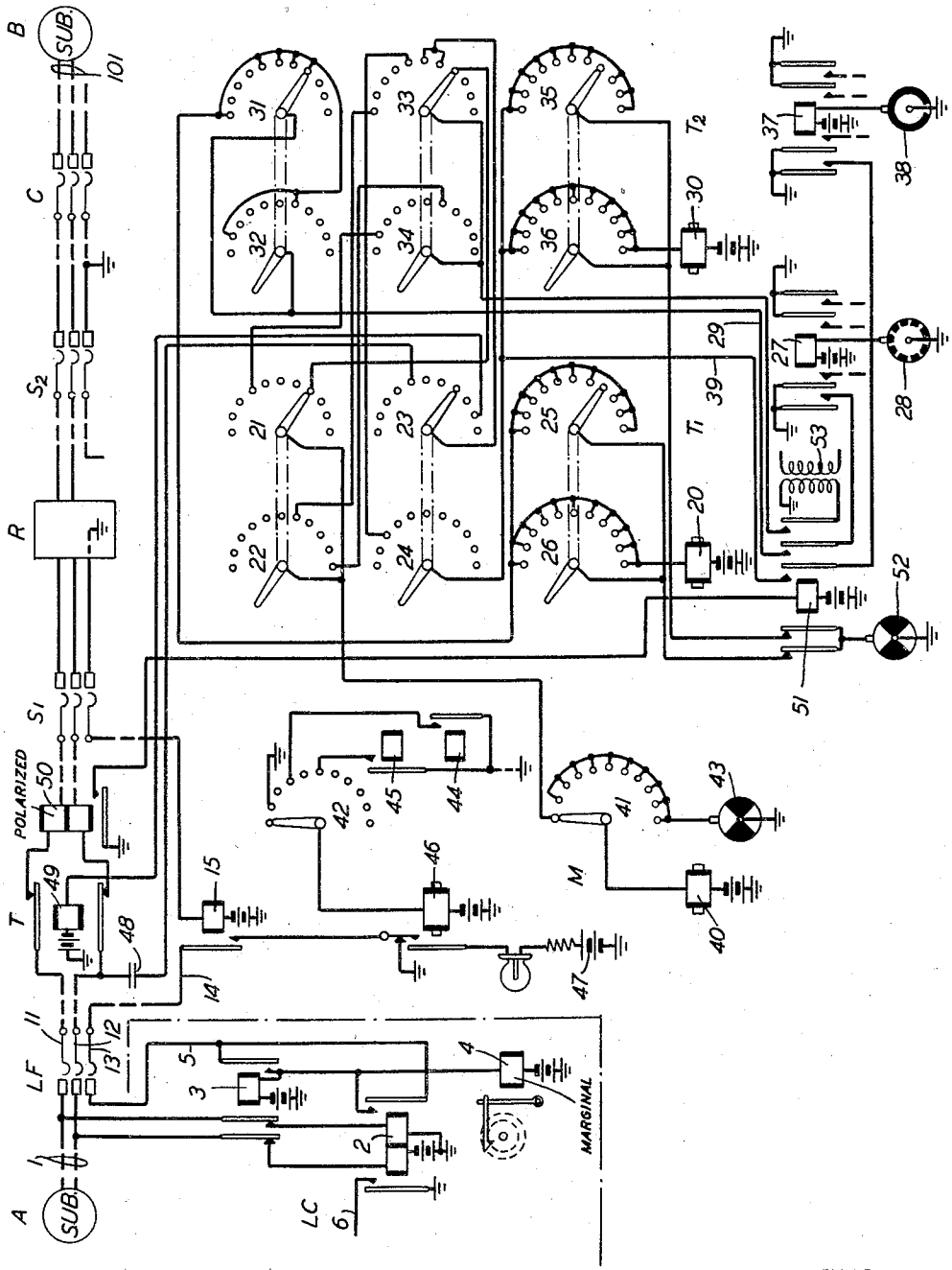
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TIME MEASURING DEVICE

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UNITED STATES PATENT OFFICE

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TIME MEASURING DEVICE

Application filed February 18, 1931, Serial No. 516,582, and in Great Britain March 5, 1930.

This invention relates to time measuring devices and more particularly to devices of this character when used in measured service telephone systems.

The object of the invention is to provide such systems with means for more accurately and reliably measuring and indicating the lapse of predetermined intervals of time.

