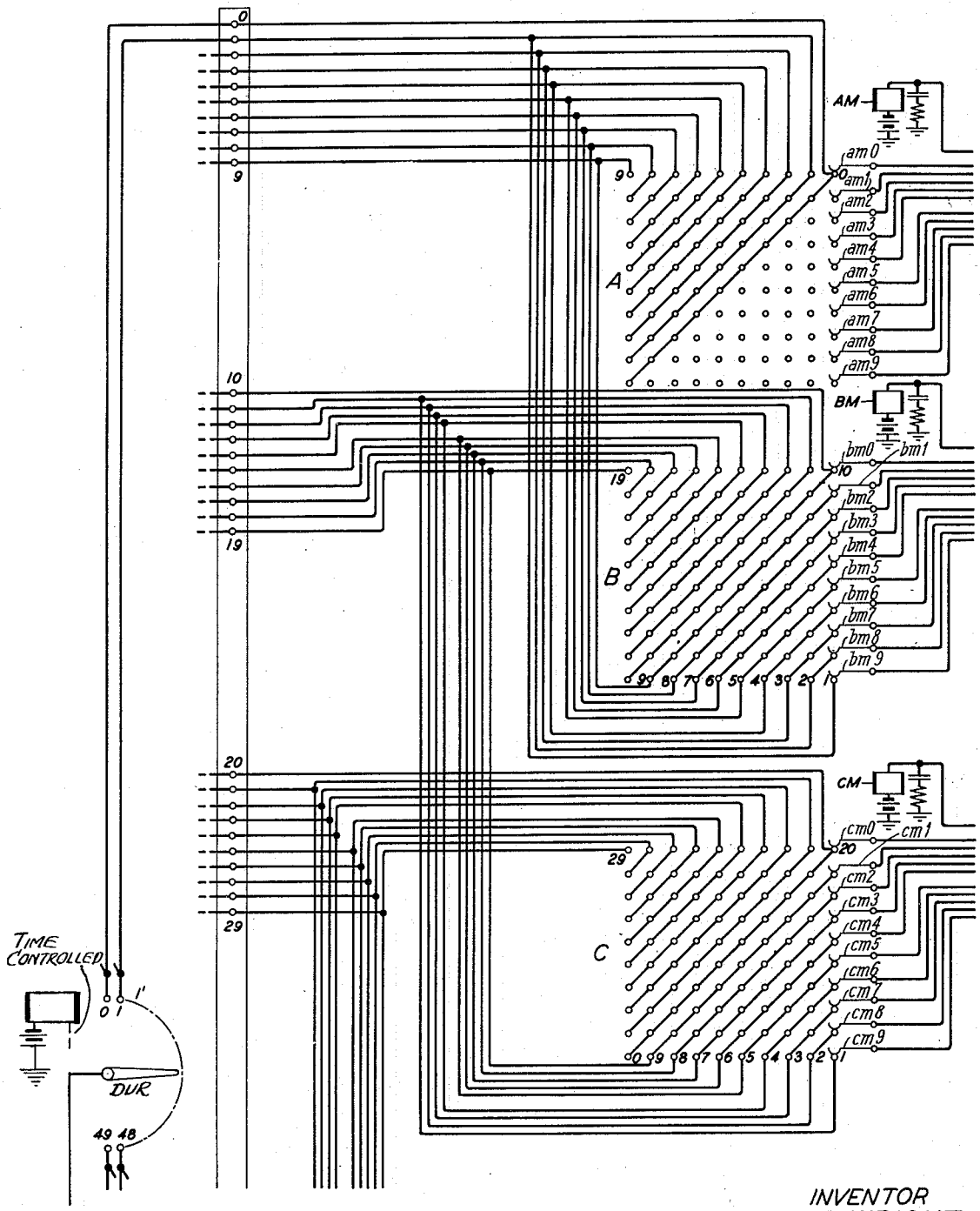
Aug. 26, 1941. E. P. G. WRIGHT 2,253,596

ELECTRICAL CALCULATING EQUIPMENT FOR TELEPHONE SYSTEMS

Filed Feb. 16, 1939 6 Sheets-Sheet 1

FIG. 1



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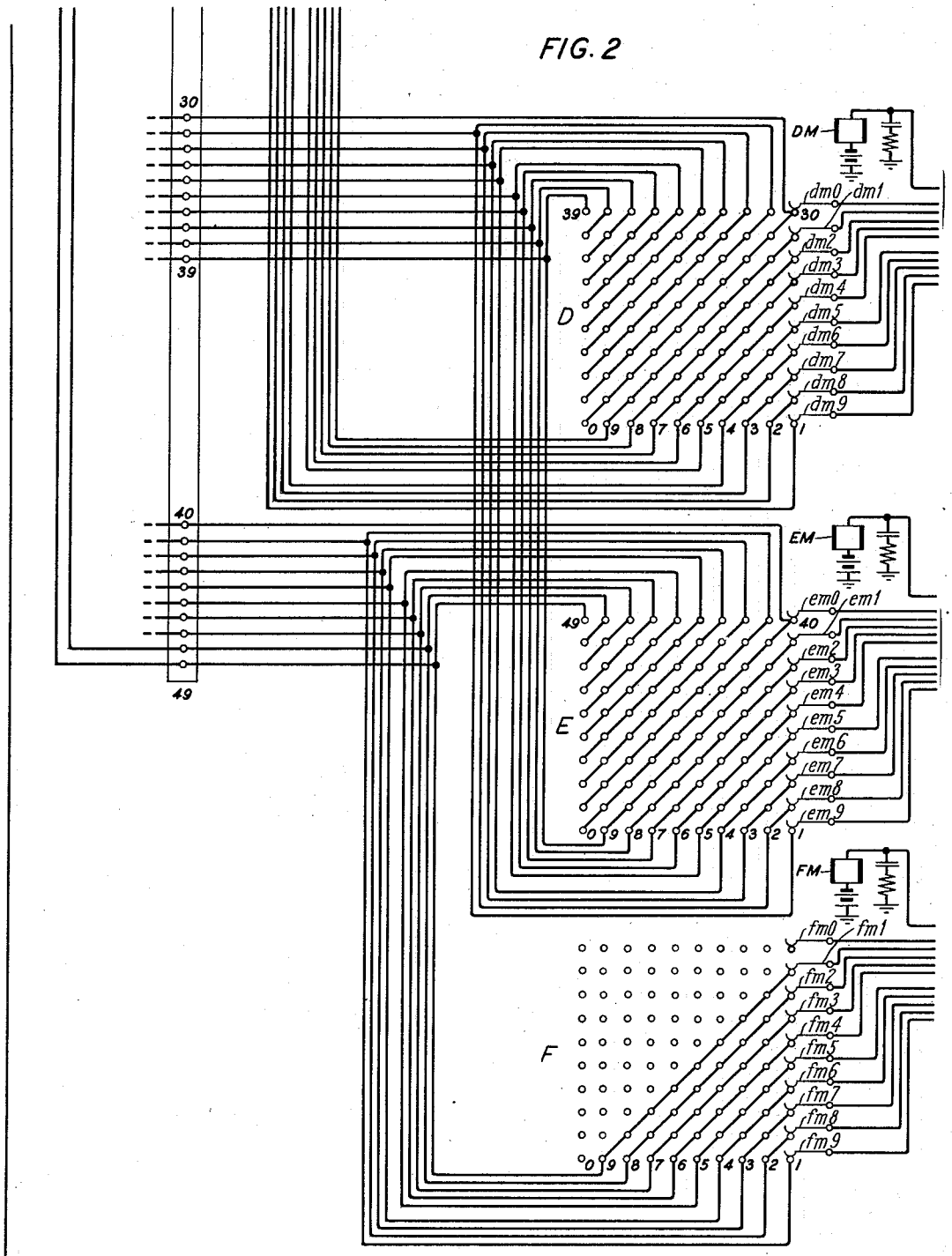
ELECTRICAL CALCULATING EQUIPMENT FOR TELEPHONE SYSTEMS

