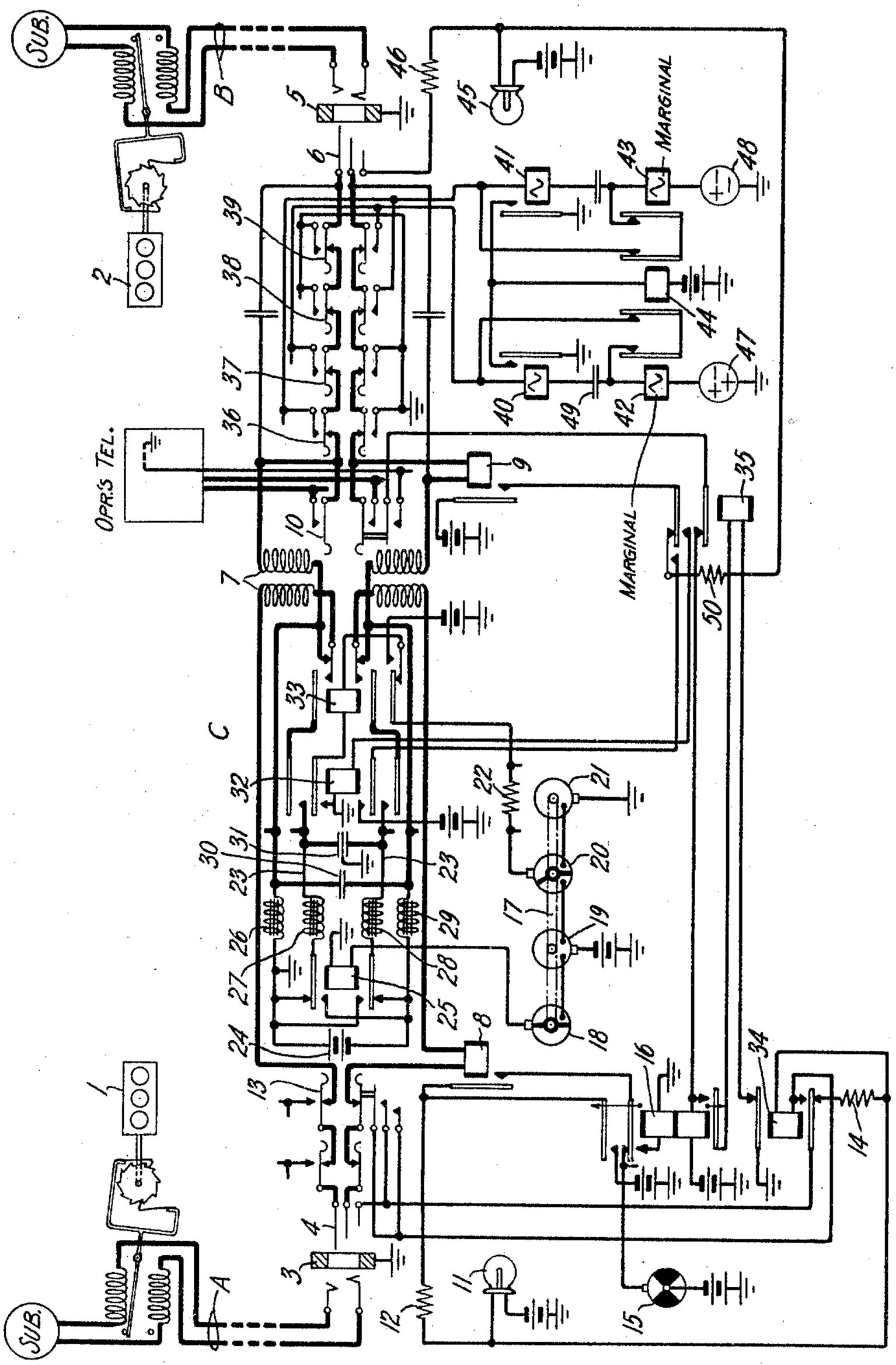
Dec. 3, 1929. L. H. JOHNSON 1,738,298

TELEPHONE SYSTEM

Filed Jan. 17, 1928



INVENTOR
LEWIS H JOHNSON
BY W. W. McKenney
ATTORNEY

Patented Dec. 3, 1929 1,738,298

UNITED STATES PATENT OFFICE

LEWIS H. JOHNSON, OF MADISON, NEW JERSEY, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

TELEPHONE SYSTEM

Application filed January 17, 1928. Serial No. 247,275.