A feature of the invention is a time measuring circuit for use in communication systems in which two or more switching mechanisms are each adapted to operate in accordance with periodic impulses of a relatively different character and are adapted for cooperating at predetermined positions to indicate the lapse of specific intervals of time.

According to another feature of the invention, a timing circuit is controlled by periodic impulses of two different frequencies to measure unit periods of conversation for which a subscriber is to be charged, the maximum variation in the initial unit period being equal to one cycle of the higher frequency.

According to another feature of the invention, the circuits of a telephone system are arranged for operating a calling subscriber's meter initially when a call is successfully established and thereafter at predetermined intervals according to the setting of a plurality of switching mechanisms which are adapted to advance at different speeds and to cooperate in effecting the necessary metering operations.

Another feature of the invention is a time measuring circuit, for a telephone system, in which two switching mechanisms cooperate in consequence of the answer of a called subscriber for effecting an initial registration on the calling subscriber's meter, for thereafter effecting additional registrations at predetermined intervals, and for initiating the release of the connection after a predetermined time has elapsed, said switching mechanisms being respectively controlled by impulses of different frequencies.

Another feature of the invention is a circuit arrangement, for a telephone system, in which a tone is transmitted to the calling subscriber after a predetermined interval of time has elapsed, said interval being measured by the cooperation of two switching mechanisms.

The features of this invention will be better understood from the following description of one method of carrying the invention into effect. It is understood, however, that this description is given by way of example only and that various modifications and other applications of the invention will readily occur to those skilled in the art.

The drawing, which forms a part of this description, diagrammatically represents an automatic telephone system arranged for message rate service. In the drawing, A and B represent subscribers' stations, LF represents a line-finder switch, T represents a trunk circuit arranged for zone metering, S1 represents a first selector switch, R represents an outgoing-trunk impulse repeater, S2 represents an incoming selector switch, and C represents a connector switch. Only those portions of the line-finder, selector and connector circuits are shown as are involved in the description of this invention, the omitted portion of these circuit units being represented by broken lines.

The line 1 at the calling station A is connected in the usual manner to a line relay 2, to terminals in the bank of a group of line-finder switches of which only the line-finder LF is shown, and to terminals in the bank of a group of connector switches, none of which are shown in the drawing. The meter 4 is connected in parallel with the cut-off relay 3 in the usual manner, the operation of line relay 2 being effective to connect their windings over conductor 5 to the sleeve terminal associated with the terminals of line 1 in the line-finder banks. The line-finder switches are of the well known Strowger type and reference may be had to Patent 1,711,682, issued May 7, 1929, to H. Hovland for a complete description of the operation of the line-finder circuit LF; the multiple brushes designated 11, 12 and 13 correspond to one of the two sets of multiple brushes shown in the Hovland patent.

The trunk circuit T, which is permanently associated with the line-finder LF and se-

lector S1, includes the polarized supervisory relay 50, a zone metering switch M, and two timing switches T1 and T2. The windings of supervisory relay 50 are connected in series with the line conductors of trunk T but this relay does not operate during the establishment of a connection until the current over the talking conductors is reversed in consequence of the answer of a called subscriber. The operation of relay 50 is effective to initiate the operation of the timing switches T1 and T2, these switches being arranged to respond to impulses from relays 27 and 37 to measure the initial and succeeding unit periods of conversation; the operation of relay 50 is also effective to initiate the operation of the metering switch M so as to close the circuit for operating the meter 4 the proper number of times as a charge for each period. The zone relays 44 and 45 are similar to the zone relays 21 and 22 in the copending application of R. L. Stokely Serial No. 482,699, filed September 18, 1930, and are similarly operated as soon as the calling line is extended to the repeater R; the operating circuits for these relays are not shown since they are only incidental to the description of this invention. On a call to subscribers in zone 1 neither of relays 44 or 45 is operated; on a call to zone 2, relay 44 is operated; and on a call to zone 3, relays 44 and 45 are both operated.