Filed Feb. 16, 1939 6 Sheets-Sheet 2

FIG. 2



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ELECTRICAL CALCULATING EQUIPMENT FOR TELEPHONE SYSTEMS

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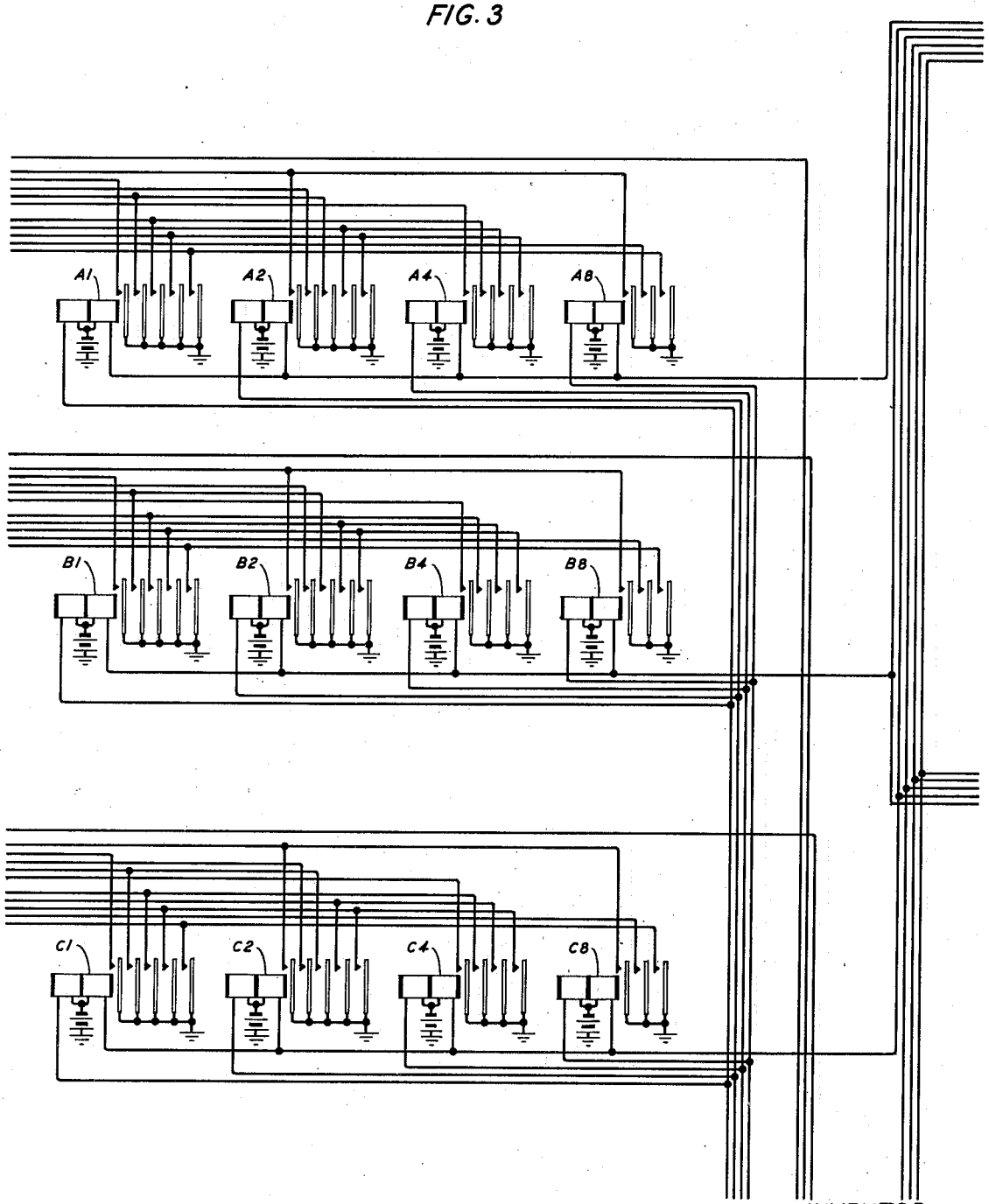
FIG. 3



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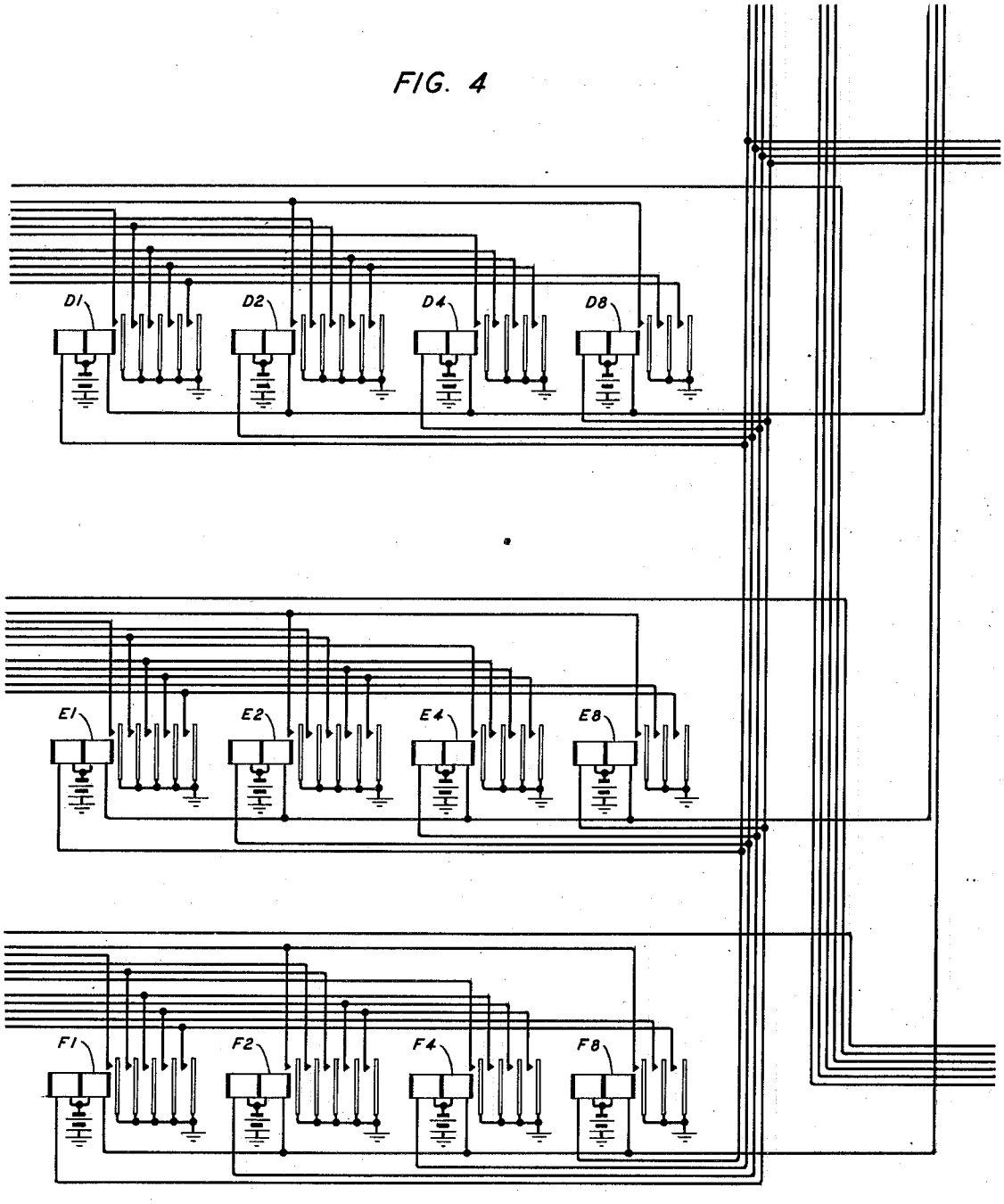
ELECTRICAL CALCULATING EQUIPMENT FOR TELEPHONE SYSTEMS

