745 and 746 of the rotary switch CN740 to be driven one step in the counterclockwise direction away from their normal positions. Also, upon operating, the relay R620 prepares, at the contacts 623, a point in a circuit traced hereinafter for energizing the winding of the magnet M841 of the rotary switch S840, which circuit is completed when the second impulsing device I615 operates to cause the conducting portion of the drum thereof to engage the associated wiper. The last-mentioned circuit extends, when completed, from ground by way of the contacts 533, C685, the contacts 622, 634 and 612, the second impulsing device I615, the contacts 623, C677 and the winding of

M841 to battery. When energized over the above-traced circuit, the magnet M841 operates, thereby to condition the wipers 843, 845, 849, 852 and 854 of the rotary switch S840 to be driven one step in the counterclockwise direction. When the second impulsing device I615 operates further, in order to cause the insulating portion of the drum thereof to engage the associated wiper, the above-traced circuit for energizing the winding of the magnet M841 of the rotary switch S840 is interrupted, thereby to cause the magnet M841 to restore and drive the wipers noted of the rotary switch S840 one step in the counterclockwise direction away from their normal positions.

It is noted that the first impulsing device I614 is adapted to complete one of two alternative impulsing paths including the trunk line 600, one of these impulsing paths being between the positive and negative line conductors C602 and C601, respectively, of the trunk line 600; and the other of these impulsing paths being between the negative line conductor C601 and ground potential in the director 64. The particular one of these alternative impulsing paths which is completed depends upon the operated or nonoperated position of the control relay R540 in the director 64, which relay occupies its restored position in the event the call is to be extended from the originating exchange 50 to a terminating exchange for which there is no toll charge, and which occupies its operated position in the event there is a toll charge between the originating exchange 50 and the terminating exchange, in a manner more fully described hereinafter. The first of these alternative impulsing paths extends from the positive line conductor C602 of the trunk line 600 by way of the contacts 547, C674, the first impulsing device I614, the unidirectional current conducting device in the form of a copper oxide rectifier 616, C673 and the contacts 661 to the negative line conductor C601 of the trunk line 600; and the second of these alternative impulsing paths extends from ground by way of the contacts 548, C674, the first impulsing device I614, the rectifier 616, C673 and the contacts 661 to the negative line conductor C601 of the trunk line 600. Further, it is noted that the utilized one of these alternative impulsing paths by way of the trunk line 600 is short-circuited until the rotary switch S840 is operated to cause the wiper 845 thereof to engage the third contact in the associated contact bank. The last-mentioned short-circuiting path extends from the conductor C674, by way of the first two contacts in the contact bank associated with the wiper 845 of the rotary switch S840, C671, the rectifier 616, C673 and the contacts 661 to the negative line conductor C601 of the trunk line 600.

Further, it is noted that, upon operating, the control relay R530 completes, at the contacts 533, a path for applying ground potential to the wiper 745 of the rotary switch CN740, this path extending from ground by way of the contacts 533, C685, the contacts 664 and C684 to the wiper 745. At this time the wipers noted of the rotary switch CN740 occupy their normal rotary positions. Accordingly, the wiper 745 engages the first contact in the associated contact bank extending to the conductor C771 extending to the first wiper 701 of the Strowger mechanism 700, which last-mentioned wiper engages a contact in the associated main contact bank which is connected by way of one of the straps 764 in the jumper field 714 to one of the leads C751 to C750,

inclusive, in the group of marking leads 858, thereby to cause ground potential to be forwarded by way of the above-traced path to the particular lead in the group of marking leads 858.

In view of the above description, it is apparent that the operation of the second impulsing device 1615 causes the wipers noted of the rotary switch S840 to be driven step by step in the counterclockwise direction, and that after the wipers have been driven two steps in the counterclockwise direction the wiper 845 thereof engages the third contact in the associated contact bank, whereupon the previously traced path for short-circuiting the impulsing path including the first impulsing device 1164 is interrupted. At this time the first impulsing device 1614 begins effectively to transmit impulses over the selected impulsing path including the trunk line 600. More particularly, the first impulsing device 1614 transmits a predetermined number of impulses over the selected impulsing path including the trunk line 600 corresponding to the particular one of the leads in the group of marking leads 858 which is marked with ground potential by way of the previously traced path including the first wiper of the Strowger mechanism 700. When the first impulsing device 1614 transmits this predetermined number of impulses, the rotary switch S840 has been operated to a predetermined rotary position, whereupon the wiper 852 thereof engages a contact in the associated contact bank terminating the marked lead in the group of marking leads 858 and thus a circuit is completed for energizing the winding of the stop relay R630. The last-mentioned circuit extends from ground potential appearing upon the marked lead in the group of marking leads 858 by way of the wiper 852 and engaged contact in the associated contact bank of the rotary switch S840, C688 and the winding of R630 to battery. When energized over the above-traced circuit, the stop relay R630 operates to complete, at the contacts 633, a holding circuit for energizing the winding thereof.

The last mentioned circuit extends from the grounded conductor C685 by way of the wiper 849 and the engaged multiplied contacts in the associated contact bank of the rotary switch S840, C860, C689, the contacts 633 and the winding of R630 to battery. Also, upon operating, the stop relay R630 completes, at the contacts 636, an obvious circuit for short-circuiting the first impulsing device 1614, thereby to prevent further impulses from being transmitted from the first impulsing device 1614 over the selected impulsing path including the trunk line 600. Also, upon operating, the stop relay R630 interrupts, at the contacts 634, a point in the previously traced circuit for energizing the winding of the control relay R620, thereby to cause this relay to restore. Upon restoring, the control relay R620 interrupts, at the contacts 621, the previously traced circuit for energizing the winding of the magnet M741, whereupon the magnet M741 restores to drive the wipers noted of the rotary switch CN740 one step in the counterclockwise direction away from their normal positions. Furthermore, upon restoring, the relay R620 completes, at the contacts 625, an alternative circuit for energizing the winding of the magnet M841 of the rotary switch S840. The last-mentioned circuit extends from ground by way of the wiper 843 thereof, the engaged multiplied contact in the associated contact bank, C679, the contacts 625, C676, the contacts 842 and the winding of M841 to battery. When energized over the above-traced circuit, 75

the magnet M841 operates to interrupt, at the contacts 842, the circuit for energizing the winding thereof, thereby to cause the magnet M841 to restore and recomplete, at the contacts 842, the circuit for energizing the winding thereof. Accordingly, the magnet M841 operates intermittently, thereby to drive the wipers noted of the rotary switch S840 step by step in the counterclockwise direction until the wiper 843 thereof disengages the fourteenth contact in the associated contact bank, thus interrupting the above-traced alternative circuit for energizing the winding of the magnet M841.

When the wiper 843 of the rotary switch S840 disengages the fourteenth contact in the associated contact bank, it immediately engages the fifteenth contact in the associated contact bank, whereupon an alternative circuit is completed for energizing the winding of the control relay R620 when the insulating portion of the drum of the second impulsing device 1615 engages the associated wiper. The last-mentioned circuit extends from ground by way of the wiper 843 and engaged fifteenth contact in the associated contact bank of the rotary switch S840, C678, the contacts 637, the winding of R620 and the resistor 613 to battery. When energized over the above-traced circuit, the relay R620 operates to interrupt, at the contacts 625, a further point in the previously traced alternative circuit for energizing the winding of the magnet M841 of the rotary switch S840 and prepares, at the contacts 623, an alternative circuit for energizing the winding of the magnet M841 of the rotary switch S840 by way of the second impulsing device 1615. The last-mentioned circuit extends, when completed, from ground by way of the wiper 843 and engaged fifteenth contact in the associated contact bank of the rotary switch S840, C678, the contacts 637, the second impulsing device 1615, the contacts 623 and the winding of M841 to battery. Accordingly, the magnet M841 of the rotary switch S840 is operated intermittently a predetermined number of times by way of the second impulsing device 1615 and until the wiper 843 of the rotary switch S840 is driven into engagement with the nineteenth contact in the associated contact bank, whereupon the above-traced alternative circuit for energizing the winding of the control relay R620 is interrupted in order to cause the relay R620 to restore. Upon restoring, the relay R620 interrupts, at the contacts 623, the previously traced alternative circuit for energizing the winding of the magnet M841 of the rotary switch S840 by way of the second impulsing device 1615 and completes, at the contacts 625, the first-mentioned alternative circuit for energizing the winding of the magnet M841 of the rotary switch S840, whereupon the magnet M841 is intermittently operated until the wiper 843 thereof is driven to disengage the last contact in the associated contact bank and into engagement with the first contact in the associated contact bank, at which time the rotary switch S840 again occupies its normal position. Further, it is noted that during the operation of the rotary switch S840, when the wiper 845 thereof engages the fourteenth contact in the associated contact bank, the previously traced path for short-circuiting the first impulsing device 1614 is again completed, which path is not again interrupted until the wiper 845 reengages the third contact in the associated contact bank, as previously explained.

In view of the foregoing description, it is

apparent that the rotary switch S840 is operated from its normal position two steps at a slow rate by the second impulsing device I615, whereupon the first impulsing device I614 becomes effective to transmit impulses over the trunk line 600. The rotary switch S840 is then operated an additional predetermined number of steps at a slow rate by the second impulsing device I615, while the first impulsing device I614 is transmitting impulses over the trunk line 600, which predetermined number of steps corresponds to the particular lead in the group of marking leads 858 marked by the first wiper 701 of the Strowger mechanism 700, thereby to cause the director 64 to transmit a first directive digit over the trunk line 600 corresponding to the marked lead in the group of marking leads 858. Subsequently, the rotary switch S840 operates at a fast rate until the fifteenth contact in the contact bank associated with the wiper 843 thereof is engaged. The rotary switch S840 is then operated four additional steps at a slow rate by the second impulsing device I615 until the wiper 843 thereof engages the nineteenth contact in the associated contact bank, the rotary switch S840 being operated four times at a slow rate at this time in order to provide a time interval at the conclusion of the first directive digit transmitted from the director 64 over the trunk line 600. Further, when the wiper 843 of the rotary switch S840 engages the nineteenth contact in the associated contact bank, the rotary switch S840 is operated at a fast rate back into its normal position, whereupon the wipers noted of the rotary switch S840 engage the first contacts in the associated contact banks. Finally, it is noted that when the rotary switch S840 is restored to its normal rotary position, the wiper 849 thereof disengages the last contact in the associated contact bank, thereby to interrupt the previously traced holding circuit for energizing the winding of the stop relay R630, whereupon the stop relay R630 restores. Upon restoring, the stop relay R630 completes, at the contacts 634, an alternative circuit for energizing the winding of the control relay R620. At this time the rotary switch S840 in the director 64 is in condition to transmit the second directive digit from the director 64 over the trunk line 600.

The alternative circuit for energizing the winding of the relay R620 extends from ground by way of the contacts 533, C685, C866, C767, the wiper 746 and engaged second contact in the associated contact bank of the rotary switch CN740, C690, the contacts 634 and 612, the winding of R620 and the resistor 613 to battery. As previously noted, this last-mentioned circuit is not completed until the second impulsing device I615 is operated to cause the insulating portion of the drum thereof to engage the associated wiper, thereby to interrupt the previously traced path for short-circuiting the winding of the control relay R620. At this time ground potential is conducted by way of the previously traced path to the wiper 745 of the rotary switch CN740 and is extended therefrom by way of the conductor C772 to the second wiper 702 of the Strowger mechanism 700 and therefrom by way of the engaged contact in the associated main contact bank and one of the straps 764 in the jumper field 714 to a particular one of the leads in the group of marking leads 858. Accordingly, a particular one of the leads in the group of marking leads 858 is marked at this time, thereby to arrest the operation of the first impulsing device I614

after it has operated, as described above, in order to transmit a predetermined number of impulses over the trunk line 600, which predetermined number of impulses corresponds to the marked lead in the group of marking leads 858, as previously explained. Accordingly, the director 64 operates in the previously described manner, thereby to transmit the second directive digit over the trunk line 600 and, after a time interval, it is conditioned to transmit other directive digits over the trunk line 600 in the event there are other digits to be transmitted thereover.

In the present example, as previously noted, only two directive digits are required. Accordingly, after the second directive digit has been transmitted over the trunk line 600, the wiper 745 of the rotary switch CN740 is operated to engage the third contact in the associated contact bank, which contact terminates the conductor C773 extending to the third wiper 703 of the Strowger mechanism 700. As previously noted, the third, fourth, fifth and sixth wipers of the Strowger mechanism 700 engage contacts in the associated contact bank which are multiplied together and connected by way of the jumper field 714 to the cut-off lead C765. Accordingly, after the second directive digit has been transmitted from the director 64 over the trunk line 600 and before the elapse of the following time interval, the wipers 743 and 745 of the rotary switch CN740 engage the third contacts in the associated contact banks, whereupon an alternative circuit for energizing the winding of the magnet M741 of the rotary switch CN740 is completed. The last-mentioned circuit extends from ground by way of the contacts 533, C685, the contacts 664, C684, the wiper 745 and engaged third contact in the associated contact bank, C773, the third wiper 703 of the Strowger mechanism 700 and engaged contact in the associated contact bank, the cut-off lead C765, the multiplied contact 744 in the contact bank associated with the wiper 743 of the rotary switch CN740, the self-interrupting contact 742 of the magnet M741, and the winding of M741 to battery. When energized over the above-traced circuit, the magnet M741 operates to interrupt, at the self-interrupting contact 742 thereof, the previously traced circuit for energizing the winding of M741. Accordingly, the rotary switch CN740 is operated step by step until the wiper 745 thereof disengages the sixth contact in the associated contact bank, the last-mentioned contact being connected by way of the conductor C776 to the sixth wiper 706 of the Strowger mechanism 700. While the wiper 745 of the rotary switch CN740 is in engagement with the third, fourth, fifth and sixth contacts in the associated contact bank, the previously traced circuit for energizing the winding of the magnet M741 of the rotary switch CN740 is completed by way of the third, fourth, fifth and sixth wipers of the Strowger mechanism 700. When the wiper 745 of the rotary switch CN740 disengages the sixth contact in the associated contact bank, the circuit for energizing the winding of the magnet M741 is interrupted, thereby to arrest further operation of the rotary switch CN740 at this time.

At this time the director 64 is conditioned to transmit the first digit of the directory number of the called subscriber line as registered in the rotary switch M720. The first and second impulsing devices I614 and I615 operate, as previously explained, until the wiper 852 of the rotary switch S840 engages a marked contact in

the associated contact bank which is connected to a marked lead in the group of marking leads 858. At this time the path for marking one of the leads in the group of leads 858 extends from ground by way of the contacts 533, C685, the contacts 664, C684, the wiper 745 and engaged seventh contact in the associated contact bank of the rotary switch CN740, C717, the wiper 725 and engaged contact in the associated contact bank of the rotary switch M720, and the particular lead in the group of marking leads 766 terminated by the engaged contact in the contact bank associated with the wiper 725 of the rotary switch M720 to a corresponding lead in the group of marking leads 858. Thus, it will be understood that the director 64 operates at this time to transmit the first digit of the directory number of the called subscriber line 2200, which is registered in the rotary switch M720, as previously explained. At the conclusion of the first, or thousand, digit of the directory number of the called subscriber line 2200, the rotary switch CN740 is operated, thereby to drive the wiper 745 thereof an additional step in the counterclockwise direction and into engagement with the eighth contact in the associated contact bank, whereupon a marking circuit for the contact bank associated with the wiper 852 of the rotary switch S840 is completed by way of the rotary switch C800. Specifically, at this time, the contact bank associated with the wiper 852 of the rotary switch S840 is marked to arrest operation of the first impulsing device I614 after the first impulsing device I614 has transmitted a number of impulses corresponding to the second, or hundred, digit of the directory number of the called subscriber line 2200.

In view of the above description, it will be understood that the wiper 745 engages the seventh, eighth, ninth and tenth contacts in the associated contact bank of the rotary switch CN740 at the beginning of the first, or thousand; the second, or hundred; the third, or ten; and the fourth, or unit, digits of the directory number of the calling subscriber line 2200, whereby the contact bank associated with the wiper 852 of the rotary switch S840 is sequentially marked by way of the rotary switches M720, C800, D810 and U820 in order to cause the director 64 to transmit the four digits of the directory number of the called subscriber line 2200 as registered in the respective rotary switches M 720, C800, D810 and U820 over the trunk line 600. At this time the director 64 has operated to transmit both the directive digits and the digits of the directory number of the called subscriber line 2200 over the trunk line 600.

At this point it is noted that, in the present example, there is a toll charge for a call between the originating exchange 50 and the terminating exchange 52. Accordingly, the director 64 transmits the digits therefrom by way of the second impulsing path, traced above, extending from the contacts 548 by way of the negative line conductor C601 of the trunk line 600 due to the operated position of the control relay R540. More particularly, after the second and third letters of the called exchange code have been dialed into the director 64 and the Strowger mechanism 700 has operated in response thereto, the rotary switch U820 is operated to cause the wiper 826 thereof to engage the third contact in the associated contact bank,

whereupon the control relay R620 is operated as previously explained. Also, upon operating, the relay R620 completes, at the contacts 622, a circuit for energizing the winding of the control relay R540 due to the fact that the contacts in the main contact bank of the Strowger mechanism engaged by the ninth and tenth wipers 709 and 710, respectively, thereof are connected by way of the straps 763 in the jumper field 714 to certain of the WXYZ leads in the group of marking leads 794 extending to the contact bank associated with the wiper 735 of the rotary switch T730, in order to establish the rate applicable to the call between the originating exchange 50 and the terminating exchange 52. The circuit for energizing the winding of the control relay R540 extends from the grounded conductor C685 by way of the contacts 622, C690, the wiper 746 and engaged first contact in the associated contact bank of the rotary switch CN740, C768, C572, the contacts 542, C570, at least one of the wipers 709 or 710 of the Strowger mechanism 700 and the engaged contact in the associated main contact bank thereof, at least one of the WXYZ leads in the group of marking leads 794, the cable 575, the corresponding one of the contacts 543, 544, 545 or 546 and the winding of R540 to battery. When energized over the above-traced circuit, the relay R540 operates to complete, at the contacts 540, a holding circuit for energizing the winding thereof, this circuit extending from ground by way of the contacts 553 and 540 and the winding of R540 to battery. Also, upon operating, the relay R540 interrupts, at the contacts 542 and at least one of the contacts 543, 544, 545 or 546, the previously traced circuit for energizing the winding thereof and completes, at the contacts 541, an alternative path for applying ground potential by way of the conductor C570 to the main wipers 707 to 710, inclusive, and to the vertical test wipers 711 and 712 of the Strowger mechanism 700. Further, the relay R540 interrupts, at the contacts 547, and completes, at the contacts 548, respectively, points in the first and second impulsing paths previously traced.

After the director 64 has operated to transmit the digits mentioned above, the rotary switch CN740 is operated, thereby to drive the wiper 745 thereof into engagement with the eleventh contact in the associated contact bank, whereupon a circuit is prepared for energizing the lower winding of the cut-off relay R610, which circuit is completed subsequent to the restoration of the stop relay R630, the stop relay R630 being restored when the rotary switch S840 is returned to its normal rotary position, as previously explained. The last-mentioned circuit extends from ground by way of the contacts 533, C685, the contacts 664, C684, the wiper 745 and engaged eleventh contact in the associated contact bank of the rotary switch CN740, C692, the contacts 635 and the lower winding of R610 to battery. When energized over the above-traced circuit, the cut-off relay R610 operates to interrupt, at the contacts 612, the previously traced circuit for energizing the winding of the control relay R620, thereby positively to prevent further energization of the winding of the control relay R620 and to interrupt, at the contacts 611, the previously traced path for applying battery potential at the resistor 557 in the director 64 to the conductor C605 of the trunk line 600, thus effecting the release of the director 64, the

director selector switch 63 and the selector hunting switch 62, in a manner more fully described hereinafter.

Operation of the first code selector switch in response to the first directive digit transmitted thereto by the director

When the impulses of the first directive digit are transmitted by the director 64 over the second impulsing path including the trunk line 600, the previously traced circuit for energizing the winding of the impulse relay R340 in the first code selector switch 61 is intermittently interrupted, thereby to cause the impulse relay R340 to follow the impulses of the first directive digit. Upon restoring, the impulse relay R340 interrupts, at the contacts 341, the previously traced circuit for energizing the lower winding of the transfer relay R360 and completes, at the contacts 342, a circuit for energizing the upper winding of the transfer relay R360 in series with the vertical magnet M392. The last-mentioned circuit extends from ground by way of the contacts 351, 342 and 366, the upper winding of R360 and the winding of the vertical magnet M392 to battery. When the winding of the vertical magnet M392 is thus energized, the vertical magnet M392 operates to drive the wiper carriage of the Strowger mechanism 480 one step in the vertical direction away from its normal position. When the wiper carriage of the Strowger mechanism 480 is driven one step in the vertical direction away from its normal position, the sets of switch springs S372, S373, S376 and S424 are actuated. More particularly, the set of switch springs S372 are actuated into disengagement, thereby to interrupt the previously traced path for short-circuiting the lower winding of the test relay R430; the contacts 374 of the set of switch springs S373 are actuated into disengagement, thereby to interrupt a further point in the previously traced circuit for energizing the lower winding of the transfer relay R360; the contacts 375 of the set of switch springs S373 are actuated into engagement; the set of switch springs S376 is actuated into engagement, thereby to prepare a circuit, traced hereinafter, for energizing the winding of the rotary magnet M390; and the set of switch springs S424 is actuated into engagement. Upon reoperating, the impulse relay R340 interrupts, at the contacts 342, the previously traced circuit for energizing the upper winding of the transfer relay R360 in series with the winding of the vertical magnet M392. Accordingly, the previously traced circuit for energizing the upper winding of the transfer relay R360 and the winding of the vertical magnet M392 is intermittently completed a number of times corresponding to the number of impulses of the first directive digit transmitted by the director 64. The transfer relay R360, being of the slow-to-release type, remains operated during impulsing. At the conclusion of the first directive digit the wiper carriage of the Strowger mechanism 480 occupies a corresponding vertical position, thereby to select two groups of trunk lines extending to toll ticket repeaters, one group of the trunk lines being accessible to the first wiper set including the wipers 481, 482 and 483 of the Strowger mechanism 480, and the other group being accessible to the second wiper set including the wipers 484, 485 and 486 of the Strowger mechanism 480.

At the conclusion of the first directive digit the impulse relay R340 reoperates and, shortly thereafter, the transfer relay R360 restores.

When the set of switch springs S376 is actuated into engagement incident to the movement of the wiper carriage of the Strowger mechanism 480 in the vertical direction away from its normal position, a circuit is also completed for energizing the intermediate windings of the switching relays R460 and R470. This circuit extends from ground by way of the contacts 453, C110, the contacts 384 and 365, the set of switch springs S376, C112, the contacts 454, and the multiple connected intermediate windings of the relays R460 and R470 to battery. When energized over the above-traced circuit, the switching relays R460 and R470 operate to complete, at the contacts 467 and 473, respectively, a holding circuit for energizing the intermediate windings thereof in multiple. This holding circuit extends from ground by way of the contacts 453, C110, the contacts 384, C109, the contacts 307, C127, the contacts 478 and 467, C124, the self-interrupting contacts 391 of the rotary magnet M390, C112, the contacts 454 and the multiple-connected intermediate windings of the relays R460 and R470 to battery.

Upon restoring, the transfer relay R360 completes, at the contacts 364, a circuit for energizing the winding of the rotary magnet M390, this circuit extending from ground by way of the contacts 453, C110, the contacts 384, C109, the contacts 307, C127, the contacts 478 and 467, C124, the contacts 391, the set of switch springs S376, the contacts 364 and the winding of M390 to battery. When energized over the above-traced circuit, the rotary magnet M390 operates to drive the first and second wiper sets of the Strowger mechanism 480 one step in the rotary direction away from their normal positions and to interrupt, at the contacts 391, the previously traced holding circuit for energizing in multiple the intermediate windings of the switching relays R460 and R470. When the first and second wiper sets of the Strowger mechanism 480 are moved one step in the rotary direction away from their normal positions, the control wiper 483 in the first wiper set and the control wiper 486 in the second wiper set respectively engage contacts terminating the control conductors of the trunk lines in the associated groups of trunk lines. More specifically, the control wiper 483 of the first wiper set engages a contact terminating the control conductor C429 of the first trunk line 426 in the associated group; while the control wiper 486 of the second wiper set engages a contact terminating the control conductor of the first trunk line 435 in the associated group. In the event the trunk lines 426 and 435 are busy, ground potential appears upon the respective control conductors thereof, and in the event these trunk lines are idle, no potential whatever appears upon the control conductors thereof. Assuming that both of the trunk lines 426 and 435 are busy, ground potential appearing upon the control conductors thereof complete respective holding circuits for energizing the upper winding of the switching relay R470 and the lower winding of the switching relay R460. Accordingly, these switching relays do not restore incident to the interruption of the previously traced holding circuit for energizing the intermediate windings thereof incident to the operation of the rotary magnet M390. The holding circuit for energizing the upper winding of the switching relay R470 extends from the grounded control conductor C429 of the trunk line 426 by way of the wiper 483 and engaged contact in the associated

contact bank of the Strowger mechanism 480, C107, the contacts 381, C106, the contacts 451, 475 and 445, the set of switch springs S400 and the upper winding of R470 to battery. The holding circuit for energizing the lower winding of the switching relay R460 extends from, the grounded control conductor of the trunk line 435 by way of the wiper 486 and engaged contact in the associated contact bank of the Strowger mechanism 480, the contacts 477 and 465 and the lower winding of R460 to battery. Also, upon operating, the rotary magnet M390 interrupts, at the contacts 391, the previously traced circuit for energizing the winding thereof, thereby to cause the rotary magnet M390 to restore and recomplete, at the contacts 391, the previously traced circuit for energizing the winding thereof, whereupon the rotary magnet M390 reoperates to drive the wipers of the first and second wiper sets of the Strowger mechanism 480 an additional step in the rotary direction. Now, assuming that the trunk lines 426 and 435 are the second trunk lines in the associated group of trunk lines and that the trunk line 426 is idle, while the trunk line 435 is busy, the previously traced holding circuit for energizing the lower winding of the switching relay R460 is recompleted, while the previously traced holding circuit for energizing the upper winding of the switching relay R470 is not recompleted. Accordingly, when the previously traced holding circuit for energizing the intermediate windings of the switching relays R460 and R470 is interrupted, the relay R460 remains in its operated position, while the relay R470 restores.

Further, it is noted that when the wiper carriage of the Strowger mechanism 480 is moved one step in the rotary direction away from its normal position, the sets of switch springs S423 and S425 are actuated into engagement for a purpose more fully explained hereinafter. Upon restoring, the switching relay R470 interrupts, at the contacts 478, a point in the previously traced circuit for energizing the winding of the rotary magnet M390 and completes, at the contacts 479, a holding circuit for energizing the upper winding of the switching relay R460. The holding circuit for energizing the upper winding of the switching relay R460 extends from ground by way of the contacts 453, C110, the contacts 384, C109, the contacts 307, C127, the contacts 479, the set of switch springs S425 and the upper winding of R460 to battery. Also, upon restoring, the switching relay R470 interrupts, at the contacts 477, a point in the previously traced holding circuit for energizing the lower winding of the switching relay R460, interrupts, at the contacts 475, a further point in the previously traced holding circuit for energizing the upper winding thereof, and completes, at the contacts 474, a path for applying ground potential to the control conductor C429 of the trunk line 426. The last-mentioned path extends from ground by way of the impedance element I458, the contacts 474 and 451, C106, the contacts 381, C107 and the control wiper 483 and engaged contact in the associated contact bank of the Strowger mechanism 480 to the control conductor C429 of the trunk line 426. This application of ground potential to the control conductor C429 of the trunk line 426 marks the trunk line 426 as busy to the other first code selector switches having access thereto.

Finally, upon restoring, the switching relay R470 completes, at the contacts 476, a circuit for energizing the winding of the switch-through

relay R440, this circuit extending from ground, at the contacts 351, C113, the set of switch springs S423, the contacts 476 and the winding of R440 to battery. It will be understood that in the event the second wiper set of the Strowger mechanism 480 had found an idle trunk line in the associated group of trunk lines prior to the time the first wiper set thereof had found an idle trunk line in the associated group of trunk lines, the switching relay R470 would have been retained in its operated position and the switching relay R460 would have restored in a manner similar to the operation of the switching relays R460 and R470 explained above.

When energized over the above-traced circuit the switch-through relay R440 operates to complete, at the contacts 446, an obvious path for applying ground potential by way of the impedance element I458 and C119 to the control conductor C263 of the trunk line 260 thereby to retain the rotary switch D220 individually associated with the calling subscriber line 250 in its operated position. Further, the switch-through relay R440 interrupts, at the contacts 441 and 443, points in the previously traced circuit for energizing the impulse relay R340 and completes, at the contacts 442 and 444, a connection between the line conductors of the trunk line 426 and the line conductors of the trunk line 600. More specifically, the positive line conductor C428 of the trunk line 426 is connected by way of the wiper 482 and engaged contact in the associated contact bank of the Strowger mechanism 480, the contacts 463, 472, 444 and 404, C905, the wiper 911 and engaged contact in the associated contact bank of the selector hunting switch 62, C132, the contacts 942, the wiper 922 and engaged contact in the associated contact bank of the Strowger mechanism 920 to the positive line conductor C602 of the trunk line 600; while the negative line conductor C427 of the trunk line 426 is connected by way of the wiper 481 and engaged contact in the associated contact bank of the Strowger mechanism 480, the contacts 462, 442 and 402, C904, the wiper 910 and engaged contact in the associated contact bank of the selector hunting switch 62, C131, the contacts 941 and the wiper 921 and engaged contact in the associated contact bank of the Strowger mechanism 920 to the negative line conductor C601 of the trunk line 600. Further, it is noted that a circuit is completed for energizing the relay R1505 in the toll ticket repeater 65 upon operation of the switch-through relay R440 in the first code selector switch 61. The last-mentioned circuit extends from ground in the director 64 by way of the contacts 548, C674, the wiper 845 and engaged first contact in the associated contact bank of the rotary switch S840, C671, the rectifier 616, C673, the contacts 661, the negative line conductor C601 of the trunk line 600, the wiper 921 and engaged contact in the associated contact bank of the Strowger mechanism 920, the contacts 941, C131, the wiper 910 and engaged contact in the associated contact bank of the selector hunting switch 62, the conductor C904 of the trunk line 900, the contacts 402, 442 and 462, the wiper 481 and engaged contact in the associated contact bank of the Strowger mechanism 480, C427 and the upper winding of R1505 to battery. When energized over the above-traced circuit, the line relay R1505 operates and the repeater 65 is seized by the first code selector switch 61.