The timing switches T1 and T2 are of the unidirectional rotary type. Switch T1 includes stepping-magnet 20 and brushes designated 21 to 26 inclusive, and switch T2 includes the stepping-magnet 30 and brushes designated 31 to 36 inclusive, the advance of the brushes being effected by the release of the corresponding magnet. Each of the brushes of these switches has access to an arc of eleven terminals, the brushes being arranged in pairs so that one of the brushes of each pair makes contact alternately with the terminals in their respective arc during rotation. The odd numbered brushes of switches T1 and T2 are normally resting in position 8. The interrupters 28 and 38 are arranged to transmit impulses to operate relays 27 and 37, relay 27 being thus operated once every two seconds and relay 37 being thus operated once every thirty-six seconds; the operation of relay 37 occurs simultaneously with one of the operations of relay 27. The switch T2 is advanced one step by each operation of relay 37 after the called subscriber answers, but switch T1 is advanced by the operations of relay 27 only if switch T2 is in certain positions. The difference in the timing of the impulses from the two interrupters renders the cooperation of timing switches T1 and T2 effective to measure predetermined intervals of time.

The metering switch M is also a unidirectional rotary type switch having a stepping-magnet 40 and two brushes 41 and 42 the advance of the brushes being effected by the release of the magnet. The brushes are advanced one complete cycle to charge the calling subscriber for each unit period of conversation. When the called subscriber answers and the supervisory relay 50 operates, the metering switch is immediately advanced from its normal position to charge the calling subscriber for the initial unit period of conversation. If the call extends beyond the initial unit period, which may be three minutes, the metering switch is again advanced from its normal position to repeat the charge for the next unit period of conversation; the circuits for advancing the metering switch to make repeated charges are closed in predetermined positions of the timing switches T1 and T2, which positions indicate the beginning of additional unit periods of conversation.

The selector switches S1 and S2 and the connector switch C are also of the well known Strowger type; and reference may be had to pages 53 to 67 inclusive of the second edition of Automatic Telephony by Smith and Campbell for a complete description of the operation of these switches.

The repeater circuit R is similar to that disclosed in the aforementioned application of R. L. Stokely, Serial No. 482,699; and reference may be made to this application for a detailed description of the operation of the repeater R. As soon as a calling line is extended to this repeater circuit, ground is extended from the repeater over the sleeve conductor to operate relay 15 of the trunk circuit and thus connect a holding ground to sleeve conductor 14; and an impulse is then transmitted from the repeater to operate that combination of the zone relays 44 and 45 of trunk circuit T as corresponds to the zone in which the distant end of the trunk outgoing from this repeater terminates.

The operation of the system disclosed in the drawing will now be described in detail, insofar as such a description tends to explain this invention. When the subscriber at station A removes the receiver from the receiver hook to originate a call, the line relay 2 operates in the usual manner. The operation of relay 2 connects the windings of the cut-off relay 3 and meter 4 over conductor 5 to the sleeve terminal associated with line 1 in the bank of line-finder LF. The operation of line relay 2 is also effective to connect ground over conductor 6 to start one of the line-finders in the associated group in search of the calling line. We will assume that the line-finder LF is the one thus started in search for line 1, and that line 1 is extended through the brushes 11 and 12 over the conductors of trunk T to the first selector switch S1. When the calling subscriber dials the office code and numerical digits of the

number of the called station B, the selector switch S1, the repeater R, the selector switch S2 and the connector switch C are operated to extend the calling line 1 to line 101 of the called station B. When the subscriber at station B answers the call, the connector C transmits a supervisory signal to the outgoing repeater R, and the repeater R then reverses the battery and ground supplied to the calling station A so as to cause the operation of the polarized supervisory relay 50 in the trunk circuit T. The cut-off relay 3, and the line-finder and first selector switches, are held operated by the ground at relay 46 connected to the sleeve conductor 14 under the control of repeater circuit R as described in the aforementioned application of R. L. Stokely, Serial No. 482,699.

When the polarized supervisory relay 50 operates, in consequence of the answer of the called subscriber, it closes a circuit for operating relay 51. Relay 51 closes a circuit from ground through the secondary winding of the transformer 53, through the right outer front contact of relay 51, through brush 33 in normal position 8, and through brush 21 in normal position 8, through the normal terminal of bank 41 of switch M to the winding of stepping-magnet 40. Magnet 40 releases as soon as brush 21 is advanced out of position 8 as hereinafter described. The release of magnet 40 advances the brushes 41 and 42 to position 2. When brush 42 enters position 2, relay 46 operates thereby transferring the connection from sleeve conductor 14 of line-finder LF from the holding ground to the booster battery 47. The marginal meter 4 is operated and the cut-off relay 3 is held operated in this circuit to the booster battery 47. With brush 41 in any of the off-normal positions, stepping-magnet 40 is alternately operated and released under the control of interrupter 43 thereby causing the advance of brushes 41 and 42 to their normal position. Relay 46 releases when the switch advances from position 2, thereby disconnecting the booster battery from conductor 14 so as to release meter 4 and reconnecting the ground to conductor 14 to hold the cut-off relay 3. If zone relay 44 is operated, the charging relay 46 reoperates when brush 42 enters position 4; and if zone relay 45 is operated, relay 46 is again operated when brush 42 reaches position 6. The one or more operations of meter 4 in positions 2, 4 and 6 constitutes the charge for the initial period of conversation.

