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TELEPHONE SYSTEM

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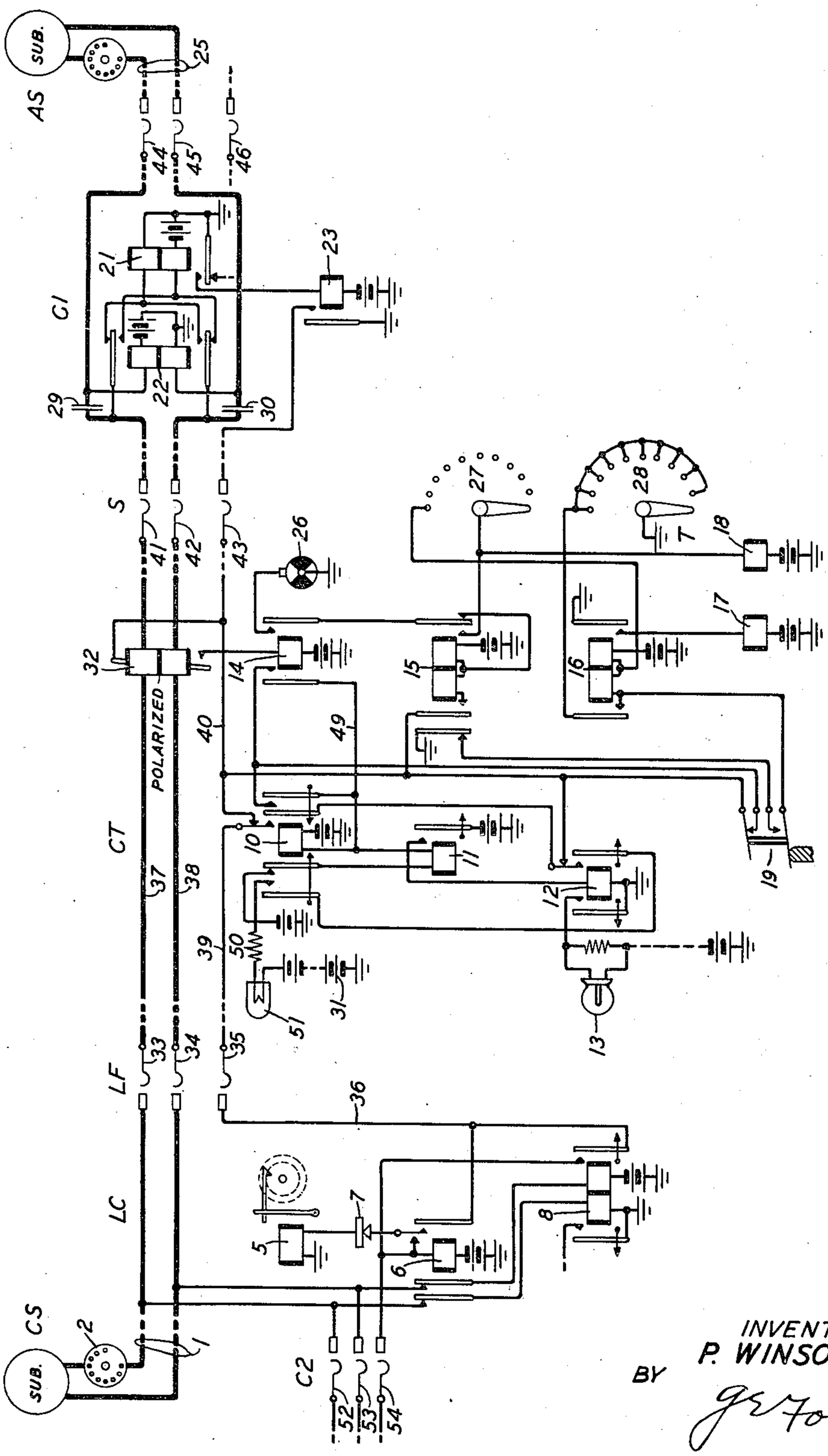

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TELEPHONE SYSTEM

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This invention relates to telephone systems and more particularly to measured service telephone systems.