Filed Feb. 16, 1939 6 Sheets-Sheet 4

FIG. 4



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ELECTRICAL CALCULATING EQUIPMENT FOR TELEPHONE SYSTEMS

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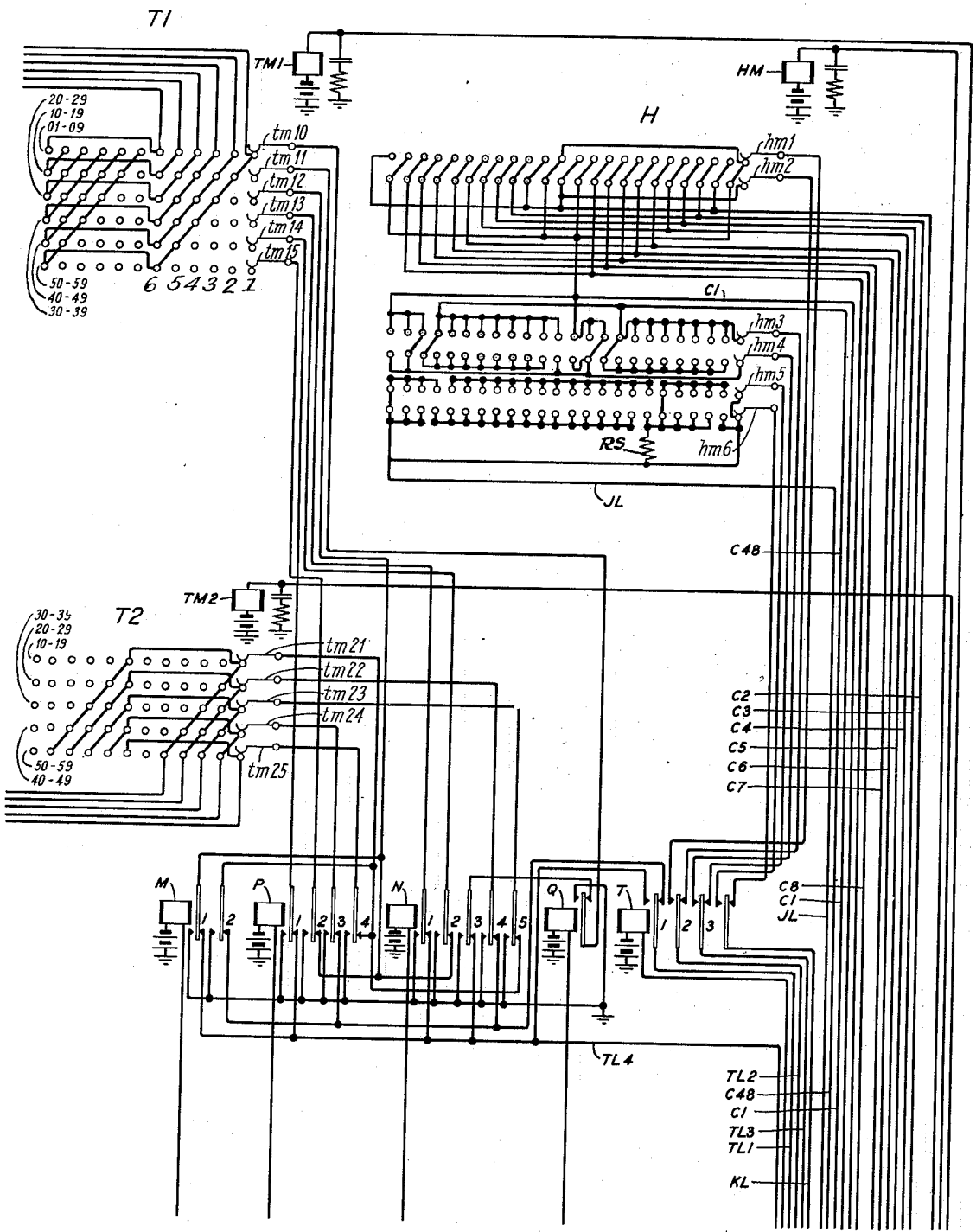
FIG. 5



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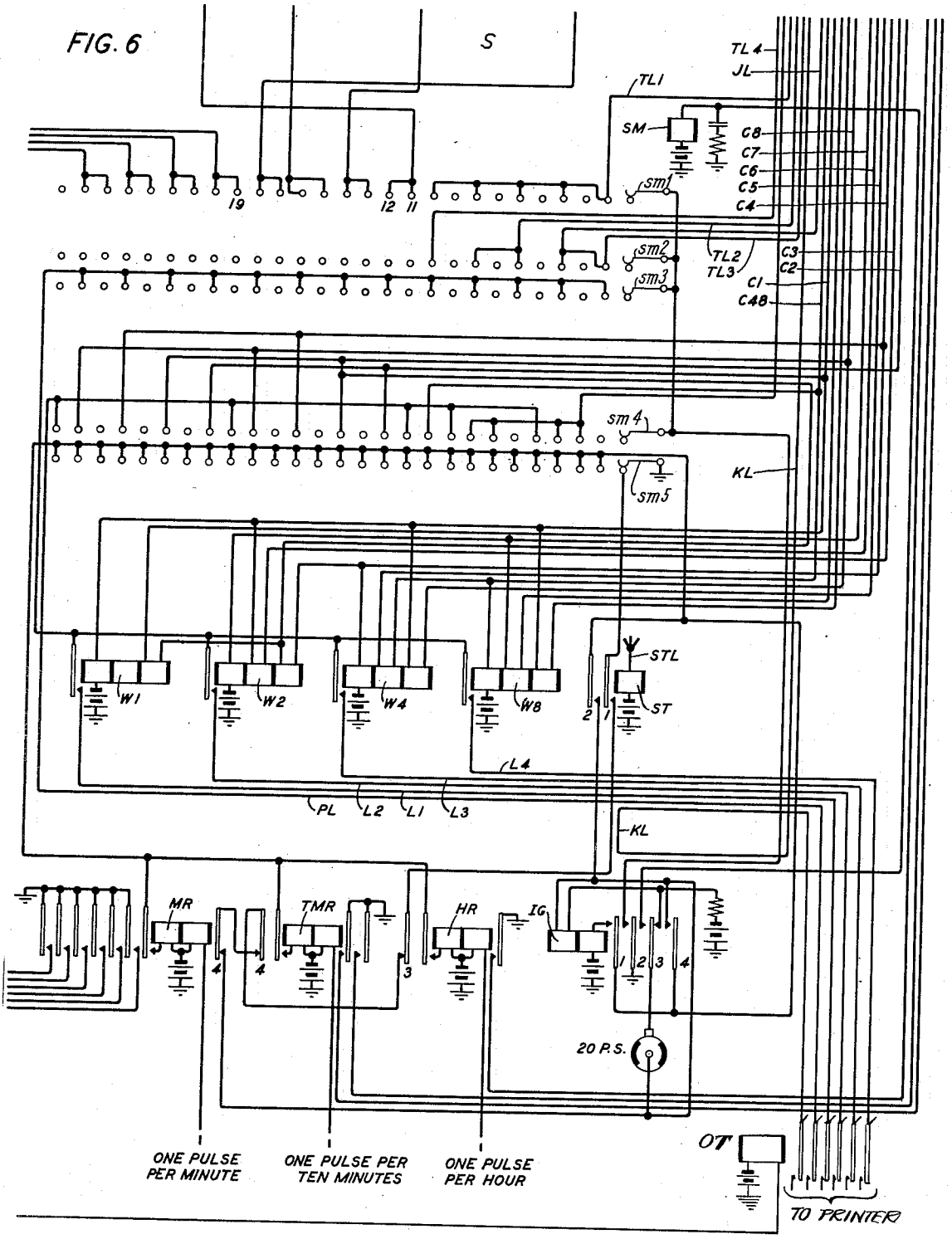
ELECTRICAL CALCULATING EQUIPMENT FOR TELEPHONE SYSTEMS

Filed Feb. 16, 1939 6 Sheets-Sheet 6

FIG. 6



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UNITED STATES PATENT OFFICE

2,253,596

ELECTRICAL CALCULATING EQUIPMENT FOR TELEPHONE SYSTEMS

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Application February 16, 1939, Serial No. 256,651
In Great Britain April 1, 1938

13 Claims. (Cl. 179—7.1)

This invention relates to telephone systems and more particularly to electrical calculating equipment for use in conjunction with automatic ticketing facilities associated with telephone lines.

The object of the invention is to provide common calculating equipment capable of performing several calculations simultaneously and/or of transmitting the results of different calculations simultaneously to a number of associated circuits.

One feature of the invention comprises electrical calculating equipment comprising a number of register circuits adapted to register different variable digital values (e. g., times, numbers, etc.) and an associated calculating circuit arranged to register a digital value (e. g., time, number, etc.) and adapted to perform simultaneously similar calculations (e. g., subtraction) between the digital value recorded in the calculating circuit and each digital value registered in a plurality of register circuits.

Another feature of the invention comprises electric calculating equipment including a digit transmitting circuit adapted to transmit, in turn, code impulses the different combinations of which are characteristic of every possible value of a digit, a number of digit receiving circuits, and connecting devices for selectively connecting different selections of the digit receiving circuits to the digit transmitting circuit while each code impulse is being transmitted, whereby the receiving circuits can receive simultaneously different code impulse combinations characteristic of different values of a digit.