Assuming that the operation of relay 51 occurs at the beginning of a cycle of interrupter 38, relays 27 and 37 will both operate simultaneously one second after relay 51 has operated. Relays 27 and 37 will remain operated for one second, relay 27 closing a circuit over conductor 29 for operating magnet 20, and relay 37 closing a circuit over conductor 39 for operating magnet 30. The brushes of switches T1 and T2 are thus advanced one step by the operation and release of magnets 20 and 30 from their normal position. After an interval of thirty-six seconds magnet 30 is again operated by relay 37 thereby advancing the brushes of switch T2 another step. The operation of relay 37 every thirty-six seconds is effective to advance the brushes of switch T2 until the brushes 32, 34 and 36 reach position 2 of their respective arcs. The circuit for operating stepping-magnet 20 of switch T1 was opened as soon as this switch advanced from its normal position; but when brushes 32, 34 and 36 of switch T2 reach terminals 2 of their respective arcs, magnet 20 is reoperated in a circuit through terminal 2 and brush 32, over conductor 29, through the inner right front contact of relay 51, to ground at relay 27. The stepping-magnet 20 is thereby successively operated and released every two seconds to advance its brushes eighteen steps before the reoperation of relay 37 and stepping-magnet 30 advances brush 32 beyond terminal 2. When brush 21 engages terminal 4 of its arc at the end of the seventeenth step, a circuit is closed for reoperating stepping-magnet 40; this circuit is traced through brush 41 in its normal position, brush 21 in position 4, brush 34 in position 2, the right outer front contact of relay 51, through the secondary winding of transformer 29 to ground. When brush 21 is advanced to terminal 5 by the eighteenth successive operation of magnet 20, magnet 40 releases to again advance the brushes of switch M from their normal position. Switch M now makes a second revolution under the control of interrupter 43 so as to operate meter 4 one or more times as a charge for the second unit period of conversation. The time which elapsed from the first revolution of switch M until the second revolution of switch M is measured by the four steps of switch T2 and the seventeen steps of switch T1. Since the operation of relays 50 and 51 may have occurred at any time between a release of relay 27 and the subsequent simultaneous operation of relays 27 and 37, it is apparent that the initial unit period of conversation is equal to three minutes with an accuracy of plus 0 to minus 2 seconds, this being the sum of the time for the initial simultaneous stepping of switches T1 and T2 plus the time for four steps of switch T2 at thirty-six seconds per step plus the time for seventeen steps of switch T1 at two seconds per step. (From 0 to 2 seconds + 4 × 36 seconds + 17 × 2 seconds = 180 seconds, plus 0 minus 2.)

When relay 27 closes the circuit for operating magnet 20 to advance the brushes of switch T1 for the eighteenth successive step, relay 37 also closes the circuit for operating magnet 30 so that brushes 32, 34 and 36 are

advanced to terminal 3 of their respective arcs at the same time that brushes 21, 23 and 25 are advanced to terminal 5 of their respective arcs. Switch T2 will now be advanced four steps under the control of relay 37 and interrupter 38 (one step every thirty-six seconds) until brushes 32, 34 and 36 engage terminal 7 of their respective arcs; whereupon switch 2 will again be advanced another eighteen steps (one step every two seconds) under the control of relay 27 and interrupter 28, the circuit for operating magnet 20 being traced through brush 32 and terminal 7. At the end of the seventeenth step, with brushes 22, 24 and 26 in contact with terminal 11 of their respective arcs, a circuit is closed from ground through the secondary winding of transformer 53, right outer front contact of relay 51, brush 34 and terminal 7, terminal 11 and brush 22, normal terminal and brush 41, to the winding of magnet 40. Magnet 40 reoperates and when brush 22 is advanced by the eighteenth successive operation of magnet 20, magnet 40 releases to again advance switch M from its normal position. Switch M now makes a third revolution, during which the meter 4 is operated one or more times as a charge for a third unit period of conversation. The time which elapsed from the beginning of the second revolution until the beginning of the third revolution of switch M is equal to the sum of the time for the eighteen steps of switch T1 plus the time for four steps of switch T2, so that the second measured unit period of conversation is exactly three minutes.