The object of the invention is to improve the control of service meters operating in accordance with the duration of a call.

Heretofore systems have been employed in which a subscriber's service meter is operated initially upon completion of a connection with a called line and the answer of the called subscriber and is thereafter operated periodically under the control of a timing device individual to the connection during the time the talking connection is maintained. Systems have also been used in which the meter is operated but once during a call. In the latter systems it is usual to connect the service meter in parallel with the cut-off relay to the sleeve conductor of the subscriber's line circuit. The cut-off relay operates when a ground potential is connected to this sleeve conductor but the meter is marginal so as to operate only when a booster-battery potential is substituted for the ground potential. It has been found that this arrangement is not satisfactory if repeated operation of the meter is desired since the meter is not certain to release when booster-battery potential is disconnected and ground potential is reconnected to the sleeve conductor.

According to this invention the timing device for controlling the meter operating circuit comprises a switch which is advanced step by step to count off a conversational unit, the brushes being restored to normal at the end of each measured unit period and also whenever the connection is released. At the beginning of each measured conversational unit period booster-battery potential is temporarily connected to the sleeve conductor of the calling line in place of holding ground potential to cause the operation and release of the calling subscriber's service meter, the closure of the meter operating circuit being dependent upon the timing switch being in normal position. The initial advance of the switch from normal may be delayed awaiting the next closure of periodically operated interrupter contacts; but on succeeding cycles this delay is eliminated. The arrangement is such that the timing device is not restored to normal if the talking connection is temporarily opened at the called station prior to release of the connection at the calling station.

A feature of the invention is the insertion of a rectifying device in series with the service meter, to insure its release between successive booster-battery impulses, and the use of a front contact of the cut-off relay to connect the meter to the sleeve conductor of the line circuit. In such an arrangement there is normally no potential impressed across the meter winding and rectifier.

A telephone system arranged in accordance with this invention is shown in schematic form in the drawing which forms a part of this specification. The invention is, however, not limited in its application to this particular system but may be applied to all measured service telephone systems.

Referring to the drawing, CS and AS represent subscribers' stations, LC represents the line apparatus individual to the line of station CS, LF represents a line-finder switch having access to a group of lines including the line 1 leading to station CS, CT represents a trunk which permanently associates the line-finder LF with a first selector switch S, C1 represents a connector switch connected to terminals in the bank of selector S and having access to a group of lines including the line 25 leading to station AS, and C2 represents a connector switch having access to a group of lines including the line 1.

The subscriber's station apparatus is of the type usually employed in automatic telephone systems and includes a dial for use in establishing desired connections.

The line apparatus LC associated with line 1 comprises the line relay 8, cut-off relay 6, service meter 5 and the unidirectional current device 7 connected in series with the winding of meter 5. The device 7 may be a rectifier of the copper-oxide type or other equivalent device.

The line finder LF, which is represented by brushes 33, 34 and 35 and the set of terminals to which line 1 is connected, may be of the two-motion step-by-step type. For a detailed description of the operation of such a line finder, reference may be had to Patent No. 1,799,654 granted to R. L. Stokely, April 7, 1931.

The trunk CT comprises the talking conductors 37 and 38, the incoming sleeve conductor 39 and the outgoing sleeve conductor 40 and has associated therewith a polarized supervisory relay 32 having windings connected in series with conductors 37 and 38, a timing switch T for measuring off intervals of time during which the trunk CT is included in a talking connection, a booster battery 31 and relays 10, 11, 12, 14, 15 and 16 for use in controlling the operation of switch T and the operation of a calling subscriber's service meter. The switch T is shown as a rotary switch having two brushes and associated banks of ter-

minals 27 and 28, a stepping magnet 18, a release magnet 17 and off-normal springs 19. The brushes of switch T are advanced by the operation of magnet 18 in one direction and returned to normal by motion in the reverse direction upon operation of release magnet 17.