The invention will be described in relation to automatic telephone systems in which information regarding long distance calls is to be automatically recorded for tariff purposes on the so-called automatic ticketing basis. In such systems, it is proposed to store the calling and called parties' numbers and the duration of a telephone connection during conversation to print a ticket after conversation ceases. It is also desired, in such circumstances, to print the duration of the call for each connection, and the embodiment of the invention to be described below includes a calculating circuit which comprises switches that record the time of day to within a minute and are arranged to be connected to any one or more conversation circuits, conversation over which ceases at about the same time to perform simultaneously subtractions of the conversation duration times recorded in these waiting conversation circuits from the actual time of day, and to transmit the different originating times simultaneously to the different conversation circuits for printing on the corresponding tickets.

The invention will be clearly understood from the following description of the embodiment shown in the accompanying drawings in which:

Fig. 1 shows a switch and an associated circuit that controls the transmission and printing of the various digits relating to the originating time;

Figs. 1 to 4, inclusive, show six minute switches A—F. These switches in conjunction with each other will determine the conversation time for a period not exceeding fifty minutes. The connections to and the multiplying of the six switches are indicated in Figs. 1 and 2;

Fig. 5 shows two ten-minute switches T1 and T2 and an hour switch H; and

Fig. 6 shows the sequence switch S for controlling the operation of the circuit.

To completely disclose the invention, Figs. 1, 3 and 5 should be placed side by side in the order named with Figs. 2, 4 and 6 placed beneath Figs. 1, 3 and 5, respectively.

A master clock (not shown) steps switches A—F each minute, switches T1, T2 each ten minutes and switch H once an hour through the operation of relays MR, TMR, and HR. When switches A—F, T1 and T2 are all in their normal positions, the time is between an exact hour and one minute past the hour. Switch H is in normal position between minutes 59 and 1. Groups of six contacts of switches T1, T2 are multipled, and groups of twelve contacts in the upper four banks of switch H are multipled.

The associated conversational circuits (not shown) comprise 50-point duration-recording switches arranged to be stepped for each minute of conversation, as, for instance, the switch represented by the designation DUR, the arm of which is stepped a terminal per minute by clock-driven means (not shown) as soon as the called subscriber removes the receiver from the switch-hook. Marking leads extend from marking banks of said switches to a marking multiple the wires of which are connected to the banks of the six 10-wiper 10-point minute switches A—F. Multiple wires 0—9 are connected to the contacts 0—9 in bank level *am*0, and the contacts in bank levels *am*0—*am*9 are multipled in the staggered manner shown in Fig. 1. The switches A—F take care of less than ten-minute intervals and the multiple from contact 0 of level *am*0 is connected to ten different positions in the ten different levels of switch A. Contacts 1—9 in bank level *bm*9 are also connected to the multiple wires 1—9 and these contacts are multipled to con-

tacts in other bank levels of switch B so that each multiple wire 1—9 has a connection to ten different positions in ten different bank levels of switches A and B, the zero multiple wire being multipled in switch A only. The multiple wires 10—19 are similarly connected to multipled groups of contacts in switches B, C, wires 11—19 being connected to contacts 1—9 of bank level *cm*9 as well as to contacts 10—19 of bank level *bm*0. Similarly multiple wires 20—29 are connected to switches C, D; 30—39 to switches D, E; 40—49 to switches E, F. Only that portion of the bank of F corresponding to the unused portion of the bank of A is used.

The wipers of switch A are connected to front contacts of a group of relays A1, A2, A4, A8, the wipers of switch B to the front contacts of relays B1, B2, B4, B8, . . ., and the wipers of switch F to front contacts of relays F1, F2, F4, F8.

The groups of relays A1—A8, . . . F1—F8 are each connected to multipled contacts of the banks of the ten-minute switches T1 and T2 in such a manner that they are allocated to the six different ten-minute intervals in an hour, the A relays being allocated to the intervals 0—9, . . ., and the F relays to the interval 50—59.

The maximum call duration which we are considering is fifty minutes and, therefore, if the time at the end of a connection is between 0—50 minutes past the hour, e. g., 10.24, the call may have started before or after 10 o'clock. If the time at the end of conversation is between 0—10 minutes past the hour then a call of almost any duration within the fifty-minute interval may have started before the hour and so on. For different purposes which will appear later, the switches T1 and T2 are arranged to operate the relay groups A1—A8, etc., in different positions.

Ten-minute switch T1 is arranged to operate over its wipers groups of relays corresponding to the ten-minute intervals or fraction thereof included in the actual time; thus in position 1 the A relays only can be operated, in position 2 the A and B relays can be operated, while in position 6 all the relay groups can be operated.

Ten-minute switch T2 is arranged to operate the relay groups corresponding to ten-minute intervals greater than that which includes the minute portion of the actual time; thus in position 1 (actual time between 0—10 minutes past the hour) the B—F relay groups can be operated, while in position 6, no relay groups are operated.

If the hour of the actual time is 1 or 10, the preceding hour differs therefrom in number of digits. Wipers *hm*3, *hm*4 of hour switch H take care of variations in the first digit. This switch is standing in the first position 1 between the hours of 1 and 2. Bank *hm*4 is arranged to give the first digit for the hour preceding the actual time, so that contacts 1, 11 and 12 are connected to code wire C1 for initiating registration of digit 1 for the first digit, while contacts 2—10 are connected to code wide C48 for initiating the registration of a space after the first digit.

Bank *hm*3 gives the first digit of the actual hour, so that contacts 1—9 are connected to C48 and 10, 11 and 12 to C1.

Banks *hm*1, *hm*2 take care of the second digit of the hour, bank *hm*1 for the actual hour, bank *hm*2 for the preceding hour. The wires C1—C0 from banks *hm*1, *hm*2 are connected to wires C1—C0 in the circuits of code relays W1—W4, Fig. 6.

The circuit has to be able to give a correct indication simultaneously to different connections which finish substantially simultaneously even though the durations of said different connections are all different. The conversation circuits which are provided with the duration recorders are associated with printers, for instance, automatic ticketing printers on which the time of start of the connections among other data is to be recorded.

The digits to be printed are sent to the printer via the conversation circuit by a four-unit code over wires L1—L4, Fig. 6, under control of code relays W1—W4. It will be seen that for digit 1, W1 alone is operated, and earth is connected to L1 only. For digit 5 (4+1), W4 and W1 are operated, and earth is connected to L1 and L3. For a spacing signal, relays W4, W8 are operated and earth is connected to L3, L4.

The time switches are stepped by means of minute, ten-minute, and hour relays MR, TMR, HR, respectively, which receive a short pulse at the end of each corresponding time period. If a pulse is received by one or more of these relays while the circuit is in use, the relay or relays lock to off-normal bank *sm*5 of the sequence switch S and, therefore, the time switches cannot be stepped until sequence switch S again reaches normal.

Thus the time recorded when the circuit is seized is maintained in the circuit until it has been recorded by the printer associated with the conversation circuits.

Leads TL1, TL2, TL3, Fig. 6, are connected to three armatures of relay T in Fig. 5. When an indication is required from one or more conversation circuits, the wire STL is grounded, the relay ST operates and a circuit is provided, battery through the left winding of relay IG through contacts 4 of relay MR, contacts 4 of relay TMR, contacts 3 of relay HR, contacts 1 of relay ST and the home position of wiper *sm*5 to ground. The left winding of IG is short-circuited by the springs 20.PS of an interrupter machine while these springs are closed. When the springs open, IG operates and locks through its right winding and No. 1 contacts, No. 4 contacts in parallel with the No. 2 contacts of relay ST over the previously traced circuit to ground on *sm*5 in its normal position.

The No. 3 contacts of relay IG open the short-circuiting path across the left winding of IG and complete the circuit for the magnet SM which is impulsed by the interrupter contacts 20.PS to step switch S. This circuit extends from ground at the normal contact of *sm*5 over the No. 1 contacts of ST, the No. 3 contacts of HR, the No. 4 contacts of TMR, the No. 4 contacts of MR, interrupter contacts 20.PS, No. 3 contacts of IG to battery through the winding of SM. When the switch advances to position 2, wiper *sm*1 extends ground via the No. 2 contacts of IG, lead TL1, No. 1 back contact of relay T, Fig. 5, through the No. 4 back contact of relay N, No. 3 back contact of P, No. 2 back contact of M, No. 5 back contact of N and No. 4 back contact of P to the wipers *tm*21—*tm*25, respectively. At the same time wiper *sm*2 extends ground via the No. 2 contacts of IG, lead TL3, No. 3 back contacts of relay T, Fig. 5, to wiper *hm*4. In this position 2 of sequence switch S, a spacing code is offered to the conversation circuits if the hour is 2—10, and digit 1 if the hour is 1, 11 or 12. Ground connected to wiper *hm*4 is thus connected to conductor *c*1 or *c*48 and operates relay W1 or relays W4 and W8. This is for the first digit of the preceding hour; that is, the hour in

which conversation commenced over the conversation circuit.