When relay 27 closes the circuit for operating magnet 20 to advance the brushes of switch T1 for the eighteenth successive step, relay 37 again closes the circuit for operating magnet 30 so that brushes 32, 34 and 36 are advanced to terminal 8 of their respective arcs at the same time that brushes 21, 23 and 25 are advanced to terminal 1 of their respective arcs. Switch T2 will now be advanced four steps under control of relay 37 and interrupter 38 (one step every thirty-six seconds) until brushes 31, 33 and 35 engage terminal 1 of their respective arcs; whereupon switch T1 will again be advanced another eighteen steps (one step every two seconds) under the control of relay 27 and interrupter 28, the circuit for operating magnet 20 being traced through brush 31 and terminal 1. At the end of the seventeenth step, with brushes 22, 24 and 26 in contact with terminal 7 of their respective arcs, a circuit is closed from ground through the secondary winding of transformer 53, right outer front contact of relay 51, brush 33 and terminal 1, terminal 7 and brush 22, normal terminal and brush 41, to the winding of magnet 40. Magnet 40 operates and when brush 22 is advanced by the eighteenth successive operation of magnet 20, magnet 40 releases to advance switch M from its normal position. Switch M now makes a fourth revolution, during which the meter 4 is operated four times as a charge for a fourth unit period of conversation. The third unit period of conversation was also exactly three minutes being measured by the advance of timing switches T1 and T2 between the third and fourth revolutions of switch M.

When relay 27 closes the circuit for operating magnet 20 to advance the brushes of switch T1 for the eighteenth successive step, relay 37 again closes the circuit for operating magnet 30 so that brushes 31, 33 and 35 are advanced to terminal 2 of their respective arcs at the same time that brushes 22, 24 and 26 are advanced to terminal 8 of their respective arcs. Switch T2 will now be advanced three steps under control of relay 37 and interrupter 38 (one step every thirty-six seconds) until brushes 31, 33 and 35 engage terminal 5 of their respective arcs; whereupon switch T1 will again be advanced eighteen steps (one step every two seconds) under the control of relay 27 and interrupter 28, the circuit for operating magnet 20 being traced through brush 31 and terminal 5. At the end of the seventeenth step, with brushes 22, 24 and 26 in contact with terminal 3 of their respective arcs, a circuit is closed from ground through the secondary winding of transformer 53, right outer front contact of relay 51, brush 33 and terminal 5, terminal 3 and brush 24, to the winding of magnet 30. When relay 27 operates to cause the eighteenth successive step of switch T1, relay 37 also operates to close the circuit for operating magnet 30; and, when relays 27 and 37 release, the eighteenth successive step of switch T1 is made simultaneously with the fourth step of switch T2. It is, therefore, apparent that the circuit for operating magnet 30 through brush 24 and terminal 3 is not necessary under the conditions assumed at the beginning of this detailed description, but this circuit is of use under other conditions as hereinafter described. Since terminals 5, 6, 7 and 8 in bank 31 are strapped together, the stepping-magnet 20 of switch T1 continues to be operated under control of relay 27 and interrupter 28; when, after seventeen additional steps, brush 23 engages terminal 10 of its arc a circuit is closed from ground through the secondary winding of transformer 53, right outer front contact of relay 51, brush 33 and terminals 6 and 7, brush 23 and terminal 10, to the winding of relay 49. Relay 49 is thus operated, at the end of the fourth unit period of conversation to open the connection between stations A and B. The fourth unit period of conversation was also exactly three minutes as measured by the advance of timing switches T1 and T2 subsequent to the fourth revolution of metering switch M, so that the total con-

versation has endured for twelve minutes. By opening the connection between stations A and B, relay 49 causes the line-finder, selector and connector switches to be restored to normal in the usual manner; the release of relay 15 when the holding ground is disconnected at repeater R is also effective to cause the release of the cut-off relay 3 so that another call may be originated or an incoming call received over line 1.