This invention relates to telephone systems and particularly to systems in which substation meters are operated under control of mechanism at the central office.

Its objects are to safeguard the subscriber against overcharges and to simplify and improve the equipment used at the central office for controlling the substation meters.

In the past systems have been proposed for operating a substation register by periodically reversing the current in the subscriber's line during conversation. In these systems, the endeavor to reduce as much as possible the disturbance in the subscriber's line due to current changes has led to the use of complicated and expensive devices for making the reversals.

According to the present invention an advantage is secured over these prior systems by the provision of a simple and efficient current reversing mechanism comprising a current supply circuit, common to a number of connecting circuits, having a current reversing device and means for preventing sudden changes in the current including choke coils in series with the supply circuit and a shunt condenser. The common circuit is normally disconnected from the connecting circuits and is associated with any desired one of said circuits by an individual connecting relay controlled by the called supervisory relay.

A feature of the invention is an arrangement in which a delay is introduced between the time when the supervisory relay operates and the time when the register operating device commences to function. This delay prevents false charging due to momentary interruptions of the circuit.

Another feature is a system in which the calling party may recall the operator before the called party has released without causing the meter operating mechanism to function.

A further feature is a ringing circuit in which the direct current associated with the ringing source is prevented from flowing over the subscriber's line and causing the false operation of his meter.

Still another feature is an arrangement to prevent the connection of the current supply circuit to the calling line when the battery is in reversed condition. This avoids objectionable noise in the subscriber's receiver.

The drawing illustrates a portion of a telephone system in which subscribers' lines appear at an operator's position. Two of these lines, A and B, are shown terminating in jacks 3 and 5 respectively at the operator's position. The lines A and B are equipped respectively with substation meters 1 and 2. These meters are designed to operate at successive intervals during conversation in response to repeated reversals of current in the line.

The operator's position is equipped with a number of cord circuits such as the cord C partly shown in detail in the drawing. A current supply and reversing circuit 23 is provided in common to a number of cord circuits C. This supply circuit consists of battery 24, a battery reversing relay 25, choke coils 27 and 28 and condenser 31. The cord circuit C is provided with two relays 32 and 33 for connecting the common supply circuit 23 to the tip and ring conductors of the cord through the winding of the repeating coil 7. Similar relays are provided for each of the cord circuits.

It is believed that an understanding of the invention will best be had from a detailed description of the operation of the system. Assume that the subscriber of line A wishes to hold conversation with the subscriber of line B. The calling subscriber initiates the call in the usual manner and the operator responds by inserting the plug 4 of an idle cord circuit C in the jack 3. When the plug is inserted in the jack a circuit is completed from battery, through the lamp 11, resistance 14, lower back contact of relay 34, sleeve of the plug 4 and jack 3 to ground. At the same time another circuit is completed from the negative pole of battery 24, through the choke coil 29, normal contacts of relay 33, lower left winding of repeating coil 7, winding of relay 8, and thence over the ring side of the subscriber's line and returning over the tip side through the upper left winding of repeating coil 7, normal contacts of relay 33,

choke coil 26 to the grounded pole of battery 24. Relay 8 operates in this circuit and completes a circuit from the interrupter 15, through the upper inner back contact of relay 16, contact of relay 8, resistances 12 and 14, back contact of relay 34 to ground at the sleeve of the jack 3. Each time the interrupter 15 closes, the supervisory lamp 11 is shunted, causing it to flash.

Next, the operator manipulates her talking key 10 to connect her telephone set to the cord circuit and converses with the calling subscriber. The depression of the talking key 10 completes a circuit from battery, through the lower winding of relay 16, inner contact of relay 35, contacts of key 10 to ground in the operator's telephone circuit. Relay 16 operates in this circuit and completes a holding circuit from ground, through its upper winding and contact, contact of the supervisory relay 8 to battery through the upper contact of relay 16. The relay 16 in operating disconnects the interrupter 15 to discontinue the flashing of the lamp 11. The lamp is now continuously shunted by the circuit through the upper winding and contact of relay 16 and contact of the supervisory relay 8. Relay 16 also closes a circuit from battery, through its lower winding and contact, winding of relay 35 to ground at the upper contact of relay 34. While the operator's talking key 10 remains depressed, however, relay 35 is shunted and does not operate.