For these preceding hour codes to be required by a conversation circuit, the duration of call recorded therein must be greater than the number of minutes past the hour recorded on switches T1, T2, A—F. It will be recalled that ground is connected in parallel to wipers *tm21*—*tm25*. Assume that the time is 10:24 and that switch T2 will be standing on its No. 3 contacts. Relay groups D1—D8, E1—E8, F1—F8 will, therefore, become energized and connect earth to all wipers of switches D, E, F. The switches A—F are standing on their No. 5 contacts and, therefore, ground via switch D will be connected to leads 25—34, via switch E to leads 35—44 and via switch F to leads 45—49.

If, therefore, the duration switch of any conversation circuit waiting for an indication is recording more than twenty-four minutes of conversation, relay OT will be operated via the duration switch DUR to connect up code responsive relays or printer magnets to leads L1—L4. The digit 1 or the space code will, therefore, be recorded ready for printing. If the duration recorder of a waiting conversation circuit is recording twenty-four minutes or less, its relay OT will not be operated and the code connected to L1—L4 will not be received thereby.

The offering of the above code takes place in position 2 of sequence switch S. When S moves to position 3, relay groups D, E, F and the operated code relays are released, and relay T is energized in a circuit over wiper *sm4* to ground at the No. 2 contact of relay IG and switches lead TL1 to wipers *tm10*—*tm15* of switch T1, lead TL2 to wiper *hm1* of switch H and lead TL3 to wiper *hm3* of switch H.

When switch S moves to position 4, relay T remains energized and ground is again connected to leads TL1, TL3. Ground via TL1, No. 1 front contact of relay T, and wipers *tm10*—*tm15* operates relay groups A, B, C instead of D, E, F as before. Ground via TL3 and the No. 3 front contact of relay T grounds C1 or C48 according to the actual hour recorded instead of the preceding hour.

Switch A grounds leads 0—4, switch B grounds leads 5—14 and switch C grounds leads 15—24 to the duration-recording switches of the associated conversation circuits. The code receiving equipment of waiting conversation circuits in which durations of twenty-four minutes or less is recorded will be connected up by their respective relays OT operated from ground via the corresponding one of leads 0—24.

When switch S steps to position 5, relay T, relay groups A, B, C and the operated code relays release. Ground is now connected via No. 2 contact of relay IG, wiper *sm4* and lead PL to the waiting conversation circuits to cause the recorded digit or space to be printed.

Thus if the conversation duration is more than twenty-four minutes and the actual time is less than twenty-four minutes past any hour, the conversation must have started in the preceding hour and consequently if the actual time is either 1, 11 or 12 o'clock a first digit 1 for the preceding hour 12, 10 or 11 will be printed, but if the actual time is either 2, 3, 4, 5, 6, 7, 8, 9 or 10 o'clock a space will be printed as the preceding hour will be 1, 2, 3, 4, 5, 6, 7, 8 or 9 o'clock and no first digit will be required. If the conversation duration is less than twenty-four minutes past any hour and the actual time is twenty-four or more minutes past the same hour, the conversation must have started in the current hour and consequently if the actual time is either 10, 11 or 12 o'clock a first digit 1 will be printed, but if the actual time is at 1, 2, 3, 4, 5, 6, 7, 8, or 9 o'clock a space will be printed as no first digit will be required.

When switch S steps to position 6, ground is connected to leads TL1, TL2 instead of to leads TL1, TL3. Relay T is not operated so that, as before, relays groups D, E, F are operated via TL1. Ground via TL2, No. 2 back contact of relay T and wiper *hm2* operates a combination of code relays W1—W4 for the second or only digit of the preceding hour and this code is registered by waiting conversation circuits in which a call duration of more than twenty-four minutes is recorded.

In position 7 switch S operates relay T and releases relay groups D, E, F and the operated code relays. In position 8, relay T remains operated so that relay groups A, B, C energize and, over conductor TL2 and wiper *hm1*, code relays for the second or only digit of the actual hour are operated, and signal said digit to waiting circuits in which a call duration of twenty-four minutes or less is recorded. In position 9, a printing signal is sent via PL to the waiting circuits to cause the second or only digit to be printed.

Thus if the conversation duration is more than twenty-four minutes and the actual time is less than twenty-four minutes past any hour, then if the actual time is either 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 or 12 o'clock, a second digit 2, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0 or 1 respectively will be printed but, if the conversation duration is less than twenty-four minutes past any hour and the actual time is twenty-four or more minutes past the same hour, then for the actual hours 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 or 12, a second digit 1, 2, 3 4 5, 6, 7, 8, 9, 0, 1 or 2, respectively, will be printed.

In this way the actual hour or the preceding hour registered by switch H has been recorded in automatic ticketing printers associated with waiting conversation circuits according to the individual duration records in said conversation circuits.

Sequence switch S now steps to position 10 in which relay T is not operated and all the relay groups A—F are operated by ground applied to all wipers of the switches T1, T2 and over conductors TL1 and TL4 code relays W4 and W8 are operated by ground applied over wiper SM4 to conductor C48. The connecting relays of all waiting conversation circuits are operated and a space code is registered by said circuits.

In position 11, all relay groups and code relays are released and an "operate" signal is sent via PL to cause the printers to space and to release the connecting relays. Relay M is operated in this position to prepare for recording of the tens minute digits of the originating times.

Switch T1 is used to control the tens digit if the conversation originating time was in the same hour as the conversation time. Wiper *tm10* controls digit value 0, *tm11* value 1, *tm12*—*tm15* values 2—5, respectively.

Switch T2 controls the tens digit if the originating conversation time was in the hour preceding the conversation terminating time. As the maximum conversation duration which can be recorded is fifty minutes, 00–99 minutes in the preceding hour is impossible and, therefore, the five levels of T2 are sufficient, *tm21*—*tm25* controlling tens digit values 1—5 respectively.

In determining the tens and units minute digit values, a subtraction has to be automatically made of the conversation duration from the record of conversation termination time. This is performed in four stages, and the complete code for a digit value may be sent in one, two or three stages. In positions 12, 14, 16, 18, respectively, of switch S, code relays W1, W2, W4, W8 are individually operated. These relays send individual signals over corresponding wires L1—L4, the individual signals signaling a digit value 1, 2, 4, 8, respectively. If the tens digit to be sent is 3, 5, 6, 7, 9, or 0, signals must be sent over two or more wires; for 3, signals over L1, L2 in positions 12 and 14; for 5, signals over L1, L3 in positions 12 and 16; for 6, signals over L2, L3 in positions 14 and 16; for 7, signals over L1, L2, L3 in positions 12, 14 and 16; for 9, signals over L1, L4 in positions 12 and 18; for 0, signals over L2, L4 in positions 14 and 18. The above code in tabular form is as follows:

Code

Relays	Leads	Digit
W2, W8	L2, L4	0
W1	L1	1
W2	L2	2
W1, W2	L1, L2	3
W4	L3	4
W1, W4	L1, L3	5
W2, W4	L2, L3	6
W1, W2, W4	L1, L2, L3	7
L4	L4	8
W1, W4	L1, L4	9

It will be seen that for every odd digit value, a signal must be sent in position 12; the operation of relay M, therefore, connects ground to the odd numbered wipers of both switches T1, T2. If the originating time of a call was fifty minutes or more past the hour in which the call has terminated, the call duration must have been less than ten minutes; therefore, in bank *tm*15 of switch T1 only the No. 6 contact is connected up and this only operates the A group of relays for checking whether the call duration was less than ten minutes. If the originating time was between ten and nineteen minutes past the same hour that the call terminates, the terminating time may be between eleven, say, and fifty-nine and the duration must have been less than ten minutes if T1 is on contact 2 so that the A group of relays is operated, and so on, the duration being less than forty-nine if T1 is on contact 6, that is, indicating a terminating time of fifty minutes or more past the hour.

Similarly with T2. If the originating time of a call was less than twenty minutes past the preceding hour in which the call terminates, the terminating time cannot be greater than nine minutes past the following hour and, therefore, only the first (and multipled) position of *tm*21 is connected up and that is connected to the F group of relays as the duration must have been forty-one minutes or more. If the originating time of a call was between 30—39 minutes past the preceding hour, then the terminating time cannot be more than twenty-nine minutes past the hour and, in consequence, only the first three contacts of *tm*23 are connected up and these energize respectively the D, E, F groups of relays according as the terminating time is 0—9; 10—19; and 20—29 minutes past the hour.