Ten seconds prior to the operation of relay 49, a tone was connected to one of the talking conductors to notify the subscribers that the connection was soon to be opened. The tone circuit is traced from ground through the secondary winding of transformer 53, right outer front contact of relay 51, brush 33 and terminal 6, brush 23 and terminal 5, through condenser 48 to one of the talking conductors of trunk T.

Should the connection be released by the calling station prior to its automatic release, the line-finder, selector and connector switches are restored to normal in the usual manner, the release of supervisory relay 50 being immediately effective to cause the release of relay 51. Relay 51 then closes circuits, from the windings of magnets 20 and 30 through the off-normal terminals of banks 25 and 26 and 35 and 36 to the interrupter 52, which are effective to alternately operate and release magnets 20 and 30 until the brushes of switches T1 and T2 reach their normal positions.

In the foregoing description it has been assumed that relay 51 was first operated just prior to the simultaneous operation of relays 27 and 37, so that both of the switches T1 and T2 were advanced out of their normal position at the same time. Since the operation of relay 51 may occur at any time between successive operations of relay 37, we will now describe the operation of the timing and charging switches assuming that relay 51 is operated just after one of the simultaneous operations of relays 27 and 37. With relay 51 operated, switch T1 is advanced eighteen steps (one step at every two seconds), under the control of relay 27 and interrupter 28, the circuit for operating magnet 20 being traced through brush 31 and terminal 8. The eighteenth operation of relay 27 occurs simultaneously with the first operation of relay 28 so that stepping magnet 30 advances brushes 31, 33 and 35 to engage terminal 9 of their respective arcs at the same time that brushes 21, 23 and 25 engage terminal 4 of their respective arcs. The stepping magnet 20 cannot now reoperate until switch T2 has been advanced four additional steps (one step every thirty-six seconds) under the control of relay 37 and interrupter 38, at the end of which brushes 32, 34 and 36 are in contact with terminal 2 of their respective arcs. The advance of switches T1 and T2 has thus measured the initial unit period of conversation, an interval of three minutes plus 0 minus 2 seconds (being equal to the time for the seventeen steps of switch T1 plus four steps of switch T2 plus the time that elapsed between the operation of relay 51 and the initial step of switch T1). As soon as brush 34 engages terminal 2 the circuit is closed for reoperating magnet 40 of switch M; and two seconds later when switch T1 advances another step, this circuit is opened by brush 21 thus releasing magnet 40 to advance switch M from its normal position. Switch M now makes its second revolution to charge the calling subscriber for the next unit period of conversation.

Switch T1 is again advanced one step every two seconds under the control of relay 27 and interrupter 28. The eighteenth operation of relay 27 occurs simultaneously with the next operation of relay 28; so that magnet 30 is operated to advance brushes 32, 34 and 36 into contact with terminal 3 of their respective arcs at the same time that magnet 20 is operated to advance brushes 22, 24 and 26 into contact with terminal 10 of their respective arcs. The stepping magnet 20 of switch T1 cannot now reoperate until switch T2 has been advanced four additional steps (one step every thirty-six seconds) under the control of relay 37 and interrupter 38, at the end of which brushes 32, 34 and 36 are in contact with terminal 7 of their respective arcs. When brush 34 engages terminal 7, magnet 40 of switch M reoperates; and, when switch T1 advances another step two seconds later, magnet 40 releases to advance switch M out of its normal position. Switch M then makes a third revolution to charge the calling subscriber for the third three minutes of conversation.

Switch T1 is again advanced eighteen steps at the end of which brushes 22, 24 and 26 engage terminal 7 of their respective arcs. Switch T2 is advanced one step simultaneously with the eighteenth step of switch T1 so that brushes 32, 34 and 36 engage terminal 8. Magnet 20 of switch T1 cannot now reoperate until switch T2 has been advanced four additional steps, at the end of which brushes 31, 33 and 35 are in contact with terminal 1 of their respective arcs. When brush 33 engages terminal 1, the fourth revolution of switch M is initiated by the operation and release of magnet 40, so that the calling subscriber is charged for the fourth period of three minutes.