Operation of the repeater 65 incident to seizure

The line relay R1505 operates when the repeater 65 is seized by the first code selector switch 61, as noted above, and completes, at the contacts 1507, an obvious circuit for energizing the lower winding of the hold relay R1500, thereby to cause the hold relay R1500 to operate. Upon operating, the hold relay R1500 completes, at the contacts 1502, a holding circuit for energizing the upper winding thereof, this circuit extending from ground in the first code selector switch 61 by way of the impedance element 1458, the contacts 474 and 451, C106, the contacts 381, C107, the wiper 483 and engaged contact in the associated contact bank of the Strowger mechanism 480, the control conductor C429 of the trunk line 426, the contacts 1502 and the upper winding of R1500 to battery. Also, upon operating, the hold relay R1500 completes, at the contacts 1503, an obvious circuit for energizing the winding of the control relay R1640, thereby to cause the relay R1640 to operate. Upon operating, the relay R1640 completes, at the contacts 1641, an obvious circuit for energizing the winding of the control relay R1520, thereby to cause the relay R1520 to operate, and prepares, at the contacts 1648, a circuit, traced hereinafter, for energizing the upper winding of the test relay R1620. Finally, the relay R1640 completes, at the contacts 1646, a circuit for energizing the winding of the magnet M1691 of the rotary switch F1690, this circuit extending from ground by way of the contacts 1622, 1646, 1653 and 1692 and the winding of M1691 to battery. When energized over the above-traced circuit, the magnet M1691 operates to interrupt, at the contacts 1692, the previously traced circuit for energizing the winding thereof, thereby to cause the magnet M1691 to restore and recomplete, at the contacts 1692, the previously traced circuit for energizing the winding thereof, whereupon the magnet M1691 reoperates. Accordingly, the magnet M1691 operates intermittently, thereby to drive the wipers 1693, 1694, 1695, 1696, 1697, 1698, 1699 and 1691 step by step in the clockwise direction until the wiper 1693 engages a contact in the associated contact bank terminating the control conductor of a trunk line extending to an idle one of the converters in the group of converters accessible to the repeater 65. In the present example, assuming that the first converter 66 in the group of converters accessible to the rotary switch F1690 is idle, battery potential appears upon the control conductor C1704 thereof, thereby to complete the previously mentioned circuit for energizing the upper winding of the test relay R1620. This circuit extends from ground by way of the contacts 1648 and 1658, the contacts 1618 of the set of switch springs S1617, the upper winding of R1620, C130, the wiper 1693 and engaged contact in the associated contact bank of the rotary switch F1690, the control conductor C1704 of the trunk line extending to the first converter 66 in the group of converters accessible to the rotary switch F1690 to the contacts 1733. One branch of this path extends from the contacts 1733 by way of the winding of the relay R1720 to battery; and the other branch of this circuit extends from the contacts 1733 by way of the contacts 1723 and the resistor 1797 to battery.

When energized over the above-traced circuit, the test relay R1620 operates to interrupt, at the contacts 1622, the previously traced circuit for

energizing the winding of the magnet M1691 of the rotary switch F1690. Accordingly, in the present example, the magnet M1691 of the rotary switch F1690 is not operated due to the fact that the wiper 1693 of the rotary switch F1690 engages a contact in the associated contact bank terminating the control conductor of an idle converter in the group of converters accessible to the rotary switch F1690 in its normal position, thereby to cause the test relay R1620 to operate prior to the operation of the magnet M1691. Also, upon operating, the test relay R1620 interrupts, at the contacts 1623, an obvious path for short-circuiting the lower winding thereof, thereby to complete a holding circuit for energizing the lower winding thereof. This circuit extends from ground by way of the contacts 1651 and 1647, the lower winding of the test relay R1620 and the resistor 1616 to battery. Also, upon operating, the test relay R1620 completes, at the contacts 1621, a path for short-circuiting the upper winding thereof and a low resistance circuit for energizing the winding of the relay R1720 in the converter 66. The last-mentioned circuit extends from ground potential appearing upon the control conductor C429 of the trunk line 426 by way of C1615, the contacts 1621, C130, the wiper 1693 and engaged contact in the associated contact bank of the rotary switch F1690, C1704, the contacts 1733 and the winding of R1720 to battery. When energized over the above-traced circuit, the relay R1720 operates to interrupt, at the contacts 1723, the previously traced path extending between the contacts 1733 and battery by way of the resistor 1797. Furthermore, upon operating, the test relay R1620 completes, at the contacts 1624, an obvious circuit for energizing the winding of the switching relay R1660 in order to cause the switching relay R1660 to operate. Upon operating, the switching relay R1660 prepares, at the contacts 1662, 1664, 1665, 1666, 1667, 1668 and 1669, control circuits, traced hereinafter, extending to the wipers 1694, 1695, 1696, 1697, 1698, 1699 and 1691 of the rotary switch F1690, for a purpose more fully described hereinafter. Also, upon operating, the switching relay R1660 completes, at the contacts 1663, a circuit for energizing the winding of the switching relay R1670, this circuit extending from ground by way of the contacts 1663 and 1655 and the winding of R1670 to battery. When energized over the above-traced circuit, the switching relay R1670 operates to prepare, at the contacts 1671, 1672, 1673 and 1674, further points in the previously mentioned control circuits extending to the wipers 1697, 1698, 1699 and 1691 of the rotary switch F1690.

Upon operating, the control relay R1520 completes, at the contacts 1521, an obvious circuit for energizing the left-hand winding of the time start relay R1540; however, the time start relay R1540 does not operate at this time as this relay is of the polarized type. Furthermore, when the line relay R1505 operated, it prepared, at the contacts 1506, a circuit, traced hereinafter, for energizing the right-hand winding of the time start relay R1540. The prepared portion of this circuit extends from the positive conductor C1557 of the toll line 1555 extending between the toll ticket repeater 65 and the group selector switch 80 in the intermediate exchange 51 by way of the right-hand winding of R1540, the impedance element 1548, C1518 and the contacts 1506 to the negative line conductor C1556 of the toll line 1555.

At this time the repeater 65 is conditioned to receive the second directive digit transmitted by

the director 64, whereupon the line relay R1505 follows the second directive digit and repeats the digit over the positive and negative line conductors C1557 and C1556, respectively, of the toll line 1555 to the group selector switch 80 in the intermediate exchange 51. More particularly, each time the line relay R1505 operates, it completes, at the contacts 1506, the previously traced path between the line conductors of the toll line 1555; and each time the line relay R1505 restores, it interrupts, at the contacts 1506, the previously traced path extending between the line conductors of the toll line 1555. Further, it is noted that the repeater 65 also receives the four digits of the directory number of the called subscriber line 2200 and repeats these digits over the toll line 1555 in a similar manner.

The group selector switch 80 in the intermediate exchange 51 responds to the second directive digit repeated thereto by the repeater 65 and selects a group of trunk lines extending to a corresponding group of dial repeaters. Subsequently, the group selector switch 80 operates automatically to seize an idle one of these repeaters such, for example, as the dial repeater 81, the dial repeater 81 being connected by way of the toll line 2201 to the first numerical selector switch 90 in the terminating exchange 52. The first numerical switch 90 in the terminating exchange 52 responds to the first digit of the directory number of the called subscriber line 2200 and selects a group of trunk lines extending to a corresponding group of second numerical selector switches. Subsequently, the first numerical selector switch 90 selects one of these trunk lines extending to an idle one of the second numerical selector switches such, for example, as the second numerical selector switch 91. The second numerical selector switch 91 in the terminating exchange 52 responds to the second digit of the directory number of the called subscriber line 2200 and selects a group of trunk lines extending to a corresponding group of connector switches. Subsequently, the second numerical selector switch 91 selects one of these trunk lines extending to an idle one of these connector switches such, for example, as the connector switch 92. The connector switch 92 responds to the third digit of the directory number of the called subscriber line 2200 and selects a group of subscriber lines including the called subscriber line 2200. Finally, the connector switch 92 responds to the fourth digit of the directory number of the called subscriber line 2200 to select the called subscriber line 2200. The subsequent operation of the connector switch 92 depends upon the idle or busy condition of the called subscriber line 2200, in the usual manner. Assuming that the called subscriber line 2200 is idle, the connector switch 92 operates to project ringing current over the subscriber line 2200 in a well-known manner. The call is answered on the subscriber line 2200 when the subscriber at the subscriber substation T2 removes the receiver of the telephone instrument thereat from its associated switchhook, whereupon a loop circuit is completed between the telephone instrument at the subscriber substation T2 and the connector switch 92. The connector switch 92 then operates to reverse battery over the first and second numerical selector switches 91 and 90 and the toll line 2201 to the dial repeater 81. Finally, the dial repeater 81 operates to reverse battery over the group selector switch 80 and the toll line 1555 to the right-hand winding of the time start relay R1540, thereby to

cause the last-mentioned relay to operate for a purpose more fully described subsequently.

At this point it is noted that after the rotary switch F1690 in the repeater 65 has found the idle converter 66 and the switching relay R1660 is operated, a circuit is prepared for energizing the upper winding of the test relay R510 in the director 64, which circuit is completed when the relay R520 in the director 64 operates. The circuit for energizing the upper winding of the test relay R510 extends from ground by way of the upper winding of R510, the contacts 513 and 522, the positive line conductor C502 of the trunk line 600, the wiper 922 and engaged contact in the associated contact bank of the Strowger mechanism 920, the contacts 942, C132, the wiper 911 and engaged contact in the associated contact bank of the selector hunting switch 62, the conductor C905 of the trunk line 900, the contacts 404, 444, 472 and 463, the wiper 482 and engaged contact in the associated contact bank of the Strowger mechanism 480, the positive line conductor C428 of the trunk line 426, the contacts 1511, C1608, the contacts 1664, the wiper 1695 and engaged contact in the associated contact bank of the rotary switch F1690, C1702 and the windings of the relays R1760 and R1765 in the converter 66 to battery.

Further, it is noted that after the director 64 has operated to transmit the directive digits over the trunk line 600, it operates to transmit the four digits of the directory number of the called subscriber line 2200 over the trunk line 600, as previously explained. Further, it is noted that when the first digit of the directory number of the called subscriber line 2200 is transmitted from the director 64 over the trunk line 600, the wiper 745 of the rotary switch CN740 engages the seventh contact in the associated contact bank, whereupon a circuit is completed for energizing the winding of the control relay R520, the relay R540 being operated at this time, as previously explained. The circuit for energizing the winding of the relay R520 extends from ground by way of the contacts 533, C685, the contacts 664, C684, the wiper 745 and engaged seventh contact in the associated contact bank of the rotary switch CN740, C777, C576, the contacts 549 and 511, and the winding of R520 to battery. When energized over the above-traced circuit, the relay R520 operates to complete, at the contacts 522, the previously traced circuit for energizing the upper winding of the test relay R510 in the director 64 from battery by way of the previously traced circuit including the windings of the relays R1760 and R1765 in the converter 66 in the event the rotary switch F1690 in the repeater 65 has found the idle converter 66 in the group of converters. On the other hand, in the event the rotary switch F1690 has not found an idle converter in the group of converters, the test relay R510 and the control relay R520 in the director 64 respectively remain in their restored and operated positions. Also, upon operating, the control relay R520 interrupts, at the contacts 524, a point in the circuit for energizing the control relay R620 at this time, thereby to prevent the operation of the second impulsing device I615 to cause operation of the rotary switch S840. In view of the fact that the rotary switch S840 is operated by the operation of the control relay R620, the operation of the first impulsing device I614 is ineffective to transmit the first digit of the directory number of the called subscriber line 2200 over the trunk line 600 and fur-

ther operation of the director 64 is arrested until the rotary switch F1690 in the repeater 65 seizes an idle converter in the group of converters accessible thereto.

When the rotary switch F1690 seizes the idle converter 66, the previously traced circuit for energizing the upper winding of the test relay R510 in the director 64 is completed, in the event this circuit had not been previously completed incident to the operation of the control relay R520 in the director 64. Upon operating, the test relay R510 completes, at the contacts 514, a holding circuit for energizing the lower winding thereof, this circuit extending from ground by way of the contacts 553 and 514 and the lower winding of R510 to battery. Also, the test relay R510 interrupts, at the contacts 513, the previously traced circuit for energizing the upper winding thereof and interrupts, at the contacts 511, the previously traced circuit for energizing the winding of the control relay R520, whereupon the relay R520 restores shortly thereafter, this relay being of the slow-to-release type. Upon restoring, the control relay R520 completes, at the contacts 524, the previously mentioned circuit for energizing the winding of the control relay R620, thereby to cause the relay R620 to operate and render the director 64 operative to transmit the first digit of the directory number of the called subscriber line 2200. The circuit for energizing the winding of the control relay R620 at this time extends from ground by way of the contacts 533, C685, the contacts 653, C683, the contacts 524, C670, the wiper 805 and engaged contact in the associated contact bank of the rotary switch C800, C785, the wiper 746 and engaged seventh contact in the associated contact bank of the rotary switch CN740, C690, the contacts 634 and 612, the winding of R620 and the resistor 613 to the negative terminal of battery. Accordingly, the director 64 operates at this time to transmit the first digit of the directory number of the called subscriber line 2200 over the trunk line 600 as previously explained.

Also, upon restoring, the control relay R520 prepares, at the contacts 521, a path for projecting ground pulses over the positive line conductor C602 of the trunk line 600 and completes, at the contacts 623, a circuit for energizing the upper and lower windings of the impulse relay R500. The last-mentioned circuit extends from ground by way of the contacts 523, 512 and 502 to the terminals of the upper and lower windings of R500, one branch of this circuit extending by way of the upper winding of R500 to battery, and the other branch of this circuit extending by way of the lower winding of R500 and the condenser 500 to battery. Thus, it will be understood that the upper winding of the impulse relay R500 is energized and the condenser 500 associated with the lower winding of the relay R500 is charged. When the upper winding of the impulse relay R500 is energized, this relay operates to interrupt, at the contacts 502, the previously traced circuit for energizing the upper winding thereof and the previously traced circuit for charging the condenser 500. The condenser 500 immediately discharges, thereby to cause the impulse relay R500 to restore immediately. Accordingly, the impulse relay R500 operates and restores intermittently. Each time the impulse relay R500 operates and restores, it completes, at the contacts 503, an obvious circuit for energizing the winding of the magnet M731 of the rotary switch T730, thereby to cause the magnet M731

to operate and restore intermittently. Each time the magnet M731 operates and restores, it drives the wipers 733 and 735 of the rotary switch T730 one step in the counterclockwise direction. Also, each time the impulse relay R500 operates, it completes, at the contacts 501, the previously mentioned circuit for projecting ground potential over the positive line conductor C602 of the trunk line 600.

It is noted that when the impulse relay R500 operates and the wiper 735 of the rotary switch T730 engages a contact in the associated contact bank terminating a lead in the groups of marking leads having ground potential thereupon, a path for applying direct ground potential to the positive line conductor C602 of the trunk line 600 is completed. On the other hand, when the impulse relay R500 operates and the wiper 735 of the rotary switch T730 engages a contact in the associated contact bank terminating a lead in the group of marking leads which has no ground potential thereupon, a path for connecting ground potential by way of the resistor 558 is completed to the positive line conductor C602 of the trunk line 600. The path for extending direct ground potential to the positive line conductor C602 of the trunk line 600 extends from the wiper 735 of the rotary switch T730 by way of C574, the contacts 501 and 521 to the positive line conductor C602; and the path for applying resistance ground potential to the positive line conductor C602 of the trunk line 600 extends from ground by way of the resistor 558 and the contacts 501 and 521 to the positive line conductor C602. A heavy ground pulse is transmitted over the positive line conductor C602 of the trunk line 600 when direct ground potential is applied thereto; while a light ground pulse is transmitted over the positive line conductor C602 of the trunk line 600 when resistance ground potential is applied thereto.

As previously noted, the WXYZ leads in the group of marking leads 791 are permanently marked in accordance with the code M; the WXYZ leads in the group of marking leads 792 are marked in accordance with the code A as determined by the vertical operated position of the Strowger mechanism 700; and the WXYZ leads in the groups of marking leads 793 and 794 are marked in accordance with the codes D and 6, respectively, as determined by the combination vertical and rotary positions of the Strowger mechanism 700. The paths for applying ground potential to the WXYZ leads in the groups of marking leads 792, 793 and 794 by way of the jumper field 714 and the wipers of the Strowger mechanism 700 include the conductor C570 having ground potential applied thereto at the contacts 541 due to the operated position of the control relay R540.

Accordingly, the intermittent operation of the impulsing relay R500 causes the wiper 735 of the rotary switch T730 to be driven in the counterclockwise direction into successive engagements with the contacts in the associated contact bank terminating the WXYZ leads in the groups of marking leads 791, 792, 793 and 794. Hence, the director 64 operates to transmit four sets of code markings over the positive line conductor C602 of the trunk line 600 at this time, which sets of code markings respectively correspond to the letters MAD designating the originating exchange 50 and the rate factor 6 applicable to a call from the originating exchange 50 to the terminating exchange 52. When the previously traced cir-

cuit for energizing the upper winding of the test relay R510 in the director 64 in series with the windings of the control relays R1760 and R1765 in the converter 66 is completed, the test relay R510 operates to cause the director 64 to transmit impulses over the positive line conductor C602 of the trunk line 600 corresponding to the WXYZ code of the called exchange code and the rate factor as noted above. Also, at this time, the control relay R1760 in the converter 66 operates; however, the control relay R1765 in the converter 66 does not operate due to the fact that this relay is of the marginal type and will not operate in series with the high resistance of the upper winding of the test relay R510 in the director 64. Upon operating, the relay R1760 completes, at the contacts 1761, an obvious circuit for energizing the winding of the magnet M1791 of the rotary switch R1790, whereupon the magnet M1791 operates to condition the wipers 1793 and 1794 of the rotary switch R1790 to be driven one step in the clockwise direction. Subsequently, when the test relay R510 in the director 64 operates, it interrupts, at the contacts, 513, the previously traced circuit for energizing the upper winding of the test relay R510 in series with the windings of the control relays R1760 and R1765, thereby to cause the relay R1760 to restore. Upon restoring, the relay R1760 interrupts, at the contacts 1761, the previously mentioned circuit for energizing the windings of the magnet M1791 of the rotary switch R1790 in order to cause the magnet M1791 to restore and drive the wipers noted of the rotary switch R1790 one step in the clockwise direction. When the wiper 1793 of the rotary switch R1790 is driven one step in the clockwise direction, it engages the first contact in the associated contact bank, thereby to prepare a circuit, traced hereinafter, for energizing the winding of the 1W relay in the first code storing device S1701 in the converter 66.

The director 64 operates first to transmit the code of the first letter M designating the terminating exchange 52, which code causes light and heavy ground pulses to be transmitted over the positive line conductor C602 of the trunk line 600 as previously explained. Each time a heavy or a light ground pulse is transmitted over the positive line conductor C602 of the trunk line 600, the previously traced circuit for energizing in series the windings of the control relays R1760 and R1765 is completed. The control relay R1760 operates when either a heavy or a light ground pulse is transmitted over the positive line conductor C602 of the trunk line 600; however, the control relay R1765 operates only in the event a heavy ground pulse is transmitted over the positive line conductor C602 of the trunk line 600. Each time the control relay R1760 operates and restores, it causes the magnet M1791 to drive the wipers noted of the rotary switch R1790 one step in the clockwise direction as previously explained. Each time the control relay R1765 operates it completes, at the contacts 1766, a circuit for energizing the winding of the particular one of the relays 1W, 1X, 1Y or 1Z in the first code storing device S1701, the circuit of which is prepared at the wiper 1793 and associated contact of the rotary switch R1790. For example, the circuit for energizing the winding of the 1W relay in the first code storing device S1701 extends, when completed, from ground by way of the contacts 1766, C1739, the wiper 1793 and engaged contact in the associated contact bank of the

rotary switch R1790, C151 and the winding of 1W to battery. When energized over the above-traced circuit the 1W relay in the first code storing device C1701 operates to complete, at the contacts 1W1, a holding circuit for energizing the winding thereof. This holding circuit extends from ground by way of the contacts 1715 of the operated relay R1710, C1726, the contacts 1W1 and the winding of 1W to battery.

In view of the foregoing, it will be apparent that when the code corresponding to the letter M is transmitted over the positive line conductor C602 of the trunk line 600 corresponding ones of the relays 1W, 1X, 1Y and 1Z in the first code storing device S1701 will be operated and held in their operated positions. Accordingly, a code is stored in the first code storing device S1701 corresponding to the first letter M of the exchange code of the terminating exchange 52. Furthermore, it will be understood that further operation of the rotary switch R1790 incident to the transmission of the second and third letters A and D, respectively, of the code of the terminating exchange 52 and to the transmission of the rate factor 6 will cause the letters A and D and the rate factor 6 to be stored in WXYZ code respectively in the second, third and fourth code storing devices S1702, S1703 and S1704 in the converter 66.

Furthermore, when the wipers noted of the rotary switch R1790 in the converter 66 are operated one step away from their normal rotary positions at the beginning of the transmission by the director 64 of the first digit of the directory number of the called subscriber line 2200, the set of switch springs S1796 is actuated into engagement, thereby to prepare a circuit for energizing in series the winding of the control relay R1755 and the winding of the magnet M1777 of the rotary switch N1770. When the line relay R1505 in the repeater 65 restores at the beginning of the first impulse of the first digit of the directory number of the called subscriber line 2200, it completes, at the contacts 1508, the previously mentioned circuit for energizing the winding of the control relay R1755 in series with the winding of the magnet M1777 of the rotary switch N1770. The last-mentioned circuit extends from ground by way of the contacts 1508 and 1515, C1609, the contacts 1662, the wiper 1694 and engaged first contact in the associated contact bank of the rotary switch F1690, C1701, the set of switch springs S1796, the winding of R1755 and the winding of M1777 to battery. When energized over the above-traced circuit, the relay R1755 operates to complete, at the contacts 1756, an obvious circuit for energizing the winding of the control relay R1750, thereby to cause the relay R1750 to operate. Also, when the winding of the magnet M1777 is energized, this magnet operates to condition the wipers 1771, 1772, 1773 and 1775 of the rotary switch N1770 to be driven one step in the clockwise direction. Upon operating, the control relay R1750 prepares, at the contacts 1752, paths, traced hereinafter, for applying ground potential to the wipers 1771 and 1772 of the rotary switch N1770 and completes, at the contacts 1751, a circuit for energizing the magnet M1681 of the rotary switch S1680 in the repeater 65. The last-mentioned circuit extends from ground by way of the contacts 1751, C1703, the wiper 1696 and engaged contact in the associated contact bank of the rotary switch F1690, the contacts 1665 and the winding of M1681 to

battery. When the winding of the magnet M1681 is energized over the above-traced circuit, the magnet M1681 operates to condition the wipers 1684, 1685, 1686, 1687, 1688 and 1689 of the rotary switch S1680 to be driven one step in the clockwise direction.

At the end of the first pulse of the first digit of the directory number of the called subscriber line 2200, the line relay R1505 in the repeater 65 reoperates to interrupt, at the contacts 1508, the previously traced circuit for energizing in series the winding of the control relay R1755 and the winding of the magnet M1777 of the rotary switch N1770, thereby to cause the magnet M1777 to restore and drive the wipers noted of the rotary switch N1770 one step in the clockwise direction. It is noted that the control relay R1755 is of the slow-to-release type. Accordingly, this relay does not restore during pulsing. Hence, the relay R1755 remains in its operated position until the conclusion of the first digit of the directory number of the called subscriber line 2200. At this time the magnet M1777 has been energized and deenergized a predetermined number of times corresponding to the first digit of the directory number of the called subscriber line 2200, whereupon the wipers noted of the rotary switch N1770 engage corresponding contacts in the associated contact banks. More particularly, the wipers 1771 and 1772 of the rotary switch N1770 engage contacts in the associated contact banks corresponding in WXYZ code to the first digit of the directory number of the called subscriber line 2200. Assuming that the directory number of the called subscriber line is 5555, the wipers 1771 and 1772 of the rotary switch N1770 engage the fifth contacts in the associated contact banks. Accordingly, the wiper 1771 engages the fifth contact in the associated contact bank terminating the conductor extending to the first contact in the contact bank associated with the wiper 1784 of the rotary switch S1780; while the wiper 1772 engages the fifth contact in the associated contact bank terminating the conductor extending to the first contact in the contact bank associated with the wiper 1786 of the rotary switch S1780. At this point it is noted that the wipers 1783, 1784, 1785 and 1786 of the rotary switch S1780 respectively correspond to the codes WXYZ. Accordingly, at this time, the wipers 1771 and 1772 of the rotary switch N1770 have marked, by way of the paths noted above, the X and Z wipers 1784 and 1786, respectively, of the rotary switch S1780, the X and Z wipers being marked in order to indicate that the first digit of the directory number of the called subscriber line 2200 is the digit 5. Shortly following the first digit of the directory number of the called subscriber line 2200, the control relay R1755 restores to complete, at the contacts 1757, the previously mentioned paths for applying ground potential to the wipers 1771 and 1772 of the rotary switch N1770 and thus to the wipers 1784 and 1786 of the rotary switch S1780. More particularly, these paths extend from ground by way of the contacts 1752 and 1757 to the wipers 1771 and 1772 of the rotary switch N1770, from the wiper 1771 by way of the engaged fifth contact in the associated contact bank and the engaged first contact in the contact bank associated with the wiper 1784 of the rotary switch S1780 to the wiper 1784, and from the wiper 1772 by way of the engaged fifth contact in the associated contact bank and the engaged first contact in the

contact bank associated with the wiper 1786 of the rotary switch S1780 to the wiper 1786. It will be understood that had the first digit of the directory number of the called subscriber line 2200 been other than the digit 5, appropriate ones of the WXYZ wipers 1783, 1784, 1785 and 1786 of the rotary switch S1780 would have been marked with ground potential in a similar manner.

This application of ground potential to the X and Z wipers 1784 and 1786, respectively, of the rotary switch S1780 completes circuits for energizing the IX and IZ relays in the first code storing device S1601 in the repeater 65. The circuit for energizing the IX relay in the first code storing device S1601 extends from the grounded wiper 1784 of the rotary switch S1780 by way of the X lead in the cable 1700, the engaged first contact in the contact bank associated with the wiper 1698 of the rotary switch F1690, the wiper 1698, the contacts 1667 and 1672, the wiper 1686 of the rotary switch S1680, the engaged first contact in the associated contact bank, and the winding of IX to battery. The circuit for energizing the IZ relay in the first code storing device S1601 extends from the grounded wiper 1786 of the rotary switch S1780 by way of the Z lead in the cable 1700, the engaged first contact in the contact bank associated with the wiper 1691 of the rotary switch F1690, the wiper 1691, the contacts 1669 and 1674, the wiper 1688 of the rotary switch S1690, the engaged first contact in the associated contact bank, and the winding of IZ to battery. When energized over the above-traced circuits, the relays IX and IZ in the first code storing device S1601 operate to complete, at the contacts IX1 and IZ1, respectively, obvious holding circuits for energizing the windings thereof, ground potential being present upon the conductor C1602 at the contacts 1522 of the operated control relay R1520.

Also, upon restoring, the relay R1755 interrupts, at the contacts 1756, the previously mentioned circuit for energizing the winding of the control relay R1750. Shortly thereafter, the control relay R1750, being of the slow-to-release type, restores to interrupt, at the contacts 1752, the previously traced marking circuits for the wipers 1771 and 1772 of the rotary switch N1770. Also, the relay R1750 interrupts, at the contacts 1751, the previously traced circuit for energizing the winding of the magnet M1681 of the rotary switch S1680, thereby to cause the magnet M1681 to restore and drive the wipers noted of the rotary switch S1680 one step in the clockwise direction. At this time the WXYZ wipers 1685, 1686, 1687 and 1688 of the rotary switch S1680 engage the respective WXYZ leads in the cables 136, 135, 134 and 133, respectively, extending to the second code storing device S1602 in the repeater 65. Finally, upon restoring, the relay R1750 completes, at the contacts 1753, an alternative circuit for energizing the winding of the magnet M1777 of the rotary switch N1770. The last-mentioned circuit extends from ground by way of the wiper 1773 and engaged fifth contact in the associated contact bank, the multiple 1774, the contacts 1753 and 1778, and the winding of M1777 to battery. When energized over the above-traced circuit, the magnet M1777 operates to interrupt, at the contacts 1778, the alternative circuit for energizing the winding thereof, whereupon the magnet M1777 restores to recomplete, at the contacts 1778, the previously traced alternative circuit for energizing the winding there-

of. Accordingly, the magnet M1777 operates intermittently to drive the wipers noted of the rotary switch N1770 step by step in the clockwise direction until the wiper 1773 of the rotary switch N1770 disengages the tenth contact in the associated contact bank included in the multiple 1774. At this time the wiper 1773 of the rotary switch N1770 engages the eleventh contact in the associated contact bank, which position constitutes a normal position for the rotary switch N1770. At this point it is noted that the codes appearing upon the first ten contacts in the contact banks associated with the wipers 1771 and 1772 of the rotary switch N1770 also reappear upon the twelfth to twenty-first contacts in the contact banks associated with the wipers 1771 and 1772 of the rotary switch N1770 in order to mark, by way of the WXYZ wipers 1783, 1784, 1785 and 1786, respectively, of the rotary switch S1780, the WXYZ code of the second digit 5 of the directory number of the called subscriber line 2200.

In view of the above description, it will be understood that when the second, third and fourth digits of the directory number of the called subscriber line 2200 are transmitted by the director 64 over the trunk line 600, the corresponding operation of the line relay R1505 in the repeater 65 is effective to cause further operation of the apparatus in the converter 66 and the repeater 65 in the manner described, whereby the second, third and fourth digits of the directory number of the called subscriber line 2200 are translated into code in the converter 66 and stored in the code storing devices S1602, S1603 and S1604, respectively, in the repeater 65. At this time there are stored in WXYZ code in the code storing devices S1601 to S1604, inclusive, in the repeater 65 respectively the first, second, third and fourth digits of the directory number of the called subscriber line 2200; while there are also stored in WXYZ code in the code storing devices S1701 to S1704, inclusive, in the converter 66 respectively the three letters of the code designating the terminating exchange 52 and the rate factor applicable to the call between the originating exchange 50 and the terminating exchange 52.

Release of the director, the director selector switch, and the selector hunting switch

When the wiper 745 of the rotary switch CN740 in the director 64 engages the eleventh contact in the associated contact bank, the cut-off relay R610 in the director 64 is operated, thereby to effect the release of the director 64, the director selector switch 63 and the selector hunting switch 62 as previously noted. At this time the director 64 has transmitted the directive digits, the digits of the directory number of the called subscriber line 2200 and the WXYZ codes corresponding to the three letters designating the terminating exchange 52 and the rate factor applicable to the call between the originating exchange 50 and the terminating exchange 52 in the manner previously explained. More particularly, upon operating, the cut-off relay R610 interrupts, at the contacts 611, the previously traced circuit for applying battery potential in the director 64 to the control conductor C605 of the trunk line 600, thereby to interrupt the previously traced holding circuit for energizing the winding of the test relay R950 in the director selector switch 63. The test relay R950 then restores to interrupt, at the contacts 951, the previously traced circuit for energizing the

winding of the control relay R940, whereupon the relay R940 restores. Also, upon restoring, the test relay R950 interrupts, at the contacts 952, a further point in the previously traced holding circuit for energizing the lower winding thereof and prepares, at the contacts 954, a point in the previously traced circuit for energizing the winding of the rotary magnet M991. Subsequently, when the relay R940 restores, it completes, at the contacts 943, the previously traced circuit for energizing the winding of the rotary magnet M991. The rotary magnet M991 operates intermittently in order to drive the wiper carriage of the Strowger mechanism 920 step by step in the rotary direction until the wiper carriage is driven eleven steps in the rotary direction away from its normal rotary position, whereupon the wiper carriage is returned to its normal vertical and rotary positions in a well-known manner. When the wiper carriage of the Strowger mechanism 920 is returned to its normal vertical position, the sets of switch springs S964, S965, S966 and S990 are actuated, the sets of switch springs S965 and S980 being actuated into engagement and the sets of switch springs S964 and S966 being actuated into disengagement. When the set of switch springs S964 is actuated into disengagement, the previously traced circuit for energizing the winding of the rotary magnet M991 is interrupted, thereby positively to arrest further operation of the rotary magnet M991. Also, when the wiper carriage of the Strowger mechanism 920 is actuated back into its normal rotary position, the set of switch springs S976 is actuated into disengagement. At this time the director selector switch 63 is completely released for further use.