Let us take the previous assumption of a terminating time of 10:24. The wipers of switches T1, T2 are on contacts 3 and when relay M is energized in position 11 of switch S the relay groups B via wiper *tm*11, D via wiper *tm*25, and F via wiper *tm*23, are energized.

Switches B, D, F are on contacts 5 and, therefore, earth will be connected to leads 5—14; 25—34, and 45—49.

If as assumed the actual time is twenty-four minutes after 10 o'clock and a duration switch has advanced to connect with any lead between 5 and 14 indicating a conversation duration of five to fourteen minutes, the actual starting time for the conversation must lie between 24—14 and 24—5 minutes after 10 o'clock or between 10:10 and 10:19, or if the switch has advanced to connect with any lead between 25 and 34, indicating a conversation duration of twenty-five to thirty-four minutes, the actual starting time for the conversation must lie between 24—34 or —10 and 24—25 or —1 minutes before 10 o'clock or in fact between 9:50 and 9:59; or if the switch is advanced to connect with any lead between 45 and 49 indicating the conversation duration of forty-five to forty-nine minutes, the actual starting time for the conversation must lie between 24—49 or —25 and 24—45 or —21 minutes before 10 o'clock or in fact between 9:35 and 9:39.

If the duration switches of any waiting conversation circuit are standing on the corresponding contacts they will receive ground via switch B, D or F and their duration switches to operate their respective connecting relays which connect up their code register magnets to receive the pulse on L1 to record the digit 1 as the total code of the tens digit for those duration switches which are connected to leads 5—14; as part of the code of the digit 5 for those duration switches which are connected to leads 25—34; and as part of the code of the digit 3 for those duration switches which are connected to leads 45—49.

When sequence switch S steps to position 13, relay M and relay groups B, D, F are released as well as the connecting relays of the waiting conversation circuits.

Relay N is operated in position 13, remains operated when switch S steps to position 14 and connects ground to *tm*10, *tm*12, *tm*13, *tm*22 and *tm*23, and relay W2 is operated to offer a ground pulse on lead L2 (digit value 2), required for originating tens minute digit values, 0, 2, 3 for past 10 o'clock, and 2, 3 for past 9 o'clock. With switches T1 and T2 in position 2 the C, A, F relay groups are operated. With switches A, C, F in position 5, leads 0—4; 15—24; 45—49 are grounded. These duration times give corresponding originating times 10:20—10:24; 10:00—10:09; 9:35—9:39, for which alone signal L2 is required as the total code of the digit for the times 10:20—10:24, as part of the code for the digit 0 for the times 10:00—10:09 and as part of the code of the digit 3 for the times 9:35—9:39. Those conversation switches of which the duration switches are standing on any one of contacts 0—4; 15—24; 45—49, therefore, receive the "2" code over wire L2.

When sequence switch S moves to position 15, relays N and W2 and the A, C, F relays release. Relay P operates and remains operated when switch S steps to position 16 in which position relay W4 is operated to offer the "4" code signal over L3 to the waiting conversation circuits.

Relay P grounds wipers *tm*14, *tm*15, *tm*24 and *tm*25 corresponding to originating times of 40—49 minutes past the hour and the preceding

hour, 50—59 minutes past the hour and the preceding hour.

With switches T1 and T2 in position 3, relay groups D and E are operated so that switches D, E are rendered effective. No relay groups are operated via switch T1 because an originating time between 10.40 and 10.59 is, of course, impossible. Ground via wipers of switches D and E is connected to leads **25—34** and **35—44**. Durations of 25—44 minutes give an originating time of 40—59 minutes past nine and, therefore, a signal over lead L3 as the complete code of the tens digit 4 for the times 9:40—9:49 and as part of the code of the tens digit 5 for the time 9:50—9:59.

Once again, connecting relays of waiting conversation circuits may be operated; this time if their duration switches record durations of 25—44 minutes. Such circuits will record the "4" signal over wire L3.

When switch S steps to position 17, relays P and W4, and relay groups D, E release, relay Q is operated and remains operated when switch S steps to 18, in which position relay W8 is operated. The "8" code is only required for digit 0 (the other part of the code for this digit being L2) and, therefore, relay Q only grounds wiper *tm*10 to operate relay group C1—C8 so that leads **15—24** only are grounded. Duration times of 15—24 mean an originating time range 10:00—10:09, and the "8" code signal via L4 is sent to the waiting conversation circuits which require it. The code registers of waiting conversation circuits may, therefore, have any one of the following relay or magnet combinations energized: 1, 2, 1 and 2, 4, 1 and 4, and 2 and 8.

When switch S steps to position 19, relays Q and W8 and relay group C1—C8 release, and a printing signal is sent via PL to cause the registered digits to be printed and the registers released.

In addition, in position 19, relays A1, B1,—F1 are operated over their left windings. Taking B1 as an example, it grounds wipers *bm*1, *bm*3, *bm*5, *bm*7 and *bm*9 of switch B and, taking position 5 for the units digit of the terminating time, if any duration switch is standing on its terminal connected to lead 13, indicating a duration time of thirteen minutes, the actual starting time must be then 10:24—13 or 10:11 thus closing a circuit from ground over bank level *bm*1 for preparing the conversation circuit to register the code digit "1" as a part of the units digit registration 3; if any duration switch is standing on its terminal connected to lead 11, indicating a duration time of eleven minutes, the actual starting time must be then 10:24—11 or 10:13 thus closing a circuit from ground over bank level *bm*3 for preparing the conversation circuit to register a code digit "1" as a part of the units digit registration 3; if any duration switch is standing on its terminal connected to lead 9, indicating a duration time of nine minutes, the actual starting time must have been 10:24—9 or 10:15, thus closing a circuit from ground over bank level *bm*5 for preparing the conversation circuit to register a code digit "1" as a part of the units digit registration 5; if any duration switch is standing on its terminal connected to lead 7, indicating a duration time of seven minutes, the actual starting time must have been 10:24—7 or 10:17, thus closing a circuit from ground over bank lever *bm*7 for preparing the conversation circuit to register a code digit "1" as a part of the units digit registration 7 or if any duration switch is standing on its terminal connected to lead 5, indicating a duration time of five minutes, the actual starting time must have been 10:24—5 or 10:19, thus closing a circuit from ground over bank level *bm*9 for preparing the conversation circuit to register a code digit "1" as a part of the units digit registration 9.

Similarly, the other relays A1, C1, D1, E1, and F1 will cause the preparation of circuits to prepare conversation circuits to register a units code digit "1" if any duration switch has been set to an odd numbered terminal indicating a duration time having an odd number of minutes. If, however, the actual or terminating time has an odd number of minutes, ground will be connected by the operation of these relays to even numbered terminals of the duration switches and when therefore any duration switch is set upon an even numbered terminal a circuit will be prepared to a register for registering the code digit "1". As an example assume that the terminating time is 10:25 and that a duration switch is set upon a terminal connected to lead **14**, indicating a duration time of fourteen minutes, then the starting time must have been 10:25—14 or 10:11 and the operation of relay B1 will therefore establish a circuit from ground over the position 6 terminal of the bank *bm*1, lead **14** and thence to the conversation circuit for preparing the register thereof to register the code digit "1".

When switch S steps to position 20, relay W1 is operated and the "1" code signal is received by waiting conversation circuits, the duration switches of which are registering an "odd" minutes duration.

Switch S then steps to **21** in which the A1—F1 relays and relay W1 are released and the A2—F2 relays are energized to ground the 0, 2, 3, 6 and 7 wipers of the switches A—F. Contacts of relay B2 ground level *bm*0 to subtract duration units equal to the terminating time units recorded on B thus giving an originating time minutes unit 0.

Contacts of relay B2 ground level *bm*2 to subtract units digits two less than those recorded, thus giving an originating time minutes unit 2.

Contacts of relay B2 ground *bm*3, *bm*6, *bm*7 to subtract respectively: units digits 3 less than those recorded; units digits 6 less; and units digits 7 less than those recorded.