The operator, having obtained the number of the called line, releases the talking key 10, seizes the plug 6 and inserts it in the jack 5 of the called line B. The release of the key 10 removes the shunt and permits relay 35 to operate in series with the lower winding of relay 16. The insertion of the plug 6 in jack 5 results in the closure of a circuit from battery, through the lamp 45, resistance 46 to ground through the sleeve of plug 6 and jack 5. Lamp 45 lights in this circuit.

The operator now proceeds to apply ringing current to the called line to signal the wanted subscriber. For this purpose her cord circuit is equipped with ringing keys 36, 37, 38 and 39 which serve to apply ringing current from the sources 47 and 48 either to one side of the line or the other according to the character of the called line. The sources 47 and 48 may supply any well-known type of ringing current, such as alternating current superimposed on direct current. Assume that the key 37 is the one used for signaling the wanted subscriber on line B. The operator manipulates this key and a circuit is closed from the ringing source 47, through the marginal relay 42, contact of said relay, left contact of relay 44, upper alternate contact of key 37, through the normal contacts of keys 38 and 39, tip of the plug 6 and the jack 5, thence over the subscriber's line to the bell at the substation and returning over the ring side of the line through the normal contacts of keys 39 and 38, alternate contact of key 37 to ground. The relay 42 being marginal does not operate until the called subscriber answers. The ringing current causes the operation of the subscriber's bell and, when he answers, the resistance of the loop is sufficiently decreased to permit the operation of relay 42. Relay 42 at its contact opens the direct current path so that direct current from the source 47 cannot continue to flow over the subscriber's loop in case the operator holds the ringing key depressed after the called subscriber has answered. The alternating ringing current, however, continues to flow through the winding of relay 42, condenser 49, winding of relay 40 and thence over the circuit previously traced if the key is held depressed. Relay 40 operates due to this current and closes an obvious circuit for relay 44. Relay 44 opens the original direct current circuit so that in the event of relay 42 releasing, this circuit is not completed to permit the flow of direct current over the called subscriber's loop. This arrangement eliminates the danger of falsely operating the subscriber's meter 2 which is designed to respond to direct current only.

When the called subscriber answers, a circuit is completed from the free pole of battery 24, choke coil 29, lower right winding of repeating coil 7, supervisory relay 9, through the normal contacts of the ringing keys, thence over the loop of the subscriber's line and returning through the ringing keys, upper right winding of coil 7, choke coil 26 to the grounded pole of battery 24. Relay 9 operates in this circuit and closes a circuit from battery, through its contacts, upper front contact of relay 35, winding of relay 32 to ground. Relay 32 closes a circuit from battery, through its inner lower contact, front contacts of relay 35, resistance 50, resistance 46 to ground at the sleeve of jack 5. This circuit shunts the lamp 45 which becomes extinguished.

The operation of relay 32 renders the interrupter 17 effective to bring about the connection of the battery supply circuit 23 to the calling subscriber's line. The interrupter 17 through its segment 18 causes the repeated operation and release of the battery reversing relay 25. Accordingly, the battery 24 may be in reversed or its non-reversed condition when the called subscriber answers and relay 32 operates. If the battery is in its non-reversed condition it is proper to connect the supply circuit 23 to the calling line immediately. If, however, the battery is reversed the supply circuit should not be connected to the calling line. To do so would bring about an abrupt reversal of current from the line producing a disagreeable noise in the calling subscriber's circuit. Assume first that the battery 24 is

in its normal condition in which case the relay 25 is deenergized as shown. Relay 32 in operating, therefore, closes a circuit from ground through its inner upper contact, winding of relay 33, lower normal contacts of relay 33, resistance 22, through the segments 20 and 19 to battery. Relay 33 operates at once and in so doing connects the supply circuit 23 through the left winding of repeating coil 7 to the calling subscriber's line. A circuit may now be traced from free pole of battery 24, lower back contact of relay 25, choke coil 28, lower contact of relay 32, inner lower contact of relay 33, lower left winding of coil 7, and thence over the subscriber's line and returning through the upper left winding of coil 7, upper contact of relay 33, upper contact of relay 32, choke coil 27, upper back contact of relay 25 to the grounded pole of battery 24. It will be seen that the direction of current flow over the subscriber's line in this case is the same as it was before the supply circuit 23 was connected thereto.