The selector S and connectors C1 and C2 may also be of the well known two-motion step-by-step type. For a complete description of the operation of such switches, reference may be had to pages 53 to 67 inclusive of the second edition of "Automatic Telephony" by Smith and Campbell published in 1921. The selector S is represented by brushes 41, 42 and 43 and a single set of terminals. The connector C1 is represented by its brushes 44, 45 and 46, the set of terminals to which line 25 is connected, relays 21, 22 and 23, and talking condensers 29 and 30. The connector C2 is represented by its brushes 52, 53 and 54 and the set of terminals to which the line 1 is connected.

Let it be assumed that the calling subscriber CS desires to establish connection with the called subscriber AS. Removing the receiver from the switchhook closes a circuit over the conductors of line 1 which may be traced from battery through the right-hand winding of relay 8, inner left back contact of cut-off relay 6, over line 1, through the subscriber's set and contacts of dial 2, outer left back contact of relay 6, to ground through the left winding of relay 8. Relay 8 operates and connects the winding of cut-off relay 6 to the sleeve terminal of line 1 in the bank of line-finder LF. Relay 8 also closes at its left front contact a circuit (not shown) for causing line finder LF to hunt for and establish connection with the terminals to which line 1 is connected. Upon finding the calling line, a connection (not shown) is closed from ground potential in the line finder through brush 35 to conductor 36, to cause the operation of relay 6 and constitute a busy potential to guard against seizure of the line 1 on an incoming call. In operating, relay 6 closes a holding circuit through its front contacts and causes the release of relay 8. Upon extension of line 1 through brushes 33 and 34 over conductors 37 and 38 to the line relay (not shown) of selector S, holding ground potential is connected to conductor 40 in usual manner to hold the line finder LF and cut-off relay 6. Relay 8 is slow in releasing so that the holding circuit for relay 6 will be closed before its operating circuit is opened due to the release of relay 8.

With relay 6 operated, a circuit may also be traced from battery through the winding of relay 6, through its inner front contact, through rectifier 7 and the winding of meter 5 to ground. Since the sleeve conductor resistance is low, the winding of meter 5 is substantially short-circuited as long as holding ground potential is connected to conductor 36; and the rectifier 7 is so poled that the current through the windings of cut-off relay 6 and meter 5 in series, with neither ground nor booster battery potential connected to conductor 36, is insufficient to operate meter 5 or to hold relay 6.

After station CS has been connected through line finder LF and charging trunk CT to the selector S, the subscriber dials the number of the called subscriber. The selector S, intermediate selectors if any, and the connector C1 are selectively operated in response to the impulses created by the dialing of the called station's number to complete the connection between the calling and called lines. Upon extension of the connection to connector C1, relays 21 and 23 operate and the holding ground potential is supplied from this switch under control of the calling subscriber in well known manner. The circuit for operating relay 21 is traced from battery, through the lower winding of relay 21, lower back contact of relay 22, brush 42 of selector S, lower winding of polarized relay 32, over conductor 38, brush 34 of line finder LF, over line 1 and through the subscriber's set at station CS, brush 33 of line finder LF, over conductor 37, through the upper winding of polarized relay 32, brush 41 of selector S, upper back contact of relay 22, and upper winding of relay 21 to ground. The current through the windings of polarized relay 32 is not in the operating direction so that relay 32 does not operate. The ringer at the called station is operated in the usual manner and, when the receiver is removed from the switchhook, relay 22 operates in a circuit that may be traced from battery through the upper winding of relay 22, brush 44 of connector C1, over line 25, through the subscriber's set at station AS, brush 45 of connector C1, and through the lower winding of relay 22 to ground. Relay 22, in operating, reverses the direction of current through the windings of polarized relay 32 thereby causing the operation of relay 32. The conversational connection between stations CS and AS includes condensers 29 and 30, transmission battery for the station CS being furnished through the windings of relay 21 and for station AS through the windings of relay 22.