Considering the operation of relay B2, if the terminating time is for example 10:20 and switch B is therefore in position 1 and any duration switch is standing on its terminal 10, indicating a duration time of ten minutes, the starting time must have been 10:20—10 or 10:10, or if the terminating time is for example 10:21 and switch B is therefore in position 2 and any duration switch is standing on its terminal 11, indicating a duration time of eleven minutes, the starting time must have been 10:21—11 or 10:10. In either case a circuit is closed from ground over bank level *bm*0 for preparing the associated conversation circuit to register a code digit "2" as a part of the units digit registration 0. If the terminating time is for example 10:22 and switch B is in position 3, and any duration switch is standing on its terminal 10, indicating a duration time of ten minutes, the starting time must have been 10:22—10 or 10:12 or if the terminating time is for example 10:23 and switch B is in position 4 and any duration switch is standing on its terminal 11, indicating a duration time

of eleven minutes, the starting time must have been 10:23—11 or 10:12. In either case a circuit is closed from ground over bank level *bm2* for preparing the associated conversation circuit to register a code digit "2". If the terminating time is, for example, 10:24 and switch B is in position 5 and any duration switch is standing on its terminal 11, indicating a duration time of eleven minutes, the starting time must have been 10:24—11 or 10:13 or if the terminating time is for example 10:25 and switch B is in position 6 and any duration switch is standing on its terminal 12, indicating a duration time of twelve minutes, the starting time must have been 10:25—12 or 10:13. In either case a circuit is closed from ground over bank level *bm4* for preparing the associated conversation circuit to register a code digit "2" as a part of the units digit registration "3". If the terminating time is for example 10:26 and switch B is in position 7, and any duration switch is standing on its terminal 10, indicating a duration time of ten minutes, the starting time must have been 10:26—10 or 10:16 or if the terminating time is for example 10:27 and switch B is in position 8 and any duration switch is standing on its terminal 11, indicating a duration time of eleven minutes, the starting time must have been 10:27—11 or 10:16. In either case the circuit is closed from ground over bank level *bm6* for preparing the associated conversation circuit to register the code digit "2" as a part of the units digit registration "6". If the terminating time is for example 10:28 and switch B is in position 9 and any duration switch is standing on its terminal 11, indicating a duration time of eleven minutes, the starting time must have been 10:28—11 or 10:17 or if the terminating time is for example 10:29 and switch B is in position 10 and any duration switch is standing on its terminal 12, indicating a duration time of twelve minutes, the starting time must have been 10:29—12 or 10:17. In either case a circuit is closed from ground over bank level *bm7* for preparing the associated conversation circuit to register a code digit "2" as a part of the units digit registration 7. Other similar circuits are prepared in the several positions of switch B over its grounded wipers for preparing the associated conversation circuits to register the code digit "2".

Relays A2, C2, D2, E2 and F2 function in a similar manner. Thus connecting relays are operated in waiting conversation circuits, the originating conversation times for which have a units minutes digit 0, 2, 3, 6, or 7 for preparing such circuits to receive the "2" code signal. When thereafter switch S advances into position 22, code relay W2 is operated and relays A2 to F2 remain operated. With relay W2 operated, conductor L2 is grounded and the code signal "2" is thereby registered in all prepared conversation circuits.

In position 23 of switch S relays A4 to F4 are operated to connect ground to the 4, 5, 6 and 7 wipers of switches A to F and relays A2 to F2 and relay W2 are released. Taking relay B4 as an example, if the terminating time is 10:20 and switch B is therefore in position "1" and any duration switch is standing on its terminal 6, indicating a duration time of six minutes, the starting time must have been 10:20—6 or 10:14, or if the terminating time is for example 10:21 and switch B is therefore in position "2" and any duration switch is standing on its terminal 7, indicating a duration time of seven minutes, the starting time must have been 10:21—7 or 10:14. In either case a circuit is closed from ground over bank level *bm4* for preparing the associated conversation circuit to register a code digit "4". If the terminating time is for example 10:22 and switch B is in position "3" and any duration switch is standing on its terminal 7, indicating a duration time of seven minutes, the starting time must have been 10:22—7 or 10:15 or if the terminating time is for example 10:23 and switch B is in position "4" and any duration switch is standing on its terminal 8, indicating a duration time of eight minutes, the starting time must have been 10:23—8 or 10:15. In either case a circuit is closed from ground over bank level *bm5* for preparing the associated conversation circuit to register a code digit "4" as a part of the units digit registration 5. If the terminating time is for example 10:24 and switch B is in position "5" and any duration switch is standing on its terminal 8, indicating a duration time of eight minutes, the starting time must have been 10:24—8 or 10:16 or if the terminating time was for example 10:27 and switch B is in position "8" and any duration switch is standing on its terminal 11, indicating a duration time of eleven minutes, the starting time must have been 10:27—11 or 10:16. In either case a circuit is closed from ground over bank level *bm6* for preparing the associated conversation circuit to register a code digit "4" as a part of the units digit registration 6. If the terminating time is for example 10:25 and switch B is in position "6" and any duration switch is standing on its terminal 8, indicating a duration time of eight minutes, the starting time must have been 10:25—8 or 10:17 or if the terminating time is for example 10:28 and switch B is in position "9" and any duration switch is standing on its terminal 11, indicating a duration time of eleven minutes, the starting time must have been 10:28—11 or 10:17. In either case the circuit is closed from ground over bank level *bm7* for preparing the associated conversation circuit to register a code digit "4" as a part of the units digit registration 7. Other similar circuits are prepared in the several positions of switch B over its grounded wipers and in the several positions of switches A, C, D, E and F over their grounded wipers for preparing associated conversation circuits to register the code digit "4".

Thus connecting relays are operated in waiting conversation circuits, the originating times of which have a units digit 4, 5, 6 or 7 for preparing such circuit to receive the "4" code signal. When thereafter switch S advances into position 24, code relay W4 is operated and relays A4 to F4 remain operated. With relay W4 operated conductor L4 is grounded and the code signal "4" is thereby registered in all prepared conversation circuits.

In position 25 of switch S, relays A4 to F4 and code relay W4 are released and relays A8 to F8 are operated to connect ground to the 0, 8 and 9 wipers of switches A to F. Taking relay B8 as an example, if the terminating time is 10:20 and switch B is in position 1 and any duration switch is standing in position 10, indicating a duration time of ten minutes, then the starting time must have been 10:20—10 or 10:10 or if the terminating time was 10:25 and switch B is in position 2, and any duration switch is standing on terminal 11, indicating a duration time of eleven minutes, then the starting time must have been 10:21—11 or 10:10. In either case a circuit is

closed from ground over wiper *bm0* for preparing the associated conversation circuit to register a code digit "8" as a part of the digit registration 0. If the terminating time is 10:22 and switch B is in position 3 and any duration switch is standing in position 14, indicating a duration time of fourteen minutes, then the starting time must have been 10:22—14 or 10:08 or if the terminating time is 10:23 and switch B is in position 4 and any duration switch is standing in position 15, indicating a duration time of fifteen minutes, then the starting time must have been 10:23—15 or 10:08. In either case a circuit is closed from ground over wiper *bm8* for preparing the associated conversation circuit to register a code digit "8". If the terminating time is 10:24 and switch B is in position 5 and any duration switch is standing in position 15, indicating a duration time of fifteen minutes, then the starting time must have been 10:24—15 or 10:09 or if the terminating time is 10:25 and switch B is in position 6 and any duration switch is standing in position 16, indicating a duration time of sixteen minutes, then the starting time must have been 10:25—16 or 10:09. In either case a circuit is closed from ground over wiper *bm9* for preparing the associated conversation circuit to register a code digit "8" as a part of the units digit registration 9. Other similar circuits are prepared in the several positions of switch B over its grounded wipers and in the several positions of switches A, C, D, E and F over their grounded wipers for preparing associated conversation circuits to register the code digit "8".

Thus connecting relays are operated in waiting conversation circuits, the originating times for which have a units digit 0, 8 or 9 for preparing such circuits to receive the "8" code digit signal. When thereafter switch S advances into position 26, code relay W8 is operated and relays A8 to F8 remain operated. With relay W8 operated, conductor L8 is grounded and the code signal "8" is thereby registered in all prepared conversation circuits.

To recapitulate in all conversation circuits which were prepared as above outlined to register the units digit 1 only, the code signal "1" will be registered; in circuits prepared to register the units digit 3, code signals "1" and "2" will be registered; in circuits prepared to register the units digit 5, code signals "1" and "4" will be registered; in circuits prepared to register the units digit 7, code signals "1", "2" and "4" will be registered; in circuits prepared to register the units digit "9", code signals "1" and "8" will be registered; in circuits prepared to register the units digit "2", code signal "2" will be registered; in circuits prepared to register the units digit "6", code signals "2" and "4" will be registered and in circuits prepared to register the units digit 0, code signals "2" and "8" will be registered. In position 27, a printing signal will be sent via PL to all waiting conversation circuits to print the digit corresponding to the registered code signal or signals and to release the register magnets. The conversation circuits then release relay ST. Switch S homes and releases IG. If one or more relays HR, TMR, MR have been operated and locked they are now released and the corresponding switches are stepped.