When the control relay R940 in the director selector switch 63 is restored, it interrupts, at the contacts 946, the previously traced circuit for energizing the upper winding of the impulse relay R560 in the director 64, whereupon the impulse relay R560 restores. Upon restoring, the impulse relay R560 interrupts, at the contacts 562, the previously traced circuit for energizing the winding of the control relay R550 and completes, at the contacts 561, the previously traced path for short-circuiting the winding of the control relay R550, thereby to cause the relay R550 to restore. Upon restoring, the relay R550 interrupts, at the contacts 553, the previously traced holding circuit for energizing the winding of the relay R540 and the lower winding of the test relay R510, thereby to cause these relays to restore. Upon restoring, the test relay R510 interrupts, at the contacts 512, the previously traced circuit for energizing the impulse relay R500, thereby to arrest further operation of the impulse relay R500. Also, upon restoring, the relay R550 interrupts, at the contacts 552, the previously mentioned circuit for energizing the winding of the control relay R530, thereby to cause the relay R530 to restore shortly thereafter, this relay being of the slow-to-release type. Finally, upon restoring, the relay R550 completes, at the contacts 551, a holding circuit for energizing the upper winding of the cut-off relay R610. This circuit extends from ground by way of the contacts 551, the set of switch springs S563, C680, the contacts 651 and the upper winding of R610 to battery. Upon restoring, the relay R530 completes, at the contacts 537, a chain circuit for restoring the rotary switches CN740, U820, D810, C800, M720 and T730, and the Strowger mechanism 700 to their

normal positions, the rotary switch CN740 being restored to its normal position first. This chain circuit extends from ground by way of the wiper 843 and engaged first contact in the associated contact bank of the rotary switch S840, the rotary switch S840 being returned to its normal position after the last digit of the directory number of the called subscriber line 2200 is transmitted from the director 64 over the trunk line 600 as previously explained. C675, the contacts 537, C571, the wiper 743 and engaged eleventh contact in the associated contact bank of the rotary switch CN740, the multiple 744, the contact 742 and the winding of the magnet M741 to battery. When energized over the above-traced circuit, the magnet M741 operates to drive the wipers noted of the rotary switch CN740 one step in the counterclockwise direction, as previously explained, whereupon the wiper 743 of the rotary switch CN740 engages the first contact in the associated contact bank, thereby to complete a circuit for energizing the magnet M821 of the rotary switch U820. The last-mentioned circuit extends from ground by way of the previously traced path to the wiper 743 of the rotary switch CN740 and therefrom by way of the engaged first contact in the associated contact bank, C784, the wiper 822 of the rotary switch U820 and engaged contact in the associated contact bank, the multiple 823, the contacts 821 and the winding of the magnet M821 to battery. When energized over the above-traced circuit, the magnet M821 operates to drive the wipers noted of the rotary switch U820 step by step in the counterclockwise direction back to their normal rotary positions, whereupon the wiper 822 disengages the contacts in the associated contact bank included in the multiple 823 and engages the first contact in the associated contact bank. When the wiper 822 of the rotary switch U820 disengages the contacts in the associated contact bank connected to the multiple 823, the previously traced circuit for energizing the magnet M821 is interrupted, thereby to arrest further operation of the magnet M821; and when the wiper 822 of the rotary switch U820 engages the first contact in the associated contact bank, a circuit is completed for energizing the winding of the magnet M811 of the rotary switch D810. The last-mentioned circuit extends from ground by way of the previously traced path to the wiper 822 of the rotary switch U820 and therefrom by way of the engaged first contact in the associated contact bank, the wiper 813 of the rotary switch D810, the engaged contact in the associated contact bank, the multiple 814, the contacts 812 and the winding of the magnet M811 to battery. When energized over the above-traced circuit, the magnet M811 operates in order to drive the wipers noted of the rotary switch D810 step by step in the counterclockwise direction back into their normal positions, whereupon the wiper 813 disengages the contacts in the associated contact bank included in the multiple 814 and engages the first contact in the associated contact bank, thereby to arrest further operation of the magnet M811 of the rotary switch D810 and to complete a circuit for energizing the magnet M801 of the rotary switch C800.

The last-mentioned circuit extends from ground by way of the previously traced path to the wiper 813 of the rotary switch D810 and therefrom by way of the wiper 803 of the rotary switch C800 and engaged contact in the associ-

ated contact bank, the multiple 804, the contacts 802 and the winding of M801 to battery. When energized over the above-traced circuit, the magnet M801 operates to drive the wipers noted of the rotary switch C800 step by step in the counterclockwise direction back into their normal rotary positions, whereupon the wiper 803 disengages the contacts in the associated contact bank included in the multiple 804 and engages the first contact in the associated contact bank, thereby to arrest further operation of the magnet M801 of the rotary switch C800 and to complete a circuit for energizing the winding of the magnet M721 of the rotary switch M720.

The last-mentioned circuit extends from ground by way of the previously traced path to the wiper 803 of the rotary switch C800 and therefrom by way of the wiper 723 of the rotary switch M720, the engaged contact in the associated contact bank of the rotary switch M720, the multiple 724, the contacts 722 and the winding of M721 to battery. When energized over the above-traced circuit, the magnet M721 operates to drive the wipers noted of the rotary switch M720 step by step in the counterclockwise direction back into their normal rotary positions, whereupon the wiper 723 disengages the contacts in the associated contact bank included in the multiple 724 and engages the first contact in the associated contact bank, thereby to arrest further operation of the magnet M721 and to complete a circuit for energizing the winding of the magnet M731 of the rotary switch T730.

The last-mentioned circuit extends from ground by way of the previously traced path to the wiper 723 of the rotary switch M720 and therefrom by way of the wiper 733 of the rotary switch T730 and engaged contact in the associated contact bank, the multiple 734, the contacts 732 and the winding of M731 to battery. When energized over the above-traced circuit, the magnet M731 operates to drive the wipers noted of the rotary switch T730 step by step in the counterclockwise direction back into their normal rotary positions, whereupon the wiper 733 disengages the contacts in the associated contact bank included in the multiple 734 and engages the first contact in the associated contact bank, thereby to arrest further operation of the magnet M731 and to complete a circuit for energizing the rotary magnet M716 of the Strowger mechanism 700.

The last-mentioned circuit extends from ground by way of the previously traced path to the wiper 733 of the rotary switch T730 and therefrom by way of the set of switch springs S718, the contacts 717 and the winding of M716 to battery. When energized over the above-traced circuit, the rotary magnet M716 operates to drive the wiper carriage of the Strowger mechanism 700 step by step away from its operated position into a position disposed eleven steps away from its normal position, whereupon the wiper carriage of the Strowger mechanism is returned to its normal vertical and rotary positions. When the wiper carriage of the Strowger mechanism 700 is returned to its normal position, the sets of switch springs S718 and S563 are actuated into disengagement. When the set of switch springs S718 is actuated into disengagement, the previously traced circuit for energizing the winding of the rotary magnet M716 is interrupted, thereby to arrest further operation of the rotary magnet M716. When the set of switch springs S563 is actuated into disengagement, the previously

traced holding circuit for energizing the winding of the cut-off relay R610 is interrupted, thereby to cause the cut-off relay R610 to restore shortly thereafter, this relay being of the slow-to-release type. At this time the director 64 is completely released and battery potential therein is connected by way of the previously traced circuit to the control conductor C605 of the trunk line 600, thereby rendering the director 64 accessible to the director selector switches having access thereto.

When the control relay R940 in the director selector switch 63 restores, it interrupts, at the contacts 948, the previously traced circuit for applying battery potential in the director selector switch 63 to the control conductor C135 of the trunk line 130, thereby to interrupt the previously traced holding circuit for energizing the upper winding of the control relay R430 in the first code selector switch 61. Shortly thereafter, the control relay R430 restores, this relay being rendered slow to release due to the completed path for short-circuiting the lower winding thereof. Upon restoring, the control relay R430 completes, at the contacts 434, the previously traced circuit for energizing the winding of the magnet M917 of the selector hunting switch 62, thereby to cause the magnet M917 to operate intermittently and drive the wipers noted of the selector hunting switch 62 in the counterclockwise direction back into their normal rotary positions. At this time the selector hunting switch 62 is completely released.

Also, upon restoring, the control relay R430 interrupts, at the contacts 431, the previously traced circuit for energizing the winding of the cut-through relay R400, thereby to cause the cut-through relay R400 to restore. Upon restoring, the cut-through relay R400 interrupts, at the contacts 402 and 404, the connection between the Strowger mechanism 480 in the first code selector switch 61 and the trunk line 900 extending between the first code selector switch 61 and the selector hunting switch 62 and completes, at the contacts 401 and 402, a connection between the trunk line 260 extending between the rotary switch D220 individually associated with the calling subscriber line 250 and the Strowger mechanism 480 in the first code selector switch 61.

When the subscriber at the subscriber substation T2 answers the call extended thereto, a two-way communication connection is established between the subscriber substation T1 and the subscriber substation T2. At this point it is noted that after the fourth digit of the director number of the called subscriber line 2200 has been repeated by the repeater 65 over the toll line 1555, the rotary switch S1680 in the repeater 65 is operated to cause the wipers noted thereof to engage the fifth contacts in the associated contact banks. More specifically, the wiper 1689 of the rotary switch S1680 engages the fifth contact in the associated contact bank, whereupon a circuit is completed for energizing the control relay R1510. This circuit extends from ground by way of the contacts 1645, the wiper 1689 and engaged fifth contact in the associated contact bank, C1606 and the winding of R1510 to battery. When energized over the above-traced circuit, the relay R1510 operates to complete, at the contacts 1516, a holding circuit for energizing the winding thereof, this circuit extending from ground by way of the contacts 1645, C1607, the contacts 1516 and the winding of R1510 to battery. Also, upon operating, the relay R1510 in-

terrupts, at the contacts 1514, a shunt path extending between the line conductors C1556 and C1557 of the toll line 1555, this path extending, before it is interrupted, from the positive line conductor C1557 of the toll line 1555, by way of the contacts 1514 and 1506, to the negative line conductor C1556 of the toll line 1555. Further, the relay R1510 completes, at the contacts 1512, a circuit for energizing the line relay R1505 directly across the positive and negative line conductors C428 and C427, respectively, of the trunk line 426 and completes, at the contacts 1513, the previously mentioned communication connection between the trunk line 426 and the toll line 1555.

After the subscriber at the subscriber substation T2 answers the call extending thereto, the communication connection between the subscriber substations T1 and T2 extends from the subscriber substation T1 by way of the positive line conductor C252 of the subscriber line 250, the contacts 214, the wiper 222 and engaged contact in the associated contact bank of the rotary switch D220, the positive line conductor C262 of the trunk line 260, the contacts 313 and the lower winding of R370 to ground and from the negative line conductor C251 of the subscriber line 250 by way of the contacts 212, the wiper 221 and engaged contact in the associated contact bank of the rotary switch D220, the negative line conductor C261 of the trunk line 260, the contacts 312 and the upper winding of the line relay R370 to battery. The telephone instrument at the calling subscriber substation T1 is bridged across the positive and negative line conductors C252 and C251, respectively, of the subscriber line 250, as previously noted. Also, the telephone instrument at the called subscriber substation T2 is bridged across the positive and negative line conductors of the subscriber line 2200, the subscriber line 2200 being connected by way of the connector switch 92, the second numerical selector switch 91 and the first numerical selector switch 90 to the dial repeater 81. The dial repeater 81 is connected by way of the group selector switch 80 to the toll line 1555, the positive line conductors C1557 of the toll line 1555 being connected by way of the right-hand winding of the time start relay R1540, the impedance element I1548, C1518 and the contacts 1506 to the negative line conductor C1556 of the toll line 1555. Also, there is completed a circuit extending from ground by way of the lower winding of the line relay R1505, the contacts 1512, the positive line conductor C428, the wiper 482 and engaged contact in the associated contact bank of the Strowger mechanism 480, the contacts 463, 472 and 444, the upper winding of the relay R420, the contacts 412, C104, the right-hand winding of the relay R330, C101, the contacts 401, 442 and 462, the wiper 481 and engaged contact in the associated contact bank of the Strowger mechanism 480, the negative line conductor C427 of the trunk line 426 and the upper winding of the line relay R1505 to battery. Furthermore, it is noted that the above-traced circuit is coupled, by way of the condensers 353 and 354, to the previously traced circuit including the telephone instrument at the calling subscriber substation T1; and is coupled, by way of the condensers 1550 and 1551, to the previously traced circuit extending to the dial repeater 81, which is coupled in turn to the circuit including the telephone instrument at the called subscriber substation T2.

Finally, it is noted that after the rotary switch

R1790 in the converter 66 operates to cause the rate factor to be stored in the fourth code storing device S1704 in the converter 66, the wiper 1794 of the rotary switch R1790 engages a contact in the associated contact bank included in the multiple 1796, thereby to complete an alternative circuit for energizing the winding of the magnet M1791 of the rotary switch R1790. This circuit extends from ground by way of the wiper 1794 and engaged contact in the associated contact bank of the rotary switch R1790, the multiple 1796, the contacts 1792 and the winding of the magnet M1791 to battery. When energized over the above-traced circuit, the magnet M1791 operates to interrupt, at the contacts 1792, the previously traced circuit for energizing the winding thereof, thereby to cause the magnet M1791 to restore and recomplete, at the contacts 1792, the previously traced circuit for energizing the winding thereof. Thus, the magnet M1791 operates intermittently to drive the wipers noted of the rotary switch R1790 step by step in the clockwise direction until the wiper 1794 of the rotary switch R1790 disengages the last contact in the associated contact bank included in the multiple 1796. The rotary switch R1790 in the converter 66 occupies its normal position at this time.

Operation of the detectors

When the repeater 65 is seized by the first code selector switch 61 the rotary switch F1690 operates to find the idle converter 66 in the group of converters accessible thereto, as previously explained, whereupon the relay R1720 in the converter 66 operates as previously noted. Upon operating, the relay R1720 completes, at the contacts 1722, a path for applying ground potential to the start conductor C1109 extending to the detectors 70 and 71, this path extending from ground by way of the contacts 1732 and 1722 to the start conductor C1109. This application of ground potential to the start conductor C1109 completes an obvious path for energizing the winding of the start relay R1350 in the detector 70 and a similar path for energizing the winding of the corresponding start relay in the detector 71. When energized over the above-traced circuit the start relay R1350 operates to complete, at the contacts 1351, a circuit for energizing the winding of the magnet M1121 of the rotary switch F1120. This circuit extends from ground by way of the contacts 1302, 1326 and 1351, C1111, the contacts 1122, and the winding of M1121 to battery. When energized over the above-traced circuit the magnet M1121 operates to condition the wiper 1123 of the rotary switch F1120 to be driven one step in the clockwise direction and to interrupt, at the contacts 1122, a point in the previously traced circuit for energizing the winding thereof, thereby to cause the magnet M1121 to restore. Upon restoring, the magnet M1121 recompletes, at the contacts 1122, the previously traced circuit for energizing the winding thereof and drives the wiper 1123 of the rotary switch F1120 one step in the clockwise direction. Accordingly, the magnet M1121 operates intermittently, thereby to drive the wiper 1123 of the rotary switch F1120 step by step in the clockwise direction until the wiper 1123 engages the contact in the associated contact bank terminating the conductor C1106, whereupon a circuit is completed for energizing the winding of the test relay R1320 in the detector 70 in series with the test relay R1740 in the converter 66

whereupon the test relays R1320 and R1740 operate. Upon operating, the test relay R1320 interrupts, at the contacts 1326, the previously traced circuit for energizing the winding of the magnet M1121, thereby positively to prevent further operation of the rotary switch F1120. Upon operating, the test relay R1740 in the converter 66 prepares a test circuit between the control conductor C253 of the calling subscriber line 250 and the detector 70. The portion of the test circuit prepared extends from the control conductor C253 of the subscriber line 250 by way of the contacts 216, the wiper 226 and engaged contact in the associated contact bank of the rotary switch D220, the control conductor C263 of the trunk line 260, the contacts 446, 474, 451, C106, the contacts 381, C107, the wiper 483 and engaged contact in the associated contact bank of the Strowger mechanism 480, the control conductor C429 of the trunk line 426, C1615, the contact 1621, C130, the wiper 1693 and engaged first contact in the associated contact bank of the rotary switch F1690, C1704, and the contacts 1733 and 1741 to the tone conductor C1107. Further this test circuit extends from the tone conductor C1107 by way of a secondary winding 1357 of the transformer 1355 to the conductor C1380, and from the conductor C1380 by way of the conductor C1421 to the detector 71. Further it will be understood that a rotary switch in the detector 71 corresponding to the rotary switch F1120 in the detector 70 operates to find the conductor C1106 extending into the converter 66.

Also, upon operating, the test relay R1320 completes, at the contacts 1324, a circuit for energizing the primary winding 1356 of the transformer 1355, this circuit extending from one terminal of the 2000 cycle generator 1352 by way of the primary winding 1356 of the transformer 1355 and the contacts 1324 to the other terminal of the generator 1352. The generator 1352 causes a 2000 cycle alternating current to traverse the primary winding 1356 of the transformer 1355 and induce a corresponding alternating potential in the secondary winding 1357 included in the previously traced test circuits extending to the detectors 70 and 71 for a purpose more fully described hereinafter. Also, upon operating, the test relay R1320 completes at the contacts 1321 a circuit for energizing the lower winding of the impulse relay R1310, this circuit extending from ground by way of the contacts 1321, C1370, the contacts 1333, 1303 and 1311 and the lower winding of R1310 to battery. When energized over the above-traced circuit the impulse relay R1310 operates to interrupt at the contacts 1311 the previously traced circuit for energizing the lower winding thereof, thereby to cause the impulse relay R1310 to restore in order to recomplete, at the contacts 1311, the previously traced circuit for energizing the lower winding thereof. Accordingly, the impulse relay R1310 operates intermittently. Furthermore, upon operating, the test relay R1320 prepares, at the contacts 1322, points in holding circuits for energizing the winding of the locking relay ML, CL, DL and UL, and prepares, at the contacts 1323, circuits traced hereinafter for energizing the windings of the control relays RA, RB and RC in series with various ones of the counting relays 1R to 10R, inclusive, in a manner more fully described hereinafter.

It is noted that the intermittent operation of the impulse relay R1310 controls the counting relay network 1200. More particularly, the first

time the impulse relay R1310 operates it completes, at the contacts 1312, a circuit for energizing the winding of the first counting relay 1R, this circuit extending from ground by way of the contacts 1312, RC1, RB1, RA1, and the winding of 1R to battery. When energized over the above-traced circuit, the counting relay 1R operates to prepare, at the contacts 1R2, a holding circuit for energizing the winding thereof in series with the switching relay RA subsequent to the restoration of the impulse relay R1310, and prepares, at the contacts 1R3, a circuit traced hereinafter for energizing the winding of the second counting relay 2R. When the impulse relay R1310 restores, the previously mentioned holding circuit for energizing the winding of the first counting relay 1R in series with the switching relay RA is completed. This circuit extends from ground by way of the contacts 1323 and 1301, C1372, the contacts RB3, the winding of RA, the contacts 1R2, and the winding of 1R to battery. When energized over the above-traced circuit, the first counting relay 1R is retained in its operated position and the switching relay RA is operated. Upon operating, the switching relay RA interrupts, at the contacts RA1, a point in the previously traced original circuit for energizing the winding of the first counting relay 1R, prepares, at the contacts RA2, a further point in the previously mentioned circuit for energizing the winding of the second counting relay 2R, and interrupts, at the contacts RA3, a point in the holding circuit for energizing the winding of the switching relay RC.

When the impulse relay R1310 operates for the second time, it completes, at the contacts 1312, the previously mentioned circuit for energizing the winding of the second counting relay 2R, this circuit extending from ground by way of the contacts 1312, C1373, the contacts RC1, RB1, RA2 and 1R3, and the winding of 2R to battery. When energized over the above-traced circuit, the second counting relay 2R operates to prepare, at the contacts 2R3, a holding circuit for energizing the winding thereof in series with the winding of the switching relay RB subsequent to the restoration of the impulse relay R1310, and prepares, at the contacts 2R4, a point in a circuit for energizing the winding of the third counting relay 3R. Subsequent to the restoration of the impulse relay R1310, the previously mentioned holding circuit for energizing the winding of the second counting relay 2R in series with the winding of the switching relay RB is completed, this circuit extending from ground by way of the contacts 1323 and 1301, C1372, the contacts RC3, the winding of RB, the contacts 2R3 and the winding of 2R to battery. When the above-traced circuit is completed, the second counting relay 2R remains in its operated position and the switching relay RB operates to interrupt, at the contacts RB3, the previously traced holding circuit for energizing the winding of the first counting relay 1R in series with the winding of the switching relay RA, thereby to cause the first counting relay 1R and the switching relay RA to restore. Also, upon operating, the switching relay RB interrupts, at the contacts RB1, a point in the previously traced original circuit for energizing the winding of the second counting relay 2R, and prepares, at the contact RB2, a point in a circuit for energizing the winding of the third counting relay 3R. Upon restoring, the switching

relay RA prepares, at the contacts RA3, a point in a holding circuit for energizing the winding of the third counting relay 3R in series with the switching relay RC.

In view of the above description of the operation of the counting relay network 1200, it will be understood that the counting relays 1R to 10R, inclusive, and the switching relays RA, RB and RC are operated in the following order:

Number of operations and restorations of the impulse relay R1310	Operated relays in the counting relay network 1200
1	1R and RA
2	2R and RB
3	3R and RC
4	4R and RA
5	5R and RB
6	6R and RC
7	7R and RA
8	8R and RB
9	9R and RC
10	10R and RA

Upon operating, the first counting relay 1R completes, at the contacts 1R1, an obvious path for applying ground potential to one of the conductors in the cable 1201; upon operating, the second counting relay 2R completes, at the contacts 2R1, an obvious path for applying ground potential to one of the conductors in the cable 1202, and interrupts, at the contacts 2R2, the previously mentioned path for applying ground potential to one of the conductors in the cable 1201; the third counting relay 3R completes, at the contacts 3R1, an obvious path for applying ground potential to one of the conductors in the cable 1203, and interrupts, at the contacts 3R2, the previously mentioned path for applying ground potential to one of the conductors in the cable 1202; etc. Accordingly, it will be understood that ground potential is sequentially applied to corresponding ones of the conductors in the cables 1201 to 1210, inclusive, incident to the operation of the counting relay network 1200.

The detector 70 operates at this time to determine the particular 1000 group of lines in the 10,000 group of lines terminating at the originating exchange 50 which includes the calling subscriber line 250. More particularly, upon operating, the test relay R1320 completes, at the contacts 1325, a circuit for energizing the winding of the selecting relay MK, this circuit extending from ground by way of the contacts 1325, ML6, C1374 and the winding of MK to battery. When energized over the above-traced circuit, the selecting relay MK operates to prepare, at the contacts MK1 to MK10, inclusive, the previously mentioned path for applying ground potential to the first conductor in each of the cables 1201 to 1210, inclusive. Accordingly, at this time, ground potential is sequentially applied to the first conductors in the cables 1201 to 1210, inclusive, incident to the operation of the counting relay network 1200, whereby the relays 1SM to 10SM, inclusive, in the first code storing device 70SM are sequentially operated. Upon operating, the first relay 1SM in the code storing device 70SM completes, at the contacts 1SM4, a circuit for energizing the first relay 1M in the crossbar switch control network 1100, this circuit extending from ground by way of the contacts 1327, C1381, the contacts 1SM4, the first conductor in the cable 1103, and the winding of 1M to battery, whereupon the relay 1M operates. Also, upon operat-

ing, the first relay 1SM prepares, at the contacts 1SM3, a holding circuit for energizing the winding thereof in series with the locking relay ML, which holding circuit is completed in the event the calling subscriber line 250 is included in the first 1000 group of lines terminating at the originating exchange 50. On the other hand, in the event the calling subscriber line 250 is not included in the first group of 1000 lines terminating at the originating exchange 50, the present example, the first relay 1SM in the code storing device 70SM subsequently restores and the second relay 2SM in the code storing device 70SM operates. More specifically, the relays 1SM to 10SM, inclusive, in the code storing device 70SM operate sequentially until the relay in the code storing device 70SM is operated, which relay corresponds to the particular group of 1000 lines terminating at the originating exchange 50 including the calling subscriber line 250.

Upon operating, the first relay 1M in the crossbar switch control network 1100 completes, at the contacts 1M1 to 1M5, inclusive, obvious circuits for energizing the first to the fifth horizontal magnets HM1 to HM5, inclusive, of the first crossbar switch 1001, these circuits extending from the grounded conductor C1102 by way of the back contacts of the relay MS and the contacts 1M1 to 1M5, inclusive, of the relay 1M, the conductors in the cable 1014 and the windings of the horizontal magnets HM1 to HM5, inclusive, to battery. Also, upon operating, the relay 1M completes, at the contacts 1M6 and 1M7, circuits for respectively energizing the even and odd relays EC and OC, respectively, these circuits extending from the grounded conductor C1102 by way of the back contacts of the relay MS, the contacts 1M6 and 1M7 of the relay 1M and the windings of the relays EC and OC to battery. When energized over the above-traced circuit, the odd relay OC operates to complete, at the contacts OC1 to OC10, inclusive, obvious circuits for energizing the vertical magnets VM1 to VM10, inclusive, these circuits extending from the grounded conductor C1116 by way of the back contacts of the relay CS, the contacts OC1 to OC10, inclusive, of the odd relay OC, the conductors in the cable 1012 and the windings of the vertical magnets VM1 to VM10, inclusive, to battery. When energized over the above-traced circuit, the even relay EC operates to complete, at the contacts EC1 to EC10, inclusive, obvious circuits for energizing the windings of the vertical magnets VM11 to VM20, inclusive, these circuits extending from the grounded conductor C1116 by way of the back contacts of the relay CS, the contacts EC1 to EC10, inclusive, of the even relay EC, the conductors in the cable 1013 and the windings of the vertical magnets VM11 to VM20, inclusive, to battery.

When the horizontal magnets HM1 to HM5, inclusive, and the vertical magnets VM1 to VM20, inclusive, are energized, these magnets operate, thereby to cause the corresponding horizontal and vertical bars in the first crossbar switch 1001 to be operated, whereupon the associated 100 contact sets in the first crossbar switch are actuated, ten pairs of contact springs in each contact set being actuated into engagement. This operation of the horizontal magnets HM1 to HM5, inclusive, and the vertical magnets VM1 to VM20, inclusive, prepares a further point in the previously mentioned test circuit. However, in the present example, the calling subscriber line 250 is included in the second 1000 group of lines

terminating at the originating exchange 50. Thus, this test circuit is not completed at this time. When the first relay 1SM in the code storing device 70SM restores and the second relay 2SM therein operates, the first relay 1M and the second relay 2M in the crossbar switch control network 1100 respectively restore and operate. When the first relay 1M restores, the previously traced circuits for energizing the windings of the horizontal magnets HM1 to HM5, inclusive, and the windings of the odd and even relays OC and EC, respectively, are interrupted at the contacts 1M1 to 1M7, inclusive, thereby to cause the horizontal magnets HM1 to HM5, inclusive, and the odd and even relays OC and EC, respectively, to restore. When the second relay 2M operates, there are completed, at the contacts 2M1 to 2M5, inclusive, obvious circuits for energizing, by way of the conductors in the cable 1015, the horizontal magnets HM6 to HM10, inclusive, of the first crossbar switch 1001. Also, upon operating, the second relay 2M completes, at the contacts 2M6 and 2M7, alternative circuits for energizing the odd and even relays OC and EC, respectively, whereupon the last-mentioned relays reoperate and recomplete, at the contacts OC1 to OC10, inclusive, and at the contacts EC1 to EC10, inclusive, respectively, the previously traced circuits for energizing the windings of the vertical magnets VM1 to VM10, inclusive, and the vertical magnets VM11 to VM20, inclusive. Accordingly, at this time, the horizontal magnets HM6 to HM10, inclusive, and the vertical magnets VM1 to VM20, inclusive, of the first crossbar switch 1001 operate, thereby to operate the associated horizontal and vertical bars in the first crossbar switch 1001, whereupon the second group of 100 contact sets are operated, each contact set including ten pairs of operated contact springs.

In view of the fact that the calling subscriber line 250 is included in the second group of 1000 lines terminating at the originating exchange 50, the previously mentioned test circuit is completed at this time. This test circuit extends from the control conductor C253 of the calling subscriber line 250 by way of the conductor C254, the set of switch springs illustrated, associated with the tenth horizontal bar and the second vertical bar in the first crossbar switch 1001, one of the conductors in the cable 1011, one of the sets of contacts DS1 to DS10, inclusive, of the relay DS and the conductor C1113 to the primary winding 1346 of the transformer 1347. Further, this test circuit extends over the previously traced prepared path by way of the converter 66, the repeater 65, the first code selector switch 61 and the rotary switch D220 to the control conductor C253 of the subscriber line 250.