Switch T1 is again advanced eighteen steps, at the end of which brushes 22, 24 and 26 engage terminal 3 of their respective arcs and switch T2 is advanced one step simultaneously with the eighteenth step of switch T1 so that brushes 31, 33 and 35 are in contact with terminal 2. Three additional steps of switch T2 bring brushes 31, 33 and 35

into contact with terminal 5, whereupon the aforementioned circuit through brush 33 and terminal 5 and terminal 3 and brush 24 is effective to immediately advance switch T2 an additional step without waiting for the next operation of relay 37. Switch T1 is now advanced another eighteen steps so that brushes 21, 23 and 25 are in contact with terminal 10, at the end of the twelve minutes of conversation, relay 49 being operated to destroy the connection as hereinbefore described. The warning tone was transmitted when brush 23 was in contact with terminal 5 at the end of the thirteenth of the last eighteen steps of switch T1.

Since relay 51 may be operated at any other time between successive operations of relay 37, the switch T1 may be advanced a part of its cycle of eighteen steps prior to each advance of switch T2 and the remainder subsequent to each advance of switch T2. Brush 33 and switch T1 might therefore not yet have advanced to position 6 by the time brush 23 engages terminal 5; in which event no warning tone would be given to the subscriber, if the aforementioned circuit through brush 24 and terminal 3 of switch T1 were not provided, to advance switch T2 independently of interrupter relay 37.

What is claimed is:

1. The combination of a plurality of progressively movable switching mechanisms, sources of periodic impulses of different characteristics, means associated with each of said mechanisms for responding to impulses from a different one of said sources, and a circuit closed by the cooperation of said mechanisms in predetermined positions for indicating the termination of specific intervals of time.

2. The combination of a plurality of switching mechanisms, sources of periodic impulses of different frequencies, means associated with each of said mechanisms for responding to impulses from a different one of said sources, means for starting the operation of said mechanisms, a circuit closed by the cooperation of said mechanisms for indicating the termination of an interval of time whose maximum variation is one cycle of that one of said sources which transmits impulses at the highest frequency, and circuits closed by the continued operation of said mechanisms for indicating the termination of succeeding predetermined intervals of time.

3. In combination, sources of periodic impulses of different characteristics, a first switching mechanism arranged to respond to impulses from one of said impulse sources, a second switching mechanism controlled by said first mechanism and arranged to respond to impulses from another of said impulse sources, and a circuit closed by the cooperation of said mechanisms in predetermined positions for indicating the termination of specific intervals of time.

4. In a telephone system, subscribers' stations, means including a trunk circuit for establishing a connection between a calling station and a called station, a meter for said calling station, a plurality of switching mechanisms associated with said trunk circuit, sources of periodic impulses of different frequencies, means associated with each of said mechanisms for responding to impulses from a different one of said sources, means for operating said meter in consequence of the answer of said called subscribed as a charge for an initial unit period of conversation and for operating said meter for additional unit periods of conversation, and a circuit closed by the cooperation of said switching mechanisms in predetermined positions for initiating the charging operation at the beginning of each unit period of conversation.

5. In a telephone system, subscribers' stations, means including a trunk circuit for establishing a connection between a calling station and a called station, a meter for said calling station, a plurality of switching mechanisms associated with said trunk circuit, sources of periodic impulses of different characteristics, means associated with each of said mechanisms for responding to impulses from a different one of said sources, means for operating said meter in consequence of the answer of said called subscriber as a charge for an initial period of conversation and for operating said meter for additional unit periods of conversation, a circuit closed by the cooperation of said switching mechanisms in predetermined positions for initiating the charging operation at the beginning of each unit period of conversation, and means for causing the release of said connection after a predetermined interval of time has elapsed.

6. In a telephone system, subscribers' stations, means including a trunk circuit for establishing a connection between a calling station and a called station, a supervisory relay arranged to operate in consequence of the answer of said called subscriber, timing switches for measuring unit periods of conversation, sources of periodic impulses of different frequencies, means including one of said sources and effective in consequence of the answer of the called subscriber for advancing one of said timing switches, means including another of said impulse sources and effective in predetermined positions of said one of said timing switches for advancing the other of said timing switches, and circuits closed by the cooperation of said timing mechanisms in predetermined positions for indicating the termination of specific intervals of time.

7. In a telephone system, subscribers' stations, means including a trunk circuit for establishing a connection between a calling station and a called station, a meter for said calling station, timing switches for measuring unit periods of conversation, sources of periodic impulses of different frequencies, means including one of said sources and effective in consequence of the answer of the called subscriber for advancing one of said timing switches, means including another of said impulse sources and effective in predetermined positions of said one of said timing switches for advancing the other of said timing switches, means for operating said meter as a charge for an initial unit period of conversation and for operating said meter for additional unit periods of conversation, and circuits closed by the cooperation of said switching mechanisms in predetermined positions for initiating the charging operation at the beginning of each unit period of conversation.