It is usual to charge different rates for calls initiated at different times of day on toll and trunk calls. For instance, there may be one rate from nine in the morning till 2 P. M., a cheaper afternoon rate from 2 P. M. till 7 P. M., and a special night rate from 7 P. M. till 9 A. M.

Wipers *hm5*, *hm6* of the hour switch H are arranged to signal the tariff rate by full ground, resistance ground, and absence of ground on a signal lead KL, Figs. 5 and 6, to the conversation circuits. In positions 2 and 4 of sequence switch S ground is connected via No. 2 contact of relay IG, wiper *sm2*, lead JL, to banks *hm5*, *hm6*. If the originating time was in the preceding hour and the tariff needs a positive signal, ground via JL is connected direct or through resistance RS, via *hm6*, No. 4 back contact of relay T, lead KL, Figs. 3 and 6, front contacts of the conversation circuit connecting relay to tariff rate relays when switch S is in position 2.

If the originating time was in the same hour as the terminating time, the connecting relays of the conversation circuit is not operated when T is normal but only when T is operated, and ground or resistance ground, if required, is connected to the tariff rate relays when switch S is in position 4 via wiper *hm5*.

The contacts of wipers *hm5*, *hm6* are differently wired to give the correct tariff rate for the same hour and preceding hour respectively.

Alternatively, a single wiper could be used merely to signal that, owing to the originating time being in the preceding hour, the tariff rate to be charged is different from that applying at the moment. The information given in this case may merely indicate a preceding tariff rate, or the actual tariff rate to be charged. This information may be used in any desired manner.

What is claimed is:

1. In a telephone system, settable means for denoting the elapsed time of a telephone conversation, settable means for denoting the hour and minutes digits of the terminating time of the conversation, means for calculating from said settings the starting time of the conversation and means controlled by said calculating means for producing code signals indicative of the digits of the hour and minute of said starting time.

2. In a telephone system, settable means for denoting the elapsed minutes of duration of a telephone conversation, settable means for denoting the hour and minutes digits of the terminating time of the conversation, means for subtracting the elapsed minutes setting from the terminating time setting for determining the hour and minute of the starting time of the conversation and means for producing code impulses indicative of the hour and minute of said starting time.

3. In a telephone system, settable means for denoting the elapsed minutes of duration of a telephone conversation, settable means for denoting the hour and minutes digits of the terminating time of the conversation, means for determining from the elapsed minutes setting if said conversation started in the same hour or in the hour preceding the terminating time, means for subtracting the elapsed minutes setting from the terminating minutes setting for determining the minutes digit of the starting time and means for transmitting code pulses indicative of the hour and minute of said starting time.

4. In a telephone system, a plurality of settable means for denoting the elapsed times of a plurality of simultaneously occurring telephone conversations and a calculating equipment common thereto comprising settable means for de-

noting the hour and minutes digits of the terminating time of said conversations, means for simultaneously calculating from said elapsed time setting and from said terminating time setting the starting times of all of said conversations and means for transmitting code impulses indicative of the digits of the hour and minute of each of said starting times.

5. In a telephone system, a plurality of settable means for denoting the elapsed minutes of duration of a plurality of simultaneously occurring telephone conversations and a calculating equipment common thereto comprising settable means for denoting the hour and minutes digits of the terminating time of said conversations, means for simultaneously subtracting each of said elapsed minutes settings from the terminating time setting for determining the hour and minute of the starting time of each of said conversations, and means for transmitting code impulses indicative of the digits of the hours and minutes of said starting times.

6. In a telephone system, a plurality of settable means for denoting the elapsed minutes of duration of a plurality of simultaneously occurring telephone conversations and a calculating equipment common thereto comprising settable means for denoting the hour and minutes digits of the terminating time of said conversations, means for simultaneously determining from said elapsed minutes setting if said conversation started in the same hour or in the hour preceding the terminating time, means for simultaneously subtracting the elapsed minutes settings from the terminating minutes setting for determining the minutes digit of the starting time of each of said conversations, and means for transmitting code impulses indicative of the digits of the hours and minutes of said starting times.

7. In a telephone system, a plurality of conversational circuits each having a device settable in accordance with the minutes of the duration of the conversation thereover and a calculating equipment common to said circuits comprising means settable in accordance with the hour and minute digits of the terminating time of conversations over said circuits, means for simultaneously determining from the setting of said duration conversation devices and from the setting of said terminating time devices the starting times of all of said conversations, means for transmitting series of code impulses indicative of the digits of the hour and minute of any staring time, different combinations of which impulses are characteristic of every possible value of each digit, and whereby said impulses are selectively transmitted in different code impulse combinations characteristic of different values of a digit for simultaneous reception by said plurality of conversational circuits.

8. In a telephone system, a plurality of conversational circuits each having a device settable in accordance with the minutes of the duration of a conversation thereover, and a calculating equipment common to said circuits comprising means settable in accordance with the hour and minute digits of the terminating time of conversations over said circuits, means for simultaneously determining from the setting of said duration conversation devices and from the setting of said terminating time devices the starting times of all of said conversations, means controlled by said calculating equipment for producing signal impulses indicative of the digits of the hour and minute of any starting time, different combinations of which impulses are characteristic of every possible value of each digit, and means for selectively transmitting said signal impulses to said conversational circuit.

9. In a telephone system, a plurality of conversational circuits each having a device settable in accordance with the minutes of the duration of a conversation thereover, means settable in accordance with the hour and minute digits of the terminating time of conversations over said circuits, means for simultaneously determining from the setting of said duration devices if said conversations started in the same hour or in the hour preceding the terminating time, means for producing series of code impulses in accordance with the digits of the hour and minute of any starting time, different combinations of which impulses are characteristic of every possible value of each digit, and means for controlling said impulse producing means for producing impulses indicative of the digits of the preceding hour when said preceding hour is the starting time of conversation.

10. In a telephone system, a plurality of conversational circuits each having a device settable in accordance with the minutes of the duration of the conversation thereover, and a calculating equipment common to said circuits comprising means settable in accordance with the hour and minutes digits of the terminating time of conversations over said circuits, means for simultaneously determining from the setting of said duration minutes means if said conversations started in the same hour or in the hour preceding the terminating time, means for producing series of code impulses indicative of the digits of the hour of any starting time, different combinations of which impulses are characteristic of every possible value of each digit, means for controlling said impulse producing means for producing codes of impulses indicative of the tens and units digits of the hour of the originating time in the preceding hour, and means for selectively transmitting said code signals to said conversational circuits.

11. In a telephone system, a plurality of conversational circuits each having a device settable in accordance with the minutes of the duration of a conversation thereover and a calculating equipment common to said circuits comprising means settable in accordance with the hour and minutes digits of the terminating time of conversations over said circuits, means for simultaneously subtracting duration minutes settings from the terminating minutes setting for determining the minutes digits of the starting time of each conversation, means for producing codes of impulses indicative of the tens and units digits of the minutes of any starting time, different combinations of which impulses are characteristic of every possible value of each digit, and means for selectively transmitting signals in accordance with the tens and units digits of the minutes of the starting hour of conversation over said conversational circuits.

12. In a telephone system, a plurality of conversational circuits each having a device settable in accordance with the minutes of the duration of a conversation thereover, and a calculating equipment common to said circuits comprising an hour switch settable in accordance with the hour, a plurality of multi-wiper switches settable in accordance with the tens digit of the minutes and a plurality of multiwiper switches settable in accordance with the units digit of the minutes

of the terminating time of conversation over said circuits, said latter switches having bank terminals in a plurality of their bank levels each allocated to a different possible settable position of said duration devices, a sequence switch, means under the joint control of said sequence switch and said hour switch for transmitting codes of impulses indicative of the digits of the hour of the terminating time and under the control of said sequence switch alone for transmitting codes of impulses indicative of the minutes of said hour, different combinations of which impulses are characteristic of every possible value of each digit, and a plurality of relays operable in different combinations under the joint control of said tens digit minute switches and said sequence switch and under the sole control of said sequence switch for selectively establishing partial signaling circuits to said conversational circuits over the bank levels of said units digit minute switches and a terminal of each of said duration switches.

13. In a telephone system, a first switch, means for advancing said switch in accordance with elapsed time intervals, a plurality of other switches, means for advancing said other switches in accordance with the hour and minute of elapsed time intervals, means for comparing the setting of said first switch with the settings of said other switches to determine the starting time of said first switch, and means controlled by said last-mentioned means for transmitting code signals indicative of the digits of the hour and minute of the starting time of said first switch.

ESMOND P. G. WRIGHT.