In view of the fact that this test circuit is completed, 2000 cycle current traverses the primary winding 1346 of the transformer 1347 and induces a similar alternating current potential in the secondary winding 1345 of the transformer 1347. At this point, it is noted that the vacuum tube detector 1305 comprises a filamentary cathode 1306 included in a circuit extending from ground by way of the switch S1342, the resistor 1343, the filamentary cathode 1306 and the resistor 1344 to battery. Also, negative battery biasing potential is applied to the grid 1307 of the vacuum tube 1305 by way of the secondary winding 1345 of the transformer 1347. At this time, when 2000 cycle voltage is induced in the secondary winding 1345 of the transformer 1347

and applied to the grid 1307, the detector 1305 operates, in a well-known manner, to cause direct current to traverse the winding of the test relay R1330 over a circuit extending from the positive terminal of the anode current source by way of the winding of the test relay R1330, the anode 1308, the cathode 1306 and the resistor 1344 to the negative terminal of the anode current source. When the winding of the test relay R1330 is energized by way of the above-traced circuit, this relay operates to interrupt, at the contacts 1333, the previously traced circuit for energizing the winding of the impulse relay R1310 and to prepare, at the contacts 1332, a circuit for energizing the winding of the locking relay ML in series with the winding of the second relay 2SM in the code storing device 70SM subsequent to the restoration of the second counting relay 2R in the counting relay network 1200. Also, upon operating, the test relay R1320 completes, at the contacts 1331, a circuit for energizing the reset relay R1300, this circuit extending from ground by way of the contacts 1321, C1317, the contacts 1331 and the winding of R1300 to battery. When energized over the above-traced circuit, the reset relay R1300 operates to interrupt, at the contacts 1301, the previously traced holding circuit for energizing the winding of the switching relay RB in series with the winding of the second counting relay 2R in the counting relay network 1200, thereby to cause the switching relay RB and the second counting relay 2R to restore. Upon restoring, the second counting relay 2R interrupts, at the contacts 2R1, the previously traced original circuit for energizing the winding of the second relay 2SM in the code storing device 70SM, whereupon the previously mentioned circuit for energizing the winding of the locking relay ML in series with the second relay 2SM in the code storing device 70SM is completed. The last-mentioned circuit extends from ground by way of the contacts 1321, C1370, the contacts 1332, C1371, the contacts ML2, the winding of ML, C1414, the contacts 2SM3 and the winding of 2SM to battery. When energized over the above-traced circuit, the locking relay ML operates to interrupt, at the contacts ML2, a point in the previously traced circuit for energizing the winding thereof in series with the winding of the second relay 2SM in the code storing device 70SM, and to complete, at the contacts ML4, an obvious holding circuit for energizing the winding thereof in series with the winding of the second relay 2SM.

Also, upon operating, the locking relay ML prepares, at the contacts ML3, a point in a circuit traced hereinafter for energizing the winding of the locking relay CL and completes, at the contacts ML1, an obvious circuit for energizing the winding of the relay MS, thereby to cause operation of the relay MS. Also, upon operating, the locking relay ML interrupts, at the contacts ML6, the previously traced circuit for energizing the winding of the selecting relay MK in order to cause the selecting relay MK to restore, and completes, at the contacts ML5, a circuit for energizing the winding of the selecting relay CK. The last-mentioned circuit extends from ground by way of the contacts 1325, ML5 and CL5, C1375 and the winding of CK to battery. When energized over the above-traced circuit, the selecting relay CK operates to prepare the previously mentioned path for applying ground potential to the second conductors in the cables 1201 to 1210,

inclusive, incident to the reoperation of the counting relay network 1200.

Upon operating, the relay MS interrupts, at the back contacts MS1B to MS5B, inclusive, the previously traced circuits for energizing the windings of the horizontal magnets HM6 to HM10, inclusive, and to interrupt, at the back contacts MS6B and MS1B, the previously traced circuits for energizing the windings of the even and odd relays EC and OC, respectively, thereby to cause the horizontal magnets HM6 to HM10, inclusive, and the even and odd relays EC and OC to restore. When the odd and even relays OC and EC restore, the previously traced circuits for energizing the windings of the vertical magnets VM1 to VM20, inclusive, are interrupted, at the contacts OC1 to OC10, inclusive, and at the contacts EC1 to EC10, inclusive.

Accordingly, at this time, the horizontal magnets HM6 to HM10, inclusive, and the vertical magnets VM1 to VM20, inclusive, restore to interrupt, at the set of contact springs illustrated, the previously traced test circuit, whereupon the vacuum tube detector 1305 cuts off and interrupts the previously traced circuit for energizing the winding of the test relay R1330. The test relay R1330 then restores to recomplete, at the contacts 1333, the previously traced circuit for causing intermittent operation of the impulse relay R1310, and interrupts, at the contacts 1331, the previously traced circuit for energizing the winding of the reset relay R1300. Shortly thereafter, the reset relay R1300, being of the slow-to-release type, restores to recomplete, at the contacts 1301, the previously traced circuit for energizing the counting relays in the counting relay network 1200. At this time, further operation of the counting relay network 1200 is initiated and the second relay 2SM in the code storing device 70SM corresponding to the particular 1000 group of lines terminating at the originating exchange 50 and including the calling subscriber line 250 is operated and locked in its operated position in series with the locking relay ML. Also the relays 2M and MS remain operated.

The detector 70 then operates to determine the particular 100 group of lines in the previously determined 1000 group of lines terminating at the originating exchange 50 which includes the calling subscriber line 250. More particularly, the operation of the counting relay network 1200 causes the relays 1SC to 10SC, inclusive, in the code storing device 70SC to be operated sequentially, due to the fact that the selecting relay CK occupies its operated position at this time. When the first relay 1SC in the code storing device 70SC is operated, it completes, at the contacts 1SC2, a circuit for energizing the horizontal magnet HM6 in the first crossbar switch 1001. This circuit extends from ground by way of the contacts 1327, C1381, the contacts 1SC2, the first conductor in the cable 1101, the front contact MS1F of the relay MS, the contacts 2M1, the first conductor in the cable 1015 and the winding of HM6 to battery. Also, upon operating, the first relay 1SC in the code storing device 70SC completes, at the contacts 1SC3, a circuit for energizing the winding of the odd relay OC, this circuit extending from ground by way of the contacts 1327, C1381, C1432, the contacts 1SC3, the odd conductor in the cable 1101, the contacts MS1F and 2M7 and the winding of the odd relay OC to battery. When energized over the above-traced circuit, the odd relay OC operates to complete, at the contacts OC1 to OC10,

inclusive, the previously traced circuits for energizing the windings of the vertical magnets VM1 to VM10, inclusive. Accordingly, at this time, the horizontal magnet HM6 and the vertical magnets VM1 to VM10, inclusive, occupy their operated positions, thereby to cause the 10 contact sets associated therewith to be operated. In the present example, the calling subscriber line 250 is included in the ninth 100 group. Accordingly, the test relay R1330 is not operated as the previously traced test circuit is not completed at this time.

Subsequently, the first relay ISC restores and the second relay 2SC operates in the code storing device 70SC. Upon operating, the second relay 2SC completes, at the contacts 2SC2, an obvious alternative circuit for energizing the horizontal magnet HM6 and completes, at the contacts 2SC3, a circuit for energizing the winding of the even relay EC, this circuit extending from ground by way of the contacts 1327, C1381, C1432, the contacts 2SC3, the even conductor in the cable 1101, the contacts MS6F and 2M6 and the winding of EC to battery. When energized over the above-traced circuit, the even relay EC operates to complete, at the contacts EC1 to EC10, inclusive, the previously traced circuits for energizing the windings of the magnets VM11 to VM20, inclusive. At this time, the horizontal magnet HM6 and the vertical magnets VM11 to VM20, inclusive, occupy their operated positions, thereby to operate the ten contact sets associated therewith. As previously noted, the calling subscriber line 250 is terminated in the ninth 100 group at the originating exchange 50. Hence, the test relay R1330 is not operated at this time.

In view of the foregoing description, it will be understood that, when the third and fourth SC relays are operated, the horizontal magnet HM7 will be operated; when the fifth and sixth SC relays are operated, the horizontal magnet HM8 will be operated; when the seventh and eighth SC relays are operated, the horizontal magnet HM9 will be operated; and when the ninth and tenth SC relays are operated, the horizontal magnet HM10 will be operated. Furthermore, when the third, fifth, seventh and ninth SC relays are operated, the OC relay will be operated; and when the fourth, sixth, eighth and tenth SC relays are operated, the even relay EC will be operated. Accordingly, in the present example, when the relay 9SC is operated, the horizontal magnet HM10 and the vertical magnets VM1 to VM10, inclusive, will be operated; and the previously traced test circuit will be completed, whereupon the test relay R1330 will operate. Upon operating, the test relay R1330 resets the counting relay network 1200, as previously explained, and completes a holding circuit for energizing the winding of the locking relay CL in series with the winding of the relay 9SC in the code storing device 70SC. The last-mentioned circuit extends from ground, at the contacts 1321, by way of C1370, the contacts 1332, C1371, the contacts ML3 and CL2, the winding of CL, C1415 and the contacts and winding of 9SC to battery. The operated relay 9SC retains the horizontal magnet HM10 and the odd relay OC in their operated positions at this time. Upon operating, the locking relay CL completes, at the contacts CL4', an obvious holding circuit for energizing the winding thereof in series with the operated relay 9SC in the code storing device 70SC. Further, the locking relay CL interrupts, at the contacts CL5, the previously traced circuit for energizing the wind-

ing of the selecting relay CK, thereby to cause the relay CK to restore, and completes, at the contacts CL4, a circuit for energizing the winding of the selecting relay DK. This circuit extends from ground by way of the contacts 1325, ML5, CL4 and DL5, C1376, and the winding of DK to battery. When energized over the above-traced circuit, the selecting relay DK operates to condition the counting relay network 1200 to apply ground potential sequentially to the third conductors in the cables 1201 to 1210, inclusive. Also, upon operating, the locking relay CL completes, at the contacts CL1, an obvious circuit for energizing the winding of the relay CS, thereby to cause the last-mentioned relay to operate and interrupt, at the contacts CS1B to CS10B, inclusive, the previously traced circuits for energizing the windings of the vertical magnets VM1 to VM10, inclusive, whereupon the vertical magnets VM1 to VM10, inclusive, restore to interrupt the previously traced test circuit, whereby the test relay R1330 restores to initiate further operation of the counting relay network 1200.

The detector 70 then operates to determine the particular 10 group of lines in the previously determined 100 group of lines terminating at the originating exchange 50 which includes the calling subscriber line 250. More particularly, the SD relays in the code storing device 70SD operate sequentially, thereby to sequentially complete circuits for energizing the windings of the vertical magnets VM1 to VM10, inclusive, of the first crossbar switch 1001. Specifically, when the first SD relay operates, a circuit is completed for energizing the vertical magnet VM1, this circuit extending from ground by way of the contacts 1327, C1381, C1434, the contacts controlled by the first SD relay, the first conductor in the cable 1104, CS1F, OC1, the first conductor in the cable 1012 and the winding of VM1 to battery. Upon operating, the vertical magnet VM1 operates the particular contact set individually associated with the horizontal and vertical operating bars respectively associated with the horizontal magnet HM10 and the vertical magnet VM1. As previously noted, the calling subscriber line 250 is included in the second 10 line group. Accordingly, the previously traced test circuit is not completed at this time. When the second SD relay in the code storing device 70SD operates, a circuit similar to that previously traced is completed for energizing the winding of the vertical magnet VM2. When the horizontal magnet HM10 and the vertical magnet VM2 are operated, the set of contact springs illustrated is operated, whereupon the previously traced test circuit is completed, and the test relay R1330 operates in order to reset the counting relay network 1200, as previously explained. At this time, a holding circuit is completed for energizing the winding of the locking relay DL in series with the second SD relay in the code storing device 70SD, this circuit extending from ground by way of the contacts 1322 and DL4', the winding of DL, C1416, the contacts controlled by the second SD relay and the winding of the second SD relay to battery. The operated second SD relay in the code storing device 70SD retains the vertical magnet VM2 in its operated position at this time.

Upon operating, the locking relay DL interrupts, at the contacts DL5, the previously traced circuit for energizing the winding of the selecting relay DK and completes, at the contacts DL4, a circuit for energizing the winding of the se-

lecting relay UK. The last-mentioned circuit extends from ground by way of the contacts 1325, ML5, CL4 and DL4, C1377 and the winding of UK to battery. When energized over the above-traced circuit, the selecting relay UK operates to prepare, at the contacts UK1 to UK10, inclusive, paths for causing the counting relay network 1200 to apply ground potential sequentially to the fourth conductors in the cables 1201 to 1210, inclusive. Also, upon operating, the locking relay DL prepares, at the contacts DL3, a circuit traced hereinafter for energizing the winding of the locking relay UL in series with an operated one of the SU relays in the code storing device 70SU, and completes, at the contacts DL1, an obvious circuit for energizing the winding of the relay DS, thereby to cause the relay DS to operate. Upon operating, the relay DS interrupts, at the contacts DS1 to DS10, inclusive, the connection between the ten conductors in the cable 1011 and the conductor C1113, thereby to interrupt the previously traced test circuit. When the previously traced test circuit is interrupted, the test relay R1330 restores in order to initiate further operation of the counting relay network 1200.

The detector 70 then operates to determine the particular line in the previously determined 10 group of lines terminating at the originating exchange 50 which is the calling subscriber line 250. More particularly, the SU relays in the code storing device 70SU begin to operate sequentially, thereby to test the individual pairs of contact springs illustrated to determine the particular pair of contact springs terminating the conductor C254 extending to the control conductor C253 of the calling subscriber line 250 and included in the previously traced test circuit. More specifically, when the first SU relay in the code storing device 70SU operates, the previously traced test circuit is completed, this test circuit extending by way of the previously traced path to the conductor C1113, and therefrom by way of the conductor C1420, the contacts associated with the first SU relay in the code storing device 70SU, the first conductor in the cable 1105, the first conductor in the cable 1011, the condenser 1021, and the first pair of switch springs S1 in the contact set illustrated to the conductor C254, and therefrom by way of the previously traced path to the control conductor C253 of the calling subscriber line 250. When this test circuit is completed, the test relay R1330 operates, as previously explained, thereby to reset the counting relay network 1200, whereupon a holding circuit is completed for energizing the winding of the first SU relay in the code storing device 70SU in series with the locking relay UL. The last-mentioned circuit extends from ground by way of the contacts 1322, UL3, the winding of UL, C1417, the contacts controlled by the first SU relay and the winding of the SU relay to battery.

At this time, the detector 70 has operated to determine the directory number of the calling subscriber line 250 terminating at the originating exchange 50, the directory number of the calling subscriber line 250 being 2921, as previously noted. This directory number of the calling subscriber line 250 terminating at the originating exchange 50 is determined by the operated positions of the second SM relay in the 1000 code storing device 70SM, the ninth SC relay in the 100 code storing device 70SC, the second SD relay in the 10 code storing device 70SD, and the first SU relay in the unit code storing device 70

70SU. In a similar manner, the detector 71 operates to determine the directory number of the calling subscriber line 250 terminating at the originating exchange 50, and corresponding relays in the code storing devices 71SM, 71SC, 71SD and 71SU in the detector 71 should be operated at this time.

In the event both of the detectors 70 and 71 operate and determine that the calling subscriber line 250 terminating at the originating exchange 50 has the same directory number—in other words, both of the detectors 70 and 71 check with each other concerning the directory number of the calling subscriber line 250—a chain circuit is completed for operating the check relay R1360 upon operation of the locking relay UL. This chain circuit extends from ground by way of the contact UL1, C1382, the contacts controlled by the second SM relay in the code storing device 70SM, the second conductor in the cable 1440, the contacts controlled by the second SM relay in the code storing device 71SM, the conductor C1441, the contacts controlled by the ninth SC relay in the code storing device 71SC, the ninth conductor in the cable 1442, the contacts controlled by the ninth SC relay in the code storing device 70SC, the conductor C1443, the contacts controlled by the second SD relay in the code storing device 70SD, the second conductor in the cable 1444, the contacts controlled by the second SD relay in the code storing device 71SD, the conductor C1445, contacts controlled by the first SU relay in the code storing device 71SU, the first conductor in the cable 1446, contacts controlled by the first SU relay in the code storing device 70SU, C1418 and the winding of the check relay R1360 to battery. When the above-traced chain circuit is completed, the check relay R1360 operates to interrupt, at the contacts 1363, a point in a circuit traced hereinafter for energizing the winding of the alarm relay R1340.

In the event that the detectors 70 and 71 fail to check with each other concerning the directory number of the calling subscriber line 250 terminating at the originating exchange 50, the above-traced chain circuit for energizing the winding of the check relay R1360 is not completed and the check relay R1360 does not operate. Furthermore, in the last-mentioned event, upon operation of the locking relay UL in the detector 70 and the locking relay 71UL in the detector 71, the previously mentioned circuit for energizing the winding of the alarm relay R1340 is completed. The last-mentioned circuit extends from ground in the detector 71, by way of the contacts 71UL1 of the locking relay 71UL in the detector 71, C1419, the contacts 1363, the winding of the alarm relay R1340 and the contacts UL4 of the locking relay UL in the detector 70 to battery. In the event the above-traced circuit is completed, the alarm relay R1340 operates to complete, at the contacts 1341, an obvious circuit for energizing the winding of the alarm device A1300, thereby to cause operation of the alarm device A1300 in order to indicate to the attendant at the originating exchange 50 that the detectors 70 and 71 have failed to check with each other concerning the directory number of a calling subscriber line terminating at the originating exchange 50.

Furthermore, it is noted that the operated second relay 2SM in the code storing device 70SM completes, at the contacts 2SM1 and 2SM2, obvious paths for applying ground potential to the W and Y leads in the first group of marking leads 1451 included in the cable 1455 extending into

the converter 66, thereby to mark with code the 1000 digit of the directory number of the calling subscriber line 250 terminating at the originating exchange 50, this code corresponding to the digit 2, as previously explained. This marking circuit extends from ground by way of the contacts 1361, C1378 to the conductor C1410, from the conductor C1410 by way of the contacts 2SM1 to the W lead in the first group of marking leads 1451, and from the conductor C1410 by way of the contacts 2SM2 to the Y lead in the first group of marking leads 1451. In a similar manner, the operated ninth SC relay in the code storing device 70SC marks the WXYZ leads in the second group of marking leads 1452 with ground potential; the second SD relay in the code storing device 70SD marks the WXYZ leads in the third group of marking leads 1453 with ground potential; and the first SU relay in the code storing device 70SU marks the WXYZ leads in the fourth group of marking leads 1454 with ground potential. It is noted that the WXYZ leads in the first, second, third and fourth or 1000, 100, 10 and unit groups of marking leads 1451, 1452, 1453 and 1454, respectively, are marked with ground potential only in the event that the check relay R1360 operates, which check relay operates only in the event the detectors 70 and 71 check with each other concerning the directory number of the calling subscriber line 250 terminating at the originating exchange 50.

Finally, upon operating, the check relay R1360 completes, at the contacts 1362, the circuit for energizing the upper winding of the cut-off relay R1730 in the converter 66, thereby to cause operation of the cut-off relay R1730. This circuit extends from ground, at the contacts 1362, C1108, the upper winding of R1730 and the contacts 1743 to battery.

Operation of the converter

The operation of the check relay R1360 in the detector 70 to mark the WXYZ leads in the first, second, third and fourth groups of marking leads included in the cable 1455 causes operation of the corresponding WXYZ relays in the fifth, sixth, seventh and eighth code storing devices S1705 to S1708, inclusive, in the converter 66. For example, the application of ground potential to the W and Y leads in the first group of marking leads 1451 completes circuits for energizing the W and Y relays 5W and 5Y, respectively, in the fifth code storing device S1705 in the converter 66. The circuit for energizing the relay 5W extends from ground potential appearing upon the W lead in the first group of marking leads 1451, by way of the contacts 1706, the switching relay R1705 being operated at this time, and the winding of the relay 5W to battery. Upon operating, the relay 5W completes, at the contacts 5W1, a holding circuit for energizing the winding thereof, this circuit extending from ground by way of the contacts 1715, C1726, C158, the contacts 5W1 and the winding of 5W to battery. From the above description, it will be understood that the fifth, sixth, seventh and eighth code storing devices S1705, S1706, S1707 and S1708 in the converter 66 are operated at this time, respectively, to store in code the 1000, 100, 10 and unit digits of the directory number of the calling subscriber line 250 terminating at the originating exchange 50.

Upon operating, the cut-off relay R1730 in the converter 66 completes, at the contacts 1734, a holding circuit for energizing the lower winding

thereof, this circuit extending from ground by way of the contacts 1713 and 1734, and the lower winding of R1730 to battery. Also, upon operating, the cut-off relay R1730 interrupts, at the contacts 1732, the previously traced path for applying ground potential to the start conductor C1108, thereby to interrupt the previously traced circuit for energizing the start relay R1350 in the detector 70, whereupon the start relay R1350 restores. Also, upon operating, the cut-off relay R1730 interrupts, at the contacts 1731, the previously traced circuit for energizing the winding of the test relay R1740 in the converter 66 in series with the test relay R1320 in the detector 70, whereupon the test relays R1740 and R1320 restore. Upon restoring, the test relay R1320 interrupts at the contacts 1325, the previously traced circuit for energizing the selecting relay UK, thereby to cause the last-mentioned relay to restore. Further, the test relay R1320 interrupts, at the contacts 1327, the previously traced circuit for energizing the relay 2M and the odd relay OC in the crossbar switch control network 1100, thereby to cause these relays to restore. Upon restoring, the relay 2M interrupts the previously traced circuit for energizing the winding of the horizontal magnet HM10 of the first crossbar switch 1001; and upon restoring the odd relay OC interrupts the previously traced circuit for energizing the winding of the vertical magnet VM2 of the first crossbar switch 1001; whereupon the horizontal magnet HM10 and the vertical magnet VM2 restore in order to return the first crossbar switch 1001 to its normal position. Further, the test relay R1320 interrupts, at the contacts 1322, the previously traced circuit for energizing the winding of the locking relay ML in series with the winding of the second SM relay in the code storing device 70SM, the circuit for energizing the winding of the locking relay CL in series with the winding of the ninth SC relay in the code storing device 70SC, the circuit for energizing the winding of the locking relay DL in series with the second SD relay in the code storing device 70SD and the circuit for energizing the winding of the locking relay UL in series with the first SU relay in the code storing device 70SU; whereupon the locking relays ML, CL, DL and UL, the second SM relay, the ninth SC relay, the second SD relay and the first SU relay restore. Also, the test relay R1320 interrupts, at the contacts 1324, the previously traced circuit for energizing the primary winding 1356 of the transformer 1355 with 2000 cycle alternating current from the generator 1352, and interrupts at the contacts 1321, the previously traced circuit for energizing the winding of the reset relay R1300, thereby to cause the reset relay R1300 to restore shortly thereafter. Upon restoring, the locking relay ML interrupts, at the contacts ML1, the previously traced circuit for energizing the winding of the relay MS in order to cause the relay MS to restore; upon restoring, the locking relay CL interrupts, at the contacts CL1, the previously traced circuit for energizing the winding of the relay CS in order to cause the relay CS to restore; upon restoring, the locking relay DL interrupts, at the contacts DL1, the previously traced circuit for energizing the winding of the relay DS in order to cause the relay DS to restore; and, upon restoring, the locking relay UL interrupts, at the contacts UL1, the previously traced circuit for energizing the winding of the check relay R1360 in order to cause the check relay R1360 to restore. Upon restoring, the

check relay R1360 interrupts, at the contacts 1361, the previously traced marking circuits for the WXYZ leads in the groups of marking leads included in the cable 1455. At this time, the detector 70 is completely released. Furthermore, it will be understood that the detector 71 is simultaneously released with the detector 70, and in a similar manner. The detectors 70 and 71 are completely released at this time and available to the use of other calling subscriber lines terminating at the originating exchange 50.

At this point, it is noted that, when the rotary switch M1770 in the converter 66 is operated away from its normal position to convert the fourth or unit digit of the directory number of the called subscriber line 2200 into WXYZ code to be stored in the fourth code storing device S1604 in the repeater 65, in the previously described manner, the wiper 1775 thereof engages the contacts in the associated contact bank included in the multiple 1776, whereupon a circuit is completed for energizing the winding of the magnet M1781 of the rotary switch S1780. The last-mentioned circuit extends from ground by way of the wiper 1775 and the engaged contact in the associated contact bank of the rotary switch M1770, the multiple 1776 and the winding of M1781 to battery. When energized over the above-traced circuit, the magnet M1781 operates to condition the wipers 1783, 1784, 1785, 1786, 1787 and 1788 of the rotary switch S1780 to be driven one step in the clockwise direction. Subsequently, after the fourth or unit digit of the directory number of the called subscriber line 2200 has been transmitted in code from the converter 66 to the fourth code storing device S1604 in the repeater 65, the rotary switch M1770 is returned back to its normal rotary position, as previously explained, whereupon the wiper 1775 thereof disengages the last contact in the associated contact bank included in the multiple 1776, whereupon the previously traced circuit for energizing the winding of the magnet M1781 of the rotary switch S1780 is interrupted. The magnet M1781 then restores to drive the wipers noted of the rotary switch S1780 one step in the clockwise direction. At this time, the wiper 1787 of the rotary switch S1780 engages the first contact in the associated contact bank, thereby to complete a circuit for energizing the lower winding of the impulse relay R1745 when the rotary switch R1790 is returned back to its normal rotary position, as previously explained. The last-mentioned circuit extends from ground by way of the wiper 1794 of the rotary switch R1790, the engaged first contact in the associated contact bank, the wiper 1787 of the rotary switch S1780 and the engaged second contact in the associated contact bank, the contact 1746 and the lower winding of R1745 to battery. When energized over the above-traced circuit, the impulse relay R1745 operates to interrupt, at the contacts 1746, the previously traced circuit for energizing the lower winding thereof, whereupon the impulse relay R1745 restores to recomplete, at the contacts 1746, the previously traced circuit for energizing the lower winding thereof. Accordingly, the impulse relay R1745 operates intermittently. Each time the impulse relay R1745 operates, it completes, at the contacts 1745, an obvious circuit for energizing the winding of the magnet M1781 of the rotary switch S1780; and each time the impulse relay R1745 restores it interrupts, at the contacts 1745, the previously mentioned circuit for energizing the winding of the magnet M1781. Accordingly, the magnet

M1781 operates and restores intermittently to drive the wipers noted of the rotary switch S1780 step by step in a clockwise direction. Also, each time the impulse relay R1745 operates, it completes, at the contacts 1744, an alternative circuit for energizing the winding of the magnet M1681 of the rotary switch S1680, this circuit extending from ground by way of the contacts 1744, C1703, the wiper 1696 and engaged first contact in the associated contact bank of the rotary switch F1690, the contacts 1665 and the winding of M1681 to battery. When the impulse relay R1745 restores it interrupts, at the contacts 1744, the previously traced circuit for energizing the winding of the magnet M1680 of the rotary switch S1680. Accordingly, it will be understood that the intermittent operation of the relay R1745 causes the rotary switch S1780 in the converter 66 and the rotary switch S1680 in the repeater 65 to be operated in synchronism. At this point, it is noted that, at the conclusion of the fourth digit of the directory number of the called subscriber line 2200, the wipers 1783, 1784, 1785 and 1786 of the rotary switch S1780 engage the second contacts in the associated contact banks; while the wipers 1685, 1686, 1687 and 1688 of the rotary switch S1680 in the repeater 65 engage the fifth contacts in the associated contact banks. Thus, it will be understood that, at the conclusion of the fourth digit of the directory number of the called subscriber line 2200, the first code storing device S1701 in the converter 66 is connected to the fifth code storing device S1605 in the repeater 65. For example, in the event that the 1W relay in the first code storing device S1701 in the converter 66 is operated at this time, a circuit is completed for energizing the corresponding 5W relay in the fifth code storing device S1605 in the repeater 65. The last-mentioned circuit extends from ground, in the converter 66, by way of the contacts 1715, C1726, the contacts 1W1, C151, the wiper 1783 and engaged second contact in the associated contact bank of the rotary switch S1780, the W lead in the cable 1700, the wiper 1697 and engaged first contact in the associated contact bank of the rotary switch F1690, the contacts 1666 and 1671, the wiper 1685 and engaged fifth contact in the associated contact bank of the rotary switch S1680 and the winding of the 5W relay in the fifth code storing device S1605 in the repeater 65 to battery. Accordingly, the WXYZ relays in the fifth code storing device S1605 in the repeater 65 are operated in accordance with the operation of the WXYZ relays in the first code storing device S1701 in the converter 66, at this time.

In view of the foregoing description of the manner in which the code registered in the first code storing device S1701 in the converter 66 is transferred to the fifth code storing device S1605 in the repeater 65, it will be understood that the codes stored in the registers S1702, S1703 and S1704 in the converter 66 will be successively transferred to the code storing devices S1606, S1607 and S1608, respectively, in the repeater 65; while the rotary switch S1780 in the converter 66 and the rotary switch S1680 in the repeater 65 are operated in synchronism incident to the operation of the impulse relay R1745 in the converter 66.

After the code stored in the fourth code storing device S1704 in the converter 66 has been transferred to the code storing device S1608 in the repeater 65, the wiper 1787 of the rotary switch

S1780 in the converter 66 disengages the fifth contact in the associated contact bank which is included in the multiple connected to the conductor terminated by the first contact in the contact bank associated with the wiper 1794 of the rotary switch R1790. Accordingly, when the wiper 1787 of the rotary switch S1780 disengages the fifth contact in the associated contact bank and engages the sixth contact in the associated contact bank, the previously traced circuit for energizing the lower winding of the impulse relay R1745 from ground by way of the wiper 1794 of the rotary switch R1790 is interrupted; and an alternative circuit is prepared for energizing the lower winding of the impulse relay R1745 from ground, at the contact 1735 of the cut-off relay R1730. Accordingly, when the cut-off relay R1730 operates it completes, at the contacts 1735, the previously mentioned alternative circuit for energizing the winding of the impulse relay R1745, this circuit extending from ground by way of the contacts 1735, the wiper 1787 and engaged sixth contact in the associated contact bank, the contacts 1746 and the lower winding of R1745 to battery. Hence, the impulse relay R1745 again operates intermittently in order to cause the rotary switch S1780 in the converter 66 and the rotary switch S1680 in the repeater 65 to operate further in synchronism. At this time, the wipers 1783, 1784, 1785 and 1786 of the rotary switch S1780 engage the sixth contacts in the associated contact banks extending to the fifth code storing device S1705 in the converter 66; while the wipers 1685, 1686, 1687 and 1688 of the rotary switch S1680 in the repeater 65 engage the ninth contacts in the associated contact banks extending to the ninth code storing device S1609 in the repeater 65. Accordingly, the code stored in the fifth code storing device S1705 in the converter 66 is transferred to the ninth code storing device S1609 in the repeater 65, in the previously described manner. Subsequently, as the rotary switch S1780 in the converter 66 and the rotary switch S1680 in the repeater 65 operate in synchronism, the codes stored in the sixth, seventh and eighth code storing devices S1706, S1707 and S1708, respectively, in the converter 66 are transferred to the tenth, eleventh and twelfth code storing devices S1610, S1611 and S1612 in the repeater 65.

After the code in the eighth code storing device S1708 in the converter 66 has been transferred to the twelfth code storing device S1612 in the repeater 65, the wiper 1787 of the rotary switch S1780 disengages the last contact in the associated contact bank included in the multiple connected to ground by way of the contact 1735 of the cut-off relay R1730, thereby to arrest further operation of the impulse relay R1745. When the impulse relay R1745 restores at this time, the wipers noted of the rotary switch S1680 in the repeater 65 are driven into engagement with the thirteenth contacts in the associated contact banks. When the wiper 1689 of the rotary switch S1680 engages the thirteenth contact in the associated contact bank, a circuit is completed for energizing the winding of the relay R1650, this circuit extending from ground by way of the contacts 1645, the wiper 1689, the engaged thirteenth contact in the associated contact bank, and the winding of R1650 to battery. When energized over the above-traced circuit, the relay R1650 operates to complete, at the contacts 1656, a holding circuit for energizing the winding thereof, this circuit extending from ground by way of the

contacts 1645 and 1656, and the winding of R1650 to battery. Also, upon operating, the relay R1650 interrupts, at the contacts 1655, the previously traced circuit for energizing the winding of the switching relay R1670, thereby to cause the switching relay R1670 to restore and interrupt, at the contacts 1671, 1672, 1673 and 1674, the previously traced connections between the wipers 1685, 1686, 1687 and 1688 of the rotary switch S1680, and the wipers 1697, 1698, 1699 and 1691 of the rotary switch F1690. Further, the relay R1650 interrupts, at the contacts 1651, the previously traced holding circuit for energizing the lower winding of the test relay R1620, and interrupts, at the contacts 1658, the previously traced holding circuit for energizing the upper winding of the test relay R1620 in series with the winding of the control relay R1720, thereby to cause the test relay R1620 and the control relay R1720 to restore.