8. In a telephone system, subscribers' stations, means including a trunk circuit for establishing a connection between a calling station and a called station, a meter for said calling station, timing switches for measuring unit periods of conversation, sources of periodic impulses of different frequencies, means including one of said sources and effective in consequence of the answer of the called subscriber for advancing one of said timing switches, means including another of said impulse sources and effective in predetermined positions of said one of said timing switches for advancing the other of said timing switches, means for operating said meter as a charge for an initial unit period of conversation and for operating said meter for additional unit periods of conversation, circuits closed by the cooperation of said switching mechanisms in predetermined positions for initiating the charging operation at the beginning of each unit period of conversation, and means for causing the release of said connection after a predetermined interval of time has elapsed.

9. In a telephone system, subscribers' stations, means including a trunk circuit for establishing a connection between a calling station and a called station, a meter for said calling station, sources of periodic impulses of different frequencies, switching mechanisms each arranged to respond to impulses from a different one of said sources for measuring unit periods of conversation, a supervisory relay effective in consequence of the answer of said called station to initiate the operation of said switching mechanisms, and means initially rendered effective in the normal positions of said switching mechanisms in consequence of the operation of said relay for operating said meter and subsequently rendered effective at predetermined intervals by the cooperation of said switching mechanisms for repeating the operation of said meter.

10. In a telephone system, subscribers' stations, means including a trunk circuit for establishing a connection between a calling station and a called station, a meter for said calling station, means including a switch for variably operating said meter according to the zone within which the called station is located, a supervisory relay for operation in consequence of the answer of said called subscriber, switching mechanisms for measuring predetermined intervals of time, sources of periodic impulses of different frequencies, means for advancing one of said switching mechanisms in response to impulses from one of said sources, means effective in certain predetermined positions of said switching mechanism for advancing the other of said switching mechanisms in response to impulses from another of said sources, means including said relay for advancing said switch in consequence of the answer of said called subscriber to charge the calling subscriber for an initial unit period of conversation, and means effective at predetermined intervals by the cooperation of said switching mechanisms to initiate additional operations of said switch as a charge for additional periods of conversation.

11. In a telephone system, subscribers' stations, means including a trunk circuit for establishing a connection between a calling station and a called station, a meter for said calling station, a switch for closing the operating circuit of said meter one or more times per cycle of operation, timing switches for measuring unit periods of conversation, sources of periodic impulses of different frequencies, means including one of said sources and effective in consequence of the answer of the called subscriber for advancing one of said timing switches, means including another of said impulse sources and effective in predetermined positions of said one of said timing switches for advancing the other of said timing switches, a circuit closed through the normal positions of said timing switches for initiating the advance of said metering switch to operate said meter for the initial period of conversation, and circuits closed in predetermined positions of said timing switches to initiate repeated cycles of said measuring switch.

12. In a telephone system, subscribers' stations, means including a trunk circuit for establishing a connection between a calling station and a called station, a meter for said calling station, timing switches for measuring unit periods of conversation, sources of impulses of different frequencies, means including one of said sources and effective in consequence of the answer of the called subscriber for advancing one of said timing

switches, means including another of said impulse sources and effective in predetermined positions of said one of said timing switches for advancing the other of said timing switches, circuits closed by the cooperation of said switching mechanisms in predetermined positions for initiating the charging operation at the beginning of each unit period of conversation, and means effective in predetermined positions of said timing switches for transmitting a tone to said calling station.

13. In a telephone system, subscribers' stations, means including a trunk circuit for establishing a connection between a calling station and a called station, a meter for said calling station, timing switches for measuring unit periods of conversation, sources of impulses of different frequencies, means including one of said sources and effective in consequence of the answer of the called subscriber for advancing one of said timing switches, means including another of said impulse sources and effective in predetermined positions of said one of said timing switches for advancing the other of said timing switches, circuits closed by the cooperation of said switching mechanisms in predetermined positions for initiating the charging operation at the beginning of each unit period of conversation, means effective in predetermined positions of said timing switches for transmitting a tone to said calling station, and means effective in predetermined positions of said timing switches for causing the release of said connection.

In witness whereof, we hereunto subscribe our names this 22nd day of January, 1931, and on the 2nd day of February, 1931.

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