Relay 33 in operating locks in a circuit from battery, through its lower front contacts, winding of said relay to ground at the contact of relay 32. As the interrupter 17 continues its rotation the relay 25 is alternately operated and released at periodic intervals. During each operation and release of relay 25, the current in the calling line is reversed to cause the operation of the substation meter 1.

Assume next that the battery 24 is in its reversed condition at the time the called subscriber answers. Relay 32 in operating now completes a circuit from ground through the winding of relay 33, lower normal contacts of relay 33, resistance 22, through the segments 20 and 21 to ground. Therefore, the relay 33 does not operate and the connection of the supply circuit 23 to the calling line is delayed. When, later, the segment 20 shifts, the circuit above traced is completed from battery, through the relay 33 to ground and relay 33 operates to connect the supply circuit to the calling line.

After the operator answers the calling subscriber, if she finds the called line busy, it is common practice to insert the plug 6 in the jack of a busy-back circuit. The busy-back apparatus operates in the well-known manner to cause the repeated and rapid opening and closing of the cord circuit. This causes the repeated operation of relay 9 and relay 32. Should the relay 32 be permitted to release just before the battery 24 is reversed and to actuate just after reversal, the calling subscriber will be assessed with a false charge. To prevent this an interval of about two seconds is introduced before the battery 24 is reversed. During this interval if the relay 33 is released due to the busy-back apparatus or due to the called subscriber flashing his switchhook, it will not reoperate to cause a false charge when the battery 24 is reversed subsequently. This is due to the manner in which the segment 20 is cut as will be clear from an inspection of the drawing. Thus, it will be seen that the calling subscriber is guarded against false operation of his meter. If a short interruption occurs in the cord circuit or in the called line within the two second interval prior to the reversal of current, the supply circuit 23 is disconnected from the calling line, but is not reconnected thereto until a complete charge interval has expired.

At the end of conversation the subscribers replace their receivers on the switchhooks. When the called subscriber hangs up his receiver, relay 9 releases, causing the release of relay 32 which in turn releases the relay 33, disconnecting the reversing circuit from the calling line. If the calling subscriber first hangs up his receiver his line is opened at the switchhook contacts to render the meter operating circuit ineffective. The calling subscriber by hanging up his receiver also causes the release of relay 8, which opens the holding circuit through the upper winding of relay 16. The energization of the lower winding of relay 16 is not sufficient to hold the relay operated. Accordingly, this relay releases, in turn releasing the relay 35. The lamp 11 illuminates to advise the operator that the calling subscriber has replaced his receiver. The lamp 45 also lights in an obvious circuit and the operator takes down the connection by removing the plugs from the jacks.

It may happen that the calling subscriber wishes to recall the operator after completing his conversation with the called party. Since he should be entitled to make a recall without charge, provision is made to prevent the operation of his meter in case the called subscriber has not replaced his receiver on the switchhook. So long as the called subscriber keeps his receiver off the switchhook and until the operator withdraws the plug, the relay 9 remains operated and if relay 35 is permitted to reoperate the charging mechanism will be connected to the calling subscribers line.

The calling subscriber on replacing his receiver temporarily and then removing it to initiate the recall releases the relay 8 as explained, resulting in the release of relay 16. The subsequent removal of the receiver permits relay 8 to reoperate and the lamp 11 is flashed as previously described. The operator, seeing the lamp 11 flashing, knows that the calling subscriber is recalling and before taking down the connection she answers him again to ascertain what he desires. In depressing the key 10 the circuit previously traced is closed through the lower winding of relay 16 and the back contact of relay

35. Relay 16 reoperates and discontinues the flashing of the lamp 11. While the operator is conversing with the calling subscriber the key 10 is depressed and relay 35 is shunted so that it does not operate in series with relay 16. So long as relay 35 remains de-energized the circuit for relay 32 is held open and the charging mechanism cannot be connected to the calling line. Therefore, the calling subscriber may recall the operator without causing the operation of his meter 1.