Furthermore, upon operating, the relay R1650 completes, at the contacts 1657, a circuit for energizing the winding of the magnet M1681 of the rotary switch S1680, this circuit extending from ground by way of the contacts 1643 and 1632, C131, the contacts 1657, the wiper 1684 and engaged contact in the associated contact bank of the rotary switch S1680, the contacts 1682 and the winding of M1681 to battery. When energized over the above-traced circuit, the magnet M1681 operates to interrupt, at the contact 1682, the previously traced circuit for energizing the winding thereof, whereupon the magnet M1681 restores to recomplete, at the contacts 1682, the previously traced circuit for energizing the winding thereof. Accordingly, the magnet M1681 operates intermittently, thereby to drive the wipers noted of the rotary switch S1680 step by step in the clockwise direction until the wiper 1684 disengages the last contact in the associated contact bank of the rotary switch S1680, whereupon the previously traced circuit for energizing the winding of the magnet M1681 is interrupted and further operation of the magnet M1681 is arrested. At this time, the wipers noted of the rotary switch S1680 engage the first contacts in the associated contact banks.

Upon restoring, the control relay R1720 interrupts, at the contacts 1725, the previously mentioned circuit for energizing the winding of the control relay R1710, thereby to cause the relay R1710 to restore. Upon restoring, the relay R1710 interrupts, at the contacts 1713, the previously traced circuit for energizing the lower winding of the cut-off relay R1730, thereby to cause the cut-off relay R1730 to restore. Further, the relay R1710 completes, at the contacts 1714, an alternative circuit for energizing the winding of the magnet M1781 of the rotary switch S1780. The last-mentioned circuit extends from ground by way of the wiper 1788 of the rotary switch S1780 and engaged contact in the associated contact bank, the contacts 1714, 1782 and the winding of M1781 to battery. When energized over the above-traced circuit, the magnet M1781 operates to interrupt, at the contacts 1782, the previously traced alternative circuit for energizing the winding thereof, thereby to cause the magnet M1781 to restore and recomplete, at the contacts 1782, the previously traced alternative circuit for energizing the winding thereof. Accordingly, the magnet M1781 operates intermittently to drive the wipers noted of the rotary switch S1780 step by step in the clockwise direction back into their normal rotary positions,

wherein the wiper 1788 disengages the last contact in the associated contact bank included in the previously traced circuit for energizing the winding of the magnet M1781. Finally, the relay R1710 interrupts, at the contacts 1715, the previously traced holding circuits for energizing the windings of the WXYZ relays in the first to eighth, inclusive, code storing devices S1701 to S1708, inclusive, in the converter 66. At this time, the converter 66 is completely released and is available for further use.

It is noted that, at this time, the four digits of the directory number of the called subscriber line 2200 are registered in code in the code storing devices S1601 to S1604, inclusive, respectively, in the repeater 65; the three letters identifying the terminating exchange 52 are registered in code in the code storing devices S1605 to S1607, inclusive, respectively, in the repeater 65; the rate factor applicable to a call between the originating exchange 50 and the terminating exchange 52 is registered in code in the code storing device S1608 in the repeater 65; while the four digits of the directory number of the calling subscriber line 250 are registered in code in the code storing devices S1609 to S1612, inclusive, respectively, in the repeater 65.

Further operation of the repeater

When the call is answered at the called subscriber substation T2, the time start relay R1540 in the repeater 65 is operated on the reversal of battery over the toll line 1555, as previously explained. Upon operating, the time start relay R1540 prepares, at the contacts 1541, a circuit for energizing the winding of the timing relay R1545 by way of the impulsing conductor C1553. It is noted that a timing mechanism is associated with the impulsing conductor C1553 which is operated to cause ground impulses to be applied to the impulsing conductor C1553 at a rate of twelve impulses per minute. When the first ground impulse is applied to the impulsing conductor C1553, the previously mentioned circuit for energizing the winding of the timing relay R1545 is completed, this circuit extending from ground by way of the impulsing conductor C1553, the contacts 1541 and 1526 and the winding of R1545 to battery. Each time the timing relay R1545 is energized over the above-traced circuit, it operates to complete at the contacts 1546, an obvious circuit for energizing the winding of the magnet M1561 of the rotary switch T1560, thereby to cause the magnet M1561 to operate and restore intermittently. Each time the magnet M1561 operates and restores, the wipers 1563 and 1564 of the rotary switch T1560 are driven one step in the counterclockwise direction. Accordingly, the rotary switch T1560 is operated twelve steps each minute. After the wiper 1564 of the rotary switch T1560 has been moved three steps away from its normal rotary position corresponding to an elapse of approximately fifteen seconds, it engages the fourth contact of the associated contact bank, whereupon a circuit is completed for energizing the winding of the magnet M1571 of the rotary switch U1570. This circuit extends from ground by way of the wiper 1564 of the rotary switch T1560, the engaged fourth contact in the associated contact bank, C1582, the wiper 1575 and engaged first contact in the associated contact bank of the rotary switch U1570, the contacts 1572 and the winding of M1571 to battery. When energized over the above-traced circuit, the magnet M1571 operates

to interrupt, at the contacts 1572, the previously traced circuit for energizing the winding thereof, thereby to cause the magnet M1571 to restore. When the magnet M1571 operates and restores, the wipers 1573, 1575, 1578 and 1581 of the rotary switch U1570 are driven one step in the clockwise direction, thereby to cause the wiper 1575 to disengage the first contact in the associated contact bank and engage the second contact therein, whereupon the previously traced circuit for energizing the winding of the magnet M1571 of the rotary switch U1570 is interrupted. Also, when the wipers noted of the rotary switch U1570 are moved one step in the clockwise direction away from their normal rotary positions, the set of switch springs S1597 and S1598 are actuated into engagement. At this time, the wipers 1578 and 1581 of the rotary switch U1570 engage the second contacts in the associated contact banks, thereby to apply ground potential to the W and Z leads in the group of marking leads included in the cable 1600. At this point, it is noted that the marked W and Z leads in the group of marking leads included in the cable 1600 correspond in code to the digit 3 in view of the fact that the minimum charge time is three minutes.

The rotary switch T1560 continues to operate, as previously explained and, at the conclusion of the first minute, the wiper 1564 thereof engages the sixteenth contact in the associated contact bank, thereby to complete a circuit for energizing the upper winding of the control relay R1530, this circuit extending from ground by way of the wiper 1564 and engaged sixteenth contact in the associated contact bank of the rotary switch T1560, C1588, the contacts 1535 and the upper winding of R1530 to battery. When energized over the above-traced circuit, the relay R1530 operates partially to prepare, at the contacts 1537, a holding circuit for energizing the lower and upper windings thereof in series after the wiper 1564 of the rotary switch T1560 disengages the sixteenth contact in the associated contact bank. This holding circuit extends, when completed, from ground by way of the contacts 1644, C1603, the contact 1537, and the lower and upper windings of the relay R1530 to battery. When this holding circuit for energizing in series the lower and upper windings of the relay R1530 is completed, the relay R1530 fully operates to prepare, at the contacts 1536, a circuit traced hereinafter for energizing the winding of the magnet M1571 of the rotary switch U1570.

The rotary switch T1560 continues to operate step by step every five seconds until the wiper 1564 thereof engages the last contact in the associated contact bank, whereupon the magnet M1516 of the rotary switch T1560 is energized to cause the rotary switch T1560 to be driven one step to its normal rotary position, which occurs at the lapse of the second minute. At the conclusion of the third minute, the wiper 1564 of the rotary switch T1560 reengages the sixteenth contact in the associated contact bank, whereupon a circuit is completed for energizing the winding of the magnet M1571 of the rotary switch U1570, this circuit extending from ground by way of the wiper 1564, the engaged sixteenth contact in the associated contact bank of the rotary switch T1560, C1588, the contacts 1536, C1585, the multiple 1577, the wiper 1575 and engaged second contact in the associated contact bank of the rotary switch U1570; the contacts 1572, and the winding of M1571 to battery. The magnet M1571

then operates to drive the wipers noted of the rotary switch U1570 an additional step in the clockwise direction. Accordingly, at the beginning of the fourth minute, the wipers noted of the rotary switch U1570 engage the third contacts in the associated contact bank.

The rotary switch T1560 continues to operate, as previously explained, and, when the wiper 1564 thereof engages the fourth contact in the associated contact bank, an alternative circuit is completed for energizing the winding of the magnet M1571 of the rotary switch U1570. This circuit extends from ground by way of the wiper 1564 and engaged fourth contact in the associated contact bank of the rotary switch T1560, C1582, the multiple 1576, the wiper 1575 and engaged third contact in the associated contact bank of the rotary switch U1570, the contacts 1572 and the winding of M1571 to battery. The magnet M1571 then operates to drive the wipers noted of the rotary switch U1570 into engagement with the fourth contacts in the associated contact bank.

Thenceforth, each time the wiper 1564 engages the fourth and sixteenth contacts in the associated contact bank of the rotary switch T1560, the magnet M1571 of the rotary switch U1570 operates to drive the wipers noted of the rotary switch U1570 an additional step in the clockwise direction. After an elapse of nine minutes, the magnet M1571 operates while the wiper 1578 engages the eighth contact in the associated contact bank of the rotary switch U1570, whereupon a circuit is completed, at the contacts 1571, for energizing the winding of the magnet M1591 of the rotary switch D1590, this circuit extending from ground by way of the wiper 1578 and engaged eighth contact in the associated contact bank of the rotary switch U1570, the contacts 1571 and the winding of M1591 to battery. When energized over the above-traced circuit, the magnet M1591 operates to condition the wipers 1593, 1595 and 1596 of the rotary switch D1590 to be driven one step in the clockwise direction. Subsequently, when the magnet M1571 restores, the wiper 1578 disengages the eighth contact in the associated contact bank of the rotary switch U1570 and the previously traced circuit for energizing the winding of the magnet M1591 is interrupted, thereby to cause the magnet M1591 to restore and drive the wipers noted of the rotary switch D1590 one step in the clockwise direction. When the wipers 1595 and 1596 of the rotary switch D1590 engage the first contacts in the associated contact banks, obvious marking circuits are completed for marking with ground potential the W and X leads in the group of marking leads included in the cable 1601, which marking of the WXYZ leads in the group of marking leads included in the cable 1601 corresponds in code to the digit 1.

In view of the foregoing description, it will be understood that the rotary switch U1570 operates step by step each minute to register the unit minutes of the duration of the established connection between the calling subscriber substation T1 and the called subscriber substation T2; while the rotary switch D1590 operates step by step each ten minutes to register the 10 minutes of the duration of the established connection between the calling subscriber substation T1 and the called subscriber substation T2. Thus, it will be understood that, at any minute, there are marked in code upon the WXYZ leads in the groups of marking leads included in the cables 1600 and 1601, respectively, the unit and ten min-

utes of the duration of the established connection between the calling subscriber substation T1 and the called subscriber substation T2.

It is noted that the rotary switches D1590 and U1570 have an ultimate capacity of registering ninety-eight minutes, whereupon the wiper 1578 of the rotary switch U1570 engages the eighth contact in the associated contact bank; and the wiper 1593 of the rotary switch D1590 engages the tenth contact in the associated contact bank, at which time a circuit is completed for energizing the winding of the timing relay R1525. The last-mentioned circuit extends from ground by way of the wiper 1578 and the engaged eighth contact in the associated contact bank of the rotary switch U1570, the winding of the timing relay R1525, the contacts 1534, the wiper 1593, and engaged tenth contact in the associated contact bank of the rotary switch D1590, C1517, the contacts 1592 and the winding of M1591 to battery. Accordingly, in the event the established connection between the calling subscriber substation T1 and the called subscriber substation T2 is maintained for ninety-eight minutes, the timing relay R1525 operates. Upon operating, the timing relay R1525 completes, at the contacts 1527, an obvious circuit for applying ground potential to the alarm conductor C1586, thereby to cause, after a predetermined time interval an alarm device in the originating exchange 50 to be operated in order to indicate to the exchange attendant that an established connection including the repeater 65 has been maintained for a time interval greater than ninety-eight minutes.

In the present example, assuming that the established connection between the calling subscriber substation T1 and the called subscriber substation T2 is maintained for twelve minutes and that, after the lapse of twelve minutes, the subscriber at the calling subscriber substation T1 replaces the receiver of the telephone instrument thereat upon its associated switchhook, when this is done the previously traced circuit for energizing in series the upper and lower windings of the line relay R370 in the first code selector switch 61 is interrupted, thereby to cause the line relay R370 to restore. Upon restoring, the line relay R370 interrupts, at the contact 371, the previously traced circuit for energizing the winding of the control relay R410, thereby to cause the relay R410 to restore. Upon restoring, the relay R410 interrupts, at the contacts 413, the previously traced circuit for energizing the winding of the hold relay R350. Shortly thereafter, the hold relay R350 restores to interrupt, at the contacts 351, the previously traced circuit for energizing the winding of the switch-through relay R440 and to interrupt, at the contacts 352, the previously traced circuit for energizing the winding of the control relay R450, thereby to cause the control relay R450 to restore immediately and the switch-through relay R440 to restore shortly thereafter, the switch-through relay R440 being of the slow-to-release type. Upon restoring, the control relay R410 interrupts, at the contacts 412, the previously traced circuit for energizing the upper winding of the control relay R420 in series with the right-hand winding of the control relay R330, thereby to cause the relays R420 and R330 to restore.

Upon restoring, the switch-through relay R440 interrupts, at the contacts 446, the previously traced path for applying ground potential to the control conductor C263 of the trunk line 260, thereby to interrupt the previously traced hold-

ing circuit for energizing the winding of the hold relay R210 in series with the magnet M228 of the rotary switch D220, thereby to cause the hold relay R210 to restore. Upon restoring, the hold relay R210 completes, at the contacts 215, an alternative circuit for energizing the winding of the magnet M228 of the rotary switch D220, this circuit extending from ground by way of the wiper 223 and engaged contacts in the associated contact bank of the rotary switch D220, the multiple 224, C241, the contacts 203, 215 and 229, and the winding of M228 to battery. When energized over the above-traced circuit, the magnet M228 operates to interrupt, at the contacts 229, the previously traced circuit for energizing the winding thereof, whereupon the magnet M228 restores to recomplete, at the contacts 229, the previously traced circuit for energizing the winding thereof. Accordingly, the magnet M228 operates intermittently to drive the wipers noted of the rotary switch D220 step by step in the clockwise direction until the wiper 223 disengages the last contact in the associated contact bank included in the multiple 224, whereupon the previously traced circuit for energizing the winding of the magnet M228 is interrupted, thereby to arrest further operation of the magnet M228. At this time, the rotary switch D220 individually associated with the calling subscriber line 250 occupies its normal position.

Also, upon restoring, the control relay R450 in the first code selector switch 61 completes, at the contacts 457, an alternative circuit for energizing the rotary magnet M390 of the Strowger mechanism 480, this circuit extending from ground by way of the contacts 434 and 400, C128, the contacts 389, the conductor C903 in the trunk line 900, the wiper 915 and engaged first contact in the associated contact bank of the selector hunting switch 62, the conductor C902 in the trunk line 900, the contacts 369, C123, the contacts 457, C124, the contacts 391, the set of switch springs S376, the contacts 364 and the winding of M390 to battery. When energized over the above-traced circuit, the rotary magnet M390 operates to interrupt, at the contacts 391, the previously traced alternative circuit for energizing the winding thereof, whereupon the rotary magnet M390 restores to recomplete, at the contacts 391, the previously traced alternative circuit for energizing the winding thereof. Accordingly, the rotary magnet M390 operates intermittently in order to drive the wiper carriage of the Strowger mechanism 480 step by step in the rotary direction eleven steps away from its rotary normal position, whereupon the wiper carriage is returned to its normal vertical and rotary positions. When the wiper carriage of the Strowger mechanism 480 is returned to its normal vertical position, the set of switch springs 376 is actuated into disengagement, thereby to interrupt the previously traced alternative circuit for energizing the winding of the rotary magnet M390 in order to arrest further operation thereof. Furthermore, when the wiper carriage of the Strowger mechanism 480 is returned to its normal vertical and rotary positions, the sets of switch springs S373, S372, S400, S423, S424 and S425 are actuated, as previously explained.

When the Strowger mechanism 480 is returned to its normal position, the first wiper set carried by the wiper carriage thereof disengages the contact set in the associated contact bank terminating the trunk line 426, thereby to interrupt the previously traced circuit for energizing the

line relay R1505 in the repeater 65, whereupon the line relay R1505 restores to interrupt, at the contacts 1507, the previously traced holding circuit for energizing the winding of the hold relay R1500 in order to cause the hold relay R1500 to restore. Also, when the Strowger mechanism 480 is returned to its normal position, the previously traced holding circuit for energizing the lower winding of the switching relay R460 in the first code selector switch 61 is interrupted, thereby to cause the first code selector switch 61 to be released. At this time, the first code selector switch 61 is completely released and available for further use.

Upon restoring, the hold relay R1500 in the repeater 65 completes, at the contacts 1504, a circuit for energizing the winding of the relay R1630. This circuit extends from ground by way of the contacts 1504, C1587, the set of switch springs S1598, C1613, the winding of R1630 and the resistor 1629 to battery. When energized over the above-traced circuit, the relay R1630 operates to complete, at the contacts 1633, an obvious alternative holding circuit for energizing the winding of the control relay R1640, thereby to retain the relay R1640 in its operated position. It is noted that upon restoring, the hold relay R1500 interrupts, at the contact 1503, the previously traced original circuit for energizing the winding of the control relay R1640. However, the relay R1640 does not restore due to the fact that it is of the slow-to-release type. Further, the relay R1630 completes, at the contacts 1631, a multiple path for applying ground potential to the control conductor C429 of the trunk line 426 extending to the repeater 65. This multiple path extends from ground by way of the contacts 1631, C1614 and the contacts 1501, to the control conductor C429 of the trunk line 426. The previously mentioned path for applying ground potential to the control conductor C429 of the trunk line 426 extends from ground by way of the operated set of switch springs S1689 associated with the rotary switch S1680, C1614, and the contacts 1501 to the control conductor C429 of the trunk line 426. This application of ground potential to the control conductor C429 of the trunk line 426 marks the repeater 65 as busy, at this time, to the first code selector switches having access thereto. Also, upon operating, the relay R1630 completes, at the contacts 1634, an obvious circuit for applying ground potential to the alarm conductor C1586, thereby to initiate operation of the alarm device at the originating exchange 50, in the event the relay R1630 remains in its operated position for a predetermined time interval, indicating that the repeater 65 has not properly released.

Also, upon operating, the relay R1630 completes, at the contacts 1635, an alternative circuit for energizing the winding of the magnet M1691 of the rotary switch F1690, this circuit extending from ground by way of the contacts 1622, 1635, 1654, 1692 and the winding of M1691 to battery. When energized over the above-traced circuit, the magnet M1691 operates to interrupt, at the contacts 1692, the previously traced alternative circuit for energizing the winding thereof, whereupon the magnet M1691 restores to recomplete, at the contact 1692, the previously traced alternative circuit for energizing the winding thereof. Accordingly, the magnet M1691 operates intermittently, thereby to drive the wipers noted of the rotary switch F1690 step by step in the clockwise direction,

At this point, it is noted that the set of switch spring S1617 associated with the rotary switch F1690 is operated to retain the contacts 1618 thereof in engagement, while the wipers noted of the rotary switch F1690 engage the first twelve contacts in the associated contact banks; and thereafter, when the wipers noted of the rotary switch F1690 engage the thirteenth to the twenty-fifth contacts in the associated contact banks, the set of switch springs S1617 operate the contacts 1618 into disengagement and operate the contacts 1619 into engagement. Accordingly, the magnet M1691 drives the wipers noted of the rotary switch F1690 step by step in the clockwise direction until the wipers noted of the rotary switch F1690 engage the thirteenth contacts in the associated contact banks, whereupon a circuit is completed for testing the idle or busy condition of the first printer controller in the group of printer controllers accessible to the rotary switch F1690. In the event the first printer controller is busy, ground potential appears upon the control conductor thereof, whereupon a path is completed by way of the wiper 1693 and engaged contact in the associated contact bank of the rotary switch F1690 for short-circuiting the upper winding of the test relay R1620. Accordingly, the magnet M1691 of the rotary switch F1690 continues to operate to drive the wipers noted of the rotary switch F1690 step by step until the wiper 1693 engages a contact in the associated contact bank terminating the control conductor of an idle one of the printer controllers.

Assuming that the printer controller 67 is the first idle printer controller in the group of printer controllers accessible to the rotary switch F1690, when the wipers 1693 engages the contact in the associated contact bank terminating the control conductor C1807 of the trunk line 1800, a circuit is completed for energizing the upper winding of the test relay R1620. This circuit extends from ground by way of the contacts 1648 and 1659, the contacts 1619 of the set of switch springs S1617, the upper winding of R1620, C130, the wiper 1693 and engaged contact in the associated contact bank of the rotary switch F1690, the control conductor C1807 of the trunk line 1800, C1857 and the contacts 2052 to the conductor C1858; one branch of this circuit extending from C1858 by way of the winding of the hold relay R1810 in the printer controller 67 to battery, and the other branch of this circuit extending from the conductor C1858 by way of the contact 1816 and the resistor 1838 to battery in the printer controller 67. When energized over the above-traced circuit, the test relay R1620 in the repeater 65 operates to interrupt, at the contact 1622, the previously traced alternative circuit for energizing the magnet M1691 of the rotary switch F1690, thereby to arrest further operation of the rotary switch F1690 at this time. Also, upon operating, the test relay R1620 interrupts, at the contact 1623, the previously mentioned path for short-circuiting the lower winding thereof, thereby to complete an alternative holding circuit for energizing the winding thereof, this alternative holding circuit extending from ground by way of the contacts 1636, 1652 and 1647, the lower winding of R1620 and the resistor 1616 to battery. Also, upon operating, the test relay R1620 completes, at the contacts 1621, a low resistance circuit for energizing the winding of the hold relay

R1810 in the printer controller 67, this circuit extending from direct ground potential appearing upon the control conductor C429 of the trunk line 426, by way of C1615, the contact 1621, C130, the wiper 1693 and engaged contact in the associated contact bank of the rotary switch F1690, the control conductor C1807 of the trunk line 1800, C1857, the contacts 2052, C1858 and the winding of R1810 to battery. When energized over the above-traced circuit, the hold relay R1810 in the printer controller 67 operates. Also, upon operating, the test relay R1620 in the repeater 65 completes, at the contacts 1624, the previously mentioned circuit for energizing the winding of the switching relay R1660, thereby to cause the switching relay R1660 to operate.

Operation of the printer controller

Upon operating, the hold relay R1810 initiates operation of the printer controller 67. More particularly, the hold relay R1810 completes, at the contacts 1818, a circuit for energizing the winding of the control relay R2025, this circuit extending from ground by way of the contacts 1818, C1861, the contacts 2057, C2077 and the winding of R2025 to battery. When energized over the above-traced circuit, the control relay R2025 operates to complete, at the contacts 2028, etc., connections between the WXYZ leads in the groups of marking leads 2030 to 2037, inclusive, and the code storing devices S2015 to S2022, inclusive, respectively, in the printer controller 67. At this point, it is noted that the date and time unit 68 marks, by way of the group of marking leads 2030, the ten digit of the day of the month and marks, by way of the group of marking leads 2031, the unit digit of the day of the month; further the date and time unit 68 marks, by way of the group of marking leads 2032, the ten digit of the month of the year, and marks, by way of the group of marking leads 2033, the unit digit of the month of the year; further the date and time unit 68 marks, by way of the group of marking leads 2034, the ten digit of the hour of the day, and marks, by way of the group of marking leads 2035, the unit digit of the hour of the day; and, finally, the date and time unit 68 marks, by way of the group of marking leads 2036, the ten digit of the minute of the hour, and marks, by way of the group of marking leads 2037, the unit digit of the minute of the hour. Accordingly, at this time, there is stored in code, in the code storing devices S2015 and S2016 the information concerning the day of the month; there is stored in code, in the code storing devices S2017 and S2018, the information concerning the month of the year; there is stored in code, in the code storing devices S2019 and S2020, the information concerning the hour of the day; and finally, there is stored in code, in the code storing devices S2021 and S2022, the information concerning the minute of the hour.

Furthermore, it is noted that, upon operating, the relay R2025 completes, at the contacts 2026, an obvious path for applying ground potential to the guard conductor C2029 extending into the date and time unit 68. This application of ground potential to the guard conductor C2029 prevents the date and time unit 68 from operating to change the markings upon the groups of marking leads 2030 to 2037, inclusive, during the short interval of time the relay R2025 is operated. Finally, upon operating, the relay

R2025 completes, at the contacts 2027, an obvious circuit for energizing the winding of the control relay R2050. The control relay R2050 then operates to interrupt, at the contacts 2057, the previously traced circuit for energizing the winding of the control relay R2025, thereby to cause the control relay R2025 to restore and release the date and time unit 68. Further, the control relay R2050 completes, at the contacts 2056, a holding circuit for energizing the winding thereof, this circuit extending from ground by way of the contacts 1818, C1861, the contacts 2056 and the winding of R2050 to battery.

When the switching relay R1660 operates it prepares, at the contacts 1666, 1667, 1668 and 1669, circuits between the respective wipers 1687, 1688, 1689 and 1691 of the rotary switch F1690, and the wipers 1685, 1686, 1687 and 1688 of the rotary switch S1680. Further, the switching relay R1660 prepares, at the contacts 1665, a circuit traced hereinafter for energizing the winding of the magnet M1836 of the rotary switch S1830 in the converter 67. Finally, the switching relay R1660 completes, at the contacts 1661, a circuit for energizing the upper winding of the impulse relay R1625, this circuit extending from ground by way of the contacts 1661, 1637 and 1628, and the upper winding of R1625 to battery. When energized over the previously traced circuit, the impulse relay R1625 operates to interrupt, at the contact 1628, the previously traced circuit for energizing the upper winding thereof, whereupon the impulse relay R1625 restores to complete, at the contact 1628, the previously traced circuit for energizing the upper winding thereof. Accordingly, the impulse relay R1625 operates intermittently. Each time the impulse relay R1625 operates it completes, at the contacts 1626, an obvious circuit for energizing the winding of the switching relay R1670, and completes, at the contacts 1627, an obvious circuit for applying ground potential to the conductor C1327. The application of ground potential to the conductor C1327 completes an obvious circuit for energizing the winding of the magnet M1681 of the rotary switch S1680, and completes a circuit for energizing the winding of the magnet M1836 of the rotary switch S1830, the last-mentioned circuit extending from the grounded conductor C1327 by way of the contacts 1665, the wiper 1696 and engaged contact in the associated contact bank of the rotary switch F1690, the conductor C1806 of the trunk line 1800 and the winding of M1836 to battery. Each time the impulse relay R1625 restores, it interrupts, at the contacts 1626, the previously mentioned circuit for energizing the winding of the switching relay R1670, and interrupts, at the contacts 1627, the previously traced circuits for energizing the windings of the magnets M1681 and M1836 of the rotary switches S1680 and S1830, respectively. Accordingly, each time the impulse relay R1625 operates, the switching relay R1670 and the magnets M1681 and M1836 operate; and each time the impulse relay R1625 restores, the switching relay R1670 and the magnets M1681 and M1836 restore. Each time the magnet M1681 is energized and subsequently deenergized, the wipers noted in the rotary switch S1680 are driven one step in the clockwise direction; and each time the magnet M1836 is energized and subsequently deenergized, the wipers 1831, 1832, 1833, 1834 and 1835 of the rotary switch S1830 are driven one step in the clockwise direction. Accordingly, the wipers noted in the rotary switches S1680

and S1830 are rotated step by step in synchronism.

The first time the impulse relay R1625 operates, the wipers noted of the rotary switch S1680 engage the first contacts in the associated contact banks; the wipers noted of the rotary switch S1830 engage the first contacts in the associated contact banks; and the switching relay R1670 operates. Upon operating, the switching relay R1670 completes, at the contacts 1671, 1672, 1673, and 1674, connections between the WXYZ relays in the first code storing device S1601 in the repeater 65 and the WXYZ relays in the first code storing device S2001 in the printer controller 67. For example, in the event the 1W relay in the first code storing device S1601 is operated at this time, a circuit is completed for energizing the winding of the 1W relay in the first code storing device S2001 in the printer controller 67, this circuit extending from ground by way of the contacts 1522, C1602, the contacts 1W1, the wiper 1685 and engaged first contact in the associated contact bank of the rotary switch S1680, the contacts 1671 and 1666, the wiper 1697 and engaged contact in the associated contact bank of the rotary switch F1690, the conductor C1801 of the trunk line 1800, the wiper 1831 and engaged first contact in the associated contact bank of the rotary switch S1830, C1851 and the winding of 1W to battery. When energized over the above-traced circuit, the relay 1W in the first code storing device S2001 operates to complete, at the contacts 1W1, a holding circuit for energizing the winding thereof, this circuit extending from ground by way of the contacts 2121 of the operated relay R2120, C2147 and 1W1 to battery, the relay R2120 being operated at this time, as a circuit for energizing the winding thereof was completed upon operation of the relay R2050. The circuit for energizing the winding of the relay R2120 extends from ground by way of the contacts 2055, C2143, the winding of R2120 and the resistor 2114 to battery.

Accordingly, the first time the impulse relay R1625 in the repeater 65 operates, the code stored in the first code storing device S1601 in the repeater 65 is transferred to the first code storing device S2001 in the printer controller 67. When the impulsing relay R1625 restores, the previously traced circuit for energizing the windings of the magnets M1681 and M1836 of the rotary switches S1680 and S1830, respectively, are interrupted, thereby to cause the wipers noted of the rotary switches S1680 and S1830 to be driven one step in the clockwise direction and into engagement with the second contacts in the associated contact banks.

In view of the foregoing description of the manner of transferring the code stored in the first code storing device S1601 in the repeater 65 to the first code storing device S2001 in the printer controller 67, it will be understood that the codes stored in the code storing devices S1602 to S1612, inclusive, in the repeater 65 are respectively transferred in a similar manner to the code storing devices S2002 to S2012, inclusive, in the printer controller 67. At this time, the wipers noted of the rotary switch S1680 engage the thirteenth contacts in the associated contact banks; and the wipers noted of the rotary switch S1830 engage the thirteenth contacts in the associated contact banks. Accordingly, the code stored in the contact banks of the rotary switch D1590 is then transferred to the thir-

teenth code storing device S2013 in the printer controller 67. Finally, the code stored in the contact banks of the rotary switch U1570 is transferred to the fourteenth code storing device S2014 in the printer controller 67.