The aforementioned operation of relay 32 closes a circuit from holding ground potential at relay 23, through brush 43 of selector S, contacts of relay 32 and through the winding of relay 14 to battery. Relay 14 operates and closes circuits which may be traced from holding ground potential through brush 43 of selector S, over conductor 48, through the upper contacts of off-normal springs 19 of switch T, through the left front contact of relay 14, to conductor 49, thence through the winding of relay 10 to battery and from conductor 49, through the winding of relay 11 to battery at the left back contact of relay 10. Relay 10 is slow in operating, so that relay 11 operates before relay 10 operates and releases after relay 10 operates. Relay 11 is slow in releasing and remains operated long enough to cause the operation of relay 12. With relays 10 and 12 both operated, a circuit is closed from the positive pole of booster battery 31 through resistance lamp 51, resistance 50, left front contact of relay 10, right front contact of relay 12, inner right front contact of relay 10, over sleeve conductor 39, through brush 35 of line finder LF, conductor 36, outer front contact of relay 6, rectifier 7, and through the winding of service meter 5 to ground. Service meter 5 now operates since the rectifier 7 offers a low resistance to the current in this circuit. The connection of booster battery 31 to conductor 36 also causes an increase in the current through the winding of relay 6 and relay 6 remains operated. When relay 11 releases, relay 12 releases thereby disconnecting sleeve conductor 39 from the booster battery 31 to cause the release of meter 5 and reconnecting conductor 39 through the inner right front contact of relay 10 and the back contact of relay 12, over conductor 40 to the holding ground potential to hold relay 6. The contacts of relays 10 and 12 which are used to transfer conductor 39 from holding ground to booster battery are of the make-before-break type, thereby assuring that

the locking current for cut-off relay 6 be maintained continuously. When relay 12 operated, it also closed a circuit from ground through its left front contact and lamp 13 to alarm apparatus (not shown) so as to give a trouble indication if for any reason relay 12 should fail to release within a predetermined interval.

When relay 14 operates, it also connects the right winding of relay 15 in series with the right back contact of relay 15, through the right front contact of relay 14 to the brush of interrupter drum 26, the brush of drum 26 being connected to ground once every thirty seconds. As soon after the operation of relay 14 as the brush of interrupter drum 26 is connected to ground, relay 15 is sufficiently energized to close its left front contact, and when the connection through drum 26 terminates, relay 15 is fully operated by the energization of its windings in series over conductor 40 to holding ground potential. When fully operated, relay 15 disconnects its right winding from the brush of interrupter drum 26 and connects the interrupter to the winding of the rotary magnet 18 of switch T. When the brush of interrupter 26 is next connected to ground, rotary magnet 18 is energized. The operation of magnet 18 advances the brushes of switch T one step into engagement with the first terminal of their respective banks. When the switch moves out of normal position, the off-normal springs 19 are actuated and the operating and holding circuits for relay 10 are opened at the upper contacts of these springs. Relay 10 accordingly releases, reconnecting sleeve conductors 39 and 40. The rotary magnet 18 is reoperated once every thirty seconds under control of interrupter 26 to advance the rotary switch T one step at a time until the tenth terminal is reached at which time an interval of approximately but not less than five minutes will have elapsed since the talking connection was established and relay 32 operated. With the brushes of switch T in the tenth off-normal position, the right winding of relay 16 is connected through terminal 10 and brush of arc 27, through the right front contacts of relays 15 and 14 to the brush of interrupter drum 26, thereby causing the immediate energization of relay 16 sufficiently to close its left front contact. As soon thereafter as the connection through interrupter 26 terminates, relay 16 is operated completely by current through both windings in series to ground on the brush of arc 28. Relay 16 closes at its right front contact a circuit for operating release magnet 17. The operation of magnet 17 causes the return of the rotary switch to normal position, relay 16 and magnet 17 being held operated until the return to normal is completed. Relay 16 then releases, opening the circuit through the winding of release magnet 17.

If, after the rotary switch has completed the measurement of one conversational unit-period of five minutes, the connection between subscribers AS and CS has not been released, relays 32, 14 and 15 of the charging trunk CT remain operated, and a second operation of service meter 5 is effected by a second cycle of operation of relays 10, 11 and 12 in the manner hereinbefore described and the rotary switch T is again advanced under control of interrupter 26 to measure another interval of five minutes. As relay 15 is already operated, there is now no pick-up delay so that each overtime period, as measured by switch T, is exactly five minutes.