If the called subscriber wishes to converse again with the called party, the operator disconnects her headset and in so doing renders the charging mechanism effective. If the called subscriber has released in the meantime, she recalls him by applying ringing current to the line in the manner described. If, on the other hand, the calling subscriber wishes to converse with another subscriber the proper connection is established.

Although the invention has been illustrated as applied to a system of the manual type it will be understood that it is also applicable to automatic systems. It will be further understood that numerous changes and alterations may be made in the circuits and apparatus illustrated without departing from the spirit of the invention.

The substation meter illustrated diagrammatically may be of any suitable type such as that shown and described in the patent to Thomson No. 1,121,953, dated December 22, 1914.

What I claim is:

1. In a telephone system, a subscriber's line, a counting device for said line, connecting circuits for establishing talking connections with said line, a source of current, a supply circuit common to the connecting circuits for feeding current from said source to said connecting circuits, means responsive to the establishment of a talking connection over one of the connecting circuits for connecting the supply circuit to such connecting circuit, means repeatedly reversing the direction of current flow in the supply circuit, and means responsive to such reversals during the conversational period for operating said counting device.

2. In a telephone system, a calling line and a called line, a meter for the calling line, connecting circuits for establishing talking connections between said lines, a source of current, a supply circuit common to the connecting circuits for feeding current from said source to the calling line, means rendered effective by the response of the called subscriber for connecting the supply circuit to the particular connecting circuit used for the talking connection, means for repeatedly reversing the direction of currernt flow in the supply circuit, and means responsive to such reversals for opertaing said meter.

3. In a telephone system, a subscriber's line, a meter for said line, connecting circuits for establishing talking connections with said line, a source of current, a supply circuit common to said connecting circuits for feeding current from said source to said connecting circuits, relays, one for each connecting circuit, means responsive to the establishment of a talking connection over one of said connecting circuits for operating the individual relay to connect the supply circuit to such connecting circuit, means for periodically reversing the direction of current flowing in the supply circuit, and means responsive to such reversals for operating the subscriber's meter.

4. In combination, a subscriber's line having a meter at the sub-station, connecting circuits for establishing talking connections with said line, a source of current, a supply circuit common to said connecting circuits for feeding current from said source to said connecting circuits, said supply circuit being normally disconnected from said connecting circuits, means responsive to the establishment of a talking connection over one of the connecting circuits for connecting the supply circuit thereto, time controlled means for periodically reversing the direction of current flow in the supply circuit and in the subscriber's line, and means responsive to such current reversals in the subscriber's line for operating said meter.

5. In combination, a subscriber's line, a recording device for said line, a number of connecting circuits for establishing talking connections with said line, a source of current, a battery feed circuit for supplying current to said connecting circuits, means effective in response to the establishment of a talking connection over one of said connecting circuits for connecting the battery feed circuit to said connecting circuit, means for repeatedly reversing the direction of current flow in the battery feed circuit to operate said recording device, and means in the battery feed circuit for preventing sudden changes of current.

6. In a telephone system, a subscriber's line, a meter for said line, connecting circuits for establishing talking connections with said line, a source of current, a supply circuit common to the connecting circuits for feeding current from said source to said connecting circuits, means for repeatedly reversing the direction of current flow in the supply circuit to operate said meter, and impedance elements in the supply circuit for preventing sudden changes of current.

7. In combination, a subscriber's line, a meter for said line, connecting circuits for establishing conversational connections with said line, a source of current, a supply circuit common to said connecting circuits for feeding current from said source to said connecting circuits, means for connecting said supply circuit to any one of said connecting circuits,

means for periodically reversing the direction of current flowing in the supply circuit to operate said meter, and inductance and capacity elements in said supply circuit for preventing sudden changes of current due to reversal of direction.

8. In a telephone system, a subscriber's line, a meter at the substation, connecting circuits for establishing talking connections with said line, a source of current and a supply circuit common to said connecting circuits, relays, one for each connecting circuit for connecting said supply circuit to said connecting circuit, and means for periodically reversing the direction of current flowing in the supply circuit to operate said meter.