When the magnet M1681 of the rotary switch S1680 in the repeater 65 drives the wipers noted into engagement with the fourteenth contacts in the associated contact banks, thereby to prepare the transfer of the code stored in the contact banks of the rotary switch U1570 to the fourteenth code storing device S2014 in the printer controller 67, the wiper 1689 of the rotary switch S1680 engaging the fourteenth contact in the associated contact bank completes a path for short-circuiting the winding of the control relay R1630. This path extends from ground by way of the contacts 1645, the wiper 1689 and engaged fourteenth contact in the associated contact bank of the rotary switch S1680, the winding of R1630, C1613, the set of switch springs S1598, C1587 and the contacts 1504 to ground. The relay R1630 then restores to interrupt, at the contacts 1633, the previously mentioned circuit for energizing the winding of the control relay R1640, thereby to cause the latter relay to restore shortly thereafter. Upon restoring, the relay R1640 interrupts, at the contacts 1647, the previously traced holding circuit for energizing the lower winding of the test relay R1620, thereby to cause the test relay R1620 to restore and interrupt, at the contact 1624, the previously traced circuit for energizing the winding of the switching relay R1660. The switching relay R1660 restores, to interrupt, at the contacts 1661, the previously traced circuit for energizing the upper winding of the impulse relay R1625, thereby to arrest further operation of the impulse relay R1625. Upon restoring, the impulse relay R1625 interrupts, at the contacts 1626, the previously mentioned circuit for energizing the winding of the switching relay R1670, thereby to cause the switching relay R1670 to restore. Upon restoring, the switching relays R1660 and R1670 interrupt, at the contacts 1666, 1667, 1668 and 1669, and at the contacts 1671, 1672, 1673 and 1674, respectively, the previously traced connections between the wipers 1697, 1698, 1699 and 1691 of the rotary switch F1690, and the wipers 1685, 1686, 1687 and 1688 of the rotary switch S1680. Also, upon restoring, the impulse relay R1625 interrupts, at the contacts 1627, the previously traced circuits for energizing the winding of the magnets M1681 and M1836 of the rotary switches S1680 and S1830, respectively. Also, upon restoring, the relay R1640 interrupts, at the contacts 1645, the previously traced holding circuit for energizing the winding of the relay R1650, thereby to cause the relay R1650 to restore, and interrupts, at the contacts 1641, the previously traced circuit for energizing the winding of the control relay R1520, thereby to cause the relay R1520 to restore. Upon restoring, the relay R1520 interrupts, at the contacts 1522, the previously traced holding circuits for the WXYZ relays in the code storing devices S1601 to S1612, inclusive, in the repeater 65, thereby to cause these relays to restore. Also, upon restoring, the relay R1640 interrupts, at the contacts 1645, the previously traced holding circuit for energizing the winding of the relay R1510, thereby to cause the relay R1510 to restore, and interrupts, at the contacts 1644, the previously traced holding circuit for energizing in series the lower and upper windings of the relay R1530, thereby to cause

the relay R1530 to restore. Upon restoring, the relay R1520 interrupts, at the contacts 1521, the previously mentioned circuit for energizing the left-hand winding of the time start relay R1540, thereby to cause the time start relay R1540 to restore.

Finally, upon restoring, the relay R1640 completes, at the contacts 1642, a circuit for energizing the winding of the magnet M1561 of the rotary switch T1560, this circuit extending from ground by way of the contacts 1642, C1610, the wiper 1563 and engaged contact in the associated contact bank of the rotary switch T1560, the contacts 1562 and the winding of M1561 to battery. When energized over the above-traced circuit, the magnet M1561 operates intermittently to drive the wipers noted of the rotary switch T1560 back to their normal rotary positions, whereupon a circuit is completed for energizing the winding of the magnet M1571 of the rotary switch U1570. The last-mentioned circuit extends from ground by way of the previously traced path to the wiper 1563 and engaged first contact in the associated contact bank of the rotary switch T1560, and therefrom by way of C1583, the wiper 1573 and engaged contact in the associated contact bank of the rotary switch U1570, the contacts 1572 and the winding of M1571 to battery. When energized over the above-traced circuit, the magnet M1571 operates to drive the wipers noted of the rotary switch U1570 back into their normal rotary positions, whereupon a circuit is completed for energizing the winding of the magnet M1591 of the rotary switch D1590. This circuit extends from ground by way of the previously traced path to the wiper 1573 and engaged first contact in the associated contact bank of the rotary switch U1570, and therefrom by way of C1589, the wiper 1593 and engaged contact in the associated contact bank of the rotary switch D1590, the contacts 1533 and 1592, and the winding of M1591 to battery. When energized over the above-traced circuit, the magnet M1591 operates to drive the wipers noted of the rotary switch D1590 back into their normal rotary positions, whereupon a circuit is completed for energizing the winding of the magnet M1681 of the rotary switch S1680. This circuit extends from ground by way of the previously traced path to the wiper 1593 and engaged first contact in the associated contact bank of the rotary switch D1590, and therefrom by way of C1605, the wiper 1684 and engaged contact in the associated contact bank of the rotary switch S1680, the contacts 1682 and the winding of M1681 to battery. When energized over the above-traced circuit, the magnet M1681 operates to drive the wipers noted of the rotary switch S1680 back into their normal rotary positions.

When the wipers noted of the rotary switch U1570 are returned to their normal rotary positions, the set of switch springs S1598 and S1597 are actuated into disengagement, thereby to interrupt the previously traced circuit for energizing the winding of the timing relay R1545 by way of the impulsing conductor C1553.

At this time, the repeater 65 is completely released and available for further use; although the rotary switch F1690 does not occupy its normal position. More particularly, the wipers noted of the rotary switch F1690 engage the contacts in the associated contact bank terminating the conductors of the trunk line 1800 extending to the printer controller 67. When the repeater 65 is again seized, the control relay R1640 re-

operates and reCompletes, at the contacts 1646, the previously traced circuit for energizing the winding of the magnet M1691 of the rotary switch F1690. The magnet M1691 then reoperates intermittently in order to drive the wipers noted step by step in the clockwise direction until the wipers engage the contacts in the associated contact banks terminating the first trunk line extending to the first converter 66. At this time, the set of switch springs S1617 are operated to move the contact 1619 into disengagement and to move the contact 1618 into engagement. When the contacts 1618 of the set of switch springs S1617 are operated into engagement, the previously traced circuit for testing the idle or busy condition of the first converter 66 is recompleted. Further operation of the rotary switch F1690 is determined by the idle or busy condition of the first converter 66, in the manner previously explained.

When the wipers noted of the rotary switch S1830 are moved in the clockwise direction into engagement with the eighth contacts in the associated contact banks, in order to cause the code stored in the eighth code storing device S1608 in the repeater 65 to be transferred to the eighth code storing device S2008 in the printer controller 67, in the manner previously explained, the wiper 1835 of the rotary switch S1830 completes a circuit for energizing the winding of the magnet M2046 of the rotary switch T2040. This circuit extends from ground by way of the wiper 1835 and engaged eighth contact in the associated contact bank of the rotary switch S1830, the contacts 1811, C1862, the wiper 2041 and engaged first contact in the associated contact bank of the rotary switch T2040, C2130, the contacts 2126, C2131, the contacts 2047 and the winding of M2046 to battery. When energized over the above-traced circuit, the magnet M2046 operates to interrupt, at the contacts 2047, the previously traced circuit for energizing the winding thereof and to condition the wipers 2041, 2042, 2043, 2044 and 2045 of the rotary switch T2040 to be driven one step in the counterclockwise direction. When the circuit for energizing the winding of the magnet M2046 is interrupted, the magnet M2046 restores to drive the wipers noted of the rotary switch T2040 one step in the counterclockwise direction and to recomplete, at the contacts 2047, an alternative circuit for energizing the winding of the magnet M2046. This alternative circuit extends from ground by way of the engaged second contact in the associated contact bank of the rotary switch T2040, C2130, the contacts 2126, C2131, the contacts 2047 and the winding of M2046 to battery. Accordingly, the magnet M2046 operates intermittently, thereby to drive the wipers noted of the rotary switch T2040 step by step in the counterclockwise direction until both of the wipers 2042 and 2043 of the rotary switch T2040 engage the contacts in the associated contact banks terminating the WXYZ leads in the group of marking leads 2075 having ground potential appearing thereon. At this point, it is noted that the code stored in the eighth code storing device S2008 in the printer controller 67 causes ground potential to appear upon one or two of the WXYZ leads in the group of marking leads 2075, as previously explained. More particularly, in the event the code stored in the eighth code storing device S2008 corresponding to the rate factor applicable to the call between the calling subscriber substation T1 and the called subscriber substation T2 comprises a

digit between 1 and 6, two of the WXYZ leads in the group of marking leads 2075 are marked. On the other hand, in the event that this code comprises a digit between 7 and 10, only one of the WXYZ leads in the group of marking leads 2075 is marked. However, the seventh, eighth, ninth and tenth contacts in the contact bank associated with the wiper 2043 of the rotary switch T2040 have direct ground potential connected thereto.

In the present example, the rate factor comprises the digit 6, as previously noted. Accordingly, the Y and Z leads in the group of marking leads 2075 have ground potential appearing thereon. Hence, when the wipers noted of the rotary switch T2040 are rotated in the counterclockwise direction six steps away from their normal rotary positions, the wipers 2042 and 2043 engage contacts in the associated contact banks respectively terminating the Y and Z leads, whereupon circuits are completed for energizing the left-hand and right-hand windings of the test relay R2125. The circuit for energizing the left-hand winding of the test relay R2125 extends from ground appearing upon the Y lead in the group of marking leads 2075 by way of the wiper 2042 and engaged contact in the associated contact bank of the rotary switch T2040, C2132 and the left-hand winding of R2125 to battery; while the circuit for energizing the right-hand winding of the test relay R2125 extends from ground appearing upon the Z lead in the group of marking leads 2075 by way of the wiper 2043 and engaged contact in the associated contact bank of the rotary switch T2040, C2133 and the right-hand winding of R2125 to battery. At this point, it is noted that the test relay R2125 is of the shunt field type and is not operated until both the right-hand and the left-hand windings thereof are energized. Thus, the test relay R2125 operates at this time to interrupt, at the contacts 2126, the previously traced alternative circuit for energizing the winding of the magnet M2046 of the rotary switch T2040, thereby to arrest further operation of the magnet M2046. At this point, it is noted that the operation of the rotary switch T2040 six steps in the counterclockwise direction away from its normal rotary position is effective to select the sixth multiplier switch 2160 illustrated. Hence, it will be understood that the rotary switch T2040 is operative to select a multiplier switch in the group of multiplier switches corresponding to the code factor stored in the eighth code storing device S2008 in the printer controller 67.

Also, upon operating, the test relay R2125 completes, at the contacts 2127, a circuit for energizing the vertical magnet M2104 of the selected sixth multiplier switch 2160, this switch being of the well-known Strowger type, as previously noted. The last-mentioned circuit extends from ground by way of the contacts 2127, C2134, the contacts 2051, the wiper 2044 and engaged contact in the associated contact bank of the rotary switch T2040, C2135, the contacts 2105 and the winding of M2104 to battery. When energized over the above-traced circuit, the vertical magnet M2104 operates to drive the vertical test wipers 2109 and 2110 of the multiplier switch 2160 one step in the vertical direction, and to interrupt, at the contacts 2105, the previously traced circuit for energizing the winding of the vertical magnet M2104. The vertical magnet M2104 then restores to recomplete, at the contacts 2105, the previously traced circuit for

energizing the winding thereof. Accordingly, the vertical magnet M2104 operates intermittently to drive the vertical test wipers 2109 and 2110 step by step in the vertical direction until both of the test wipers 2109 and 2110 engage contacts in the associated vertical test bank 2108 terminating WXYZ leads in the group of marking leads 2108 having ground potential thereupon. At this point, it is noted that the WXYZ leads in the group of marking leads 2138 are terminated in the vertical test bank 2108 of the multiplier switch 2160 and are operatively associated with the thirteenth code storing device S2013 in the printer controller 67. At this time, there is stored in code, in the code storing device S2013, the ten digit 1 of the duration of the established connection between the calling subscriber substation T1 and the called subscriber substation T2. Hence the W and X leads in the group of marking leads 2138 are marked with ground potential at this time and, when the vertical test wipers 2109 and 2110 are moved one step in the vertical direction, the contacts in the associated vertical test bank 2108 terminating the W and X leads in the group of marking leads 2038 are engaged, whereupon circuits are completed for energizing the left-hand and right-hand windings of the transfer relay R2060. The circuit for energizing the right-hand winding of the transfer relay R2060 extends from ground potential appearing upon the W lead in the group of marking leads 2138, by way of the vertical test wiper 2110 and the engaged contact in the associated vertical test bank 2108, C2137 and the right-hand winding of R2060 to battery; while the circuit for energizing the left-hand winding of the transfer relay R2060 extends from ground potential appearing upon the X lead in the group of marking leads 2138, by way of the vertical test wiper 2109 and engaged contact in the associated vertical test bank 2108, C2139 and the left-hand winding of R2060 to battery.

It is noted that the transfer relay R2060 is of the shunt field type and does not operate until both the left-hand and right-hand windings are energized. Hence, the transfer relay R2060 operates at this time to interrupt, at the contacts 2061, the previously traced circuit for energizing the winding of the vertical magnet M2104, thereby to arrest further operation thereof and to complete, at the contacts 2062, a circuit for energizing the rotary magnet M2106 of the multiplier switch 2160. The last-mentioned circuit extends from ground by way of the contacts 2127, C2134, the contacts 2062 and 2071, the wiper 2045 and engaged contact in the associated contact bank of the rotary switch T2040, C2136, the contacts 2107 and the winding of M2106 to battery. When energized over the above-traced circuit, the rotary magnet M2106 operates to drive the rotary test wipers 2112 and 2113 one step in the rotary direction, and to interrupt, at the contacts 2107, the previously traced circuit for energizing the winding thereof. Accordingly, the rotary magnet M2106 operates intermittently to drive the rotary test wipers 2112 and 2113 step by step in the rotary direction until both of the test wipers 2112 and 2113 engage contacts in the associated rotary test bank 2111 terminating WXYZ leads in the group of marking leads 2140 having ground potential appearing thereon. Further, it is noted that the group of marking leads 2140 are operatively associated with the fourteenth code storing device S2014 in the printer controller 67, which code storing device S2014

has stored therein, at this time, the unit 2 of the duration of the established connection between the calling subscriber substation T1 and the called subscriber substation T2. Hence, the W and Y leads in the group of marking leads 2140 have ground potential appearing thereon at this time; and, when the rotary test wipers 2112 and 2113 engage the second contacts in the associated rotary test bank 2111 terminating the W and Y leads in the group of marking leads 2140, circuits are completed for energizing the left-hand and right-hand windings of the stop relay R2070. It is noted that the stop relay R2070 is of the shunt field type and is not operated until both the right-hand and left-hand windings thereof are energized. The circuit for energizing the right-hand windings of the stop relay R2070 extends from ground potential appearing upon the W lead in the group of marking leads 2140, by way of the rotary test wiper 2113 and engaged contact in the associated rotary test bank 2111, C2141 and the right-hand winding of R2070 to battery; while the circuit for energizing the left-hand winding of the stop relay R2070 extends from ground potential appearing upon the Y lead in the group of marking leads 2140, by way of the rotary test wiper 2112 and engaged contact in the associated rotary test bank 2111, C2142 and the left-hand winding of R2070 to battery. Hence, the stop relay R2070 operates, at this time, to interrupt, at the contacts 2071, the previously traced circuit for energizing the winding of the rotary magnet M2106, thereby to arrest further operation thereof, and to prepare, at the contacts 2072 and 2073, control circuits traced hereinafter including the control conductors C2145 and C2146, respectively, extending to the toll ticket printer 69. At this time, it is noted that the wipers 2101, 2102, 2103 and 2104 of the Strowger mechanism 2100 included in the multiplier switch 2160 engage corresponding contacts in the associated main contact bank corresponding to the vertical and rotary positions thereof, which contacts terminate leads which are operatively connected by way of the straps 2152 in the jumper field 2151 to predetermined ones of the leads in the group of marking leads 2150. The particular leads in the group of marking leads 2150, to which the straps 2152 are connected, is determined by the particular selected sixth multiplier switch 2160 and the vertical and rotary operated positions of the wipers 2101 to 2104, inclusive, thereof, these factors determining the ultimate cost of the call between the calling subscriber substation T1 and the called subscriber substation T2.

Further, it is noted that, when the wipers of the rotary switch T2040 are operated one step away from their normal rotary positions, the set of switch springs S2049 associated with the rotary switch T2040 are operated into engagement, thereby to complete an alternative circuit for energizing the winding of the control relay R2050, this circuit extending from ground by way of the set of switch springs S2049, C1861, the contacts 2056 and the winding of R2050 to battery. Further, it is noted that, upon operating, the relay R2050 interrupts, at the contacts 2052, a point in the previously traced original circuit for energizing the winding of the hold relay R1810. Accordingly, at this time, the hold relay R1810 is retained in its operated position, by way of the holding circuit extending from ground potential appearing upon the control conductor C1867 in

the trunk line 1800, the contacts 1815 and the winding of R1810 to battery.

As previously noted, after the code stored in the contact banks of the rotary switch U1570 in the repeater 65 is transferred therefrom to the fourteenth code storing device S2014 in the printer controller 67, the repeater 65 is released. When the repeater 65 is released, the previously traced path for applying ground potential to the control conductor C1807 of the trunk line 1800 is interrupted, thereby to interrupt the previously traced holding circuit for energizing the winding of the hold relay R1810 in the printer controller 67. The hold relay R1810 then restores to complete, at the contacts 1817, a path for applying ground potential to the control conductor C2145 extending to the toll ticket printer 69, this circuit extending from ground by way of the contacts 1822 and 1817, C1860, and the contacts 2051' and 2072 to the control conductor C2145. This application of ground potential to the control conductor C2145 extending to the toll ticket printer 69 causes the toll ticket printer 69 to be seized, whereupon ground potential in the toll ticket printer 69 is applied to the control conductor C2146. This application of ground potential to the control conductor C2146 in the toll ticket printer 69 completes a circuit for energizing the winding of the control relay R1820, this circuit extending from ground on the control conductor C2146, the contacts 2073 and 2052', C1859, the contacts 1814 and the winding of R1820 to battery. When energized over the above-traced circuit, the relay R1820 operates to interrupt, at the contacts 1822, the previously traced path for applying ground potential to the control conductor C2145 extending to the toll ticket printer 69, and completes, at the contacts 1821, a circuit for energizing the upper winding of the impulse relay R1940. This circuit extends from ground by way of the contacts 1821, C1864, the contacts 1944 and the upper winding of R1940 to battery. When energized over the above-traced circuit, the impulse relay R1940 operates to interrupt, at the contacts 1944, the previously traced circuit for energizing the upper winding thereof, whereupon the impulse relay R1940 restores to recomplete, at the contacts 1944, the previously traced circuit for energizing the upper winding thereof. Accordingly, the impulse relay R1940 operates intermittently. Also, upon restoring, the hold relay R1810 completes, at the contacts 1813, an alternative circuit for energizing the winding of the magnet M1836 of the rotary switch S1830, this circuit extending from ground by way of the wiper 1835 and engaged contact in the associated contact bank of the rotary switch S1830, the contacts 1813 and 1837, and the winding of M1836 to battery. When energized over the above-traced circuit, the magnet M1836 operates to interrupt, at the contacts 1837, the previously traced circuit for energizing the winding thereof, whereupon the magnet M1836 restores to recomplete, at the contacts 1837, the previously traced circuit for energizing the winding thereof. Accordingly, the magnet M1836 operates and restores intermittently, thereby to drive the wipers noted of the rotary switch S1830 step by step in the clockwise direction until the wiper 1835 disengages the last contact in the associated contact bank included in the previously traced circuit for energizing the winding of the magnet M1836, thereby to interrupt the circuit for energizing the winding of the magnet M1836 in order to arrest further operation thereof. At this time, the wip-

ers noted of the rotary switch S1830 are returned to their normal rotary positions.

At this point, it is noted that the code storing devices S2001 to S2022, inclusive, in the printer controller 67 have stored therein, in code, the following information:

Code storing device	Information stored in code
S2001	The respective first, second, third and fourth digits of the directory number of the called subscriber line 2200, the digits 5, 5, 5 and 5, respectively.
S2002	
S2003	
S2004	
S2005	The respective first, second and third letters identifying the terminating exchange 52, the letters M, A and D, respectively.
S2006	
S2007	
S2008	
S2009	The rate factor applicable to the call between the calling subscriber substation T1 and the called subscriber substation T2, the digit 6.
S2010	
S2011	
S2012	
S2013	The respective first, second, third and fourth digits of the directory number of the calling subscriber line 250, the digits 2, 9, 2 and 1, respectively.
S2014	
S2015	
S2016	
S2017	The respective ten and unit digits of the time duration of the established connection between the calling subscriber substation T1 and the called subscriber substation T2, the digits 1 and 2, respectively.
S2018	
S2019	
S2020	
S2021	The ten and unit digits of the day, the digits 1 and 0, respectively.
S2022	
	The ten and unit digits of the month, the digits 1 and 2, respectively.
	The ten and unit digits of the hour, the digits 1 and 2, respectively.
	The ten and unit digits of the minute, the digits 4 and 5, respectively.

Each time the impulse relay R1940 operates it completes, at the contacts 1943, an obvious path for applying ground potential to the wipers 1901 and 1902 of the rotary switch R1900; completes, at the contacts 1942, obvious paths for applying ground potential to the wipers 1903 and 1904 of the rotary switch R1900; and completes, at the contacts 1941, an obvious circuit for energizing the magnet M1907 of the rotary switch R1900. Each time the magnet M1907 of the rotary switch R1900 is energized, it conditions the wipers 1901, 1902, 1903, 1904, 1905 and 1906 of the rotary switch R1900 to be driven one step in the counterclockwise direction; and each time the magnet M1907 restores, the wipers noted of the rotary switch R1900 are driven one step in the counterclockwise direction. After the wipers 1903 and 1904 of the rotary switch R1900 are rotated a predetermined number of steps, they engage contacts in the associated contact banks terminating the conductor C1866, thereby to complete an obvious circuit for energizing the winding of the magnet M1846 of the rotary switch C1840, thereby to cause the magnet M1846 to operate and condition the wipers 1841, 1842, 1843, 1844 and 1845 of the rotary switch C1840 to be driven one step in the counterclockwise direction. When the previously mentioned circuit for energizing the magnet M1846 is interrupted, the magnet M1846 restores to drive the wipers noted of the rotary switch C1840 one step in the counterclockwise direction.

From the foregoing, it will be understood that, each time the impulse relay R1940 operates and restores, the wipers noted of the rotary switch R1900 are driven one step in the counterclockwise direction; while the wipers noted in the rotary switch C1840 are driven one step in the counterclockwise direction, upon each of certain of the operations and restorations of the impulse relay R1940. At this point, it is noted that the first three contacts in the contact bank associated with the wiper 1901 of the rotary switch R1900 terminate the conductors C1920, C1921 and C1922, respectively, which are permanently connected by way of the straps 2154 in the jumper

field 2151 to certain of the leads in the group of marking leads 2150 extending to the toll ticket printer 69. Hence, upon the first three operations of the impulse relay R1940, ground potential is applied by way of the wipers 1901 and the first three contacts in the associated contact bank of the rotary switch R1900 successively to the conductors C1920, C1921 and C1922; and therefrom, by way of the straps 2154 in the jumper field 2151 to predetermined ones of the leads in the group of marking leads 2150. More particularly, the conductors C1920, C1921 and C1922 are connected by way of the straps 2164 in the jumper field 2151 to certain of the leads in the group of marking leads 2150, thereby to cause the toll ticket printer 69 to print the letters MON upon the toll ticket, as shown in Fig. 24, these letters identifying the originating exchange 50.

Subsequently, upon the fourth operation of the impulse relay R1940, the wiper 1903 engages a contact in the associated contact bank of the rotary switch included in the previously traced circuit for energizing the winding of the magnet M1846 of the rotary switch C1840, thereby to cause the magnet M1846 to operate and condition the wipers noted of the rotary switch C1840 to be driven one step in the counterclockwise direction. Furthermore, the wiper 1901 engages the fourth contact in the associated contact bank of the rotary switch R1900, thereby to complete a path for causing ground potential to be applied to the second marking lead in the group of marking leads 1863 extending by way of the group of marking leads 2150 to the toll ticket printer 69. This path extends from the grounded wiper 1901 and the engaged fourth contact in the associated contact bank of the rotary switch R1900, by way of the conductor C1867, the contacts WA1, XA2 and YA1 to the second lead in the group of marking leads 1863, the relays WA and YA being operated at this time, in a manner more fully described hereinafter. This application of ground potential to the second lead in the group of marking leads 1863 causes the toll ticket printer 69 to print the digit 2 upon the toll ticket, as shown in Fig. 24.

Before explaining the manner of operation of the WA, XA, YA and ZA relays associated with the wipers 1841, 1842, 1843 and 1844, respectively, of the rotary switch C1840 incident to the operation of the rotary switch C1840, the general operation of the rotary switch R1900 will be explained. Continuing now with the operation of the rotary switch R1900, it is noted that, after the wiper 1901 thereof successively engages the first three contacts in the associated contact bank terminating the conductors C1920, C1921 and C1922, thereby to cause the toll ticket printer 69 to print the letters MON in the space entitled Calling No. on the toll ticket, it then engages successively four contacts in the associated contact bank terminating the conductor C1867, thereby to cause the printer 69 to print the numerals 2, 9, 2 and 1 in the space entitled Calling No. on the toll ticket. Thus, at this time, in the space on the toll ticket entitled Calling No., there is printed MON 2921. The wiper 1901 of the rotary switch R1900 then engages the contact in the associated contact bank terminating the conductor C1930, thereby to cause ground potential to be applied to the conductor C1930, whereupon the printer 69 shifts the toll ticket so that the succeeding information will be printed in the space entitled Called No. on the toll ticket.

The wiper 1901 then successively engages seven additional contacts in the associated contact bank terminating the conductor C1867, thereby to cause the printer 69 to print the letters MAD and the numerals 5555 in the space on the toll ticket entitled Called No. The wiper 1901 then engages the contact in the associated contact bank terminating the conductor C1930, whereupon the printer 69 shifts the toll ticket to the space entitled Date Day Mo. on the toll ticket. Subsequently, the wiper 1901 engages successively two contacts in the associated contact bank terminating the conductor C1867 thereby to cause the printer 69 to print the numerals 10 in the space entitled Date Day Mo. on the toll ticket. The wiper 1901 then engages the contact in the associated contact bank terminating the conductor C1931, thereby to cause the printer 69 to print the / in the space entitled Date Day Mo. on the toll ticket. Subsequently, the wiper 1901 successively engages two contacts in the associated contact bank terminating the conductor C1867, thereby to cause the printer 69 to print the numerals 12 in the space entitled Date Day Mo. on the toll ticket.

The wiper 1901 then successively engages the two contacts in the associated contact bank terminating the conductor C1933, thereby to cause the printer 69 to space the toll ticket to the space entitled Time Hour Min. on the toll ticket. The wiper 1901 then successively engages two contacts in the associated contact bank terminating the conductor C1867, thereby to cause the printer 69 to print the numerals 12 in the space entitled Time Hour Min. on the toll ticket. The wiper 1902 then engages the contact in the associated contact bank terminating the conductor C1932, thereby to cause the printer 69 to print a period (.) in the space entitled Time Hour Min. on the toll ticket. Subsequently, the wiper 1902 successively engages two contacts in the associated contact bank terminating the conductor C1867, thereby to cause the printer 69 to print the numerals 45 in the space entitled Time Hour Min. on the toll ticket.

The wiper 1902 then engages the contact in the associated contact bank terminating the conductor C1930, thereby to cause the printer 69 to shift the toll ticket to the space entitled Rate on the toll ticket. The wiper 1902 then successively engages two contacts in the associated contact bank terminating the conductor C1933, thereby to cause the printer 69 to space the toll ticket twice. The wiper 1902 then engages the contact in the associated contact bank terminating the conductor C1867, thereby to cause the printer 69 to print the numeral 6 in the space entitled Rate on the toll ticket.

The wiper 1902 then successively engages the four contacts in the associated contact bank terminating the conductor C1933, thereby to cause the printer 69 to space the toll ticket four times. The wiper 1902 then engages successively two contacts in the associated contact bank terminating the conductor C1867, thereby to cause the printer 69 to print the numerals 12 in the space entitled Duration of call in mins. on the toll ticket. The wiper 1902 then engages the contact in the associated contact bank terminating the conductor C1930, thereby to cause the printer 69 to shift the toll ticket to the space entitled Cost of call on the toll ticket. The wiper 1902 then engages the contact in the associated contact bank terminating the conductor C1933, thereby

to cause the printer 69 to space the toll ticket one space.

The wiper 1902 then engages successively the two contacts in the associated contact bank terminating the conductors C1923 and C1924, respectively, extending to the wipers 2101 and 2102 of the Strowger mechanism 2100, thereby to cause the printer 69 to print the numerals 12 in the space entitled Cost of call on the toll ticket, the numerals 12 indicating the cost of the call in shillings. The wiper 1902 then engages the contact in the associated contact bank terminating the conductor C1931, thereby to cause the printer 69 to print the / in the space entitled Cost of call on the toll ticket. The wiper 1902 then engages successively the contacts in the associated contact bank terminating the conductors C1925 and C1926 connected to the wipers 2103 and 2104, respectively, of the Strowger mechanism 2100, thereby to cause the printer 69 to print the numerals 11 in the space entitled Cost of call on the toll ticket, the numerals 11 indicating the cost of the call in pence. Finally, the wiper 1902 engages the contact in the associated contact bank terminating the conductor C1930, thereby to cause the printer 69 to shift the toll ticket out of the printer 69.

When the wipers 1841, 1842, 1843 and 1844 of the rotary switch C1840 engage the first contacts in the associated contact banks, the ninth code storing device S2009 in the printer controller 67 is operatively connected to the windings of the relays WA, XA, YA and ZA, as previously noted. In view of the fact that a code corresponding to the digit 2 is stored in the code storing device S2009, the W and Y relays in this code storing device are operated, thereby to complete obvious circuits by way of the W and Y leads in the group of marking leads in the cable 1855 for energizing the windings of the relays WA and YA, thereby to cause these relays to operate and complete, at the contacts WA1 and YA1, respectively, the previously traced path for applying ground potential upon the conductor C1867 to the second marking lead in the group of marking leads 1863, extending by way of the group of marking leads 2150 to the toll ticket printer 69. From the foregoing, it will be understood that, as the wipers noted of the rotary switch C1840 are rotated step by step in the counterclockwise direction, they engage contacts in the associated contact banks terminating the WXYZ lead of the various groups of marking leads in the cable 1855 extending to the various code storing devices S2001 to S2022, inclusive, thereby to cause the WA, XA, YA and ZA relays to operate in accordance with the code stored in the particular code storing device. The various combinations of operation of the WA, XA, YA and ZA relays complete marking paths between the conductor C1867 and the ten marking leads in the group of marking leads 1863, in an obvious manner.