If the called subscriber AS should disconnect during the stepping of the rotary switch T, relay 22 releases, restoring to normal the direction of current through polarized relay 32. The release of relay 32 causes the release of relay 14, thereby disconnecting the interrupter 26 and arresting the progress of the rotary switch T. However, relay 15 continues to hold to ground on conductor 40. Should the called subscriber AS again remove the receiver before the subscriber at station CS has released the connection, relay 22 reoperates, causing the reoperation of relay 32. Relay 14 then reoperates and connects interrupter 26 to the rotary magnet 18, causing the switch T to continue its advance.

When the calling subscriber CS disconnects, relays 21 and 32 release. The release of relay 21 causes the release of relay 23 and the release of relay 32 causes the release of relay 14. The disconnection of the holding ground potential from sleeve conductor 40, when relay 23 releases, causes the release of relay 6 and the return of selector S and line finder LF to normal. As hereinbefore explained, the device 7 is so poled that cut-off relay 6 cannot remain operated in series with the winding of meter 5 when holding ground potential is disconnected from conductor 36. The connector C1 is also returned to normal in well known manner. Relay 15, if operated, releases when the holding ground is disconnected from conductor 40. With relay 15 released and switch T off-normal, a circuit is closed from ground at the left back contact of relay 15 through the lower contacts of off-normal springs 19, and through the windings of relay 16 in series to battery. Relay 16 operates and closes the circuit for operating release magnet 17. Relay 16 is held operated through its left front contact to ground through the brush of bank 28 as long as switch T is off-normal.

The foregoing description is for a call originating at station CS. If, however, station CS is called by another station, the connection will be established through the brushes and bank of a connector C2 in the usual manner. In this case, ground is connected to the sleeve terminal of connector C2 to operate cut-off relay 6. Relay 6, in operating, connects this ground potential through its right front inner contact to rectifier 7 which is in series with the winding of service meter 5. When the connector circuit is restored to normal after completion of the conversation, the holding ground potential is disconnected, releasing relay 6. Meter 5 cannot be operated on such a call and relay 6 cannot lock in series with meter 5 since rectifier 7 is poled to prevent current through the windings of relay 6 and meter 5 when connected in series by the operation of relay 6.

The length of a conversational unit period depends upon the frequency of the closures through interrupter drum 26 and also upon the particular terminal of bank 27 to which the right winding of relay 16 is connected. It is apparent therefore that the arrangement may be such as to give any desired length of conversational period for which a charge is made.

What is claimed is:

1. In a telephone system, subscribers' stations and lines, means including a trunk for establishing a talking connection between a calling station and a called station, a service meter for said calling station, a switch for said trunk, means responsive to the answer of the called subscriber for advancing said switch to measure conversational units of predetermined duration, and a circuit for operating said meter at the beginning of each measured conversational unit during which the

talking connection exists, the closure of said circuit being dependent upon said switch being in normal position.

2. In a telephone system, subscribers' stations and lines, means including a trunk for establishing a talking connection between a calling line and a called line, a service meter and a cut-off relay for said calling line connected in parallel to the sleeve conductor of the line, a switch for said trunk, means responsive to the answer of the called subscriber for advancing said switch to measure conversational units of predetermined duration, and means operatively dependent upon said switch being in normal position for operating said meter at the beginning of each measured conversational unit during which the talking connection exists.

3. In a telephone system, subscribers' stations and lines, means including a trunk for establishing a talking connection between a calling station and a called station, a service meter for the calling line, timing mechanism for said trunk, said mechanism comprising a switch and means responsive to the answer of the called subscriber for advancing said switch to measure a conversational unit of predetermined duration, means effective each time said switch has been advanced to the limit of its forward motion for causing the restoration of said switch to normal position, and means dependent upon said switch being in normal position for operating said meter at the beginning of each measured conversational unit during which the talking connection exists.