9. In combination, a subscriber's line, a meter for said line, connecting circuits for establishing talking connection with said line, repeating coils one for each of said connecting circuits, a source of current, a supply circuit common to said connecting circuits, relays, one for each connecting circuit for connecting said supply circuit through the windings of the repeating coil to the corresponding connecting circuit, means responsive to the establishment of a talking connection over one of said connecting circuits for operating the corresponding relay, and means for periodically reversing the direction of current flowing in the supply circuit and subscriber's line to operate said meter.

10. In a telephone system, a calling subscriber's line and a measuring device therefor, a called subscriber's line, means for establishing a connection between said lines, a current controlling device for repeatedly changing the current in the calling line to actuate said measuring device, time delay means rendered operative by the response of the called party, and means controlled by said delay means for rendering effective said current controlling device.

11. In a telephone system, a calling subscriber's line and a meter therefor, a called subscriber's line, means for establishing a connection between said lines, a current reversing device for repeatedly reversing the direction of current in the calling line to actuate said meter, and timing means rendered operative by the response of the called party and serving after an interval to render said current reversing device effective.

12. The combination in a telephone system of a calling line and a called line, a meter at the calling substation, means for interconnecting said lines for conversation, a device for periodically reversing the direction of current in the calling line to operate said meter during conversation, means controlled by the response of the called party for rendering said reversing device effective, and means for causing a delay between the response of the called party and the time when said device is rendered effective.

13. The combination in a telephone system of a calling line and a called line, a meter at the calling substantion, means for establishing a connection between said lines, a current controlling device for periodically changing the current in the calling line to actuate said meter, a supervisory relay operated when the called party answers, a timing device set in operation by said supervisory relay, and means controlled by said timing device for rendering effective said current controlling device.

14. In a telephone system, a calling line and a called line, means for interconnecting said lines, a message meter for the calling line, a current reversing device for repeatedly reversing the direction of current in the calling line to operate said meter, a relay for connecting said device to the calling line, a timing means controlled over the called line, and means controlled by said timing means after a definite interval for operating said relay.

15. The combination in a telephone system of a calling line and a called line, a meter at the calling substation, means for establishing a talking connection between said lines, a device for repeatedly reversing the direction of current in the calling line to operate said meter during conversation, means controlled by the response of the called party for rendering said device effective, and means for rendering said last means ineffective in order to distinguish between an original call and a recall by the calling subscriber.

16. The combination in a telephone system of a calling line and a called line, a meter at the calling substation, means for establishing a talking connection between said lines, a device for repeatedly reversing the direction of current in the calling line to operate said meter during conversation, means controlled by the response of the called party for rendering said device effective, an operator's position, and means controlled by the operator in answering a recall to prevent said last means from rendering the reversing device effective.

17. In combination, a subscriber's line having a bell and a meter at the substation, means for establishing a connection with said line, a ringing device comprising direct current and alternating current sources, means for connecting said device to the line to ring said bell, means for preventing the direct current from flowing over said line without preventing the flow of the alternating current, and means for operating said meter.

18. In a telephone system, a telephone line having a bell and a meter, means for establishing a connection with said line, a ringing device comprising direct current and alternating current sources, means for applying current from both sources to said line, means controlled over said line to disconnect the direct current source therefrom without dis-

connecting the alternating current source, and means for operating said meter.

19. In a telephone system, a subscriber's line, a meter for said line, connecting circuits for establishing talking connections with said line, a source of current, a supply circuit common to the connecting circuits for feeding current from said source to said connecting circuits, means responsive to the establishment of a talking connection over one of the connecting circuits for connecting the supply circuit to such connecting circuit, means repeatedly reversing the direction of current flow in the supply circuit, means responsive to such reversals during the conversational period for operating the subscriber's meter, and means to prevent the connection of the supply circuit to a connecting circuit while the current is reversed.

20. In combination, a telephone line, connecting circuits for establishing connections with said line, a source of current, a supply circuit for supplying current from said source to said connecting circuits, means for connecting said supply circuit to one of said connecting circuits, means for repeatedly reversing the direction of current flow in the supply circuit, and a timing device for preventing the connection of the supply circuit to a connecting circuit while the current is reversed.

In witness whereof, I hereunto subscribe my name this 13th day of January, 1928.

LEWIS H. JOHNSON.