In order to cause the toll ticket printer 69 to operate and print the information, previously described, upon the toll ticket, it is necessary for the different code storing devices S2001 to S2022, inclusive, in the printer controller 67 to be connected to the various contacts in the contact banks associated with the wipers 1841, 1842, 1843 and 1844 of the rotary switch C1840, in a predetermined order.

The code storing devices S2001 to S2022, inclusive, are connected to the various contacts

in the contact banks of the rotary switch S1840 in accordance with the following schedule:

Code storing device	Position of terminating contacts in the contact banks of the rotary switch C1840
5 S2009	1
S2010	2
S2011	3
S2012	4
S2005	5
10 S2006	6
S2007	7
S2001	8
S2002	9
S2003	10
S2004	11
S2015	12
15 S2016	13
S2017	14
S2018	15
S2019	16
S2020	17
S2021	18
S2022	19
20 S2008	20
S2013	21
S2014	22

After the toll ticket printer 69 has operated to print the toll ticket as shown in Fig. 24, the wipers of the rotary switch R1900 are moved an additional step in the counterclockwise direction incident to the restoration of the magnet M1907, whereupon the wiper 1906 engages the contact in the associated contact bank terminating the conductor C1928, whereupon a path is completed for short-circuiting the winding of the control relay R2120, this path extending from ground by way of the wiper 1906 and engaged contact in the associated contact bank of the rotary switch R1900, C1928, the contacts 2058, C2144, the winding of R2120, C2143 and the contacts 2055 to ground. When the winding of the relay R2120 is thus short-circuited, the relay R2120 restores to interrupt, at the contacts 2121, the previously mentioned path for applying ground potential to the conductor C2147 extending to the code storing devices S2001 to S2022, inclusive, in the printer controller 67, whereupon the WXYZ relays in the code storing devices S2001 to S2022, inclusive, restore to their normal positions. When the WXYZ relays in the code storing device S2008 restore to their normal positions, the previously traced circuits for energizing the right-hand and left-hand windings of the test relay R2125 are interrupted, thereby to cause the test relay R2125 to restore. Upon restoring, the test relay R2125 completes, at the contacts 2126, an alternative circuit for energizing the winding of the magnet M2046 of the rotary switch T2040, this circuit extending from ground, by way of the wiper 2041 and engaged contact in the associated contact bank of the rotary switch T2040, C2130, the contacts 2126, C2131, the contacts 2047 and the winding of M2046 to battery. When energized over the above-traced circuit, the magnet M2046 operates to interrupt, at the contacts 2047, the previously traced alternative circuit for energizing the winding thereof, whereupon the magnet M2047 restores to recomplete, at the contacts 2047, the previously traced alternative circuit for energizing the winding thereof. Accordingly, the magnet M2046 operates intermittently, thereby to drive the wipers noted of the rotary switch T2040 step by step in the counterclockwise direction until the wiper 2041 disengages the last contact in the associated contact bank having ground potential connected thereto. At this time, further operation of the magnet M2046 is arrested and the rotary switch T2040 occupies its normal rotary position.

When the rotary switch T2040 is returned to its normal rotary position, the set of switch springs S2049 is operated into disengagement, thereby to interrupt the previously traced holding circuit for energizing the winding of the control relay R2050, whereupon the relay R2050 restores to recomplete, at the contacts 2051, an alternative circuit for energizing the winding of the rotary magnet M2106 of the Strowger mechanism 2100 included in the multiplier switch 2160. This circuit extends from ground by way of the contacts 2051, the set of switch springs S2074, C2136, the contacts 2107 and the winding of M2106 to battery. When energized over the above-traced circuit, the rotary magnet M2106 operates to drive the wipers of the Strowger mechanism 2100 an additional step in the rotary direction and to interrupt, at the contacts 2107, the previously traced alternative circuit for energizing the winding thereof, whereupon the magnet M2106 restores to recomplete, at the contacts 2107, the previously traced alternative circuit for energizing the winding thereof. Accordingly, the magnet M2106 operates intermittently to drive the wipers of the Strowger mechanism 2100 in the rotary direction eleven steps away from the normal rotary position thereof, whereupon the wipers of the Strowger mechanism are returned to their normal vertical and rotary positions. When the wipers of the Strowger mechanism 2100 are returned to their normal vertical position, the set of switch springs S2074 are operated into disengagement, thereby to interrupt the previously traced alternative circuit for energizing the winding of the rotary magnet M2106. At this time, the Strowger mechanism 2100 is completely released.

Also, when the WXYZ relays in the code storing devices S2013 and S2014 restore to their normal positions, the previously traced circuits for respectively energizing the right-hand and left-hand windings of the transfer relay R2060 and the stop relay R2070 are interrupted, thereby to cause the transfer relay R2060 and the stop relay R2070 to restore. At this time, the multiplier switch 2160 is completely released.

Also, upon restoring, the control relay R2050 completes, at the contacts 2059, an alternative circuit for energizing the winding of the magnet M1907 of the rotary switch R1900, this circuit extending from ground by way of the wiper 1906 and engaged contact in the associated contact bank of the rotary switch R1900, C1928, the contacts 2059, C1929, the contacts 2054, C1927, the contacts 1908 and the winding of M1907 to battery. When energized over the above-traced circuit, the magnet M1907 operates to interrupt, at the contacts 1908, the previously traced circuit for energizing the winding thereof and conditions the wipers noted of the rotary switch R1900 to be driven an additional step in the counterclockwise direction. The magnet M1907 then restores to drive the wipers noted of the rotary switch R1900 an additional step in the counterclockwise direction. At this time, the wiper 1906 engages the contact in the associated contact bank terminating the conductor C1929, whereupon an additional alternative circuit for energizing the winding of the magnet M1907 is completed, this alternative circuit extending from ground by way of the wiper 1906 and engaged contact in the associated contact bank of the rotary switch R1900, C1929, the contacts 2054, C1927, the contacts 1908 and the winding of M1907 to battery. When energized over the above-traced circuit, the magnet M1907 operates

intermittently to drive the wipers noted of the rotary switch R1900 step by step in the counterclockwise direction until the wiper 1906 disengages the last contact in the associated contact bank of the rotary switch R1900 terminating the conductor C1929; whereupon the previously traced alternative circuit for energizing the winding of the magnet M1907 is interrupted, thereby to arrest further operation thereof. The rotary switch R1900 occupies its normal rotary position at this time.

Also, upon restoring, the relay R2050 interrupts, at the contacts 2052', the previously traced circuit for energizing the winding of the relay R1820, by way of the conductor C2146 extending to the toll ticket printer 69, thereby to cause the relay R1820 to restore and the toll ticket printer 69 to be completely released. Finally, the relay R2050 completes, at the contacts 2053, an alternative circuit for energizing the winding of the magnet M1846 of the rotary switch C1840, this circuit extending from ground, by way of the contacts 2053, C1856, the wiper 1845 and engaged contact in the associated contact bank of the rotary switch C1840, the contacts 1847 and the winding M1846 to battery. When energized over the above-traced circuit, the magnet M1846 operates to interrupt, at the contacts 1847, the previously traced alternative circuit for energizing the winding thereof, whereupon the magnet M1846 restores to recomplete, at the contacts 1847, the previously traced alternative circuit for energizing the winding thereof. Accordingly, the magnet M1846 operates intermittently to drive the wipers noted of the rotary switch C1840 step by step in the counterclockwise direction until the wiper 1845 disengages the last contact in the associated contact bank terminating the conductor C1856, whereupon the previously traced alternative circuit for energizing the winding of the magnet M1846 is interrupted, thereby to arrest further operation thereof. At this time, the rotary switch C1840 occupies its normal rotary position and the printer controller 67 is completely released. Furthermore, it is noted that the trunk line 1800 extending to the printer controller 67 is marked as idle to the repeaters having access thereto, battery potential being applied to the control conductor C1807 of the trunk line 1800 at the resistor 1838 and at the winding of the hold relay R1810 in the printer controller 67.

It will be understood that, when the repeater 65 is released, the group selector switch 80 and the dial repeater 81 in the intermediate exchange 51 will be released, whereupon the first numerical switch 90, the second numerical switch 91 and the connector switch 92 in the terminating exchange 52 will be released in a well-known manner. Finally, the subscriber line 2200 will be marked as idle to the connector switches having access thereto, assuming that the subscriber at the subscriber substation T2 has replaced the receiver of the telephone instrument thereat upon its associated switchhook. Accordingly, at this time, the established connection between the calling subscriber substation T1 and the called subscriber substation T2 is completely released and all of the apparatus utilized in this established connection is restored to its normal position.

Operation of the alternative detector arrangement

As previously noted, it is contemplated that an alternative detector arrangement may be substituted for the detectors 70 and 71, shown in

Figs. 10 to 14, inclusive. This alternative detector arrangement comprises the apparatus shown in Figs. 25, 10 and 11 and a portion of the apparatus shown in Fig. 13, as previously explained. Referring to Figs. 10, 11, 13 and 25, when the converter 66 is seized, the relay R1720 therein operates to apply ground potential to the start conductor C1109, as previously explained, thereby to complete an obvious circuit for energizing the winding of the start relay R2585 when the alternative detector arrangement is utilized. The start relay R2585 then operates to complete, at the contacts 2586, a circuit for energizing the winding of the magnet M2582 of the rotary switch F2580. This circuit extends from ground by way of the contacts 2563 and 2576, C2587, the wiper 2504 and engaged first contact in the associated contact bank of the rotary switch M2500, C2576, the wiper 2515 and engaged first contact in the associated contact bank of the rotary switch C2510, C2577, the wiper 2524 and engaged first contact in the associated contact bank of the rotary switch D2520, C2578, the wiper 2534 and engaged first contact in the associated contact bank of the rotary switch U2530, C2579, the wiper 2543 and engaged first contact in the associated contact bank of the rotary switch S2540, C2552, the contacts 2586 and 2583, and the winding of M2582 to battery. When energized over the above-traced circuit, the magnet M2582 operates to interrupt, at the contacts 2583, the previously traced circuit for energizing the winding thereof, whereupon the magnet M2582 restores to recomplete, at the contacts 2583, the previously traced circuit for energizing the winding thereof. Accordingly, the magnet M2582 operates intermittently, thereby to drive the wiper 2581 of the rotary switch F2580 step by step in the clockwise direction until the wiper 2581 engages the contact in the associated contact bank terminating the control conductor C1106 extending to the converter 66, whereupon a circuit is completed for energizing the winding of the test relay R2560. This circuit extends from ground, by way of the winding of R2560, the wiper 2581 and engaged contact in the associated contact bank of the rotary switch F2580 to the conductor C1106, battery potential in the converter 66 being impressed upon the conductor C1106. When this circuit is completed, the test relay R2560 operates to interrupt, at the contacts 2563, the previously traced circuit for energizing the winding of the magnet M2582 of the rotary switch F2580, thereby to arrest further operation thereof. Also, upon operating, the test relay R2560 completes, at the contacts 2566, the previously traced circuit for energizing the primary winding of the transformer 1355 from the 2000 cycle alternating current generator 1352, as explained. Further, the test relay R2560 completes, at the contacts 2564, a circuit for energizing the lower winding of the impulse relay R2555, this circuit extending from ground, by way of the contacts 2572, 2564 and 2556, and the lower winding of R2555 to battery. When energized over the above-traced circuit, the impulse relay R2555 operates to interrupt, at the contacts 2556, the previously traced circuit for energizing the lower winding thereof, whereupon the impulse relay R2555 restores to recomplete, at the contacts 2556, the previously traced circuit for energizing the winding thereof. Accordingly, the impulse relay R2555 operates intermittently. Also, upon operating, the test relay R2560 completes, at the contacts 2562, an obvious path for applying

ground potential to the wipers 2501, 2511, 2512 and 2521 of the rotary switches M2500, C2510 and D2520; and completes, at the contacts 2565, a circuit for energizing the winding of the magnet M2545 of the rotary switch S2540. This circuit extends from ground, by way of the contacts 2565 and 2574, and the winding of M2545 to battery. When energized over the above-traced circuit, the magnet M2545 operates to condition the wipers 2541, 2542, 2543 and 2544 of the rotary switch S2540 to be driven one step in the counterclockwise direction.

At this time, the wiper 2542 of the rotary switch S2540 engages the contact in the associated contact bank terminating the conductor C2593. Accordingly, each time the impulse relay R2555 operates, at this time, a circuit is completed, at the contacts 2557, for energizing the winding of the magnet M2505 of the rotary switch M2500. This circuit extends from ground, by way of the contact 2557, C2597, the wiper 2542 and engaged first contact in the associated contact bank of the rotary switch S2540, C2593, and the winding of the magnet M2505 to battery. Each time the above-traced circuit for energizing the winding of the magnet M2505 is completed and subsequently interrupted, the magnet M2505 operates and then restores to drive the wipers 2501, 2502, 2503 and 2504 of the rotary switch M2500 step by step in the counterclockwise direction. When the wiper 2505 of the rotary switch M2500 is driven step by step in a counterclockwise direction, it successively engages the contacts in the associated contact bank terminating the conductors in the cable 1103, thereby to cause the relays 1M, 2M, etc., in the crossbar switch control network 1100 to operate successively, whereupon the crossbar switch control network 1100 controls the operation of the crossbar switches 1001, 1002, 1003, 1004 and 1005, in the manner previously described, in order to test the various 1000 groups of lines terminating at the originating exchange 50 in the manner previously explained. When the particular 1000 group of lines including the calling subscriber line 250, terminating at the originating exchange 50, is tested, the vacuum tube amplifier 1305 operates to cause the test relay R2550 to operate, as previously explained. Upon operating, the test relay R2550 completes, at the contacts 2551, an obvious circuit for energizing the upper winding of the control relay R2570, thereby to cause the relay R2570 to operate. Upon operating, the relay R2570 completes, at the contacts 2571, an obvious path for short-circuiting the lower winding thereof, thereby rendering the relay R2570 slow to release. Further, the relay R2570 interrupts, at the contacts 2572, the previously traced circuit for energizing the lower winding of the impulse relay R2555, thereby to arrest further operation of the impulse relay R2555 at this time. Finally, the relay R2570 interrupts, at the contacts 2574, the previously traced circuit for energizing the winding of the magnet M2545 of the rotary switch S2540, whereupon the magnet M2545 restores to drive the wipers noted of the rotary switch S2540 one step in the counterclockwise direction. At this time, the wiper 2542 of the rotary switch S2540 engages the second contact in the associated contact bank terminating the conductor C2594, thereby to prepare a circuit traced hereinafter for energizing the winding of the magnet M2516 of the rotary switch C2510. Furthermore, when the wiper 2541 of the rotary switch S2540 engages the second contact in the

associated contact bank, it completes an obvious circuit for energizing the winding of the relay MS, this circuit extending from ground by way of the contacts 2561, the wiper 2541 and engaged second contact in the associated contact bank of the rotary switch S2540, and the winding of MS to battery. When energized over the above-traced circuit, the relay MS operates to complete, at the contacts MS1, an obvious holding circuit for energizing the winding thereof.

Also, upon operating, the relay MS causes the crossbar switch control network 1100 to control the first crossbar switch 1001 which is utilized at this time in the previously described manner, whereupon the previously traced test circuit is interrupted, and the test relay R2550 restores. Upon restoring, the test relay R2550 interrupts, at the contacts 2551, the previously mentioned circuit for energizing the upper winding of the relay R2570, thereby to cause the relay R2570 to restore shortly thereafter. Upon restoring, the relay R2570 reoperates, at the contacts 2572, the previously traced circuit for energizing the lower winding of the impulse relay R2555, thereby to cause the impulse relay R2555 to operate intermittently, as previously explained. Also, upon restoring, the relay R2570 reoperates, at the contacts 2574, the previously traced circuit for energizing the winding of the magnet M2545 of the rotary switch S2540, thereby to cause the magnet M2545 to operate and condition the wipers noted of the rotary switch S2540 to be driven an additional step in the counterclockwise direction. The operation of the impulse relay R2555, at this time, completes, at the contacts, 2557, the previously mentioned circuit for energizing the winding of M2516 of the rotary switch C2510. This circuit extends from ground, by way of the contacts 2557, the wiper 2542 and engaged second contact in the associated contact bank of the rotary switch S2540, C2594 and the winding of M2516 to battery. Accordingly, the wipers 2511, 2512, 2513, 2514 and 2515 of the rotary switch C2510 are operated step by step in the counterclockwise direction at this time. As the wiper 2512 of the rotary switch C2510 is operated step by step in the counterclockwise direction, ground potential is alternately applied to the odd and even conductors in the cable 1101; and as the wiper 2511 of the rotary switch C2510 is rotated step by step in the counterclockwise direction, ground is successively applied upon each two steps of the rotary switch C2510 to the control conductor in the cable 1101. This application of ground potential to the conductors noted in the cable 1101 causes the crossbar switch control network 1100 to control the operation of the first crossbar switch 1001, in the previously described manner, in order to test the 100 groups of lines terminating at the originating exchange 50 for the calling subscriber line 250, in the previously described manner.

In view of the foregoing description of the mode of operation of the rotary switches M2500 and C2510, it will be understood that the rotary switches D2520 and U2530 are subsequently operated step by step in order to determine, respectively, the particular group of 10 lines terminating at the originating exchange 50 including the calling subscriber line 250 and the particular line terminating at the originating exchange 50 which is the calling subscriber line 250.

When the wipers 2531, 2532, 2533 and 2534 of the rotary switch U2530 are operated away from

their normal positions, the set of switch springs S2537 are actuated into engagement, thereby to prepare a path traced hereinafter for applying ground potential to the conductor C1108 extending to the converter 66. After the operation of the rotary switch U2530 is completed, the test relay R2550 again operates, thereby to cause the relay R2570 to again operate. Upon operating, the relay R2570 completes, at the contacts 2573, the previously mentioned path for applying ground potential to the conductor C1108 extending to the converter 66. This path extends from ground, by way of the contacts 2565 and 2573, and the set of switch springs S2537, to the conductor C1108. This application of ground potential to the conductor C1108 extending to the converter 66 causes the cut-off relay R1730 therein to operate, as previously explained.

At this point, it is noted that the wipers 2502 and 2503 of the rotary switch M2500 mark, by way of the engaged contacts in the associated contact bank, the WXYZ leads in the first group of marking leads 1451 included in the cable 1455 extending to the converter 66, the marking of the WXYZ leads in the first group of marking leads 1451 being in accordance with the operated position of the rotary switch M2500, and consequently in accordance with the particular 1000 group of lines terminating at the originating exchange 50 including the calling subscriber line 250; the wipers 2513 and 2514 of the rotary switch C2510 mark, by way of the engaged contacts in the associated contact banks, the WXYZ leads in the second group of marking leads 1452 included in the cable 1455 extending to the converter 66, the marking of the WXYZ leads in the second group of marking leads 1452 being in accordance with the operated position of the rotary switch C2510, and consequently in accordance with the particular 100 group of lines terminating at the originating exchange 50, including the calling subscriber line 250; the wipers 2522 and 2523 of the rotary switch D2520 mark, by way of the engaged contacts in the associated contact banks, the WXYZ leads in the third group of marking leads 1453 included in the cable 1455 extending to the converter 66, the marking of the WXYZ leads in the third group of marking leads 1453 being in accordance with the operated position of the rotary switch D2520, and consequently in accordance with the particular 10 group of lines terminating at the originating exchange 50, including the calling subscriber line 250; and finally, the wipers 2532 and 2533 of the rotary switch U2530 mark, by way of the engaged contacts in the associated contact banks, the WXYZ leads in the fourth group of marking leads 1454 included in the cable 1455 extending to the converter 66, the marking of the WXYZ leads in the fourth group of marking leads 1454 being in accordance with the operated position of the rotary switch U2530, and consequently in accordance with the particular calling line 250 terminating at the originating exchange 50.

Furthermore, it is noted that, after the rotary switch M2500 is set to a predetermined rotary position, the rotary switch S2540 is operated to cause the wiper 2544 thereof to engage the second contact in the associated contact bank, thereby to complete the previously mentioned marking circuits for the WXYZ leads in the first group of marking leads 1451, in order to cause operation of the fifth code storing device S1705 in the converter 66, in the previously described man-

ner. Furthermore, after the rotary switches C2510, D2520 and U2530 are successively operated to predetermined rotary positions, the rotary switch S2540 operates to cause the wiper 2544 thereof to engage successively the third, fourth and fifth contacts in the associated contact bank, thereby to complete the marking circuits, by way of the WXYZ leads in the second, third and fourth groups of marking leads 1452, 1453 and 1454, respectively, whereby the sixth, seventh and eighth code storing devices S1706, S1707 and S1708, respectively, in the converter 66 are operated, in the previously described manner.

At this time, the code storing devices S1705, S1706, S1707 and S1708 in the converter 66 have been operated in order to register the first, second, third and fourth digits of the directory number of the calling subscriber line 250 terminating at the originating exchange 50; and the cut-off relay R1730 in the converter 66 has operated. Upon operating, the cut-off relay R1730 in the converter 66 interrupts the previously traced circuit for energizing the winding of the test relay R2560, thereby to cause the test relay R2560 to restore. Upon restoring, the test relay R2560 interrupts, at the contacts 2561, the previously mentioned holding circuits for energizing the windings of the relays MS, CS and DS, whereupon the relays MS, CS and DS restore and control the crossbar switch control network 1100 in order to cause the first crossbar switch 1001 to restore to its normal position. The test relay R2550 then restores and shortly thereafter the relay R2570 restores. When the relay R2570 restores it completes, at the contacts 2575, an alternative circuit for energizing the winding of the magnet M2505 of the rotary switch M2500. This circuit extends from ground, by way of the contacts 2563 and 2575, C2587, the wiper 2504 and engaged contact in the associated contact bank of the rotary switch M2500, the contacts 2506 and the winding of M2505 to battery. When energized over the above-traced circuit, the magnet M2505 operates to interrupt, at the contacts 2506, the previously traced circuit for energizing the winding thereof, whereupon the magnet M2505 restores to recomplete, at the contacts 2506, the previously traced alternative circuit for energizing the winding thereof. Accordingly, the magnet M2505 operates intermittently to drive three wipers noted of the rotary switch M2500 step by step in the counterclockwise direction, back into their normal rotary positions, whereupon the wiper 2504 of the rotary switch M2500 disengages the last contact in the associated contact bank included in the circuit for energizing the winding of the magnet M2505, and engages the first contact in the associated contact bank, thereby to complete a circuit for energizing the winding of the magnet M2516 of the rotary switch C2510. The last-mentioned circuit extends from ground, by way of the previously traced path, to the wiper 2504 and engaged first contact in the associated contact bank of the rotary switch M2500, and therefrom, by way of C2576, the wiper 2515 and engaged contact in the associated contact bank of the rotary switch C2510, the contact 2517 and the winding of M2516 to battery. When energized over the above-traced circuit, the magnet M2516 operates to drive the wipers noted of the rotary switch C2510 step by step in the counterclockwise direction, back into their normal rotary positions, whereupon the wiper 2515 engages the first contact in the associated contact bank, thereby to complete a circuit for

energizing the winding of the magnet M2525 of the rotary switch D2520. The last-mentioned circuit extends from ground, by way of the previously traced path, to the wiper 2515 and engaged first contact in the associated contact bank of the rotary switch C2510, and therefrom, by way of C2577, the wiper 2524 and engaged contact in the associated contact bank of the rotary switch D2520, the contacts 2526 and the winding of M2525 to battery. When energized over the above-traced circuit, the magnet M2525 operates to drive the wipers noted of the rotary switch D2520 in a counterclockwise direction, back into their normal rotary positions, whereupon the wiper 2524 engages the first contact in the associated contact bank of the rotary switch D2520, thereby to complete a circuit for energizing the winding of the magnet M2535 of the rotary switch U2530. The last-mentioned circuit extends from ground, by way of the previously traced path, to the wiper 2524 and engaged first contact in the associated contact bank of the rotary switch D2520, and therefrom, by way of C2578, the wiper 2534 and engaged contact in the associated contact bank of the rotary switch U2530, thereby to engage contacts 2536 and the winding of M2535 to battery. When energized over the above-traced circuit, the magnet M2535 operates to drive the wipers noted of the rotary switch U2530 step by step in the counterclockwise direction, back into their normal rotary position, whereupon the wiper 2534 engages the first contact in the associated contact bank of the rotary switch U2530, thereby to complete a circuit for energizing the winding of the magnet M2545 of the rotary switch S2540. The last-mentioned circuit extends from ground, by way of the previously traced path, to the wiper 2534 and engaged first contact in the associated contact bank of the rotary switch U2530, and therefrom, by way of C2579, the wiper 2543 and engaged contact in the associated contact bank of the rotary switch S2540, the contacts 2546 and the winding of M2545 to battery. When energized over the above-traced circuit, the magnet M2545 drives the wipers noted of the rotary switch S2540 until the wiper 2543 disengages the sixth contact in the associated contact bank of the rotary switch S2540 and engages the seventh contact in the associated contact bank of the rotary switch S2540. When the sixth contact in the contact bank associated with the wiper 2543 of the rotary switch S2540 is disengaged, the previously traced circuit for energizing the winding of the magnet M2545 is interrupted, thereby to arrest further operation thereof. Furthermore, when the wiper 2543 engages the seventh contact in the associated contact bank of the rotary switch S2540, this rotary switch occupies a normal position. At this time, the alternative detector arrangement is completely released and available for further use.

CONCLUSIONS

From the foregoing, it is apparent that an automatic telephone system is provided which comprises improved automatic recording apparatus operative to record, without the aid of an operator, given particulars of certain calls in the system for which special charges are made.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein, and it is intended to cover in the appended claims

all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a telephone system, a first exchange having lines extending thereto, a plurality of second exchanges, switching mechanism operative to establish a connection between said first exchange and any one of said second exchanges, a register sender, means for associating said register sender with a calling line in said first exchange, said register sender including a two-motion switch operative to register two digits sent over said calling line and designating a particular one of said second exchanges, said register sender including a sender controlled in accordance with the operation of said two-motion switch for governing the operation of said switching mechanism, thereby to establish a connection between said calling line and said particular second exchange, a rotary switch provided with a wiper and an associated contact bank, and means controlled in accordance with the operation of said two-motion switch for registering in the contact bank of said rotary switch the particular rate factor applicable to a call from said first exchange to said particular second exchange.

2. In a telephone system, a first exchange having lines extending thereto, a plurality of second exchanges, switching mechanism operative to establish a connection between said first exchange and any one of said second exchanges, a trunk circuit including an automatic switch, means for associating said trunk circuit with a calling line in said first exchange, a plurality of groups of register senders, means included in said automatic switch and operative in response to a first digit sent over said calling line for selecting a corresponding group of said register senders and then for selecting an idle register sender in said selected group of register senders, said selected register sender including a digit register operative to register two additional digits sent over said calling line, a particular one of said second exchanges being designated by the three digits sent over said calling line, said register sender including a sender controlled in accordance with the operation of said digit register for governing the operation of said switching mechanism, thereby to establish a connection between said calling line and said particular second exchange, a code register individually associated with said selected register sender, means for permanently registering in said code register one digit corresponding to said selected group of register senders, and means controlled in accordance with the operation of said digit register for registering in said code register two additional digits and the particular rate factor applicable to a call from said first exchange to said particular second exchange, the three digits registered in said code register designating said particular second exchange.

3. In a telephone system, a first exchange having lines extending thereto, a plurality of second exchanges, switching mechanism operative to establish a connection between said first exchange and any one of said second exchanges, a trunk circuit including an automatic switch, means for associating said trunk circuit with a calling line in said first exchange, a plurality of groups of register senders, means included in said automatic switch and operative in response to a first digit sent over said calling line for selecting a corresponding group of said register senders and then for selecting an idle register sender in said

selected group of register senders, said selected register sender including a two-motion switch operative to register two additional digits sent over said calling line, a particular one of said second exchanges being designated by the three digits sent over said calling line, said register sender including a sender controlled in accordance with the operation of said two-motion switch for governing the operation of said switching mechanism, thereby to establish a connection between said calling line and said particular second exchange, a rotary switch individually associated with said selected register sender and provided with a wiper and an associated contact bank, means for permanently registering in the contact bank of said rotary switch one digit corresponding to said selected group of register senders, and means controlled in accordance with the operation of said two-motion switch for registering in the contact bank of said rotary switch two additional digits and the particular rate factor applicable to a call from said first exchange to said particular second exchange, the three digits registered in the contact bank of said rotary switch designating said particular second exchange.

4. In a telephone system, a first exchange having lines extending thereto, a plurality of second exchanges, switching mechanism operative to establish a connection between said first exchange and any one of said second exchanges, a trunk circuit including two line conductors and an automatic switch, means for associating said trunk circuit with a calling line in said first exchange, a plurality of groups of register senders, means included in said automatic switch and operative in response to a first digit sent over said calling line for selecting a corresponding group of said register senders and then for selecting an idle register sender in said selected group of register senders, said selected register sender including a digit register operative to register two additional digits sent over said calling line, a particular one of said second exchanges being designated by the three digits sent over said calling line, said selected register sender including a first sender controlled in accordance with the operation of said digit register and operative to send digits over one of the line conductors of said trunk circuit, means controlled in accordance with the digits sent over the one line conductor of said trunk circuit for governing said switching mechanism, thereby to establish a connection between said calling line and said particular second exchange, a code register individually associated with said selected register sender, means for permanently registering in said code register one digit corresponding to said selected group of register senders, means controlled in accordance with the operation of said digit register for registering in said code register two additional digits and the particular rate factor applicable to a call from said first exchange to said particular second exchange, the three digits registered in said code register designating said particular second exchange, said selected register sender including a second sender operative to send four sets of impulses respectively corresponding to the three digits and the rate factor register in said code register over the other line conductor of said trunk circuit, four code storing devices, and means for successively associating said code storing devices with the other line conductor of said trunk circuit, thereby to cause the three digits

and code factor stored in said code register to be transferred and stored in said code storing devices.

5. In a telephone system, a first exchange having lines extending thereto, a plurality of second exchanges, switching mechanism operative to establish a connection between said first exchange and any one of said second exchanges, a trunk circuit including two line conductors and an automatic switch, means for associating said trunk circuit with a calling line in said first exchange, a register sender, means for associating said register sender with said trunk circuit, said register sender including a digit register operative to register a set of digits sent over said calling line and designating a particular one of said second exchanges, said register sender including a first sender controlled in accordance with the operation of said digit register and operative to send digits over one of the line conductors of said trunk circuit, a plurality of repeaters, means included in said automatic switch and controlled by the first digit sent over the one line conductor of said trunk circuit for causing said automatic switch to select an idle one of said repeaters, said selected repeater being operative to repeat other of the digits sent over the one line conductor of said trunk circuit to said switching mechanism, thereby to establish a connection between said calling line and said particular second exchange, said register sender including a second sender controlled in accordance with the operation of said digit register and operative to send a first set of impulses corresponding to the set of digits designating said particular second exchange and a second set of impulses corresponding to the particular rate factor applicable to a call from said first exchange to said particular second exchange over the other line conductor of said trunk line, a number of code storing devices, and means for successively associating said code storing devices with the other line conductor of said trunk circuit, thereby to cause the set of digits designating said particular second exchange and the rate factor to be stored in said code storing devices.