4. In a telephone system, subscribers' stations and lines, means including a trunk for establishing a talking connection between a calling station and a called station, a service meter for the calling line, timing mechanism for said trunk, said mechanism comprising a switch and means responsive to the answer of the called subscriber for advancing said switch to measure a conversational unit of predetermined duration, means effective each time said switch has been advanced to the limit of its forward motion for causing the restoration of said switch to normal position, means responsive to the release of the connection by the calling subscriber for restoring said switch to normal, and means dependent upon said switch being in normal position for operating said meter at the beginning of each measured conversational unit during which the talking connection exists.

5. In a telephone system, subscribers' stations and lines, means including a trunk for establishing a talking connection between a calling station and a called station, a service meter for the calling line, timing mechanism for said trunk, said mechanism comprising a switch and means responsive to the answer of the called subscriber for advancing said switch to measure a conversational unit of predetermined duration, means for suspending the advance of said switch upon the opening of the talking connection at the called subscriber's station, means effective each time said switch has been advanced to the limit of its forward motion for causing the restoration of said switch to normal position, and means dependent upon said switch being in normal position for operating said meter at the beginning of each measured conversational unit during which the talking connection exists.

6. In a telephone system, subscribers' stations and lines, means including a trunk for establishing a talking connection between a calling station and a called station, timing mechanism comprising a switch for said trunk, means effective after the expiration of a predetermined minimum interval of time and within a predetermined maximum interval of time subsequent to the answer of the called subscriber for initiating the advance of said switch from normal and for continuing the step-by-step operation of said switch as long as the talking connection exists to measure conversational units of predetermined duration, means effective each time said switch has reached the limit of its forward motion for causing the restoration of the switch to normal, means effective after the initial advance of said switch from normal for making the first step of a succeeding cycle follow the last step of the preceding cycle at exactly the same interval as elapses between any other two steps of the switch, and a circuit for operating said meter once for each measured conversational unit or part thereof during which the talking connection is maintained, the closure of said circuit being dependent upon said switch being in normal position.

7. In a telephone system, subscribers' lines, a line relay and a line cut-off relay for each line, means including a trunk for establishing a talking connection between the line of a calling subscriber and a called line, a service meter for said calling line, said meter and cut-off relay both being connected to the sleeve conductor of said trunk, a unidirectional switch individual to said trunk, means effective while said talking connection exists for periodically advancing said switch step-by-step the advance of the wipers of said switch to the limit of their motion being effective to measure one conversational unit of predetermined duration, means effective each time the wipers have been advanced to the limit of their forward motion for causing the restoration of said switch to normal, and means operatively dependent upon said switch being in normal position for temporarily operating said meter at the beginning of each measured conversational unit during which said talking connection exists, said cut-off relay being held operated while said meter is operated.

8. In a telephone system, a subscriber's station, line and line circuit, said line circuit comprising talking conductors, a sleeve conductor, a cut-off relay and a service meter, means for connecting ground potential to said sleeve conductor to operate the cut-off relay, contacts closed by the operation of the cut-off relay for connecting the winding of the meter to said sleeve conductor, means for temporarily connecting a booster-battery potential to said sleeve conductor to operate and release said meter without releasing said cut-off relay, and a unidirectional conductor in series with the winding of said meter to prevent the operation of the meter in series with said cut-off relay.

9. In a telephone system, subscribers' stations and lines, a line circuit including a line relay and a cut-off relay for each line, a sleeve conductor for said line circuit, the winding of said cut-off relay being connected to said sleeve conductor by the operation of said line relay, means including a trunk for establishing a talking connection between a calling station and a called station, means responsive to the extension of the calling line to said trunk for connecting ground potential to the sleeve conductor of the line circuit for operating the cut-off relay to disconnect the windings of the line relay from the line, a service meter for said calling line, a unidirectional conductor, contacts closed by the operation of

the cut-off relay for connecting the sleeve conductor of the calling line through said unidirectional conductor to the winding of said meter, said unidirectional conductor being so poled as to prevent the operation of said meter in series with the winding of the cut-off relay, said meter and unidirectional conductor being substantially short-circuited by the ground potential connected to the sleeve conductor of the line circuit, and means in said trunk operatively responsive to the answer of the called subscriber for temporarily connecting a booster-battery potential in place of ground potential to the sleeve conductor of the calling line whereby said meter is operated and released without releasing said cut-off relay.

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