6. In a telephone system, a first exchange, a plurality of second exchanges, lines extending to said exchanges, a trunk circuit, means for associating said trunk circuit with a calling line in said first exchange, a register sender, means for associating said register sender with said trunk circuit, said register sender including a first digit register operative to register a first set of digits sent over said calling line and designating a particular one of said second exchanges and a second digit register operative to register a second set of digits sent over said calling line and designating a particular called line in said particular second exchange, means controlled in accordance with the operation of said first digit register for causing said register sender to send a first set of digits over said trunk circuit, means controlled in accordance with the operation of said second digit register for causing said register sender to send a second set of digits over said trunk circuit, a repeater including an automatic switch, means for associating said repeater with said trunk circuit, a first switching mechanism operative to establish a connection between said first exchange and any of said second exchanges, a second switching mechanism in said particular second exchange operative to establish a connection to any one of the lines therein, said repeater

being operative to repeat at least one of the digits of said first set sent over said trunk circuit to said first switching mechanism, thereby to establish a connection between said calling line and said particular second exchange, said repeater being operative to repeat said second set of digits sent over said trunk circuit to said second switching mechanism, thereby to establish a connection between said calling line and said called line, a number of converters, means for causing said automatic switch to search for an idle one of said converters when said repeater is associated with said trunk circuit, said register sender including first and second relays, means controlled after said register sender has sent said first set of digits over said trunk circuit for operating said first relay, means controlled by the operation of said first relay for preventing said register sender from sending said second set of digits over said trunk circuit, means controlled jointly by the operation of said first relay and the operation of said automatic switch to select an idle one of said converters for operating said second relay, and means controlled by the operation of said second relay for causing said first relay to restore.

7. In a telephone system, a first exchange, a plurality of second exchanges, lines extending to said exchanges, a trunk circuit, means for associating said trunk circuit with a calling line in said first exchange, a register sender, means for associating said register sender with said trunk circuit, said register sender including a first digit register operative to register a first set of digits sent over said calling line and designating a particular one of said second exchanges and a second digit register operative to register a second set of digits sent over said calling line and designating a particular called line in said particular second exchange, means controlled in accordance with the operation of said first digit register for causing said register sender to send a first set of digits over said trunk circuit, means controlled in accordance with the operation of said second digit register for causing said register sender to send a second set of digits over said trunk circuit, a repeater including an automatic switch and a number of code storing devices, means for associating said repeater with said trunk circuit, a first switching mechanism operative to establish a connection between said first exchange and any of said second exchanges, a second switching mechanism in said particular second exchange operative to establish a connection to any one of the lines therein, said repeater being operative to repeat at least one of the digits of said first set sent over said trunk circuit to said first switching mechanism, thereby to establish a connection between said calling line and said particular second exchange, said repeater being operative to repeat said second set of digits sent over said trunk circuit to said second switching mechanism, thereby to establish a connection between said calling line and said called line, a number of converters, means for causing said automatic switch to search for an idle one of said converters when said repeater is associated with said trunk circuit, said register sender including first and second relays, means controlled after said register sender has sent said first set of digits over said trunk circuit for operating said first relay, means controlled by the operation of said first relay for preventing said register sender from sending said second set of digits over said trunk circuit, means controlled jointly by the opera-

tion of said first relay and the operation of said automatic switch to select an idle one of said converters for operating said second relay, means controlled by the operation of said second relay for causing said first relay to restore, and means included in the selected converter for converting the digits of said second set into codes and for storing the codes in said code storing devices.

8. In a telephone system, an exchange having lines extending thereto, a trunk circuit, means for associating said trunk circuit with a calling line in said exchange, a register sender, means for associating said register sender with said trunk circuit, said register sender including a first digit register operative to register a first set of digits sent over said calling line and a second digit register operative to register a second set of digits sent over said calling line, means controlled in accordance with the operation of said first digit register for causing said register sender to send a first set of digits over said trunk circuit, means controlled in accordance with the operation of said second digit register for causing said register sender to send a second set of digits over said trunk circuit, a repeater including an automatic switch, means for associating said repeater with said trunk circuit, said repeater being operative to repeat at least one of the digits of said first set sent over said trunk circuit and all of the digits of said second set sent over said trunk circuit, a number of converters, means for causing said automatic switch to search for an idle one of said converters when said repeater is associated with said trunk circuit, said register sender including first and second relays, means controlled after said register sender has sent said first set of digits over said trunk circuit for operating said first relay, means controlled by the operation of said first relay for preventing said register sender from sending said second set of digits over said trunk circuit, means controlled jointly by the operation of said first relay and the operation of said automatic switch to select an idle one of said converters for operating said second relay, and means controlled by the operation of said second relay for causing said first relay to restore.

9. In a telephone system, an exchange having lines extending thereto, a trunk circuit, means for associating said trunk circuit with a calling line in said exchange, a register sender, means for associating said register sender with said trunk circuit, said register sender including a first digit register operative to register a first set of digits sent over said calling line and a second digit register operative to register a second set of digits sent over said calling line, means controlled in accordance with the operation of said first digit register for causing said register sender to send a first set of digits over said trunk circuit, means controlled in accordance with the operation of said second digit register for causing said register sender to send a second set of digits over said trunk circuit, a repeater including an automatic switch and a number of code storing devices, means for associating said repeater with said trunk circuit, said repeater being operative to repeat at least one of the digits of said first set sent over said trunk circuit and all of the digits of said second set sent over said trunk circuit, a number of converters, means for causing said automatic switch to search for an idle one of said converters when said repeater is associated with said trunk circuit, said register sender including first and second relays, means controlled after said register sender has sent said first set of digits

over said trunk circuit for operating said first relay, means controlled by the operation of said first relay for preventing said register sender from sending said second set of digits over said trunk circuit, means controlled jointly by the operation of said first relay and the operation of said automatic switch to select an idle one of said converters for operating said second relay, means controlled by the operation of said second relay for causing said first relay to restore, and means included in the selected converter for converting the digits of said second set into codes and for storing the codes in said codes storing devices.

10. In a telephone system, an exchange having a group of lines extending thereto, a plurality of detectors, each said detector being independently operative to detect a line in said group of lines having a predetermined condition thereon, means for initiating operation of said detectors, and means for producing an indication in the event said detectors fail to detect the same line in said group of lines.

11. In a telephone system, an exchange having a group of lines extending thereto, a plurality of detectors, each said detector being independently operative to detect a line in said group of lines having a predetermined condition thereon, means for initiating operation of said detectors when said predetermined condition is present upon a line in said group of lines, and means for producing an alarm in the event said detectors fail to detect the same line in said group of lines.

12. In a telephone system, an exchange having a group of lines extending thereto, a plurality of detectors, each said detector being independently operative to detect a line in said group of lines having a predetermined condition thereon, means for initiating operation of said detectors, means for producing a registration corresponding to the detected line in said group of lines in the event said detectors detect the same line in said group of lines, and means for producing an alarm in the event said detectors detect different lines in said group of lines.

13. In a telephone system, an exchange having a group of lines extending thereto, a plurality of detectors, each of said detectors being independently operative to detect a line in said group of lines having a calling condition thereon, means for initiating operation of said detectors, and means for producing an indication in the event said detectors fail to detect the same line in said group of lines.

14. In a telephone system, an exchange having a group of lines extending thereto, a plurality of detectors, each of said detectors being independently operative to detect a line in said group of lines having a calling condition thereon, means for initiating operation of said detectors when a calling condition is present upon a line in said group of lines, and means for producing an alarm in the event said detectors detect different lines in said group of lines.

15. In a telephone system, an exchange having a group of lines extending thereto, a plurality of detectors, each of said detectors being independently operative to detect a line in said group of lines having a calling condition thereon, means for initiating operation of said detectors when a calling condition is present upon a line in said group of lines, means for producing a registration corresponding to the detected line in said group of lines in the event said detectors detect the same line in said group of lines, and means for

producing an alarm in the event said detectors detect different lines in said group of lines.

16. In a telephone system, an exchange having a group of lines extending thereto, each of said lines including a control conductor, means controlled after a call is initiated on one of said lines for impressing a predetermined potential upon the control conductor thereof, a plurality of detectors, each of said detectors being independently operative to detect a line in said group of lines having said predetermined potential impressed upon the control conductor thereof, means for initiating operation of said detectors, a register, and means for operating said register to identify the detected line in said group of lines in the event said detectors detect the same line in said group of lines.

17. In a telephone system, an exchange having a group of lines extending thereto, each of said lines including a control conductor, means controlled after a call is initiated on one of said lines for impressing a predetermined potential upon the control conductor thereof, a plurality of detectors, each of said detectors being independently operative to detect a line in said group of lines having said predetermined potential impressed upon the control conductor, means for initiating operation of said detectors, an alarm device, and means for operating said alarm device in the event said detectors detect different lines in said group of lines.

18. In a telephone system, an exchange having a group of lines extending thereto, said group of lines being arranged in progressively smaller subgroups of lines, a plurality of detectors, each of said detectors being independently operative to detect the various progressively smaller subgroups of lines including a calling line and the particular position of the calling line in the smallest subgroup of lines, means for initiating operation of said detectors, a register, and means for operating said register to identify the various subgroups of lines and the particular position detected in the event said detectors detect the same subgroups of lines and the same particular position.

19. In a telephone system, an exchange having a group of lines extending thereto, said group of lines being arranged in progressively smaller subgroups of lines, a plurality of detectors, each of said detectors being independently operative to detect the various progressively smaller subgroups of lines including a calling line and the particular position of the calling line in the smallest subgroup of lines, means for initiating operation of said detectors, an alarm device, and means for operating said alarm device in the event said detectors detect different subgroups of lines or different particular positions.

20. In a telephone system, an exchange having a group of lines extending thereto, each of said lines being assigned a directory number indicative of the progressively smaller subgroups including the line and the particular position of the line in the smallest subgroup, a plurality of detectors, each of said detectors being individually operative to detect the directory number of a calling line in said group of lines, means for initiating operation of said detectors, a register, and means for operating said register to identify the directory number of the detected line in said group of lines in the event said detectors detect the same directory number of the calling line in said group of lines.

21. In a telephone system, an exchange having a group of lines extending thereto, each of said lines being assigned a directory number indicative of the progressively smaller subgroups including the line and the particular position of the line in the smallest subgroup, a plurality of detectors, each of said detectors being individually operative to detect the directory number of a calling line in said group of lines, means for initiating operation of said detectors, an alarm device, and means for operating said alarm device in the event said detectors detect different directory numbers of the calling line in said group of lines.

22. In a telephone system, an exchange having a group of lines extending thereto, a trunk circuit, means for associating said trunk circuit with a calling line in said group of lines, a number of registers, means for associating an idle one of said registers with said trunk circuit, a detector operative to detect a calling line in said group of lines, means for associating said one register with said detector, means controlled when said one register is associated with said detector for initiating operation of said detector, and means for causing said detector to operate said one register to identify the calling line in said group of lines.

23. In a telephone system, an exchange having a group of lines extending thereto, a trunk circuit including a first automatic switch, means controlled over a calling line in said group of lines for associating said trunk circuit with said calling line, a number of registers accessible to said first automatic switch, means controlled when said trunk circuit is associated with said calling line for causing said first automatic switch to select an idle one of said registers, a second automatic switch operative to find the one of said registers selected by said first automatic switch, means controlled when said first automatic switch selects an idle one of said registers for initiating operation of said second automatic switch, a detector operative to detect a calling line in said group of lines, means controlled when said second automatic switch finds said one register for initiating operation of said detector and for associating said one register with said detector, and means controlled by the operation of said detector for governing the operation of said one register to identify said calling line.

24. In a telephone system, an exchange having a group of lines extending thereto, a trunk circuit, means for associating said trunk circuit with a calling line in said group of lines, a number of registers, means for associating an idle one of said registers with said trunk circuit, a detector operative to detect a calling line in said group of lines, means controlled when said one register is associated with said trunk circuit for seizing said detector and for initiating operation thereof, means for causing said detector to operate said one register to identify the calling line in said group of lines, and means controlled by the operation of said one register for releasing said detector.

25. In a telephone system, an exchange having a group of lines extending thereto, a trunk circuit, means for associating said trunk circuit with a calling line in said group of lines, a number of registers, means for associating an idle one of said registers with said trunk circuit, a plurality of detectors, each of said detectors being independently operative to detect a calling line

in said group of lines, means controlled when said one register is associated with said trunk circuit for initiating operation of said detectors, and means for operating said one register to identify the detected line in said group of lines in the event said detectors detect the same line in said group of lines.

26. In a telephone system, an exchange having a group of lines extending thereto, each of the lines in said group having an individual designation comprising a given number of digits of particular numerical values, a detector having access to each of the lines in said group and comprising said given number of digit registers respectively corresponding to the digits in said designations, each of said digit registers including ten relays respectively corresponding to the numerical values 1 to 0, means for causing said detector to detect any one of the lines in said group having a calling condition thereon and to operate in each of said digit registers the relay corresponding to the numerical value of the corresponding digit in the designation of the detected line in said group of lines, and means controlled in accordance with the operation of the relays in said digit registers for recording the digits in the designation of said one line.

27. In a telephone system, an exchange having a group of lines extending thereto, each of said lines having an individual designation comprising a thousand digit, a hundred digit, a ten digit and a unit digit of particular numerical values; a detector having access to each of said lines and comprising a thousand digit register, a hundred digit register, a ten digit register and a unit digit register, each of said digit registers including ten relays respectively corresponding to the numerical values 1 to 0; and means for causing said detector to detect any one of the lines in said group having a calling condition thereon and to operate in each of said digit registers the relay corresponding to the numerical value of the corresponding digit in the designation of the detected line in said group of lines.

28. In a telephone system, an exchange having a group of lines extending thereto, each of the lines in said group having an individual designation comprising a given number of digits of particular numerical values, a detector having access to each of the lines in said group and comprising said given number of digit registers respectively corresponding to the digits in said designations, each of said digit registers including ten relays respectively corresponding to the numerical values 1 to 0, means for causing said detector to detect any one of the lines in said group having a calling condition thereon and to operate in each of said digit registers the relay corresponding to the numerical value of the corresponding digit in the designation of the detected line in said group of lines, a group of marking conductors individually associated with each of said digit registers, means controlled in accordance with the operation of the different relays in each of said digit registers for marking the conductors in the associated group of marking conductors in accordance with different code combinations, thereby to identify the particular operated relay in the associated digit register, and means controlled in accordance with the code markings of the conductors in said groups for recording the digits in the designation of said one line.

29. In a telephone system, an exchange having a group of lines extending thereto, a tester,

switching mechanism having access to each of the lines in said group, a number of digit registers, means for operating said digit registers successively, means controlled by the operation of said digit registers for causing said switching mechanism to connect the progressively smaller subgroups of said group of lines including a calling line to said tester and then to connect the calling line in the smallest subgroup of said group of lines to said tester, and means controlled jointly by said tester and said switching mechanism for governing said first-mentioned means, thereby to cause said digit registers to identify the calling line in said group of lines.

30. In a telephone system, an exchange having a group of lines extending thereto, each of the lines in said group having an individual designation comprising a given number of digits of particular numerical values, a plurality of detectors, each of said detectors being independently operative to detect a calling line in said group of lines and comprising said given number of digit registers, means for initiating operation of said detectors, means controlled by the operation of each of said detectors for operating the digit registers therein in accordance with the numerical values of the corresponding digits of the designation of the line detected thereby, and means for producing an alarm in the event any two corresponding digit registers in said detectors have registered therein different numerical values.

31. In a telephone system, an exchange having a group of lines extending thereto, each of the lines in said group having an individual designation comprising a given number of digits of particular numerical values, a plurality of detectors, each of said detectors being independently operative to detect a calling line in said group of lines and comprising said given number of digit registers, means for initiating operation of said detectors, means controlled by the operation of each of said detectors for operating the digit registers therein in accordance with the numerical values of the corresponding digits of the designation of the line detected thereby, a number of digit storing registers respectively corresponding to the digit registers in one of said detectors, and means for operating said digit storing registers in accordance with the numerical values registered in the respective digit registers in said one detector in the event the corresponding digit registers in said detectors have registered therein the same numerical values.

32. In a telephone system, a first exchange, a plurality of second exchanges, switching mechanism for routing a call from said first exchange to any one of said second exchanges, means for establishing a rate factor dependent upon the one of said second exchanges to which a call is routed from said first exchange, means for establishing a time factor dependent upon the duration of an established connection between said first exchange and one of said second exchanges, a plurality of two-motion calculating switches, each of said calculating switches including first and second magnets operative to set the calculating switch in the two respective directions, means for selecting one of said calculating switches in accordance with one of said established factors, means including a first relay common to said calculating switches for

controlling the operation of the first magnet of a selected one of said calculating switches, means including a second relay common to said calculating switches for controlling the operation of the second magnet of a selected one of said calculating switches, and means governed in accordance with the other of said established factors for controlling said first relay and said second relay.

33. In a telephone system, a first exchange, a plurality of second exchanges, switching mechanism for routing a call from said first exchange to any one of said second exchanges, means for establishing a rate factor dependent upon the one of said second exchanges to which a call is routed from said first exchange, means for establishing a time factor dependent upon the duration of an established connection between said first exchange and one of said second exchanges, a plurality of two-motion calculating switches, each of said calculating switches including first and second magnets operative to set the calculating switch in the two respective directions, circuits for said magnets, automatic switching means having access to the circuits of said magnets and operative in accordance with one of said established factors to select simultaneously the circuits of the first and the second magnets of one of said calculating switches, means including a first relay common to said calculating switches for controlling the circuit of the first magnet of a selected one of said calculating switches, means including a second relay common to said calculating switches for controlling the circuit of the second magnet of a selected one of said calculating switches, and means governed in accordance with the other of said established factors for controlling said first relay and said second relay.

34. In a telephone system, a first exchange, a plurality of second exchanges, lines extending to each of said exchanges, switching mechanism operative to establish a connection between any calling line in said first exchange and any called line in any one of said second exchanges, means for controlling said switching mechanism, a rate factor selector, a timer, means controlled when said switching mechanism is operated to establish a connection between a calling line in said first exchange and a called line in a particular one of said second exchanges for operating said selector to select a rate factor applicable to the call and for initiating operation of said timer, means controlled when said switching mechanism is released for arresting the operation of said timer, thereby to establish a time factor, first and second registers in said first exchange, means controlled by the operation of said selector for operating said first register to register the rate factor, and means controlled by the operation of said timer to establish a time factor for operating said second register to register the time factor.

35. In a telephone system, an exchange having a group of lines extending thereto, a plurality of detectors, each of said detectors being independently operative to detect a line in said group of lines having a calling condition thereon, means for initiating operation of said detectors when a calling condition is present upon a line in said group of lines, and means for producing a registration corresponding to the detected line in said group of lines in the event said detectors detect the same line in said group of lines.

36. In a telephone system, an exchange having a group of lines extending thereto, each of said lines being assigned a directory number, a plurality of detectors, each of said detectors being individually operative to detect the directory number of a calling line in said group of lines, means for initiating operation of said detectors, a register, and means for operating said register to identify the directory number of the detected line in said group of lines in the event said detectors detect the same directory number of the calling line in said group of lines.

37. In a telephone system, a group of lines divided into a plurality of progressively smaller sub-groups of lines, switching apparatus having access to said group of lines, a tester, means responsive to the presence of a calling line in said group of lines for progressively operating said switching apparatus through a plurality of successive stages to connect progressively smaller subgroups of said group of lines including said calling line to said tester and then for progressively operating said switching apparatus through a final stage to connect progressively the lines in the smallest subgroup of said group of lines including said calling line to said tester, and means governed by said tester in response to the progressive operation of said switching apparatus through said successive stages and the progressive operation of said switching apparatus through said final stage for identifying both the progressively smaller subgroups of said group of lines including said calling line and the position of said calling line in the smallest subgroup of said group of lines.

38. In a telephone system, a group of lines divided into a plurality of progressively smaller subgroups of lines, switching apparatus having access to said group of lines, a tester, means responsive to the presence of a calling line in said group of lines for progressively operating said switching apparatus through a plurality of successive stages to connect progressively smaller subgroups of said group of lines including said calling line to said tester and then for progressively operating said switching apparatus through a final stage to connect progressively the lines in the smallest subgroup of said group of lines including said calling line to said tester, a set of registers, and means governed by said tester in response to the progressive operation of said switching apparatus through said successive stages and the progressive operation of said switching apparatus through said final stage for storing in said set of registers identifications of both the progressively smaller subgroups of said group of lines including said calling line and the position of said calling line in the smallest subgroup of said group of lines.

39. In a telephone system, a group of lines divided into a plurality of progressively smaller subgroups of lines, switching apparatus having access to said group of lines, a set of counting relays, a set of cycle relays, means for cyclically operating said counting relays and for progressively operating said cycle relays, means responsive to the presence of a calling line in said group of lines for governing said last-mentioned means, whereby said switching apparatus is progressively operated through a plurality of successive stages to select progressively smaller subgroups of said group of lines including said calling line and then operated progressively through a final stage to select progressively the lines in the

smallest subgroup of said group of lines until said calling line is selected, and means governed by the progressive operation of said switching apparatus through said successive stages and the progressive operation of said switching apparatus through said final stage for identifying both the progressively smaller subgroups of said group of lines including said calling line and the position of said calling line in the smallest subgroup of said group of lines.

40. In a telephone system, a group of lines divided into a plurality of progressively smaller subgroups of lines, switching apparatus having access to said group of lines, a set of counting relays, a set of cycle relays, means including an electric discharge device for cyclically operating said counting relays and for progressively operating said cycle relays, means responsive to the presence of a calling line in said group of lines for governing said last-mentioned means, whereby said switching apparatus is progressively operated through a plurality of successive stages to select progressively smaller subgroups of said group of lines including said calling line and then operated progressively through a final stage to select progressively the lines in the smallest subgroup of said group of lines until said calling line is selected, and means governed by the progressive operation of said switching apparatus through said successive stages and the progressive operation of said switching apparatus through said final stage for identifying both the progressively smaller subgroups of said group of lines including said calling line and the position of said calling line in the smallest subgroup of said group of lines.

41. In a telephone system including a plurality of lines arranged in a group; a detector having access to said lines; said detector comprising a number of cross-bar switches, each including first and second groups of bars arranged in crossing relationship; and means for operating successively a first subgroup of the first group of bars and the second group of bars in a first of said cross-bar switches, then a second subgroup of said first group of bars and said second group of bars in said first cross-bar switch, then a first subgroup of the first group of bars and the second group of bars in a second of said cross-bar switches, etc., until a subgroup of said group of lines is detected which includes a calling line, thereby to detect said last-mentioned subgroup of lines.

42. In a telephone system including a plurality of lines arranged in a group; a detector having access to said lines; said detector comprising a number of cross-bar switches, each including first and second groups of bars arranged in crossing relationships; and means for operating successively in a given one of said cross-bar switches a first bar in said first group of bars and a first subgroup of bars in said second group of bars, then said first bar in said first group of bars and a second subgroup of bars in said second group of bars, then a second bar in said first group of bars and said first subgroup of bars in said second group of bars, etc., until a sub-subgroup of a subgroup of said group of lines accessible to said given cross-bar switch is detected which includes a calling line, thereby to detect said last-mentioned sub-subgroup of lines.

43. In a telephone system, a trunk circuit including two line conductors, said trunk circuit being provided with a first impulsing path including both of said line conductors and a sec-

ond impulsing path including only one of said line conductors, a register sender including a digit register and an impulse sender, means for selectively operating said digit register, and means controlled by the operation of said digit register for selecting one of said impulsing paths and then for operating said impulse sender to send impulses over said selected impulsing path.

44. In a telephone system, a trunk circuit including two line conductors, said trunk circuit being provided with a first digit path including both of said line conductors and a second digit path including only one of said line conductors and an impulsing path including the other of said line conductors, a register sender including a digit register and a digit sender and an impulse sender, means for selectively operating said digit register, means controlled by a first operation of said digit register for causing said digit sender to send digits over said first digit path, and means controlled by a second operation of said digit register for causing said digit sender to send digits over said second digit path and for causing said impulse sender to send impulses over said impulsing path.

45. In a telephone system, a trunk circuit including two line conductors, a register sender including a digit register and a digit sender and an impulse sender, means for selectively operating said digit register, means controlled by a first operation of said digit register for causing said digit sender to send digits over both of said line conductors, and means controlled by a second operation of said digit register for causing said digit sender to send digits over one of said line conductors and for causing said impulse sender to send impulses over the other of said line conductors.

46. In a telephone system, a trunk circuit including a digit path and an impulsing path, a register sender including a digit register and a digit sender and an impulse sender, said digit sender being operative to send digits over said digit path and said impulse sender being operative to send impulses over said impulsing path, means for selectively operating said digit register, and means controlled by the operation of said digit register for operating said digit sender in accordance with the routing of a connection over said trunk circuit and for simultaneously operating said impulse sender in accordance with certain record information pertaining to the connection.

47. In a telephone system, a trunk circuit including two line conductors, a register sender including a digit register and a digit sender and an impulse sender, said digit sender being operative to send digits over one of said line conductors and said impulse sender being operative to send impulses over the other of said line conductors, means for selectively operating said digit register, and means controlled by the operation of said digit register for operating said digit sender in accordance with the routing of a connection over said trunk circuit and for simultaneously operating said impulse sender in accordance with certain record information pertaining to the connection.

48. In a telephone system, a plurality of lines, a switch train operative in response to numerical digits transmitter thereto to set up connections between said lines, a register operative in response to code digits transmitted thereto to store certain items of record information pertaining to a connection, and means for transmitting simul-

taneously numerical digits to said switch train and code digits to said register.

49. In a telephone system, a trunk circuit, switching apparatus associated with said trunk circuit and operative in response to numerical digits transmitted thereover to set up a telephone connection, a register associated with said trunk circuit and operative in response to code digits transmitted thereover to store certain items of record information pertaining to a telephone connection, and means including a register sender for transmitting simultaneously over said trunk circuit numerical and code digits.

50. In a telephone system, a plurality of exchanges, each of said exchanges comprising collecting apparatus and registering apparatus and printing apparatus, said printing apparatus being operative to print ordinary language characters, switching apparatus for setting up telephone connections between said exchanges, means controlled incident to the setting up of a connection from an originating exchange to a terminating exchange for causing the collecting apparatus in the originating exchange to collect certain items of record information pertaining to the connection and to store the collected items in the registering apparatus in the originating exchange, and means controlled incident to the termination of a connection between an originating exchange and a terminating exchange and governed in accordance with the items pertaining to the connection mentioned stored in the registering apparatus in the originating exchange for selectively operating the printing apparatus in the originating exchange to print the items mentioned on a ticket individual to the connection mentioned.

51. In a telephone system, a plurality of exchanges, each of said exchanges comprising collecting apparatus and registering apparatus and calculating apparatus and recording apparatus, switching apparatus for setting up telephone connections between said exchanges, means controlled incident to the setting up of a connection from an originating exchange to a terminating exchange for causing the collecting apparatus in the originating exchange to collect certain items of record information pertaining to the connection and to store the collected items in the registering apparatus in the originating exchange, means controlled incident to the termination of a connection between an originating exchange and a terminating exchange for causing the calculating apparatus in the originating exchange to establish a cost item pertaining to the connection in accordance with both the originating exchange and terminating exchange involved therein and the duration of the connection and to store the established cost item in the registering apparatus in the originating exchange, and means controlled incident to the termination of a connection between an originating exchange and a terminating exchange for causing the recording apparatus in the originating exchange to make a record of the items pertaining to the connection stored in the registering apparatus in the originating exchange.

52. In a telephone system, a plurality of exchanges, each of said exchanges comprising collecting apparatus and registering apparatus and calculating apparatus and recording apparatus, switching apparatus for setting up telephone connections between said exchanges, means controlled incident to the setting up of a connection from an originating exchange to a terminating

exchange for causing the collecting apparatus in the originating exchange to collect certain items of record information pertaining to the connection and to store the collected items in the registering apparatus in the originating exchange, means controlled incident to the termination of a connection between an originating exchange and a terminating exchange for causing the calculating apparatus in the originating exchange to establish a cost item pertaining to the connection in accordance with both the originating exchange and terminating exchange involved therein and the duration of the connection and to store the established cost item in the registering apparatus in the originating exchange, and means controlled incident to the termination of a connection between an originating exchange and a terminating exchange for causing the recording apparatus in the originating exchange to make a record individual to the connection of the items pertaining thereto stored in the registering apparatus in the originating exchange.

53. In a telephone system, a plurality of exchanges, each of said exchanges comprising collecting apparatus and registering apparatus and calculating apparatus and printing apparatus, said printing apparatus being operative to print ordinary language characters, switching apparatus for setting up telephone connections between said exchanges, means controlled incident to the setting up of a connection from an originating exchange to a terminating exchange for causing the collecting apparatus in the originating exchange to collect certain items of record information pertaining to the connection and to store the collected items in the registering apparatus in the originating exchange, means controlled incident to the termination of a connection between an originating exchange and a terminating exchange for causing the calculating apparatus in the originating exchange to establish a cost item pertaining to the connection in accordance with both the originating exchange and terminating exchange involved therein and the duration of the connection and to store the established cost item in the registering apparatus in the originating exchange, and means controlled incident to the termination of a connection between an originating exchange and a terminating exchange and governed in accordance with the items pertaining to the connection mentioned stored in the registering apparatus in the originating exchange for selectively operating the printing apparatus in the originating exchange to print the items mentioned on a ticket individual to the connection mentioned.

54. In a telephone system, a plurality of exchanges, switching apparatus including links and operative to set up connections between said exchanges, means for selectively operating said switching apparatus, means controlled in accordance with the exchanges included in a connection for establishing a rate factor applicable to the connection, means controlled in accordance with the duration of a connection for establishing a time factor applicable to the connection, a calculating device operative to assess a charge for a connection, means controlled upon the termination of a given connection for associating said calculating device therewith, means controlled jointly in accordance with the established rate and time factors applicable to said given connections for selectively operating said

calculating device, means for positively preventing the release of a link utilized in said given connection prior to the association of said calculating device with said given connection, additional means controlled subsequent to the association of said calculating device with said given connection for causing the link utilized therein

to be released, a signal, and means controlled in the event the link utilized in said given connection is not released within a predetermined time interval following the termination of said given connection for controlling said signal.

JOHN ELLIS OSTLINE.

Disclaimer

2,297,365.—*John Ellis Ostline*, Chicago, Ill. TELEPHONE SYSTEM. Patent dated Sept. 29, 1942. Disclaimer filed Oct. 27, 1948, by the assignee, *Automatic Electric Laboratories, Inc.*; the inventor consenting.

Hereby enters this disclaimer of claims 27 and 29 of said patent.

[*Official Gazette November 30, 1948.*]